Effective Virtual Teamwork Development in Online Higher Education

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Akinul Islam Jony

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I would like to dedicate this book to my beloved parents.

Universitat Oberta de Catalunya

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Abstract

The evolution of technological advancement along with the globalized nature of today's business organization has increased the demands for virtual teams and teamwork. Nowadays, virtual teamwork is considered one of the building blocks for a successful organization, and hence, employers are increasingly including virtual teamwork in their business process, or thinking of implementing in foreseeable future. Besides, employers are also asking frequently for virtual teamwork skills in the graduate's job advertisements. As a consequence, it has resulted in the emergence and importance of implementing and exercising virtual teamwork in higher education so that future graduates can be prepared with the necessary knowledge and skills in virtual teamwork for getting success in their foreseeable professional career. This is particularly more important for online higher education where everything is online and thus conducting teamwork virtually is the only option. Also, it is believed that higher education is the medium that provides the necessary foundation for graduates in their future occupational life. However, the key factors that affect the effectiveness of virtual teamwork development in online higher education are still unexplored.

Therefore, the purpose of this research study is to investigate the key factors that boost the effectiveness of virtual teamwork and propose a conceptual model for developing virtual teamwork in online higher education. Key factors for developing the conceptual model has been derived based on the analysis of the existing literature. Then, the proposed model has been evaluated through an empirical study where data is collected from real teamwork of university-level students conducted virtually. The collected data is analysed by applying the partial least squares structural equation modeling (PLS-SEM) second-generation statistical technique (which is considered as one of the essential tools for developing theories in exploratory research like this one) to validate the model and prove its statistical significance.

The in-depth evaluation of the model has shown that the proposed conceptual model is statistically significant and has a significant positive impact on the effectiveness of virtual teamwork in online higher education. Hence, it is believed that the application of the model would be useful for promoting, building, and enhancing the virtual teamwork skills of future graduates from online higher education, which eventually enable them to be succeeded in their professional career. Besides, the outcome of the research study can be useful for both students and practitioners. Moreover, managerial personnel of any business organization or company can also be benefited from the findings of this research for better managing the virtual teams. In general, the model can be used as a strategic tool in different stages of virtual teams and teamwork.

Keywords: Virtual Teams, Teamwork, Higher Education, Key Factors, Effectiveness Criteria.

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Research Introduction & Review

Chapter 1

Introduction

1.1 Chapter Overview

This chapter presents the research introduction of the thesis. Specifically, it presents the research motivation, discusses the research background, explains the research problem statements, specifies the research objectives, addresses the research question, illustrates the research outcomes, and finally outlines the structure of the thesis.

1.2 Motivation

The rapid development of information and communication technology and the increasing demands for the globalization of business have changed the business policy, process, and structure of organizations or institutions (Cascio, 1995; Parker, Wall, & Cordery, 2001). As a consequence, traditional face-to-face teamwork is not compatible with a globalized working place or environment. Besides, the globalized nature of today's world along with the evolution of technological growth makes virtual teamwork as one of the successful building blocks or business processes for any organization, or company, or institutions (Powell, Piccoli, & Ives, 2004).

In virtual teamwork, team members are geographically scattered all over the world, where a traditional face-to-face meeting or discussion is no longer required (Hahm, 2017). Thus, virtual teamwork comes with many benefits for both employers and employees. For example, employers can recruit experts in their virtual teams from all over world based on their needs, whereas, employees can have more flexibility to balance their jobs and personal lives which improves their job satisfaction and makes them more efficient and productive (Maruping & Agarwal, 2004). Also, it provides significant benefits to (globalized) business organizations or companies in terms of flexibility and responsiveness (Powell et al., 2004), minimizing travel expenses and accommodation costs (Duarte & Snyder, 2006; Geber, 2008; Gordon & Curlee, 2011), and so on. Therefore, virtual teamwork becomes extremely important and significant in today's globalized business process and environment (Anantatmula & Thomas, 2010; Hertel, Geister, & Konradt, 2005; Kirkman, Rosen, Tesluk, & Gibson, 2004; Ludden & Ledwith, 2014).

As a consequence, virtual teamwork is increasingly being implemented by the employers in their business organization, or the employers are planning to facilitate virtual teamwork in their business organization in foreseeable future (Lipnack & Stamps, 1997; McDonough, Kahn, & Barczak, 2001). That's why, employers are continuously giving emphasize on the importance and development, or having of virtual teamwork skills in employees for success in a professional career in a globalized business organization (Riebe, Girardi, & Whitsed, 2017).

By considering these facts, the online higher education should value the importance of developing virtual teamwork skills, and take initiative to include virtual teamwork activity in the learning process so that the future graduates can achieve the required skills, ability, and knowledge on virtual teamwork before starting their professional career. In this process, graduates from higher education will be able to achieve early success in their careers, and to become assets for their employers. Since, it is believed that among the many, one of the purposes of higher education is to prepare and produce future graduates with required skills, knowledge, and ability which are essential for their career development, and to become successful in their professional field in foreseeable future (Lau, Kwong, Chong, & Wong, 2014).

Moreover, nowadays, virtual teamwork is considered as one of the most demanding job skills in the recruitment process and frequently mentioned in the graduate job advertisements as a job requirement (Bennett, 2002), which rationale the importance of including teamwork activity and developing teamwork skills in the context of online higher education.

Considering the growing demands on virtual teamwork activity, an effective virtual teamwork development has become essential in online higher education so that graduates can achieve the required skills, ability, and knowledge regarding virtual teamwork before going to their occupational field, where teamwork is considered as one of the tops most demanding skills in the recruitment process.

1.3 Background

Teamwork refers to a team-wise activity (Lundy, 1994) where two or more students formally working together with the distinct responsibility to perform individually and meet together over time to time for achieving a common goal. There is a complete version of the definition from Salas, Dickinson, Converse, and Tannenbaum (1992) that defined teamwork as the process where team members work together with available resources and performed assigned tasks by interacting with each other towards achieving a common goal within an organizational context.

This research focuses on virtual teams and teamwork in online higher education however many uses the term group and group work as well. However, there are significant differences between them. For example, Katzenbach and Smith (2005) defined a team as,

> A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually account-

able.

From this definition, a common purpose or goal, and interdependence among the members are the two criteria for team building, whereas, a group focuses only on individual work product (Katzenbach & Smith, 2005). Besides, the group is a subset of people having similar characteristics or attributes, interests, or culture, whereas, in teams, members work interdependently to complete a project which is driven by a common goal (Kirby, 2011). So, all groups are not teams (Katzenbach & Smith, 2005; Riebe et al., 2017). These differences are important because, in working place, team member's attitude is different from the group member's attitude (Woods, 1994). However, this thesis has considered team and teamwork terms only which means the ability to work effectively with others to achieve a common goal. The reason is that in the virtual environment team members are geographically scattered and work independently on his part of the work to achieve a common goal of the team by combining the individual inputs effectively. Also, these characteristics are more common in the professional field while organizing virtual teamwork in a globalized business organization.

However, in higher education, teamwork is mostly facilitated in face-to-face settings than in the virtual context. Learning outcomes of students in teamwork from both face-to-face settings and virtual context can be used to outline the gaps between these two versions of teamwork. Besides, by identifying which factors of teamwork mostly enhanced the effectiveness in virtual teamwork, can be used to make virtual teamwork as competitive as traditional face-to-face teamwork or even more. Also, the key criteria of teamwork are seen as the major factors for achieving effectiveness in teamwork (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995). It means the knowledge, ability, or skill each individual has to have to successfully act in teamwork (Baker, Horvarth, Campion, Offermann, & Salas, 2005), which includes motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance (theses key factors are considered for this research study of the thesis).

But key factors that affect the effectiveness of virtual teamwork (Anantatmula & Thomas, 2010) are not successfully explored yet in the context of online higher education. Therefore, a much more in-depth research is needed to identify the key factors that could influence the effectiveness of virtual teamwork (Anantatmula & Thomas, 2010; Idrus, Sodangi, & Husin, 2011; Nader, Shamsuddin, & Zahari, 2009; El-Tayeh, Gil, & Freeman, 2008), and the relationships between the key factors in order propose and develop a conceptual framework for effective virtual teamwork development in the context of online higher education.

1.4 Research Problem Statements

This research work is about the development of effective virtual teamwork in online higher education by identifying the key factors which impact the effectiveness of virtual teamwork, the relationships among the key factors, and then eventually developing a conceptual model. The *effectiveness* term in this thesis is related to the performance of virtual teamwork.

Teamwork is a team-wise activity (Lundy, 1994) and a team is consists of two or more team members. In teamwork, each team member performs a distinct responsibility to collectively achieve a common goal. When teamwork is organized and developed in a virtual environment with the help of various ICT tools, is called virtual teamwork. In virtual teamwork, team members meet together virtually over time to time for achieving the team's goal.

Nowadays, virtual teamwork becomes a common practice in working organization because of the rapid growth of technology and globalization of business and made virtual teamwork more demanding in an occupational field (Anantatmula & Thomas, 2010; Hertel et al., 2005; Kirkman et al., 2004; Ludden & Ledwith, 2014). Besides, the employer advertises teamwork skills in the job circular as well as looks for teamwork skills among candidates with high importance in their employee recruiting process (Bennett, 2002). These circumstances emphasize the building of teamwork skills among students in online higher education. It is believed that good teamwork skills give the advantage to pursue one's career development and therefore, higher education should equip students with teamwork skills. The purpose of higher education is not only to produce graduates but also prepared them with required skills, ability, and knowledge for their future professional life so that they could become successful in their working place and make themselves a valuable asset for their employer (Lau et al., 2014). Besides, higher education should be a suitable environment to develop students' teamwork skills because group activities are one of the commonly used activities in teaching and learning.

Thus, online higher education should facilitate virtual teamwork activity in the curriculum so that graduates have hands-on practice on virtual teamwork for obtaining the required knowledge, skills, and ability on it before start their professional career. However, research suggests that there still need a complete guideline or a model for developing effective virtual teamwork in online higher education.

Towards developing an effective virtual teamwork model, it is necessary to identify the key factors that affect the effectiveness of virtual teamwork in online higher education which is still unexplored (Anantatmula & Thomas, 2010). The existing literature mentioned several models or research works on teamwork' effectiveness but there still has a big gap concerning virtual teamwork (Salas, Cooke, & Rosen, 2008). For example, a study by Salas, Rosen, Burke, Nicholson, and Howse (2007) mentioned different models that studied the performance of teamwork. But still, there has a limitation on the exploration of key factors that foster or influence the effectiveness (i.e. performance) of virtual teamwork (Ebrahim, Ahmed, & Taha, 2009a). That's why, Nader et al. (2009) suggested the necessity of identifying the key factors for effective virtual teamwork development, which will eventually be used for the construction of the conceptual model or framework of this study.

Therefore, profound research needs to be carried out on virtual teamwork to identify its key factors that affect the effectiveness of virtual teamwork (Anantatmula & Thomas, 2010; Idrus et al., 2011; Nader et al., 2009; El-Tayeh et al., 2008) in the context of online higher education.

Hence, this research addresses the importance and necessity of proposing a conceptual framework or model for effective virtual teamwork development in online higher education, in which the main problem is to identify the key factors (that affect the effectiveness of virtual teamwork) and the relationships between the key factors that constitute the proposed conceptual model.

1.5 Research Goals & Objectives

Having discussed the motivation and problem statement of the research, the main objective of this thesis is as follows.

> **Main Research Goal:**
> To propose a conceptual model for effective virtual teamwork development in online higher education.

Additionally, along with the main purpose of the research study, the other objectives and goals of the thesis are mentioned below. To ease of explaining and better orientation, the main objective is also further broken down into several objectives and presented below together with others.

- To focus on the importance of virtual teamwork skills in online higher education.
- To understand the learning outcomes of virtual teamwork in online higher education.
- To focus on the development of effective virtual teamwork in online higher education.
- To emphasize on the preparation for future graduates from online higher education on virtual teamwork skills.

- To promote or building essential teamwork skills among students through online higher education.
- To make virtual teamwork as effective as in face-to-face traditional teamwork.
- To identify the key factors that foster the effectiveness of virtual teamwork in online higher education.
- To identify the relationships between the key factors that constitute the proposed conceptual model for effective virtual teamwork development in online higher education.
- To facilitate better management and evaluation of virtual teamwork by the teachers in online higher education.
- To facilitate as a guideline for the teachers in online higher education to enhance the level of performance of students in virtual teamwork.
- To develop a framework for building skilled graduates on virtual teamwork so that they can avail early success in their career and make themselves as essential assets to their employers.

In a summary, the purpose of this research study is to investigate key factors (that affect the effectiveness of virtual teamwork) and the relationships between the key factors in order to propose a conceptual model for effective virtual teamwork development in the context of online higher education. The proposed conceptual model is then will be validated through a survey of virtual teams of university-level students. This proposed conceptual framework of virtual teamwork is targeted for implementing in online higher education so that the graduates can have the opportunity to achieve the required skills, knowledge, ability to be succeeded in virtual teamwork before going to their occupational field, which eventually helps them to avail early success in their career and make themselves essential assets for their employer.

1.6 Research Questions

Having presented the problem statements, and goals and objectives of the research, the main research question for this research work of the thesis is as follows.

> **Main Research Question:**
> What are the key factors that affect the effectiveness of virtual teamwork in online higher education?

Some sub-questions to support the main research question are given below.

- What are the relationships between the key factors that constitute the proposed conceptual model for effective virtual teamwork development in online higher education?
- How to evaluate the effectiveness of virtual teamwork in the context of online higher education?
- Who or what benefits from using the conceptual model for effective virtual teamwork?

This research work will investigate this main research question along with these supporting sub-questions of the main research question for developing a comprehensive conceptual model or framework which eventually will facilitate an effective virtual teamwork development in the context of online higher education. Not only that, any globalized business organization or company can also be benefited from this proposed conceptual framework for better managing, organizing, and evaluating their virtual teams and teamwork.

1.7 Research Outcomes

The research work of the thesis will identify the key factors (that affect the effectiveness of virtual teamwork), and the relationships between the identified key factors in order to develop and propose a complete framework or model for effective virtual teamwork development in the context of online higher education. As a consequence, the outcomes of this research can be used to implement virtual teamwork effectively in online higher education. The successful implementation of this research in higher education can enable students to learn the necessary skills, ability, and knowledge on virtual teamwork which eventually will help them in their professional careers to achieve early success and make themselves become assets for their employer. Also, a teacher can use the knowledge of the model for managing and evaluating virtual teams of students in online higher education.

Besides, top managerial personnel of any globalized business organization or company can also be benefited from the virtual teamwork model of this study for managing, organizing, and evaluating their virtual teams effectively. That means, it can be used as a strategic tool in different stages of projects such as development, management, and evaluation which involves virtual teams.

In a nutshell, a major contribution of the research study is the model of key factors that contributes to virtual team effectiveness, and it can be used and useful for both students and practitioners.

1.8 Structure of the Doctoral Thesis

This chapter has just presented the research introduction of the thesis. The rest of the thesis is structure as follows.

Chapter 2: Systematic Review
It contains a systematic review of the research subject of the thesis to illustrate the necessity and importance of exploring the research and to synthesize and summarize the information about the research.

Chapter 3: Theory & Literature Review
It contains a detailed description and review of the theory and existing literature related to the research subject of the thesis.

Chapter 4: Research Process & Approaches
It contains a detailed description of the research methodology used in this thesis. It also presents the design of the research process of the thesis.

Chapter 5: PLS-SEM Statistical Technique
It contains a discussion about the PLS-SEM technique which will be applied in this research as a statistical tool for testing the statistical significance of the proposed conceptual model. Specifically, this chapter justifies why PLS-SEM is chosen and how it is applied in this research study.

Chapter 6: Conceptual Model
It contains a detailed description of the proposed conceptual model development of this research work. It covers the structural model of the PLS path modeling of this research work.

Chapter 7: Measurement Model
It contains a detailed description of the measurement model development of the research work which will be used to measure the latent variables of the proposed conceptual model. It covers the measurement model of the PLS path modeling of this research work.

Chapter 8: Data Collection & Examination
It contains a detailed description of the dataset used for the model estimation of this thesis. In particular, it discusses the data collection procedure and different aspects of the dataset.

Chapter 9: Model Estimation
It contains a detailed evaluation of the model for effective virtual teamwork development in online higher education by using the PLS-SEM technique for testing the model's statistical significance. Specifically, it contains the assessment of both the structural model and measurement model. Finally, it presents an assessment of the model fit.

Chapter 10: Discussion & Conclusion
It contains a detailed discussion about the findings of the research study. It also addresses the limitations and future recommendations of the study. Finally, it concludes the research work of this thesis.

Bibliography
It contains a list of bibliography used for the research work of this thesis.

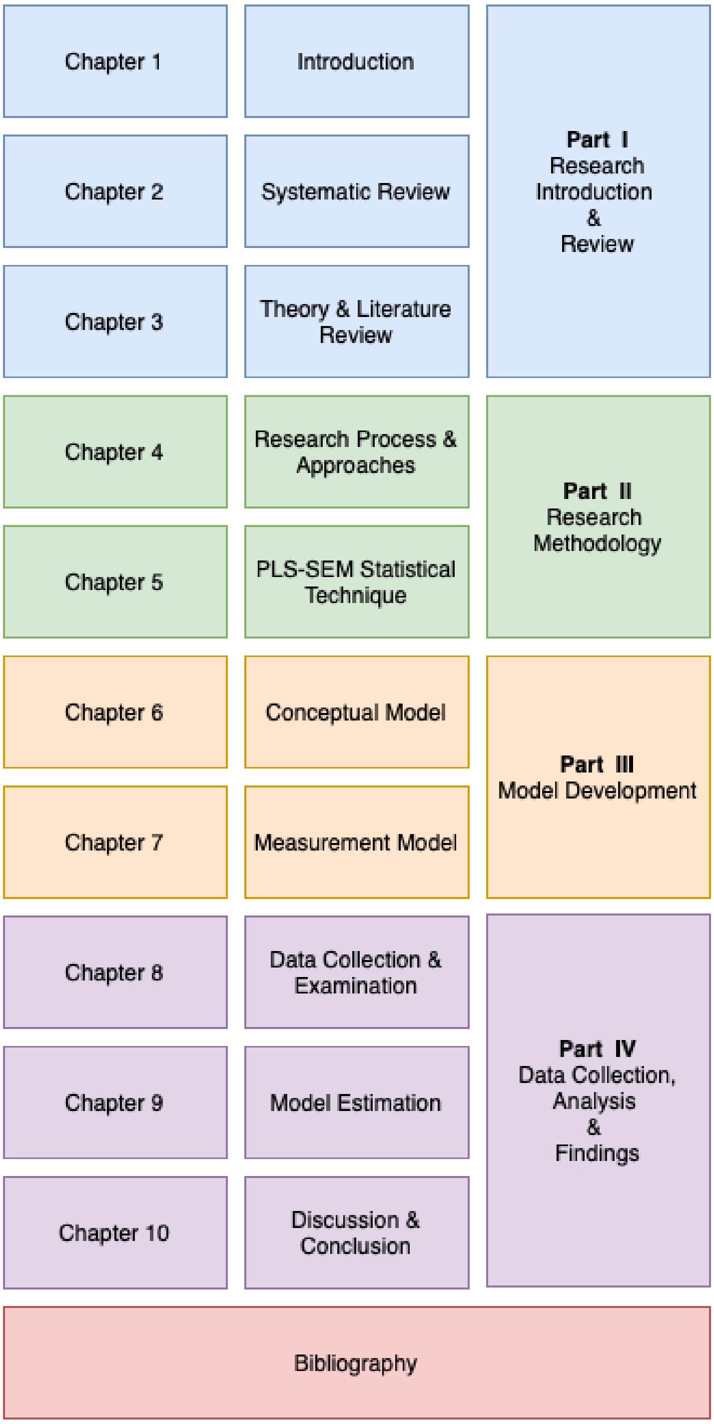
The complete roadmap (i.e. structure) of the doctoral thesis is depicted in figure 1.1 to ease of visualization.

1.9 Summary

This chapter has placed the study into perspective by providing the motivation and background of the study. It has explained the problem statements of the study to highlights the necessity of exploring virtual teamwork in the context of online higher education. As a consequence, it has set out the main purpose of the study to propose a conceptual model for effective virtual teamwork development in online higher education.

Having presented the problem statements and goals of the research it addresses the main research question to investigate the key factors that effectiveness of virtual teamwork in online higher education. After that, it has discussed the outcomes of the research work of this thesis. Finally, the structure of the doctoral thesis is presented with a brief outline of each chapter.

Figure 1.1: Structure of the Doctoral Thesis



Chapter 2

Systematic Review

Chapter Preface

The content of this chapter is already published as an article in the *EDULEARN19* Proceedings. The author and supervisor of the article is the same as the author and supervisor of this thesis. Full citation of the article is mentioned below:

> Jony, A. I., & Serradell-López, E. (2019). Effective virtual teamwork developement in higher education: A systematic literature review. In *Edulearn19 proceedings* (pp. 873–882). 11th International Conference on Education and New Learning Technologies. doi:10.21125/edulearn.2019.0285

2.1 Chapter Overview

This chapter presents a systematic literature review on the research subject of this thesis. The purpose of this review is to illustrate the necessity and importance of exploring this research subject and to synthesize and summarize information about the research subject.

2.2 Introduction

The importance and necessity of developing effective virtual teamwork in online higher education drives to conduct a systematic literature review according to the state-of-the-knowledge on the research subject of this thesis to find the research gaps in the context of the effective virtual teamwork development in online higher education. The specific attention of this systematic review is on the education domain because of the interest and scope of the research subject, and the intention of synthesizing and summarizing information, particularly from the existing literature in the domain of university-level education towards developing effective virtual teamwork in online higher education.

After the compilation of the articles through the systematic review, there was no research study found which particularly performed a similar study on the research topic of this thesis. However, some articles only discussed the necessity, or importance of integrating virtual teamwork activity in higher education (e.g. Davidekova and Gregus, 2017). Besides, few articles discussed the individual factor for developing virtual teamwork (e.g. Coronas, Oliva, Luna, and Palma, 2015; Laifa, Giglou, Akhrouf, and Maamri, 2015; Topchyan, 2016, and few of them discussed the impact of leadership or leadership characteristics on virtual teamwork (e.g. Chang and Lee, 2013; Chen, Wu, Yang, and Tsou, 2008). But none of them discussed effective virtual teamwork development in the context of online higher education, which is the concern of this thesis work. That's why, the research study of the thesis has been convinced to perform a systematic review on this research subject to find out the existing research works and theories on that area of the research interests, and systematically analyse them.

The rest of the chapter describes the process of the systematic review and presents the analysis of the selected articles of the systematic review in the respective sections. Finally, in the end, the chapter is concluded with a summary.

2.3 The Systematic Review

A systematic review is a standard for summarizing and synthesizing the information from the existing literary works. The purpose of the systematic review is to "comprehensively locate and synthesize research that bears on a particular question, using organized, transparent, and replicable procedures at each step in the process" (Littell, Corcoran, & Pillai, 2008, p. 1). Usually, to conduct a systematic review is very common to any research area before jumping into the original research work and it is initiated by the researcher who is going to research a particular field and who needs to summarize the existing information according to the state-of-the-knowledge of the research topic and finds the research gaps if any and outlines areas for further research.

A quality systematic review paper can input significant benefits to the research area. But before conducting a systematic review, it is needed to ensure the necessity of reviewing literature systematically. Palmatier, Houston, and Hulland (2018) mentioned three standards for producing a sufficient contribution from a systematic review research paper, which are given below.

(a) The domain of the research subject has to be well suited for conducting a systematic review such that sufficient information already exists for contributing a valuable synthesis form that.

(b) The systematic review needs to be consists of a set of related literature, suitable analysis techniques, in-depth literature coverage, and a convincing writing technique.

(c) The systematic review contains a significant amount of new insights into the research subject.

A well-structured or organized review process can help to get the significant benefits from the systematic review paper. Littell et al. (2008) outlined six steps for conducting a systematic review: topic formulation, study design, sampling, data collection, data analysis, and reporting. Also, Oates (2006) organized the review process into six steps: search, acquisition, evaluation, reading, critical evaluation, and critical review which are also compatible with the review process proposed by Tranfield, Denyer, and Smart (2003). Besides, there are many more different guidelines for the systematic review process, for example, guideline by Australian National Health and Medical Research Council (2000), CRD Report (2001), and Pai, McCulloch, and Colford (2002) are few references of among them for the systematic review process.

The existing guidelines of the systematic review process have different suggestions and have a different ordering of steps or phases. However, the review process considered for conducting this systematic review can be summarized in the following 4 steps.

Step 1: Identification of resources for performing the searches on the research subject. For example, identification of database, or identification of a range of the period for searching.

Step 2: Identification of search queries for searching in the database based on the interest of the research study. In this step, all the possible alternatives need to be considered to cover the scope of the research.

Step 3: Selection of the articles based on the interest of the research subject and discard those articles which are not relevant and which are covering residual subjects.

Step 4: Analysis of the selected articles in various ways to synthesize the review. For example, analysis of the keywords from the titles and abstracts of the articles.

The detailed description of the systematic review of this chapter that is how it is carried out, and how the results are analysed are presented in section 2.4, and 2.5 respectively in a detailed and organized way.

2.4 Description of the Systematic Review

This section contains how the systematic review has been performed and what are the search queries are used to search the relevant articles from the Web of Science database. The detailed description of the initial setup and the search queries of the systematic review are presented in the respective subsections of this section.

2.4.1 Initial Setup of the Systematic Review

The initial setup of the systematic review is presented to show the details of how the search activity is carried out in the database. That is, a detailed description of the review protocol which is followed to conduct this systematic review is described in this subsection. A well-defined review protocol is necessary for a systematic review because it can reduce the possibility of researcher bias (Kitchenham, 2004).

First thing is to select the resource database for performing the search activity. In this regard, the Web of Science database is chosen for this systematic review because this is one of the most widely used and accepted databases in research, especially in the field of educational research. Not only that, but it also contains top-ranked journals and conferences which ensures the quality of the available resources.

Second thing is to define the search query for searching the database. All the possible alternatives need to be considered in defining search queries. Because it reduces the possibility of missing any relevant articles and increases the chance of covering most articles of the research subject. The detailed description of how the search queries are defined is presented in the following subsection.

Third thing is to set out the inclusion and exclusion criteria to select the articles. In this systematic review, the publication period of the articles is ranged from 1998 to 2018. However, 1998 is not set intentionally by the author of the thesis as a lower bound while performing the search. It is produced systematically on the Web of Science database while searching for the articles based on the interest of the research study.

Finally, check out the search results for the selection of relevant articles only. That means, to read out all the titles and abstracts of the results for selecting the list of relevant articles, and discards those which are not relevant and those covering residual subjects.

2.4.2 Search Queries for the Systematic Review

The searching is carried out by using the "Title" criteria on the Web of Science database. That means the keywords in the search query had to be present in the title of the literature. However, the "Topic" criteria on the Web of Science database is not included to avoid the irrelevant and duplicate articles. Also, the wildcard ∗ (asterisk) is used within the search keywords to include the different variations of the keywords because they produce quality search results and also reduce the chance of missing relevant articles. For example, to search the keyword *team*, we can use different variations of the *team* such as *teams*, *teaming*, or *teamwork* by only using the *team** in the search query.

As this systematic review is about to study effective virtual teamwork development in higher education, so initially "(virtual team∗ AND higher education)" search query is used to find the relevant literature which produced 8 articles only. So, other keywords such as *education*, *university*, and *learning* are considered to include in the search query because many authors might only use *education* or *university* or *learning* in the title of their articles and those articles might also be relevant for this research study. So, the following four search queries are used to find out the relevant articles of the research topic.

(a) (virtual team∗ AND higher education)

(b) (virtual team∗ AND universit∗)

(c) (virtual team∗ AND learn∗)

(d) (virtual team∗ AND education∗)

It is to mention that as the search query included *education* or *higher education* keywords so the search results will eventually count the *online education*, or *online higher education*. That's why to include the *online* keyword here will be redundant.

Afterwards, the search query "(virtual team∗ AND universit∗)" has found 4 articles, the search query "(virtual team∗ AND learn∗)" has found 79 articles of which excluding duplicates from the previous search results 77 is counted, and the search query "(virtual team∗ AND education∗)" has found 32 articles of which excluding duplicates from the previous search results 20 is counted.

This research focuses specifically on the higher education or university level education only to study the development of virtual teamwork because the main purpose is to find the research gap in the area such as how to make virtual teamwork effective, or how to conduct virtual teamwork successful, or what factors affect the effectiveness of virtual teamwork, or what factors foster the performance and success of virtual teamwork in higher education. This is particularly important because the graduates form higher education are going to exercise virtual teamwork activity in their professional life and nowadays in the globalized environment and nature of the business made virtual teamwork is one of the most demanding skills to the employer. So, only the education domain is considered in the search criteria to conduct the systematic review on the topic (i.e. effective virtual teamwork development in online higher education).

Besides, we also considered other keywords for searching on the Web of Science database like *development (develop∗)*, *effectiveness (effective∗)*, *performance (performance∗)*, and *success (success∗)* along with the keywords of the previously mentioned four search queries, but no new list of relevant articles was found to be included in the search results. This is because all of them are already found with the four search queries. So, it can be said that all the relevant articles have been covered with these four search queries to conduct the systematic review of this research work.

So, after combining the four search queries, 109 articles are found of which only 2 articles are from different languages that mean only 1.835% of total articles whereas English articles are 98.165% of total articles (see table 2.1). So, it is fair enough to state that excluding only these 2 articles does not hamper the quality of this systematic review.

Table 2.1: Number of articles in different languages by the search queries

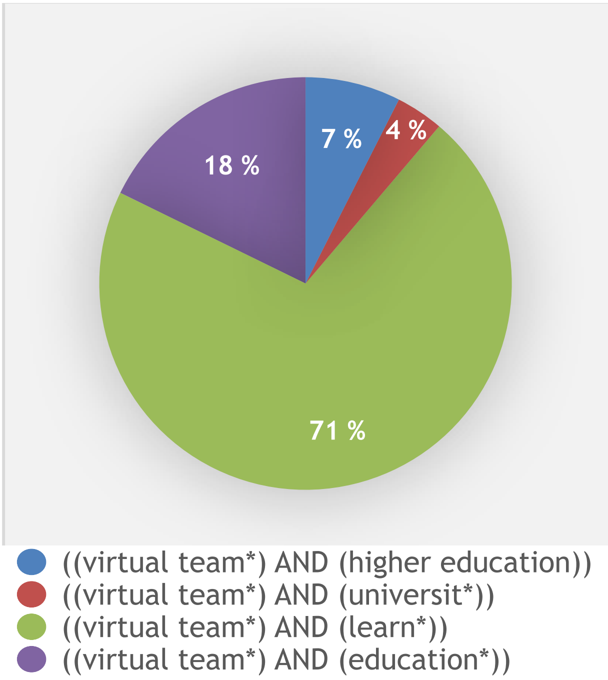
Languages of Articles	Number of Articles	Percentage of Total Articles (i.e. 109)
English	107	98.165%
Portuguese	1	0.917%
Spanish	1	0.917%
Total =	**109**	**100%**

Source: Web of Science database (2018)

Among the 107 articles (only English articles are considered in this research work), most of them are found by the "((virtual team∗) AND (learn∗))" search query, i.e. 71% of the total articles which is understandable because in comparing to the other search queries this one is wider to include most of the articles. Whereas, the next search query which produced the most articles (18%) is "((virtual team∗) AND (education∗))". The other two search queries, "((virtual team∗) AND (higher education))" and "((virtual team∗) AND (universit∗))" produced less number of articles i.e. 7% and 4% of the total articles respectively which is also understandable because these two are more specific than the others in terms of the interest of the topic. The results of these statistics are presented in figure 2.1.

Finally, the search results included in total 107 articles from the four search queries of which 68 articles have been selected after excluding duplicates and articles which are not related to the interest of the topic. Table 2.2

Figure 2.1: Percentage of number of articles by the search queries



Source: Web of Science database (2018)

listed the search queries, search results, and the number of articles selected for systematically reviewing and studying the research topic of this thesis.

In the time of searching carried out and after the searching completed, all the abstracts of the selected articles have been read out but did not find any article which specifically concentrates on the main subject area of this research study i.e. development of effective virtual teamwork in online higher education or university-level education system so that graduates could gain a good knowledge of virtual teamwork skills before going to their professional life.

2.5 Analysis of the Results

This section contains the analysis of the selected articles by the search queries in the Web of Science database. The search is conducted in 2018,

Table 2.2: Search results by the search queries

Search Queries	**Search Results**	**Number of Selected Articles**
((virtual team∗) AND (higher education))	8	6
((virtual team∗) AND (universit∗))	4	4
((virtual team∗) AND (learn∗))	76	46
((virtual team∗) AND (education∗))	19	12
Total =	**107**	**68**

Source: Web of Science database (2018)

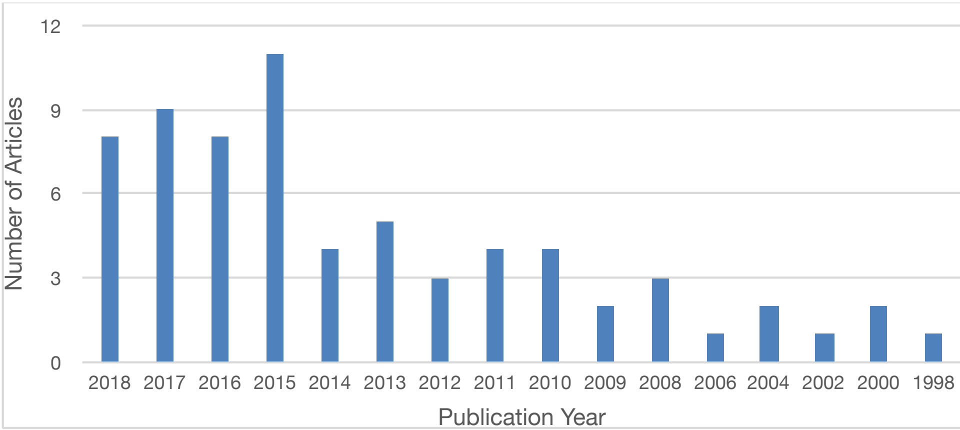
and the elaboration of the search results is based on the information of the Web of Science database.

2.5.1 Analysis of Publication Year of the Selected Articles

The study topic of this research found in the literature regularly form 2008 and the growth of publications is also significant. The interest in the subject of study has an increasing trend over the years as shown in figure 2.2, which is particularly reflected significantly in the number of publications of the last decade of the selected articles.

The point to be noted that the lower bound of the publication years in figure 2.2 is not set by the author intentionally. In the selected article list from the Web of Science database, the publication year 1998 is found as a lower bound in the search result.

Figure 2.2: Number of articles by publication year of the selected articles



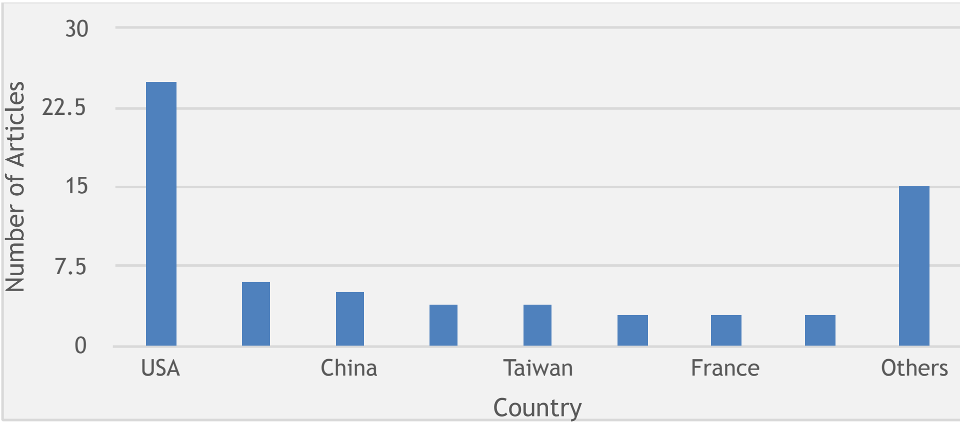
Source: Web of Science database (2018)

2.5.2 Analysis of Geographic Area of the Selected Articles

The analysis of the geographic area of the selected articles is depicted in figure 2.3 and also presented in table 2.3. The subject area of the study is mostly published and studied in the USA region which is 36.765% of the total articles. It is understandable because of the selection of only English language-based publications and the long tradition researching this particular area of the study. This particular area of research is geographically scattered in main regions of all over the world. European countries such as Spain, England, France, and the Netherlands have 23.53% of all the selected articles and Asian countries such as China and Taiwan have 13.24% of all the selected articles.

In table 2.3, the "others" category includes the countries which have 2 or less number of publications. It includes 22.058% of all the selected articles. So, it is shown that this type of research study has gained reasonable attention in almost all over the countries in the world.

Figure 2.3: Number of articles by geographic areas



Source: Web of Science database (2018)

2.5.3 Analysis of Research Area of the Selected Articles

The additional classification has been presented in this subsection based on the research areas on the Web of Science database to classify the subject of the study. This will helps to identify the focused areas of research for this research study and get an overall idea about the scope of the study. This classification can determine which research areas are more close to the subject of the study about effective virtual teamwork development in higher education.

Table 2.4 shows the number of articles in different research areas. It is needed to be mentioned that a single article can belong to more than one category of research areas, and hence the sum of total articles here in table 2.4 (i.e. 93) is more than the total number of selected articles (i.e. 68).

The statistics of table 2.4 show that most of the articles are in the research area of "Education & Educational Research" (i.e. 52.94% of the total articles) which is very logical in this context as the subject of the study mostly belongs to the education domain. Besides, this type of study is also very close to the research areas of "Computer Science", "Engineering", and

Table 2.3: Number of articles by geographic areas

Country	**Number of Articles**	**Percentage of Total Articles**
USA	25	36.765 %
Spain	6	8.824 %
China	5	7.353 %
England	4	5.882 %
Taiwan	4	5.882 %
Australia	3	4.412 %
France	3	4.412 %
Netherlands	3	4.412 %
Others	15	22.058 %
Total =	**68**	**100 %**

Source: Web of Science database (2018)

"Communication" because of its technical aspects. For example, the virtual term belongs to "Computer Science" and "Engineering", and as the medium of communication in terms of virtual teamwork is conducted through a virtual environment, it also belongs to a "Communication" research area. As a result, in this analysis of the study, 45.59% of that total number of articles are falling in these three categories (i.e. Computer Science, Engineering, and Communication) of research areas. Whereas, virtual teamwork is practically applied and exercised professionally in a Business organization. That's why this scenario is also reflected in table 2.4, that is 14.71% of total articles are falls in the category of "Business Economics" research area.

In table 2.4, the "others" category includes the research areas which have 2 or fewer publications. It includes 16.18% of all the selected articles. So, it is shown that this type of research study has gained reasonable attention

Table 2.4: Number of articles by research areas

Research Areas	**Number of Articles**	**Percentage of Total Articles**
Education & Educational Research	36	52.941 %
Computer Science	12	17.647 %
Engineering	11	16.176 %
Business Economics	10	14.706 %
Communication	8	11.765 %
Psychology	5	7.353 %
Ohters	11	16.179 %
Total =	**93**	

Source: Web of Science database (2018)

in many areas of research which is also understandable because virtual teamwork is a popular and demanding activity in today's globalized world.

2.5.4 Analysis of General Category of the Selected Articles

This subsection describes the analysis of the selected articles in terms of general categories of the Web of Science database while searching facilitated. This type of analysis is particularly important to determine the general category of the research subject. At the same time, it can help to compare and to see the relationship with the analysis based on the research areas performed in the previous subsection.

Table 2.5 shows the classification of the selected articles based on the general categories where 80.88% of the total articles are falling in the category of Social Science, and 63.24% of the total articles are falling in the categories of Technology and Science Technology together which make sense with the subject of the study. Besides, these statistics show that it has a close relationship with the classification based on the research areas performed in the previous subsection. That is, the most common research areas were "Education & Educational Research" (i.e. 52.94% of the total articles) and the combination of "Computer Science", "Engineering", and "Communication" research areas (i.e. 45.59% of the total articles) which is understandably reflected by the analysis based on general categories in table 2.5 where most of the articles fall in the categories of "Social Science" and the combination of "Technology", and "Science Technology" categories. That means both analyses (classification by research areas and general categories) are closely related in terms of the subject of this research study.

Table 2.5: Number of articles by general categories

General Category	**Number of Articles**	**Percentage of Total Articles**
Social Science	55	80.882
Science Technology	23	33.824
Technology	20	29.412
Ohters	9	13.236
Total =	**107**	

Source: Web of Science database (2018)

Moreover, in table 2.5, the "others" category includes the general categories which have 2 or fewer articles. It includes 13.24% of all the selected articles. It is also needed to be mentioned that a single article can be categorized into more than one category, and hence the sum of total articles here in table 2.5 (i.e. 107 articles) is more than the total number of selected articles (i.e. 68 articles).

2.5.5 Analysis of Keywords in Titles of the Selected Articles

The analysis of the keywords found in the titles of the selected articles has been discussed in this subsection. In total, we have counted 815 single-word keywords from the titles of the articles of which 11 individual keywords are selected according to the interest of the research subject. Table 2.6 listed out these keywords along with their corresponding frequencies (i.e. the number of occurrences in the titles) and percentage of occurrences.

Table 2.6: Keywords frequency from the titles of the articles

Keywords	**Frequency**	**Percentaage**
team∗	77	29.06
virtual	73	27.55
learning	49	18.49
education	21	7.92
performance	8	3.02
global	8	3.02
effect∗	7	2.64
higher	6	2.26
develop∗	6	2.26
online	6	2.26
universit∗	4	1.51
Total =	**265**	**100%**

Source: Web of Science database (2018)

Most of the keywords found are *team∗* , and *virtual* which is understandable in terms of the research subject, and they have a total 56.60% frequency rate in comparison to others. Whereas, based on the domain of the research topic such as *learning*, *education*, *higher (education)*, *university∗*, and *online* had a 32.45% occurrence rate in the titles of the articles. Lastly, 7.92% of occurrence rate is found from *effect∗*, *develop∗*, and *performance* keywords which are very specific to the subject area of the research (e.g. effective virtual teamwork, or performance of virtual teamwork).

The analysis stated in table 2.6 is understandable and reflective according to the research subject of the study, and the searches conducted on the Web of Science database.

2.5.6 Analysis of Keywords in Abstracts of the Selected Articles

An analysis of all the abstracts of the selected articles is presented here based on the keywords and their corresponding frequency (number of occurrences), which is presented in table 2.7 by ordering from higher to lower frequency. The total number of keywords is 9169 found in the abstracts of the selected articles.

Table 2.7 shows the list of keywords found in abstracts of the selected articles, which are related to the subject of the study, and have frequency 4 or higher, and in total 20 keywords are finally selected which have 4694 occurrences altogether in the abstracts of the articles. As expected, the *virtual team∗* keyword has the highest frequency rate (i.e. 23.88% occurrence). Besides, other keywords related to the virtual term such as *virtual learning*, *virtual learning team∗*, *global virtual team∗*, *virtual leader∗*, and *virtual team leader∗* also have a good number of occurrences in the abstracts of the articles and all together they have 17.48% frequency rate. As the research is specifically on the education domain, so keywords like *education*, *higher education*, *university∗*, *elearning/e-learning*, and *online learning* are also listed, and these keywords together have a 14.29% frequency rate. Moreover, some specific keywords are also listed such as *performance*, *satisfaction*, *success∗*, *effect∗*, and *team∗ effectiveness* to highlights the research subject more specifically in terms of virtual teamwork's performance, or satisfaction, or

Table 2.7: Keywords frequency from the abstracts of the articles

Keywords	**Frequency**	**Percentage**
virtual team∗	112	23.88
learning	65	13.86
develop∗	43	9.17
virtual learning	32	6.82
education	26	5.54
effective∗	25	5.33
univerit∗	24	5.12
team*learnig	21	4.48
ICT	21	4.48
virtual learning team*	20	4.26
performance	20	4.26
success∗	11	2.35
satisfaction	10	2.13
higher education	6	1.28
global virtual team∗	6	1.28
team∗ effectiveness	6	1.28
elearning/e-learning	6	1.28
online learning	5	1.07
virtual leader∗	5	1.07
virtual team leader∗	5	1.07
Total =	**469**	**100%**

Source: Web of Science database (2018) success, or effectiveness, and these keywords have a total 15.35% frequency rate.

The analysis presented in table 2.7 is understandable because these are determined based on the specific keywords related to the interest of the study and while performing the search on the Web of Science database. However, there are other keywords with importance for virtual teamwork but not specific to the research interest of this thesis, and hence left out for future research to be analysed in-depth in a bigger domain of virtual teamwork like a business.

The keywords presented in table 2.7 can also be classified or clustered based on the interest of our research subject to highlight them in a more organized way. Table 2.8 listed that classification, that is, four categories of keywords: research topics, specific characteristics of the research topics, research domain, and others.

Table 2.8: Categorization of Keywords found in the abstracts of the articles

Keywords			
Research Topics	**Specific Characteristics**	**Research Domain**	**Others**
virtual team*,	develop*,	education,	
virtual learning team*,	effective*,	higher education,	
virtual leader*,	performance,	universit*,	ICT
virtual team leader*,	success*,	elearning/e-learning,	
global virtual team*,	satisfaction,	online learning,	
team*learning	team* effectiveness	learning	

The "Others" category includes the *ICT* term which is in general related to the interest of the research subject because of the technical nature (such as virtual environment, online, electronic, etc.) of the research study.

2.6 Summary

The systematic review of effective virtual teamwork in higher education has been presented in this chapter. The analysis of the systematic review has shown the necessity and importance of exploring this subject more to develop a generalized solution for developing effective virtual teamwork in higher education so that graduates can get the knowledge, skills, and ability about virtual teamwork. More specifically, how virtual teamwork can be effective, or what factors improve the performance or foster the success of virtual teamwork. The reason is that the systematic review is not found in any study which particularly researched developing effective virtual teamwork in online higher education. For example, Davidekova and Gregus (2017) mentioned the necessity of integrating virtual teaming in university and shown that it can improve the soft skills and technical proficiency. Another article by Pane, Suhardi, and Irawan (2017) presented the role of instant messaging for developing virtual teamwork in university-level education. However, none of these articles proposed a generalized solution about how to develop effective virtual teamwork in higher education so that graduates can be benefited from that early in their career.

Some articles in this review only discussed individual factors and their effect on virtual teamwork. For example, Topchyan (2016) confirmed that social presence relates to knowledge sharing in virtual teamwork. Besides, Laifa et al. (2015) discussed the effects of trust in a virtual team while conflicts occur. Another article by Coronas et al. (2015) focused only on the critical factors of creative performance in virtual teamwork. On the other hand, some papers discussed only the effects of leadership in virtual teamwork. For example, Chang and Lee (2013) discussed the leadership styles in virtual teams. Whereas, Chen et al. (2008) discussed diversified leadership roles and their effects on the virtual teamwork.

So, none of the articles in the review discussed explicitly and completely about the interest of the research subject. That's why, with this systematic review, the main purpose was to justify the importance and necessity of exploring this research subject in the area of education domain because of its applicability and competency in the academic and professional world. Besides, it is known that graduates are prepared through their higher education for the professional world. But the research about developing effective virtual teamwork in online higher education is still largely unexplored. The systematic literature review on this research subject, therefore, was the primary objective of the research work presented in this chapter.

Chapter 3

Theory & Literature Review

3.1 Chapter Overview

This chapter contains the discussion and reviews of existing literature, theory, and concept related to the research subject of the thesis.

3.2 Introduction

The exploration of both theory and the current scientific literature around the themes of virtual teamwork is presented in this chapter. Particularly, it discusses the concepts of virtual teams and teamwork, and key factors that affect the effectiveness of virtual teamwork. The chapter introduces an exploratory view on the concept of virtual teamwork for developing a conceptual model of effective virtual teamwork in the context of online higher education.

The research on virtual teamwork in online higher education is a fairly new research topic. Therefore, it is needed and important to explore the concept of virtual teamwork in the context of higher education, and understand the key factors that boost the effectiveness of virtual teamwork. These explorations and knowledge will construct the foundation for developing a conceptual model of virtual teamwork in online higher education in the later part of the research.

3.3 Concept of Teams and Teamwork

A team consists of two or more people to work collaboratively towards achieving a common goal (Isenberg, Fisher, & Paul, 2012; Marks, Mathieu, & Zaccaro, 2001). In a team, team members share the same objectives and aim to achieve the desired objective (Clements & Gido, 2012; Schwalbe, 2014). Generally, a team is a group of people who work independently on their assigned tasks, share responsibility, and manage relationships to achieve the team's goal within an organizational boundary (Cohen & Bailey, 1997). There are other definitions of the team. For example, Heathfield (2005) defined a team as,

> A team is any group of people organized to work together interdependently and cooperatively to meet the needs of their customers by accomplishing a purpose and goals.

Besides, Katzenbach and Smith (2005) defined a team as,

> A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable.

The above definitions indicate that a team is a group of people worked together to achieve a common goal set by the team, where all the team members share the common interests and defined goals. On the other hand, teamwork is a team-wise activity to achieve the team's goal (Lundy, 1994). Teamwork is a more powerful activity than an individual's effort (Katzenbach & Smith, 1993) because all the team members are committed to achieve a common goal and act accordingly with individual contributions towards the productivity of the teamwork (Clements & Gido, 2012; Schwalbe, 2014). Upon achievement of the team's goal by the teamwork, the team is dissolved.

The organizational needs determine the basis of team formation (Clements & Gido, 2012; Owen, 1998; Schwalbe, 2014). A well-organized and managed team can contribute to organizational competitive advantage and value (Alavi & Tiwana, 2002). In an organizational setting, the project manager forms the team and employs the team members based on their strengths and skills, expertise, and personality (Clements & Gido, 2012; Grutterink, der Vegt, Molleman, & Jehn, 2012; Isenberg et al., 2012). Sometimes, team members are included in a team because of having common interests (Chandler & Lyon, 2001; Grutterink et al., 2012; Schwalbe, 2014), such as similarity of attitudes, interests, interpersonal compatibility, and personalities, which leads to interpersonal attraction (Brehm, Kassin, & Fein, 2002). However, in higher education, team formation usually depends on the teacher who organizes and manages the teams of students. Sometimes, students having common interests form the basis of forming teams in higher education.

Moreover, the formation of a team can be based on the complementary skills of the team members (Grutterink et al., 2012; Katzenbach & Smith, 1993) because each team member performs a specific purpose and function, and the success of the teamwork depends on the team spirit. That's why, strong connection (e.g. in terms of communication, trust, cohesion, sharing, or coordination) between team members affect positively towards achieving the effectiveness of teamwork (Gibson & Cohen, 2003; Gordon & Curlee, 2011; Ludden & Ledwith, 2014; Segal-Horn & Dean, 2009; Warkentin & Beranek, 2001). In a nutshell, the main purpose of a team formation is for facilitating effective teamwork towards improving the performance and effectiveness of teamwork (Clements & Gido, 2012; Schwalbe, 2014).

3.4 Concepts of Virtual Teams

Over the past several decades, organizations are moving to Team-based work. In this shifting trend, information and communication technologies played the main role along with the globalized nature of business nowadays. As a consequence, virtual teamwork becomes one of the successful building block for any organization works globally (Powell et al., 2004). So, team formation now includes members from different geographic locations and different organizations than the same locations (Berry, 2011), which constitutes virtual teams with different working patterns, new decision-making styles, and different ways of relationship building. Thus, team-based activity is now a common scenario in any globalized organization.

There are multiple definitions of virtual teams in the existing literature. One of the introductory definitions of virtual teams is given by Ebrahim, Ahmed, and Taha (2009b), which is as follows:

> A virtual team is a small temporary group of geographically, organizationally, and/or time dispersed knowledge workers who coordinate their work predominantly with electronic information and communication technologies in order to accomplish one or more organization tasks.

A major advantage of virtual teams is their ability to span boundaries across the globe. Team members can be included from anywhere in the world to meet the skill requirements of the teamwork. Thus, Blackburn, Furst, and Rosen (2003) stated that virtual teams can be more capable than traditional face-to-face teams or collocated teams. Another study by Hossain and Wigand (2003) also mentioned that virtual teams have the potential for a better coordinated and collaborative task.

3.5 Virtual Teamwork in Higher Education

Virtual teamwork is considered as one of the successful building blocks for today's globalized business organizations (Powell et al., 2004). As a consequence, it is increasingly being implemented in business organizations, or planning to be implemented in the foreseeable future (Lipnack & Stamps, 1997; McDonough et al., 2001). Also, employers are seeking for employees skilled in virtual teamwork (Riebe et al., 2017), and asking for virtual teamwork skills as one of the requirements in the graduate job advertisements (Bennett, 2002).

These demands and circumstances rationale the importance of virtual teamwork to be implemented in higher education with greater emphasize because higher education produces future graduates to be recruited in various occupational fields. Therefore, one of the purposes of higher education is to prepare and produce future graduates with required skills, ability, and knowledge so that they can avail success in their professional field and become a valuable asset to their employers (Lau et al., 2014).

However, in higher education, teamwork is usually facilitated in face-to-face settings. Thus, effective virtual teamwork development is necessary for the context of (online) higher education so that graduates can be skilled in virtual teamwork. In this regard, key factors of teamwork are seen as vital for developing effective virtual teamwork (Cannon-Bowers et al., 1995), which is also true and applicable in the case of online higher education in order to develop effective virtual teamwork. But the key factors that boost the effectiveness of virtual teamwork in online higher education are not explored yet successfully. Therefore, in-depth research works are needed to identify the key factors that affect the effectiveness of virtual teamwork (Anantatmula & Thomas, 2010; Idrus et al., 2011; El-Tayeh et al., 2008), and to provide a complete guideline or a model for developing effective virtual teamwork in online higher education. So, future graduates from higher education could become skilled in virtual teamwork.

3.6 Effective Virtual Teamwork Development

Nowadays, teams are fundamental and a very common form of activities in an organizational structure (Clements & Gido, 2012; Klepper, 2001; Schwalbe, 2014; Slechta, 2007). Hence, research suggests that it is essential to have effective teamwork for the success of any business (Slechta, 2007). Hence, higher education also needs to put emphasize on virtual teamwork skills development to students so that they could become skilled in virtual teamwork before starting their professional career. But, there are unique challenges to theory, practice, and research on developing effective virtual teamwork (Berry, 2011; DeOrtentiis, Summers, Ammeter, Douglas, & Ferris, 2013; Tannenbaum, Mathieu, Salas, & Cohen, 2012). Particularly, it is more challenging because the traditional face-to-face team's effectiveness factors are less effective or may not apply in the context of virtual teams and teamwork (Berry, 2011).

However, reviewed literature suggests that there are several key factors of a virtual team that impacts positively on team's effectiveness, and responsible for developing effective virtual teamwork (such as motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance) (e.g. Clements and Gido, 2012; Gordon and Curlee, 2011; Lippert and Dulewicz, 2018; Ludden and Ledwith, 2014; Richardson, Casey, McCaffery, and Burton, 2012; Schwalbe, 2014; Sridhar, Nath, Paul, and Kapur, 2007).

The analysis of the literature also suggests other factors, such as cultural awareness, work environment, team size, team values, and team member's behaviour, as some criteria which affect the effectiveness of virtual teamwork (Dinsmore & Cabanis-Brewin, 2014; Gordon & Curlee, 2011; Ludden & Ledwith, 2014; Omorede, Thorgren, & Wincent, 2013). For this study, only the factors that are significant, relevant, applicable, and key for developing effective virtual teamwork in the context of online higher education are discussed in the following subsections.

3.6.1 Performance in Virtual Teamwork

The general meaning of performance is referred to the achievement of quantified goals or intended outputs (Armstrong, 2007). So, in the context of teamwork, performance can be defined as the achievement of the team's goals or desired outputs. Performance is the key factor of both virtual and traditional face-to-face teams (Pinar, Zehir, Kitapci, & Tanriverd, 2014). It is defined as the effectiveness, development, and satisfaction towards the accomplishment of teamwork efficiently (N. A. Ali, Mahat, & Zairi, 2006; Katou & Budhwar, 2006). The research revealed performance as the evaluation of teamwork's success (e.g. Idrus et al., 2011; Ludden and Ledwith, 2014). Performance is the key factor to evaluate or judge how well a team performed in order to achieve the desired outputs or goals of the team (Zigon, 2000).

Performance in a virtual team is improved when team members have access to a variety of knowledge bases, and information (Kirkman & Mathieu, 2007; Ludden & Ledwith, 2014). That's why a team performs better when it consists of individuals with relevant knowledge and expertise (Gardner, Gino, & Staats, 2012; Malhotra & Majchrzak, 2004; Pangil & Chan, 2014). Besides, Xiao and Jin (2010) mentioned that knowledge sharing practices within a virtual team enhance the performance of the team. Another study by Alsharo, Gregg, and Ramirez (2017) also suggested that knowledge must be shared or exchanged among the team members for the effectiveness of any virtual team. Technological advancement and usage in virtual teams make it easier of sharing knowledge and information, and collaboration among the team members effectively and efficiently (Kirkman & Mathieu, 2007; Ludden & Ledwith, 2014).

Moreover, the presence of trust among team members boosts the performance of virtual teamwork (Anantatmula & Thomas, 2010; Roth, 2012; Schwalbe, 2014). It indicates a higher level of trust increases the level of performance of virtual teams (Rad & Levin, 2006; Wise, 2013). Thus, trust can be used as the evaluator between a high and low-performance virtual team (Lippert & Dulewicz, 2018). In addition to trust, team cohesiveness also influences virtual team's performance (Hannah, Walumbwa, & Fry, 2011; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000), which is also reflected by existing literature (e.g. Cohen and Bailey, 1997; Powell et al., 2004).

However, coordination is the core of virtual teamwork for managing and coordinating it successfully (Pinsonneault & Caya, 2005; Powell et al., 2004) because it is directly related to the performance of virtual teamwork. A study by Montoya-Weiss, Massey, and Song (2001) indicated that coordination deals with the management of virtual teamwork to foster the performance (Montoya-Weiss et al., 2001). Another study by Lin, Standing, and Liu (2008) found that the coordination factor is strongly related to the performance factor of a virtual team. In addition to these, other research studies also revealed that coordination is directly linked to the performance of virtual teamwork (e.g. Johansson, Dittrich, and Juustila, 1999; Lu, Watson-Manheim, Chudoba, and Wynn, 2006; Maznevski and Chudoba, 2000).

The existing literature revealed that there are some factors that directly or indirectly influence the performance factor, and, the effectiveness of teamwork is evaluated by the performance of the team (Clements & Gido, 2012; Ocker, 2001). When the individual performance of the team member is not up to the mark or poor then the overall team performance is poor and so affects the effectiveness of the teamwork (Clements & Gido, 2012; Schwalbe, 2014). That means, teamwork is a collective responsibility and its success depends on the collective performance of all the team members. That's why effective teamwork development is directly connected to the team's performance (Clements & Gido, 2012; Ocker, 2001).

Besides, many researchers also mentioned that the team's effectiveness is measured by the team performance (e.g. Clements and Gido, 2012; Hackman and Powell, 2004; Schwalbe, 2014; Segal-Horn and Dean, 2009; Sivunen, 2008; Slechta, 2007). That's why, for a team to be effective, the team members should involve in all activities of the teamwork for having a good team spirit and performance.

The literature review has identified performance as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.2 Motivation in Virtual Teamwork

Motivation is a kind of force or driver that encourages team members to work actively in a virtual team (Lurey & Raisinghani, 2001; Sridhar et al., 2007). It means to inspire, encourage, stimulate each team member to perform their responsibilities in the team towards achieving the goals (Peterson, 2007). Geister, Konradt, and Hertel (2006) stated that motivation has a significant impact on the performance of virtual teams. On the other hand, Wallace and Keil (2004) indicated that lack of motivation is considered as one of the vital risks for virtual teams. That's why, Lurey and Raisinghani (2001) pointed out that when team members feel discouraged in virtual teamwork, the performance level decreases, on the contrary, performance level improves when they find motivation in the teamwork. From the existing literature, it is cleared that motivation influences virtual team performance significantly, and hence, it is considered as one of the critical factors for the development of effective virtual teamwork (Hertel et al., 2005; Peterson, 2007).

However, motivation does not develop automatically in the virtual team. It has to be promoted within each of the team members. It is necessary to motivate each team member and to identify what motivates each team member to develop a motivated virtual team (Peterson, 2007; Rad & Levin, 2006). A motivated team member always stays positive, eagerly contribute to the team, and participate actively to accomplish the team's goal (Ardichvili, Page, & Wentling, 2003). That's why it is essential to motivate each team member in s virtual team to develop effective teamwork.

There are different ways of motivation in a virtual team, for example, rewards for good performance, give incentives, shows a positive attitude, etc. (Peterson, 2007). Also, regular feedback regarding teamwork often works as a motivation (Geister et al., 2006). However, in the context of online higher education usually, motivation works differently. In a virtual team, students can be motivated when they are confident about the learning outcomes or prospects from the teamwork, or they have the opportunity to gain new knowledge and skills by the teamwork (Slechta, 2007). They can be motivated when they find challenges by the teamwork, which eventually drives their enthusiasm and enhance their performance in the teamwork (Slechta, 2007). Besides, students usually like to contribute to teamwork as it is part of their academic activities, and has an impact on their academic grades. That's why they feel motivated when they have the opportunity to contribute sufficiently to the team. Most importantly, when they feel valued as team members in the teams, it works as an encouragement for them, which is the general essence and foundation of the motivation in the context of virtual teamwork in online higher education.

The literature review has identified motivation as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.3 Communication in Virtual Teamwork

Communication is the backbone of any virtual teamwork for its success and effectiveness (Duarte & Snyder, 2006; Gordon & Curlee, 2011; Setle-Murphy, 2013). To have effective communication in virtual teamwork, ICT plays a vital role. The rapid advancement of ICT has made the communication even easier in virtual teamwork (Friedman, 2007; Grisham, 2010; Haines, 2014; Lilian, 2014; Rad & Levin, 2006; Wildman & Griffith, 2015). There are different forms of communication in virtual teams using ICT such as emails, video conference, voice message, text message, blogs, forums, and electronic documents (Gordon & Curlee, 2011; Ludden & Ledwith, 2014; Richardson et al., 2012; C. Saunders, Van-Slyke, & Vogel, 2004). So, in the context of virtual teamwork, communication can be defined as the interaction between team members using ICT required to achieve the team's goals and objectives (Duarte & Snyder, 2006; Lepsinger & DeRosa, 2011; Lilian, 2014).

However, generally, it is a challenging task to maintain effective communication in any team (Chiocchio, 2007), which becomes much more challenging in the case of virtual teams (Horwitz, Bravington, & Silvis, 2006; Ludden & Ledwith, 2014). So, successful virtual teamwork vastly depends on effective communication between team members. That's why, it is considered as the core of virtual teamwork success, and if properly organized it helps to build trust, share knowledge, foster learning, work as a cohesive unit, and improve the overall activities in virtual teams (Gordon & Curlee, 2011; Hinds & Mortensen, 2005; Lilian, 2014; Ludden & Ledwith, 2014; Thommsen, 2010).

Even though its importance in virtual teamwork sometimes it is overlooked and undervalued (Gordon & Curlee, 2011; Richardson et al., 2012). Studies by Clements and Gido (2012) and Schwalbe (2014) highlight that failure in communication is the major threat to the success of virtual teamwork. Besides, existing literature also reveals that many challenges of virtual teamwork are rooted in the process and behaviour of communication (e.g. Connaughton and Shuffler, 2007; Gordon and Curlee, 2011. Effective and regular communication can enhance team activity and reduce conflicts (Hinds & Mortensen, 2005). So, the communication between team members of a virtual team affects the overall performance and effectiveness of virtual teamwork (Duarte, 2001; Setle-Murphy, 2013; Wise, 2013).

The literature review has identified communication as a key factor in virtual teams, so it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.4 Knowledge Sharing in Virtual Teamwork

Knowledge is seen as a valuable asset in an organization which impacts prosperity and improve effectiveness (Alavi & Leidner, 2001; Gold, Malhotra, & Segars, 2001). In an organizational setting, it can create competitive advantages for both individuals and organizations (Nonaka, 1994). Therefore, the distribution and sharing of knowledge among individuals like in a virtual team can improve performance and outcomes. The reason is that a team has individuals with different expertise and skills (Hoegl & Gemuenden, 2001), as a result, sharing of knowledge among team members foster team performance and outcomes (Lam, 2000). Because of the combination of individual expertise in a virtual team, each of the team members has the advantages of being benefited from each other's expertise, and hence, there has a high chance of generating an innovative result from a virtual teamwork (Pinjani & Palvia, 2013).

However, the sharing of knowledge depends on the willingness of individual team members of a team (Bock, Zmund, Kim, & Lee, 2005). As it is an independent practice in a (virtual) team (i.e. knowledge sharing is a voluntary activity in a team) (Hahm, 2017), sometimes, team members are reluctant to sharing of knowledge because they feel it may lead to a loss of their knowledge ownership and power. Research shows that this kind of negative attitude in a virtual team plays an obstacle in knowledge sharing practice which could hamper the team performance and effectiveness (e.g. Kankanhalli, Tan, and Wei, 2005).

Thus, it is certain that knowledge sharing and information exchange among team members is crucial for virtual team collaboration and improved team performance. For that reason, all the team members in a virtual team should have a willingness in knowledge and information sharing practice (Jessica & Leslie, 2012). Through knowledge sharing, it is not that only the team is benefited but also every team member has the opportunity to improve their knowledge, skills, and experiences (Hahm, 2017).

As a consequence, Alsharo et al. (2017) and Hahm (2017) stated that knowledge sharing has a positive impact on the performance and effectiveness of virtual teamwork. Another research by Xiao and Jin (2010) also suggested similarly that knowledge sharing is one of the major activities for enhancing team performance and the effectiveness of virtual teamwork.

The literature review has identified knowledge sharing as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.5 Trust in Virtual Teamwork

Trust is a core element of effective teamwork (Carroll, 2008) for both traditional face-to-face and virtual teams. However, building trust in virtual teams is one of the most challenging issues, mentioned by many research studies (e.g. Rad and Levin, 2006; Zigurs and Khazanchi, 2008. But for the effectiveness of virtual teamwork, it is essential to build trust among team members, which grows over time gradually based on frequent communication and interaction (Mayer, Davis, & Schoorman, 1995; Roth, 2012). Many studies suggested that the rapid development of trust in virtual teams vastly depends on the team member's trustworthiness, capability, and dependability (e.g. Carroll, 2008; Gordon and Curlee, 2011; Rad and Levin, 2006; Wise, 2013). However, the healthy trust of a virtual team can be destroyed anytime. A study by Grisham (2010) stated that building trust in a virtual team takes a longer time to grow but it can be destroyed instantly. Thus, along with trust-building it is also needed to maintain a healthier level of trust in the virtual teams.

The importance of trust is indicated by McAllister (1995) and Jang (2013) who pointed out trust as the core foundation of interpersonal cooperation. Other research studies stated that trust is linked to positive attitudes such as commitments, performance, satisfaction, and behaviour (e.g. Anantatmula and Thomas, 2010; Roth, 2012; Schwalbe, 2014) which also reflects its importance in developing effective virtual teamwork. Moreover, trust can also play an important role in sharing activities of virtual teamwork (Roth, 2012; Zigurs, 2010). For example, a study by Young and Tseng (2008) defined trust as a supporting factor for the effectiveness of knowledge sharing. Thus, other studies considered trust as a key success factor to produce and deliver quality work (Jarvenpaa, Knoll, & Leidner, 1998; Sarker, Lau, & Sahay, 2001).

A study of trust by Wise (2013) found that higher levels of trust in virtual teams enable team members to maintain regular communication, to be engaged in a team, and to focus on the task. In line with this, recent studies have found that trust is a key success factor for developing effective virtual teamwork (Duran & Popescu, 2014; Haines, 2014; Schiller, Mennecke, Nah, & Luse, 2014). As the levels of trust increase among the team members, the productivity and creativity of the team are also increased (Hahm, 2017), and as a consequence, all team members experience a higher level of satisfaction (Haines, 2014; O'Toole & Lawler, 2006; Roth, 2012; Schiller et al., 2014). So, the presence of trust among team members has a significant impact on the effectiveness and efficiency of virtual teamwork. On the other hand, a lack of trust in virtual teams leads failure to achieve the team's goal (Duran & Popescu, 2014; Jarvenpaa & Keating, 2011). That's why, higher levels of trust are essential for better management, organization, and improved performance of virtual teams, which ultimately leads to the success of virtual teamwork (Chudoba, Wynn, Lu, & Watson-Manheim, 2005; Lipnack & Stamps, 2000; Schiller et al., 2014).

The literature review has identified trust as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.6 Cohesion in Virtual Teamwork

In virtual teamwork, cohesion means to stay united as a team until the accomplishment of the team's goals, and the achievement of satisfaction with the team's outcomes (Carron, Brawley, & Widmeyer, 1998; Forrester & Tashchian, 2006). This suggests that cohesion is an essential factor for the success and effectiveness of virtual teamwork. Some research indicated that cohesion can foster the effectiveness and performance of virtual teamwork (e.g. Hannah et al., 2011; Lurey and Raisinghani, 2001; Maznevski and Chudoba, 2000).

Usually, the traditional face-to-face team has higher levels of cohesion than in virtual teams (Anantatmula & Thomas, 2010; Warkentin & Beranek, 2001). That why, virtual teams required a lot more attention to enhance the levels of cohesion because it is one of the key factors to improve the performance of team members and teams in the context of a virtual environment (Cohen & Bailey, 1997). A study by Tan, Tyler, and Manica (2008) indicate that time spent by team members on previous teamwork can enhance the cohesion in current virtual teamwork. However, in reality, this could not be the situation every time. In the context of online higher education, it is an even more rare situation because they hardly get a chance to build a team with team members worked together before. In any case, it can be said that frequent interaction among team members has a positive impact on building strong cohesion in a virtual team. Studies found that healthy cohesion is one of the prerequisites of improved performance and effectiveness of a virtual team (Maznevski & Chudoba, 2000; Powell et al., 2004).

Furthermore, the characteristics of cohesion include (a) open communication among team members to discuss together and contribute to the team, (b) share responsibilities, respect each other, and show urges to cooperation in teamwork, and (c) establish or share clear common goals in the teamwork (Anantatmula & Thomas, 2010; Clements & Gido, 2012; Hannah et al., 2011; Maznevski & Chudoba, 2000; Schwalbe, 2014). In a nutshell, a team has to be a cohesive unit and should perform a shared collective responsibility in order to achieve the team's goals and objectives in a virtual teamwork (Hackman & Powell, 2004; Slechta, 2007).

The literature review has identified cohesion as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.6.7 Coordination in Virtual Teamwork

In general, coordination means gathering and evaluating of the required information to coordinate the tasks, and then structuring the tasks to be performed, and also, learning and adapting as per the team's goal so that the desired outputs of the team can be achieved. In a virtual team, coordination is a key factor of team effectiveness which refers to the efforts for planning, monitoring, and supporting individual actions of its team members in order to achieve the team's desired outcomes (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008). Majchrzak, Jarvenpaa, and Hollingshead (2007) indicated that it is essential to monitor the individual team member's action for establishing effective coordination in a virtual team. Therefore, team coordination can be defined as

> "the process of orchestrating the sequence and timing of interdependent actions". (Marks et al., 2001)

In addition to these, the coordination factor in virtual teamwork can be defined as the effort of team members for managing collective resources of the team and maintaining the consistent and coherent team activities (Pinsonneault & Caya, 2005; Powell et al., 2004). That means coordination played a crucial role in conflict management in virtual teams (Montoya-Weiss et al., 2001). Hence, it can be said that coordination is linked to the performance or effectiveness of virtual teamwork (Johansson et al., 1999; Maznevski & Chudoba, 2000). In line with this, a study by Lin et al. (2008) also found that coordination is strongly related to the performance of virtual teamwork. According to this literature, there has a clear indication that an improved performance of any virtual team is largely dependent on how efficiently and effectively the coordination of a virtual team is maintained.

Moreover, some factors that impact on the effectiveness of coordination. For example, knowledge and information sharing between team members in virtual teams boosts the coordination of virtual teamwork (Massey, Montoya-Weiss, & Hung, 2002; Maznevski & Chudoba, 2000). That means virtual team members should share knowledge among themselves adequately for the effective collaboration in virtual teamwork (Pangil & Chan, 2014; Pinjani & Palvia, 2013; Xiao & Jin, 2010). Otherwise, virtual teamwork will be less efficient because of poor coordination, such as missing relevant information essential for the teamwork, difficulties in decision-making crucial for the success of teamwork, miscommunication, etc. (Gray, 2001; Pinjani & Palvia, 2013). These indicate that the knowledge sharing factor boosts the coordination factor towards developing effective virtual teamwork in online higher education.

Trust is also considered as another essential factor for effective coordination in virtual teamwork because it relates with many activities of coordination for collaborating in virtual teamwork such as, reducing risk management, dealing with complexity and uncertainty, and facilitating a positive atmosphere to team members (e.g. Baba, 1999; Jarvenpaa and Leidner, 1999; Kollock, 1994; Paul and McDaniel, 2004). These suggest that the trust factor has a positive impact on the coordination factor towards developing effective virtual teamwork in online higher education.

Besides, cohesion also plays a vital role to have a successful coordination in virtual teams (Lipnack & Stamps, 2000; Sarker et al., 2001). A study by Deeter-Schmelz, Kennedy, and Ramsey (2002) indicated that strong cohesion between team members leads to better coordination in virtual teamwork. These suggest that cohesiveness nature of teams positively affects the coordination factor towards developing effective virtual teamwork in online higher education (Deeter-Schmelz et al., 2002; Lipnack & Stamps, 2000; Sarker et al., 2001).

The literature review has identified coordination as a key factor in virtual teams, hence, it needs to be considered for the development of effective virtual teamwork in the context of online higher education.

3.7 Virtual Teamwork Model in Higher Education

The key factors that boost the effectiveness of virtual teamwork are the vital elements for developing a virtual teamwork model in the context of online higher education, which is still unexplored (Anantatmula & Thomas, 2010). Though several research works mentioned some models still those have big gaps concerning virtual teamwork (Salas et al., 2008). In the context of online higher education, these gaps are even bigger and in most cases, these are largely unexplored. For example, Salas et al. (2007) mentioned different models that mainly studied the performance of teamwork. But this study lacks in suggesting the key factors that impact on the effectiveness of virtual teamwork (Ebrahim et al., 2009b). Whereas, Nader et al. (2009) mentioned the importance of identifying key factors to develop effective virtual teamwork, which eventually can be used for building a model of virtual teamwork.

The existing literature suggests that profound research is necessary to develop a model for virtual teamwork with the key factors that affect the effectiveness of virtual teamwork (Anantatmula & Thomas, 2010; Idrus et al., 2011; Nader et al., 2009; El-Tayeh et al., 2008). Therefore, this research work aims to identify the key factors that boost the effectiveness of virtual teamwork, and then propose a model for virtual teamwork with these identified key factors in order to develop effective virtual teamwork in the context of online higher education.

3.8 Summary

An in-depth discussion has been presented in this chapter for exploring the research topic of this thesis based on the theories and existing literature. The understanding of the concepts of virtual teamwork and key factors that affect the effectiveness of virtual teamwork in online higher education has been achieved through this chapter. It sets the path for advancing the research and developing a conceptual model for effective virtual teamwork which is discussed in the corresponding chapter of the thesis.

Part II

Research Methodology

Chapter 4

Research Process & Approaches

4.1 Chapter Overview

This chapter presents the research process and the methodological and statistical approaches adopted and considered for carrying out the research work of this thesis.

4.2 Introduction

The research process and the methodological and statistical approaches of the thesis summarize how the research is designed and carried out, and what are the approaches are considered for the empirical study (i.e. how the data is collected, how the data is analysed, and how the results are interpreted and reported). The main purpose of this chapter is to present the research process and approaches which are adopted and applied in this thesis in order to develop the proposed conceptual model of effective virtual teamwork in the context of online higher education and then to validate the model with statistical significance.

The research process and methodological and statistical approaches adopted in this thesis are tightly linked to the nature and objectives of the research. It rightly addresses the required information for answering the research questions. The adopted methodological and statistical approaches facilitate the collection of empirical data and the analysis and interpretation of the data. Thus, the research process and the methodological and statistical approaches used in this thesis are justified according to the nature of the study to address the research question, facilitate the empirical study, and obtain the research objectives.

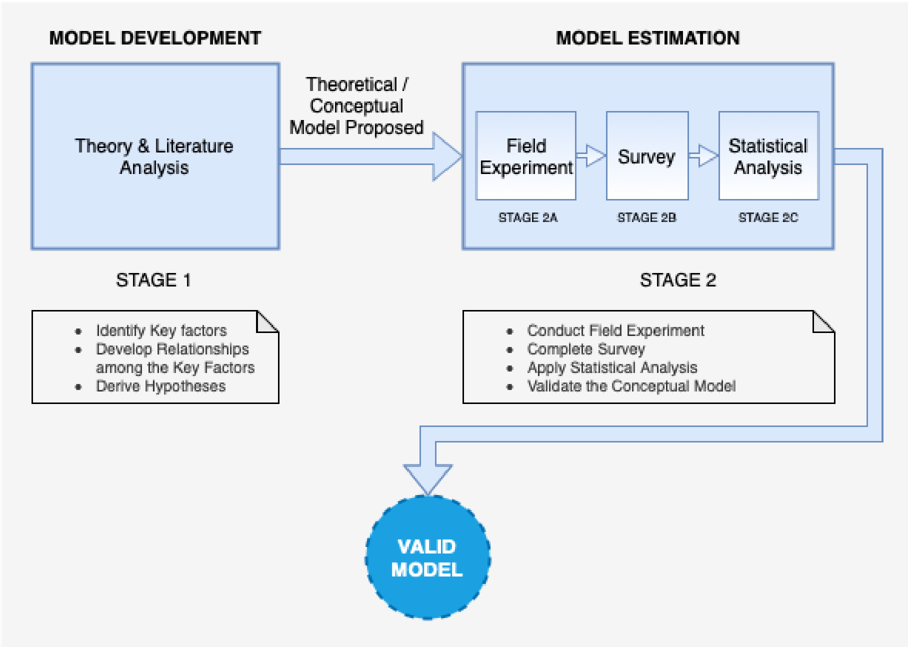
The rest of the chapter briefly describes and justifies the research process (i.e. how the research is designed for carrying out), the methodological approach (i.e. how the research is conducted), and the statistical approach (i.e. how the data is analysed and interpreted in this research) respectively in sections 4.3, 4.4, and 4.5.

4.3 Research Process

The research process design is referred to as the ways or precesses of conducting a research study. The adopted research process for the research work of this thesis is depicted in figure 4.1. As can be seen in the figure, the research study of this thesis has adopted a two-stage research process primarily to conduct the research work (such as *Stage 1: Model Development*, and *Stage 2: Model Estimation*). However, *Stage 2* further contains three more sub-stages (such as *Stage 2A: Field Experiment*, *Stage 2B: Survey*, and *Stage 2C: Statistical Analysis*). That means, it is a pluralist approach research design. The use of multiple methods in research work increases the reliability of the study.

The first stage illustrates how the theoretical or conceptual model is developed and proposed, while the second stage illustrates how the empirical study is conducted to evaluate the proposed conceptual model. The second stage further involves three more sub-stages, *field experiment*, *survey*, and *statistical analysis* to estimate and validate the conceptual model developed earlier. After that, the desired model of effective virtual teamwork in the context of online higher education will be validated and established.

Figure 4.1: The Research Process



4.3.1 Stage 1: Model Development

The analysis or review of existing literature and theories determined the key factors that affect the effectiveness of virtual teamwork in online higher education as well as the relationships among the key factors influencing the effectiveness of a virtual team. The results of the analysis of the literature and theories provided the foundation for a framework that illustrates the relationship between the key factors identified in the review. As a consequence, a set of hypotheses is derived based on that. Finally, the theoretical or conceptual model of effective virtual teamwork is developed and proposed in the context of online higher education.

The detailed process and description of the conceptual model development of this thesis are presented, explained, and proposed in *chapter 6: Conceptual Model*. Next, the evaluation of the proposed model for testing the statistical significance is conducted through an empirical study. The research process, *Stage 2* describes how this empirical study is designed and carried out, which is presented in the following section 4.3.2.

4.3.2 Stage 2: Model Estimation

In order to estimate the conceptual model, that is, to conduct the empirical study of the thesis, three sub-stages (i.e. *Stage 2A: Field Experiment*, *Stage 2B: Survey*, and *Stage 2C: Statistical Analysis*) are considered and designed, which are presented respectively in 4.3.2.1, 4.3.2.2, and 4.3.2.3 sub-subsections.

However, it is to mention that the empirical study (to validate the conceptual model) of the thesis adopts the quantitative research methodology which is described and justified in section 4.4.

Finally, the detailed description of the sample data and the data collection procedure for the empirical study of the thesis are presented in *chapter 8: Data Collection & Examination*.

4.3.2.1 Stage 2A: Field Experiment

A field experiment is an experimental design method carried out in the natural settings as per the phenomenon of research interest but without experimental controls and manipulation of the independent variables of the experiment. For this particular research study, real virtual teams of undergraduate students have participated in the field experiment where they are given a task to complete or solve in a natural setting. It is found that real participants in a field experiment are useful for studying situations or variables, such as examining the key factors that affect the effectiveness of virtual teamwork (Ross & Blasch, 2002).

Therefore, according to the research objectives of this thesis, the main purpose of the field experiment is to explore the key factors that affect the effectiveness of virtual teamwork in the context of online higher education. An online tournament is held as the field experiment where different virtual teams consisting of undergraduate students from different universities are participated and competed virtually to solve or finish the given tasks. More information about the online tournament of virtual teams can be found in *chapter 8: Data Collection & Examination*. The field experiment is conducted to examine the theoretical or conceptual model (i.e. developed and proposed by the *Stage 1*), and to prepare for the subsequent survey (i.e. collects data from virtual teams by the *Stage 2B*).

4.3.2.2 Stage 2B: Survey

A survey is a method or technique used for collecting data required for the empirical study (Mouton, 2001; Sue & Ritter, 2011; Walter, 2019). A survey is chosen for this study because it allows the systematic gathering of data from a wide range of participants to examine and predict some aspects of the behaviour of the population of interest (Sue & Ritter, 2011; Walter, 2019). Besides, there are some advantages to using a survey as a data-gathering technique. For example, it is less time-consuming (like, it saves data processing time), and cost-effective (like, it saves printing and travelling costs) (Biggam, 2011; Mouton, 2001; Sue & Ritter, 2011). Hence, it is believed that survey is the right technique of collecting data for this empirical study of the thesis.

In the survey technique, an extensive literature review is required to develop the questionnaire for collecting data from the participants (i.e. virtual teams in this empirical study). That's why in this study, the literature review is conducted on the key factors of virtual teamwork which affect the effectiveness of virtual teamwork in online higher education. Thus, all the measurement items in the questionnaire were derived based on the existing literature, theories, and best of the knowledge and logic. A detailed description and literature review of developing the questionnaire for the survey is presented in *chapter 7: Measurement Model*.

The virtual teams consisting of undergraduate students from different universities participate in the survey to answer the questionnaire. The respondents were informed of the purpose of the survey, which was to measure the key factors and their relationships for developing effective virtual teamwork in online higher education. Besides, it was mentioned that participation in the survey was voluntary.

So, after completing the field experiment, all the virtual teams were asked to fill out a questionnaire. A 5-point Likert scale is used in answering the questions related to the conceptual model developed and proposed (in *Stage 1*) in order to validate the model with regard to statistical significance or supports. Questionnaires are distributed, filled out, and returned virtually. A total of 159 questionnaires (i.e. data samples) are collected finally from the survey. A detailed description and examination of data are presented in *chapter 8: Data Collection & Examination*.

Finally, the data recorded from the survey were analysed and reported through the statistical analysis (i.e. examine the statistical significance of the proposed conceptual model by *Stage 2C*).

4.3.2.3 Stage 2C: Statistical Analysis

The statistical analysis applies to justify the statistical significance of the proposed conceptual model with the sample data which is collected through field experiments and surveys. The detailed about the statistical approach and tool used for the statistical analysis of the model is presented in section 4.5.

4.4 Methodological Approach

The research study is a systematic way of finding facts and gathering data to advance knowledge for particular research (M. Saunders, Lewis, & Thornhill, 2009). As a consequence, research methodologies are used to conduct research studies. That means, how research should be conducted is defined by the research methodology based on the nature of the research (M. Saunders et al., 2009). It usually executes a certain research process through collecting data in different ways like surveys, or interviews (Flick, 2011; Morgan, 2014; M. Saunders et al., 2009), and then processed and analysed the data for testing theories, ideas, or hypotheses (Morgan, 2014; Mouton, 2001).

Generally, there are three major research methodologies: quantitative, qualitative, and mixed methods (i.e. employs both qualitative and quantitative methodologies) (Flick, 2011; Morgan, 2014; Mouton, 2001). However, the empirical study of this thesis (i.e. the model estimation stage of the research process) has adopted a quantitative research methodology.

The quantitative research methodology is used to collect numerical data and then analysed the data statistically (Creswell & Clark, 2011; King, Keohane, & Verba, 1994; Mouton, 2001). M. Saunders et al. (2009), and Mouton (2001) define the quantitative methodology as an approach for collecting numerical data using techniques like a questionnaire-based survey and analysing numerical data using statistical analysis tools and techniques. In this research methodology, researchers are detached from the people he or she studies (i.e. researcher is an external entity to the subjects understudy) (Mouton, 2001). That means the role of the researcher is to focus only on data measurement and analysis (Glesne & Peshkin, 1992; Morgan, 2014). This type of methodology is suitable for examining people on a larger scale (Morgan, 2014; Mouton, 2001; Roberts, 2010). The empirical study of this thesis is about collecting numerical data using a questionnaire-based survey and apply the statistical technique to analyse the data. Thus, according to the definitions and explanations on quantitative methodology, it is clear enough to say that quantitative methodology is aligned and matched with the purpose and nature of the empirical study of this thesis, and hence, it is more appropriate to use it in this study.

On the other hand, qualitative research methodology is used for collecting data through discussions and interviews by asking very broad questions to the participants (Easterby-Smith, 2003; Morgan, 2014). Unlike quantitative, qualitative research is based on close contact with the researchers and the subjects being studied, and hence, the researchers become an instrument for recording and collecting data or observations (Morgan, 2014). That's why, qualitative methodology assists researchers in expressing their perspectives to the people, and understand people's experiences as well (R. Johnson & Waterfield, 2004) This type of methodology is suitable for examining people on a smaller scale (Morgan, 2014; Mouton, 2001). These definitions and explanations of qualitative methodology indicated that it is not matched and aligned with the purpose and nature of the empirical study of this thesis.

In a nutshell, the quantitative research methodology is an appropriate choice for this empirical study based on the following strengths of this methodology, which aligned and matched with the nature and objectives of this empirical study of the thesis.

- Sampling from a larger population for measuring the phenomenon of the research interests. In this study, virtual teams of undergraduate students represent the population for measuring the key factors of virtual teams towards developing effective virtual teamwork in online higher education.

- Gathering of numerical data, using numerical data, and providing statistical information which cannot be misinterpreted and biased (because researchers are detached from the subjects) (Morgan, 2014; M. Saunders et al., 2009).

- Collecting data from the virtual teams through an online questionnaire-based survey to measure the key factors and the relationships among them the key factors of virtual teamwork.

- Surveys can be conducted in a larger setting, so there has a chance to collect more information for statistical purposes.

- Using statistical analysis for analysing and interpreting the results.

- Cost-effective and time-efficient. In this study, an online survey is used to collect the data, so it takes less time, and it is cost-effective as well.

Therefore, the choice of quantitative as a research methodology for the empirical study of this thesis is justified sufficiently, which indicated that the quantitative research methodology is the appropriate choice for conducting the empirical study of this thesis.

4.5 Statistical Approach

The statistical analysis is the most essential tools and techniques for social science researchers and scientists to develop, explore, and confirm research findings. In this thesis, the partial least squares structural equation modeling (PLS-SEM) technique is used as a statistical tool for the empirical study along with the *SmartPLS* software (a standard software for the PLS-SEM statistical technique).

4.5.1 PLS-SEM

The PLS-SEM is a second-generation statistical technique for multivariate analysis broadly accepted and used in many research disciplines. The nature and objectives of this research study are perfectly matched with the recommendations for choosing PLS-SEM. That's why it is chosen for the empirical study of this thesis. A detailed description and justification of using PLS-SEM, specifically what are the reasons for choosing PLS-SEM and, how it is applied in this study is presented in chapter 5: PLS-SEM Statistical Technique.

4.5.2 SmartPLS

The *SmartPLS* is a software with a user-friendly graphical user interface (GUI) which is used for variance-based structural equation modeling (SEM) by applying the partial least squares (PLS) path modeling method (**Hair**; Hair, Hult, Ringle, & Sarstedt, 2017; Hair, Sarstedt, Ringle, & Gudergan, 2016; Wong, 2013, 2019). It estimates PLS path models with latent variables (i.e. constructs) using the PLS-SEM algorithm (Lohmöller, 1989; Wold, 1982), and also facilitates different standard evaluation criteria for assessing the results such as structural model assessment criteria, measurement model (reflective and formative) assessment criteria, and model fit measures

(Ramayah, Cheah, Chuah, & H. Ting, 2016).

In addition to the supports of the PLS Algorithm, bootstrapping procedure, and blindfolding procedure, it also supports additional statistical analyses for example, multi-group analysis, confirmatory tetrad analysis, importance-performance map analysis, prediction-oriented segmentation, permutation (Garson, 2016; Sarstedt & Cheah, 2019). Another advantage of the *SmartPLS* software is that it can be used in different computer operating systems (such as *Windows*, and *Mac*) as it is programmed in *Java* (Temme, Kreis, & Hildebrandt, 2010).

Therefore, nowadays, *SmartPLS* is considered as a widely used and standard software for the PLS-SEM statistical technique. That's why it is considered for this research study as well. Particularly, the version *SmartPLS3* (Ringle, Wende, & Becker, 2015) is used in this empirical study of the thesis.

4.6 Summary

The main goal of the chapter has been achieved by designing the research process and adopting the appropriate methodological and statistical approaches for conducting the research work of this thesis. The research process and approaches adopted in this thesis is justified and reflected with the nature and objectives of the research. Therefore, it is believed that the adopted research process and approaches for conducting this research work will be sufficient and appropriate to address the research questions and achieve the desired outcomes of the thesis.

Chapter 5

PLS-SEM Statistical Technique

Chapter Preface

The shorter version of this chapter is already published as an article in the peer-reviewed *RII Forum 2020* Proceedings. The author and supervisor of the article is the same as the author and supervisor of this thesis. Full citation of the article is mentioned below:

> Jony, A. I., & Serradell-López, E. (2020a). A pls-sem approach in evaluating a virtual teamwork model in online higher education: Why and how? In A. Visvizi, M. D. Lytras, & N. R. Aljohani (Eds.), *Research & innovation forum 2020: Disruptive technologies in times of change.* Springer Proceedings in Complexity, Springer

5.1 Chapter Overview

This chapter contains the discussion about PLS-SEM statistical technique, mainly why it is chosen for this research study, what are the preliminary considerations need to take into account before applying PLS-SEM, and how it is applied in this research study.

5.2 Introduction

The power of structural analysis is to develop, explore, and confirm research findings that undoubtedly makes it one of the most essential tools for social science researchers or scientists for many years. In which partial least squares structural equation modeling (PLS-SEM) is considered as one of the most emerging second-generation statistical tools for multivariate analysis. Another second-generation statistical technique is covariance-based structural equation modeling (CB-SEM) which was popular for publishing articles mostly in social science until 2010, however, in recent time PLS-SEM becomes a widely used technique in terms of the number of publications relative to CB-SEM (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017).

Nowadays, PLS-SEM has been broadly accepted and used in many disciplines, such as human resource management (Ringle, Sarstedt, Mitchell, & Gudergan, 2018), marketing management (Hair, Sarstedt, Ringle, & Mena, 2012), organizational management (Sosik, Kahai, & Piovoso, 2009), operations management (Peng & Lai, 2012), international management (Richter, Sinkovics, Ringle, & Schlägel, 2015), strategic management (Hair, Sarstedt, Pieper, & Ringle, 2012), supply chain management (Kaufmann & Gaeckler, 2015), hospitality management (F. Ali, Rasoolimanesh, & Cobanoglu, 2018; F. Ali, Rasoolimanesh, Sarstedt, Ringle, & Ryu, 2018), tourism and travel management (do Valle & Assaker, 2016; Henseler, Müller, & Schuberth, 2018), management accounting (Nitzl, 2016), and management information systems (Ringle, Sarstedt, & Straub, 2012). Besides, the PLS-SEM technique is widely is applied in a vast range of additional disciplines as well such as economics, engineering, environmental sciences, medicine, political sciences, and psychology (Richter, Carrión, Roldán, & Ringle, 2016). Recently PLS-SEM has been advanced and adopted in a banking and finance discipline (Avkiran & Ringle, 2018). Also, PLS-SEM is addressed, proposed, and illustrated in different forms of publication such as special issues of scholarly journals (Rasoolimanesh & Ali, 2018; Richter et al., 2016; Shiau, Sarstedt, & Hair, 2019), textbooks (Garson, 2016; Ramayah et al., 2016), and edited volumes (F. Ali, Rasoolimanesh, & Cobanoglu, 2018; Avkiran &

Ringle, 2018), which indicate the increasing popularity and applicability of PLS-SEM in a wide range of disciplines and research works.

Therefore, PLS-SEM is chosen as a statistical tool for the research study (i.e., virtual teamwork development in online higher education), specifically to analyse the research findings and to explore, evaluate, or assess the model of virtual teamwork development in online higher education.

This chapter presents a detailed discussion about PLS-SEM statistical technique. Mainly it addresses and justifies three (3) questions: (a) what are the reasons of choosing PLS-SEM for the research work?, (b) what are preliminary considerations need to take into account before applying PLS-SEM?, and (c) how PLS-SEM is applied in the research work?

Though the discussion about PLS-SEM of this chapter is based on a particular research context (i.e. virtual teamwork in online higher education), however, it can be useful in the general research context as well. Such as, why and when PLS-SEM can be considered in research work, what are preliminary considerations need to ensure before applying it in research work, and how to apply PLS-SEM to develop, explore, or analyse any research findings. In general, it can be used as a guideline to apply PLS-SEM statistical technique in a research study.

5.3 Background

The section will present some background information and theory to ease of understating about PLS-SEM statistical technique before starting the main discussion of this chapter.

5.3.1 Structural Equation Modeling

In the past, researchers mainly used **univariate** (analysis of a single variable) and **bivariate** (analysis of two different variables) analysis to analyse data for finding patterns within it and identifying relationships among them respectively. However, to analyse a more complex relationship, **multi-**

variate (analysis of multiple variables) analysis is required which involves different statistical methods (such as factor analysis, cluster analysis, logistic regression, multiple regression, multidimensional scaling, etc.) to analyse multiple variables simultaneously. These multivariate based statistical methods are often called **first-generation methods** (Fornell, 1982, 1987), which can be further classified into exploratory and confirmatory. **Confirmatory** means testing the hypotheses of a priori established theories and concept. The example of first-generation statistical methods for multivariate analysis which falls into the category of confirmatory includes logistic regression, multiple regression, analysis of variance, and confirmatory factor analysis. On the other hand, **exploratory** means testing the hypotheses to identify patterns or relationships when there is no prior knowledge or only a little prior knowledge of how the different constructs or variables are related. The example of first-generation statistical methods for multivariate analysis that falls into the category of exploratory includes cluster analysis, multidimensional scaling, and exploratory factor analysis.

In the past, the researchers of social science usually applied these first-generation techniques on regularly. However, to overcome the weakness of first-generation techniques, in recent times, they are increasingly moving into **second-generation techniques**, which are typically called **structural equation modeling (SEM)**. SEM is considered as a complex statistical technique (Gefen, Straub, & Boudreau, 2000; Golob, 2003), which becomes a powerful technique because of its ability for assessing relations between constructs, including latent (unobserved) variables and indicator (observed) variables, and measurement error in observed variables as well (Chin, 1998). There are two approaches in an SEM to estimate the relationship of a model or as whole to estimate the model, one is **covariance-based SEM (CB-SEM)** and another one is component-based or **partial least squares SEM (PLS-SEM)** (Hair, Black, Babin, & Anderson, 2010; Hair, Ringle, & Sarstedt, 2011). It is noted that PLS-SEM was initially called **PLS path modeling** and the term is still used to refer to PLS-SEM (Hair et al., 2011).

5.3.2 CB-SEM VS PLS-SEM

Traditionally CB-SEM statistical technique is considered as the best known SEM method (Chin, 1998), and it is developed by Jöreskog (1973). CB-SEM uses covariance and considers only common variance to estimate the model parameters (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017). But it is typically very restrictive and based on numerous assumptions (Hair et al., 2011).

On the other hand, PLS-SEM statistical technique is typically viewed as the alternative method to CB-SEM and it is developed by Wold (1975, 1982, 1985). PLS-SEM is a two-step method: the first step refers to path estimates of the measurement (outer) model, and the second step refers to path estimates of the structural (inner) model (Tenenhaus, 2008). PLS-SEM method combines principal components analysis with ordinary least squares regressions to assess partial model structures (Mateos-Aparicio, 2011).

In comparison between these two SEM techniques, CB-SEM uses covariance to estimate the model parameters, and PLS-SEM uses total variance to estimate the model parameters (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017). Besides, CB-SEM uses constructs as common factors to explain the covariance of indicator variables, on the other hand, PLS-SEM uses proxies for a particular construct in the model (Hair, Hult, Ringle, & Sarstedt, 2017). It is to note that, proxies are not identical to constructs, but they are referred to as weighted composites of indicators for a particular construct and explicitly recognized as approximations (Rigdon, 2012). That's why PLS-SEM facilitates a composite-based approach whereas, CB-SEM uses common factors with strong assumptions to explain all the covariance of indicators(Henseler et al., 2014; Rigdon, 2012; Rigdon et al., 2014). Besides, PLS-SEM uses mainly for prediction purposes, whereas, CB-SEM mainly focuses on parameter estimation. In terms of sample size, PLS-SEM can estimate with a smaller sample size due to its small population size (Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016), while CB-SEM always needs a larger sample size for better estimation. So, in a nutshell, it can be said that PLS-SEM and CV-SEM techniques differ in terms of objectives, assumptions, parameter estimates, latent-variable scores, model complexity, and sample size (Chin & Newsted, 1999).

In terms of the application of these two methods, CB-SEM is applied to confirm or reject theories, whereas, PLS-SEM is applied to develop theories in exploratory research. The choice between CB-SEM and PLS-SEM depends on the characteristics and objectives of the research study (Hair, Sarstedt, Ringle, & Mena, 2012). When the primary objective of a research study is to predict and explain the target construct, or to detect important constructs of a structural model then the PLS-SEM approach should consider for the study (Rigdon, 2012). Also, when the theory is less developed or no prior knowledge then PLS-SEM is preferable in comparison to CB-SEM (Rigdon, 2012).

In terms of software packages, there are several options available that can be used for executing PLS-SEM and CB-SEM. The PLS-SEM technique can be executed by the PLS-Graph (Chin, 2003), SmartPLS (Ringle et al., 2015; Ringle, Wende, & Will, 2005), and statistical computing environment R (e.g. semPLS by Monecke & Leisch, 2012), whereas, CB-SEM can be executed by LISREL, AMOS, CALIS, EQS, and SEPATH.

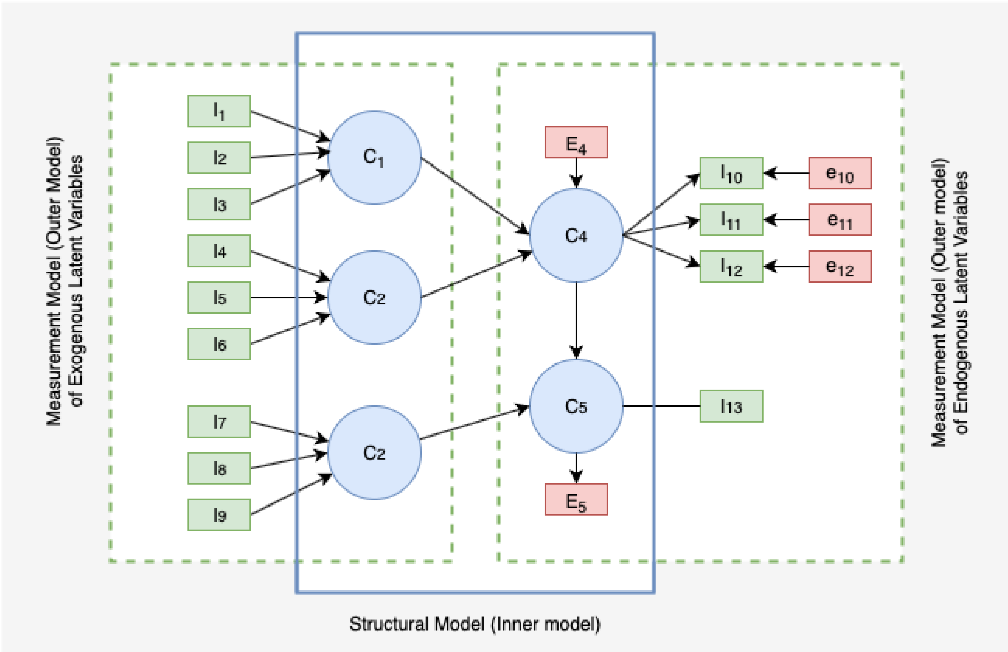
5.3.3 PLS Path Modeling

It is already mentioned that PLS-SEM is also referred to as PLS path modeling. In this section, a detailed discussion about PLS path modeling is presented to point out what are the components or elements are required in order to develop a PLS path model.

A **path model** is a diagram that is developed to visualize the hypotheses and variable relationships and then examined those hypotheses and relationships by using the SEM technique (Hair, Celsi, Money, Samouel, & Page, 2016; Hair et al., 2011). A PLS path model can be described from the perspective of two models: the structural model (also called the inner model) and the measurement model (also called the outer model) (Chatelin, Vinzi, & Tenenhaus, 2002; Diamantopoulos, 2006; Tenenhaus, Vinzi, Chatelin, &

Lauro, 2005). That means, a structural model and a measurement model together construct a complete PLS path model. An example of a PLS path model is shown in figure 5.1.

Figure 5.1: An example of a PLS path model



Source: Adapted form Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (pls-sem)* (2nd ed.). Los Angeles: Sage.

The **structural model** contains constructs and relationships between constructs. **Constructs** are variables that are not directly measured and represented as circles or ovals in the structural model (e.g. in figure 5.1, C_1 to C_5 are constructs). The relationships between constructs are shown as arrows in the path model.

The **measurement models** contain indicator variables and relationships between indicator variables and constructs. **Indicator variables** are directly measured proxy variables which are also called items, or manifest variables. Indicator variables contain the raw data and are represented as rectangles in the path model (e.g. in figure 5.1, I_1 to I_{13} are indicator variables). The relationships between constructs in the structural model and indicator variables in the measurement model are also shown as arrows in the path model. It is also noted that there are two types of measurement model based on the latent (unobservable) variables. If the latent variables i.e. the constructs which explain other constructs in the model then it is called the **measurement model of exogenous latent variables** (e.g. in figure 5.1, left dashed rectangle represents measurement model of exogenous constructs). On the other hand, if constructs are explained by other constructs in the model then it is called the **measurement model of endogenous latent variables** (e.g. in figure 5.1, the right dashed rectangle represents the measurement model of endogenous constructs).

There are also **error terms** in the path models which are connected to the endogenous latent variables (constructs) and the reflectively measured indicator variables. When a path model is estimated, in that case, the unexplained variance is represented by the error terms. On the other hand, exogenous latent variables (constructs) and formatively measured variables do not have error terms. For example, in figure 5.1, e_{10} to e_{12} are the error terms for the reflectively measured indicators I_{10} to I_{12} respectively. However, C_5 is a single-item construct, so there is no error term connected to I_{13}. And, E_4 and E_5 are the error terms for endogenous latent variables C_4 and C_5 respectively, which are labelled differently than the error terms connected to the reflectively measured indicators.

Finally, a theory is required to develop path models, where **theory** is referred to as a set of related hypotheses. **Hypotheses** are individual conjectures that are systematically developed and logically linked together and can be tested empirically to explain and predict outcomes. To develop a PLS path model, two types of theory are required, one is structural theory and another one is measurement theory.

Structural theory shows how the latent variables (constructs) are related to each other in the structural model. The position and sequence of the constructs in the structural model are determined by the theory or the experiences and knowledge of researchers. In the path models, the sequence of constructs is placed from left to right. Any construct which is at the starting (left side) of a sequence is called an **independent variable** (also called an **exogenous latent variable**) (e.g. in figure 5.1, C_1, C_2, and C_3 are independent variables), and which is at the ending of a sequence is called a **dependent variable** (also called an **endogenous latent variable**) (e.g. in figure 5.1, C_4 and C_5 are dependent variables). It is to note that if any construct which is in the middle of a sequence or which serves as both an independent and dependent variable is also called an **endogenous latent variable**. In a nutshell, the construct on the left (independent variable) of a sequence is preceding and predicting the construct in the right (dependent variable) of the sequence. It is to mention that, as the independent variables explain the dependent variables in the path model, they do not have error terms.

Measurement theory specifies how the constructs in the structural model are measured, which can be done in two ways mainly, one is a formative measurement model and another one is a reflective measurement model. It is an important concern to choose a suitable approach (formative measure vs. reflective measure) for modeling a construct in developing the path model which needs to be taken cautiously based on the particular research study.

In a **formative measurement model**, the arrow directions are pointing from the indicator variables to the constructs, which refers to predicting relationships or casual relationships, that means, the indicators variables causes the measurement of the constructs. For example, in figure 5.1, C_1, C_2, and C_3 are formatively measured constructs. It is to note that formative measures are assumed to be error-free (Diamantopoulos, 2006, 2011; Edwards & Bagozzi, 2000).

On the other hand, in a **reflective measurement model**, the arrow directions are pointing from the constructs to the indicator variables, which refers to the assumption relationships, that means the indicator variables causes the measurement of the indicator variables. For example, in figure 5.1,

C_4, and C_5 are reflectively measured constructs. However, in a reflective measure, all the indicator variables have error terms (Diamantopoulos, 2011).

5.3.4 PLS-SEM Bootstrapping Procedure

The bootstrapping procedure is a non-parametric method to examine the stability and significance of various coefficients (such as outer weights, outer loading, and path coefficients) based on resampling subsamples with replacement from the original sample. These subsamples are randomly drawn from the original data.

PLS-SEM uses this bootstrapping procedure because it does not assume a normal distribution of data, and hence, parametric significance tests cannot be applied for testing the statistical significance of coefficients such as outer weights, outer loading, and path coefficients. Therefore, PLS-SEM relies on a non-parametric bootstrapping procedure to test the significance of coefficients (Davison & Hinkley, 1997; Efron & Tibshirani, 1986).

In bootstrapping of PLS-SEM, a big number subsamples (i.e. bootstrap samples) are drawn randomly from the original data sample, where each bootstrap sample contains the same number of observations as in the original sample. A higher number of bootstrap samples provides more reliable results. For example, Chin (1998) recommends 500 bootstrap subsamples. However, in PLS-SEM literature, a widely used recommended number for the bootstrap samples is 5000 (e.g. Hair, Hult, Ringle, and Sarstedt, 2017).

In the context of PLS-SEM, bootstrap confidence intervals are also considered because it provides additional information on the stability of an estimated coefficient. The confidence interval is the range that excludes 2.5% lowest and 2.5% highest values, and the true value of parameter estimates will be somewhere within the range with a 95% probability. It is to note that, an estimated parameter will be significant if its confidence interval does not include zero value. This approach of constructing a bootstrap confidence interval is called the percentile method. However, prior research suggests that in the case of small sample size and asymmetric distribution, this percentile method is subject to coverage error (e.g. Chernick, 2008), and as a consequence, the 95% confidence interval actually would be a 90% confidence interval. Therefore, one of the most useful approaches for constructing bootstrap interval is the bias-corrected and accelerated (BCa) bootstrap confidence interval by Efron (1987), which adjust for biases and skewness in the bootstrap distribution. The more information on BCa bootstrap method can be found in Gudergan, Ringle, Wende, and Will (2008), Henseler, Ringle, and Sinkovics (2009), Sarstedt, Henseler, and Ringle (2011).

Besides, there is another approach for constructing a bootstrap confidence interval called double bootstrapping which is found more accurate than other regular bootstrapping. However, the performance of the double bootstrapping method has not been tested in the context of PLS-SEM. Therefore, primarily a reliable method should the BCa bootstrap method for constructing bootstrap intervals (Hair, Hult, Ringle, & Sarstedt, 2017).

More detailed information on the bootstrapping procedure of PLS-SEM can be found in Hair, Hult, Ringle, and Sarstedt (2017).

5.3.5 PLS-SEM Blindfolding Procedure

PLS-SEM uses a blindfolding procedure for testing the model's predictive relevance with regard to each endogenous construct in the structural model.

The blindfolding procedure is a sample reuse technique that runs iteratively until each data point has been omitted and the model has been re-estimated with remaining data points (Chin, 1998; Henseler et al., 2009; Tenenhaus et al., 2005). Where, the omission distance of the blindfolding procedure should an integer number ranging from 5 to 10 (Apel & Wold, 1982; Chin, 1998; Hair, Sarstedt, Ringle, & Mena, 2012), however, omission distance value 7 is mostly recommended in the literature (Andreev, Heart, Maoz, & Pliskin, 2009). It is to remember that the number of observations (used in the model estimation) divided by omission distance value should not be an integer, otherwise it will delete the same set of observations in each round (Hair, Hult, Ringle, & Sarstedt, 2017).

More detailed information on blindfolding procedure of PLS-SEM can be found in Hair, Hult, Ringle, and Sarstedt (2017).

5.4 Reason for Choosing PLS-SEM

In general, PLS-SEM is a recommended approach to apply as a statistical tool for the following cases, mentioned by Sarstedt, Ringle, and Hair (2017).

- When the primary objective is to explore and predict target constructs, and/or detect important driver constructs in the structural model.
- When the constructs are measured formatively in the structural model.
- When the model to estimate is complex in nature, that means has many constructs and indicator variables.
- When the sample size is small due to its small population size.
- When the intends is to use the latent variable score in the follow-up studies.

These recommendations are matched with the target research study, i.e. virtual teamwork development in online higher education, where, the model to estimate is complex with many constructs and indicators variables, the constructs are formatively measured, and the primary objective is to predict and explore the target construct in the model. The sample size is not an issue in the target empirical study because it has a good number of sample size (more than the recommended minimum sample size requirement). Besides, the sample size issue is clearly an advantage of using PLS-SEM because it works well with a small sample size due to the small population size, and, it works very well with a large sample size as well.

There has a misconception in the case of choosing PLS-SEM for empirical studies only in terms of small sample size, which eventually forwarded a wrong criticism against PLS-SEM (Sarstedt et al., 2016). Hence, it is to remember that a small sample size should not be the sole argument for choosing the PLS-SEM technique in any empirical study but the focus should be on the goal of the study and its empirical analysis (Rigdon, 2016).

Moreover, Hair, Risher, Sarstedt, and Ringle (2018) presented an overview of points researchers should consider when choosing PLS-SEM as an appropriate SEM technique for a study. Most of the main arguments of these below points are also recommended by Sarstedt et al. (2017) which are already mentioned and discussed earlier of this section. However, for the brevity, the complete list is given below as suggested by Hair et al. (2018).

- When the study is about exploratory research for theoretical development or theoretical extensions of established theories to better understand the increasing complexity of the theories.
- When the analysis is to study a theoretical framework or a conceptual model for predicting target constructs in the model.
- When the structural model in the PLS path model is complex with many constructs, indicators variables, and relationships.
- When the sample size is small due to the small population size, however, PLS-SEM also works very well with a large sample size.
- When one or more than one formatively measured constructs present in the PLS path model.
- When latent variables scores are required for follow-up analysis of the research study.
- When financial ratios or similar data types present in the research.
- When the research study is based on secondary data.
- When data distributions assumption is absent (i.e. nonnormal or nonparametric).

This research study on virtual teamwork development is also exploratory research to estimate a theoretical framework or a conceptual model by exploring theories with little or no prior knowledge. Also, the research is primarily based on existing literary works, theories, and logic for an initial theoretical framework or a conceptual model development. These arguments are also similar and matched in favour of using PLS-SEM for the target study. Another reason for choosing PLS-SEM for this research study is the absence of distributional assumptions of data (that means the lack of normality), as this technique relies on nonnormal data. However, many researchers incorrectly indicate this argument (i.e. absence of distributional assumptions of data) as the main reason for choosing PLS-SEM (do Valle & Assaker, 2016; Hair, Sarstedt, Ringle, & Mena, 2012; Nitzl, 2016). This is another big advantage of using PLS-SEM, but should not be the sole argument, rather in combination with other main arguments for choosing the PLS-SEM technique (Hair et al., 2018).

From the above discussion about when to select PLS-SEM, a list of points is summarized in table 5.1 to outline or highlight the main reasons of choosing PLS-SEM for the target empirical study on virtual teamwork development in online higher education. The table has presented the arguments of choosing PLS-SEM based on the characteristics of the study.

Based on these arguments (in table 5.1) it can be said that PLS-SEM is the appropriate SEM to apply for the target empirical study on virtual teamwork development in online higher education because it has fulfilled all the major causes of choosing PLS-SEM as a statistical tool for the study. That's why it also can be said that PLS-SEM is highly recommended and appropriate for the target study in comparison to another SEM technique, CB-SEM.

5.5 How to Apply PLS-SEM

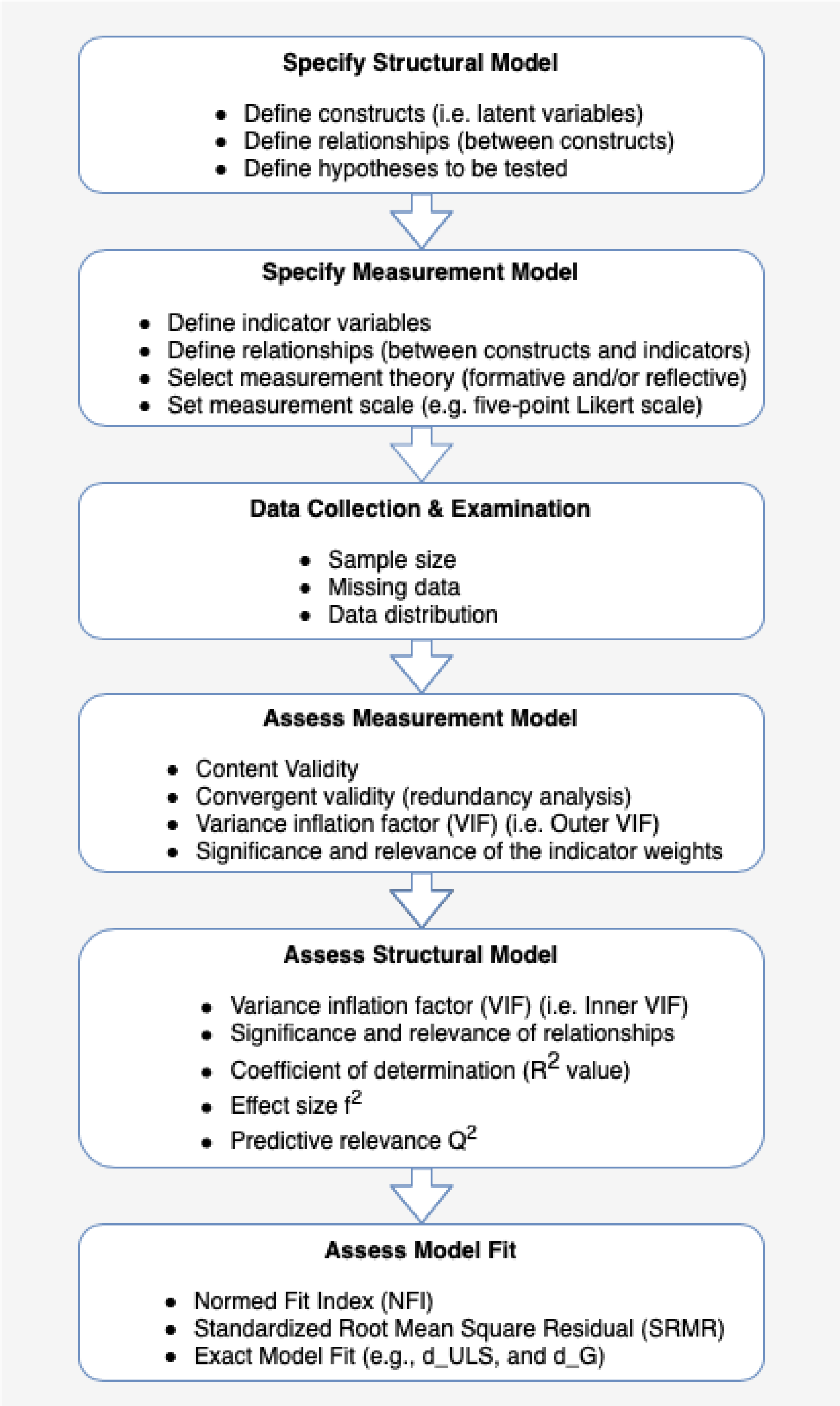
This section describes in detail the procedure of PLS-SEM. That means, how it is applied for the empirical study of effective virtual teamwork development

Table 5.1: Reasons of choosing PLS-SEM for the study

Characteristics	**Arguments in favour of PLS-SEM**
Nature of study	Exploratory
Study purpose	Estimate a theoretical framework or a conceptual model
Primary objectives	Predict or explore target constructs, and/or detect important constructs
Model Complexity	Complex with many constructs, indicator, and relationships
Sample size	More than the recommended minimum sample size
Measurement model	More than one formatively measured constructs
Follow-up analyses	Latent variable scores
Theoretical framework	Developed based on existing literary works, theories, and logics
Data distributions	Nonnormal or nonparametric

in online higher education. A step-by-step procedure for applying PLS-SEM is illustrated in figure 5.2 to outline a complete blueprint of conducting PLS-SEM analysis for this research study. The PLS-SEM procedure also includes a step at the end to assess the model fit for judging how well the hypothesized model structure fits the empirical data. A brief description of all these steps is presented in the following subsections. The evaluation of the model for effective virtual teamwork development in online higher education is presented later in the respective chapters of this thesis by following this procedure.

Figure 5.2: A procedure of applying PLS-SEM



5.5.1 Specify Structural Model

The initial stage of an SEM application is to specify the structural model which illustrates the research hypotheses and displays the constructs (i.e. latent variables) and their relationships that will be examined. This diagram (model) is often referred to as the inner model of a path model that displays constructs and connects them based on theory and logic to derive the hypotheses to be examined. The primary concern of a structural model is to specify the sequence of the constructs and the relationships among them which is developed by observing and organizing the related theory, logic, and practical experiences. However, if the existing literature is inconsistent or lack of clarity then the best judgment will be applied to determine the sequence of constructs and their hypotheses. Also, it is possible to have alternative models to examine different sequences (Sattler, Völckner, Riediger, & Ringle, 2010; Wilson, Callaghan, Ringle, & Henseler, 2007).

There is a trade-off between theoretical soundness and model parsimony to determine the sequences of constructs and their relationships. Where, theoretical soundness means to include relationships that have strong theoretical supports, and model parsimony means to include fewer relationships. However, Falk and Miller (1992, p. 24) pointed out that a parsimonious approach is more powerful than the broad application.

The complete derivation of the structural model for this research study is presented in chapter 6.

5.5.2 Specify Measurement Model

The outer model of a PLS path model is called a measurement model that specifies the relationships between constructs and their corresponding indicators variables. Where the indicator variables are used to measure the constructs, and the relationships are formed based on the measurement theory. That's why, at the very beginning the measurement theory (i.e. formative, or reflective, or both) needs to select for the measurement model to form the relationship between constructs and indicators. Also, a measurement scale is needed to define to measure the constructs through indicator variables. The reliability or validity of hypothesis tests in the structural model depends on how well the measurement model measures the constructs in the structural model.

In this research study, the formative measure is used in the measurement model and the five-point Likert scale is designed to measure the latent variables in the model.

The complete derivation of the measurement model for this research study is presented in chapter 7.

5.5.3 Data Collection & Examination

Data collection and examination is an important stage for any kind of empirical study, which is also particularly true for the applications of SEM. This stage needs to be planned very well to make the empirical study valid and reliable. This research designs questionnaire for the collection of data. However, some issues need to be examined after the collection of data such as sample size, data distribution, missing data, etc. before analysing the data using PLS-SEM.

The detailed information and procedure of data collection and examination for the empirical study of this research is presented in chapter 8.

5.5.4 Assess Measurement Model

This study uses formative measurement in the PLS path model, so the formative measures evaluation criteria will be used to evaluate the measurement model and the quality of the results in PLS-SEM. This is to note that reflective measurement evaluation criteria cannot be applied directly to the formative measurement model. However, many researchers applied reflective measurement model evaluation criteria to assess the quality of formative measures which is incorrect (Hair, Sarstedt, Pieper, & Ringle, 2012; Hair, Sarstedt, Ringle, & Mena, 2012). As the formative measures do not necessarily covary, the same evaluation criteria used for the reflective measurement model cannot be used for the assessment of the formative measurement model (Hair, Hult, Ringle, & Sarstedt, 2017). Also, as the indicator variables in the formative measures are assumed to be error-free (Diamantopoulos, 2006, 2011; Edwards & Bagozzi, 2000), the same internal consistency reliability concept in reflective measures, is not appropriate for formative measures (Hair, Hult, Ringle, & Sarstedt, 2017).

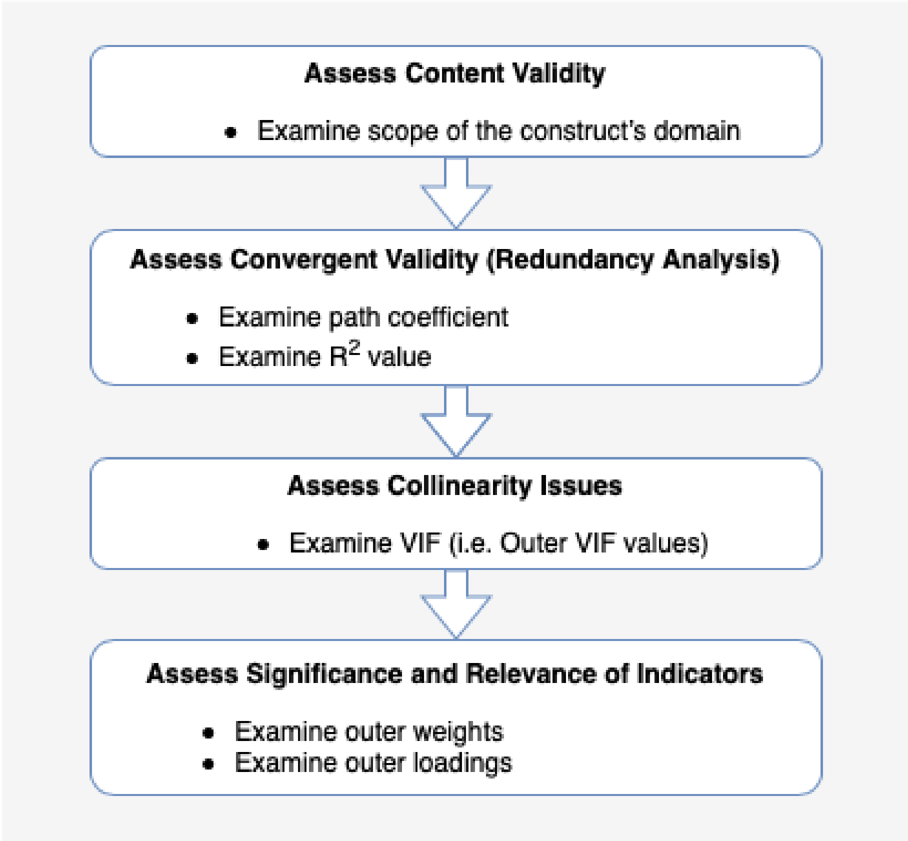
Besides, Chin (1998) mentioned that the same criteria used for assessing construct reliability or construct validity, or discriminant validity of reflective measures is not meaningful for formative measures. Therefore, this study uses the following procedure outlined in figure 5.3 to evaluate the formative measurement model particularly. These evaluation criteria are chosen based on the suggestions from existing literature (e.g. Andreev et al., 2009; Hair, Hult, Ringle, and Sarstedt, 2017; Hair et al., 2018).

5.5.4.1 Assess Content Validity

In a formative measurement model, the content validity of all the formatively measured constructs should be established first before empirically evaluating them (Hair, Hult, Ringle, & Sarstedt, 2017). Content validity ensures that the formative indicators capture the entire scope of the construct (or at least major) facets of the construct as specified by the construct's domain (i.e. the content the indicators are intended to measure) (Diamantopoulos & Winklhofer, 2001; Hair, Hult, Ringle, & Sarstedt, 2017; Straub, Boudreau, & Gefen, 2004). On the contrary, the wrong specification of indicators form construct that does not cover content in common with the explored and specified construct domain, and hence, can lead to biased estimation results (Andreev et al., 2009). Thus, this step is considered as an initial and important step for evaluating a formative measurement model before assessing other evaluation criteria of applying PLS-SEM. Besides, Petter, Straub, and Rai (2007) proposed content validity as a mandatory practice for evaluating formative constructs in the measurement model.

However, the content validity of formative constructs needs to be conducted

Figure 5.3: A procedure of assessing formative measurement model



through a literature review related to the constructs domains (Straub et al., 2004). Therefore, in assessing the content validity of a formative measurement model, to ensure the reasonable theoretical grounding of the formative measures, researchers should conduct a thorough literature review for findings their supports form the existing literature (Diamantopoulos & Winklhofer, 2001; Jarvis, MacKenzie, & Podsakoff, 2003). For that reason, it is also considered in this study for ensuring the content validity of the formative measurement model.

5.5.4.2 Assess Convergent Validity

The convergent validity assessment can be used for the examination of *construct validity* for formative constructs. Unlike construct reliability (which concerns the measurement within the construct), construct validity is the measurement which refers to the out of the construct validation of its measures (Straub et al., 2004). So, assessing convergent validity means to test whether the formatively measured construct is highly correlated with the same construct measured reflectively with multi-item or measured with a global single item. In this assessment, as the construct is redundant in the model (i.e. included as both formative construct and reflective construct), this type of analysis is also called redundancy analysis (Chin, 1998). In this analysis, a formatively measured construct (as an exogenous construct) is connected with a reflective measure of the same construct (as an endogenous construct) and check the path coefficient (for definition and details see Olobatuyi, 2006; Wright, 1934) and R^2 value (for definition and details see Everitt & Skrondal, 2010) for convergent validity of the construct. A desirable minimum path coefficient value is 0.70 or above, which means that the acceptable minimum R^2 value is 0.50 or above for the reflectively measured construct. Anything below the threshold value indicates that the formative indicators of the construct do not contribute at a sufficient degree to its intended content (Hair, Hult, Ringle, & Sarstedt, 2017).

The challenging part of this analysis is to include a number for suitable indicators of the reflectively measured construct in data collection. The reason is that including multi-item reflective indicators increase the survey length which is not desirable in most cases because it creates the chance of respondent fatigue, decreasing response rates, and increasing the number of missing values (Hair, Hult, Ringle, & Sarstedt, 2017). An alternative approach is to include a global indicator in the survey that summarizes the essence of the formatively measured construct (Sarstedt, Wilczynski, & Melewar, 2013), which is much more flexible, less time-consuming, and more importantly, does not affect the survey length. That's why this approach is adopted in this study for doing the redundancy analysis.

5.5.4.3 Assess Collinearity Issues

The assessment of collinearity is a kind of examination for testing *construct reliability*, which concerns the internal consistency of a measurement model (Straub et al., 2004). So, collinearity assessment checks whether each formative indicator in the measurement model contributes its intended meaning to the formative index (Hair, Hult, Ringle, & Sarstedt, 2017). This assessment needs to be performed for a formative measurement model because indicator information in a model could be redundant if it has a high correlation with other indicators of the same construct. The high correlation between indicators of the same construct is problematic and needs to fix because it indicates the presence of collinearity at a critical level. It is to note that when more than two indicators are involved in the same constructs, then this collinearity issue is called multicollinearity. That's why the multicollinearity term is mostly used to refer to collinearity issues in a formative measurement model as it is very common to have more than two indicators in a construct.

Multicollinearity tests the measurement properties for a formative construct (Petter et al., 2007). There are different ways to assess collinearity issues such as condition index (CI), bivariate correlation, and variance inflation factor (VIF). However, in the context of PLS-SEM, VIF (for definition see James, Witten, Hastie, & Tibshirani, 2017) is the standard approach to statistically assess the presence of critical collinearity levels in the formative measurement model. As a rule of thumb, a VIF value of less than 10 indicates the absence of multicollinearity (Gefen et al., 2000). However, research in PLS-SEM indicates that the **VIF value of less than 5** is mostly accepted (e.g. Hair, Hult, Ringle, and Sarstedt, 2017). The VIF value 5 or higher indicates the presence of a potential collinearity problem (Hair et al., 2011). In the case of collinearity at the critical level, the corresponding indicator of the construct should be removed, providing that the remaining indicators sufficiently captures the content of the construct.

5.5.4.4 Assess Significance and Relevance of Indicators

Finally, it is very important to examine whether the formative indicators contribute significantly to their corresponding constructs both relatively and absolutely (providing that collinearity is not at a critical level in the formative measurement model which is assessed in the previous step). This can be done by assessing the (statistical) significance and relevance of the formative indicators to their corresponding constructs both relatively and formatively through their outer weights and outer loadings (for definition see Latan & Noonan, 2017) respectively. Where, the outer weights are the statistics of multiple regression (Hair et al., 2010), which state the relative contribution of each indicator to its corresponding construct or express the relative importance of each indicator to forming its corresponding construct. On the other hand, outer loadings are the statistics of a simple regression, which state the absolute contribution of each indicator to its corresponding construct or express the absolute importance of each indicator for its corresponding construct (Hair, Hult, Ringle, & Sarstedt, 2017).

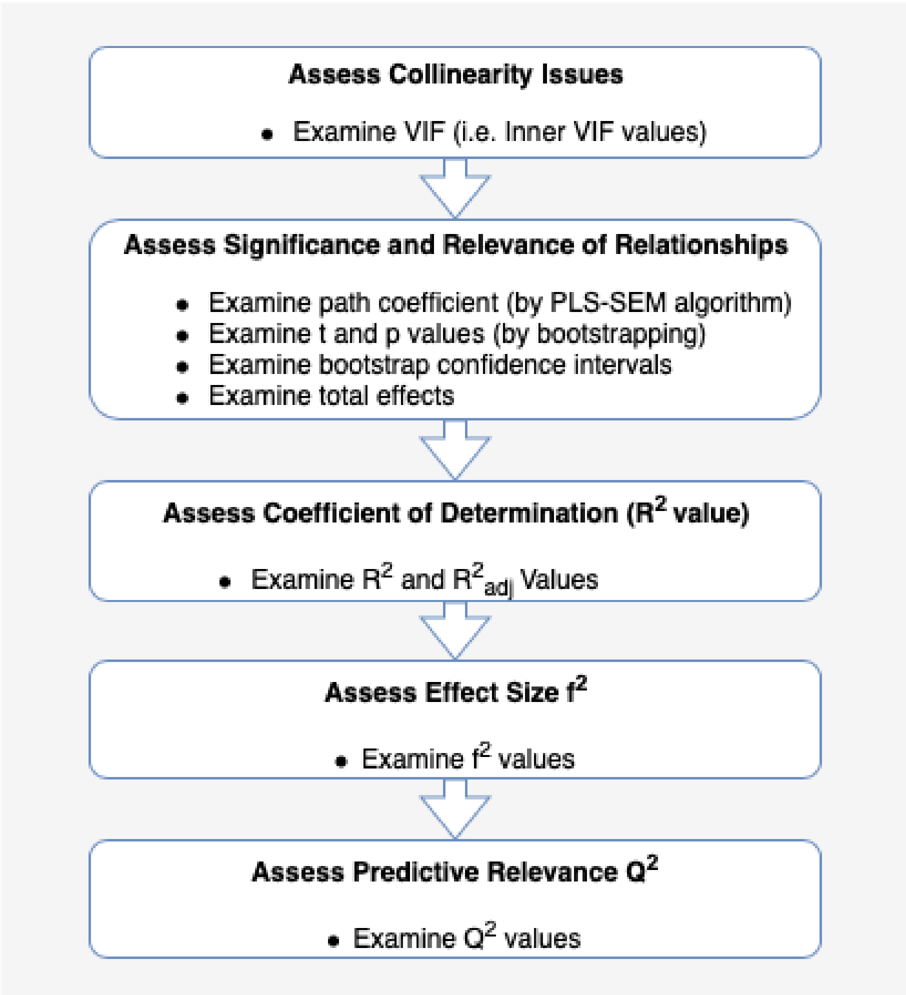
The outer loading or absolute contribution of any formative indicator comes to handy when the indicator's outer weight is found non-significant. That means, if the indicator's **outer loading is 0.5 or above**, it can be kept in the measurement model even it is found non-significant in terms of its outer weight.

The assessment of significance and relevance of indicators is done by applying the bootstrapping procedure of PLS-SEM. The more information on the bootstrapping procedure of PLS-SEM is presented in 5.3.4.

5.5.5 Assess Structural Model

This subsection contains the description of structural model evaluation criteria which will be used to assess the structural model of this study. Once the measurement model evaluation is found reliable and valid then the next step is the assessment of the structural model. The following systemic procedure outlined in figure 5.4 is considered for the assessment of the structural model of this study. These evaluation criteria are chosen based on the suggestions from existing literature (e.g. Chatelin et al., 2002; Chin, 1998; Hair, Hult, Ringle, and Sarstedt, 2017; Tenenhaus et al., 2005).

Figure 5.4: A procedure of assessing structural model



5.5.5.1 Assess Collinearity Issues

The first step to the assessment of the structural model is to examine the collinearity issues for the structural model. The reason is that the path coefficients of the structural model might be biased if the estimation indicates the presence of collinearity at a critical level among the predictor constructs. For that reason, each set of predictor constructs is examined separately for each subpart of the structural model to assess whether the collinearity reaches the critical level among the predictor constructs. Like the evaluation in the formative measurement model, the VIF (for definition see James et al., 2017) values are used for the assessment of collinearity issues for the structural model. The VIF values above 5 in the predictor constructs indicate the presence of collinearity at a critical level, and in that case, the corresponding constructs should remove, or merge into a single construct, or create higher-order constructs to treat collinearity issues for the structural model (Hair, Hult, Ringle, & Sarstedt, 2017).

5.5.5.2 Assess Significance and Relevance of Relationships

Next to assess the significance and relevance of the structural model relationships which represent the hypothesized relationships among the constructs in the model. This can be examined by the path coefficients which have standardized values approximately between -1 to $+1$. The path coefficients values close to $+1$ are usually statistically significant, that means represent strong positive relationships. On the other hand, path coefficients values close to -1 are usually not statistically significant, which means represent weaker relationships.

However, the path coefficients obtained from running the PLS-SEM algorithm is not enough to say that the path coefficients are statistically significant because it depends on the standard error that is obtained through the bootstrapping procedure. The reason is that the bootstrap standard error makes it possible to compute the empirical t values (for definition see Walpole, 2006) and p values (for definition see Fisz, 1963) for all path coefficients of the structural model. If the empirical t value is larger than the critical value then it indicates that the path coefficient is statistically significant at a certain error probability (i.e. significance level). The common critical values of t for a two-tailed test that used to examine the significance of path coefficients are 1.65 (significance level = 10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1%). The choice of significance level depends on the objective and field of the study. In general, a 10% significance level can be assumed in exploratory research, and a 5% significance level can be assumed in marketing research (Hair, Hult, Ringle, & Sarstedt, 2017). However, a 5% significance level is considered for this study which is mostly assumed in most of the study for testing the significance of path coefficients.

The empirical p values can also be used to assess the significance levels. In that case, the p value must be smaller than 0.05 to be considered as a significance level of 5%, and the p value must be smaller than 0.01 to be considered as a significance level of 1%.

Besides, the bootstrapping confidence intervals also provide information on the stability of the estimated path coefficients of the structural model, and hence allows assessing whether a path coefficient is significantly different from zero. As the bootstrap confidence interval is based on a standard error, it specifies the range which should contain the true value assuming a certain level of confidence (e.g. 95%). If the estimated path coefficient's confidence interval does not include zero then it can be considered as a significant effect. The more information on the bootstrapping procedure of PLS-SEM is presented in 5.3.4.

After assessing the significance of structural model relationships, it is important to assess the relevance of significant relationships because the path coefficients may be significant but their size may be small. For that reason, the relevance of relationships is crucial for interpreting and concluding the results even though the relationships are significant (Hair, Hult, Ringle, & Sarstedt, 2017). The relevance of relationships can be examined by the total effects (i.e. sum of indirect and direct effects).

Therefore, the bootstrapping procedure is used ultimately to assess the significance and relevance of structural model relationships (such as t values, p values, bootstrap confidence intervals, and total effects) to conclude that whether the relationships of the structural model are statistically significant and relevant respectively.

5.5.5.3 Assess Coefficient of Determination (R^2 Value)

One of the most commonly used evaluation criteria of the structural model is the coefficient of determination (R^2 Value) (see definition Everitt & Skrondal, 2010) that measure the predictive power of the model. It represents the combined effects of all the linked exogenous constructs on the endogenous construct. That is, it represents a measure of in-sample predictive power (Rigdon, 2012; Sarstedt, Ringle, Henseler, & Hair, 2014) ranges from 0 to 1, with higher levels indicating higher levels of predictive accuracy. However, the acceptable R^2 value depends on the model complexity and the study field. That's why it is difficult to provide a common rule of thumb for acceptable R^2 Values. For example, in marketing research, R^2 Values of 0.75, 0.50, and 0.25 for endogenous constructs are considered as substantial, moderate, and weak respectively (Hair et al., 2011; Henseler et al., 2009). Though this rule of thumb is particularly for marketing research, in general, it is considered as rules of thumb for R^2 values. That's why this rule of thumb is also used in this thesis for interpreting the R^2 values of the endogenous constructs of the model.

The R^2 Values should not be considered solely to understand the predictive power of the model because there might be an inherent bias towards a complex model. As a remedy in multiple regression, the adjusted coefficient of determination (R^2_{adj} value) can be considered as the evaluation criteria to avoid bias towards complex models (Hair, Hult, Ringle, & Sarstedt, 2017). Therefore, both R^2 and R^2_{adj} values are considered in this research study to evaluate the predictive power of the model.

5.5.5.4 Assess Effect Size f^2

In addition to exploring R^2 values, the changes in R^2 can also be explored, which is known as effect size (f^2) (for definition see Ellis, 2010) evaluation criteria, and was firstly presented by Cohen (1988). The f^2 effect size technique examines the substantive impact of each independent construct on the dependent construct in order to assess the structural model. More precisely, in this evaluation, a specified construct is omitted form the model to examine the impact of the omitted exogenous construct on the endogenous constructs.

Nowadays, this f^2 effect size evaluation criteria is increasingly encouraged by reviewers and editors of journals for including in the structural model assessment (Hair, Hult, Ringle, & Sarstedt, 2017). Hence, it is also considered for this research study to assess the structural model in addition to evaluating the R^2 values.

The rules of thumb for assessing the f^2 effect size are 0.35, 0.15, and 0.02, which indicate large, medium, and small effects of exogenous construct respectively (Cohen, 1988). There is no effect if the value of the effect size is less than 0.02.

5.5.5.5 Assess Predictive Relevance Q^2

In the structural model assessment, the R^2 values are used as an evaluation criterion of predictive accuracy, or as an indicator of the model's in-sample predictive power. In addition to this evaluation, there has another one which is used as an evaluation criterion of predictive relevance, or as an indicator of the model's out-of-sample predictive power. This type of evaluation of the structural model is examined by Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974). That means, Stone-Geisser's Q^2 value can be used for testing the predictive relevance of the structural model, and to be noted that it needs a blindfolding procedure with a specified omission distance to generate Q^2 values (Chin, 1998). The information on the blindfolding procedure is presented in 5.3.5. Whenever a particular endogenous construct has a Q^2 value greater than 0 then it indicates the presence of predictive relevance of the path model for a particular dependent variable. In contrast, a Q^2 value of zero, or below (negative value of Q^2) indicates the absence of predictive relevance.

There are two different approaches of calculating Q^2 values, one is cross-validated redundancy approach (includes both structural model and measurement model, and hence perfectly fits in PLS-SEM), and another one is cross-validated communality approach (without including structural model information). Among these two approaches, it is recommended to use the cross-validated redundancy approach as a measure of Q^2 values because it includes the structural model (the key element of the path model) along with the measurement (Hair, Hult, Ringle, & Sarstedt, 2017).

5.5.6 Assess Model Fit

This section explains the model fit measures in PLS-SEM. Before starting the discussion it is important to understand the model fit concepts in CB-SEM and PLS-SEM.

PLS-SEM examines the structural model so that the explained variance of the endogenous constructs is maximized. This aspect is different from CB-SEM, which examines the structural model so that the differences between the sample covariances and those predicted by the conceptual/theoretical model are minimized. That's why in CB-SEM, the covariance matrix estimated by the conceptual model is as close as possible to the sample covariance. In, CB-SEM, goodness-of-fit measures such as the chi-square statistic, or the various model fit indices are based on the differences between these two covariance matrices. Therefore, the notion of fit is not fully transferable to PLS-SEM because it works differently than CB-SEM (i.e. when PLS-SEM estimates the model parameters it maximizes the explained covariance instead of minimizing the differences between covariance matrices) (Hair, Hult, Ringle, & Sarstedt, 2017).

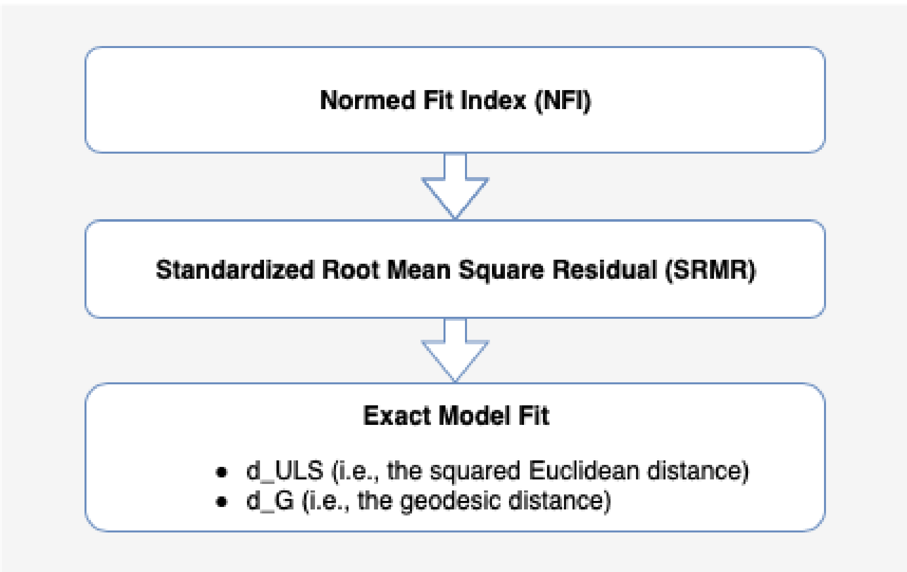
That's why in PLS-SEM, the structural model is primarily assessed based on the heuristic criteria that are determined by the predictive capabilities of the model, instead of assessing goodness-of-fit. By definition, these criteria do not allow for testing the overall goodness-of-fit of the model in PLS-SEM like in a CB-SEM sense. In PLS-SEM, the model is assessed in terms of how well it predicts the endogenous constructs in the structural model (e.g. path coefficients, total effects, R^2 values, f^2 effect sizes, and Q^2 values for testing the significance and relevance of the model in PLS-SEM). The more discussion about model fit measures in CB-SEM and PLS-SEM can be found in (Sarstedt et al., 2014).

However, there are several early stages of development model fit measures for PLS-SEM. For example, the goodness-of-fit index (GoF), one of the earliest fit indices proposed by Tenenhaus, Amato, and Vinzi (2004) and Tenenhaus et al. (2005) for validating the PLS model globally. But Henseler and Sarstedt (2013) challenged the usefulness of the GoF both conceptually and empirically and stated that it does not represent a goodness-of-fit criterion for PLS-SEM. That's why it is not considered in this study.

Another measure of model fit, the root mean square residual covariance (RMS_{theta}) introduced by Lohmöller (1989) which relies on covariances. But this criterion has not been explored yet in a PLS-SEM context until recently by the PLS-SEM researchers (Hair, Hult, Ringle, & Sarstedt, 2017). That's why it is not considered as well in this study.

Finally, the following model fit measures outlined in figure 5.5 are considered to assess the model fit of this study. The description of each of the model fit measures is presented in the rest of the section.

Figure 5.5: A procedure of assessing model fit



5.5.6.1 Normed Fit Index (NFI)

Normed fit index (NFI) is one of the first model fit measures proposed in the SEM literature by Bentler and Bonett (1980), which computes the Chi^2 value of the proposed model and compares it against the Chi^2 value of the null model (a meaningful benchmark). Afterwards, the NFI is defined as 1 minus the Chi^2 value of the proposed model divided by the Chi^2 values of the null model.

The NFI results in values between 0 and 1. Generally, the NFI value above 0.90 is considered as an acceptable fit. However, this explication is quite difficult to achieve. Therefore, in general, the NFI values closer to 1 indicate the better model fit (SmartPLS-Documentation, 2020).

5.5.6.2 Standardized Root Mean Square Residual (SRMR)

The standardized root mean square residual (SRMR) measure fit is defined as the difference between the observed correlation and the model implied correlation, which is originally known for CB-SEM. However, Henseler et al. (2014) assessed the efficacy of the SRMR in a PLS-SEM context and suggested the SRMR as a goodness of fit measure for PLS-SEM (that can be used to avoid model misspecification) as well.

The SRMR is an absolute measure of (model) fit criterion, that's why a value of zero indicates a perfect fit. However, a value of less than 0.08 is generally considered a good model fit when applying CB-SEM (Hu & Bentler, 1998). But this threshold value is likely too low for PLS-SEM. Besides, this threshold value is considered in a more conservative version, that's why a value less than 0.10 is also considered a good fit (Hu & Bentler, 1998).

5.5.6.3 Exact Model Fit

The exact model fit tests the statistical inference of the discrepancy between the observed correlation (empirical covariance) matrix and the model implied correlation matrix (covariance matrix implied by the composite factor model). Unlike SRMR, the discrepancy is expressed in terms of distances (i.e. not in the forms of residuals like in SRMR).

There are two different approaches to calculate this discrepancy, d_ULS (i.e., the squared Euclidean distance) and d_G (i.e., the geodesic distance), defined by Dijkstra and Henseler (2015). The PLS-SEM bootstrapping procedure provides the confidence intervals of these discrepancy values. The original value of the exact d_ULS and d_G fit criteria have to be compared against the confidence interval created from the sampling distribution, and then the original value should be included in the confidence interval. That means, the upper bound (is at the 95% or 99% point) of the confidence interval should be larger than the original value of the exact d_ULS and d_G fit criteria to indicate that the model has a **good fit**.

5.6 Summary

The content of this chapter discussed the PLS-SEM statistical technique to deliver the message about why, when, and how it can be applied in the research work, virtual teamwork development in online higher education. This chapter mainly summarized and synthesized the key points of choosing PLS-SEM and how it has been applied to analyse the virtual teamwork development in online higher education. Also, a general overview is presented about the difference between PLS-SEM and CB-SEM, and a brief description of PLS path modeling. It is believed that the detailed discussion of this chapter consolidated the foundation and justification of choosing PLS-SEM in the research work for virtual teamwork development in online higher education. Though the content of the chapter is presented for a specific topic bear in mind, however, it can be used useful in general for other research studies as well and can be used as a guideline about PLS-SEM statistical technique.

Part III

Model Development

Chapter 6

Conceptual Model

Chapter Preface

The shorter version of this chapter is already published as an article in the peer-reviewed *RII Forum 2020* Proceedings. The author and supervisor of the article is the same as the author and supervisor of this thesis. Full citation of the article is mentioned below:

> Jony, A. I., & Serradell-López, E. (2020c). Key factors that boost the effectiveness of virtual teamwork in online higher education. In A. Visvizi, M. D. Lytras, & N. R. Aljohani (Eds.), *Research & innovation forum 2020: Disruptive technologies in times of change.* Springer Proceedings in Complexity, Springer

6.1 Chapter Overview

The conceptual model to develop effective virtual teamwork in online higher education is proposed and described in this chapter.

6.2 Introduction

A conceptual/theoretical model is a way of representing a particular concept, or set of concepts to ease of understanding or simulating the subject of that model. Also, it is a way of representing relationships between factors, and the effects of factors on other factors. Therefore, in the context of online higher education, a conceptual model will be developed and proposed in this chapter to represent the relationships between the key factors of virtual teamwork, and the impact of the factors that foster the effectiveness of virtual teamwork in online higher education.

For evaluating the effectiveness of virtual teamwork, *performance* is the main responsible factor because the success of the virtual teamwork depends on it, which is also true for traditional face-to-face teamwork (Pinar et al., 2014). Besides, performance is defined as the measurable outcome of any task (Swanepoel, Erasmus, Wyk, & Schenk, 2011), which can be referred as a measurement of the achieving goals or desired outputs (Armstrong, 2007), or the evaluation of success (Idrus et al., 2011; Ludden & Ledwith, 2014) of a work. In this study, performance means to measure, evaluate, or judge the effectiveness of teamwork (Zigon, 2000) in the context of online higher education. That means, the performance of team members or the overall team responsible for the success or effectiveness of virtual teamwork, which is also supported by many research works (e.g. Armstrong, 2007; Gordon and Curlee, 2011; Hahm, 2017; Ludden and Ledwith, 2014; Rad and Levin, 2006; Wise, 2013).

However, there are other factors that are critical and affect *performance* directly or indirectly, and eventually, foster the effectiveness of virtual teamwork in online higher education. That's why the main focus is to identify the key factors that affect the effectiveness of virtual teamwork.

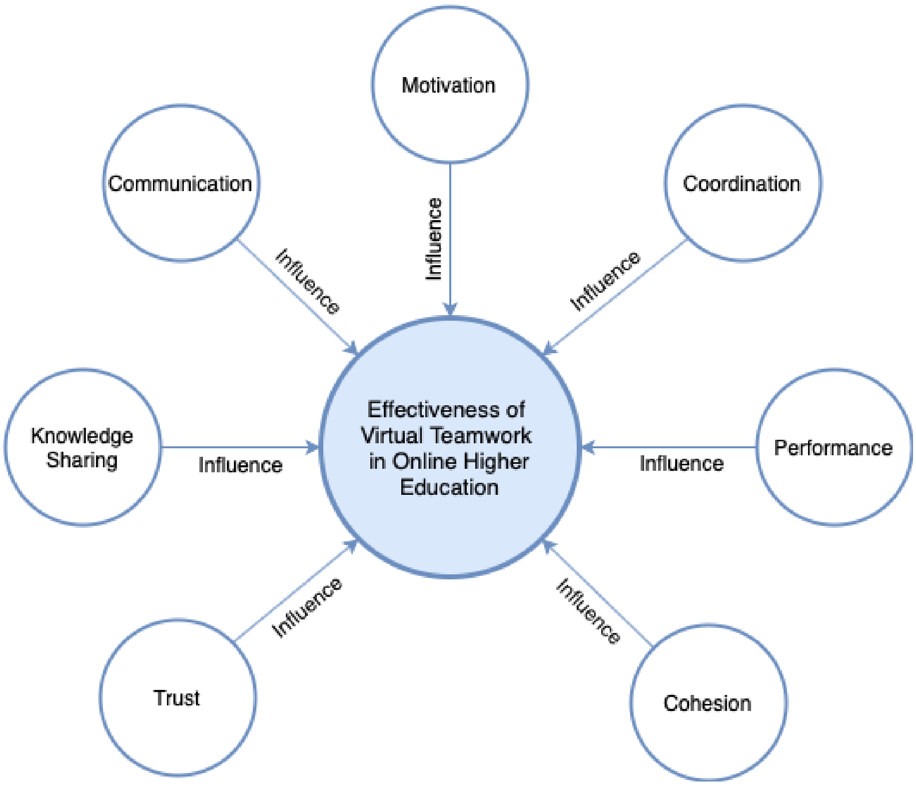
So, the plan is to discover and explore more about virtual teamwork in online higher education, and its performance criteria (i.e. effectiveness criteria) that influence the effectiveness of virtual teamwork. Therefore, qualitative research method will be used here for exploring the topic and discovering the key factors of virtual teamwork that affects the effectiveness of virtual teamwork because this method is suitable for discovering and exploring more about a topic in terms of people's experiences and perspectives (R. Johnson & Onwuegbuzie, 2004; Mouton, 2001). Besides, in general, the qualitative research method is used for interpreting or exploring information on a topic, whereas, the quantitative research method is used for measuring the data points statistically about the topic (R. Johnson & Waterfield, 2004). In addition, qualitative methodology is suitable for examining the unit of people in detail on a chosen portion of the range (Morgan, 2014; Mouton, 2001). Finally, the type of exploration of this study topic towards developing a conceptual model is particularly aligned with the qualitative research method, and hence, chosen and applied here.

For developing and proposing a conceptual model based on the theory, logic, and existing literature, an extensive systematic review is performed, which is presented in *chapter 2: Systematic Review*. The systematic review is performed based on the prestigious, popular, and widely used database, Web of Science. However, for not missing any related information and research work, the other common databases (such as Scopus, ERIC, ACM Digital Library, Springer, IEEE Xplore, and Google Scholars) are also considered for the exploration and content analysis of the topic towards developing the conceptual model of this research work.

A detailed description of the reviewed related literature and theories is presented in *chapter 3: Theory & Literature Review*. The reviewed literature and theories have revealed that there are some key factors that are responsible for the effective virtual teamwork development in online higher education (e.g. Gordon and Curlee, 2011; Lippert and Dulewicz, 2018; Ludden and Ledwith, 2014; Schwalbe, 2014; Sridhar et al., 2007 are some references among them). The key factors of virtual teamwork, which are finally selected for developing the conceptual model of this study in the context of online higher education is depicted in figure 6.1.

Besides these key factors, there are other factors found in the literature

Figure 6.1: Key Factors of Virtual Teamwork in Online Higher Education



which influence the effectiveness of virtual teamwork but those are not critical in the context of online higher education. That why those are not considered as critical factors of virtual teamwork in the context of online higher education.

The detailed description of the key factors (represented in figure 6.1) that affect the effectiveness of virtual teamwork in the context of online higher education is presented in section 6.3. Besides, the relationships between the factors are presented in section 6.4. Finally, the conceptual model along with the set of hypotheses is proposed and presented in section 6.5.

6.3 Key Factors

This section will present the description of the key factors (shown in figure 6.1) that affect the effectiveness of virtual teamwork in online higher education and eventually constructs the conceptual/theoretical model to be proposed in this thesis. This section represents the so-called coding scheme of the conceptual model and the justification of the key factors with supporting references for being included in the conceptual model to be proposed.

6.3.1 Performance

In a virtual team, each team member works independently on a given task to successfully complete it (Holmes, 2012), where the performance of each team member is measured by the assigned tasks towards achieving the objective/goals of the team. In general, team member performance means to get the desired output from the assigned task, by following the planned objectives and requirements of the team's goal (Armstrong, 2007). However, team member performance is boosted if they are given importance, value, encouragement, and appreciation (Holmes, 2012). Basically, each team member is responsible for their own performance, and a good performer is always tried hard to improve his/her performance at the same time correcting their mistakes or weakness or shortcomings.

On the other hand, team performance means combined work for achieving the team's objectives and goals (Kirkman & Mathieu, 2007; Schwalbe, 2014) by interacting and collaborating with the members of the team (Bedwell et al., 2009). That's why team performance measurement should be clearly defined according to the team's goals and objectives. In the teamwork, if all the team members are at the almost same level in terms of communication and involvement, it's easier to achieve higher team performance (Schwalbe, 2014) because it ensures the awareness about the responsibility among the team member that is, who is performing which duties in the team (Duarte, 2002; Gordon & Curlee, 2011) to meet the team's objective and goals.

In addition, if a team has a team leader then the effectiveness of a team is also depends on the performance of the team leader. In virtual teamwork, the team leader is the key person for managing, leading, and driving the whole team towards achieving the team's goal (Cardy & Miller, 2015; Scott & Wildman, 2015). A team leader's performance can ensure the performance of teamwork by managing and executing required activities for achieving the team's goals and objectives (Rad & Levin, 2006; Wise, 2013). That's why in a virtual environment, a team leader should be skilled in various aspects and competencies (Gordon & Curlee, 2011; Kaboli, Tabari, & Kaboli, 2006; Setle-Murphy, 2013). A skilled team leader builds trust among the team members and maintains a neutral atmosphere in the team (Setle-Murphy, 2013). Besides, a team leader is responsible for managing all the resources for performing teamwork and improving team performance, and also responsible for maintaining a clear plan and schedule for the successful completion of the teamwork according to the team's goals (Jassawalla & Sashital, 2000; Wise, 2013). Moreover, team leaders also should have intercultural awareness in virtual teamwork (Dinsmore & Cabanis-Brewin, 2014; Koster, 2010; Yazici, 2009). But, in the context of higher education or university-level education, having a team leader in a virtual team of students is not a very common scenario. That's why the leadership aspect of the virtual team is not considered in this study.

Therefore, performance will be considered as the target key factor in the conceptual model of this study that evaluates the effectiveness of virtual teamwork in the context of online higher education.

6.3.2 Motivation

In teamwork, motivation is the level of enthusiasm which encourages team member to actively work in a team to achieve the team goal (Lurey & Raisinghani, 2001; Sridhar et al., 2007). In addition, it influences the performance of the team (Geister et al., 2006) as a consequence, affects the effectiveness of teamwork in a virtual environment as well. On the other hand, without motivation team member feels discouraged which affects the performance and decreases the effectiveness of the teamwork (Lurey & Raisinghani, 2001). Therefore, motivation is considered as one of the key factors in terms of the effectiveness of virtual teamwork (Hertel et al., 2005; Peterson, 2007).

Moreover, a motivated team member always stays active within the team and willingly contributes to achieving the goal of the team (Ardichvili et al., 2003). For that reason, it is important to know how a team member get motivated while working in a team in the virtual environment (Peterson, 2007). A team member can be motivated by giving incentives or rewards for good performance or showing positive attitudes whatever the situation (Peterson, 2007). According to Geister et al. (2006), regular information and feedback about the team situation could have positive impacts on motivation. However, in the context of online higher education, team members can be motivated when they are challenged by the tasks given, or when they are confident about the learning outcome and future prospects, and/or when they are able to add value or contributes sufficiently to the teamwork.

6.3.3 Communication

In virtual teamwork, communication refers to the exchange of information and discussion between team members by means of electronic documents, text or voice messages, video conference, emails, blogs, and forums to successfully complete the teamwork (Gordon & Curlee, 2011; Ludden & Ledwith, 2014; Richardson et al., 2012; C. Saunders et al., 2004). Technological development makes the communication process easier for an activity like virtual teamwork. In the context of virtual teamwork, communication is the first thing to be considered seriously for its effectiveness (Duarte & Snyder, 2006; Gordon & Curlee, 2011; Maznevski & Chudoba, 2000; Setle-Murphy, 2013; Wise, 2013) because fruitful communication makes knowledge sharing, periodical meeting, and discussion easier in virtual teamwork which is regular activities of any team for its successful completion or effectiveness. Therefore, communication between team members has a strong influence on the performance and effectiveness of virtual teamwork

(Duarte, 2002; Setle-Murphy, 2013; Suchan & Hayzek, 2001; Wise, 2013).

On the other hand, poor communication causes many problems in virtual teamwork (Rosen, Furst, & Blackburn, 2006), and eventually negatively affects the effectiveness of virtual teamwork. For example, a study by Schwalbe (2014) shown that failure in communication between team members is one of the major causes against the success of virtual teamwork. Besides, the importance of communication is sometimes overlooked and undervalued (Gordon & Curlee, 2011; Richardson et al., 2012) which leads to failure in virtual teamwork. That's why, team members without having proper communication skills, abilities, and knowledge it is difficult to obtain the effectiveness of virtual teamwork (Duarte & Snyder, 2006). Thus, communication is considered as one of the key factors that affect the effectiveness of virtual teamwork, and it is advisable to measure the communication factor for effective virtual teamwork development in the context of online higher education.

6.3.4 Knowledge Sharing

A team consists of individuals with the necessary skills and expertise to collaborate on organizational tasks (Hoegl & Gemuenden, 2001). This type of orientation of a team enables the distribution of knowledge and information among team members and facilitates effectiveness in teamwork and achievement of more effective outcomes (Lam, 2000). So, the exchange of knowledge, or information, or experiences between team members is called knowledge sharing in the case of virtual teamwork.

However, knowledge sharing depends on the willingness of the team members (Bock et al., 2005). That means knowledge sharing is a voluntary activity in a team (Hahm, 2017). So, the team member should have a willingness to share knowledge/information in the team (Jessica & Leslie, 2012) when necessary for the effectiveness of virtual teamwork. By the means of knowledge sharing, team members can acquire new knowledge, information, experiences, know-how, and organizational and business policy which improves their performance, and makes them knowledgeable as well (Hahm, 2017). As a consequence, it affects the effectiveness of teamwork (Alsharo et al., 2017). That means knowledge sharing has a positive influence on the effectiveness of virtual teamwork (Alsharo et al., 2017; Hahm, 2017). Moreover, knowledge sharing practices within the team is considered as the key activity of virtual teamwork to enhance the performance and effectiveness of the virtual teams (Xiao & Jin, 2010). Therefore, knowledge sharing is also considered as the key factor for the conceptual model of virtual teamwork of this study.

6.3.5 Trust

Trust is referred to as the basis of interpersonal cooperation in organizations (McAllister, 1995), and hence considered as the key factor that affects the performance or effectiveness of virtual teamwork (Gordon & Curlee, 2011; Lipnack & Stamps, 2000; Wise, 2013). The presence of trust in the team encourages the sharing of knowledge and makes knowledge sharing activity easier and effective (Alsharo et al., 2017; Young & Tseng, 2008). Besides, trusting each other in the team makes easier to accept ideas, share knowledge, and come up with a decision which eventually fosters the performance of teamwork (Alsharo et al., 2017; Gordon & Curlee, 2011; Schwalbe, 2014; Wise, 2013), and eventually affects the effectiveness of virtual teamwork. Therefore, trust is considered as a key factor and has a significant impact and positive influence for the success and effectiveness of a virtual team (Hakonen & Lipponen, 2009; Henttonen & Blomqvist, 2005; Jarvenpaa & Leidner, 1999; Zolin, Hinds, Fruchter, & Levitt, 2004).

Moreover, Rad and Levin (2006) and Wise (2013) mentioned that the higher level of trust between team members increases the performance level, and hence, increases the possibility of successful completion of virtual teamwork (Gordon & Curlee, 2011; Greiner & Metes, 2005). That's why trust can be stated as the key factor for assessing between high and low performing virtual teams (Lippert & Dulewicz, 2018). However, it is also needed to remember that the level of trust in virtual teamwork largely varies depending on the team environment and culture (Yusof & Zakaria, 2012). Therefore, trust is also considered as one of the key factors of virtual teamwork for the development of the conceptual model of this study.

6.3.6 Cohesion

In teamwork, cohesiveness means to stick together in the team until the team goal is not achieved, and the team members are satisfied with the outcomes of the teamwork (Forrester & Tashchian, 2006). Another definition of team cohesiveness is given by Carron et al. (1998, p. 213), who defined team cohesiveness as

> "a dynamic process that is reflected in the tendency for a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs".

The above definitions of cohesion indicate it as one of the key factors for the success and effectiveness of teamwork. Besides, research suggests that cohesion is a critical factor that fosters the effectiveness as well as the performance of the virtual teamwork (e.g. Hannah et al., 2011; Lurey and Raisinghani, 2001; Maznevski and Chudoba, 2000). A study by Cohen and Bailey (1997) also stated that cohesion is a critical factor that improves the performance of the team and the team members. Another study by Powell et al. (2004) and Maznevski and Chudoba (2000) also provided a similar suggestion that cohesion is one of the key factors for the improved performance and effectiveness of virtual teamwork.

So, team cohesion helps team members to stay united in order to achieve the team's goal. The higher the cohesiveness in the virtual teams, the better the performance and effectiveness.

6.3.7 Coordination

In a virtual team, coordination is positively linked to the performance or effectiveness of virtual teamwork (Johansson et al., 1999; Maznevski &

Chudoba, 2000). Coordination means the effort of virtual team members for managing the collective resources of the team and maintaining consistent and coherent team activities (Pinsonneault & Caya, 2005; Powell et al., 2004). In addition, coordination can play a big rule in conflict management in the virtual team and team performance (Montoya-Weiss et al., 2001).

Besides, a meta-analysis by Lin et al. (2008) found that coordination is strongly related to the performance of virtual teamwork. The improvement of the performance of a virtual team is depended on how efficiently and effectively the coordination of a virtual team is maintained.

These suggest that coordination is crucial for the effectiveness of virtual teamwork. Therefore, coordination is also considered as one of the key factors of virtual teamwork for the development of the conceptual model in the context of online higher education.

As a summary, all the key factors are listed in table 6.1 along with their supporting references which justifies their inclusion in the conceptual model (to be proposed) as key factors for the effective development of virtual teamwork in the context of online higher education.

6.4 Relationships & Hypotheses Development

This section presents the relationships between the key factors to construct the conceptual model for effective virtual teamwork development in online higher education. All the relationships are explained, discussed, and presented based on the existing literature and theories. That's why their inclusion in the conceptual model are justified undoubtedly with sufficient supporting references. All these relationships of the key factors are presented and discussed as follows along with their supporting references from the existing literature and theories, and according to the best of the knowledge. In addition, a set of hypotheses is also derived and proposed from the following explained relationships of the key factors.

Table 6.1: Set of Key factors with Supporting References

Key Factors	**Supporting References**
Motivation	Ardichvili, Page, and Wentling (2003), Hertel, Geister, and Konradt (2005), Peterson (2007)
Communication	Duarte and Snyder (2006), Gordon and Curlee (2011), Maznevski and Chudoba (2000), Setle-Murphy (2013), Suchan and Hayzek (2001)
Knowledge Sharing	Alsharo, Gregg, and Ramirez (2017), Hahm (2017), Xiao and Jin (2010)
Trust	Greiner and Metes (2005), Hakonen and Lipponen (2009), Henttonen and Blomqvist (2005), Jarvenpaa and Leidner (1999), Wise (2013), Zolin, Hinds, Fruchter, and Levitt (2004)
Cohesion	Cohen and Bailey (1997), Hannah, Walumbwa, and Fry (2011), Lurey and Raisinghani (2001), Maznevski and Chudoba (2000), Powell, Piccoli, and Ives (2004)
Coordination	Johansson, Dittrich, and Juustila (1999), Lin, Standing, and Liu (2008), Maznevski and Chudoba (2000), Montoya-Weiss, Massey, and Song (2001)
Performance	Armstrong (2007), Kirkman and Mathieu (2007), Schwalbe (2014)

6.4.1 Motivation → Communication

Motivation factor stimulates desire and energy in team members to be continually interested and committed to a job or role or a specific topic to make an effort for achieving a team's goal (Lurey & Raisinghani, 2001; Sridhar et al., 2007).

Since team members in virtual teams do not have traditional face-to-face interaction, virtual collaboration might meet challenges, where motivation factor can play a vital role to overcome the challenges (Geister et al., 2006). The reason is that a motivated team member always contributes to teamwork willingly, and stays active and focused within the team for achieving the team's goal (Ardichvili et al., 2003). On the contrary, lack of motivation discourages team members which eventually decreased the performance and effectiveness of virtual teamwork (Lurey & Raisinghani, 2001). That's why it is necessary to motivate the team members while working in a virtual team for the effectiveness of virtual teamwork (Peterson, 2007).

On the other side, it is believed that in the context of virtual teamwork, communication is the first thing to be considered seriously for its effectiveness (Duarte & Snyder, 2006; Gordon & Curlee, 2011; Maznevski & Chudoba, 2000; Setle-Murphy, 2013; Wise, 2013). These suggest that the *Motivation* factor should have a strong positive impact on the *Communication* factor towards developing effective virtual teamwork in online higher education.

Therefore, according to the discussion and explanation of this relationship between *Motivation* and *Communication* factors, the following hypothesis is derived.

$\boldsymbol{H_{MT \rightarrow CM}}$: Motivation affects positively to Communication

6.4.2 Communication → Knowledge Sharing

Effective communication between team members facilitate the sharing of information and knowledge clearly and accurately to achieve the team goal (Clements & Gido, 2012; D. W. Johnson, Johnson, & Stanne, 2000;

Schwalbe, 2014; Segal-Horn & Dean, 2009; Slechta, 2007).

Besides, communication plays a vital role to articulate team member's feelings or opinions, express plans and goals, share ideas or knowledge or information and discuss each other's viewpoints (Clements & Gido, 2012; Grutterink et al., 2012; Schwalbe, 2014). That's means, *Communication* affects *Knowledge Sharing* towards the effective development of virtual teamwork in online higher education.

According to the discussion and explanation of this relationship between *Communication* and *Knowledge Sharing* factors, the following hypothesis is derived.

> $\boldsymbol{H_{CM \to KS}}$: Communication affects positively to Knowledge Sharing

6.4.3 Communication → Trust

Effective communication and participation among the team members ensure the trust in the team which eventually leads to reliable performance and concern for each other in teamwork (Duarte, 2002; Wise, 2013). The building of trust among the team members and in the team gradually improves over time based on communication (Mayer et al., 1995; Roth, 2012). According to Jarvenpaa and Leidner (1999), communication is the key to building trust in virtual teams. That means *Communication* has a significant impact on *Trust* building in the virtual team which enhances the performance and eventually fosters the effectiveness of virtual teamwork.

According to the discussion and explanation of this relationship between *Communication* and *Trust* factors, the following hypothesis is derived.

> $\boldsymbol{H_{CM \to TR}}$: Communication affects positively to Trust

6.4.4 Communication → Cohesion

Cohesion is considered as an important factor for the effectiveness of virtual teamwork (Salisbury, Carte, & Chidambaram, 2006). However, a significant effort needs to take in the virtual team's communication than in the traditional face-to-face team for building effective cohesion in virtual teams (Pinsonneault & Caya, 2005). Besides, in comparison to the traditional face-to-face team, the virtual team generally has weaker interpersonal relationships between team members (Burke & Chidambaram, 1996; Warkentin, Sayeed, & Hightower, 1997).

These suggest that effective communication can foster cohesiveness in virtual teams. That's means, *Communication* has a positive impact on *Cohesion* towards developing effective virtual teamwork in online higher education (Pinsonneault & Caya, 2005; Walther, 1992; Warkentin et al., 1997).

According to the discussion and explanation of this relationship between *Communication* and *Cohesion* factors, the following hypothesis is derived.

> $\boldsymbol{H_{CM \rightarrow CH}}$: Communication affects positively to Cohesion

6.4.5 Knowledge Sharing → Coordination

The exchange of information or knowledge between team members fosters or improves the coordination of virtual teamwork (Massey et al., 2002; Maznevski & Chudoba, 2000). That means virtual team members should share and distribute knowledge adequately for effective collaboration in virtual teamwork (Pangil & Chan, 2014; Pinjani & Palvia, 2013; Xiao & Jin, 2010). Otherwise, virtual teamwork will be less efficient and poor in coordination, for example, suffering from relevant information, difficulties in decision-making, miscommunication, etc. (Gray, 2001; Pinjani & Palvia, 2013). These suggest that *Knowledge Sharing* has a positive impact on *Coordination* towards developing effective virtual teamwork in online higher education.

According to the discussion and explanation of this relationship between *Knowledge Sharing* and *Coordination* factors, the following hypothesis is derived.

> $\boldsymbol{H_{KS \rightarrow CR}}$: Knowledge Sharing affects positively to Coordina-

tion

6.4.6 Trust → Coordination

Trust is considered an essential factor for the coordination process in teamwork which ultimately improves the performance of the virtual team. In a teamwork, the act of one team member affects other members of the team (Hoegl & Gemuenden, 2001). The relationship among individuals in a social system like virtual teams has a big influence on the team's action, coordination, resources management, and collaboration (Adler & Kwon, 2002; Chiu, Hsu, & Wang, 2006; Coleman, 1988). The research reported trust as a key factor in reducing risk management, dealing with complexity and uncertainty, facilitating a positive atmosphere to team members for collaborating within a social system like virtual teamwork (e.g. Baba, 1999; Jarvenpaa and Leidner, 1999; Kollock, 1994; Paul and McDaniel, 2004). Besides, the research found that trust has a direct effect on a team's outcome (e.g. Muethel, Siebdrat, and Hoegl, 2012; Pangil and Chan, 2014; Paul and McDaniel, 2004; Peters and Manz, 2007). These suggest that *Trust* has a positive impact on *Coordination* factor towards developing an effective virtual teamwork in online higher education.

According to the discussion and explanation of this relationship between *Trust* and *Coordination* factors, the following hypothesis is derived.

$\boldsymbol{H_{TR \rightarrow CR}}$: Trust affects positively to Coordination

6.4.7 Cohesion → Coordination

Cohesion plays a vital role for a successful coordination in virtual teams (Lipnack & Stamps, 2000; Sarker et al., 2001). A strong cohesion between team members leads to better coordination in virtual teamwork (Deeter-Schmelz et al., 2002).

These suggest that cohesiveness nature of teams positively affects the coordination in virtual teamwork. That's means, *Cohesion* has a positive impact on *Coordination* towards developing effective virtual teamwork in online higher education (Deeter-Schmelz et al., 2002; Lipnack & Stamps, 2000; Sarker et al., 2001).

According to the discussion and explanation of this relationship between *Cohesion* and *Coordination* factors, the following hypotheses is derived.

$\boldsymbol{H_{CH \rightarrow CR}}$: Cohesion affects positively to Coordination

6.4.8 Knowledge Sharing → Performance

A team performs better when it contains individuals with relevant knowledge and skills (Gardner et al., 2012; Malhotra & Majchrzak, 2004; Pangil & Chan, 2014). In other words, knowledge sharing practices within the virtual teams enhance the performance of the team (Xiao & Jin, 2010). Besides, Alsharo et al. (2017) suggested that knowledge must be shared or exchanged among the team members for the effectiveness of a virtual team. These suggest that *Knowledge Sharing* is positively related to *Performance*, or has a positive impact on the performance of the effectiveness of virtual teamwork.

According to the discussion and explanation of this relationship between *Knowledge Sharing* and *Performance* factors, the following hypothesis is derived.

$\boldsymbol{H_{KS \rightarrow PF}}$: Knowledge Sharing affects positively to Performance

6.4.9 Trust → Performance

Team performance can be improved if team members among the team trust and rely on each other, otherwise it leads to failure (Armstrong, 2007). Research indicates that trust has a positive influences on performance in virtual teamwork (e.g. Anantatmula and Thomas, 2010; Roth, 2012; Schwalbe, 2014).

The higher level of trust among team members improves the performance levels of the virtual teams (Rad & Levin, 2006; Wise, 2013). Thus, trust can be used as the evaluator between high and low performing virtual teams (Lippert & Dulewicz, 2018). So, *Trust* has positive impact on the *Performance* for the effectiveness of virtual teamwork.

According to the discussion and explanation of this relationship between *Trust* and *Performance* factors, the following hypothesis is derived.

$\boldsymbol{H_{TR \rightarrow PF}}$: Trust affects positively to Performance

6.4.10 Cohesion → Performance

Team cohesiveness is considered as critical for improving the performance of virtual teamwork (Hannah et al., 2011; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000). Also, different studies by Cohen and Bailey (1997), and Powell et al. (2004) mentioned that cohesion is a critical factor that influences the performance factor. These suggest that *Cohesion* has a positive impact on the *Performance* for the effectiveness of virtual teamwork.

According to the discussion and explanation of this relationship between *Cohesion* and *Performance* factors, the following hypothesis is derived.

$\boldsymbol{H_{CH \rightarrow PF}}$: Cohesion affects positively to Performance

6.4.11 Coordination → Performance

Coordination is the core of virtual teamwork for managing and coordinating it successfully (Pinsonneault & Caya, 2005; Powell et al., 2004). Besides, it deals with conflict management to foster performance (Montoya-Weiss et al., 2001). These suggest that coordination is positively related to the performance and success of virtual teamwork.

Moreover, a study by Lin et al. (2008) found that the coordination factor of a virtual team is strongly related to the performance factor of a virtual team. In addition to this, other research studies also outlined that coordination is positively linked to the performance or effectiveness of virtual teamwork (e.g. Johansson et al., 1999; Lu et al., 2006; Maznevski and Chudoba, 2000).

Therefore, according to the discussion and explanation of this relationship between *Coordination* and *Performance* factors, the following hypothesis is derived.

$\boldsymbol{H_{CR \to PF}}$: Coordination affects positively to Performance

As a summary, all the relationships of the key factors are listed in table 6.2 along with their supporting references which justifies their inclusion in the conceptual model (to be proposed) for effective virtual teamwork development in the context of online higher education.

Table 6.2: Set of Relationships with Supporting References

Relationships	**Supporting References**
Cohesion → Coordination	Deeter-Schmelz et al. (2002), Lipnack and Stamps (2000), Sarker et al. (2001)
Cohesion → Performance	Cohen and Bailey (1997), Hannah et al. (2011), Lurey and Raisinghani (2001), Powell et al. (2004)
Communication → Cohesion	Pinsonneault and Caya (2005), Walther (1992), Warkentin et al. (1997)
Communication → Knowledge Sharing	Clements and Gido (2012), Grutterink et al. (2012), Schwalbe (2014), Segal-Horn and Dean (2009)
Communication → Trust	Jarvenpaa and Leidner (1999), Mayer et al. (1995), Roth (2012), Wise (2013)

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Table 6.2: Set of Relationships with Supporting References

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Relationships	**Supporting References**
Coordination → Performance	Johansson et al. (1999), Lin et al. (2008), Lu et al. (2006), Maznevski and Chudoba (2000), Montoya-Weiss et al. (2001)
Knowledge Sharing → Coordination	Massey et al. (2002), Maznevski and Chudoba (2000), Pangil and Chan (2014), Pinjani and Palvia (2013), Xiao and Jin (2010)
Knowledge Sharing → Performance	Alsharo et al. (2017), Gardner et al. (2012), Malhotra and Majchrzak (2004), Pangil and Chan (2014), Xiao and Jin (2010)
Motivation → Communication	Ardichvili et al. (2003), Geister et al. (2006), Peterson (2007)
Trust → Coordination	Baba (1999), Jarvenpaa and Leidner (1999), Muethel et al. (2012), Paul and McDaniel (2004)
Trust → Performance	Anantatmula and Thomas (2010), Rad and Levin (2006), Roth (2012), Wise (2013)

6.5 The Proposed Conceptual Model

This section will present and propose the conceptual model for effective virtual teamwork development in online higher education as per the key factors and their relationships presented in the previous two sections (i.e. 6.3 and 6.4).

The relationships of the key factors presented in the previous section (i.e. 6.4) are interpreted and proposed as hypotheses which will be tested further for the statistical significance in the respective chapter of this thesis. The set of proposed hypotheses of the conceptual model are presented in table 6.3.

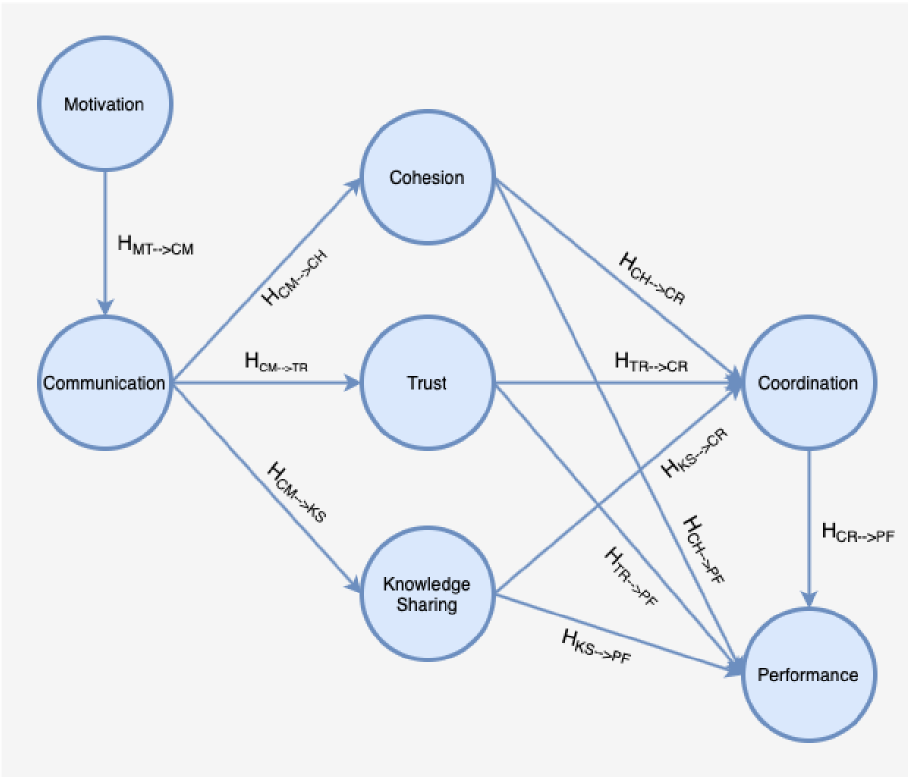
Table 6.3: Set of Proposed Hypotheses

Relationships	**Hypotheses**	**Hypotheses Description**
Cohesion ->Coordination	$H_{CH \to CR}$	Cohesion affects positively to Coordination
Cohesion ->Performance	$H_{CH \to PF}$	Cohesion affects positively to Performance
Communication ->Cohesion	$H_{CM \to CH}$	Communication affects positively to Cohesion
Communication ->Knowledge Sharing	$H_{CM \to KS}$	Communication affects positively to Knowledge Sharing
Communication ->Trust	$H_{CM \to TR}$	Communication affects positively to Trust
Coordination ->Performance	$H_{CR \to PF}$	Coordination affects positively to Performance
Knowledge Sharing ->Coordination	$H_{KS \to CR}$	Knowledge Sharing affects positively to Coordination
Knowledge Sharing ->Performance	$H_{KS \to PF}$	Knowledge Sharing affects positively to Performance
Motivation ->Communication	$H_{MT \to CM}$	Motivation affects positively to Communication
Trust ->Coordination	$H_{TR \to CR}$	Trust affects positively to Coordination
Trust ->Performance	$H_{TR \to PF}$	Trust affects positively to Performance

MT: Motivation; CM: Communication; KS: Knowledge Sharing;
TR: Trust; CH: Cohesion; CR: Coordination; PF: Performance.

Finally, considering these derived key factors, relationships, and hypotheses, the conceptual model of this study is proposed and presented in figure 6.2. As can be seen, it includes the key factors, their relationships, and a set of corresponding hypotheses (will be tested for statistical supports and significance in chapter 9).

Figure 6.2: The Proposed Conceptual Model



MT: Motivation; CM: Communication; KS: Knowledge Sharing;
TR: Trust; CH: Cohesion; CR: Coordination; PF: Performance.

This proposed conceptual model is intended to be promoted in online higher education for effective virtual teamwork development so that students could able to gain the required knowledge and skills for being successful in virtual teamwork.

It is to mention that this conceptual model represents the structural model of the PLS path model, in which the factors represent the constructs (i.e. latent variables) in the structural model.

6.6 Summary

A conceptual/theoretical model of this research study to develop effective virtual teamwork in online higher education is presented and proposed in this chapter along with the set of hypotheses. The key factors and the set of hypotheses of the proposed conceptual model are selected and developed based on the theories, logic, and existing literature.

This proposed conceptual model will be assessed further using the PLS-SEM technique for testing the statistical significance, which is presented in chapter 9. Before that, a measurement model will be developed to illustrate how the constructs (i.e. latent variables) of the conceptual model are measured. That is, the description of the set of indicator variables for measuring the constructs of the conceptual model is presented and eventually proposed the measurement model, which is described in chapter 7.

Chapter 7

Measurement Model

7.1 Chapter Overview

The measurement model (one element of the PLS path model) to measure the latent variables (i.e. constructs) in the structural model (other elements of the PLS path model) is presented in this chapter. The other part of the PLS path model that is, the structural model is already presented in the previous chapter as a conceptual model. So, the end of this chapter with the development of the measurement model will provide the complete picture of the PLS path model of this study.

7.2 Introduction

In a PLS path model, the structural model represents the relationships between constructs while the measurement model represents the relationships between constructs and their corresponding indication variables. This chapter will present the detailed description and development of the measurement model for evaluating the proposed conceptual model of this study using the PLS-SEM statistical technique. The representation of a measurement model can be either formative or reflective or a mix of both models. However, the formative type is chosen for designing the measurement model of this study.

The reason for choosing the formative measurement model for this study is discussed in the next section. Then, the set of indicators variables for measuring the corresponding constructs of the conceptual model are derived and described along with their supporting references.

7.3 Formative Measurement Model

The choice between formative and reflective has gained a lot of attention in research which also reflected in existing literature (Coltman, Devinney, Midgley, & Venaik, 2008; Diamantopoulos, Riefler, & Roth, 2008; Jarvis et al., 2003; MacKenzie, Podsakoff, & Jarvis, 2005; Petter et al., 2007). Generally, the decision of using formative or reflective measures should be made at the preliminary stage of the model design.

For example, Hair, Hult, Ringle, and Sarstedt (2017) mentioned that in a reflective measurement model all indicators are caused by the same construct, and so, indicators of a particualar construct should be highly correlated with each other, and can be interchangable (i.e. any single indicator of a construct can be left out without changing the meaning of the construct, providing that the construct has sufficient reliability). In contrast of reflective measurement model, they stated that in a formative measurement model all the indicators of a construct jointly determine the meaning of the construct because each formative indicaor of a construct captures a specific aspect fo the construct's domain (i.e. removing an indicator changes the nature of the construct, and hence, formative indicators of a constuct are not interchangeable). So, the choice between formative and reflective meausrement model can be made by observing these criteria.

However, at the end, Hair, Hult, Ringle, and Sarstedt (2017) also claimed that there is not a definite answer on the choice between formative and reflecrtive measurement model, instead they suggested that the specification should depends on the construct conceptualization and the objective of the research study.

Besides, a study by Andreev et al. (2009) suggested some criteria to consider in determining whether a construct of the model should be formative or reflective, which are presented in table 7.1. These suggestions are derived based on the works of Jarvis et al. (2003) and Petter et al. (2007) (more information can be found in the original papers). It is worth to mention that most of these suggestions (in table 7.1) are also similar to the criteria mentioned by Hair, Hult, Ringle, and Sarstedt (2017).

Table 7.1: Criteria for determining formative constructs

Criteria	**Description**
Nature of relationships between each construct and its indicators	If the indicators define the constructs then the construct is formative. On the other hand, if the indicators are manifestations of the construct then the construct is reflective.
Impacts of changes in the constructs and indicators	Changes in the formative indicators influence the formative construct (however, changes in the construct not necessarily impact all its indicators). On the other hand, reflective indicators are the reflections of the construct, and hence, changes in the construct impact all indicators simultaneously.
Interchangeability of indicators	Formative indicators of a construct are not interchangeable. On the other hand, reflective indicators of a construct are interchangeable.

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Table 7.1: Criteria for determining formative constructs

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Criteria	**Description**
Correlations of indicators	Formative indicators should not be highly correlated because multicollinearity can weaken a formative construct. On the other hand, reflective indicators should be highly correlated because they represent the same phenomenon of a reflective construct, and thus, any change implies in all indicators of the construct.
Antecedents and consequences of the indicators	Formative indicators define different aspects of the construct and thus they do not represent the same reasons (antecedents) and consequences. On the other hand, reflective indicators of the construct are expected to have the same reasons (antecedents) and consequences.

Table Source: Adapted form Andreev, P., Heart, T., Maoz, H., & Pliskin, N. (2009). Validating formative partial least squares (pls) models: Methodological review and empirical illustration. In *Icis 2009 proceedings.*

These decision criteria for choosing one from the formative and reflective as a measurement model suggested that formative measurement model is the appropriate choice for the PLS path model of this study. For example, all the indicators of this model define their corresponding constructs, which means all the constructs are formative. The changes in any formative indicator of this model influence its construct which also matches the characteristics of formative measures. Finally, none of the formative indicators of the model is correlated and interchangeable because all define different aspects of their corresponding constructs. These are also aligned with the characteristics of formative measures. Therefore, based on all these decision criteria it is found that the formative measurement model is the appropriate choice for the PLS path model of this study.

7.4 Indicators of the Constructs

This section presents all the indicator variables to be used for measuring each of the latent variables of the conceptual model (i.e. structural model) of this study.

7.4.1 Indicators of Motivation

To measure the *Motivation* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.2), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Motivation* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.2: Set of Indicators for Motivation

Indicator Name	**Indicator Description**
Motivation_1	All the team members had the opportunity to develop knowledge and skills
Motivation_2	As team members, we were able to add value to the teamwork
Motivation_3	In our team, we found that we were challenged by the teamwork

In order to keep team members motivated in virtual teamwork, they should have been provided with new opportunities to develop their knowledge and skills. According to Slechta (2007), learning and skill development opportunities work as encouragement and motivation to the team members to stay committed in virtual teamwork. In higher education, one of the aims of students is to develop the necessary knowledge and skills for their future professional careers. So, this works as a kind of reward for students in higher education which makes them motivated in virtual teamwork. The literature revealed that there are various types of rewards to motivate team members in virtual teamwork (e.g. Peterson, 2007), which eventually influences the performance of the virtual team (Geister et al., 2006). That's why for assessing the *Motivation* factor it is necessary to measure whether team members had the opportunity to develop their knowledge and skills in the virtual teamwork (i.e. indicator *Motivation_1* in table 7.2).

Besides, team members feel motivated when their roles are important enough in the team to add value in the virtual teamwork. This works as an encouragement that drives team members to work actively in virtual teamwork (Lurey & Raisinghani, 2001; Sridhar et al., 2007). It means to inspire, encourage, stimulate each team member to perform their responsibilities in the virtual team towards achieving the team's goals (Peterson, 2007). That's why for assessing the *Motivation* factor it is necessary to measure whether team member's roles were important enough to add value to the virtual teamwork (i.e. indicator *Motivation_2* in table 7.2).

In virtual teamwork, new challenges encouraged and inspired team members to stay motivated in virtual teamwork (Slechta, 2007). This fosters their enthusiasm and improves their performance, and as a result, affect the effectiveness of virtual teamwork. The reason is that a motivated team member always stays positive, eagerly contribute to the team, and participate actively to accomplish the team's goal (Ardichvili et al., 2003). On the other hand, lack of motivation for the team members causes risks for virtual teams (Wallace & Keil, 2004). That's why for assessing the *Motivation* factor it is necessary to measure whether team members were challenged by the virtual teamwork (i.e. indicator *Motivation_3* in table 7.2).

The above discussion based on the existing literature reveals that, to have a motivated team in virtual teamwork these three indicators (i.e. *Motivation_1*, *Motivation_2*, and *Motivation_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.2), the *Motivation* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.2 Indicators of Communication

To measure the *Communication* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.3), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Communication* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.3: Set of Indicators for Communication

Indicator Name	**Indicator Description**
Communication_1	Communication in our team was open and honest
Communication_2	Team members were in contact with each other on a regular basis in order to conduct the teamwork
Communication_3	Team members exchanged information clearly and accurately

Effective communication is the key to the success of any virtual teamwork (Berkun, 2008). It can be effective if the communication in the team is open and honest so that team members feel free and do not hesitate to express their ideas, share information, and communicate when required (Clements & Gido, 2012; Grutterink et al., 2012; Schwalbe, 2014). That's why it is important to measure whether the communication in a virtual team is open and honest in order to make it effective (i.e. indicator *Communication_1* in table 7.3).

Besides, team members should have regular contact with each other to successfully complete the virtual teamwork (i.e. indicator *Communication_2* in table 7.3) because regular communication between team members is essential for success (Berkun, 2008; Kayworth & Leidner, 2000). A study by Hinds and Mortensen (2005) showed that frequent and effective communication in a virtual team enhances team identity and reduces team conflicts. On the other hand, less intensive interaction and communication cause a problem in virtual teamwork (Blackburn et al., 2003).

Another thing needs to be ensured for effective communication which is clear and accurate communication between team members (i.e. indicator *Communication_3* in table 7.3) so that there are no communication gaps and misunderstanding. A study by Thommsen (2010) suggests that clear communication is essential for effective communication in virtual teams. On the other hand, poor communication or inaccurate communication is the root of many problems in virtual teamwork (Rosen et al., 2006), and the main threat to the success of virtual teamwork (Clements & Gido, 2012; Schwalbe, 2014). That means messages or information transferred through communication has to be cleared to all and received accurately by all.

The above discussion based on the existing literature reveals that, to have effective communication in virtual teamwork these three indicators (i.e. *Communication_1*, *Communication_2*, and *Communication_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.3), the *Communication* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.3 Indicators of Knowledge Sharing

To measure the *Knowledge Sharing* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.4), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Knowledge Sharing* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.4: Set of Indicators for Knowledge Sharing

Indicator Name	**Indicator Description**
Knowledge_Sharing_1	Knowledge and information sharing were understood to be the norm in our team
Knowledge_Sharing_2	Team members exchanged knowledge and information with each other to solve a problem together
Knowledge_Sharing_3	All the team members exchanged their opinion in important decision making

In the context of higher education, virtual teamwork can be effective if knowledge sharing is considered as a common practice and norm in the virtual team (i.e. indicator *Knowledge_Sharing_1* in table 7.4) so that all team members participate in this activity. The argument in favour of this indicator is that knowledge is considered as a valuable asset in an organizational setting (Alavi & Leidner, 2001; Gold et al., 2001) which can create competitive advantages for both individuals and organizations (Nonaka, 1994) by being distributed and shared properly. Research founds that for team effectiveness, the distribution and sharing of knowledge among team members must be facilitated properly and adequately (e.g. Gray, 2001) because it influences and fosters team performance and outcomes (Lam, 2000). That's why for assessing the *Knowledge Sharing* factor it is necessary to measure whether team members in the virtual team consider knowledge sharing as a regular practice and norm as it has an impact on the effectiveness of virtual teamwork.

Besides, team members should exchange information, knowledge, and opinions to solve any problem in teamwork (i.e. indicator *Knowledge_ Sharing_ 2* in table 7.4). The reason is that knowledge sharing has the potential of generating innovative solutions and valuable results (Pinjani & Palvia, 2013). Besides, because of the combination of individual team members with different expertise and skills in a virtual team (Hoegl & Gemuenden, 2001), and the sharing of knowledge among them generate effective outcomes (Lam, 2000). Thus, all the team members should willingly share knowledge with each other in a virtual team in order to solve any problem or improve team performance (Jessica & Leslie, 2012).

Finally, in the times of important decision-making, every team member should share their thought or opinion towards making it fruitful to achieve the ultimate team goal (i.e. indicator *Knowledge_ Sharing_ 3* in table 7.4). The argument in favour of this indicator is that knowledge sharing practice in a virtual team can generate innovative ideas and fruitful results (Pinjani & Palvia, 2013). That means a fruitful decision can be achieved in a virtual team through the sharing of knowledge, ideas, or opinions which is essential for the success of virtual teamwork. The reason is that knowledge sharing has positive impacts on the performance and effectiveness of virtual teamwork, which is also suggested by many research works (such as Alsharo et al., 2017; Hahm, 2017; Xiao and Jin, 2010). That's why for assessing the *Knowledge Sharing* factor it is necessary to measure whether team members in a virtual team share and exchange their thought or opinion while making an important decision.

The above discussion based on the existing literature reveals that to have strong knowledge sharing practice in virtual teamwork these three indicators (i.e. *Knowledge_ Sharing_ 1*, *Knowledge_ Sharing_ 2*, and *Knowledge_ Sharing_ 3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.4), the *Knowledge Sharing* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.4 Indicators of Trust

To measure the *Trust* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.5), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Trust* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.5: Set of Indicators for Trust

Indicator Name	**Indicator Description**
Trust_1	Team members consulted with each other if they needed support
Trust_2	Our team valued individual input from the team members
Trust_3	There was no mutual distrust between team members

Trust building is another key factor for the effectiveness of virtual teamwork. It is a core foundation of managing better collaborations and improving the performance of virtual teams (Lawley, 2006). Trust can be improved in a team if team members help (or consulted with) each other when support is needed for the success of teamwork (i.e. indicator *Trust_1* in table 7.5). The research highlighted that higher levels of trust among team members enhance team performance (e.g. Ba and Pavlou, 2002; Rad and Levin, 2006; Wise, 2013). Also, the level of trust among team members is built when team members support one another towards accomplishing a goal of the team (Roth, 2012). Wise (2013) has indicated that team members should be trusted in teamwork. That's why for assessing the *Trust* factor it is necessary to measure whether team members in the team help (or consult with) each other when supports are needed.

Next, when individual input is valued or recognized by the team-mates or the team (i.e. indicator *Trust_2* in table 7.5), it helps to build trust among the team, and as a result, it affects the effectiveness of virtual teamwork. Research finds that positive recognition or being valued by the team-mates improves the performance of team members (Harris, 2003; Slechta, 2007). Besides, many researchers have pointed out that the presence of trust among team members makes it easier to accept new ideas, value individual inputs, and ultimately improve performance (Gordon & Curlee, 2011; Schwalbe, 2014; Wise, 2013) That's why *Trust* factor should judge by the *Trust_2* indicator for the effectiveness of virtual teamwork in online higher education.

Another important aspect of judging *Trust* is to check whether there has any mutual distrust between team members (i.e. indicator *Trust_3* in table 7.5). The reason is that lack of trust affects negatively in trust-building in a virtual team, and leads to the failure of teamwork (Duran & Popescu, 2014; Jarvenpaa & Keating, 2011). As a consequence, it affects negatively the effectiveness of whole virtual teamwork. So, if distrust exists among the team members, teamwork goes nowhere (Kiser, 2000, p. 8). On the other hand, researchers have outlined that the presence of trust among team members is key to produce quality teamwork (Jarvenpaa et al., 1998; Sarker et al., 2001). That's why for assessing the *Trust* factor it is also necessary to measure whether there has any mutual distrust between team members in virtual teamwork (i.e. *Trust_3*).

The above discussion based on the existing literature reveals that to have strong trust in virtual teamwork these three indicators (i.e. *Trust_1*, *Trust_2*, and *Trust_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.5), the *Trust* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.5 Indicators of Cohesion

To measure the *Cohesion* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.6), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Cohesion* construct are described in the rest of this subsection, which are based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.6: Set of Indicators for Cohesion

Indicator Name	**Indicator Description**
Cohesion_1	Our team was a very cohesive unit
Cohesion_2	Our team members experienced a sense of shared goals and objectives
Cohesion_3	Team members had interpersonal connections with each other

In virtual teamwork, a team has to be a cohesive unit in order to achieve the team goal (Hackman & Powell, 2004; Slechta, 2007). Besides, a cohesive virtual team can foster team performance and effectiveness (Hannah et al., 2011; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000). That's why for assessing the *Cohesion* factor it is necessary to measure whether a virtual team acts as a cohesive unit (i.e. indicator *Cohesion_1* in table 7.6).

Next, in virtual teamwork, the team members should perform a shared collective responsibility to achieve the team goal (Hackman & Powell, 2004; Slechta, 2007), which positively linked to the cohesiveness of a virtual team. The reason is that one of the characteristics of cohesion is to share responsibilities and show a willingness to cooperate in teamwork with regard to the team's goals and objectives (Anantatmula & Thomas, 2010; Clements & Gido, 2012; Hannah et al., 2011; Maznevski & Chudoba, 2000; Schwalbe, 2014). That's why for assessing the *Cohesion* factor it is necessary to measure whether the team members experienced a sense of shared goals and objectives (i.e. sharing team responsibilities together to achieve the team's goals and objectives) in the virtual teamwork (i.e. indicator *Cohesion_2* in table 7.6).

For effective cohesion in virtual teamwork, another important aspect is to have interpersonal connections among team members (i.e. indicator *Cohesion_3*) because it also improves the cohesiveness of virtual teamwork. One of the characteristics of cohesion is open communication among team members so that they can discuss together and contribute to the team (Anantatmula & Thomas, 2010; Clements & Gido, 2012; Hannah et al., 2011; Maznevski & Chudoba, 2000; Schwalbe, 2014). That means, there should have interpersonal communication among team members which ultimately boosts cohesion in the virtual team. Considering these facts, it is important and essential to measure whether team members have interpersonal connections among each other (i.e. indicator *Cohesion_3* in table 7.6) in order to assess the *Cohesion* factor.

The above discussion based on the existing literature reveals that, to have strong cohesion in virtual teamwork these three indicators (i.e. *Cohesion_1*, *Cohesion_2*, and *Cohesion_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.6), the *Cohesion* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.6 Indicators of Coordination

To measure the *Coordination* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.7), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Coordination* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Table 7.7: Set of Indicators for Coordination

Indicator Name	**Indicator Description**
Coordination_1	Our team coordinated tasks effectively among each other
Coordination_2	Team members in our team displayed high levels of cooperation
Coordination_3	When disagreement occurred, they were addressed promptly in order to solve them

In a virtual team, the effectiveness of teamwork is largely depended on how efficiently and effectively the tasks are coordinated among the team members. The efforts for planning, monitoring, and supporting individual actions or tasks of the team members are required to achieve the team's desired outcomes (LePine et al., 2008). Research suggests that it is essential to monitor to manage the individual team member's tasks for establishing an effective coordination in a virtual team (e.g. Majchrzak et al., 2007; Marks et al., 2001). That's why for assessing the *Coordination* factor it is necessary to measure whether a virtual team coordinated tasks effectively among the team members (i.e. indicator *Coordination_1* in table 7.7).

In virtual teamwork, the act of one team member affects others of the team (Hoegl & Gemuenden, 2001). The relationship among individuals in a virtual team has a big influence on the team's action, coordination, resources management, and collaboration (Adler & Kwon, 2002; Chiu et al., 2006; Coleman, 1988). That's why it is essential to have a high level of cooperation of among team members for effective coordination in a virtual team because it helps in reducing risk management, dealing with complexity and uncertainty, and facilitating a positive atmosphere to team members for collaborating in virtual teamwork (e.g. Baba, 1999; Jarvenpaa and Leidner, 1999; Kollock, 1994; Paul and McDaniel, 2004). That's why for assessing the *Coordination* factor it is necessary to measure whether a virtual team exhibits a high level of cooperation among the team members (i.e. indicator *Coordination_2* in table 7.7).

In teamwork, disagreement among team members is a common and normal phenomenon but it has to be addressed efficiently for the sake of effective virtual teamwork. This issue is related to the coordination factor of a virtual team. The reason is that the coordination of virtual teamwork refers to the effort of team members for managing collective resources of the team and maintaining consistent and coherent team activities (Pinsonneault & Caya, 2005; Powell et al., 2004). That means coordination played a crucial role in conflict management (such as resolved disagreement among team members) in virtual teams (Montoya-Weiss et al., 2001). That's why for assessing the *Coordination* factor it is necessary to measure whether the disagreement (if occurred) in a virtual team is addressed or resolved promptly and efficiently (i.e. indicator *Coordination_3* in table 7.7).

The above discussion based on the existing literature reveals that, to have strong coordination in virtual teamwork these three indicators (i.e. *Coordination_1*, *Coordination_2*, and *Coordination_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.7), the *Coordination* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

7.4.7 Indicators of Performance

To measure the *Performance* latent variable of the conceptual model, the following set of indicators are selected (presented in table 7.8), and so, considered for the construction of the measurement model of this study. The justifications of choosing each of these indicator variables for measuring the *Performance* construct are described in the rest of this subsection, which is based on the existing literature and theories, and according to the best of the author's knowledge.

Performance is defined as the accomplishment of teamwork efficiently and

Table 7.8: Set of Indicators for Performance

Indicator Name	**Indicator Description**
Performance_1	Our team worked effectively
Performance_2	Our team is satisfied with the outcomes
Performance_3	Our team generally worked on time

effectively (N. A. Ali et al., 2006; Katou & Budhwar, 2006). Basically, it measures how well a team performed in order to achieve the desired outputs or goals of the team (Zigon, 2000). When the individual performance of the team member is not up to the mark or poor then the overall team performance is poor and so affects the effectiveness of the teamwork (Clements & Gido, 2012; Schwalbe, 2014). That means, teamwork is a collective responsibility and its success depends on the collective performance of all the team members. So, effective teamwork is essential for the team's performance (Clements & Gido, 2012; Ocker, 2001). That is why for assessing the *Performance* factor it is necessary to measure whether a virtual team worked effectively in the teamwork (i.e. indicator *Performance_1* in table 7.8).

In virtual teamwork, performance is the key to determining the satisfaction of the team members (Kirkman et al., 2004; Pinsonneault & Caya, 2005; Swan, 2001). Performance measurement should ensure that the team's outcomes have been met and that the team members are satisfied with the outputs (Armstrong, 2007; Duarte, 2002). Also, many research studies suggested the satisfaction of team members (regarding the team's outcomes) as a key measurement of performance factor (e.g. Bosch-Sijtsema, Virpi, and Matti, 2009; Mathieu, Maynard, Rapp, and Gilson, 2008; Maznevski and Chudoba, 2000; Schweitzer and Duxbury, 2010). That's why for assessing the *Performance* factor it is necessary to measure the satisfaction of the team regarding the outcomes of virtual teamwork (i.e. indicator *Performance_2* in table 7.8).

Another measurement of a virtual team's performance should be based on the timeliness of the team's deliverables (Gibson & Cohen, 2003; Gordon & Curlee, 2011; Ludden & Ledwith, 2014). Teamwork is unsuccessful if it is not completed within the timeline. On the other hand, a good performing virtual team completes its tasks on time (Duarte, 2002; Gibson & Cohen, 2003; Gordon & Curlee, 2011; Ludden & Ledwith, 2014; Rad & Levin, 2006; Schwalbe, 2014). A study by Wu and Davis (2009) also mentioned that the most effective virtual teams should be able to deliver their tasks within the timeline. That's why for assessing the *Performance* factor it is necessary to measure whether the virtual teams are worked on time (i.e. indicator *Performance_3* in table 7.8).

The above discussion based on the existing literature reveals that, to have improved performance for effective development of virtual teamwork these three indicators (i.e. *Performance_1*, *Performance_2*, and *Performance_3*) have to be measured. Therefore, it is believed that through these indicator variables (as can be seen in table 7.8), the *Performance* construct can be measured sufficiently towards developing effective virtual teamwork in the context of online higher education.

As a summary, all the indicators for measuring the key factors of the proposed conceptual model are listed in table 7.9 along with their supporting references.

Table 7.9: List of Indicators with Supporting References

Indicator Name	**Supporting References**
Motivation_1	Geister et al. (2006), Peterson (2007), Slechta (2007)
Motivation_2	Lurey and Raisinghani (2001), Peterson (2007), Sridhar et al. (2007)

(continued on next page . . .)

Table 7.9: List of Indicators with Supporting References

(... continued from previous page)

Indicator Name	Supporting References
Motivation_3	Ardichvili et al. (2003), Slechta (2007), Wallace and Keil (2004)
Communication_1	Clements and Gido (2012), Grutterink et al. (2012), Schwalbe (2014)
Communication_2	Berkun (2008), Blackburn et al. (2003), Hinds and Mortensen (2005), Kayworth and Leidner (2000)
Communication_3	Clements and Gido (2012), Rosen et al. (2006), Schwalbe (2014), Thommsen (2010)
Knowledge_Sharing_1	Alavi and Leidner (2001), Gold et al. (2001), Gray (2001), Lam (2000), Nonaka (1994)
Knowledge_Sharing_2	Hoegl and Gemuenden (2001), Jessica and Leslie (2012), Lam (2000), Pinjani and Palvia (2013)
Knowledge_Sharing_3	Alsharo et al. (2017), Hahm (2017), Pinjani and Palvia (2013), Xiao and Jin (2010)
Trust_1	Ba and Pavlou (2002), Lawley (2006), Roth (2012), Wise (2013)
Trust_2	Gordon and Curlee (2011), Harris (2003), Schwalbe (2014), Wise (2013)

(continued on next page ...)

Table 7.9: List of Indicators with Supporting References

(... continued from previous page)

Indicator Name	Supporting References
Trust_3	Duran and Popescu (2014), Jarvenpaa and Keating (2011), Jarvenpaa et al. (1998), Kiser (2000)
Cohesion_1	Hackman and Powell (2004), Hannah et al. (2011), Lurey and Raisinghani (2001), Maznevski and Chudoba (2000)
Cohesion_2	Anantatmula and Thomas (2010), Hackman and Powell (2004), Hannah et al. (2011), Maznevski and Chudoba (2000), Slechta (2007)
Cohesion_3	Anantatmula and Thomas (2010), Clements and Gido (2012), Hannah et al. (2011), Maznevski and Chudoba (2000), Schwalbe (2014)
Coordination_1	LePine et al. (2008), Majchrzak et al. (2007), Marks et al. (2001)
Coordination_2	Adler and Kwon (2002), Baba (1999), Chiu et al. (2006), Hoegl and Gemuenden (2001), Jarvenpaa and Leidner (1999), Paul and McDaniel (2004)
Coordination_3	Montoya-Weiss et al. (2001), Pinsonneault and Caya (2005), Powell et al. (2004)

(continued on next page ...)

Table 7.9: List of Indicators with Supporting References

(... continued from previous page)

Indicator Name	Supporting References
Performance_1	N. A. Ali et al. (2006), Clements and Gido (2012), Katou and Budhwar (2006), Ocker (2001), Schwalbe (2014), Zigon (2000)
Performance_2	Armstrong (2007), Duarte (2002), Kirkman et al. (2004), Pinsonneault and Caya (2005), Schweitzer and Duxbury (2010), Swan (2001)
Performance_3	Gibson and Cohen (2003), Gordon and Curlee (2011), Ludden and Ledwith (2014), Rad and Levin (2006), Wu and Davis (2009)

7.5 Global Indicator Variables

This section presents the set of global indicators that will be used particularly in the convergent validity evaluation criteria of the measurement model assessment to measure the convergent validity of the constructs in the structural model.

Table 7.10 has presented the set of global indicators to measure each of the latent variables in the conceptual model for testing their convergent validity in the case of measurement model evaluation.

The justifications of choosing each of the global indicator variables for assessing the convergent validity of the corresponding constructs are presented

Table 7.10: Set of Global Indicators

Global Indicator Name	**Global Indicator Description**
Motivation_Global	We feel valued as team members in our team
Communication_Global	The methods used to communicate with each other were effective
Knowledge_Sharing_Global	Team members were open to sharing any knowledge and information
Trust_Global	Members of our team trusted each other
Cohesion_Global	Our team members help each other deal with problems or resolve issues
Coordination_Global	There has been coordination among the team members in the team to achieve the goals
Performance_Global	Our team met the team's objective

in the following subsections.

7.5.1 Global Indicator of Motivation

A team member in a virtual team feels motivated when given equal importance or value for the success of teamwork. It fosters the level of enthusiasm which encourages team member to actively work in a team to achieve the team goal (Lurey & Raisinghani, 2001; Sridhar et al., 2007). It inspires, and encourage the team member to stay motivated and perform their responsibilities in the team towards achieving the goals (Hertel et al., 2005; Peterson, 2007). As a result, it boosts the performance of virtual teams (Geister et al., 2006).

So, according to the discussion from the existing literature, and the best of the knowledge, it is believed that feeling valued as a team member in a virtual team is the fundamental and generic assessment of the *Motivation* factor. Hence, the *Motivation_Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Motivation* factor.

7.5.2 Global Indicator of Communication

Effective virtual teamwork development largely depends on the *Communication* factor, of which communication method sets the foundation for having effective communication in virtual teamwork. Hence, it is necessary to establish effective communication within the team for developing effective virtual teamwork so that team members can share ideas, knowledge, and information accurately and clearly to achieve the team goal (Clements & Gido, 2012; D. W. Johnson et al., 2000; Schwalbe, 2014; Segal-Horn & Dean, 2009; Slechta, 2007).

Besides, research founds that communication difficulties lead to poor performance in both traditional and virtual teams (e.g. Carletta, Garrod, and Fraser-Krauss, 1998). These suggest that effective communication method is the core and foundational aspect for the *Communication* factor.

So, according to the discussion from the existing literature, and the best of the knowledge, it is believed that judging communication based on the effective communication method in a virtual team is the fundamental and generic assessment of the *Communication* factor. Hence, the *Communication_Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Communication* factor.

7.5.3 Global Indicator of Knowledge Sharing

In virtual teamwork, knowledge sharing is occurred through the interaction and collaboration of team members (Alavi & Leidner, 2001) but depends on the individual's willingness (Bock et al., 2005), as it is a voluntary activity (Hahm, 2017). The reluctance of individual team members in knowledge sharing hinders team collaboration and hampers achieving the team's goals (den Bosch, Volberda, & Boer, 1999). Besides, Kankanhalli et al. (2005)

indicated that the negative attitude of team members in knowledge sharing can decrease team performance and effectiveness.

On the other hand, the research found that knowledge sharing has a positive impact on collaboration which eventually influence team effectiveness in a virtual setting (Alsharo et al., 2017). It is crucial for virtual team collaboration and improved team performance. Besides, sharing of knowledge in a virtual team can generate innovative ideas, and an individual team member can be benefited from each other's expertise (Pinjani & Palvia, 2013), and as a result, it can foster the team performance and outcomes (Lam, 2000). Hence, every team member of a virtual team should be open and willingly share knowledge and information among themselves (Jessica & Leslie, 2012).

So, according to the discussion from the existing literature, and best of the knowledge, it is believed that judging knowledge sharing based on the open nature of sharing by the team members in a virtual team is the fundamental and generic assessment of the *Knowledge Sharing* factor. Hence, the *Knowledge_ Sharing_ Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Knowledge Sharing* factor.

7.5.4 Global Indicator of Trust

Trust is the foundation of interpersonal cooperation (McAllister, 1995). The existence of trust in teams or among team members consolidates the confidence in team vision (Schwalbe, 2014). When team members are trusted each other, they are not afraid (or willing) to go through a challenging task to a difficult process and support each other in teamwork (Mitchell & Zigurs, 2009). Besides, the presence of higher levels of trust among team members helps to manage and organize better virtual teamwork (Haines, 2014; Lipnack & Stamps, 2000; Roth, 2012). That's why it is believed that trusting each other in virtual teamwork is the basic and generic assessment of the *Trust* factor.

So, according to the discussion from the existing literature, and best of the knowledge, it is believed that trusting each other in virtual teamwork is the fundamental and generic assessment of the *Trust* factor. Hence, the *Trust_ Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Trust* factor.

7.5.5 Global Indicator of Cohesion

The virtual team cohesiveness mainly refers to stick together in a team until achieving the team's goal and being satisfied with the team's outcomes (Forrester & Tashchian, 2006). In other words, all the team members should have the tendency to stick together and be united for achieving the team's success and satisfaction in virtual teamwork (Carron et al., 1998). From these explanations of cohesion it can be said that whenever required, team members should help each other in virtual teamwork to be a strong cohesive virtual team. A cohesive team can produce an improved performance in virtual teamwork (Cohen & Bailey, 1997). Studies by Powell et al. (2004) and Maznevski and Chudoba (2000) also provided similar observation that cohesion is essential for improving the performance and the effectiveness of virtual teamwork.

So, according to the discussion from the existing literature, and best of the knowledge, it is believed that judging cohesion based on the helping mentality and attitude of the team members as a cohesive unit in order to deal with problems or resolve issues in virtual teamwork is the fundamental and generic assessment of the *Cohesion* factor. Hence, the *Cohesion_ Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Cohesion* factor.

7.5.6 Global Indicator of Coordination

Coordination is the core of virtual teamwork for managing it successfully (Pinsonneault & Caya, 2005; Powell et al., 2004). The research found that it is positively linked to the performance or effectiveness of virtual teamwork (e.g. Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski and Chudoba, 2000). Besides, it deals with conflict management in coordination to foster the performance (Montoya-Weiss et al., 2001). That means the presence of effective coordination among team members is essential for achieving the team's goals.

On the other hand, lack of coordination among team members or in the virtual team causes many problems such as missing relevant information, difficulties in decision-making, miscommunication, and mismanagement in virtual teamwork (Gray, 2001; Pinjani & Palvia, 2013).

So, according to the discussion from the existing literature, and best of the knowledge, it is believed that judging coordination based on the presence of coordination among the team members towards achieving the team goals is the fundamental and generic assessment of the *Coordination* factor. Hence, the *Coordination_ Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Coordination* factor.

7.5.7 Global Indicator of Performance

The meaning of performance is to achieve the desired result from teamwork by following the team's objectives and goals (Armstrong, 2007). So, team performance means a collective work for achieving the team's objectives and goals (Kirkman & Mathieu, 2007; Schwalbe, 2014). Besides, many researchers indicated that meeting the team's primary objectives is an effective indicator of judging *Performance* (e.g. Bosch-Sijtsema et al., 2009; Mathieu et al., 2008; Maznevski and Chudoba, 2000; Schweitzer and Duxbury, 2010; West, 2012). That's why team performance measurement should be clearly defined according to the team's goals and objectives, and meeting the team's goal is the main target of a high-performance team.

So, according to the discussion from the existing literature, and best of the knowledge, it is believed that judging performance based on the team's goals is the fundamental and generic assessment of the *Performance* factor. Hence, the *Performance_ Global* is chosen as the global indicator variable (as can be seen in table 7.10) to measure the *Performance* factor.

As a summary, all the global indicators for measuring convergent validity of the corresponding factors of the proposed conceptual model along with their supporting references are listed in table 7.11 .

Table 7.11: List of Global Indicators with Supporting References

Global Indicator Name	**Supporting References**
Motivation_Global	Geister et al. (2006), Hertel et al. (2005), Lurey and Raisinghani (2001), Peterson (2007), Sridhar et al. (2007)
Communication_Global	Clements and Gido (2012), D. W. Johnson et al. (2000), Schwalbe (2014), Segal-Horn and Dean (2009), Slechta (2007)
Knowledge_Sharing_Global	Alsharo et al. (2017), den Bosch et al. (1999), Hahm (2017), Jessica and Leslie (2012), Kankanhalli et al. (2005), Pinjani and Palvia (2013)
Trust_Global	Haines (2014), Lipnack and Stamps (2000), McAllister (1995), Mitchell and Zigurs (2009), Roth (2012), Schwalbe (2014)
Cohesion_Global	Carron et al. (1998), Cohen and Bailey (1997), Forrester and Tashchian (2006)

(continued on next page . . .)

Table 7.11: List of Global Indicators with Supporting References

(. . . continued from previous page)

Global Indicator Name	Supporting References
Coordination_Global	Gray (2001), Lin et al. (2008), Lu et al. (2006), Maznevski and Chudoba (2000), Montoya-Weiss et al. (2001), Pinsonneault and Caya (2005), Powell et al. (2004)
Performance_Global	Armstrong (2007), Bosch-Sijtsema et al. (2009), Kirkman and Mathieu (2007), Mathieu et al. (2008), Schweitzer and Duxbury (2010), West (2012)

7.6 Measurement Scale

A measurement scale is a tool that is used to obtain an answer from the respondent (or participant) to a question with a predetermined number of closed-ended responses. In this study, the ordinal scale such as the Likert scale is used to obtain answers from the participants. The use of the Likert scale is very common in the SEM context (Hair, Hult, Ringle, & Sarstedt, 2017). As this study is also applying PLS-SEM as a statistical technique, thus, it is considered in this study as well.

In particular, a five-point Likert scale is used in this study as a measurement scale for measuring the constructs (i.e. latent variables) of the conceptual model based on these indicator variables (i.e. measuring items) of the measurement model. Typically, a five-point Likert scale is ranged from 1 (*strongly disagree*) to 5 (*strongly agree*) (as shown in table 7.12), which is also adapted in this study.

Table 7.12: The Five-point Likert Scale

Categories	**Points**
strongly disagree	1
disagree	2
neither agree or disagree	3
agree	4
strongly agree	5

The participant virtual teams have measured the constructs based on these indicators of the measurement model, and answer according to the specified five-point Likert scale.

7.7 Summary

This chapter has presented the measurement model to measure the latent variables of the conceptual model (i.e. the structural model), and also completed the PLS path model of this study which will be evaluated next for statistical significance. The set of indicators presented in this measurement model will be used to collect the data for measuring the latent variable of the model. The complete evaluation of the measurement model and as well as the structural model, that is the estimation of the conceptual model of this study will be described in chapter 9.

Part IV

Data Collection, Analysis & Findings

Chapter 8

Data Collection & Examination

8.1 Chapter Overview

This chapter contains a description of the dataset used for the model estimation of this thesis in PLS-SEM. In particular, it discusses the source of the collected data, the sample size of the dataset, missing value treatment of the dataset, and distributional assumptions of the data.

8.2 Introduction

An empirical study has been conducted for assessing the proposed conceptual model. For that reason, empirical data are collected to evaluate the statistical significance of the model. This chapter contains a description of how the data are collected. It also presents the basic examinations of the data sample such as missing value treatment and data distributions.

The sample size is an important issue to consider before going to analyse the data. As this study has applied the PLS-SEM statistical technique to evaluate the model, a detailed explanation of the sample size is presented with regard to PLS-SEM. Besides, the rule of thumbs for sample size recommendation is discussed as well to consolidate the discussion as per the minimum sample size requirement in PLS-SEM.

8.3 Data Source

The data has been collected from a virtual teamwork competition, named ACBSP (Accreditation Council for Business Schools and Programs) - CompanyGame Tournament (Competition, 2019) held in 2019 (from 9^{th} September 2019 to 12^{th} October 2019) organized by a Spanish company named COMPANY GAME (CompanyGame, 2019). After the completion of the virtual teamwork competition, each team was asked to answer a survey-based questionnaire voluntarily about the effectiveness of virtual teamwork in online higher education.

8.3.1 The Online Competition/Tournament

The competition was open to all Ibero-American or Spanish-language universities that are members of the ACBSP Network. Participating students had to be in the last or penultimate semester of their study program. In the bases of the Tournament it was proposed that the universities participate with a enough volume of teams (between 4 and 10) to obtain results that could be representative. Finally, not all universities registered a minimum of 4 teams per category.

The Tournament has allowed students to manage a virtual company for 4 years (management periods). The participants have been organized into four categories:

- International Business
- Administration
- Finance - Accounting
- Marketing

Although initially, the possibility of a Postgraduate category had been raised, finally, not enough registrants were obtained so that a competition between universities could be established . The registered graduate teams were incorporated into the respective selected categories .

8.3.2 Call and Communication of the Tournament

The tournament was approved by the Region 9 Committee at the meeting held in Houston in late June 2019. At that meeting, adjusted the dates for holding the event, adapting the calendar to reality the academic year of the majority of universities . Some of them start the last cycle of the year at the beginning of September, which required that the registration of the teams be extended until 9th September 2019.

Universities wishing to participate in the Tournament could register as of July. The registration of the teams was carried out from mid-August to the first days of September 2019.

The communication and announcement of the Tournament by the universities towards their students was open to the good judgment of each one of them. Each one better knows its student body and the opportunities offered by its subjects and school calendar to motivate and attract students.

On this occasion, no prizes were foreseen for the winners, but Diplomas were considered for the winners.

To facilitate the understanding of the dynamics of the tournament, two virtual sessions were organized with coordinators, in which all the doubts raised were answered. The leagues of the sessions were accessible on YouTube (https://www.youtube.com/watch?v=5400uLO1OB0).

8.3.3 Simulation Exercises of the Tournament

The simulation exercise of the online tournament was conducted during the months of September and October 2019, in agreement and following schedule (see table 8.1):

Table 8.1: Schedule for the Exercises of the Tournament

Number of Weeks	**Description**
Week 1	– Starting from 9th September 2019. – Study the case. – Two sessions were organized for the resolution of doubts on September 10 and 11 that later they were available on Youtube (https://www.youtube.com/watch?v=9hJrdpjgKnY).
Week 2	– Starting from 16th September 2019. – Complete a company management planning document which is a format to prepare the action/business plan. – Taking the first round of decisions.
Week 3 and 4	– Starting from 23rd September 2019 (week 3) and 30th September 2019 (week 4). – Complete 3 decision rounds. – After each round, answer a quiz from the simulator itself.
Week 5	– Starting from 7th October 2019. – Present a Management Report of the simulated company in the format sent and a final video (5 min video recording + 10 slides).

Besides, the classification of each of the categories was obtained from the following parameters (see table 8.2).

Table 8.2: Classification and Ranking of the Categories

Parameters	**Percentage**
Company Value	80%
Management Report	8 %
Planning	8 %
Intermediate Test	4 %
Total =	**100%**

Each of the simulators has an indicator (Company Value) that reflects the evolution of the results of each company. Based on the different decisions that are taken, the Company's Value evolves positively or negatively.

At the beginning, the need to complete all the activities was indicated in order to be classified and consider the exercise as complete. Later a margin was given, since the intensity of the work was very high and various teams had not been able to do some of the activities, although they had done a very good job.

8.3.4 Participation

In this competition, 393 teams were registered from 34 universities to compete around different countries of South America such as Mexico, Columbia, Argentina, Peru, Ecuador, Dominican Republic, Paraguay, and Honduras.

When analysing the results, it has been necessary to qualify this participation, adjusting it to what has been the reality. For this, the different teams have been qualified in:

- Active Teams
- Valid Teams
- Classified Teams

The criteria considered carrying out this classification are:

1. Dedication: time registered on the platform, total and for the decision rounds.

2. Questionnaires: response to the various questionnaires provided.

3. Additional activities: send in due time and form the Action Plan, Management Report and Final Video.

According to the previous criteria, the level of participation by category has been presented in table 8.3.

Table 8.3: Total Registered, Active, Valid, and Classified Teams of the Tournament

Category	**Simulator**	**Registered**	**Active**	**Valid**	**Classified**
International Business	Global Business	85	54	45	34
Finance	Corbatul	104	56	47	30
Administration	FoodCompany	150	102	91	61
Marketing	TechCompany	54	32	26	17
Total =		**393**	**244**	**209**	**142**

As can be seen, among all the registered teams, there were 244 active teams, 209 valid teams, and 142 classified teams. That means, according to the previous data (in table 8.3), only 62.1% of the total participants have been active, 53.1% valid, and 36.1% classified. However, among all these teams, only the classified teams appear in the final ranking.

In the competition, each team worked completely in a virtual environment. All participants in the competition were from the undergraduate level of university students. In the survey of this study, each team answered only a single copy of the questionnaire as a team. That means one observation by each virtual team.

8.4 Sample Size

Among all the participant virtual teams, 159 teams answered the questionnaire. That means in total 159 observations are collected from the competition (i.e. one observation by each team). In table 8.4, the sample size is presented as per the countries.

Table 8.4: Sample size

Country	**Number of Observations**
Peru	55
Mexico	54
Columbia	29
Ecuador	11
Argentina	5
Paraguay	3
Honduras	1
Dominican Republic	1
Total Sample Size =	**159**

The good thing about PLS-SEM is that it capable of generating solution with a small sample size even if the model comprises many constructs and indicators variables (Fornell & Bookstein, 1982; Hair, Hult, Ringle, Sarstedt, & Thiele, 2017; Willaby, Costa, Burns, MacCann, & Roberts, 2015) by computing measurement model and structural model relationships separately in the PLS-SEM algorithm. Technically, the PLS-SEM algorithm uses separate OLS regression to compute partial regression relationships in the measurement model and the structural model. However, this advantage of PLS-SEM cannot be taken to obtain a solution with a tiny sample size which many researchers tried to do (Hair, Ringle, & Sarstedt, 2013) but this is incorrect and the most often abused argument of choosing PLS-SEM

(Goodhue, Lewis, & Thompson, 2012; Marcoulides & Saunders, 2006). This misconception in the case of choosing PLS-SEM for empirical studies only in terms of small sample size eventually forwarded a wrong criticism against PLS-SEM (Sarstedt et al., 2016), and damaged the reputation of PLS-SEM to some extent (Marcoulides, Chin, & Saunders, 2009).

Hence, it is to remember that small sample size should not be the sole argument for choosing the PLS-SEM technique in any empirical study rather in combination with other main arguments for choosing the PLS-SEM technique such as the goal of the study and its empirical analysis (Rigdon, 2016).

As a remedy in multivariate analysis, the minimum sample size ensures the safeguard of having enough statistical power of the PLS-SEM results. That's why there is a recommendation for a minimum sample size which should be fulfilled in PLS-SEM.

The minimum sample size for the application of PLS-SEM can be calculated by the 10 times rule (Barclay, Higgins, & Thompson, 1995), which indicates that the minimum sample size should be

- 10 times of the maximum number of formative indicators of a construct in the model, or
- 10 times of the maximum number of structural paths directed at a construct in the model.

However, the 10 times rule only provides a rough guideline for calculating the minimum sample size. That's why, a more reliable result for the sample size requirement should be calculated by means of statistical power analysis that consider the model structure, expected R^2 value, and anticipated significance level (Marcoulides & Chin, 2013). Such kind of sample size requirement can be determined by the rules of thumb (or the recommendations) provided by Cohen (1992) which is based on the statistical power analysis for multiple regression models.

Table 8.5 shows the minimum sample size requirements in order to achieve a statistical power of 80% for detecting the minimum R^2 values of 0.10, 0.25, 0.50, and 0.75 in the significance levels of 1%, 5%, and 10%.

As per the 10 times rule, the minimum sample size requirement for this study is **40** because the maximum number of structural paths pointing at a construct in the structural model is 4 as well. So, 4 times 10 is 40, which is almost 4 times smaller than the original sample size (i.e. 159) of this study.

Now, as per the recommendation by Cohen (1992), the minimum sample size requirement for this study is **41** to detect R^2 values of around 0.25, assuming a significant level of 5%, and statistical power of 80% (see table 8.5). The reason is that the maximum number of arrows pointing at a construct in the model of this study is 4. This minimum sample size is also almost 4 times smaller than the original sample size (i.e. 159) of this study.

However, it is to mention that there are several relationships in the PLS path model (as per the conceptual model derived in chapter 6) which are not found statistically significant. That's why in the final path model which is evaluated thoroughly in chapter 9, the maximum number of structural paths pointing at a construct in the structural model is 3. In this case, the minimum sample size requirement is **30** as per 10 times rule, which is 5 times smaller than the original sample size (i.e. 159) of this study. And, as per the recommendation by Cohen (1992), the minimum sample size requirement is **37** to detect R^2 values of around 0.25, assuming a significant level of 5%, and statistical power of 80% (see table 8.5). This minimum sample size is also almost 4 times smaller than the original sample size (i.e. 159) of this study.

Table 8.5: Sample Size Recommendation in PLS-SEM for 80% Statistical Power

Maximum Number of Arrows Pointing at a Construct	**Significance Level**											
	10%				**5%**				**1%**			
	Minimum R2				**Minimum R2**				**Minimum R2**			
	0.10	**0.25**	**0.50**	**0.75**	**0.10**	**0.25**	**0.50**	**0.75**	**0.10**	**0.25**	**0.50**	**0.75**
2	72	26	11	7	90	33	14	8	130	47	19	10
3	83	30	13	8	103	37	16	9	145	53	22	12
4	92	34	15	9	113	41	18	11	158	58	24	14
5	99	37	17	10	122	45	20	12	169	62	26	15
6	106	40	18	12	130	48	21	13	179	66	28	16
7	112	42	20	13	137	51	23	14	188	69	30	18
8	118	45	21	14	144	54	24	15	196	73	32	19
9	124	47	22	15	150	56	26	16	204	76	34	20
10	129	49	24	16	156	59	27	18	212	79	35	21

Source: Cohen, S. (1992). A power primer. *Psychological Bulletin*, *112*, 155–159.

Anyway, in both cases, the original sample size is sufficiently bigger than the minimum sample size requirement. So, the sample size is not an issue in the empirical study of this thesis because it has a good number of sample size (more than the recommended minimum sample size requirement). The sample size issue is clearly an advantage of using PLS-SEM as it works well with a small sample size due to the small population size, and, it works very well with a large sample size as usual.

8.5 Missing Data

Like any statistical analysis, the missing values in the dataset should be handled carefully when using PLS-SEM. Generally, missing values occur in the dataset when a respondent fails to answer one or more questions on the questionnaire either intentionally or inadvertently. Hair, Hult, Ringle, and Sarstedt (2017) provide recommendations for dealing with missing values when using PLS-SEM, which are given below.

- First, check the percentage of missing values for each of the observations in the dataset. If the percentage of missing values in an observation exceeds 15% then eliminate the observation (case-wise deletion).

- Afterwards, check the percentage of missing values for each of the indicators in the model. If the percentage of missing values in an indicator exceeds 5% then use a case-wise replacement (observation is deleted completely). Otherwise, if the percentage of missing values in an indicator remains less than 5% then use mean value replacement for the missing values in the dataset.

Among the 159 observations of the dataset, there are only 9 observations of which each has more than 15% missing values. So, as per the recommendation, these 9 observations have been eliminated from the dataset and yields a total of 150 observations in the dataset. It is worth to mention that after eliminating the 9 observations from the dataset, still, the sample size is 5 times of the recommended minimum sample size requirement as per the 10 times rule and more than 4 times of the recommended minimum sample size requirement as per the rules of thumb by Cohen (1992).

Afterwards, among the indicators, there are only 3 indicators that contain 4 missing values altogether. That means in the whole dataset (of sample size 150) there are only 4 missing values. The percentage of missing values of each of these 3 indicators is less than 5% (see table 8.6), so, as per the recommendations, the mean value replacement is used for these 4 missing values.

Table 8.6: Missing Values in the Dataset (of Sample Size 150)

Indicators	**Number of Missing Values**	**Percentage of Missing Values (<5%)**
Cohesion_3	1	0.67%
Performance_2	2	1.33%
Performance_3	1	0.67%
Total (in the Dataset) =	**4**	**2.67%**

Table 8.6 shows that these 3 indicators have 0.67%, 1.33%, and 0.67% missing values respectively which are significantly less than 5%, so fair enough to use the mean value replacement for them. Besides, as a whole, the dataset contains only 2.67% missing values which are also very low.

8.6 Data Distributions

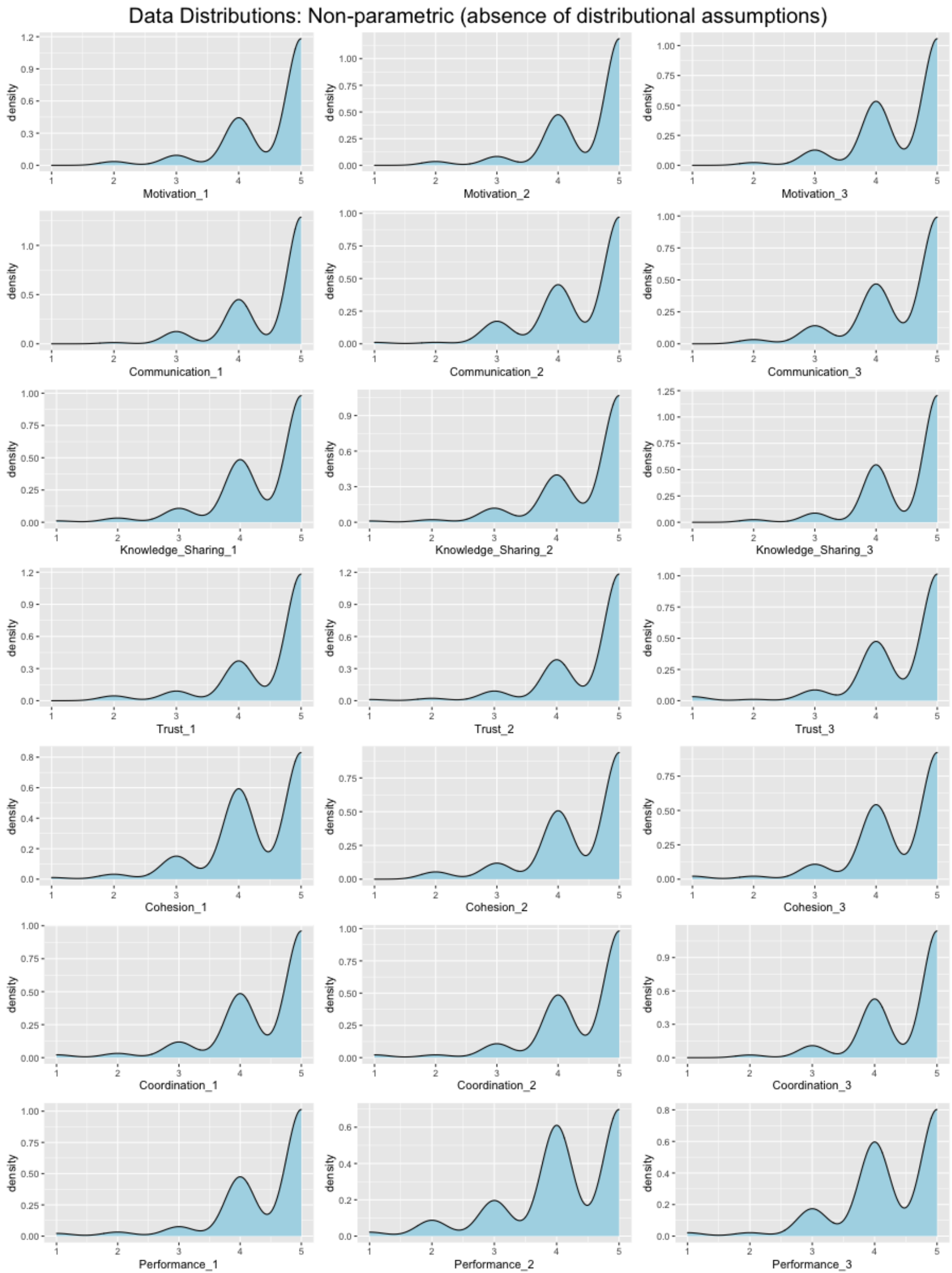
The collected data for this study is non-parametric (i.e. non-normal, or absence of distributional assumptions), which is shown in figure 8.1. In the figure, data distributions of the sample dataset are shown by the density plots for each of the indicator variables of the constructs in the conceptual model. The density plot provides a visual judgment about whether the data distribution is bell shaped (i.e. normal distribution), or not (i.e. non-parametric). The figure clearly shows that none of the density plots in figure 8.1 are bell shaped. That means, the data distribution of the collected dataset of this study is non-parametric.

The good thing about the PLS-SEM is that it generally makes no assumption about the data distributions, while in contrast CB-SEM generally requires normal distributions of data (Hair, Hult, Ringle, & Sarstedt, 2017). Moreover, CB-SEM might be robust against non-parametric data (Chou, Bentler, & Satorra, 1991; Olsson, Foss, Troye, & Howell, 2000) but in that case, it requires a larger sample size (Boomsma & Hoogland, 2001). Otherwise, in the case of small sample size, it produces abnormal results because of the absence of normality (Reinartz, Haenlein, & Henseler, 2009). On the other hand, in these situations, PLS-SEM exhibits higher robustness against the absence of distributional assumptions (Sarstedt et al., 2016).

Though in a limited number of situations, PLS-SEM results can be affected by the non-normal data (Sarstedt et al., 2017) but this issue can be handled with the use of bias-corrected and accelerated (BCa) bootstrapping procedure which adjusts the bootstrap confidence intervals for skewness (Efron, 1987). This BCa bootstrapping procedure is also applied in this study.

However, many researchers incorrectly indicate the non-normality of the data as the main argument for selecting PLS-SEM as a statistical technique (do Valle & Assaker, 2016; Hair, Sarstedt, Ringle, & Mena, 2012; Nitzl, 2016). This is clearly a big advantage of using PLS-SEM, but should not be the sole argument, rather in combination with other main arguments for choosing the PLS-SEM technique (Hair et al., 2018). So, this advantage is also applicable in this study as the collected data for the empirical study of this thesis is non-normal.

Figure 8.1: Data Distributions of the Collected Dataset



8.7 Summary

This chapter has presented the data collection procedure and some basic examinations on the collected sample data. This sample data will be analysed by applying PLS-SEM statistical technique to evaluate the conceptual model which is illustrated in detail in the next chapter (i.e. *Model Estimation*).

Chapter 9

Model Estimation

Chapter Preface

The shorter version of this chapter is already published as an article in the peer-reviewed *RII Forum 2020* Proceedings. The author and supervisor of the article is the same as the author and supervisor of this thesis. Full citation of the article is mentioned below:

> Jony, A. I., & Serradell-López, E. (2020b). An evaluation of virtual teamwork model in online higher education. In A. Visvizi, M. D. Lytras, & N. R. Aljohani (Eds.), *Research & innovation forum 2020: Disruptive technologies in times of change*. Springer Proceedings in Complexity, Springer

Also, it is to mention that the *SmartPLS* (Ringle et al., 2015) reports for the model estimation of this thesis is used in this chapter.

9.1 Chapter Overview

This chapter presents the evaluation of the model for effective virtual teamwork development in online higher education by analysing the data using the PLS-SEM technique. At the beginning it assesses the PLS-SEM results of the measurement model and then it assesses the PLS-SEM results of the structure model, to illustrate the evaluation of the model and the quality assessment of the results. Finally, it presents the assessment of the model fit.

9.2 The PLS Path Model

As per the conceptual model derived in chapter 6, and the measurement model specified in chapter 7, the following PLS path (presented in figure 9.1) model will be evaluated using the PLS-SEM statistical technique. Before going for the step-by-step evaluation of the model, let's check whether all the relationships (i.e. hypotheses) of the model are supported statistically or not. Afterwards, the model will be assessed with all the standard evaluation criteria of the PLS-SEM technique, separately for both measurement and structural parts of the model.

Therefore, after running the PLS-SEM algorithm and bootstrapping procedure for the model estimation, there are found 3 relationships (i.e. *Knowledge Sharing→Performance*, *Trust→Performance*, and *Cohesion→Performance*) which are not statistically significant. As table 9.1 shows, the coefficients of these 3 relationships are not statistically supported according to the path coefficients, t values, and p values. Thus, these 3 relationships (i.e. hypotheses, $H_{KS \to PF}$, $H_{TR \to PF}$, and $H_{CH \to PF}$) can be eliminated from the model. In addition, the 3 predecessor constructs *Knowledge Sharing*, *Cohesion*, and *Trust* have already affected positively on the *Performance* construct through the *Coordination* construct. So, it is believed that the elimination of these 3 relationships does not damage the quality and orientation of the model.

As there are 3 relationships in the PLS path model which are not statistically significant, the following PLS path model (presented in figure 9.2) after eliminating those insignificant relationships will be evaluated next thoroughly in this chapter.

Figure 9.1: The PLS path model

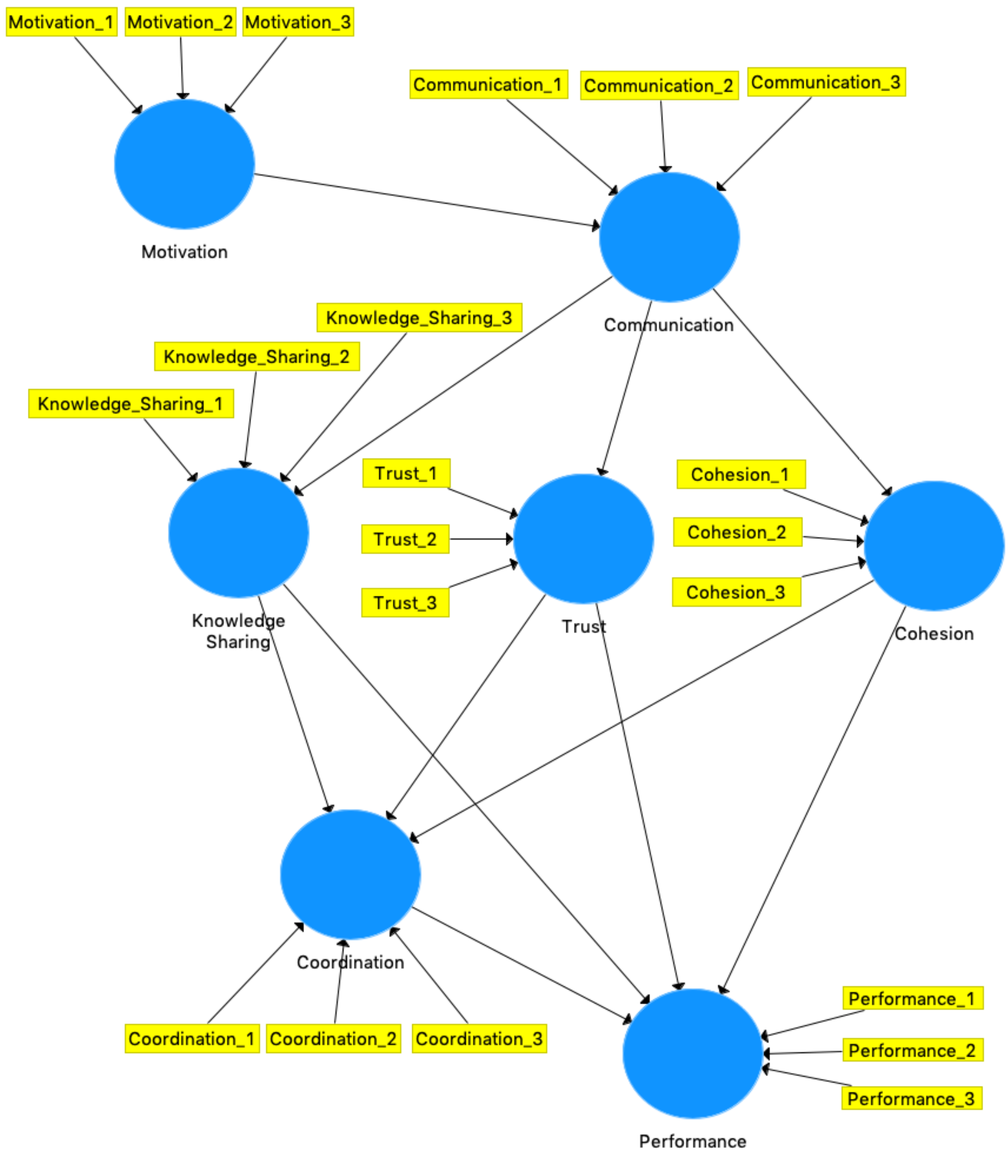
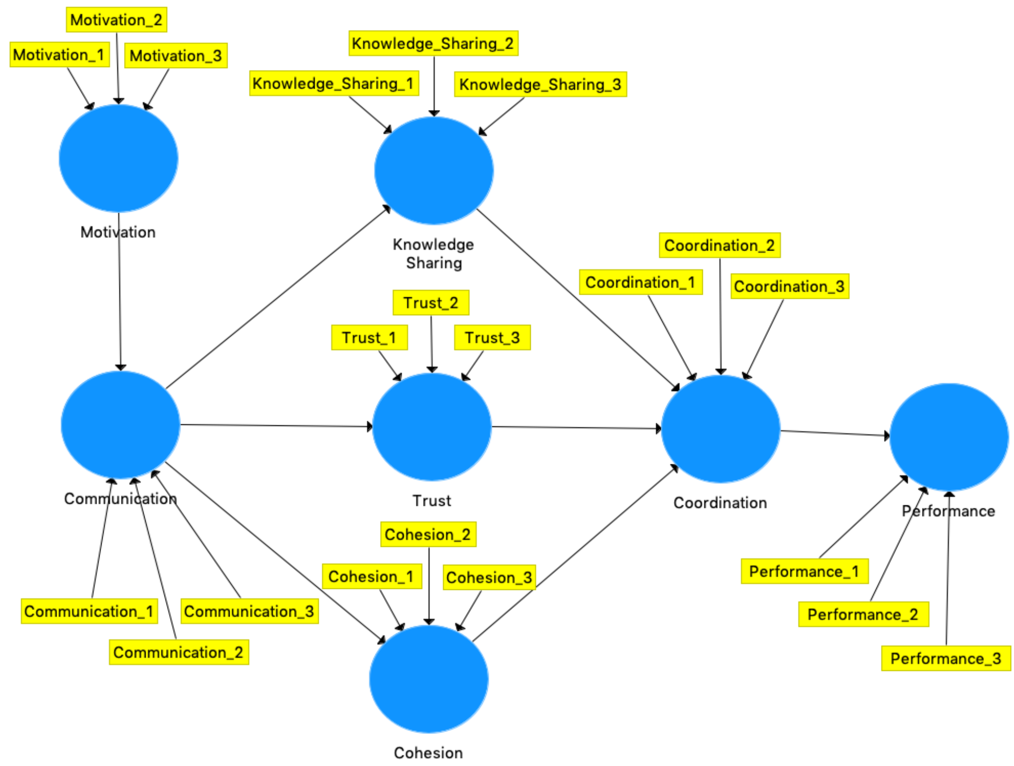


Table 9.1: Significance Testing of the Model's Relationships

Relationships	**Hypotheses**	**Path Coefficients**	**t Values**	**p Values**	**Significance (p <0.05)?**
Cohesion ->Coordination	$H_{CH \to CR}$	0.529	6.894	0.000	Yes
Cohesion ->Performance	$H_{CH \to PF}$	0.011	0.089	0.929	**No**
Communication ->Cohesion	$H_{CM \to CH}$	0.896	38.539	0.000	Yes
Communication ->Knowledge Sharing	$H_{CM \to KS}$	0.843	26.023	0.000	Yes
Communication ->Trust	$H_{CM \to TR}$	0.767	16.130	0.000	Yes
Coordination ->Performance	$H_{CR \to PF}$	0.925	5.806	0.000	Yes
Knowledge Sharing ->Coordination	$H_{KS \to CR}$	0.255	2.492	0.013	Yes
Knowledge Sharing ->Performance	$H_{KS \to PF}$	-0.064	0.460	0.645	**No**
Motivation ->Communication	$H_{MT \to CM}$	0.858	25.996	0.000	Yes
Trust ->Coordination	$H_{TR \to CR}$	0.188	2.298	0.022	Yes
Trust ->Performance	$H_{TR \to PF}$	-0.071	0.515	0.607	**No**

MT: Motivation; CM: Communication; KS: Knowledge Sharing;
TR: Trust; CH: Cohesion; CR: Coordination; PF: Performance.

Figure 9.2: The PLS path model to be estimated



The complete evaluation of the measurement and structural parts of the PLS path model are presented in the following two subsequent sections, 9.3, and 9.4 respectively. Finally, the evaluation of model fit is presented in section 9.5.

9.3 Evaluation of Measurement Model

This section presents the measurement model evaluation (by following the procedure presented in figure 5.3) by assessing content validity and other evaluation criteria of applying PLS-SEM in order to estimate the (formative) measurement model of this research study.

9.3.1 Assessment of Content Validity

The content validity of the formative measurement model has been established through the reviewed literature. The contents for all the indicators of the constructs are supported and validated by the literature as per the explored and specified domains of the constructs. A detailed description and explanation about the content validity of the seven constructs (i.e. motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance) of the measurement model of this study is presented in *chapter 7: Measurement Model*.

Thus, content validity for the seven constructs (i.e. motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance) of the measurement model is established based on theoretical considerations by the supports from the existing literature.

9.3.2 Assessment of Convergent Validity

In the formative measurement model, it is needed to examine whether the constructs exhibit convergent validity (i.e. redundancy analysis). In this assessment, separate redundancy analysis is carried out for each construct in the measurement model. For doing redundancy analysis, the original questionnaire contained global single-item measures with generic assessments of the 7 constructs, *Motivation*, *Communication*, *Knowledge Sharing*, *Trust*, *Cohesion*, *Coordination*, and *Performance* —which will be used as measures of the dependent construct in the redundancy analysis.

Now, to assess convergent validity, seven new models have to be developed for the seven constructs respectively, which are displayed in figure 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, and 9.9. In these models, the original formative construct is labeled as Construct_F (e.g. *Motivation_F*) and its global assessment as a dependent construct with a single-item measure is labeled as Construct_G (e.g. *Motivation_G*), and the global indicator is labeled as Construct_Global (e.g. *Motivation_Global*).

In the redundancy analysis displayed in figures 9.3, 9.4, 9.5, 9.6, 9.7, 9.8,

Figure 9.3: Convergent Validity Assessment for "Motivation"

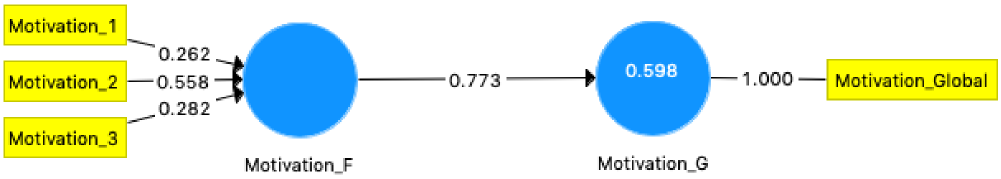


Figure 9.4: Convergent Validity Assessment for "Communication"

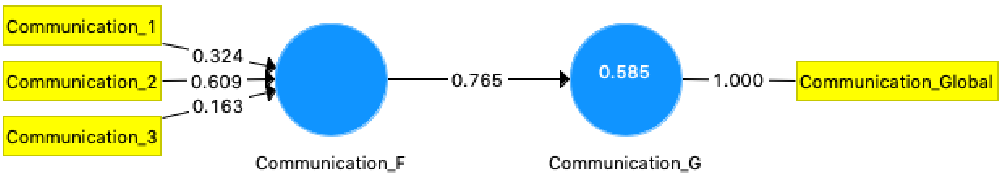


Figure 9.5: Convergent Validity Assessment for "Knowledge Sharing"

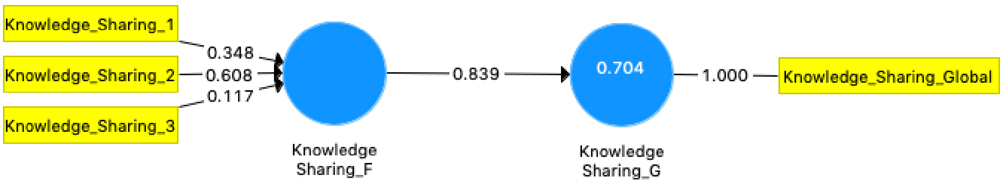


Figure 9.6: Convergent Validity Assessment for "Trust"

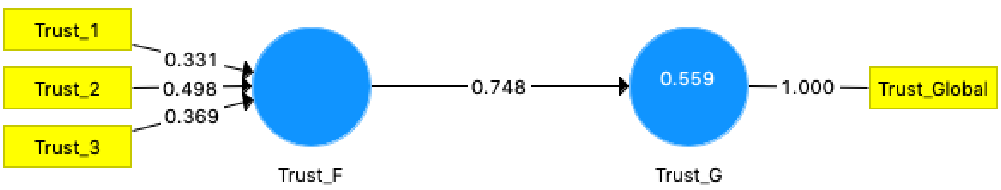


Figure 9.7: Convergent Validity Assessment for "Cohesion"

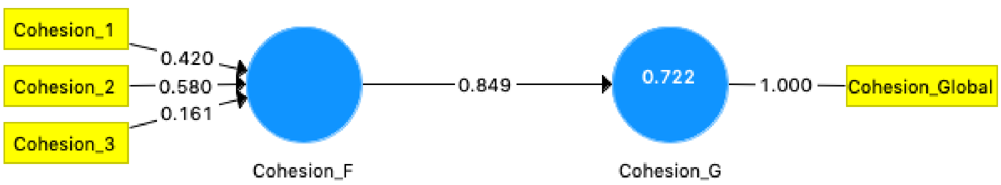


Figure 9.8: Convergent Validity Assessment for "Coordination"

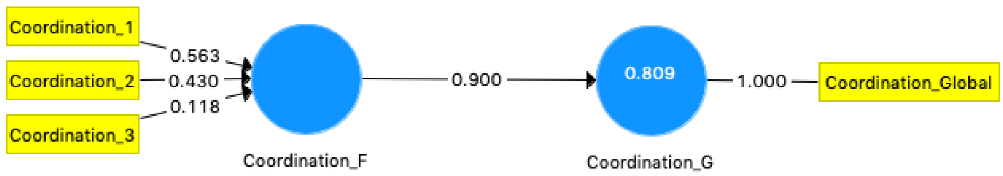
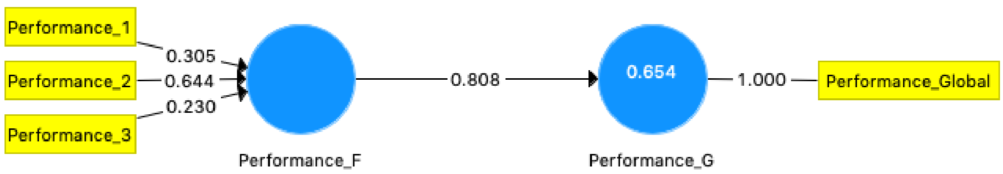


Figure 9.9: Convergent Validity Assessment for "Performance"



and 9.9, the path coefficients for *motivation*, *communication*, *knowledge sharing*, *trust*, *cohesion*, *coordination*, and *performance* constructs are 0.773, 0.765, 0.839, 0.748, 0.849, 0.900, and 0.808 respectively, where all these values are above the recommended threshold of 0.70. Thus, indicates that all the formatively measured constructs exhibit convergent validity.

9.3.3 Assessment of Collinearity Issues

In the evaluation of the measurement model, the next step is to examine the collinearity of indicators to assess the formative measurement model by the VIF values of indicators. The VIF values for all the indicators are shown in table 9.2 to assess the collinearity issues of the measurement model.

According to the result displayed in table 9.2, the highest VIF value is 3.686 for *Motivation_2* indicator. That indicates that all the VIF values of the indicators are below the threshold of 5. Therefore, it can be said that collinearity for any constructs does not reach critical levels and hence, is not an issue for the PLS path model estimation.

Table 9.2: Collinearity Statistics (VIF values of indicators)

Indicators	**VIF Values**
Cohesion_1	1.836
Cohesion_2	1.656
Cohesion_3	1.579
Communication_1	2.402
Communication_2	2.469
Communication_3	2.890
Coordination_1	2.157
Coordination_2	2.419
Coordination_3	1.699
Knowledge_Sharing_1	2.805
Knowledge_Sharing_2	3.641
Knowledge_Sharing_3	2.258
Motivation_1	3.614
Motivation_2	3.686
Motivation_3	1.789
Performance_1	1.784
Performance_2	1.474
Performance_3	1.912
Trust_1	2.795
Trust_2	2.591
Trust_3	1.258

9.3.4 Assessment of Significance and Relevance of Indicators

In the previous step of measurement model evaluation, there was found no collinearity issues so it is time to assess the significance and relevance of the indicators next. The outer weights of the indicators will be analysed to assess the significance and relevance of the indicators. Later, the outer loadings of the indicators will be analysed to assess the absolute contribution (or absolute importance) of the indicators to (for) their constructs.

The significance of outer weights can be obtained by means of bootstrapping procedure, where (recommended) 5000 subsamples, BCa bootstrap confidence interval method, and 0.05 Significance level are the parameter settings to execute the bootstrap procedure.

According to the results produced by bootstrapping, the outer weights of the indicators are shown in table 9.3, where

Original Sample (O) indicates the original estimate of the outer weights,

Sample Mean (M) indicates the bootstrap mean values,

Standard Deviation (STDEV) indicates the bootstrap standard deviations,

T Statistics (|O/STDEV|) indicates the outer weights results in its empirical t values, and

P Values indicates the translation of t values into significance levels.

The statistics in table 9.3 exhibits that all the indicators in the measurement model are significant at a 5% level (i.e. 0.05), except *Performance_2*. However, this non-significant indicator should not delete as per the outer weight only, rather it should consider outer loading as well for examining the indicator's absolute contribution. The reason is that if an indicator's outer weight is non-significant but its outer loading is high (i.e. more than 0.50) then the indicator should be interpreted as absolutely important but not as relatively important, and hence, in this situation, the indicator generally should be retained in the measurement model (Hair, Hult, Ringle, & Sarstedt, 2017).

The outer loadings of the indicators are presented in table 9.4, which indicates all the indicator' outer loadings are above the threshold of 0.50, and also all the p values of the indicator's outer loadings are clearly below 0.01. So, it suggests that all outer loadings are significant at a level of 1%. Considering this fact, the only non-significant indicator, *Performance_2* (as per the value of outer weight) should be retained in the measurement model as it absolutely contributes to (absolutely important for) its construct. Thus, there is no problem to proceed with the evaluation of the structural model.

In addition to the statistics of outer weights and outer loadings, the bootstrapping procedure also provides bootstrap confidence intervals for outer weights and outer loadings. The statistics presented in table 9.5, and table 9.6 shows the bootstrap confidence intervals for outer weights, of which one is without bias correction, and another one is bias-corrected confidence intervals (BCa method).

On the other hand, the statistics presented in table 9.7, and table 9.8 shows the bootstrap confidence intervals for outer loadings, of which one is without bias correction, and another one is bias-corrected confidence intervals (by BCa method).

All the statistics of confidence intervals (shown in tables 9.5, 9.6, 9.7, and 9.8) for the outer weights and outer loadings indicate that the true values of indicator's outer weights and outer loadings are somewhere within the range with 95% probability. Also, all the indicators are significant as their confidence intervals do not include zero value.

Table 9.3: Outer Weights of the indicators

Indicators ->Constructs	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Cohesion_1 ->Cohesion	0.457	0.454	0.067	6.852	0.000
Cohesion_2 ->Cohesion	0.522	0.516	0.059	8.888	0.000
Cohesion_3 ->Cohesion	0.189	0.196	0.072	2.631	0.009
Communication_1 ->Communication	0.386	0.387	0.075	5.116	0.000
Communication_2 ->Communication	0.376	0.374	0.075	4.984	0.000
Communication_3 ->Communication	0.347	0.345	0.077	4.519	0.000
Coordination_1 ->Coordination	0.368	0.371	0.055	6.631	0.000
Coordination_2 ->Coordination	0.519	0.515	0.067	7.780	0.000
Coordination_3 ->Coordination	0.246	0.248	0.071	3.470	0.001
Knowledge_Sharing_1 ->Knowledge Sharing	0.244	0.253	0.096	2.548	0.011
Knowledge_Sharing_2 ->Knowledge Sharing	0.499	0.489	0.112	4.457	0.000
Knowledge_Sharing_3 ->Knowledge Sharing	0.353	0.353	0.096	3.664	0.000
Motivation_1 ->Motivation	0.413	0.405	0.124	3.334	0.001
Motivation_2 ->Motivation	0.309	0.308	0.140	2.205	0.028
Motivation_3 ->Motivation	0.395	0.400	0.095	4.146	0.000
Performance_1 ->Performance	0.560	0.580	0.125	4.493	0.000
Performance_2 ->Performance	0.138	0.128	0.084	1.651	0.099
Performance_3 ->Performance	0.450	0.430	0.133	3.371	0.001
Trust_1 ->Trust	0.439	0.434	0.173	2.531	0.011
Trust_2 ->Trust	0.444	0.435	0.155	2.870	0.004
Trust_3 ->Trust	0.297	0.299	0.116	2.560	0.010

Table 9.4: Outer loadings of the indicators

Indicators ->Constructs	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Cohesion_1 ->Cohesion	0.877	0.872	0.035	25.104	0.000
Cohesion_2 ->Cohesion	0.890	0.886	0.031	28.641	0.000
Cohesion_3 ->Cohesion	0.712	0.711	0.087	8.195	0.000
Communication_1 ->Communication	0.898	0.897	0.027	33.738	0.000
Communication_2 ->Communication	0.898	0.894	0.035	25.498	0.000
Communication_3 ->Communication	0.912	0.908	0.030	30.530	0.000
Coordination_1 ->Coordination	0.878	0.876	0.033	26.485	0.000
Coordination_2 ->Coordination	0.937	0.932	0.025	36.903	0.000
Coordination_3 ->Coordination	0.774	0.768	0.068	11.354	0.000
Knowledge_Sharing_1 ->Knowledge Sharing	0.870	0.865	0.045	19.221	0.000
Knowledge_Sharing_2 ->Knowledge Sharing	0.956	0.951	0.020	47.832	0.000
Knowledge_Sharing_3 ->Knowledge Sharing	0.880	0.874	0.042	20.971	0.000
Motivation_1 ->Motivation	0.923	0.915	0.035	26.676	0.000
Motivation_2 ->Motivation	0.910	0.904	0.039	23.240	0.000
Motivation_3 ->Motivation	0.855	0.851	0.052	16.329	0.000
Performance_1 ->Performance	0.916	0.908	0.061	14.893	0.000
Performance_2 ->Performance	0.651	0.641	0.085	7.688	0.000
Performance_3 ->Performance	0.883	0.874	0.049	18.117	0.000
Trust_1 ->Trust	0.921	0.907	0.050	18.440	0.000
Trust_2 ->Trust	0.899	0.892	0.043	21.073	0.000
Trust_3 ->Trust	0.662	0.660	0.111	5.976	0.000

Table 9.5: Bootstrap confidence intervals for outer weights without bias correction

Indicators ->Constructs	**Original Sample (O)**	**Sample Mean (M)**	**2.5 %**	**97.5 %**
Cohesion_1 ->Cohesion	0.457	0.454	0.326	0.587
Cohesion_2 ->Cohesion	0.522	0.516	0.401	0.631
Cohesion_3 ->Cohesion	0.189	0.196	0.061	0.340
Communication_1 ->Communication	0.386	0.387	0.244	0.542
Communication_2 ->Communication	0.376	0.374	0.222	0.517
Communication_3 ->Communication	0.347	0.345	0.194	0.497
Coordination_1 ->Coordination	0.368	0.371	0.265	0.483
Coordination_2 ->Coordination	0.519	0.515	0.375	0.634
Coordination_3 ->Coordination	0.246	0.248	0.117	0.392
Knowledge_Sharing_1 ->Knowledge Sharing	0.244	0.253	0.063	0.442
Knowledge_Sharing_2 ->Knowledge Sharing	0.499	0.489	0.255	0.694
Knowledge_Sharing_3 ->Knowledge Sharing	0.353	0.353	0.170	0.547
Motivation_1 ->Motivation	0.413	0.405	0.165	0.653
Motivation_2 ->Motivation	0.309	0.308	0.023	0.582
Motivation_3 ->Motivation	0.395	0.400	0.229	0.596
Performance_1 ->Performance	0.560	0.580	0.352	0.818
Performance_2 ->Performance	0.138	0.128	-0.031	0.298
Performance_3 ->Performance	0.450	0.430	0.174	0.685
Trust_1 ->Trust	0.439	0.434	0.101	0.780
Trust_2 ->Trust	0.444	0.435	0.099	0.705
Trust_3 ->Trust	0.297	0.299	0.088	0.537

Table 9.6: Bootstrap confidence intervals for outer weights with bias-corrected (by BCa method)

Indicators ->Constructs	Original Sample (O)	Sample Mean (M)	Bias	2.5 %	97.5 %
Cohesion_1 ->Cohesion	0.457	0.454	-0.003	0.332	0.593
Cohesion_2 ->Cohesion	0.522	0.516	-0.006	0.415	0.641
Cohesion_3 ->Cohesion	0.189	0.196	0.008	0.050	0.329
Communication_1 ->Communication	0.386	0.387	0.002	0.244	0.543
Communication_2 ->Communication	0.376	0.374	-0.001	0.225	0.520
Communication_3 ->Communication	0.347	0.345	-0.002	0.196	0.499
Coordination_1 ->Coordination	0.368	0.371	0.003	0.263	0.480
Coordination_2 ->Coordination	0.519	0.515	-0.004	0.376	0.634
Coordination_3 ->Coordination	0.246	0.248	0.002	0.119	0.397
Knowledge_Sharing_1 ->Knowledge Sharing	0.244	0.253	0.009	0.048	0.427
Knowledge_Sharing_2 ->Knowledge Sharing	0.499	0.489	-0.010	0.268	0.700
Knowledge_Sharing_3 ->Knowledge Sharing	0.353	0.353	0.001	0.171	0.548
Motivation_1 ->Motivation	0.413	0.405	-0.008	0.182	0.680
Motivation_2 ->Motivation	0.309	0.308	-0.001	0.021	0.580
Motivation_3 ->Motivation	0.395	0.400	0.005	0.229	0.596
Performance_1 ->Performance	0.560	0.580	0.019	0.336	0.804
Performance_2 ->Performance	0.138	0.128	-0.010	-0.009	0.322
Performance_3 ->Performance	0.450	0.430	-0.019	0.198	0.709
Trust_1 ->Trust	0.439	0.434	-0.005	0.105	0.784
Trust_2 ->Trust	0.444	0.435	-0.009	0.093	0.701
Trust_3 ->Trust	0.297	0.299	0.002	0.091	0.540

Table 9.7: Bootstrap confidence intervals for outer loadings without bias correction

Indicators ->Constructs	**Original Sample (O)**	**Sample Mean (M)**	**2.5 %**	**97.5 %**
Cohesion_1 ->Cohesion	0.877	0.872	0.796	0.931
Cohesion_2 ->Cohesion	0.890	0.886	0.817	0.938
Cohesion_3 ->Cohesion	0.712	0.711	0.517	0.859
Communication_1 ->Communication	0.898	0.897	0.840	0.944
Communication_2 ->Communication	0.898	0.894	0.814	0.950
Communication_3 ->Communication	0.912	0.908	0.840	0.957
Coordination_1 ->Coordination	0.878	0.876	0.800	0.929
Coordination_2 ->Coordination	0.937	0.932	0.871	0.970
Coordination_3 ->Coordination	0.774	0.768	0.619	0.884
Knowledge_Sharing_1 ->Knowledge Sharing	0.870	0.865	0.760	0.937
Knowledge_Sharing_2 ->Knowledge Sharing	0.956	0.951	0.903	0.980
Knowledge_Sharing_3 ->Knowledge Sharing	0.880	0.874	0.781	0.945
Motivation_1 ->Motivation	0.923	0.915	0.835	0.967
Motivation_2 ->Motivation	0.910	0.904	0.814	0.964
Motivation_3 ->Motivation	0.855	0.851	0.739	0.940
Performance_1 ->Performance	0.916	0.908	0.765	0.988
Performance_2 ->Performance	0.651	0.641	0.454	0.790
Performance_3 ->Performance	0.883	0.874	0.761	0.952
Trust_1 ->Trust	0.921	0.907	0.790	0.979
Trust_2 ->Trust	0.899	0.892	0.797	0.961
Trust_3 ->Trust	0.662	0.660	0.432	0.858

Table 9.8: Bootstrap confidence intervals for outer loadings with bias-corrected (by BCa method)

Indicators ->Constructs	**Original Sample (O)**	**Sample Mean (M)**	**Bias**	**2.5 %**	**97.5 %**
Cohesion_1 ->Cohesion	0.877	0.872	-0.005	0.799	0.932
Cohesion_2 ->Cohesion	0.890	0.886	-0.004	0.821	0.939
Cohesion_3 ->Cohesion	0.712	0.711	-0.001	0.508	0.851
Communication_1 ->Communication	0.898	0.897	-0.001	0.838	0.943
Communication_2 ->Communication	0.898	0.894	-0.004	0.817	0.951
Communication_3 ->Communication	0.912	0.908	-0.004	0.841	0.958
Coordination_1 ->Coordination	0.878	0.876	-0.002	0.795	0.928
Coordination_2 ->Coordination	0.937	0.932	-0.005	0.875	0.972
Coordination_3 ->Coordination	0.774	0.768	-0.006	0.620	0.884
Knowledge_Sharing_1 ->Knowledge Sharing	0.870	0.865	-0.005	0.761	0.937
Knowledge_Sharing_2 ->Knowledge Sharing	0.956	0.951	-0.005	0.909	0.981
Knowledge_Sharing_3 ->Knowledge Sharing	0.880	0.874	-0.006	0.788	0.948
Motivation_1 ->Motivation	0.923	0.915	-0.008	0.844	0.971
Motivation_2 ->Motivation	0.910	0.904	-0.006	0.816	0.965
Motivation_3 ->Motivation	0.855	0.851	-0.004	0.737	0.939
Performance_1 ->Performance	0.916	0.908	-0.007	0.755	0.986
Performance_2 ->Performance	0.651	0.641	-0.010	0.468	0.797
Performance_3 ->Performance	0.883	0.874	-0.009	0.770	0.955
Trust_1 ->Trust	0.921	0.907	-0.013	0.807	0.984
Trust_2 ->Trust	0.899	0.892	-0.007	0.805	0.963
Trust_3 ->Trust	0.662	0.660	-0.002	0.428	0.856

9.4 Evaluation of Structural Model

This section presents the structural model evaluation criteria (by following the procedure presented in figure 5.4) of applying PLS-SEM in order to estimate the model of this research study. The structural model assessment builds on the results from the standard PS-SEM algorithm, the bootstrapping routine/procedure, and the blindfolding procedure, which will be presented thoroughly in the following subsections of this section.

9.4.1 Assessment of Collinearity Issues

As per the structural model assessment procedure (presented in figure 5.4), the first step is to check the structural model for collinearity issues by examining the VIF values (i.e. Inner VIF) of all sets of predictor constructs in the structural model. Table 9.9 shows the VIF values of all combinations of endogenous constructs (presented by the columns in the table), and corresponding exogenous (i.e., predictor) constructs (presented by the rows in the table). Specifically, the following sets of (predictor) constructs will be assessed for collinearity issues:

(a) *Motivation* as a predictor of *Communication*,

(b) *Communication* as a predictor of *Knowledge Sharing*, *Trust*, and *Cohesion*,

(c) *Knowledge Sharing*, *Trust*, and *Cohesion* as predictors of *Coordination*, and

(d) *Coordination* as a predictor of *Performance*.

Table 9.9: Collinearity Statistics (VIF values in the structural model)

	Cohesion	**Communication**	**Coordination**	**Knowledge Sharing**	**Motivation**	**Performance**	**Trust**
Cohesion			3.678				
Communication	1.000			1.000			1.000
Coordination						1.000	
Knowledge Sharing			4.314				
Motivation		1.000					
Performance							
Trust			2.855				

The results presented in table 9.9 indicates that all the VIF values are clearly below the threshold of 5. Hence, the collinearity is not a critical issue among the predictor constructs in the structural model.

9.4.2 Assessment of Coefficient of Determination (R^2 Value)

The next evaluation criterion of the structural model is the coefficient of determination (R^2 values) of endogenous constructs, which measures the predictive power of the model. Besides, as there might have the possibility of inherent bias towards a complex model, the adjusted coefficient of determination (R^2_{adj} value) is also considered here as the evaluation criteria to avoid the bias.

Therefore, both R^2 and R^2_{adj} values of endogenous constructs of the model are presented in table 9.10 to evaluate the predictive power of the model. The graphical representation of R^2 and R^2_{adj} values are also exhibited in figure 9.10, and 9.11 respectively.

Table 9.10: R^2 and R^2_{adj} values of endogenous constructs

Endogenous Constructs	**R^2 Values**	**R^2_{adj} Values**
Cohesion	0.803	0.801
Communication	0.737	0.735
Coordination	0.835	0.831
Knowledge Sharing	0.711	0.709
Performance	0.680	0.678
Trust	0.587	0.585

Following the rules of thumb (for interpreting R^2 values), both values of R^2 and R^2_{adj} (presented in table 9.10) of *Cohesion*, and *Coordination* are found substantial (i.e., above the threshold of 0.75), whereas, *Communication*, *Knowledge Sharing*, *Performance*, and *Trust* are found moderate (i.e., above

Figure 9.10: R^2 values of endogenous constructs

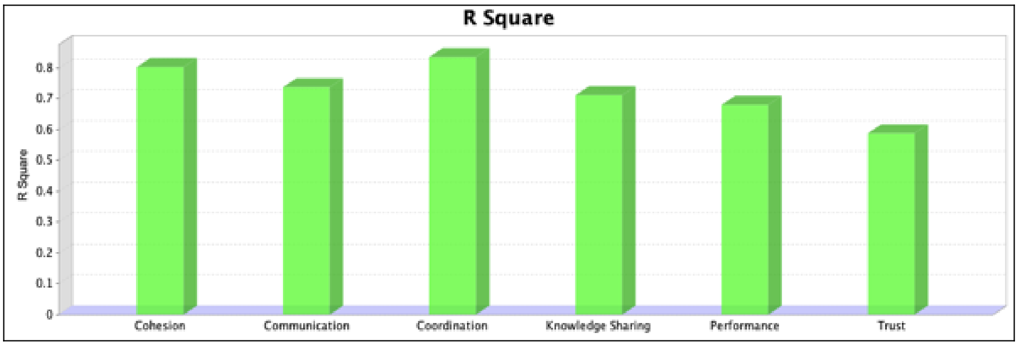
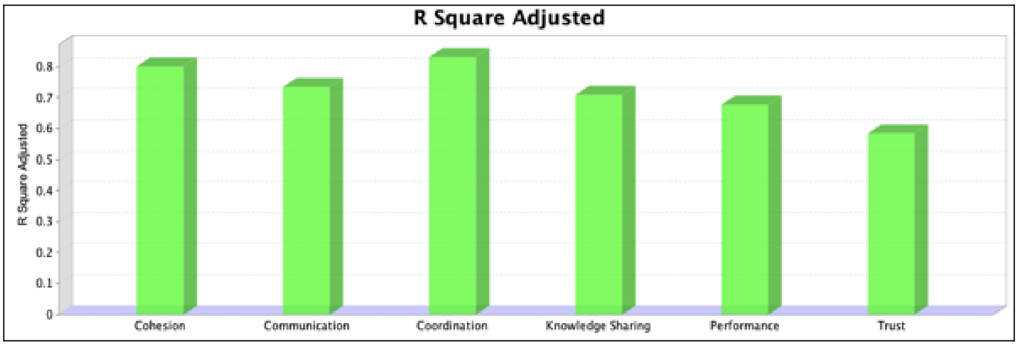


Figure 9.11: R^2_{adj} values of endogenous constructs



the threshold of 0.50), which statistically proves the predictive power of the model.

9.4.3 Assessment of Effect Size f^2

Now to examine the effect size f^2 of exogenous constructs on their corresponding endogenous constructs. Table 9.11 shows the f^2 values for all combinations of endogenous constructs (represented by the columns in the table) and corresponding exogenous (i.e., predictor) constructs (represented by the rows in the table).

Table 9.11: f^2 Effect Sizes

	Cohesion	**Communication**	**Coordination**	**Knowledge Sharing**	**Motivation**	**Performance**	**Trust**
Cohesion			0.453				
Communication	4.065			2.464			1.424
Coordination						2.125	
Knowledge Sharing			0.091				
Motivation		2.799					
Performance							
Trust			0.080				

Following the rules of thumb (for interpreting f^2 values), the f^2 effect sizes (presented in table 9.11) of *Motivation* on *Communication*, *Communication* on *Knowledge Sharing*, *Trust*, and *Cohesion*, *Cohesion* on *Coordination*, and *Coordination* on *Performance* are found large (i.e., above the threshold of 0.35), whereas, *Knowledge Sharing* on *Coordination*, and *Trust* on *Coordination* are found small (i.e., above the threshold of 0.02), which statistically proves the effect of exogenous constructs on their corresponding endogenous constructs of the model. That means, there are no exogenous constructs in the model which do no effect on their corresponding endogenous constructs.

9.4.4 Assessment of Significance and Relevance of Relationships

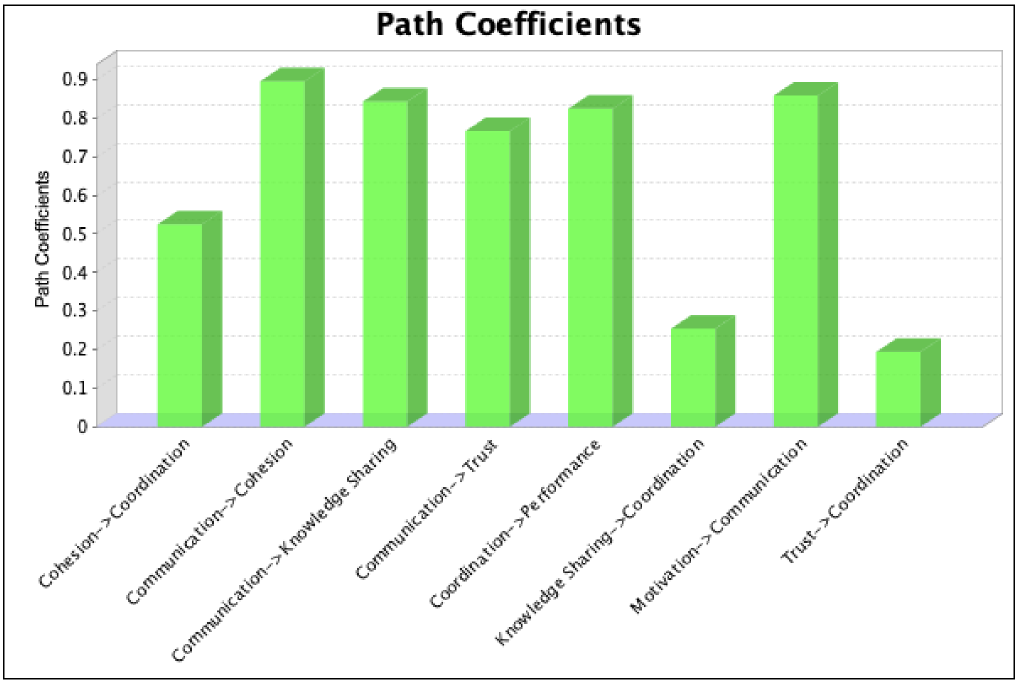
Next to assess the significance and relevance of the structural model relationships that represent the hypothesized relationships among the constructs in the model. This can be examined by the path coefficients which have standardized values approximately between -1 to $+1$. The path coefficients values close to $+1$ represent strong positive relationships, whereas, path coefficients values close to -1 represent weaker relationships.

Table 9.12 shows the path coefficients of relationships in the structural model, which are also represented graphically in figure 9.12. The statistics indicate that all the relationships in the model are positive and strong. Among all the relationships in the model, *Trust*→*Coordination* relationship has the lowest values in comparison to the other relationships but that also represents a positive relationship.

Table 9.12: Path Coefficients of Relationships in the Model

	Cohesion	**Communication**	**Coordination**	**Knowledge Sharing**	**Motivation**	**Performance**	**Trust**
Cohesion			0.525				
Communication	0.896			0.843			0.766
Coordination						0.825	
Knowledge Sharing			0.255				
Motivation		0.858					
Performance							
Trust			0.194				

Figure 9.12: Path Coefficients of Relationships in the Model



Another interesting evaluation criterion is the examination of total effects, which assess the influence of predecessor constructs on the key target constructs (i.e. *Performance*). Table 9.13 exhibits the examination of total effects, where each column represents a target construct, and each row represents a predecessor construct.

Table 9.13: Total Effects

	Cohesion	**Communication**	**Coordination**	**Knowledge Sharing**	**Motivation**	**Performance**	**Trust**
Cohesion			0.525			0.433	
Communication	0.896		0.834	0.843		0.688	0.766
Coordination						0.825	
Knowledge Sharing			0.255			0.210	
Motivation	0.769	0.858	0.716	0.724		0.590	0.658
Performance							
Trust			0.194			0.160	

As the statistics show (table 9.13), all the predecessor constructs influence the target constructs significantly. For example, among all the predecessor constructs *Coordination* (0.825) has the strongest effect on the key target construct *Performance*, followed by *Communication* (0.688), *Motivation* (0.590), *Cohesion* (0.433), *Knowledge Sharing* (0.210), and *Trust* (0.160). On the other hand, the *Coordination* target construct mostly influenced by Communication (0.834), followed by Motivation (0.716), Cohesion (0.525), Knowledge Sharing (0.255), and Trust (0.194) predecessor constructs. Besides, *Communication* has three direct effects on *Knowledge Sharing*, *Trust*, and *Cohesion* constructs by 0.843, 0.766, and 0.896 respectively, of which the strongest effect is on *Cohesion*.

Though the path coefficients of relationships obtained by the PLS-SEM algorithm are statistically significant but that solely not enough to declare it. Therefore, the empirical t values for all path coefficients of the structural model is needed to prove the statistical significance, and also consolidate the statistical significance so far achieved. The empirical t values can be obtained by means of the bootstrapping procedure. Along with the t values, the empirical p values are also used here to assess the significance levels (in this study, the p value must be smaller than 0.05 to be considered as a significance level of 5%).

After running the bootstrapping procedure, the results for the model are shown in figure 9.13 with p values (both for the measurement and structural model). It indicates that all the relationships in the structural model are significant assuming a significance level of 5%.

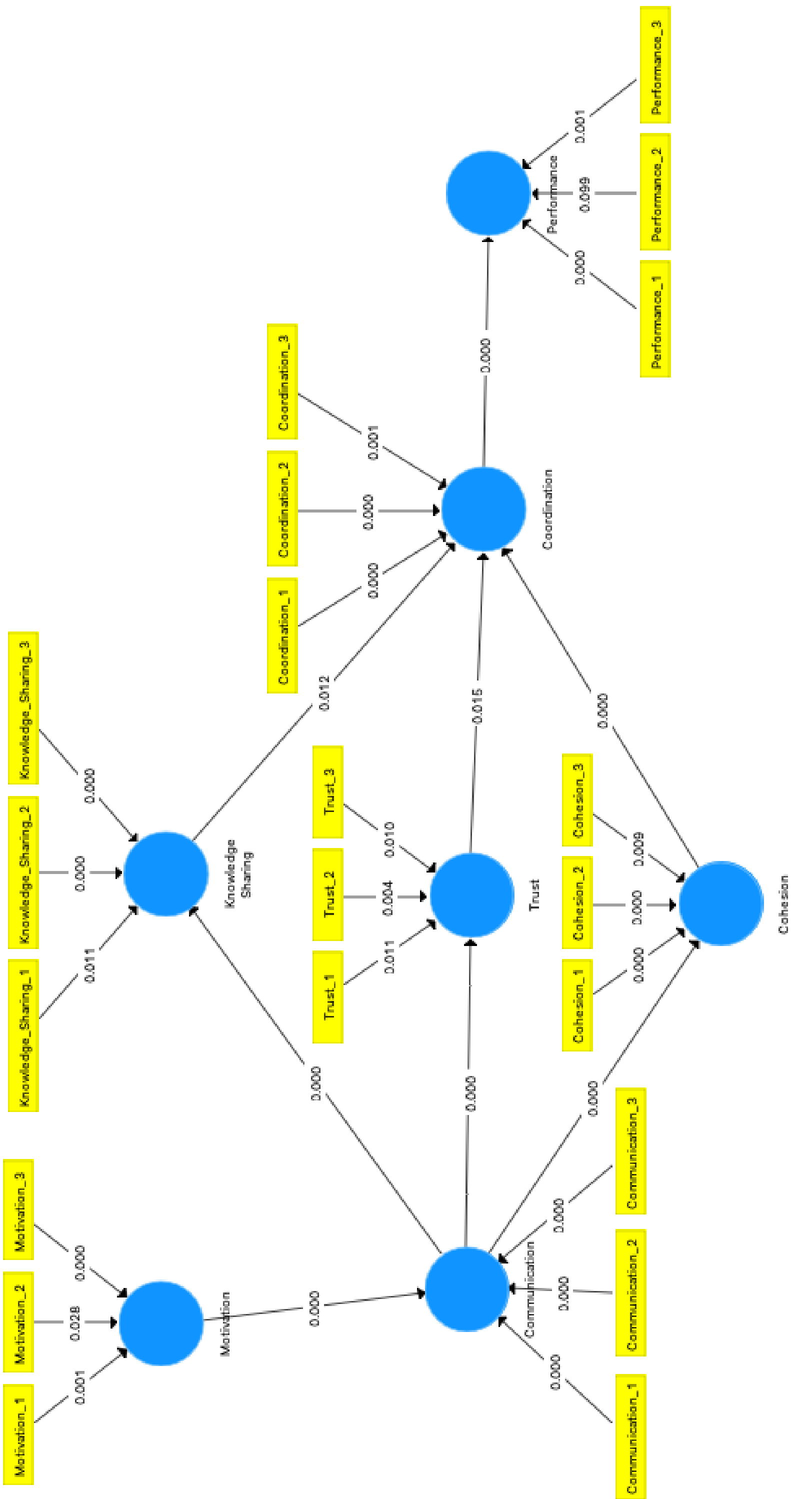


Figure 9.13: Bootstrapping results of the Model

Besides, table 9.14 provide a more detailed overview of the results of path coefficients by means of bootstrapping procedure including bootstrap mean values, t values, and p values. It indicates that all the relationships in the structural model are found statistically significant (i.e., all p values less than 0.05).

Table 9.14: Bootstrapping Results for Path Coefficients of Relationships in the Model

Relationships	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Cohesion ->Coordination	0.525	0.517	0.077	6.784	0.000
Communication ->Cohesion	0.896	0.897	0.023	38.634	0.000
Communication ->Knowledge Sharing	0.843	0.847	0.033	25.679	0.000
Communication ->Trust	0.766	0.778	0.048	15.951	0.000
Coordination ->Performance	0.825	0.831	0.042	19.763	0.000
Knowledge Sharing ->Coordination	0.255	0.264	0.101	2.515	0.012
Motivation ->Communication	0.858	0.862	0.034	25.550	0.000
Trust ->Coordination	0.194	0.190	0.080	2.430	0.015

The bootstrapping confidence intervals provides additional information on the stability of the estimated path coefficients of the structural model, and hence allows assessing whether a path coefficient is significantly different from zero, and its true value is somewhere within the range assuming a certain level of confidence (i.e. 95%). If the estimated path coefficient's confidence interval does not include zero then it can be considered as a significant effect.

Therefore, the bootstrap confidence intervals of the path coefficients are exhibited in tables 9.15, and 9.16, of which one is without bias correction, and another one is bias-corrected confidence intervals (by BCa method).

The statistics of confidence intervals (table 9.15, and 9.16) for the path coefficients of relationships indicate that the true values of the path coefficients are somewhere within the range with 95% probability. Also, all the relationships are significant as their confidence intervals do not include zero value.

Table 9.15: Bootstrap Confidence Intervals for Path Coefficients without Bias Correction

Relationships	**Original Sample (O)**	**Sample Mean (M)**	**2.5 %**	**97.5 %**
Cohesion ->Coordination	0.525	0.517	0.371	0.673
Communication ->Cohesion	0.896	0.897	0.845	0.935
Communication ->Knowledge Sharing	0.843	0.847	0.772	0.901
Communication ->Trust	0.766	0.778	0.677	0.862
Coordination ->Performance	0.825	0.831	0.737	0.900
Knowledge Sharing ->Coordination	0.255	0.264	0.073	0.472
Motivation ->Communication	0.858	0.862	0.785	0.917
Trust ->Coordination	0.194	0.190	0.026	0.345

So far the relationships of the structural model are found statistically significant. Now it is time to assess the relevance of significant relationships (by means of the bootstrapping procedure) because the path coefficients may be significant but their size may be small. For that reason, the relevance of relationships is examined here by the total effects (i.e. sum of indirect and direct effects).

Table 9.17 shows the total effects of the predecessor constructs on the target constructs by considering both direct and indirect effects.

As can be seen, all total effects (9.17) are significant at a 5% level (i.e. all p values are less than 0.05). That means, it proves the relevance of significant relationships of the structural model.

Again, the bootstrap confidence intervals of total effects for significance testing are exhibited in table 9.18, and 9.19, of which one is without bias correction, and another one is bias-corrected confidence intervals (by BCa method).

The statistics of confidence intervals (table 9.18, and 9.19) for the total effects of predecessor constructs on the target constructs indicate that the

Table 9.16: Bootstrap Confidence Intervals for Path Coefficients with Bias-Corrected (by BCa method)

Relationships	**Original Sample (O)**	**Sample Mean (M)**	**Bias**	**2.5 %**	**97.5 %**
Cohesion ->Coordination	0.525	0.517	-0.007	0.382	0.691
Communication ->Cohesion	0.896	0.897	0.001	0.835	0.930
Communication ->Knowledge Sharing	0.843	0.847	0.003	0.755	0.891
Communication ->Trust	0.766	0.778	0.012	0.630	0.839
Coordination ->Performance	0.825	0.831	0.006	0.708	0.887
Knowledge Sharing ->Coordination	0.255	0.264	0.009	0.054	0.455
Motivation ->Communication	0.858	0.862	0.004	0.758	0.907
Trust ->Coordination	0.194	0.190	-0.004	0.035	0.351

true values of the total effects are somewhere within the range with 95% probability. Also, all the total effects are significant as their confidence intervals do not include zero value.

9.4.5 Assessment of Predictive Relevance Q^2

Previously, the R^2 values are used as an evaluation criterion in the structural model for the model's predictive accuracy, which indicates the model's in-sample predictive power. In addition to this evaluation, there has another evaluation criteria to assess the model's predictive relevance, which indicates the model's out-of-sample predictive power. Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974) is used for testing the predictive relevance of the structural model, by using a blindfolding procedure with a specified omission distance to generate the Q^2 values (Chin, 1998). Omission distance value 7 is mostly recommended in the literature (Andreev et al., 2009), providing that the number of observations (used in the model estimation) divided by omission distance value should not be an integer (Hair, Hult, Ringle, & Sarstedt, 2017). Hence, omission distance value 7 is also used herein blindfolding procedure to generate the Q^2 values because it does not

Table 9.17: Bootstrapping Results for Total Effects

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Cohesion ->Coordination	0.525	0.517	0.077	6.784	0.000
Cohesion ->Performance	0.433	0.430	0.070	6.187	0.000
Communication ->Cohesion	0.896	0.897	0.023	38.634	0.000
Communication ->Coordination	0.834	0.836	0.035	23.826	0.000
Communication ->Knowledge Sharing	0.843	0.847	0.033	25.679	0.000
Communication ->Performance	0.688	0.696	0.056	12.256	0.000
Communication ->Trust	0.766	0.778	0.048	15.951	0.000
Coordination ->Performance	0.825	0.831	0.042	19.763	0.000
Knowledge Sharing ->Coordination	0.255	0.264	0.101	2.515	0.012
Knowledge Sharing ->Performance	0.210	0.220	0.087	2.422	0.015
Motivation ->Cohesion	0.769	0.774	0.045	16.929	0.000
Motivation ->Communication	0.858	0.862	0.034	25.550	0.000
Motivation ->Coordination	0.716	0.722	0.053	13.408	0.000
Motivation ->Knowledge Sharing	0.724	0.731	0.051	14.068	0.000
Motivation ->Performance	0.590	0.601	0.065	9.070	0.000
Motivation ->Trust	0.658	0.672	0.061	10.869	0.000
Trust ->Coordination	0.194	0.190	0.080	2.430	0.015
Trust ->Performance	0.160	0.157	0.065	2.465	0.014

yield an integer value while dividing the number of observations. In this assessment, if the Q^2 values for the endogenous constructs are greater than 0 then they indicate the presence of predictive relevance of the path model, whereas, zero, or negative values of Q^2 indicate the absence of predictive relevance.

Table 9.20 exhibits the blindfolding results, where the cross-validated redundancy approach is used to generate the Q^2 values because this approach includes both structural model and measurement model, and hence perfectly fits in PLS-SEM. The specification of the table is given below.

SSO shows the sum of the squared observations,

SSE shows the sum of the squared prediction errors, and

Q^2 is the final value obtained from the calculation of $(1-SSE/SSO)$ to

Table 9.18: Bootstrap Confidence Intervals for Total Effects without Bias Correction

	Original Sample (O)	**Sample Mean (M)**	**2.5 %**	**97.5 %**
Cohesion ->Coordination	0.525	0.517	0.371	0.673
Cohesion ->Performance	0.433	0.430	0.301	0.571
Communication ->Cohesion	0.896	0.897	0.845	0.935
Communication ->Coordination	0.834	0.836	0.758	0.894
Communication ->Knowledge Sharing	0.843	0.847	0.772	0.901
Communication ->Performance	0.688	0.696	0.572	0.792
Communication ->Trust	0.766	0.778	0.677	0.862
Coordination ->Performance	0.825	0.831	0.737	0.900
Knowledge Sharing ->Coordination	0.255	0.264	0.073	0.472
Knowledge Sharing ->Performance	0.210	0.220	0.058	0.402
Motivation ->Cohesion	0.769	0.774	0.671	0.851
Motivation ->Communication	0.858	0.862	0.785	0.917
Motivation ->Coordination	0.716	0.722	0.603	0.813
Motivation ->Knowledge Sharing	0.724	0.731	0.616	0.818
Motivation ->Performance	0.590	0.601	0.463	0.717
Motivation ->Trust	0.658	0.672	0.545	0.780
Trust ->Coordination	0.194	0.190	0.026	0.345
Trust ->Performance	0.160	0.157	0.022	0.282

Table 9.19: Bootstrap Confidence Intervals for Total Effects with Bias-Corrected (by BCa method)

	Original Sample (O)	**Sample Mean (M)**	**Bias**	**2.5 %**	**97.5 %**
Cohesion ->Coordination	0.525	0.517	-0.007	0.382	0.691
Cohesion ->Performance	0.433	0.430	-0.003	0.308	0.583
Communication ->Cohesion	0.896	0.897	0.001	0.835	0.930
Communication ->Coordination	0.834	0.836	0.002	0.732	0.885
Communication ->Knowledge Sharing	0.843	0.847	0.003	0.755	0.891
Communication ->Performance	0.688	0.696	0.008	0.542	0.775
Communication ->Trust	0.766	0.778	0.012	0.630	0.839
Coordination ->Performance	0.825	0.831	0.006	0.708	0.887
Knowledge Sharing ->Coordination	0.255	0.264	0.009	0.054	0.455
Knowledge Sharing ->Performance	0.210	0.220	0.010	0.042	0.384
Motivation ->Cohesion	0.769	0.774	0.005	0.636	0.836
Motivation ->Communication	0.858	0.862	0.004	0.758	0.907
Motivation ->Coordination	0.716	0.722	0.006	0.568	0.798
Motivation ->Knowledge Sharing	0.724	0.731	0.007	0.580	0.800
Motivation ->Performance	0.590	0.601	0.011	0.427	0.695
Motivation ->Trust	0.658	0.672	0.014	0.489	0.749
Trust ->Coordination	0.194	0.190	-0.004	0.035	0.351
Trust ->Performance	0.160	0.157	-0.003	0.029	0.287

judge the model's predictive relevance with regard to each endogenous constructs in the structural model.

Table 9.20: Q^2 Values for Endogenous Constructs

Endogenous Constructs	**SSO**	**SSE**	**Q^2 (=1-SSE/SSO)**
Cohesion	450.000	218.904	0.514
Communication	450.000	204.111	0.546
Coordination	450.000	198.555	0.559
Knowledge Sharing	450.000	208.592	0.536
Motivation	450.000	450.000	
Performance	450.000	266.742	0.407
Trust	450.000	279.085	0.380

As can be seen in table 9.20, all the endogenous constructs in the structural model have Q^2 values considerably above zero. More specifically, *Coordination* has the highest Q^2 value (0.559), followed by *Communication* (0.546), *Knowledge Sharing* (0.536), *Cohesion* (0.514), *Performance* (0.407), and *Trust* (0.380). These results provide clear support for the model's predictive relevance regarding the endogenous constructs in the structural model.

9.5 Evaluation of Model Fit

Though PLS-SEM was originally designed for prediction purposes, however, researchers are continuously trying to extend its capabilities for theory testing by developing model fit measures. Model fit indices measure how well the hypothesized model structure fits the empirical data.

The model estimation of this study is also concluded with the measure of model fit as usual. The model fit measures outlined in figure 5.5 are applied to examine the evaluation of the model fit. Each of these fit measures is examined one by one and presented in the following subsections of this section.

It is to mention that all the results of fit measures are presented for both the estimated model and the saturated model. The saturated model assesses correlation between all constructs. On the other hand, the estimated model is based on a total effect scheme, which takes the model structure into account. However, in PLS-SEM, the distinction between the estimated model and saturated model is in its very early stages, and hence, the choice between them is difficult to make. Though the estimated model seems to be a reasonable choice but both estimated and saturated model are reported here in the evaluation of model fit.

9.5.1 Normed Fit Index (NFI)

The results of the NFI measure of the model fit are presented in table 9.21 for both the saturated model and the estimated model. As can be seen, the NFI values of both estimated and saturated models are close to 1, which indicates that the model has a good fit.

Table 9.21: NFI Measure of Model Fit

	NFI Values
Saturated Model	0.889
Estimated Model	0.854

9.5.2 Standardized Root Mean Square Residual (SRMR)

The results of the SRMR measure of the model fit are presented in table 9.22 for both the saturated model and the estimated model. As can be seen, both the saturated model (0.043) and the estimated model (0.062) have SRMR values less than 0.08, which are acceptable values for good model fit as per the rules of thumb for SRMR.

Besides, the PLS-SEM bootstrapping procedure provides the confidence

Table 9.22: SRMR Measure of Model Fit

	Original Sample (O)	**Sample Mean (M)**	**95 %**	**99 %**
Saturated Model	0.043	0.035	0.046	0.051
Estimated Model	0.062	0.042	0.056	0.063

intervals of these SRMR measures. As can be seen, the original values of the SRMR for the both saturated model, and the estimated model are included in the upper bound of 99% of the confidence intervals, which indicate that the model has a good fit.

9.5.3 Exact Model Fit

As there are two approaches for exact model fit, thus the results of the exact model fit are presented separately in table 9.23, and 9.24 for d_ULS (i.e., the squared Euclidean distance) and d_G (i.e., the geodesic distance) respectively.

As can be seen (table 9.23), the original values of the d_ULS approach for the both saturated model, and the estimated model are included in the upper bound of 99% of the confidence intervals, which indicate that the model has a good fit.

Table 9.23: d_ULS Measure of Model Fit

	Original Sample (O)	**Sample Mean (M)**	**95 %**	**99 %**
Saturated Model	0.429	0.293	0.479	0.600
Estimated Model	0.887	0.429	0.717	0.909

Also, as can be seen (table 9.24), the original values of the d_G approach for the both saturated model, and the estimated model are included in the upper bound of 99% of the confidence intervals, which indicate that the model has a good fit.

Table 9.24: d_G Measure of Model Fit

	Original Sample (O)	**Sample Mean (M)**	**95 %**	**99 %**
Saturated Model	0.479	0.386	0.550	0.623
Estimated Model	0.647	0.422	0.601	0.714

Therefore, the statistics of the exact model fit for both d_ULS and d_G approaches indicate that the model has a good fit.

9.6 Summary

This chapter has presented the complete evaluation of the model in PLS-SEM. More specifically, it presented the evaluation of both measurement and structural model separately, and in the end, it presented the model fit measures in PLS-SEM.

In this model estimation process, the PLS-SEM algorithm, bootstrapping routine, and blindfolding procedure are applied for testing the significance and relevance of the model. However, in general, the bootstrapping procedure is ultimately sufficient to assess the significance and relevance of the model's relationships (e.g., t values, p values, bootstrap confidence intervals, and total effects) to conclude whether the model or in particular the relationships of the model are statistically significant and relevant.

Table 9.25 provides a summary of the model's path coefficient estimates, t values, p values, and confidence intervals. In addition, table 9.26 summarizes the results for the total effects of the predecessor constructs on the target constructs in the model along with the corresponding t values, p values, and confidence intervals. However, it is sufficient to reports either t values (and their significance levels) or the p values or the confidence intervals for the significance of the path coefficient of the model, and also for the relevance of significant relationships of the model. In this model estimation, all of these criteria are used for the evaluation, and also for the purpose of illustrations. It is found that all these criteria come to the same outcome for testing the significance of the path coefficient of the model, and also for testing the relevance of significant relationships of the model.

The results of the evaluation indicate clear statistical supports for the model's significance and relevance. Finally, the model fit measures show that the hypothesized model structure fits well the empirical data.

Table 9.25: Results Summary of Path Coefficients

	Path Coefficients	**t Values**	**p Values**	**95 % Confidence Intervals**	**Significance (p <0.05)?**
Cohesion ->Coordination	0.525	6.784	0.000	[0.382, 0.691]	Yes
Communication ->Cohesion	0.896	38.634	0.000	[0.835, 0.930]	Yes
Communication ->Knowledge Sharing	0.843	25.679	0.000	[0.755, 0.891]	Yes
Communication ->Trust	0.766	15.951	0.000	[0.630, 0.839]	Yes
Coordination ->Performance	0.825	19.763	0.000	[0.708, 0.887]	Yes
Knowledge Sharing ->Coordination	0.255	2.515	0.012	[0.054, 0.455]	Yes
Motivation ->Communication	0.858	25.550	0.000	[0.758, 0.907]	Yes
Trust ->Coordination	0.194	2.430	0.015	[0.035, 0.351]	Yes

Table 9.26: Results Summary of Total Effects

	Total Effects	t Values	p Values	95 % Confidence Intervals	Significance (p <0.05)?
Cohesion ->Coordination	0.525	6.784	0.000	[0.382, 0.691]	Yes
Cohesion ->Performance	0.433	6.187	0.000	[0.308, 0.583]	Yes
Communication ->Cohesion	0.896	38.634	0.000	[0.835, 0.930]	Yes
Communication ->Coordination	0.834	23.826	0.000	[0.732, 0.885]	Yes
Communication ->Knowledge Sharing	0.843	25.679	0.000	[0.755, 0.891]	Yes
Communication ->Performance	0.688	12.256	0.000	[0.542, 0.775]	Yes
Communication ->Trust	0.766	15.951	0.000	[0.630, 0.839]	Yes
Coordination ->Performance	0.825	19.763	0.000	[0.708, 0.887]	Yes
Knowledge Sharing ->Coordination	0.255	2.515	0.012	[0.054, 0.455]	Yes
Knowledge Sharing ->Performance	0.210	2.422	0.015	[0.042, 0.384]	Yes
Motivation ->Cohesion	0.769	16.929	0.000	[0.636, 0.836]	Yes
Motivation ->Communication	0.858	25.550	0.000	[0.758, 0.907]	Yes
Motivation ->Coordination	0.716	13.408	0.000	[0.568, 0.798]	Yes
Motivation ->Knowledge Sharing	0.724	14.068	0.000	[0.580, 0.800]	Yes
Motivation ->Performance	0.590	9.070	0.000	[0.427, 0.695]	Yes
Motivation ->Trust	0.658	10.869	0.000	[0.489, 0.749]	Yes
Trust ->Coordination	0.194	2.430	0.015	[0.035, 0.351]	Yes
Trust ->Performance	0.160	2.465	0.014	[0.029, 0.287]	Yes

Chapter 10

Discussion & Conclusion

10.1 Chapter Overview

This chapter aims to provide theoretical and practical discussion. It also highlights implications and future research on virtual teamwork in online higher education. Finally, it draws a conclusion with concluding remarks.

10.2 Introduction

This final chapter provides a summary of key research findings and concludes the research study by revisiting the research goal and objectives, research question, and problem investigated as outlined in chapter 1. The goal of this study was to determine the key factors that boost the effectiveness of virtual teamwork and can be applied to develop a conceptual model for effective teamwork development in online higher education. Teachers or project managers can use this model for better managing the virtual teams and enhancing the effectiveness of virtual teamwork. In the context of higher education, there were no clear guidelines on the effectiveness factors for developing and managing virtual teamwork. Therefore, this study was aimed at addressing and filling this gap by investigating key factors that affect the effectiveness and proposing a conceptual model of virtual teamwork (as presented in chapter 6).

A set of brief observations and discussions of the data is presented in this chapter that has been collected (as outlined in chapter 8) and analysed (as outlined in chapter 9) through the course of this study. This kind of discussion stems from empirical data but it is influenced by the theory and literature review, and the personal views and experiences of the researcher as presented in chapter 3. The overall discussion offered in this chapter has outlined the key findings and observations of this research study. Also, the chapter discusses the limitations of the study and introduces ideas and recommendations that could spark interest in future research. Finally, this chapter concludes with a personal view on the theoretical and practical contributions of the study.

10.3 Revisiting Research Goal & Objective

The main research goal and objective of this study were to propose a conceptual model for effective virtual teamwork development in online higher education, which was achieved in *chapter 6: Conceptual Model*. This conceptual model is (along with its derived hypotheses) evaluated through an empirical study to prove its statistical significance as a valid model, which was achieved in *chapter 9: Model Estimation*. The other research objectives were actually the breakdown of the main research objectives of this study, and thus, had been fulfilled by achieving the main research objectives.

10.4 Response to Research Question

According to the main research goal, the main research question of the study was to address the key factors that boost the effectiveness of virtual teamwork in online higher education. The findings of the study confirm that the factors identified and discussed in *chapter 6* are vital and key factors that affect the effectiveness of virtual teamwork in online higher education. Besides, one sub-question of the main research question was to derive a set of relationships between the identified key factors, which was achieved and discussed in *chapter 6*. Finally, the conceptual model had been developed with these key factors and their relationships, which is proposed and presented in *chapter 6: Conceptual Model*. Therefore, the proposed conceptual model does address the main research question of this study.

Furthermore, the results of the empirical study confirmed that the identified key factors were essential for the development of the conceptual model, and also proved that the conceptual model was valid and statistically significant, which is presented and discussed in *chapter 9: Model Estimation*.

Further discussion and summary of the research findings of this study are presented in the next section (i.e. section 10.5).

10.5 Summary of Research Findings

The detailed discussion on research findings and outcomes based on the empirical study as well as the theoretical consideration of reviewed literature is presented in this section.

10.5.1 Discussion on Model Development

The main objective of this research work was to propose a conceptual model to develop effective virtual teamwork in online higher education. To fulfil this purpose, a conceptual model for effective virtual teamwork development in online higher education had been derived and proposed based on the content analysis of the existing literature, which was achieved in *chapter 6*. A brief discussion on the model development is presented below of this subsection.

10.5.1.1 Key Factors of Virtual Teamwork

To construct and propose the conceptual model, the main research question was to identify the key factors that boost the effectiveness of virtual teamwork in online higher education. However, in the beginning, to gain a holistic overview of the key factors that affect the effectiveness of virtual teamwork, an array of literature sources was explored on various essential areas relating to factors that boost the effectiveness of virtual teamwork in online higher education. *chapter 2* and *chapter 3* mentioned and discussed what had been covered in the area of virtual teamwork from other scholarly studies.

The content analysis of existing literature suggested seven key factors that boost the effectiveness of virtual teamwork in online higher education: *Motivation* (e.g. Ardichvili et al., 2003; Hertel et al., 2005; Peterson, 2007), *Communication* (e.g. Duarte and Snyder, 2006; Gordon and Curlee, 2011; Maznevski and Chudoba, 2000; Setle-Murphy, 2013; Suchan and Hayzek, 2001), *Knowledge Sharing* (e.g. Alsharo et al., 2017; Hahm, 2017; Xiao and Jin, 2010), *Trust* (e.g. Greiner and Metes, 2005; Hakonen and Lipponen, 2009; Henttonen and Blomqvist, 2005; Jarvenpaa and Leidner, 1999; Wise, 2013; Zolin et al., 2004), *Cohesion* (e.g. Cohen and Bailey, 1997; Hannah et al., 2011; Lurey and Raisinghani, 2001; Maznevski and Chudoba, 2000; Powell et al., 2004), *Coordination* (e.g. Johansson et al., 1999; Lin et al., 2008; Maznevski and Chudoba, 2000; Montoya-Weiss et al., 2001), and *Performance* (e.g. Armstrong, 2007; Kirkman and Mathieu, 2007; Schwalbe, 2014).

The analysis of the literature also suggested other factors that might be crucial for the effectiveness of both traditional face-to-face and virtual teamwork, such as, intercultural awareness, working environment, team size, team values, and team member's behaviour (e.g. Dinsmore and Cabanis-Brewin, 2014; Gordon and Curlee, 2011; Ludden and Ledwith, 2014; Omorede et al., 2013). However, for the purpose of this study, the factors that were relevant, crucial, significant, applicable, and the key to the effectiveness of virtual teamwork in the context of online higher education were only considered or employed and discussed (i.e. motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance).

10.5.1.2 Relationships of the Key Factors

To construct the conceptual model, one sub-question of the main research question was to address the set of relationships between the key factors. The content analysis of existing literature found the following set of relationships between the key factors in order to construct the proposed conceptual model of virtual teamwork in online higher education: *Motivation* → *Communication* (e.g. Ardichvili et al., 2003; Geister et al., 2006; Peterson, 2007), *Communication* → *Knowledge Sharing* (e.g. Clements and Gido, 2012; Grutterink et al., 2012; Schwalbe, 2014; Segal-Horn and Dean, 2009), *Communication* → *Trust* (e.g. Jarvenpaa and Leidner, 1999; Mayer et al., 1995; Roth, 2012; Wise, 2013), *Communication* → *Cohesion* (e.g. Pinsonneault and Caya, 2005; Walther, 1992; Warkentin et al., 1997), *Knowledge Sharing* → *Coordination* (e.g. Massey et al., 2002; Maznevski and Chudoba, 2000; Pangil and Chan, 2014; Pinjani and Palvia, 2013; Xiao and Jin, 2010), *Trust* → *Coordination* (e.g. Baba, 1999; Jarvenpaa and Leidner, 1999; Muethel et al., 2012; Paul and McDaniel, 2004), *Cohesion* → *Coordination* (e.g. Deeter-Schmelz et al., 2002; Lipnack and Stamps, 2000; Sarker et al., 2001), *Coordination* → *Performance* (e.g. Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski and Chudoba, 2000; Montoya-Weiss et al., 2001), *Knowledge Sharing* → *Performance* (e.g. Alsharo et al., 2017; Gardner et al., 2012; Malhotra and Majchrzak, 2004; Pangil and Chan, 2014; Xiao and Jin, 2010), *Trust* → *Performance* (e.g. Anantatmula and Thomas, 2010; Rad and Levin, 2006; Roth, 2012; Wise, 2013), and *Cohesion* → *Performance* (e.g. Cohen and Bailey, 1997; Hannah et al., 2011; Lurey and Raisinghani, 2001; Powell et al., 2004).

10.5.1.3 The Conceptual Model

The identified key factors and the derived relationships between the key factors were used to construct the conceptual model, which was proposed and presented in *chapter 6: Conceptual Model*. The objective has therefore been achieved by developing and proposing the conceptual model based on the above findings.

However, to measure the constructs (i.e. latent variables) of the conceptual model, a set of formative indicators had been derived based on the existing literature and a complete formative measurement model had been developed, which was discussed and presented in *chapter 7: Measurement Model*.

The conceptual model had been proposed with a set of derived hypotheses, which was tested and evaluated through a complete empirical study to prove its validity and statistical significance. The evaluation of the conceptual model (i.e. evaluation of both measurement model and structural model along with the model fit assessment) was achieved and presented in detail in *chapter 9: Model Estimation*.

The next subsection contains the discussion on the research findings based on the empirical study (i.e. model evaluation and validation) of the thesis.

10.5.2 Discussion on Model Evaluation and Validation

This subsection contains the discussion on the conceptual model evaluation in order to assess its validity or statistical significance, which was achieved in *chapter 9*. The rest of the part of this subsection briefly discussed the evaluation of the measurement model, structural model, and model fit of the proposed conceptual model.

10.5.2.1 Discussion on Measurement Model Evaluation

The formative measurement model was used for measuring the latent variables or constructs of the proposed conceptual model. A brief discussion on the measurement model evaluation of the proposed conceptual model is presented below.

Content validity is a mandatory practice for the evaluation of the formative measurement model (as proposed by Petter et al., 2007) because it ensures that the presented formative indicators captured the entire scope of the constructs (Diamantopoulos & Winklhofer, 2001; Straub et al., 2004). Otherwise, the indicators could have misspecification with the explored content domain, and biased estimation results. However, the evaluation of content validity of the formative measurement model of this study found that the presented formative indicators captured the entire scope of the constructs through the supports from the reviewed literature (a detailed derivation of content validity of the measurement model is presented in *chapter 7*, but the summary can be seen in table 7.9). Thus, *content validity* for all the constructs is established based on theoretical considerations with the supports from reviewed literature.

Besides, in the empirical study, the model evaluation found that VIF values for all the indicator variables of constructs are ranged from 1.258 to 3.686 (as can be seen in table 9.2), showing that collinearity did not reach critical levels (i.e. as per the recommendation, VIF values are below the threshold of 5). Thus, *construct reliability* is established for all the indicators of the constructs by the absence of multicollinearity.

Furthermore, redundancy analysis found path coefficients for all the construct are ranged from 0.748 to 0.900 (as can be seen in figures 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, and 9.9), where all are above the recommended threshold of 0.70, so indicating that convergent validity was achieved for all the formative constructs. Thus, *construct validity* is established for the constructs in the measurement model by convergent validity assessment (i.e. redundancy analysis).

Finally, the assessment of significance and relevance of indicators for all the constructs were found statistically significant at a 5% level (i.e. p value less than 0.05), except *Performance_2* indicator (which is significant at a 10% level) as per the values of outer weights (as can be seen in table

9.3). However, in an exploratory study like this, a significance level of 10% can also be commonly used (Hair, Hult, Ringle, & Sarstedt, 2017). Even *Performance_2* indicator would consider as a non-significant indicator, it should not be removed as long as it is found significant as per outer loadings (i.e. absolute contribution). In this case, it is interpreted as absolutely important but not as relatively important, hence, should be retained in the measurement model (Hair, Hult, Ringle, & Sarstedt, 2017). The statistics of outer loadings (as can be seen in table 9.4) showing that not only *Performance_2* indicator but also all the indicators of the constructs were found statistically significant at a 1% level (i.e. p value less than 0.01) which is even better than the expected threshold (i.e. p value less than 0.05). Therefore, all the indicators of the constructs in the measurement model were found valid and significant and should be retained. In addition to these statistics, the bootstrap confidence intervals for outer weights and outer loadings also found that the true values of all indicators outer weights and outer loadings of the constructs are somewhere within the range with 95% probability, and do not contain zero values (as can be seen in tables 9.5, 9.6, 9.7, and 9.8), so indicating that indicators of the construct are significant. Thus, statistical significance and relevance are established for all the indicators of the constructs by assessing outer weights and outer loadings, and their bootstrap confidence intervals.

In a nutshell, the whole measurement model of this study was found appropriate and valid, and significant based on the assessment of content validity, construct reliability, and construct validity, and also based on the assessment of significance and relevance. These findings pave the way to discussing the evaluation of the structural model next (i.e. validation of the conceptual model).

10.5.2.2 Discussion on Initial Conceptual Model

The initial conceptual model (as shown in 6.2) had eleven hypotheses, of which three had been found non-significant based on the model estimation of the empirical study (as can be seen in 9.1).

Among these non-significant hypotheses, $H_{TR \to PF}$ (i.e. Trust affects positively to Performance) has p value 0.607. That means it is far from the 5% significance level, whereas the acceptable p value should be less than 0.05. However, this result is not surprising because Aubert and Kelsey (2003) also found that the level of *Trust* does not have a direct impact on the *Performance* of virtual teamwork. Whereas, literature revealed that *Trust* has a direct impact on *Coordination* (e.g. Baba, 1999; Jarvenpaa and Leidner, 1999; Muethel et al., 2012; Paul and McDaniel, 2004), which is also found statistically significant at a 5% level (i.e. p value is 0.022). Then, *Coordination* affects directly and positively to *Performance* (Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski & Chudoba, 2000; Montoya-Weiss et al., 2001) at a 1% significant level (i.e. p value is 0.000). That means *Trust* boosts *Performance* through *Coordination*. So, the relationship (i.e. Trust → Performance) and its corresponding hypothesis (i.e. $H_{TR \to PF}$) can be removed from this conceptual model.

Another non-significant hypothesis, $H_{KS \to PF}$ (i.e. Knowledge Sharing affects positively to Performance) has p value 0.645. That means it is far from the 5% significance level, whereas the acceptable p value should be less than 0.05. But *Knowledge Sharing* directly affects *Coordination* at a 5% significant level (i.e. p value is 0.013) which is also supported by the existing literature (e.g. Massey et al., 2002; Maznevski and Chudoba, 2000; Pangil and Chan, 2014; Pinjani and Palvia, 2013; Xiao and Jin, 2010). Then, *Coordination* affects directly and positively to *Performance* (Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski & Chudoba, 2000; Montoya-Weiss et al., 2001) at a 1% significant level (i.e. p value is 0.000). That means *Knowledge Sharing* boosts *Performance* through *Coordination*. So, the relationship (i.e. Knowledge Sharing → Performance) and its corresponding hypothesis (i.e. $H_{KS \to PF}$) can be removed from this conceptual model.

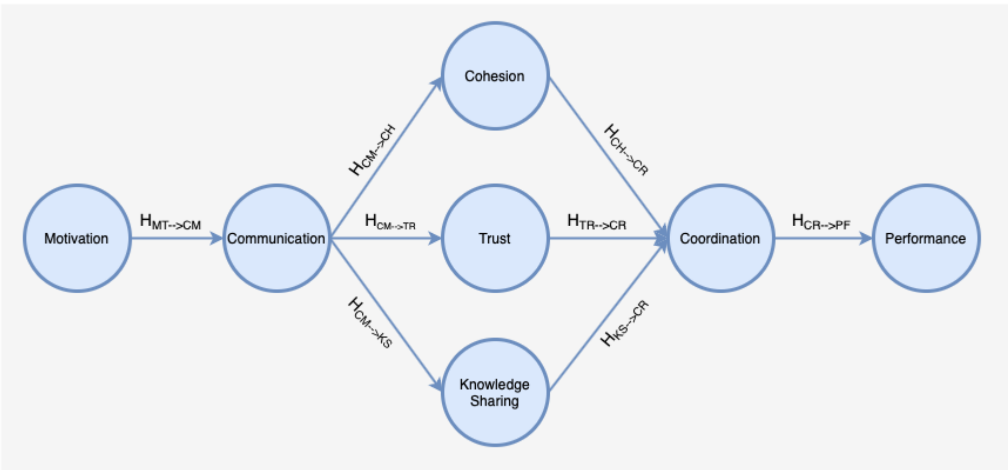
Lastly, the non-significant hypothesis, $H_{CH \to PF}$ (i.e. Cohesion affects positively to Performance) has p value 0.929. That means it is far from the 5% significance level, whereas the acceptable p value should be less than 0.05. But *Cohesion* directly affects *Coordination* at a 1% significant level (i.e. p value is 0.000) which is also supported by the existing literature (e.g. Deeter-Schmelz et al. (2002), Lipnack and Stamps (2000), Sarker et al. (2001)). Then, *Coordination* affects directly and positively to *Performance* (Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski & Chudoba, 2000; Montoya-Weiss et al., 2001) at a 1% significant level (i.e. p value is 0.000). That means *Cohesion* boosts *Performance* through *Coordination*. So, the relationship (i.e. Cohesion → Performance) and its corresponding hypothesis (i.e. $H_{CH \rightarrow PF}$) can be removed from this conceptual model.

As the three hypotheses (i.e. $H_{TR \rightarrow PF}$, $H_{KS \rightarrow PF}$, and $H_{CH \rightarrow PF}$) are not statistically supported, thus, these three non-significant relationships should be excluded from this conceptual model.

10.5.2.3 Discussion on Final Conceptual Model

The initial conceptual model estimation found that three hypotheses were not statistically significant. Thus, excluding those hypotheses following model (as shown in figure 10.1) was derived as the final conceptual model for effective virtual teamwork development in online higher education.

Figure 10.1: Final Conceptual Model of Developing effective Virtual Teamwork in Online Higher Education



MT: Motivation; CM: Communication; KS: Knowledge Sharing;
TR: Trust; CH: Cohesion; CR: Coordination; PF: Performance.

The evaluation of the model confirmed that the conceptual model has been proved its predictive power through the coefficient of determination, R^2 values (because all the endogenous constructs' R^2 values are greater than the threshold of 0.50) (as can be seen in table 9.10). However, to avoid the inherent bias towards a complex model, the adjusted coefficient of determination, R^2_{adj} values are also considered, which also confirmed the predictive power of the model. The R^2, or R^2_{adj} values actually represent the combined effects of all the linked exogenous constructs on the endogenous construct (Rigdon, 2012; Sarstedt et al., 2014). For example, the target endogenous (i.e. dependent) construct, *Performance* has R^2 value 0.680 (or, $R^2_{adj} = 0.678$), which is the combined effect of all the linked exogenous constructs of the model, thus, the model explained 68% of the construct' variance.

In addition, change in R^2 values was explored to investigate the impact of each independent construct on the dependent construct (i.e. effect size (f^2)) (Cohen, 1988). The examination of effect size (f^2) confirmed the substantive impact of each independent construct on the dependent construct of the model because all the f^2 values are greater than the threshold of 0.02 (as can be seen in table 9.11). That means there is no exogenous constructs in the conceptual model which have no effect on their corresponding endogenous constructs.

Likewise, all the structural path coefficients of the model were found statistically significant (because all path coefficients values close to +1, thus, represent strong positive relationships (Hair, Hult, Ringle, & Sarstedt, 2017)). Besides, the multicollinearity issues indicated that the path coefficients of the structural model are not biased because none of the predictor constructs of the model reach at critical levels of collinearity (i.e. all the VIF values are clearly below the threshold of 5, as can be seen in table 9.9). That means, there is no collinearity issues among the predictor constructs of the structural model. The absence of multicollinearity issues among the predictor's constructs confirmed that the path coefficients of the structural model are not biased (Hair, Hult, Ringle, & Sarstedt, 2017).

Moreover, the assessment of total effects shown that all the predecessor constructs influenced significantly to their corresponding target constructs in the model. For example, *performance* is positively influenced by the *coordination* (Johansson et al., 1999; Lin et al., 2008; Lu et al., 2006; Maznevski & Chudoba, 2000; Montoya-Weiss et al., 2001), and the total effect of *coordination* on its direct target construct, *performance* is 0.825, which also statistically proved that *coordination* has a strong effect on *performance*. Similarly, all the predecessor constructs in the model have significant effects on their corresponding target constructs (as can be seen in table 9.13).

Though the path coefficients of the model were found statistically significant by applying the PLS-SEM algorithm it should be tested by employing the bootstrapping resampling technique to declare it as a valid model undoubtedly (Hair, Hult, Ringle, & Sarstedt, 2017). The evaluation of the model through bootstrapping procedure has shown that all the path coefficients of the model are also statistically significant according to the empirical t values and their corresponding p values at a significant level of 5% (as can be seen in figure 9.13, and table 9.14). Along with these statistics, the bootstrapping confidence intervals were also assessed to consolidate the stability of the estimated path coefficients of the model. The statistics of bootstrap confidence intervals (as can be seen in tables 9.15 (without bias correction), and 9.16 (bias-corrected)) shown that all the path coefficients of the model are significantly different from zero (i.e. none of their confidence intervals contain zero values), and their corresponding true values are somewhere within the range with 95% probability. Therefore, all the estimated path coefficients of the model clearly have significant effects.

So far, the statistical significance of the relationships of the model was discussed and achieved. Together with these, the relevance of the significant relationships can also be achieved through assessment of total effects by means of the bootstrapping procedure. The reason is that the estimated path coefficients might be significant but their size could be small. That's why the total effects (i.e. sum of indirect and direct effects) using the bootstrapping procedure were also assessed to establish the relevance of the significant path coefficients. The statistics of total effects through the bootstrapping procedure (as can be seen in table 9.17) confirmed that all the total effects are significant at 5%. Thus, the relevance of significant relationships of the model is achieved. Additionally, bootstrap confidence intervals of total effects (as can be seen in tables 9.18 (without bias correction), and 9.19 (bias-corrected)) also confirmed that all the total effects are significant (i.e. none of their confidence intervals contain zero values) and their corresponding true values are somewhere within the range with 95% probability.

Finally, the predictive relevance of the model has also been achieved through the assessment of Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974) by using the blindfolding procedure. The blindfolding test with recommended omission distance value 7 (Andreev et al., 2009; Chin, 1998) revealed that all values of Q^2 were greater than zero (*Performance* - 0.407, *Coordination* - 0.559, *Cohesion* - 0.514, *Knowledge Sharing* - 0.536, *Trust* - 0.380, and *Communication* - 0.546). So, positive Q^2 values provide clear evidence that the omitted observations were well-reconstructed and that the predictive relevance of the model is achieved successfully.

The discussion above confirmed the significance and relevance of the model using the PLS-SEM algorithm, bootstrapping routine, and blindfolding procedure. In general, the bootstrapping procedure is sufficient for testing a model's significance and relevance, and to declare the model as a statistically significant and valid model (Hair, Hult, Ringle, & Sarstedt, 2017; Hair et al., 2018). A summary of the model's path estimates together with t values, p values, confidence intervals is shown in table 9.25, and a summary of total effects together with t values, p values, confidence intervals is shown in table 9.26. However, all these evaluation criteria have been considered for this model estimation and found that all criteria come to the same outcomes to prove the model's statistical significance and relevance. Therefore, all the derived hypotheses of the final conceptual model were proven with statistical supports and found statistically significant (as can be seen in table 10.1).

Table 10.1: The Supported Hypotheses

Hypotheses	Hypotheses Description	Supported?
$H_{CH \to CR}$	Cohesion affects positively to Coordination	Yes
$H_{CM \to CH}$	Communication affects positively to Cohesion	Yes
$H_{CM \to KS}$	Communication affects positively to Knowledge Sharing	Yes
$H_{CM \to TR}$	Communication affects positively to Trust	Yes
$H_{CR \to PF}$	Coordination affects positively to Performance	Yes
$H_{KS \to CR}$	Knowledge Sharing affects positively to Coordination	Yes
$H_{MT \to CM}$	Motivation affects positively to Communication	Yes
$H_{TR \to CR}$	Trust affects positively to Coordination	Yes

In a nutshell, the conceptual model had been proposed together with a set of derived hypotheses based on the supports from existing literature for developing effective virtual teamwork in online higher education. The analysis of the literature revealed that the model is conceptually significant for developing effective virtual teamwork in online higher education. Finally, the evaluation of the model through an empirical study proved that the proposed conceptual model is also statistically significant and valid. Also, the derived hypotheses of the final conceptual model were statistically supported. So, this model can be implemented in the context of online higher education for developing effective virtual teamwork.

10.5.2.4 Discussion on Model Fit

This subsection presents the discussion on model fit measures of the proposed conceptual model which has been found valid and significant. However, the model fit measure is not fully transferable to PLS-SEM in compare to CB-SEM because PLS-SEM works differently than CB-SEM (Hair, Hult, Ringle, & Sarstedt, 2017). For example, PLS-SEM maximizes the explained covariance instead of minimizing the differences between covariance matrices. Also, PLS-SEM assesses based on the heuristic criteria that are determined by the predictive capabilities of the model, instead of assessing goodness-of-fit. That's why, by definition, these criteria do not allow for testing the overall model fit in PLS-SEM, whereas, the model fit measure is suitable and essential in the context of CB-SEM (Hair, Hult, Ringle, & Sarstedt, 2017; Sarstedt et al., 2014).

Though the model fit measure is not essential in the context of PLS-SEM. Still, several model fit measures (such as NFI, SRMR, and exact model fit measure for both d_ULS and d_G approaches) are considered and tested to assess the model fit of this study, which are until now the standard for testing model fit (SmartPLS-Documentation, 2020) in PLS-SEM. The model fit measures are presented for both estimated and saturated models and found that in both cases the model had a good fit. For example, the NFI (proposed by Bentler and Bonett, 1980) values (as can be seen in table 9.21) of both estimated (NFI = 0.854) and saturated (NFI = 0.889) models are close to 1, indicating that the model has a good fit.

In SRMR fit measure (suggested by Henseler et al., 2014), the both saturated model (0.043) and estimated model (0.062) have values less than 0.08 (as can be seen in table 9.22), indicating a good model fit. Besides, the bootstrapping procedure provided confidence intervals of these SRMR values, showing that the original values of the SRMR for both the saturated and the estimated model are included in the upper bound of 99% of the confidence intervals.

Finally, the exact model fit measure for both d_ULS and d_G approaches (defined by Dijkstra and Henseler, 2015) indicate that the model has a good fit in the case of both estimated and saturated model. The original values from both approaches (as can be seen in tables 9.23, and 9.24) are included in the upper bound of 99% of the confidence intervals, indicating that the model has a good fit.

The discussion on the fit measures confirmed that the conceptual model which had been found valid and significant is also had a good model fit.

10.5.3 Discussion on Benefits of the Model

The final conceptual model for developing effective virtual teamwork in online higher education had been developed and proposed in this study. The findings of the study confirmed that all the key factors were essential and important to develop effective virtual teamwork in online higher education. Also, the detailed evaluation of the conceptual model proved it as a valid and statistically significant model.

The conceptual model can be used as a holistic way to determine the overall performance of the virtual team, but each factor can be analysed individually to evaluate the impact on the overall performance. The knowledge of key factors for virtual teamwork can aid team managers (who manage the virtual teams) in enhancing the success of the virtual teams or boosting the effectiveness of the virtual teamwork, and taking a different approach to better manage and coordinate the virtual teams.

The conceptual model can be used to build virtual teamwork in higher education. That means, it can facilitate future graduates to learn and practice necessary knowledge and skills on virtual teamwork. As a consequence, the future graduates skilled in virtual teamwork can get earlier success in their profession and can become valuable employees to their employers who organize and manage virtual teamwork regularly. Besides, teachers in higher education can use this model for better managing and evaluating virtual teams of students.

Moreover, managerial personnel (who organize and manage virtual teams regularly) of any globalized business organization or company can also be benefited from this conceptual model of virtual teamwork. That means, it can be used as a strategic tool in different stages of virtual teams such as development, management, and evaluation.

In a nutshell, the contribution of the model of key factors that affect the effectiveness of virtual teamwork can be useful for both students and practitioners.

10.6 Limitations of the Study

Although this study developed and proposed a conceptual model by revealing the key factors that affect the effectiveness of virtual teamwork in online higher education, there were some limitations. For example, this research is specific to virtual teamwork in higher education, as the data collected was specifically from this sector. However, it is believed that it would be applicable to the business domain as well. In that case, further data analysis is needed specific to the virtual teamwork of employees in business organizations.

Also, further research is required to validate the conceptual model with a larger sample size from the virtual teams of higher education institutes. Besides, for testing the model in terms of the business domain, separate big sample size is required from the virtual teams of business organizations as well.

Besides, each virtual team answered only a single questionnaire. That means, each member of the team did not answer a separate questionnaire but a single questionnaire as a team. In order to analyse the model from the perspective of individual team members, another data sample is required where every member of the team will answer the questionnaire of the survey. However, it is believed that a team-wise single questionnaire is more significant and relevant to this study. The reason is that in this analysis as a team the virtual teamwork is being evaluated so team-wise one sample is more relevant to evaluate this conceptual model for effective virtual teamwork development.

Finally, the research findings from the data analysis reflect the views or experiences or perspectives of the respondents who participated in the survey and do not necessarily represent those of all higher education institutes in the world.

10.7 Future Research & Recommendations

The following ideas and constitute areas of future research for this study can be expanded and recommended:

- This study can be expanded to incorporate with a simulation for executive training, education, or analysis on virtual teamwork. With this kind of simulation students from higher education and also executive from business organizations can practice and exercise on virtual teamwork. Therefore, this study can be recommended to be implemented into business simulations or gamification for facilitating executive education and training on virtual teamwork.
- The study can be expanded to adopt machine learning techniques so that various automated services can be generated such as monitoring virtual teamwork, giving timely feedback to team members, and evaluating virtual teams according to their activities on virtual teamwork. This can make virtual teamwork more effective and interactive in terms of managing, monitoring, evaluating, and making team members more engaged in the teamwork.

However, according to the limitations of the study (as discussed in section 10.6), the following constitute areas of future research for this study can be expanded and examined:

- This study could be expanded by collecting data from the business organization's virtual teams across the globe and analyse the results for testing the final conceptual model's validity and statistical significance.

That means, the applicability of the conceptual model in the business domain can be analysed with this expanded research of the study.

- Future studies can be conducted to check whether the conceptual model is applicable in both higher education and business domain as a generalized model. So, if required then the study can be expanded to convert the conceptual model to a generalized model for better organizing the virtual teams and improving the performance of virtual teamwork in both higher education and business domain.
- The study can be conducted with a larger sample size to check whether it produces the same impact for developing effective virtual teamwork.

10.8 Concluding Remarks

This study focused on determining the factors that enhance the effectiveness of virtual teamwork and on developing the conceptual model for effective virtual teamwork development in online higher education. The empirical validation and confirmation of data were presented and examined for testing the model's validity and statistical significance.

The key findings confirm that the identified key factors are essential and there is a strong relationship between the identified factors motivation, communication, knowledge sharing, trust, cohesion, coordination, and performance in virtual teams as revealed in the review of the literature. The empirical study confirmed that the proposed conceptual model is valid and statistically significant to develop effective virtual teamwork in online higher education.

The benefits of this study are twofold. The first benefit is a theoretical contribution. It contributes to the current body of knowledge on virtual teams. Particularly, virtual teamwork in online higher education is a fairly new research topic and thus any new knowledge is welcome in this area. Also, for managing virtual teamwork successfully, it is needed to understand the key factors that boost the effectiveness of virtual teamwork and the relationships between the key factors. This knowledge or theoretical contribution of this research is important for effective virtual teamwork development in both higher education and business domain.

The second benefit is a practical contribution to organizing and managing virtual teamwork. For example, the identified key factors can be implemented to enhance the effectiveness and success of virtual teamwork. Besides, the proposed conceptual model can be implemented for better managing the virtual teamwork and can be used as a complete guideline for a better understanding of virtual teams in both higher education and business.

In the end, like any other research study, the limitations and future research recommendations are also mentioned to draw the complete picture and conclusion of the study.

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