



HAL
open science

Analysis of the factors that increase innovation and success in complex projects to propose a partner selection framework

Malihehsadat Vaezalaei

► **To cite this version:**

Malihehsadat Vaezalaei. Analysis of the factors that increase innovation and success in complex projects to propose a partner selection framework. Business administration. Ecole des Mines d'Albi-Carmaux, 2021. English. NNT : 2021EMAC0016 . tel-04861111

HAL Id: tel-04861111

<https://theses.hal.science/tel-04861111v1>

Submitted on 2 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Université Fédérale



Toulouse Midi-Pyrénées

THÈSE

en vue de l'obtention du

DOCTORAT DE L'UNIVERSITÉ DE TOULOUSE

délivré par

IMT – École Nationale Supérieure des Mines d'Albi-Carmaux

présentée et soutenue par

Malihehsadat VAEZALAEI

le 13 décembre 2021

Analysis of the factors that increase innovation and success in complex projects to propose a partner selection framework

École doctorale et discipline ou spécialité :

EDSYS : Génie Industriel

Unité de recherche :

Centre Génie Industriel, IMT Mines Albi

Directeurs de thèse :

Didier GOURC, Professeur, IMT Mines Albi (Directeur de thèse)

Robin COWAN, Professeur, Université de Strasbourg (Co-directeur de thèse)

Autres membres du jury :

Franck MARLE, Professeur, CentraleSupélec Paris, Gif-sur-Yvette (*Rapporteur*)

Bruno VALLESPIR, Professeur, Université de Bordeaux, Talence (*Rapporteur*)

Robert PELLERIN, Professeur, Polytechnique Montréal (*Président*)

Ioana DENIAUD, Maître de conférences, Université de Strasbourg (*Encadrante*)

Claude BARON, Professeur, INSA de Toulouse (*Invitée*)

François MARMIER, Maître de conférences, Université de Strasbourg (*Invité encadrant*)

To all Afghan girls and women who have been unjustly deprived of their inalienable right to education.

Abstract

The connection between economic growth, progress, development, and innovation in projects is inevitable these days. Moreover, competitive pressures and the necessity for innovation increase the need for complex projects. However, in innovative complex projects, an organization is usually not capable to manage all aspects individually, since it does not have all the needed competencies, skills, or resources. In this case, the formation of a strategic alliance can be a solution for the development of innovative projects.

These strategic alliances share knowledge, collaborate in project activities, and make joint decisions to achieve complex project objectives. However, in alliances one of the difficulties is achieving effective collaboration: miscommunication, missing skills, missing resources, and lack of trust create a high risk of failure. To decrease this risk, and to overcome potential collaboration inefficiency, partner selection must take place among firms that are able to trust each other and communicate well while at the same time having the required knowledge to achieve their objectives.

In the first part of this thesis, the research problem and a guideline for readers are demonstrated. Then an overview on the increasing need for research regarding complex innovative projects as well as their common challenges and solutions is presented. We have also reviewed the notion of collaboration in innovative complex projects. We have observed that collaboration is increasingly seen as a preferable form of performing complex projects involving many partners, suppliers, and customers. Moreover, we have concluded that different innovation levels in innovative projects are significantly related to the selected partners of the project. This review led us to address an important question “How to increase the complex innovative project success conducted with strategic alliances?” Many efforts have been made to contribute to this question in the second and third parts of this thesis.

In the second part of the thesis, a new conceptual model based on hypotheses extracted from the literature review is proposed. This conceptual model proposed to investigate the effect of different knowledge criteria on trust between partners, the effect of trust on project innovation, the effect of complexity on innovation, and the effect of innovation on the success of complex projects. We have also considered the trust capability of the project player as a moderator of the relationship between knowledge criteria and trust between project partners. Then a survey is designed and filled by project managers to provide the required data to analyze the conceptual model. Partial Least Squares Structural Equation Modeling (PLS-SEM) is used to analyze the proposed structural model. Then, the correlation between project managers’ work experience and their opinion about the success of a complex project is analyzed.

The third part focuses on proposing a novel partner selection framework based on the findings of the two previous parts and also a literature review on influential factors of

alliance formation and partners selection. The framework aims at enhancing the collaboration efficiency considering project complexity degree, project knowledge requirement, and partners' past experiences. The framework also presents potentials for future studies. Finally, data of a European project in the aeronautics field named Knowledge Alliance in Air Transport (KAAT) which conducted in form of a strategic alliance is used to (1) demonstrate the applicability of the proposed framework on real data, and (2) to provide a novel foundation for future research in this field.

Keywords: Partnership, Strategic alliance, Complex project, Innovation, Trust, Partner selection, PLS-SEM

Resumé

Le lien entre la croissance économique, le progrès, le développement et l'innovation dans les projets est inévitable de nos jours. En outre, les pressions concurrentielles et la nécessité d'innover augmentent le besoin de projets complexes. Cependant, dans les projets complexes innovants, une organisation n'est généralement pas capable de gérer tous les aspects individuellement, car elle ne dispose pas de toutes les compétences, aptitudes ou ressources nécessaires. Dans ce cas, la formation d'une alliance stratégique peut être une solution pour le développement de projets innovants.

Ces alliances stratégiques partagent leurs connaissances, collaborent aux activités du projet et prennent des décisions conjointes pour atteindre les objectifs complexes du projet. Cependant, dans les alliances, l'une des difficultés est de parvenir à une collaboration efficace : une mauvaise communication, des compétences manquantes, des ressources manquantes et un manque de confiance créent un risque élevé d'échec. Pour réduire ce risque et surmonter l'inefficacité potentielle de la collaboration, la sélection des partenaires doit se faire parmi les entreprises qui sont capables de se faire confiance et de bien communiquer tout en ayant les connaissances requises pour atteindre leurs objectifs.

Dans la première partie de la thèse, le problème de recherche et une ligne directrice pour les lecteurs sont d'abord démontrés. Ensuite, un aperçu sur le besoin croissant de recherche concernant les projets innovants, complexes ainsi que leurs défis communs et leurs solutions sont présentées. Nous avons également examiné la notion de collaboration dans les projets complexes innovants. Nous avons observé que la collaboration est de plus en plus considérée comme une forme préférable de réalisation de projets complexes impliquant de nombreux partenaires, fournisseurs et clients. De plus, nous avons conclu que les différents niveaux d'innovation dans les projets innovants sont significativement liés aux partenaires sélectionnés pour le projet. Cette revue nous a conduit à aborder une question importante : "Comment augmenter le succès des projets innovants complexes menés avec des alliances stratégiques ?". De nombreux efforts ont été faits pour contribuer à cette question dans les deuxièmes et troisièmes parties de cette thèse.

Dans la deuxième partie de la thèse, un nouveau modèle conceptuel basé sur les hypothèses extraites de la revue de la littérature est proposé. Ce modèle conceptuel propose d'étudier l'effet de différents critères de connaissance sur la confiance entre les partenaires, l'effet de la confiance sur l'innovation du projet, l'effet de la complexité sur l'innovation, et l'effet de l'innovation sur le succès des projets complexes. Nous avons également considéré la capacité de confiance de l'acteur du projet comme un modérateur de la relation entre les critères de connaissance et la confiance entre les partenaires du projet. Ensuite, une enquête est conçue et remplie par des chefs de projet afin de fournir les données nécessaires à l'analyse du modèle conceptuel.

La troisième partie se concentre sur la proposition d'un nouveau cadre de sélection des partenaires basé sur les résultats des dernières parties et sur une revue de la littérature sur les facteurs influents de la formation d'alliances et de la sélection des partenaires. Le cadre vise à améliorer l'efficacité de la collaboration en tenant compte du degré de complexité du projet, des connaissances requises pour le projet et des expériences passées des partenaires. Enfin, les données d'un projet européen dans le domaine de l'aéronautique, appelé Knowledge Alliance in Air Transport (KAAT), qui s'est déroulé sous la forme d'alliances stratégiques, sont utilisées pour (1) démontrer l'applicabilité du cadre proposé sur des données réelles, et (2) fournir une nouvelle base pour les recherches futures dans ce domaine.

Mots-clés: Partenariat, Alliance stratégique, Projet complexe, Innovation, Confiance, Sélection de partenaires, PLS-SEM

1

Acknowledgement

“When I started counting my blessings, my whole life turned around.”

Willie Nelson

It took me too long to hesitate on how to start writing the acknowledgment of my thesis. The last three years of working on this thesis were the most special and blessing time of my life and I have to thank several people who helped me through this great achievement. Hence, it is a real pleasure to have this page to write my appreciation and deep gratitude to all those people in my life who encouraged me helped me and supported me to go through all difficult moments of challenging times during my Ph.D. journey.

First and foremost, I want to thank the four most influential people in my research, my supervisors. Starting with Didier who accepted to be my thesis director and supported me through this difficult challenge of my professional life. He helped me in every step, he always asked me challenging questions, and he always kept me in the right direction. He was always there for my questions. So thank you so much, Didier, for all the support, it was an honor to work with you, and I am sorry that my French did not become as good as you expected me, but one day it will be ☺I promise.

Then Robin, the one with who I had the most distance in terms of my educational background. He introduced me to a new way of thinking. Robin challenged me a lot! He always pushed me toward my weaknesses and he helped me to try to change those weaknesses into strengths, I hope I was a little successful. I will always remember the meeting that we had, maybe the shortest possible meeting but the most productive ones ever. He is always to the point, he always sees what you don't see, and he always has brilliant ideas. Thank you, Robin, I appreciate the opportunity to work with you. And it is truly an honor to have your name as a co-director of my Ph.D.

Then François, who recruited me as a Ph.D. candidate 3 years ago with so many motivations and ideas, and the one who helped me to find a direction in my research at the beginning. So thank you François for trusting me. I am thankful for always encouraging me to think out of the box. For all the supporting texts that you have sent me in stressful moments and for always having critical look at my research. For all the time that you have spent with me to work on the subject together. You were not just my supervisor; you are my friend and I hope this friendship between us always lasts.

And Ioana, it is the hardest one, I don't know how to thank you. Because the feeling that I have for Ioana is really deep. Of course, she was my Ph.D. supervisor, and she supported me a lot, helped me a lot in my research. So I appreciate all her effort as my Ph.D. supervisor.

Acknowledgement

But Ioana is not just a Ph.D. supervisor to me. She is the biggest support that I had in France, she is my friend, to be honest, she is more like family to me. And not just to me but also to my husband. She was always there for us in any challenges, to help us solve our problems, especially problems as immigrants. Ioana, thank you for all your support and your kind heart. I am so lucky to have you in my life. I cannot thank you enough.

Then, I would like to thank all the jury members for their time, their brilliant questions, and their valuable comments and remarks. prof. Franck MARLE, prof. Bruno VALLESPER, prof. Robert PELLERIN and prof. Claude BARON, it was an honor to have you all as the committee of my defense. I was inspired by the way you have conducted your research and honored to defend my dissertation in front of you.

In addition, special thanks to all my friends and colleagues from BETA as well as CGI, I was lucky enough to work in two different laboratories with amazing people. Of course, I cannot thank everyone by their name. But special thanks to Julien Pénin and Xavier Lorca the lab directors for making this collaboration possible. Then to my friends and colleagues who survived or are surviving their Ph.D. journey, Arnaud, Enrico, Huy, Sila, Benoit, Benoît, Sina, Mehran, Nafe, Abdallah, Raphaël, and Manon for being such good friends to me, and making this Ph.D. life much easier.

To my family, my mother, my father, and my sister for their unconditional love, support, and encouragement throughout my entire life. They are always in my heart and I am always thankful to them for always encouraging me to follow my dreams even if it makes me live far from them. I hope that I will always be a daughter and a sister that you can count on.

And finally the last but of course not least to my best friend, my love, my husband, Mohammad, who supported me, loved me, and always be there for me in difficult moments. Thank you Mohammad without you it was not possible.

Contents

<i>Abstract</i>	v
<i>Resumé</i>	vii
<i>Acknowledgement</i>	ix
<i>Contents</i>	xi
<i>List of Figures</i>	xv
<i>List of Tables</i>	xix

Part I First part—Context, problematic, and background of the thesis	1
1 Introduction	3
1.1 Introduction	3
1.2 Research background	4
1.3 Research approach	5
1.4 Guideline for readers	7
2 Past, present and future of risk and success in innovative complex projects - state of the art	9
2.1 Introduction	9
2.2 Complex innovative project	11
2.2.1 Project management in complex innovative project	12
2.3 Risk Management	15
2.3.1 Risk management in innovative complex project	16
2.3.2 Risk management solutions and suggestions	17
2.4 Knowledge Management Concepts	18
2.4.1 Knowledge management in innovative complex project	19
2.4.2 Knowledge management solutions and suggestions	19
2.5 Risk management VS knowledge management	20
2.5.1 Knowledge management applied to managing risk	21
2.6 Role of collaboration in success of innovative complex project	22
2.6.1 Strategic alliances and models of collaboration	24
2.7 Conclusion	25

Part II	Second part—A proposed hypothesized conceptual model	27
3	Conceptual model and analysis	29
3.1	Introduction	29
3.2	Theoretical background and research hypotheses	31
3.2.1	Project success	31
3.2.2	Project innovation	32
3.2.3	Innovation and complex project success	33
3.2.4	Project complexity and innovation	33
3.2.5	Trust and innovation	35
3.2.6	Knowledge criteria and trust	36
3.2.7	A moderator called trust capability	37
3.3	Research methodology	42
3.3.1	Survey design	42
3.3.2	Sampling and data collection	42
3.3.3	Analytical methods	43
3.4	Data analysis	43
3.4.1	Data screening and pre-analysis	43
3.4.2	Common-method variance bias test	46
3.4.3	Reliability and validity of the data	47
3.4.4	Analysis of measurement model	47
3.4.5	Analysis of formative measurement model	50
3.4.6	Analysis of conceptual model	50
3.4.7	Moderator effect - Trust Capability of respondents	54
3.4.8	Importance-Performance Map Analysis (IPMA)	54
3.4.9	Multi-group analysis (MGA)	60
3.5	Conclusion and discussion	64
3.5.1	Implications for practice	65
3.5.2	Limitation and future research direction	66
4	The role of project managers experience	67
4.1	Introduction	67
4.2	Theoretical background	68
4.2.1	The role of work experience	68
4.3	Current chapter and research questions	69
4.4	Materials and methods	71
4.4.1	Survey design and data collection	71
4.5	Data analysis	71
4.5.1	Data screening and pre-analysis	73
4.5.2	Validation of the collected data	73
4.5.3	Hypothesis assessment	75
4.5.4	Descriptive statistical analysis	75
4.5.5	Correlation analysis between variables	77
4.6	Conclusion and discussion	82
4.6.1	Practical implications	83
4.6.2	Limitation and future research direction	83

Part III Third part—Partner selection in complex projects	85
5 A partner selection framework	87
5.1 Introduction	87
5.2 Literature review	89
5.2.1 Partner selection problem and most commonly used criteria	89
5.2.2 Influential factors in strategic alliances	90
5.3 Proposed hypotheses	97
5.4 Proposed framework	98
5.5 Conclusion and discussion	102
5.5.1 Conclusion	102
5.5.2 Managerial insight	102
5.5.3 Limitations and future research	102
6 A case study-Test the framework on real collaboration	103
6.1 Motivation	103
6.2 Presentation of the case study	104
6.3 Data preparation	105
6.3.1 Project technological complexity degree	105
6.3.2 Partners' collaboration history	106
6.3.3 Project required knowledge and partners' knowledge	110
6.4 Design the proposed framework	111
6.4.1 Results of the proposed framework	114
6.4.2 Robustness check of the proposed approach	117
6.4.3 Application of the proposed framework	120
6.5 Discussion	120
6.5.1 Future research	121
—————	
Conclusion	123
Limitations	126
Future research	128
Résumé long en français	129
Contexte et problématique	130
Partie 1 : Contexte, problématique et historique de la thèse	131
Partie 2 : Un modèle conceptuel hypothétique proposé	133
Partie 3 : Sélection des partenaires dans les projets complexes	135
Les contributions de la thèse	136
Limitation de la recherche	137
La recherche future	138
—————	
A First appendix	141
B Second appendix	157
C Third appendix	159
—————	
<i>Bibliography</i>	167

List of Figures

1.1	Common challenges in strategic alliances	5
1.2	An overall view of this thesis	8
2.1	An overview of the content of chapter 2	11
2.2	The five dimensions of project management (Claire et al., 2014; Galvez et al., 2018)	13
2.3	Comparison between relational risk and performance risk	16
2.4	Publication number per year based on searching “Strategic Alliances”, “Collaborative Networks” and “Virtual Organizations” as a topic phrase in the Web of Science	24
3.1	Selected model for measuring project success	31
3.2	Selected model for measuring innovation	32
3.3	Complexity classification	34
3.4	Complexity dimensions	34
3.5	Similarity, complementarity and coverage demonstration in two firms knowledge areas.	36
3.6	Research proposed conceptual model	39
3.7	A schematic view of all the steps of proposed approach for data analysis	44
3.8	Number of projects managed by respondents	45
3.9	Respondents’ country of origin	46
3.10	Type of the projects that respondents filled the survey based on	46
3.11	PLS-SEM path modeling	49
3.12	Simple moderator model	50
3.13	Findings of proposed conceptual model	53
3.14	Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship of Similarity (Sim) on Relational Trust (RT)	55

List of Figures

3.15	Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship of Similarity (Sim) on Competence-Based Trust (CBT)	55
3.16	Importance- performance map analysis for complex project success (vertical axis and horizontal axis represent performance and importance respectively)	56
3.17	Importance- performance map analysis for project innovation (vertical axis and horizontal axis represent performance and importance respectively) .	57
3.18	Importance- performance map analysis for relational trust (vertical axis and horizontal axis represent performance and importance respectively)	59
3.19	Importance- performance map analysis for competence-based trust (vertical axis and horizontal axis represent performance and importance respectively)	59
4.1	Hypothesized relationship between project managers' experience and complex project success	69
4.2	Factors related to the innovative complex project from Chapter 3 of this thesis	70
4.3	An example of questions related to the project managers opinion (degree of importance for respect the allocated budget)	72
4.4	Work experience question in the survey	72
4.5	Responses of first question of CPS	77
4.6	Responses of second question of CPS	77
4.7	Responses of third question of CPS	78
4.8	Responses of fourth question of CPS	78
4.9	Responses of fifth question of CPS	78
4.10	Responses of sixth question of CPS	79
5.1	A schematic overview of the proposed framework	97
5.2	An overview of criteria weighting based on knowledge	99
5.3	Example of using the proposed framework	101
6.1	Inputs, outputs and steps of the partner selection algorithm	106
6.2	Knowledge weight calculation approach	113
6.3	Plot of partnership scores for all the possible partnerships	115
6.4	Paired sample t-test between rank 1 and other rankings when they are sorted based on the exact solution	118
6.5	Paired sample t-test between rank 1 and other rankings when they are sorted based on the average of the partnership scores of 1000 iterations	118
6.6	Paired sample t-test between rank i and rank i+1 when they are sorted based on the exact solution	119
6.7	Paired sample t-test between rank i and rank i+1 when they are sorted based on the average of the partnership scores of 1000 iterations	119
A.1	Importance- performance map analysis for complex project success - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)	147

A.2	Importance- performance map analysis for project innovation - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)	149
A.3	Importance- performance map analysis for relational trust - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)	151
A.4	Importance- performance map analysis for competence-based trust - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)	153
C.1	Partnership ranking algorithm	165

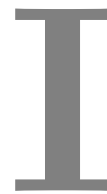
List of Tables

1.1	Scientific questions and the proposed solutions	6
3.1	Selected studies based on trust in partnership context	40
3.2	Demographic characteristic of the respondents	45
3.3	Reliability of latent variables	48
3.4	Validity of indicators	48
3.5	Outer weights	51
3.6	hypotheses assessment	52
3.7	Moderator assessment	54
3.8	Importance- performance map analysis for complex project success	57
3.9	Organizational complexity questions in the designed survey	58
3.10	Importance- performance map analysis for project innovation	58
3.11	Importance- performance map analysis for relational trust	59
3.12	Importance- performance map analysis for competence-based trust	60
3.13	Multi-Group Analysis for Trust Capability (TrC)	61
3.14	Multi-Group Analysis for age of respondents	62
3.15	Multi-Group Analysis for N. of projects	63
3.16	Multi-Group Analysis for familiarity rate	64
4.1	Work experience of the respondents (project managers)	73
4.2	Importance measurement scale	73
4.3	Work experience measurement scale	73
4.4	Reliability of latent variables	74
4.5	Validity of indicators	74
4.6	Path coefficients between work experience and complex project success	75
4.7	Results of descriptive statistics	76

List of Tables

4.8	Correlation between work experience and their judgement about project success dimensions	79
4.9	Path coefficients between work experience and judgment about importance of factors related to project success	80
4.10	Correlation between work experience and their judgement about social complexity dimensions	80
4.11	Correlation between work experience and their judgement about knowledge complementarity dimensions	81
4.12	Correlation between work experience and their judgement about knowledge coverage dimensions	81
4.13	Correlation between work experience and their judgement about relational trust dimensions	81
4.14	Correlation between work experience and their judgement about competence-based trust dimensions	82
5.1	Criteria in partnership literature	95
5.2	Summary of hypotheses	98
6.1	Partners' history of collaboration	108
6.2	Partners' history of collaboration matrix	109
6.3	The partnership score, and the weight of similarity, complementarity and coverage of the actual state of the KAAT project	114
6.4	The result of algorithm for the 10 last set of partnership with highest partnership score	116
6.5	The result of algorithm for the 10 partnerships with highest average of partnership scores in 1000 iterations	117
A.1	A survey on impact of knowledge criteria and complexity level on success of innovative complex projects	142
A.2	Harman's single-Factor Test	145
A.3	Collinearity statistics (VIF) of indicators	146
A.4	Importance-performance map analysis for complex project success - indicators	148
A.5	Importance-performance map analysis for project innovation - indicators .	150
A.6	Importance-performance map analysis for relational trust - indicators . .	152
A.7	Importance-performance map analysis for competence-based trust - indicators	154
A.8	Multi-Group Analysis for work experience of respondents	155
B.1	Correlation between work experience and their judgement about project innovation dimensions	158
B.2	Correlation between work experience and their judgement about organizational complexity dimensions	158
B.3	Correlation between work experience and their judgement about technological complexity dimensions	158

B.4	Correlation between work experience and their judgement about knowledge similarity dimensions	158
C.1	Project required knowledge: Soft skills and Hard skills	160
C.2	Project required knowledge: Resources and Services	163
C.3	Project required knowledge: Organizational culture, Language and Others	164



First part—Context, problematic, and background of the thesis

Purpose: risk of project failure is high in innovative complex projects, especially when different organizations are involved in joint management of these projects. Recently many research has been developed to reduce the risk of strategic alliances while taking advantage of them. The first chapter of this part aims to demonstrate the research problem and concise background of the research. Moreover, the research approach is presented and at the end of the chapter, a guideline for readers is presented. In the second chapter, the concept of innovative complex projects is reviewed, so as to understand the common challenges and solutions in this domain. In addition, the final purpose of the second chapter is to recognize desired spaces for further research.

Design/methodology/approach: the methodology used for this part of the thesis is a literature review based on common keywords of the domain.

Findings: a comprehensive overview of the history and specification of the innovative complex project is provided. Common challenges in the management of innovative complex projects with the focus on collaboration of different organizations are presented.

Originality/value: our state-of-the-art study on innovative complex projects is not limited to complexity and innovation. An overview of recent research work about concepts and definitions of project, innovation, complexity, project management, risk management, and knowledge management underlines the important role of collaboration as strategic alliances in managing innovative complex projects. Additionally, one of the objectives of this part is

to show the readers the various interesting problems raised in innovative complex projects literature.

Research implications: this part of the thesis contributes to a better understanding of the challenges and research questions in innovative complex projects, where the uncertainty and risk of failure are high as well as the required knowledge. Moreover, the collaboration of different partners is essential in developing such projects. But at the same time, these collaborations bring more challenges to the projects in terms of lack of effective communications, hidden objectives, etc. The research questions that become apparent from the first part, will be discussed and answered in the two following parts.

1

Introduction

1.1	Introduction	3
1.2	Research background	4
1.3	Research approach	5
1.4	Guideline for readers	7

“Would you like me to give you a formula for success? It’s quite simple, really: Double your rate of failure. You are thinking of failure as the enemy of success. But it isn’t at all. You can be discouraged by failure or you can learn from it, so go ahead and make mistakes. Make all you can. Because remember that’s where you will find success.”

Thomas J. Watson

1.1 Introduction

Nowadays there are competitive pressures and the need for innovation that increase the necessity for complex projects. Pursuing innovation in projects is one of the ways organizations choose to develop new products and services to maintain market satisfaction. Furthermore, all projects are exposed to risks that could affect their objectives, costs, and time. This is much more the challenge with highly complex projects where there are higher levels of risk, that is to say, the complexity of a project is a factor that affects project development. Hence, innovative complex projects are recognized as a dynamic arrangement that develops in an environment with high uncertainty and unpredictability.

Notwithstanding, in an innovative complex project, an organization is often not able to manage all aspects alone, since it does not have all the required competencies, skills, or resources. In this case, strategic alliance formation can be a solution for innovative project development. These strategic alliances share knowledge, collaborate in project activities, and make joint decisions to achieve complex project objectives. This strategic alignment allows partners to not only develop innovation potentials through sharing knowledge and resources but also to jointly manage the project risks.

For all the benefits that strategic alliances provide for managing complex innovative projects, it is important to note that the failure rate in these collaborations is very high. While accepting that failure is an integral part of innovation, sharing knowledge and technology between partners is not immune to risk. In strategic alliances one of the frequent challenges

is achieving effective collaboration: miscommunication, missing skills, missing resources, hidden objectives, and lack of trust create a high risk of failure.

To decrease this risk, and to overcome potential collaboration inefficiency, partner selection takes place among firms that are able to trust each other and communicate well while at the same time having the required knowledge to achieve their objectives. This knowledge can be known by evaluating the influential factors in the success of the projects, and also considering the project technological point of view to estimate their challenging degrees, and studying the partners' background in past projects or partnerships.

In this regard, this thesis is aimed to identify the factors that increase innovation and success in innovative complex projects conducted by strategic alliances. Moreover to propose a methodology to choose the best set of partners in alliance formation in order to increase trust among partners as well as knowledge sharing quality and success of the projects. This research uses data that is collected by a survey from European project managers to investigate influential factors of project success. Besides, by studying the detailed analysis of historical data of a European project in the aeronautics field named Knowledge Alliance in Air Transport (KAAT), the proposed partner selection of this study is examined.

The objective of this chapter is to present a general overview of research context, research background, research approach, main research contributions, and finally, thesis organization is discussed briefly to provide a guideline for readers.

1.2 Research background

In academic literature, the number of papers in innovative complex projects is increasing recently. The more complex the deliverable of a project, the less a single firm has all the skills or the means to carry out its development alone. A major consequence is that alliances must be formed to continue the project. Among the things put in place to support these alliances, quality and risk management plans are implemented to maximize the chances of success of the projects. However, despite this, alliances face difficulties in achieving their goals. More than 60% of New Product Development (NPD) alliances fail (Bruner et al., 1998) due to difficulties of communication between partners, hidden objectives, or missing skills.

Reasons for risk and failure in strategic alliances have been perfectly described by Elmuti et al. (2001). According to their research some of the failure reasons can be classified as follows: (Figure 1.1 has also shown some of the challenges in strategic alliances)

- **Clash of cultures:** clash of cultures is probably one of the biggest challenges in strategic alliances that consist of: partners' egos, language barriers, chauvinism, etc.
- **Lack of trust:** building mutual trust is one of the most difficult aspects of forming an alliance. Many alliances fail due to the lack of trust that causes hiding information, unsolved problems, and lack of understanding.
- **Lack of clear objectives:** having non-similar objectives, the inability of sharing risk, and forming alliances for wrong reasons are also some of the common reasons for failure.
- **Lack of coordination between managers:** coordination can be a huge problem in strategic alliances, especially if organizations remain to be competitors instead of collaborators.
- **Different in operations and attitudes among partners:** organizations involved in the strategic alliance might have different attitudes and operation scheduling that might lead to conflict.

Moreover, in a research by Doloji (2009), based on a practical study, the research addressed the criticality and importance of different aspects in the partners' selection process. Among them, "communications difficulties" between involved partners were reported to be the most influential aspect in the partner selection process.

Thus, as we have seen in the previous paragraph, our research is triggered by the identification of the project and partners' characteristics that can affect the project result. Also as stated in the literature, the majority of the research in this domain have adopted complex solutions for decreasing the risk of failure in complex projects which these solutions are often not practically applicable in projects due to the need for various competencies (Firmenich, 2017). Hence, there is motivation to adopt a practical solution to help decision-makers in innovative complex projects.



Figure 1.1 – Common challenges in strategic alliances

1.3 Research approach

To understand the challenges and problems in innovative complex projects conducted in strategic alliances, first, the context of innovative complex projects and the notion of risk and knowledge management are reviewed. Through a brief history of risk and innovation management in innovative complex projects, we describe the increasing pressure on the importance of collaboration between partners to conduct these kinds of projects and consequently, on the strategic alliances in this field. We present the value of knowledge sharing in innovation, strategic alliances challenges, benefit-risk balances based on decision-making related to these challenges.

In the next step after presenting the context, we look to understanding the cause of innovation and success in projects conducted by strategic alliances. Through a deeper look at the history

of collaboration-based projects and the study of more recent and related literature of the complexity and knowledge sharing in innovative projects, first, we propose a new aspect to knowledge criteria and project complexity. Then, a novel conceptual model is proposed based on several hypotheses to analyze the role of proposed factors as well as other factors driven from the related literature. Moreover, a suitable survey based on the proposed conceptual model is designed to help us gather the required data needed for analysis. The survey is filled by project managers who had the experience of managing complex projects conducted by more than one partner. Statistical methods are applied to analyze the gathered data. The results show that knowledge and innovation are significantly related to the success of the project. Also, complexity and trust between partners are significantly related to innovation. It is also proven that knowledge criteria are related to the trust between partners.

Afterward, since the survey enables us to access some information about the work experience of project managers and considering the important role of work experience in project management based on the related research, the relationship between project managers' work experience and success of projects is analyzed. Then, an analysis is performed to investigate the effect that work experience has on project managers' opinions about the factors influencing project success. The results show that more experienced project managers place more value on trust between partners, and some aspects of knowledge criteria.


Thereupon, based on the results we obtained in previous steps and a closer look at the literature of partner selection in strategic alliances, a novel framework for selecting partners in the formation phase of strategic alliances is proposed. To do so, first, a hypothesized knowledge criteria weighting methodology is presented based on project complexity level and history of potential partners collaboration. Then based on this methodology, a partner-selection framework is proposed aimed at increasing the trust, knowledge sharing, and success of the projects.

In the last step, data of partners and project from a practical strategic alliance are used to test the application of the proposed partner selection framework.

Table 1.1 provides a summary of the scientific challenges of this work and the corresponding solutions that are developed during this thesis.

Table 1.1 – Scientific questions and the proposed solutions

Scientific questions	Proposed solution	Related chapter
1. Why the complex innovative project has received so much attention?	Comprehensive literature review	Chapter 2
2. What are the challenges in strategic alliances?		
3. What are the influential variables in the success of projects conducted by strategic alliances?	Conceptual model of project success & statistical analysis	Chapter 3
4. What do project managers learn from their work experience?	Correlation analysis	Chapter 4
5. How to select the best set of partners in strategic alliances?	Partner selection framework based on project and potential partners characteristics	Chapter 5
6. What is the practical application of the proposed framework?	Using data from a strategic alliance real case study	Chapter 6



Contributions of this thesis

- A new classification for project complexity is proposed.
- A new classification for knowledge criteria is proposed.
- A novel conceptual model for project success in strategic alliances is proposed.
- Project managers' work experience is considered as a variable to investigate changes of their opinion about the importance of project success factors.
- A novel partner selection framework is proposed.
- Proposed partner selection is tested on real collaboration.

1.4 Guideline for readers

As shown in Figure 1.2, this thesis contains three main parts, six chapters, and a general conclusion as follow:

Part I focuses on introducing the research background and the state of art of this research which are presented in two chapters.

Chapter 1 presents an introduction to collaboration in innovative complex projects, concept and definition, research problem, research methodology, contributions and outline of this thesis.

Chapter 2 presents the state of art of innovative complex project, risk and knowledge management, the role of collaboration in innovative complex project, and the most common challenges and research problems in this domain.

Part II focuses on factors that affects success of innovative complex project in strategic alliances.

Chapter 3 presents a conceptual model based several hypotheses to analyze the impact of selected factors on success of innovative projects.

Chapter 4 examines the role of project managers experience on their judgment about important factors in success of innovative complex projects.

Part III focuses on partner selection phase of the alliance formation.

Chapter 5 proposes a partner selection framework that aims to maximize the probability of success of an collaboration.

Chapter 6 presents a case study, where the proposed partner selection framework of this thesis is put into action.

In addition to the above items that constitute the three parts, this thesis ends with a general conclusion. Moreover, the first page of each part is dedicated to the main idea of the part is presented including the Purpose, Design/Methodology/Approach, Findings, Originality/Value, and Research implications.

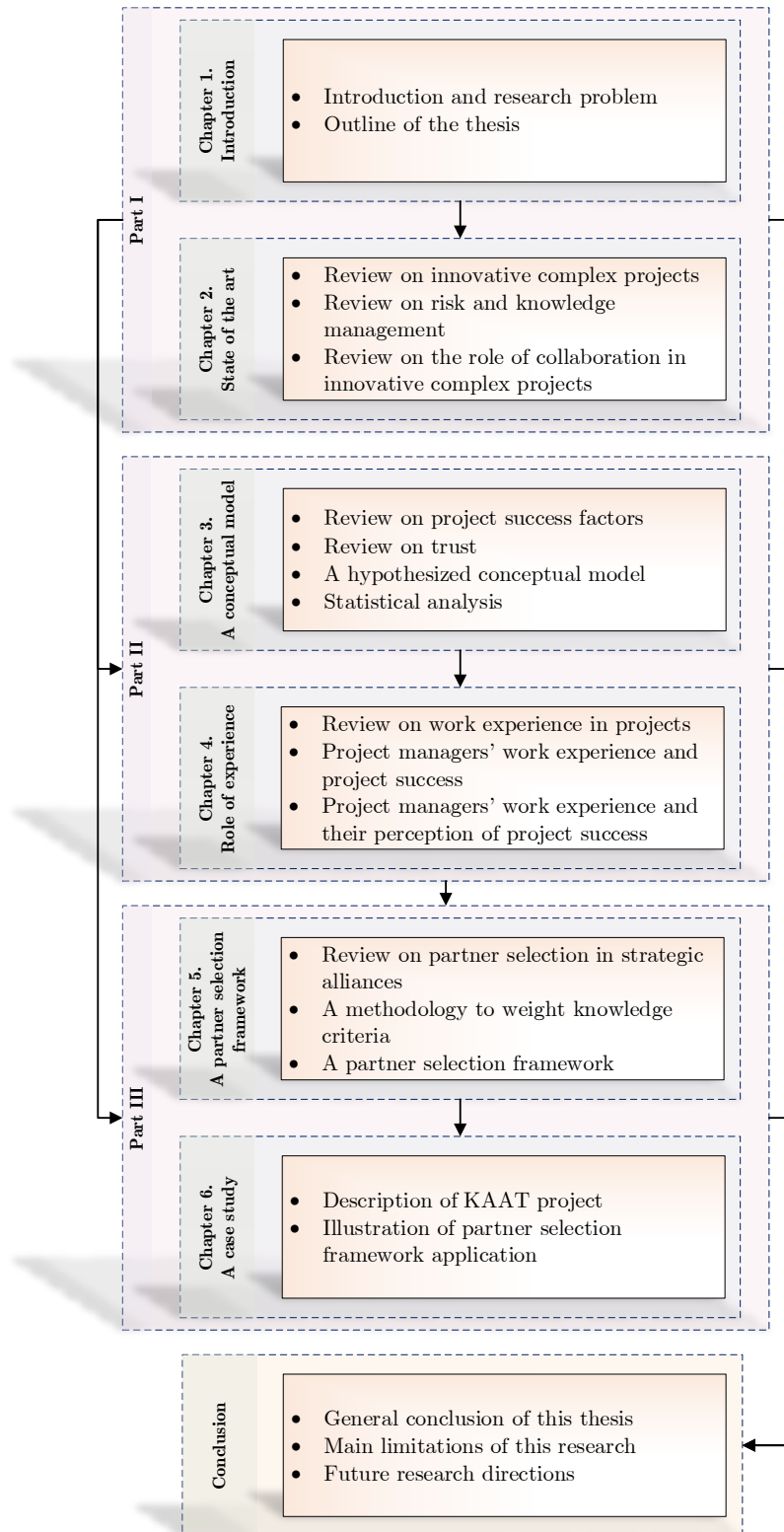


Figure 1.2 – An overall view of this thesis

2

Past, present and future of risk and success in innovative complex projects - state of the art

2.1	Introduction	9
2.2	Complex innovative project	11
2.2.1	Project management in complex innovative project	12
2.3	Risk Management	15
2.3.1	Risk management in innovative complex project	16
2.3.2	Risk management solutions and suggestions	17
2.4	Knowledge Management Concepts	18
2.4.1	Knowledge management in innovative complex project	19
2.4.2	Knowledge management solutions and suggestions	19
2.5	Risk management VS knowledge management	20
2.5.1	Knowledge management applied to managing risk	21
2.6	Role of collaboration in success of innovative complex project	22
2.6.1	Strategic alliances and models of collaboration	24
2.7	Conclusion	25

“The greatest enemy of knowledge is not ignorance, it is the illusion of knowledge.”

Stephen Hawking

2.1 Introduction

Project Management Institute (PMI) has suggested a new definition of a project which should be both “inclusive (it should not be possible to identify any agreement that is generally thought of as a project that does not conform to the definition) and exclusive (it should not be possible to describe an agreement that meets the definition and is not generally considered a project.)”. According to PMI “a project is a temporary endeavor undertaken to create a unique product or service” (PMI, 2013).

Perhaps the most popular word for any member of the project is “success” (Howsawi et al., 2014). When talking about projects, there are two main concepts of success: project success

and project management success. There are similarities and differences between these two concepts of project success. The main difference is that project success links to the outcome of achieving the overall project objectives, while project management success relates to traditional measurements of time, cost, and quality (Cooke-Davies, 2002; de Wit, 1988; Ika, 2009). However, due to the different models of project and project success, it is difficult to strongly differentiate between them, mainly due to their interrelationships.

On the other hand, project risk is defined as “the effect of uncertainty on objectives” or “an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives” (PMI, 2013). If project risks cannot be managed effectively and efficiently using a systematic approach, it is hard to achieve project objectives and might lead to project failure. Throughout a project life cycle, a risk management process mainly comprises risk assessment (involving risk identification, risk analysis, and risk evaluation, risk treatment, and risk monitoring and review). Among these steps, risk assessment is an essential activity that allows decision-makers to develop an overall risk perception of a project and thus make proper response decisions in a preventive manner (Guan et al., 2020).

Besides, all projects are exposed to risks that could affect their goals, costs, and planned time. This is much more the case with very complex projects where there are higher levels of risk, that is to say, the complexity of a project is a factor that affects project development. A complex project is acknowledged as a dynamic system that develops in an environment with high uncertainty and unpredictability (Qazi et al., 2016). Suitably managing risk makes it possible to go from a phase of uncertainty to a measurable estimation of the probability of occurrence of risk events, which therefore allows decision-making before the risk happens (Kermanshachi et al., 2016; Urgilés et al., 2019). Moreover, risk management has a tight relationship with the availability of knowledge. Therefore, many researchers have indicated that there is a strong relationship between risk management and knowledge management (Haltiwanger et al., 2010).

In addition, innovation is the driving force behind the value creation and future survival of an organization in today's economy. Also, innovation has been widely studied as a method for dealing with complexity and enhancing performance in complex projects. (Slaughter, 1998). Innovation means change or novelty (Tidd et al., 2001). At the beginning of the 20th century, Schumpeter (1939) declared that economic development directly depends on innovation. According to him, innovation can exert in the form of new products, new production processes or methods, new markets, or even new sources of supply. Since then, the concept of innovation has been broadly discussed and developed (see, for instance, the studies in the concept of business models proposed by Boons et al. (2013) and Schneider et al. (2013)), but the heart aspect of novelty as the determinant of change and economic growth has been maintained.

Successful innovation demands productive cooperation and working relationships between different parties within complex projects. In order to develop innovative performance, it is necessary to enlighten the internal mechanism of innovation through investigating collaborative relationships from a network perspective. In this case, the formation of collaborative partnerships can be considered as a potential solution to innovation challenges, and a relationship network indicates information exchanges among organizations (Xue et al., 2018). These types of collaborations allow the collaborators to not only develop their innovation potential by sharing resources and knowledge but also to manage the risk of failure together (Fernandez et al., 2018).

With regard to previous works, this chapter is aimed to provide a comprehensive and well-structured review of different aspects of risk and innovation in complex projects in order to introduce various aspects of this research field, specify the research trends, and also identify more aspects of the topic. To do so, a systematic literature review has been conducted. This chapter is dedicated to obtaining three objectives: (1) provide a representative overview of

the literature on innovative complex projects, (2) identify and highlight the recent advances and new challenges posed in this field, and (3) bring a look at the current state of the art and suggest possible future research directions. In a nutshell, our goal is to show the readers of this chapter the interesting problems raised in innovative complex projects literature.

To achieve our goal, the rest of this chapter is organised as follows: [Section 2.2](#) illustrates the background of complex innovative project. [Section 2.3](#) describes the risk management in innovative complex project. [Section 2.4](#) presents knowledge management in innovative complex project. [Section 2.5](#) presents the relationship between risk management and knowledge management. [Section 2.6](#) explores role of collaboration in success of innovative complex project. Finally, [section 2.7](#) is devoted to discussion, future research directions and conclusion. [Figure 2.1](#) demonstrate an overview of this chapter.

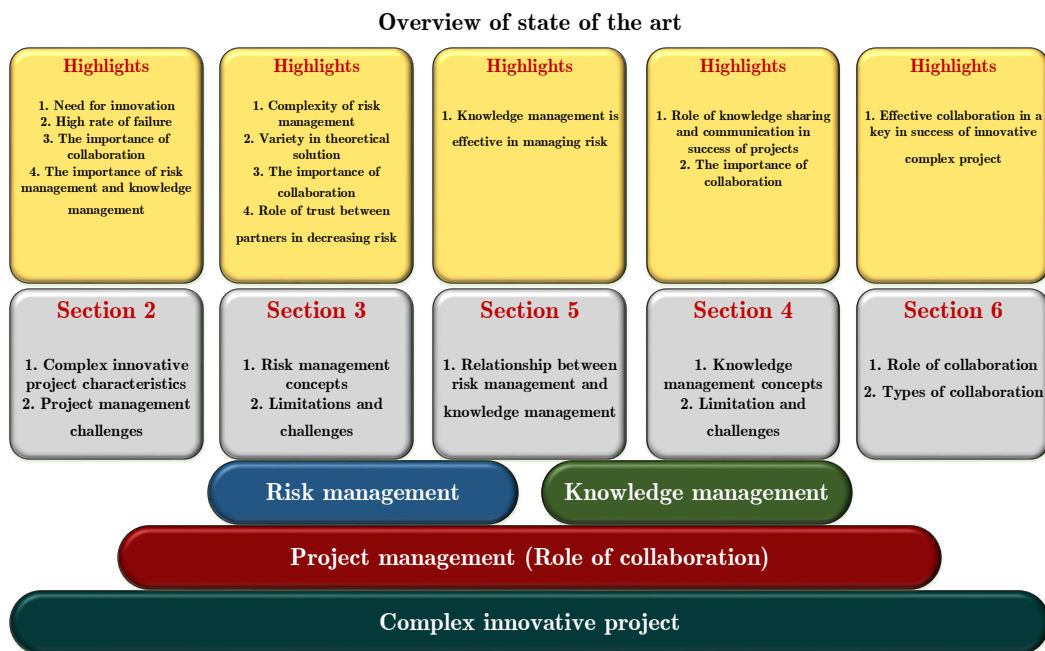


Figure 2.1 – An overview of the content of chapter 2

2.2 Complex innovative project

The speedy rate of globalization in recent years has resulted in an increase in the number of complex projects all over the world. Project networks are interconnected transmission systems that involve joint activities performed by a set of organizations over a period of time (Lundin et al., 2015). In general, innovative projects include uncertainties and inter-dependencies of several players with different goals and uneven levels of competence. These features make the project highly complex. Issues such as meeting deadlines and budgets, high investment costs (Jones et al., 2008), lack of knowledge sharing, and conflict between project players (Holti, 2011) are repetitious and problematic in innovative complex projects. These issues are mainly attributed to coordination and communication problems between the players involved (Son et al., 2011). In large projects involving many companies, coordination and control are even more complex.

Complexity is also common in innovative projects, which includes uncertainties and inter-dependencies of several actors with different goals and uneven levels of expertise (Jones et al.,

2008). Although a specific set of goals is shared among the participating companies, each actor has its own short- and long-term goals that may conflict with others (Ruuska et al., 2011). These characteristics give innovative projects a high degree of complexity, with direct implications for their governance (Koh, 2010).

According to the results of a literature review conducted by in Hu et al. (2015) number of annually published papers in the innovation of megaprojects has shown an increasing trend in the five years prior to the publication date. Moreover, the research concludes that a higher success ratio of megaprojects exerted in most of the developed countries such as the UK, US, and Australia compared to developing countries such as Russia, Turkey and India is due to lengthier experience. The authors have also pointed that some developed countries such as Spain and South Korea have not been yet recognized as contributors to this research topic.

Understanding the relationship between project complexity and innovation is crucial. Although innovation is clearly one of the main drivers of economic growth, it often leads to disappointing results or failure. For instance, Tepic et al. (2013) reported that among 38 innovative projects conducted by European industry companies, 16 projects have failed. They have used operational and strategic values to measure the success of an innovation project. The authors have studied an integrated framework of the complex relationships between innovation characteristics, organizational capabilities, innovation potential, and innovation performance to understand the failure reasons. They have collected their data from nine multinational organizations from different industries. Then, they have analyzed their framework with Partial Least Square (PLS) methodology. The result of their study has shown (1) innovativeness of innovation projects is crucial in the product potential and its chance to be successful in the market, (2) complexity associated with project innovation creates integrated project connections between team members, (3) projects that are new to the company are more at risk of negative performance, (4) these negative performance can be reduced by integrating communication between team members, (5) project managers can facilitate communication structures and knowledge sharing by setting up appropriate databases and information.

Shenhar et al. (2016) performed an analytic study on the tough experience of Boeing company in developing the highly innovative aircraft named Dreamliner. Although this project was eventually successful, it encountered considerable delays and cost overruns. Boeing's reliance on its past successful experiences has led project leaders to believe that the new project will be as successful. But based on the analysis of their article, it turned out that the challenges and scope of innovation of the new project may have been underestimated. In the Dreamliner project, the level of innovative methods required to manage technological design was much higher than in previous commercial aircraft projects. Integration of innovative technologies required much more resource allocation and knowledge than what had been predetermined. Another reason for the obstacles was the lack of sufficient organizational support to manage such a complex project. Based on their assessment, the authors suggest innovative project managers figure out "How long does it take to fix it?" alongside the most traditional question of "what can go wrong?".

2.2.1 Project management in complex innovative project

Complex projects have considerable difficulty due to a large number of components and technologies, the involvement of multiple organizations, communication and coordination requirements, and various teams. In the case of innovation in complex projects, the challenge is even greater and leads to higher risk, which often requires the adaptation of specific management processes during project development. Moreover, when complexity does exist in some large-scale projects, difficulties are usually inevitable in the organization of the projects. In complex systems development, project management is a key factor for innovation, and bringing together system capabilities to working systems and taking them to the customer.

Some researchers consider five management dimensions for the project management defined as follows and in Figure 2.2. This figure shows the breadth and diversity of the project management domain.

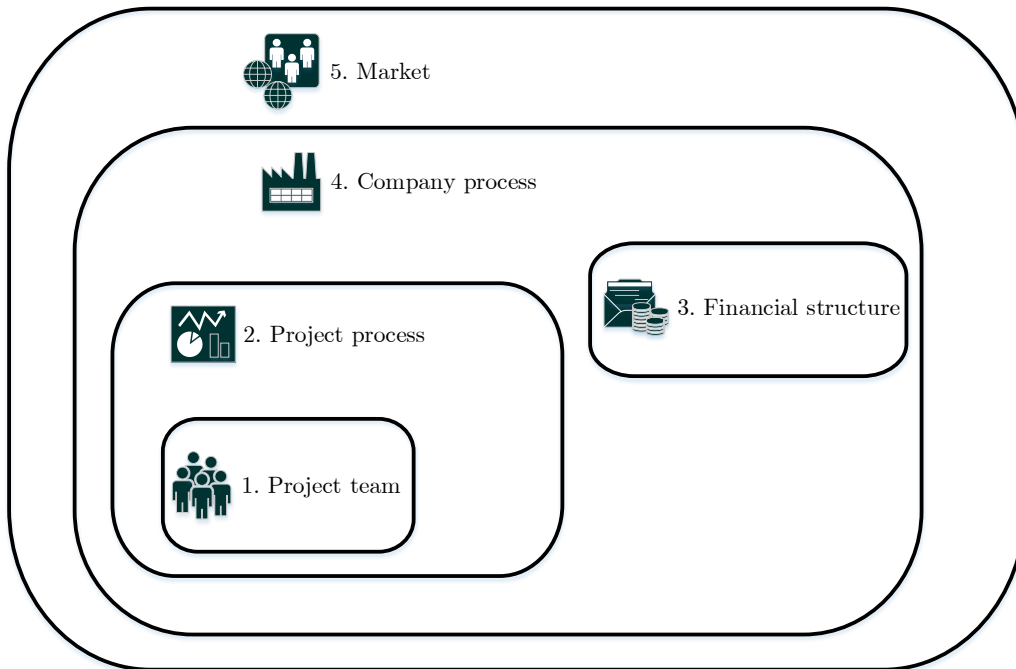


Figure 2.2 – The five dimensions of project management (Claire et al., 2014; Galvez et al., 2018)

- **Project team:** focuses on the competencies and skills of the project manager, acknowledge his weaknesses and the ability to form the appropriate team.
- **Project Process:** focuses on analysis of the information flow throughout the project.
- **Financial structure:** checks how the project manager analyzes the financial values of the project on the company.
- **Company process:** measures whether the company is estimating future adjustments related to the development of a new project in its organization.
- **Market Characterization:** determines how the project manager understands and integrates the specificity of the new project market.

Galvez et al. (2018) by noting that in innovative project management, most current methodologies are recommended to support the management process in a flexible and agile manner, proposed a complementary methodology to help decision-makers to decide whether to launch a potential innovative project or not. This methodology is based on examining the degree of maturity required in the company to succeed in an innovative project. Project characteristics, technological system components, and project impact assessment are considered as the inputs of this methodology. The authors have stated that some applications of their proposed method are: (1) It provides a comprehensive image of the project impacts, beyond the technical product features, (2) It enables a better understanding of the organization's

technological system and the means to manage it, (3) It provides communication elements to the organization team, about the influences and challenges of the new project's acquirement.

Ellinas et al. (2016) proposed network model as a solution for complex project management. The authors have indicated that risk and conflict of management are two of the most important challenges in complex project management.

A meta-analytic literature review over the progress of recent project management with a focus on complex innovative projects is reported in Michaelides et al. (2016). This study covers the literature on this subject released over forty years. The authors claimed that strategic planning is one of the top twenty topics in project management. Their analytical based findings revealed the importance of strategic alignment, agility, and competencies development in risk management of complex project risk management.

Ivan et al. (2014) indicated that by setting the innovative results as project goals, innovative project management increases the probability of accomplishing the proper results. Traditional project management concentrates on predictability, evaluation assessment, and control. Though, innovative project management concentrates on change, creative ideas, and breaking the existing situation. Additionally, they have defined characteristics for innovative project managers:

- **Risk.** An innovative project manager has to take the risk in most circumstances to succeed. But, traditional project managers take risks only if expected benefits justify it. This characteristic of innovative project managers push projects to the border of failure but in many cases, it also results in innovative outputs.
- **Failure.** An innovative project manager has to accept failure. Traditional project managers consider failure as being a tragedy. Owing to the fact that failure is closely associated with innovation.
- **Opportunities.** An innovative project manager creates opportunities. Traditional project managers recognize, understand, and utilize opportunities. Innovative management signifies creating opportunities for the project to reveal in the best potential conditions.
- **Decision-making.** An innovative project manager makes quick decisions. Traditional project manager thoroughly analyzes on a matter prior to making a decision. Making quick decisions gives managers the opportunity to embrace opportunities.
- **Ideas.** An innovative project manager has to encourage and develop creative ideas. Traditional project managers reject an idea when it does not seem proper for the project.

Moreover, while searching innovative complex networks in a research database, in addition to project success, project management, and risk, two other keywords attract ones attention as well: Knowledge sharing/management and partnership¹. The innovative complex project literature has already acknowledged several positive outcomes for organizations actively engaged in collaboration, such as higher return on equity, better return on investment, and higher success rates (Todeva et al., 2005). Also, Knowledge sharing is essential for both creation and innovation in projects. According to a review paper by Castaneda et al. (2020), the relationship between knowledge sharing and innovation is growing based on the number of research published on the topic by year.

¹There are many terms in the literature for referring to the organizations that work together: Strategic Alliance, Collaborative Networks, Virtual Organizations, Partnerships, etc.

#1-Highlights based on the state of the art

With respect to the above arguments some of the highlights of the state of the art are as follows:

- Today's economy fosters the need for innovative complex projects.
- Level of risk and uncertainties is high in innovative complex projects.
- Rate of failure is high in innovative complex projects.
- Communication and knowledge sharing are essential in the success of innovative complex projects.
- Managing an innovative complex project requires other characteristics in comparison to managing traditional projects.
- Strategic alignment, risk management, and knowledge management are repeatable keywords in innovative complex project vocabulary.

2.3 Risk Management

Uncertainty is a challenge for most complex projects. The appearance of risk generates surprises during the project life cycle, influencing everything from technical feasibility to cost, time of the project, economic achievement, and strategic goals. Risk management is not a new concept. However, considering the increasing number of complex projects, the importance of risk management is increasing. Many organizations decide to leverage their resources and quicken their plannings by forming alliances, networks, and partnerships with other organizations, universities, and public agencies that cross from simple collaborative arrangements to open innovation. In such a complex and dynamic industry environment, risks sneak in many fields not only with the technical part of the work but also with the social, cultural, organizational, and technological dimensions (Thamhain, 2013). The risk perception by the organization affects the assessment of options and decision-making in managing inter-firm relationships. T. Das et al. (2001) identified two types of risk in strategic alliances:

- **Relational risk:** shows decision-makers' concerns about the level of collaboration among the partners. One of the sources for relational trust is the opportunism behavior of project partners. Such as: preventing or distorting information, not fulfilling promises or responsibilities, delayed payments and delivery of non-standard results, and acquisition of technology or key personnel of partner company. There is an assumption that indicates some of the project partners are opportunistic, thus they will make use of one-sided benefits whenever possible. Moreover, if a partner thinks that the other partners obtain too much from the alliance compared to its own benefit, it may commit less to the collaboration. T. K. Das et al. (2001) and Doloi (2009) indicate that trust between partners can be closely related to the relational risk. Hence, increasing mutual trust among partners can lessen the level of risk in collaboration.
- **Performance risk:** refers to the probability of not achieving the alliances' predefined objectives, despite full collaboration of partners. Performance risk defines when it is assumed that relational risk does not exist (assuming the full collaboration of partners). Accordingly, in strategic alliances, performance risk is attributed to the risks that collaboration may fail because of the volatility of the market or lack of

partners' competence, despite the attempts and collaboration of the partners. T. K. Das et al. (1998) indicate that accomplishment of collaboration objectives depends on various factors, such as global environment (i.e. administrative regulation and political changes), competitive environment (i.e. choices of main competitors), and internal environment (i.e. lack of required competence and knowledge).

Therefore, the total risk of an alliance can be defined by the combination of two independent types of risk. Relational risk and performance risk have no direct effect on each other. Figure 2.3 shows the comparison between relational risk and performance risk.

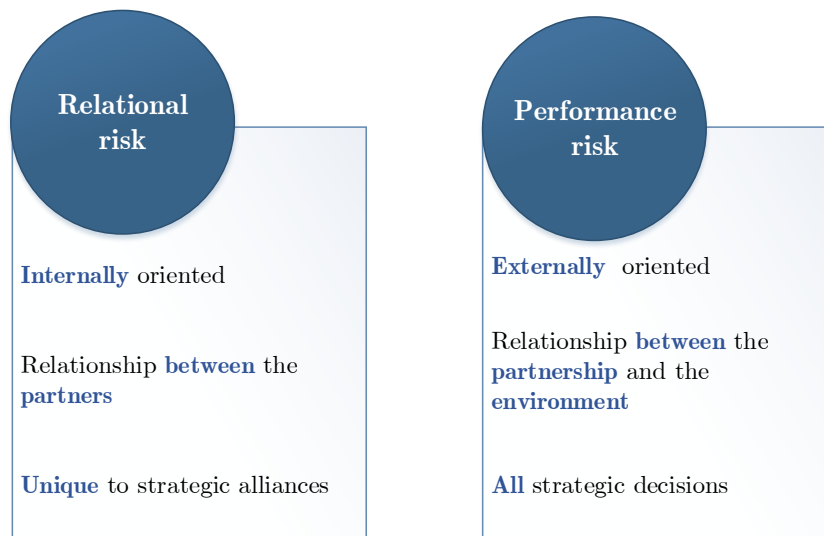


Figure 2.3 – Comparison between relational risk and performance risk

2.3.1 Risk management in innovative complex project

In Nai-ping et al. (2013), authors stated that due to the rapid development of information technology and acceleration of the merging economies for globalization, producing complex products has been turned into a propeller of progress in the technology of economical growth. Due to this fact, to ensure innovation success in industrial products, the risk of high investment, complex technology, time-consuming research period, and high cost of innovative process must be surveyed. In this article, the project's innovative risk has been analyzed using a Bayesian network. This method divides the project risk into the smallest units and regarding the relationship between previous risks and the probability of future risks, reduces the complexity of the risk prediction. Due to the learning ability of the algorithm, it is capable of constant modifications and high prediction and responsiveness. But on the other hand, as this network is constructed based on constant and long-term cooperation, requires a rich database as a training set.

According to Guo et al. (2013), literature is rich in proposing different theoretical solutions to cope with the risk of innovative complex projects. However, investigating and eventually adopting a solution among all is a tedious task. In this research work, a multi-objective analytic algorithm has been proposed to overcome this complexity. They claim that with the aid of this algorithm, a single solution can be sorted out among all to decrease the risk in technology innovative projects.

Okudan et al. (2020) have conducted research in the field of project management in the construction industry. As its dynamic, turbulent, and complex environment would result in poor performance and the appearance of numerous risks. Although risk management has an important effect on the improvement of performance in construction projects, due to the lack of information, risk management is challenging especially in the risk recognition state. This research work begins with a thorough review of the literature for extracting characteristics of construction projects. Then a questionnaire was designed to gather experts' opinions on the subject. At last, data were analyzed using the fuzzy AHP method. Findings uncovered that the most important characters of the projects of such type related to risk occurrence cases are contract type, project value, and construction-related characteristics.

The relationship between uncertainty and failure risk in complex projects has been surveyed in Walker et al. (2016). They have interviewed over 50 experts in this field for their study. Results showed that uncertainty creates many challenges for risk management. Although the risk is recognizable and predictable (these predictions are highly related to the complexity of the conditions), however, uncertainty remains unknown to the project players and managers. In this article, positive aspects of uncertainty have also been pointed out, aspects that offering perspective to new opportunities. Noteworthy opportunities among all are the ability of individuals in coping with uncertainty in complex situations and the importance of what they could achieve by effective collaboration.

In research conducted by Deniaud et al. (2015), a decision-making process concentrating on risk is proposed. According to them, in the preparation phase of projects in collaborative networks, decision-making is highly complicated. Owing to the fact that each potential choice creates different planning with a different cost, time, and level of risk. Hence, the authors presented an approach to model and assess the level of risk, time, and cost of each choice. This supporting approach is based on a decision tree to help collaborative network formation.

2.3.2 Risk management solutions and suggestions


In a research work published by Mihic et al. (2018), energy innovation projects have been studied to investigate their complexity elements to eventually come up with strategies to reduce the innovation risk in projects of such type. The results which were driven from data gathered by a questionnaire filled by 100 participants, propose a handful of practical suggestions for project managers among which, we can name 1) being open to creative methods, 2) revision of team selection criteria (since the relationship of team members significantly affect the project success). A proper team selection strategy would ensure the quality of communication, knowledge sharing, and knowledge transfer.

Authors in Z. Xu et al. (2014) have proposed an integrated risk and cost assessment model for research and development projects of complex systems. They have integrated Graphical Evaluation Review Technique (GERT), Mont Carlo simulation, and probability distribution theory. Moreover, statistical analysis methods and regression analysis have been used to analyze the outputs of the simulation. Their results showed that cost combination in risk assessment scheduling can offer more reliable risk estimation results.

Firmenich (2017) has mentioned the downside of the academic approach to the practical issues of risk management. As stated in the article, the majority of the literature have adopted complex solutions such as artificial neural network (Jin, 2010; Jin et al., 2011), fuzzy logic (Okudan et al., 2020; Yun et al., 2008), Bayesian network (Nai-ping et al., 2013) etc, for risk management without considering their efficiency in the practical phase. However, these solutions can not be adopted if the project players lack enough competency in risk management. Thus, the author has mentioned that easier solutions considering individual competency and the risks of rational decision makings in the project risk management process are yet to be proposed. The article categorizes the principal threats in the following three categories:

- **Opportunism:** each project partner may possess latent interests which are not in line with the project objectives (Flyvbjerg et al., 2003).
- **Bounded Rationality:** project partners may make cognitive mistakes during risk estimation (Bazerman et al., 2013).
- **Subjectivity:** expert project risk estimators are defined with different characters which are formed based on factors such as their individual experiences, values, and their perception of risk (Parkin, 1996).

In conclusion, many of the theoretical risk management methods are not efficient unless they are capable of answering the following two questions: 1) which competencies are required and how they can be developed. 2) how these methods can maintain their efficiency taking into account their costly implementation.

 #2-Highlights based on the state of the art

With respect to the above arguments some of the highlights of state of the art are as follows:

- The importance of risk management is increasing due to the increasing number of complex projects.
- There are two types of risk in strategic alliances: relational risk and performance risk.
- Relational risk is unique to strategic alliances while performance risk can be defined in any project.
- These two types of risk have no direct effect on each other, but by decreasing each of them the total risk of the project will be decreased.
- Trust between partners is closely related to the relational risk.
- Many complex solutions have been proposed in academic literature to improve risk management in innovative complex projects. However, these solutions are hardly applicable if the project players lack enough competency in risk management.
- Collaboration efficiency and the quality of knowledge sharing are critical in managing the risk.
- Revision of the team selection is an effective way of ensuring the quality of the knowledge sharing.

2.4 Knowledge Management Concepts

According to the literature, there is no agreement on the definition of Knowledge Management (KM) (Huotari et al., 2004). Knowledge management is defined as a combination of information processing, information technology, and individual innovative abilities (Malhotra, 1997). Alavi et al. (2001) defined KM as a systematic method to organize, share, store and utilize knowledge to profit from competitive advantages. In research by Huotari et al. (2004), knowledge management relates to managing people, their knowledge, and their social interactions. Hence, knowledge management eases the successful implementation of duties, decision-making, information flow, and work culture of organizations.

Knowledge could be examined separately or as part of knowledge management. Seufert et al. (2003) described knowledge management as a means of managing knowledge to facilitate the “creation of entirely new knowledge, while also accelerating the innovation”. Three objectives have been defined for knowledge management projects as follows (Alavi et al., 2001; Davenport et al., 1998):

- to disclose the knowledge and illustrate the role of knowledge in a project;
- to improve a knowledge-centralized culture by supporting and aggregating behaviors such as knowledge sharing, and dynamic searching and offering knowledge;
- to build a knowledge infrastructure in order to provide a technical system, in addition, to a network of connections between individuals given space, time, tools, and encourage to communicate and collaborate.

2.4.1 Knowledge management in innovative complex project

Innovation is notably related to the availability of knowledge and hence the complexity generated by the flow and reach of the knowledge has to be identified and managed to guarantee successful innovation. Knowledge management can help collaboration in innovative complex projects as a tool to develop innovation by providing the technological platforms and means to facilitate knowledge sharing. Accordingly, research in this domain may be highly valuable, especially in projects that have well-defined knowledge management and innovation plans (Du Plessis, 2007). Cowan et al. (2001) emphasized the fact that the characteristics of knowledge possessors and knowledge receivers are very relevant for the process of knowledge transfer.

In K. B. Wilson et al. (2018) a study has been done to relate crowd-sourcing, project management, and operation management. This study showed the efficiency of crowd-sourcing as open innovation in the field of complex project management. The study is based on five different Australian and American companies involved in crowd-sourcing. Results showed that companies applying a sort of crowd-sourcing, ensure a more flexible, efficient, and low-risk performance. This research work suggested crowd-sourcing as a new method to increase project success through innovation. From the operation management point of view, crowd-sourcing offers flexibility, smoothness, dynamics, and scale-ability.

Blindenbach-Driessen et al. (2006) studied knowledge management in different types of organizations, such as project-based organizations. Project-based organizations including engineering, construction, consultants, and service organizations that only manage projects for their clients. The authors focused on innovative service development projects in these organizations. Based on their study on six projects in four different organizations, they developed hypotheses on differences between the success factors of innovative projects in project-based organizations and organized companies. According to their result, some success factors for the project performance in organized companies, seem more important in project-based organizations, others seem surplus. Therefore, they concluded that the success factors in an innovative project have a lot to do with the specific structure and capabilities of the organization that manages it.


2.4.2 Knowledge management solutions and suggestions

Sunardi et al. (2015) proposed a conceptual model to understand a way to select human capital characteristics (i.e. experience, skills, and educational background) that contribute to the knowledge sharing flow in informal communication among partners. This conceptual model considers the presence of norms of mutuality, mutual trust, and cultural understanding aspect. They have indicated that in the existence of mutual trust, an individual’s experience

can be employed to enhance the quality of knowledge shared in informal knowledge sharing. Also, when mutual trust develops, norms of mutuality also increase, and both develop more beneficial informal interactions.

Considering the resource-based view and the knowledge-based view of organizations, S. K. Singh et al. (2021) investigated the precursors and consequences of open innovation in small and medium-sized enterprises (SMEs). They have collected data from more than 400 SMEs and employed structural equation modeling to test the hypotheses. Based on their findings, they have concluded that top management knowledge value affects knowledge sharing among project players, knowledge-sharing manners affect open innovation, and open innovation itself affects organizational achievement.

The research conducted by Yeong et al. (2010), improvement of project success in collaboration by combining knowledge management strategies with project management disciplines in a project life cycle is studied. It is essential to know how knowledge could be generated through projects and how the knowledge is transferred to other project members in the form of knowledge. They have concluded that continuous feedback, alignment of knowledge, and knowledge sharing are critical for project success. Also, common factors such as culture, method, and technology influence both knowledge management and project management.

 **#3-Highlights based on the state of the art**

With respect to the above arguments some of the highlights of state of the art are as follows:

- Knowledge management can help projects as a tool to develop innovation by providing the technological platforms and means to facilitate knowledge sharing.
- Existence of mutual trust can provide a platform for more effective knowledge management.
- Effective knowledge management increases project success through alignment of knowledge and knowledge sharing.
- Knowledge transfer is also related to the characteristics of the holder and receiver of the knowledge.

2.5 Risk management VS knowledge management

It is critical to note that risk management and knowledge management share many of the same objectives. These objectives contain supporting organizational action, sharing knowledge, and improving risk-based decision-making. A fundamental goal of knowledge management is to present the “right” available information, to the right person, at the right moment, to make the right decision. Hence, there is a link between knowledge management and risk management through the decision-making process (Lipa et al., 2020).

According to Cerezo-Narváez et al. (2021) knowledge management contains learning from past experiences to prevent and modify scope misalignment, the deviation for quality, safety problems, delay in time, or cost overdue. Knowledge management is usually defined as planning for risk management as it enables the prediction, prevention, and reduction of potential problems. However, knowledge management and risk management while being complementary, are nonidentical and serve different purposes. In the early fourth industrial revolution management of complex projects combines many challenges related to knowledge management. For example, the requirement of merging of variant knowledge and information

sources as well as merging most recent technological innovation. In this situation simplifying project management could be an asset to the projects. Although knowledge management is considered to be a pre-requirement of risk management, unfortunately, this relationship has remained covered in project management vocabulary. In this research article, a comprehensive model has been introduced for ship manufacturing companies relating knowledge management to risk management. This model takes into account organizational factors, technological platforms, and competitive factors. The authors have proved the efficiency of their method using offshore platform data.

2.5.1 Knowledge management applied to managing risk

In many progressive organizations knowledge management procedures, techniques and tools are being applied to perform risk management. The integration of knowledge and risk management, given the global importance of risk management, is greatly demanded in managing complex projects. According to Neef (2005), some of the important techniques in knowledge management that decrease risk in collaborative projects are indicated as follows:

- **Knowledge mapping:** refers to a process in which project managers determine “who knows what knowledge” in the collaboration. Partners’ special knowledge and project experience are listed in a database to make it available for project knowledge management.
- **Communities of practice:** refers to communities that naturally forms a network of partners who have similar concern or experience, or sometimes complementarity skills, to gather together in order to brainstorm on common issues.
- **Learning:** refers to one of the most important principles of knowledge management. Partners should share their knowledge, experience, and techniques with each other in the project in order to have a dynamic knowledge-sharing process that leads to learning.
- **Encouraging a knowledge-sharing culture:** refers to this concept that values and expectations for moral behavior are needed to be discussed broadly and effectively all over the collaboration life-cycle. This would be properly achieved as part of a knowledge-sharing formal process so that partners at all levels of projects comprehend the value of good communication.


Lauria et al. (2014) demonstrated how risk management in an organization can be developed by investment in knowledge management. They have found empirical evidence from more than 50 electric holding companies that support their theoretical proposition of the role of investment in knowledge management as a mediator of risk which affects the reduction of organizational risk.

Durst et al. (2019) conducted a comprehensive literature review of knowledge risks at the organizational level in order to establish a better understanding of knowledge management. They concluded that potential risks in knowledge can be categorized into three groups: (1) human knowledge risks, (2) operational knowledge risks, and (3) technological knowledge risks. The proposed classification emphasizes the importance of avoiding having a separate view of knowledge risk but an integrated view of all types of knowledge risk in organizations.

Rodriguez et al. (2015) investigated probable relationships between knowledge management variables related to knowledge sharing, and risk management concepts: quality of risk control and value of risk management. Knowledge variables such as people, processes, and technology are considered in their research. They have gathered data by a survey from financial institutes.

Their results have shown that better knowledge management is correlated with better risk control.

According to a comprehensive literature review on understanding the relationship between risk and knowledge management conducted by Haltiwanger et al. (2010), there is a strong relationship between risk management and knowledge management. Risk management policies have been effectively used to improve knowledge management. Moreover, knowledge management has been used as a method to improve risk management approaches. Besides, evidence exists that applications of these two can be integrated into many ways to achieve a more integrative view.

 **#4-Highlights based on the state of the art**

With respect to the above arguments some of the highlights of state of the art are as follows:

- Risk management and knowledge management share many of the same objectives.
- Knowledge management is usually defined as planning for risk management as it enables the prediction, prevention, and reduction of potential problems.
- Risk management in an organization can be developed by investment in knowledge management.
- Effective knowledge sharing can help both risk management and knowledge management.

2.6 Role of collaboration in success of innovative complex project

Collaborating on networks is critical to maintaining a competitive advantage in enhancing a dynamic industrial environment so that researchers have recommended that other industrial organizations compete not as individual businesses but now as part of industrial collectives (Durugbo, 2016). Moreover, collaboration is increasingly seen as a preferable form of performing complex projects involving many partners, suppliers, and customers (Chakkol et al., 2018).

Piranfar (2009) indicated that, unlike dominant public opinion, innovation is an outcome of well-planned projects. Innovation may happen in a single project, however, most often it is a part of a portfolio of projects which introduces new dimensions to risk management. These new dimensions would divide risk management into three different domains which are namely, (1) single project, (2) portfolio of projects, (3) project shared by a business.

It is trivial that the success of complex projects would require the alignment of more than one organization. Although we can accept the fact that projects might be the initial motivation for companies to form an alliance, however, due to the facts such as the progressive increase of business complexity in today's world, technology, and more generally economical issues of a company may encourage them to cooperate. Thus in this case, the role of the project is only a means to ease this regrouping process of companies.

Moreover, risk management has a tight relationship with innovation management. The risk of innovation in projects that conduct by more than one partner as a strategic alliance is well-known. However, this risk is not equally distributed between partners. For instance, in the pharmaceutical industry, let's imagine a giant pharma forming an alliance with a

biotech startup over the production of new medicine. In this case, the pharma will provide the budget of the project while the bio-tech startup contributes to the innovation part of the project. A potential failure of this project would result in gaining new experience along with a negligible financial loss from the pharma perspective. But this situation may lead to a complete bankruptcy of the poor biotech startup. This is one in thousands of examples of unfair share of risk in strategic alliances.

Cowan et al. (2009) indicated that academic studies of complementarity of knowledge have made the persuasive argument that organizations' knowledge assets, and how they fit in alliances, affect the success of strategic alliances. Practical studies of the formation of strategic alliances, while recognizing the importance of knowledge complementarities, have generally had challenges involving them directly into statistical analyses of partner selection. They have also proposed a model that shows organizations must have a specific degree of similarity in their knowledge to achieve success in a strategic alliance.

Fernandez et al. (2018) has focused on structures of projects defined as strategic collaboration for innovative mutual objectives. In this work, efforts have been conducted to find an answer to the following question: strategic collaboration is suitable for which kind of projects. The results showed that strategic collaboration is suitable for projects possessing the three following characteristics of being costly, high risk, and containing innovative objectives. These types of collaborations allow the collaborators to not only develop their innovation potential by sharing resources and knowledge but also to manage the risk of failure together. On the other hand, for low-risk and low-cost projects with the aim of having incremental innovation, other project structures such as a Separated Project Team (SPT) can be wielded. The authors have used the data of the projects of Airbus and Thales companies to examine their theory. Based on 34 interviews with high authorities, they have proved that to reach radical innovation in high-risk and costly projects, strategic collaboration is indispensable. However, to reach incremental innovation which demands less knowledge sharing, SPT is self-sufficient in ensuring the project objectives.

Deniaud et al. (2016) have also underlined the importance of the collaborative network of success in new product development projects. Authors claimed that different innovation levels in these projects are related to the selected partners of the project. They also pointed that partner selection affects uncertainty and project risk. Project risk evaluation is difficult in a newborn collaborative network.

In nowadays business ecosystem, it is often said that an organization needs innovation to achieve sustainable competitive privilege in a way to satisfy the complex requirements of the market while offering products, services, and solutions (Nunes et al., 2020). It is evident that organizations do not always possess the required resources (technological, knowledge, etc.) to adapt themselves to constantly evolving market requirements. Organizations usually engage in collaborative network models to overcome these limits. This collaboration can take place with industrial partners, state institutions, universities, and development centers. Nevertheless, it is usually noted that the lack of models supporting these collaborations is a bottleneck for these organizations. Thus, the authors have suggested a heuristic model support management in collaborative networks.

In this algorithm four different aspects of collaborations have been surveyed which are namely organizational communication degree, organizational control degree, project data dependency degree, and response preparedness degree. The algorithm is capable to predict the success probability of the project taking into account important project success factors. The algorithm takes data-driven from project meetings and reciprocated emails among partners as input.

In a research work conducted by Rosas et al. (2015) surveying open innovation as an effective strategy for achieving the goals of complex projects, it has been pointed out that one of the main failure reasons in open innovation is the dynamics of collaboration between partners.

Failure Mode Effects Analysis (FMEA) has been used as a risk analysis method in their study.

2.6.1 Strategic alliances and models of collaboration

Partnership and collaboration between independent organizations are fundamental issues in many fields, including social sciences, communications, computer science, physics, and even biology and ecosystem (Dorogovtsev et al., 2013). A large variety of partnership's forms has emerged depending on the nature of the relationship between partners as well as their collaboration strategy, for instance, Collaborative Network (CN), Virtual Organization (VO), Virtual Breeding Environment (VBE), Supply Chain Network (SCN), strategic alliance, partnership, collaborative project, and so on.

It is no surprise then that research on collaborations has been very broad-based in different scientific disciplines. The web of science counts around 9000 papers that contain the expression “Strategic Alliances”, “Collaborative Networks” and “Virtual Organizations” in the title, abstract, or keywords provided by authors over the period 1995 to 2019 (<http://www.webofknowledge.com>). Figure 2.4 shows the publication trend for each keyword per year and also the increasing trend in the total number of papers that were published each year.

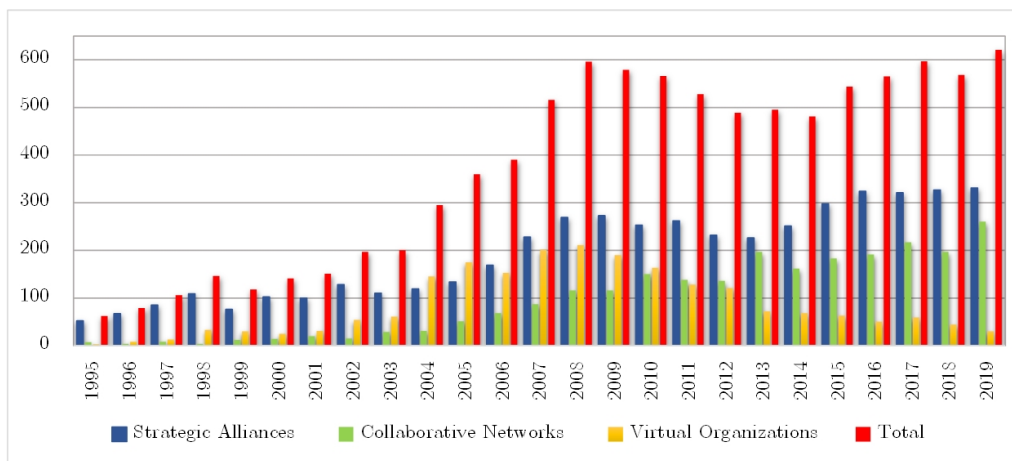


Figure 2.4 – Publication number per year based on searching “Strategic Alliances”, “Collaborative Networks” and “Virtual Organizations” as a topic phrase in the Web of Science

A state-of-the-art analysis of collaborative networks for service-based innovation ecosystems has been developed by WP2.5 of the MSEE project (Manufacturing Services Ecosystem) (Loichate, 2012). More than producing a synthetic definition of collaborative networks this study focuses on the collection, comparison, and evaluation of all types of collaborative networks and their applicability in manufacturing ecosystems.

Ben Salah et al. (2018) presented a synthetic description of collaboration forms following several other works especially those of (L. M. Camarinha-Matos et al., 2005; L. M. Camarinha-Matos et al., 2009a; L. M. Camarinha-Matos et al., 2009b; Ferrada et al., 2019) who have largely studied the concept of virtual enterprise and collaborative networks since 1998. Based on these works, most researchers have studied the need for developing collaborative networks according to IT perspectives and the effects on the performance of firms in various industry sectors, such as the chemical industry and manufacturing industry.

Other researchers have conducted works on the same field but from different aspects and perspectives such as alliance or network in construction companies (Haghbin et al., 2014),

collaborative project management (Shevtshenko et al., 2015), sustainable collaborative networks (L. M. Camarinha-Matos et al., 2010b; L. M. Camarinha-Matos et al., 2012), green virtual breeding environment (Romero et al., 2011), product-service system engineering (Elhabib et al., 2010), and manufacturing industries (Kohl et al., 2015).

For example, the expression “strategic alliance” refers to a variety of (usually formalized) inter-firm partnerships (Osborn et al., 1997) in which partner firms share resources to achieve predetermined objectives while maintaining independence. Compared to integration through acquisitions and mergers, firms engaged in strategic alliances receive several advantages: expanding customer base; networking opportunities; higher levels of innovation; increasing the chance of survival, learning, and training, higher returns on equity/ investment among others (Haghbin et al., 2014; Todeva et al., 2005). It is confirmed that owing to the cross-disciplinary essence of collaboration, there is no consensus on the use of terms such as “partnership”, “alliance” and “network” (Durugbo, 2016). Nevertheless, for this thesis, the strategy was mostly centered on investigating empirical and theoretical research on strategic alliances and identifying possibilities for future strategic alliances research. A strategic alliance includes at least two partners that (Todeva et al., 2005):

- stay legally independent after the strategic alliance is formed;
- share managerial power over the performance of specified tasks as long as benefits;
- make ongoing contributions in one or more strategic areas (i.e. technology, products or services)



#5-Highlights based on the state of the art

With respect to the above arguments some of the highlights of state of the art are as follows:

- Collaboration is increasingly seen as a preferable form of performing complex projects involving many partners, suppliers, and customers
- Risk is not equally distributed between partners.
- Collaborations allow the collaborators to not only develop their innovation potential by sharing resources and knowledge but also to manage the risk of failure together.
- Different innovation levels in these projects are related to the selected partners of the project.
- Complementarity of knowledge affects the success in strategic alliances. However, it is challenging to consider it in partner selection.

2.7 Conclusion

The main objective of this chapter is to review the academic progress in topics related to the innovative complex projects, to provide a general overview of this topic. The authors and researchers cited in this chapter present persuasive reasoning that increasing innovative complex project is inevitable due to the need for economic growth all over the world. Moreover, uncertainty and risk are inevitable when it comes to complex projects, and risk is an inseparable part of innovation. Therefore, achieving success in such projects is

associated with more challenges. The literature review outcomes of this chapter show that various solutions are suggested to reduce risk and enhance the success of complex projects. Nevertheless, the complication of this issue has led to many complex projects still failing. Hence, studies in this field have received much attention.

The majority of the research in this field highlights the necessity of collaborations and strategic alliances to manage complex projects and achieve innovation. These alliances allow partners to share their knowledge as well as deal with challenges mutually. However, in strategic alliances, relational risk also appears beside the performance risk which already exists in any project. Hence, considering the benefits of strategic alliances, decreasing the relational risk allow partners to benefit more from the alliance. It can be accomplished by reconsidering the partner selection methodology and improving mutual trust. One of the major benefits of mutual trust is improving the quality of knowledge sharing and innovation potential.

Furthermore, it is also remarked that risk management might not be possible if there is no effective knowledge management in the project life cycle. Additionally, innovation is prominently associated with the availability of knowledge, so the challenges in the flow and achievement of the right knowledge at the right time need to be identified and effectively managed to ensure the success of projects.

In conclusion, as discussed in this chapter, considering the critical role of partners, available knowledge, and their mutual trust in the performance of innovative complex projects, the rest of this thesis will focus on decreasing the risk of failure in collaboration through identifying the position of trust in the success of innovative projects and the factors influencing it. The main objective is to propose an approach to select partners who can build mutual trust and effectively share knowledge.

II

Second part—A proposed hypothesized conceptual model

Purpose: The most appealing concept in the project management literature is “success”. However, achieving this success in projects comes with many challenges. Particularly in innovative complex projects managed with strategic alliances. Because in addition to the challenges and inherent uncertainties of the project, the risk of non-cooperation between the partners is inevitable. The purpose of this part is, first, to take a deeper look at research into the success of complex projects, focusing on the relationships between project partners and the flow of knowledge between them, in order to identify some of the factors influencing the success of complex projects. Then, by considering these factors, we examine their effectiveness in real projects. Finally, we try to provide suggestions for less experienced project managers and decision-makers to increase the chance of success in strategic alliances.

Design/methodology/approach: in the first chapter of this part, a literature review on the project success and its common related factors have been applied to propose a conceptual model based on several hypotheses. Then a standard survey is designed and used to gather data from European project managers involved in complex projects with more than one partner. Finally, PLS-SEM is used to analyze the data and investigate the relationship between different variables in the proposed conceptual model. In the second chapter of this part, a literature review is performed about the role of work experience in the success of projects. Then, another part of the gathered data is used to perform Spearman’s correlation coefficient analysis to investigate, first, the role of project managers’ work experience on the project success, and second, the role of project managers’ work experience on their perception of project success factors.

Findings: our research provides a conceptual model to investigate the influence of different factors on project success. Based on the analysis of the first chapter of this part, evidence is provided for the fact that if a project is more innovative then it is more successful. Second, this study confirms the positive role of coverage of knowledge (required for the project) in the success of complex projects. Furthermore, relational trust has a significant positive effect on project innovation. Moreover, the proof is also provided for the fact that if a project is more technically complex by its nature, and organizationally complex in terms of diversity of staff and information systems then it is correlated with more innovativeness. Regarding the knowledge criteria, the effects of similarity and complementarity on the relational trust, and complementarity on competence-based trust are significantly positive. Besides, the findings have also shown that the trust capability of each project player has a significant positive impact on relational trust and competence-based trust between partners. In the second chapter of this part, the result of our analysis proves that the projects that were managed by more experienced managers were more successful. Moreover, the result of this analysis shows that increasing the work experience of project managers affects their judgment by increasing the importance level of meeting organizational objectives, team satisfaction, and stakeholders satisfaction in the success of projects. Besides, the result of this analysis shows that more experienced project managers value more for coverage of knowledge in projects and trust between partners. Finally, it is proven that more experienced project managers have more inclined to work with partners who are honest and trustworthy, have a good reputation and qualification in their domain.

Originality/value: our research in this part focuses on proposing a novel conceptual model for project success with several contributions. First of all, a new classification for knowledge criteria (similarity, complementarity, and coverage) is considered. Secondly, we propose a third aspect to the complexity of projects named “Social Complexity”, to analyze if there are any significant differences between organizational complexity and social complexity. Moreover, the trust capability of project players has been considered to evaluate its moderation role in the proposed model. Additionally, in the second chapter of this part, project managers’ work experience is considered as a variable to investigate changing their opinion about the importance of project success factors. The effort in this part is to take a look at the success factors of the project and make recommendations to project decision-makers to enhance the chances of success of complex projects.

Research implications: several practical implications are extracted from this part of the thesis. First of all, the findings of this part prove that in complex projects, innovation increases project success. Hence, project managers are encouraged to support innovative ideas, new management methods, and changes in organizational operations and production as much as innovation in the final product or service. In addition, the significant positive direct effect of coverage of knowledge in a partnership on the success of the project is verified in the first chapter of this part. Therefore, According to this finding, it is recommended that the selection of partners for complex projects be such that it covers all the knowledge necessary to complete the project. Moreover, Considering the positive effect of relational trust on innovation, we invite decision-makers in innovative complex projects to invest in increasing relational trust between partners in the partnership. This trust can be increased by increasing the similarity of knowledge between partners. Furthermore, based on the result of the second chapter of this part, we encourage less experienced project managers to invest in the satisfaction of the team member and stakeholders as well as the organizational objectives of the project. Then, we suggest the decision-makers who choose the partners at the beginning of the project to pay attention to the coverage of knowledge that they can provide with the selected partnership, and also good reputation, qualification, and honesty of the partners. Finally, we suggest that decision-makers consider the fact that experienced project managers are less willing to work with companies with different organizational processes, legal systems, and hours of operation, and should consider this if they choose these kinds of partners to be aware that they are taking more risks.

3

Conceptual model and analysis

3.1	Introduction	29
3.2	Theoretical background and research hypotheses	31
3.2.1	Project success	31
3.2.2	Project innovation	32
3.2.3	Innovation and complex project success	33
3.2.4	Project complexity and innovation	33
3.2.5	Trust and innovation	35
3.2.6	Knowledge criteria and trust	36
3.2.7	A moderator called trust capability	37
3.3	Research methodology	42
3.3.1	Survey design	42
3.3.2	Sampling and data collection	42
3.3.3	Analytical methods	43
3.4	Data analysis	43
3.4.1	Data screening and pre-analysis	43
3.4.2	Common-method variance bias test	46
3.4.3	Reliability and validity of the data	47
3.4.4	Analysis of measurement model	47
3.4.5	Analysis of formative measurement model	50
3.4.6	Analysis of conceptual model	50
3.4.7	Moderator effect - Trust Capability of respondents	54
3.4.8	Importance-Performance Map Analysis (IPMA)	54
3.4.9	Multi-group analysis (MGA)	60
3.5	Conclusion and discussion	64
3.5.1	Implications for practice	65
3.5.2	Limitation and future research direction	66

“I hadn’t been aware that there were doors closed to me until I started knocking on them.”

Gertrude B. Elion

3.1 Introduction

Due to current globalization and competitive pressures, it is becoming more and more critical to innovate to keep customers satisfied. Pursuing innovative projects is one of the ways that firms choose to develop new products and services (Porter, 1998).

Whether or not a project results in significant innovation is closely related to the knowledge involved, and integration of different types of knowledge affects innovation performance (Rundquist, 2012). Hence, there is also growing attention to the relationships between a firm's innovativeness and its knowledge, skills, and competencies. For instance, Robertson et al. (2021) studied the effect of four variables, namely knowledge creation, knowledge diffusion, knowledge absorption, and knowledge impact on innovation performance in developed and developing market economies. Among all four variables, knowledge creation had the highest effect on innovation performance. Islam et al. (2021) proposed a model to analyze the role of tacit and explicit knowledge on the innovation of developing-country suppliers in value chains. Their result indicated that both tacit and explicit knowledge contributes to innovation. Freel (2005) has demonstrated empirically that there is a strong relationship between a firm's characteristics (firm size, age, financial and technological skills) and its innovativeness.

When products, processes, and innovative projects become complex, firms struggle to innovate autonomously. Problems often arise because a firm's own internal knowledge and competence are not enough to produce relevant technological discovery or the new knowledge needed to generate novelty (Fleming, 2001). Therefore, firms look to partnerships to manage complex innovative projects (Belderbos et al., 2004; Cowan et al., 2008; Drejer et al., 2005). Partnership in projects permits firms to share different types of knowledge as a means of reaching a set of common objectives while at the same time maintaining the independence of each firm (W. Chen et al., 2019; Chung et al., 2000).

Although many scholars discussed the bright side of the partnerships, it should be noted that more than 60% of partnerships fail (Bruner et al., 1998). It is claimed that an average of 25% of complex projects in the construction field is successful, but less than 1% of them are finished on time, on budget, and with predefined benefits (Flyvbjerg, 2014). While it is acknowledged that failure seems to be an inseparable part of partnerships, studying the reasons behind the poor performance of partnerships is vital to increase the success rate (Rosas et al., 2017). One of the most common factors behind these failures is the lack of trust between partners, which leads to a lack of knowledge sharing (T. K. Das et al., 1998; T. Das et al., 2001; Maurer, 2010).

Park et al. (2014) investigated the role of trust and dependency in sharing knowledge, concluding that collaborators share their knowledge when they trust each other and feel dependent. They also found that feelings of trust are affected by the frequency of communication, the similarity in the value placed on the projects by the partners, and also their similarities in competencies. There is a strong relationship between knowledge sharing and mutual trust in information systems that develop collaboration between partners to attain their objectives (Q. Xu et al., 2008). Although there is a growing interest in partnerships and a fair number of scholars have studied in this domain, considering the extent of the topic, there is still a large space for research. To address the gaps we identified in the literature, this chapter is focused on proposing new aspects of knowledge and complexity, and investigating the relationships between knowledge, trust, and project complexity with the innovativeness of a partnership and complex project success in a model. Hence, we present a conceptual model based on several hypotheses to analyze the role of knowledge in trust, the effect of trust and complexity on project innovation, and also the effect of innovation and coverage of knowledge on complex project success.

For the purpose of analyzing the conceptual model presented in this chapter, many analyses are performed. First, we analyze the conceptual model to assess the hypotheses behind it. Then, to investigate the role of trust capability of project managers on their evaluation of the project and partnerships, the moderating role of trust capability is studied. Moreover, to have a better understanding of managerial insight of the conceptual model, both the importance and performance of the defined factors in the conceptual model is analyzed. Finally, the conceptual model is assessed based on different data groups to check the comprehensiveness of the presented model and its result.

The remaining sections of this chapter are organized as follows: [Section 3.2](#) presents the relevant literature and research hypotheses. [Section 3.3](#) provides the research design which includes survey design, data collection and data analysis methodology. [Section 3.4](#) demonstrates results and credibility of hypotheses. The chapter ends with conclusion in [Section 3.5](#).

3.2 Theoretical background and research hypotheses

3.2.1 Project success

Alongside countless studies on the cause of failures in projects, many researchers have focused on determining project success factors. Measuring project success is complicated and challenging. In traditional project management, the fundamental factors to evaluate project success were restricted to the iron triangle with cost, time, and quality on its sides (Atkinson, 1999). In recent decades the project management has turned to a wider domain because of an increasing number of involved firms and project functionality at the national or international level. Accordingly, researchers started to argue that measuring project success is a multi-dimensional subject. If we only consider the iron triangle, we are just focusing on the tangible dimensions of the final result of each project. However, project management development indicates that new models for measuring project performance should also bring up the quality of the process as well as the quality of final results (Ahmed et al., 2016; De Wit, 1988; Todorović et al., 2015; Van Der Westhuizen et al., 2005).

According to a comprehensive study by Baccarini (1999); cost, time, and quality factors in the iron triangle which is objective and tangible can be considered as “hard” dimension, and there are also “soft” dimensions which are subjective, intangible, and hard to evaluate, like project reputation and beneficiaries satisfaction. Customer satisfaction, stakeholder satisfaction, project reputation in its domain, and lots of other factors have been introduced by recent researchers as the critical role of human factors in project performance (Gunduz et al., 2018; Unterhitzberger et al., 2019).

Since this chapter is focused on complex projects and different partners involved, in order to accomplish a better measurement of project performance, the model previously used by Khan et al. (2013) and Wang et al. (2019) is selected. This model is mostly based on a literature review on project success factors over recent years. Based on this selected model in order to measure project success not only it is important that all the objectives of the project are accomplished with respecting the allocated budget on time, but also it is important to have team members and stakeholders satisfied as well as a good reputation of the project in its domain. Figure 3.1 is the schematic view of the selected model.



Figure 3.1 – Selected model for measuring project success

3.2.2 Project innovation

A comprehensive review of collaborative organization indicates that “creativity” and “innovation” are sometimes used interchangeably. While creativity is seen mostly in the field of behavioral science, innovation is closer to management and economics (Sousa et al., 2012). Charyton (2015) defined creativity as a vehicle for innovation in engineering. Further, creativity has been defined as a part of an organization’s innovation capability, by measuring the ability to create new solutions (Manual, 2018). This chapter is focused on innovation in projects conducted with partnerships.

The classification of innovation type and finding a model to evaluate a firm’s innovativeness has received considerable attention. One of the early models of innovation dimensions was that proposed by Knight (1967) and used later in different research as innovation measuring model such as (Aragón-Correa et al., 2007; Jimenez-Jimenez et al., 2011; Rowley et al., 2011). He proposed that there are four different dimensions of innovation:

- *Product or service innovation*: depending on the field of activity of an organization, it refers to the novelty in products or services which are provided.
- *Production-process innovation*: concerning changes in organizational operations and production, it originates largely in technological improvements.
- *Organizational structure innovation*: relating to innovations in the organization’s management systems, communication relations, or formal reward systems.
- *People innovation*: referring to changes of people (employees) within an organization, including changes in employees’ levels, managers, job functions, cultures, and human behaviors.

Other studies of innovation types had a binary focus (pairwise) such as product/process, administrative/technical (Damanpour et al., 1984) and radical/incremental ¹ (Dewar et al., 1986). One of the potential challenges in the identification of dimensions of innovation occurs from the reality that innovation is not isolated, and one dimension of innovation is probably to be associated with other dimensions of innovation. Moreover, process/product innovation and administrative/technical innovation can be included in the four dimensions of Knight (1967) model, and radical/incremental innovation can be considered as attributes to innovation rather than dimensions of innovation (Rowley et al., 2011). Hence for this chapter, we use the four dimensions of innovation to measure project innovation. The selected typology is presented in Figure 3.2:

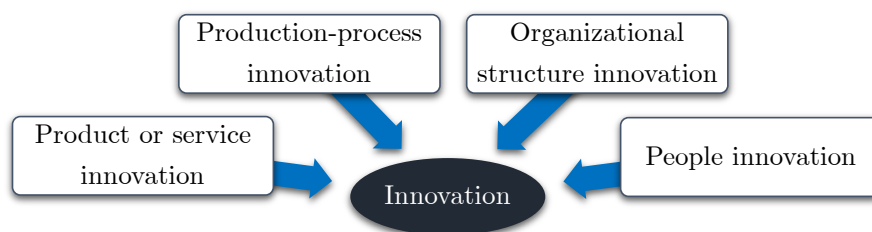


Figure 3.2 – Selected model for measuring innovation

¹Radical innovation is a fundamental change while incremental innovation is an add-on to a previous innovation

3.2.3 Innovation and complex project success

According to Schumpeter's idea, innovation is mostly the result of recombination in existing knowledge. Therefore, it can be concluded that if firms expand their access to various information and knowledge, they will increase their innovation potential. Furthermore, there is a potential relationship between innovation and success in the academic literature. Innovative business models especially customer-centered models are making customer-supplier relationships more dynamic, and with an increase in customer satisfaction, it guarantees more profits (Trimi et al., 2012). Moreover, investing in research and development, employee training, and education have proven to foster innovation potential in the construction industry in New Zealand and Australia, and also raise productivity in their projects (Chancellor et al., 2015).

Studying innovation and knowledge management in complex offshore construction projects demonstrated the affirmative effects of innovative solutions in project success by integrating firms with various objectives and knowledge domain (Barlow, 2000). Benitez-Avila et al. (2018) proposed a conceptual model of contractual and relational governance. They have gathered data with a survey from public-private partnerships in The Netherlands. Their results showed significant improvement in project performance when partners are trusting each other.

Davies et al. (2005) studied dynamic innovation in complex products and systems. After analyzing partnerships between suppliers and customers, it is indicated that system integration is a strong competitive advantage in complex systems. Practical research showed a positive effect of co-innovation in complex challenges by applying an innovative approach to five research projects. Their result confirmed that innovation leads to improvement in some cases, especially in complex problems (Vereijssen et al., 2017). Considering the logical relationship between innovation and success in complex projects derived from the aforementioned studies, this chapter proposes the following hypothesis:

Hypothesis 1. Project innovation has a positive effect on complex project success.

3.2.4 Project complexity and innovation

One of the challenges in studying the subject of project complexity is its breadth and variety in the application. Project complexity is mostly considered as a factor involved with two critical project aspects including project challenges and uncertainties. The most common classification for complexity in project management research involves both technological and organizational complexity. Technological complexity refers to the complexity of transformation procedures, which transform inputs into outputs. Organizational complexity deals with interdependent operations and interactions between elements involved (such as the number of structural levels, units, groups, departments, division of tasks, etc.) (Baccarini, 1996).

Both types of complexity can be measured along four dimensions: size, variety, interdependency, and elements of context (Vidal et al., 2008). As it is mentioned, the degree of interaction between elements involved is changing the degree of organizational complexity. In the factors presented by Vidal et al. (2008), elements related to the different legal systems and geographical distance are a part of organizational complexity factors. However, the author of this chapter proposes to differentiate between organizational complexity which comes from the collaboration of firms with more similarity in culture, geography, and legal systems (i.e. national projects), and collaboration of firms with the different legal systems, culture and geographical distance (i.e. international projects). In this research, we propose to define a third aspect to complexity named "Social Complexity", to analyze if there is any significant difference between organizational complexity and social complexity. Social complexity refers to the variety and diversity of the different legal systems and institutional configurations involved in the project. To measure complexity in this research, three terms

of complexity have been measured considering these four dimensions. Figure 3.3 and Figure 3.4 show a schematic view of project complexity dimensions and measuring factors.

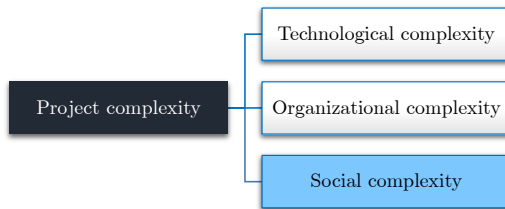


Figure 3.3 – Complexity classification

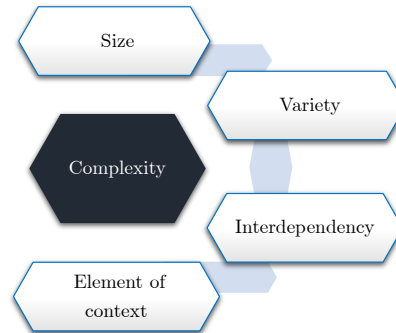


Figure 3.4 – Complexity dimensions

Technological complexity can be defined as a product and process complexity that is directly associated with the nature of the project (level of resources and technological skills needed as well as the level of demand for creativity) (Chapman et al., 2004). Moreover, the degree of technological innovation and demand for creativity are two elements of context in technological complexity (Vidal et al., 2008).

Projects involving more technological complexity are harder to manage, and accordingly, innovation is comparatively harder to understand, achieve, and use. In addition, project innovation seems necessary when a project is technologically complex and associated with a diversity of expertise, knowledge, and resources, especially in technological improvement (Rowley et al., 2011). The effects of technological complexity on innovation performance are studied by Yayavaram et al. (2015). They conclude that high domain complexity can significantly moderate the effect of knowledge on innovation performance. Frenken (2006) indicated that models with more complex interactions mostly contribute to more innovation. Based on these arguments, it can be concluded that the more complexity in the nature of the project’s final output as a product or service requires more creativity and innovativeness. The current chapter is looking at the relationship between project technological complexity and innovativeness, the following hypothesis is proposed:

Hypothesis 2. Projects that are - by their nature - technologically complex are associated with a larger amount of innovation.

The relationship between organizational complexity on innovation has been debated differently by the related research. Project complexity in terms of the legal system is considered as a moderator in a structural model for relational governance since it can negatively affect the relationship between governance different elements. Relational norms, partners trust, and partners’ contribution are affected by this project complexity in this structural model (Benitez-Avila et al., 2018). Alsaad et al. (2017) suggested the complexity as an independent variable that affects perceived desirability. The cultural discrepancy negatively affects the knowledge sharing between partners (Sunardi et al., 2015). However, some research reported the positive effect of organizational complexity on innovation. For instance, Ewens et al. (2019) analyzed the relationship between organizational complexity and admission of participatory innovation with data that were collected from the German municipal government. Their result revealed that functional differentiation as a part of organizational complexity has positively affected the occurrence of participatory innovation. A meta-analysis on the organization size and innovation potential is done by (Camisón-Zornoza et al., 2004). The result confirmed that there is a significant positive correlation between the size of the firm and innovation.

Considering the aforementioned difference in the research regarding organizational complexity, and the new dimension (social complexity) that is proposed in this study, we propose to analyze it in two different aspects. Thus, the bigger the project is to evaluate, the higher the growth innovation can take place, but involving different legal systems would result in to decrease the innovativeness. Accordingly, the following hypotheses are proposed:

Hypothesis 3. Projects that are organizationally complex (in terms of the number of activities, size of the investment, diversity of staff, diversity of information system and etc.) are associated with a larger amount of innovation.

Hypothesis 4. Projects that are socially complex (in terms of the number of different legal systems involved, local environment complexity, etc.) are associated with a smaller amount of innovation.

3.2.5 Trust and innovation

Trust is a psychological condition of individual partners in the project partnership (Kadefors, 2004). One relevant fundamental question is whether to trust someone or something or not. A substantial criterion in trusting is the acceptance of taking risks or being vulnerable (L. C. Becker, 1996). Most of the studies of trust in the management literature are in the domain of inter-firm relationships, partnerships, and alliances. There are different classifications for trust dimensions in the literature. For instance, Ring (1996) proposed two types of trust — fragile and resilient trust. Fragile trust is trusting someone based on tangible facts, whereas resilient trust is more based on an understanding of goodwill. Authors in (Kadefors, 2004) and (Rousseau et al., 1998) suggested three types of trust — relational trust, calculus-based trust and institution-based trust. T. K. Das et al. (2001) and Wang et al. (2019) used classification for trust based on the ability to carry out the agreement, and on the intention to do as you agreed, called competence-based trust and relational trust respectively. Competence-based trust is based on some tangible information, it is possible to have it from the beginning of the collaboration, but relational trust increases or decreases after successful or unsuccessful collaborations. When it comes to trust, both expectations and actions seem to be important, so in this study, we are focusing on both relational trust and competence-based trust.

Relational trust refers to the belief that partners will act in a reliable manner while competence-based trust relates to taking rational choices about whether to trust someone or not. In this case, relational trust emerges when an individual believes that his partners will take the actions in reliable manners which are beneficial to him based on the successful collaboration. Competence-based trust appears not only because of the existence of motivation but also based on reliable information about the intentions and qualifications of others.

Using information and turning it into knowledge has been introduced as a source of the organization's orientation. Interactions and exchanges between partners are key factors in sharing knowledge and increasing innovation, especially in projects with multiple partners. Nicolaou et al. (2013) investigated the effect of information quality on relational trust and competence trust in electronic data exchange's performance. Their empirical evidence confirmed that information quality has a remarkable positive effect on both kinds of trust.

There is a tight relationship between trust, information sharing, and innovation. Cai et al. (2013) studied knowledge sharing in supply chain performance of logistics firms in Singapore and found significant effects of trust on technology transfer and technical sharing. Others, for example, Sridharan et al. (2013) discussed the key role of trust in value creation through knowledge sharing and process integration. And also, Sunardi et al. (2015) suggested that employee skills, experiences, and educational background can increase informal knowledge sharing through mutual trust between partners. Thus, considering the logical effect of trust in knowledge sharing and innovation, the following hypotheses are proposed:

Hypothesis 5. Relational trust has a positive effect on project innovation.

Hypothesis 6. Competence-based trust has a positive effect on project innovation.

3.2.6 Knowledge criteria and trust

In this chapter, innovative partnerships are the object of study, that is, complex projects that are managed by different partners aimed at sharing knowledge, learning, and producing new knowledge. Collaboration is an effective way to obtain knowledge both within an existing knowledge space and beyond its boundaries. Because sharing knowledge in a competitive environment is inherently risky, how trust is created becomes central. Hence we examine the role of knowledge criteria and their effect on relational trust and competence-based trust.

Efficient communication is the basic infrastructure for successful collaboration between partners. The similarity in knowledge is one of the most important factors that help to avoid miscommunication and also minimizes the risk of failure in complex projects (Vaez-Alaei et al., 2021). The existence of similarity in professional training, communication skills, shared value, and mindsets provides a common theme on which it is possible to establish trust and a low-risk environment for solving problems (G. Wilson et al., 2007).

At the same time, though, complementarity in partnerships is a way to eliminate deficiencies in resources and reinforce each firm's ability to achieve a project's objectives. Resource complementarity was identified as the most influential factor enhancing stability and trust in ongoing collaboration (Deitz et al., 2010). A study of joint venture performance by Huang et al. (2015) found that the value gap and information asymmetry mediate the relationship between control variables and performance.

A firm's knowledge can be classified into three categories (Deniaud et al., 2017; Vaez-Alaei et al., 2019): similarity, complementarity, and coverage. Similarity refers to knowledge known by all partners. Complementarity refers to knowledge that is known by only one or other of the firms and compensates for the deficiency of a partner. Coverage refers to the knowledge required to finish the project which is covered by the partnership. The difference between similarity, complementarity and coverage are shown in Figure 3.5, which serves as a schema for understanding how potential partners can position each other and the project's needs using these criteria, at the beginning of the project.

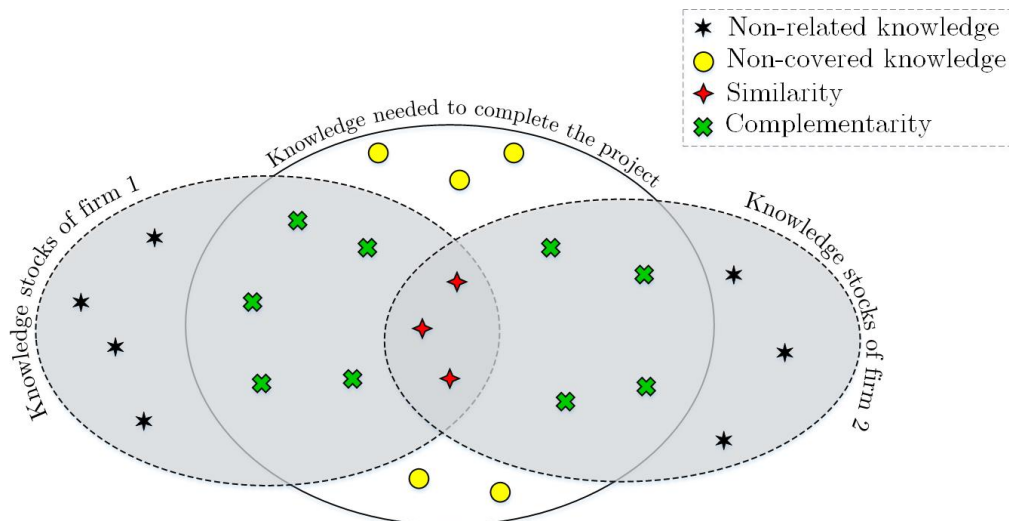


Figure 3.5 – Similarity, complementarity and coverage demonstration in two firms knowledge areas.

In Figure 3.5, as an example, there are two firms with their own knowledge stocks, which are collaborating on a project. The two grey ellipses represent the knowledge stocks of the two firms; the transparent ellipse represents the knowledge needed to complete the project.

These knowledge stocks can be any competencies, expertise, technology or resources in a firm. Not all the knowledge in a firm is related to collaboration. Among related knowledge there is some which are known by both firms, generating similarity; there is some knowledge related to the project that is known by only one or other of the firms, and this creates complementarity; the proportion of all of the knowledge, similar or complementary to the knowledge that these firms need to finish the project, generates coverage. The two firms jointly may cover all the knowledge needed in the project, or they may not, in which case they will either have to generate it, or find it elsewhere.

Therefore, following the above discussion it can be concluded that competence-based trust and relational trust may be increased by similarity, complementarity and coverage of knowledge, the following hypotheses are proposed:

Hypothesis 7a. Similarity in knowledge has a positive effect on relational trust between partners.

Hypothesis 7b. Similarity in knowledge has a positive effect on competence-based trust between partners.

Hypothesis 8a. Complementarity in knowledge has a positive effect on relational trust between partner.

Hypothesis 8b. Complementarity in knowledge has a positive effect on competence-based trust between partner.

Hypothesis 9a. Coverage of project knowledge has a positive effect on relational trust between partner.

Hypothesis 9b. Coverage of project knowledge has a positive effect on competence-based trust between partner.

In addition, although all knowledge criteria are expected to have an indirect effect on complex project success, coverage as a criterion that defines all the knowledge required to finish a project, directly can affect project success. Considering the fact that projects need sufficient knowledge and resource to survive until their task are completed (Gemünden et al., 2005), the following hypothesis is proposed:

Hypothesis 9c. Coverage of project knowledge has a positive effect on complex project success.

3.2.7 A moderator called trust capability

Alongside the tangible information or well behavior of partners in a partnership, the trust capability of an individual is an essential factor in the question concerning whether to trust someone or something. Acceptance of the risk of being vulnerable by trusting someone is related to the psychological state of each individual as well as other specifications related to the project and partnership (L. C. Becker, 1996). Benitez-Avila et al. (2018) investigated the moderating effect of trust between partners on contractual governance and partners' contributions and project performance. However, trust capability is not considered as a moderator in related literature. To measure the trust capability of people there are standard questions based on the General Social Survey (GSS) (Glaeser et al., 2000), "Generally Speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". Accordingly below hypotheses in proposed to analyze the direct effect of trust capability on relational trust and competence-based trust as well as its moderation effect:

Hypothesis 10a. Trust capability has a positive effect on relational trust.

Hypothesis 10b. Trust capability has a positive effect on competence-based trust.

Hypothesis 10c. Trust capability moderates the relationship of similarity in knowledge and relational trust.

Hypothesis 10d. Trust capability moderates effect on the relationship of similarity in knowledge and competence-based trust.

Hypothesis 10e. Trust capability moderates effect on the relationship of complementarity in knowledge and relational trust.

Hypothesis 10f. Trust capability moderates effect on the relationship of complementarity in knowledge and competence-based trust.

Hypothesis 10g. Trust capability moderates effect on the relationship of coverage of project knowledge and relational trust.

Hypothesis 10h. Trust capability moderates effect on the relationship of coverage of project knowledge and competence-based trust.

Table 3.1 summarizes some of the related research that considers trust as variable (i.e. independent variable, dependent variable and moderator variable) in partnerships. Also, the conceptual model which shows all the proposed hypotheses is shown in Figure 3.6. This model is created to investigate the role of innovation and coverage on complex project success, the role of complexity and trust on innovation, and the role of knowledge on trust. Moreover, trust capability moderates the effect of knowledge on trust between partners.

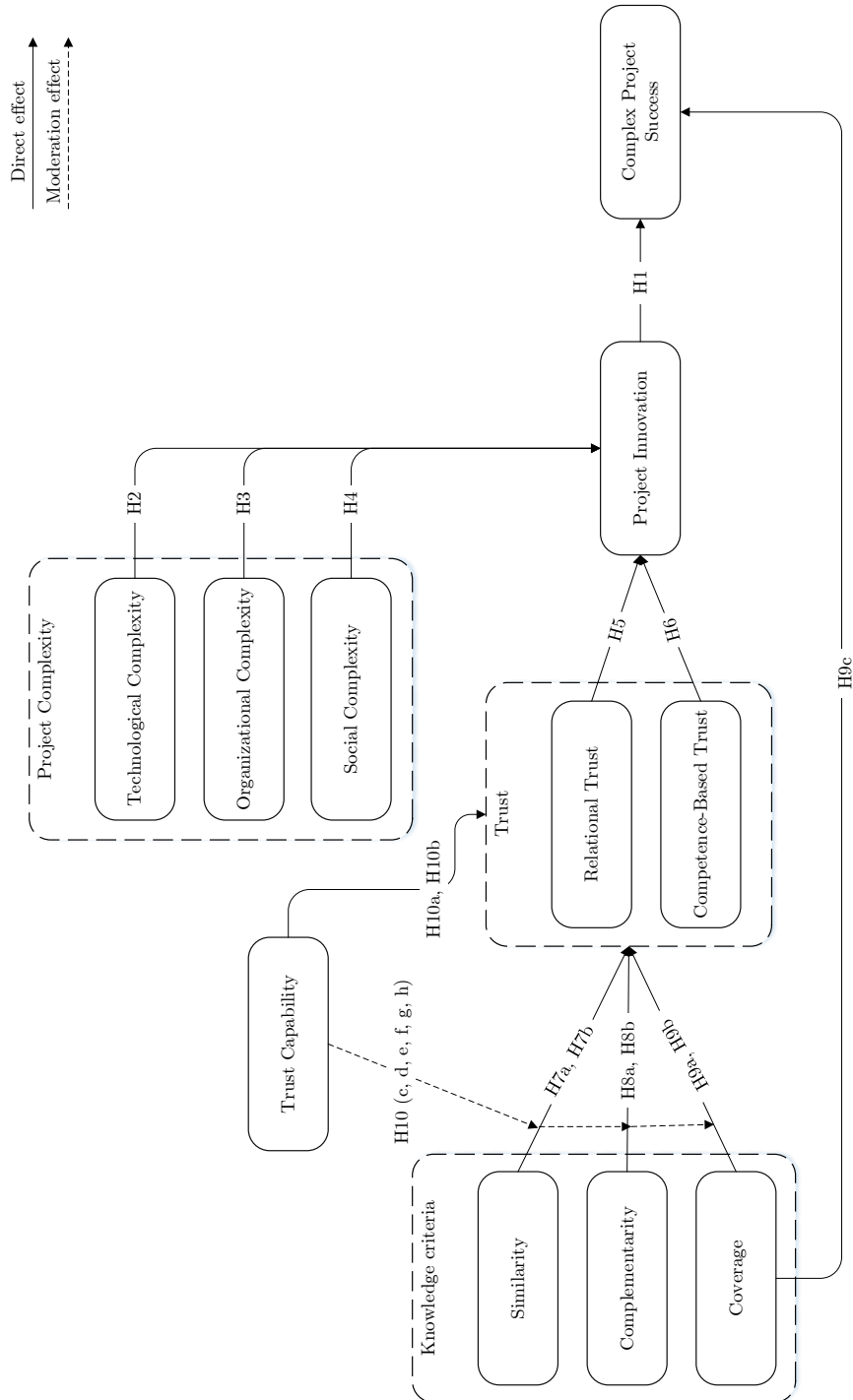


Figure 3.6 – Research proposed conceptual model

Table 3.1 – Selected studies based on trust in partnership context

No.	Publication	Context	Affecting on trust (Individual, organizational, project) characteristics,	Affected by trust Utilization of market research information	Moderator
1	Moorman et al. 1993 (Moorman et al., 1993)	Market research relationships	(Individual, organizational, project) characteristics,	Utilization of market research information	None
2	Aulakh et al. 1996 (Aulakh et al., 1996)	Cross-Border marketing partnerships	Continuity expectation, information exchange	Partnership performance	Asset specificity, host market unpredictability
3	Das and Teng 2001 (T. Das et al., 2001)	Strategic alliances	None	Relational risk, performance risk	None
4	Leonidou et al. 2008 (Leonidou et al., 2008)	Industrial buyer-seller relationships	Conflict, satisfaction	Commitment	None
5	Ke et al. 2009 (Ke et al., 2009)	Electronic supply chains	Mediated power, non-mediated power	Adoption intention	Firms size, mimetic pressures, dependence
6	Doloi 2009 (Doloi, 2009)	Construction industries	None	Relational partnering success	None
7	Wu et al. 2010 (Wu et al., 2010)	Transaction communities	Shared values, privacy policy, satisfaction	Commitment, stickiness	None
8	Deitz et al. 2010 (Deitz et al., 2010)	Joint venture alliances	Resource complementarities	Intent to remain in joint venture without changes, cooperative intent	Termination costs, size
9	Hernandez-Ortega 2011 (Hernandez-Ortega, 2011)	Acceptance of a technology	Ease of use, compatibility, security, partner's influence, manager's attitude	Performance, continuity intentions	None
10	Bazayar et al. 2013 (Bazayar et al., 2013)	New product development relationships	Relational risk perception	None	None
11	Cai et al. 2013 (Cai et al., 2013)	collaborative supply chains	None	Technical Exchange, Technology transfer	None
12	Sridharan et al. 2013 (Sridharan et al., 2013)	Supply chain collaborations	Cooperative norms	Performance accountability, information sharing, decision synchronization, process integration, incentive alignment	None
13	Nicolaou et al. 2013 (Nicolaou et al., 2013)	Electronic data exchanges	Information quality	Expected transaction performance, Intent for continued use	None

Continued on next page

Continued from previous page

No.	Publication	Context	Affecting on trust	Affected by trust	Moderator
14	Chen et al. 2014 (Y.-H. Chen et al., 2014)	Industrial parks' knowledge sharing	Shared goals, relational embeddedness, influence strategy	Collaboration, knowledge sharing	None
15	Abu-Shanab (Abu-Shanab, 2014)	E-government services	Information quality, familiarity with the internet, privacy and security concerns	Intention to use E-government	None
16	Capaldo et al. 2015 (Capaldo et al., 2015)	Supply chains	None	Supply chain performance	Degree of interdependence, interdependence pattern
17	Huo et al. 2015 (Huo et al., 2015)	Third-party logistic industries	None	Detailed contract, contract application, opportunism	Demand uncertainty, company size
18	Sunardi et al. 2015 (Sunardi et al., 2015)	Collaborations	Employee experience	Reciprocity norm, knowledge sharing	None
19	Shahmehr et al. 2015 (Shahmehr et al., 2015)	Small and medium enterprises	Personal Relations, dyadic economic interactions, dyadic social capital	Business performance	None
20	Singh and Teng (A. Singh et al., 2016)	Supply chains	None	Relational governance, IT integration, performance	None
21	Alsaad et al. 2017 (Alsaad et al., 2017)	Business to business electronic commerce	None	Benevolence, integrity, competency	Trust
22	Alharbi 2017 (Alharbi, 2017)	Technology acceptance	None	Behavioral intention	None
23	Benítez-Ávila et al. 2018 (Benítez-Ávila et al., 2018)	Public-private partnerships	Relational norms	Partners' contribution	Project complexity, contractual governance
24	Yuan et al. 2018 (Yuan et al., 2018)	Logistic service	Learning orientation	Commitment, effectiveness	Ownership, firm size
25	Wang et al. 2019 (Wang et al., 2019)	Megaprojects	None	Relational quality, megaproject success	Incentive
26	Ahlf et al. 2019 (Ahlf et al., 2019)	Business relationships	Demographic homophily, interpersonal communication	Perceived relationship quality, relationship quality	None
27	This chapter	Complex projects	Project complexity, knowledge criteria	Innovation potential, project success	Trust capacity

3.3 Research methodology

The conceptual model of this study is analysed with a propositional testing method based on practical statistics to test the hypotheses. A Survey was created out of concepts and relations are drawn from the literature above. The conceptual model includes the relationship between innovation and complex project success, trust, and innovation as well as the factors that affect trust and innovation and the moderating effects of trust capability level of project managers. The characteristics of innovative complex projects and participants in these projects are the units of analysis, and the project managers who have participated in managing innovative complex projects with more than one partner are the unit of our observation.

3.3.1 Survey design

In order to examine the conceptual model relationships, a survey research design was adopted from (Wang et al., 2019) for data collection from innovative project managers. The survey was designed, pre-tested with a small sample, validated by expert opinion in project management and innovation before sending it to the final respondents. The final survey includes 44 questions categorized into 11 groups, out of which six of questions belonged to Complex Project Success (CPS), four questions belonged to Project Innovation (PI), four questions belonged to Technological Complexity (TC), five questions belonged to Organizational Complexity (OC), four questions belonged to Social Complexity (SC), four questions belonged to Similarity (Sim), four questions belonged to Complementarity (Com), four questions belonged to Coverage (Cov), one question belonged to Trust Capability (TrC), four questions belonged to Relational Trust (RT) and four questions belonged to Competence-Based Trust (CBT). The complete survey is available in Table A.1 (Appendix A).

A 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) was used to answer the survey questions as advised by (M. Farooq et al., 2016; M. S. Farooq et al., 2018). Furthermore, to validate the questions in the survey, first, the expert opinion was taken into account, and second, a pre-tested round was conducted with a small sample of 15 volunteers among colleagues. Some minor modifications were made in the survey to be reliable and valid for data collection.

3.3.2 Sampling and data collection

This chapter is aimed to analyze the role of knowledge, trust, complexity on innovation and complex project success. To do so, project managers who were involved in projects with two conditions — projects have been completed; and they involved more than one partner — were selected to fill the survey.

Defining the right sample size is critical for verifying the quality of any study. To analyze the data we use partial least square structural equation modeling (PLS-SEM). Following Hair et al. (2011), the minimum sample size in PLS-SEM analysis is based on the 10 times rule: the minimum sample size should be equal to the larger of the following: 1) *Ten times the largest number of formative indicators used to measure one variable*; 2) *Ten times of the largest number of structural paths directed at a particular latent variable in the structural model*. In this study, the largest number of formative indicators is 6 and the minimum sample size should be 60 respondents.

However, we have adopted to reach out to more respondents as much as possible to ensure more rigorous result (M. S. Farooq et al., 2018). Accordingly, we first select European project managers from the ANR website and the survey has sent to them by email. Then we used

snowball sampling to obtain more responses.² Unfortunately, the data gathering phase of this study started in the period of confinement due to the Covid-19 pandemic, hence the authors have lost the chance of interviewing managers in face-to-face meetings and use the maximum potential of networking to find more projects managers. It is not possible to determine the exact response rate of this study since emails have sent to the respondents from different people, but we estimate that the response rate was less than 10%. Finally, we obtained 172 responses.

3.3.3 Analytical methods

When it comes to analyzing the cause and effect relations between latent variables³, Structural Equation Modeling (SEM) has become a standard tool. There are two common approaches in SEM, Covariance-based SEM (CB-SEM) and Partial Least Squares (PLS-SEM). CB-SEM fit is based on accurately estimating the observed covariance matrix, while PLS-SEM fit is based upon accounting for explained variance in the latent variables (Hair et al., 2011).

The PLS-SEM is used to analyze the data in this chapter. The reason behind this choice is first, PLS-SEM requires a smaller sample size than CB-SEM; and second, it can handle a formative structural model⁴ such as the conceptual model of this study, while CB-SEM is typically appropriate for the reflective model⁵. Moreover, in the complex project research domain, knowledge and innovation are still in the development phase, and PLS-SEM has the advantage of theory development while CB-SEM is mostly used for theory confirmation (Hair et al., 2011; Hair Jr et al., 2016).

Accordingly, PLS-SEM is the best methodology to analyze the data for this study. Moreover, in order to assure the collected data quality and consistency of the conceptual model several tests were also applied as well as reliability and validity test, prior to applying PLS-SEM analysis. A schematic flowchart of all the steps of the proposed approach for data analysis is depicted in Figure 3.7. These steps are explained in the following section. Collected data is analyzed mostly using two software: IBM SPSS Statistics version 26 and SmartPLS version 3.

3.4 Data analysis

As explained in the last section, partial least squares structural equation modeling (PLS-SEM) is performed to test the hypotheses of this study. However, it is essential to apply prior data analysis tests to ensure the quality, validity and reliability of the collected data. Also, to gain more insight from the PLS-SEM analysis, some latent analyses are applied. These steps are explained in detail in the following subsections.

3.4.1 Data screening and pre-analysis

The analysis of this study is based on the data collected from project managers of complex innovative projects. 172 respondents completed the survey. In this study, the screening for missing value is not required, since it was not possible to submit the online survey without answering all the questions. Hence, data analysis begins with a concise description of the demographic characteristic of survey respondents in terms of their gender, age, educational level, work experience and their job title. Complementary details of respondents' characteristics are shown in table 3.2.

²After the first wave of responses we used snowball sampling to increase the response rate. It means we asked people who answered the questionnaire to send it to their network to increase the sample size.

³In statistics, latent variables are variables that are not directly observed but are rather inferred from other variables that are observed.

⁴In the formative structural model, formative indicators are assumed to cause a latent variable, and changes in the indicators determine changes in the value of the latent variables.

⁵In the reflective structural model, reflective indicators are seen as functions of the latent variable, and changes in the latent variable are reflected in changes in the indicator.

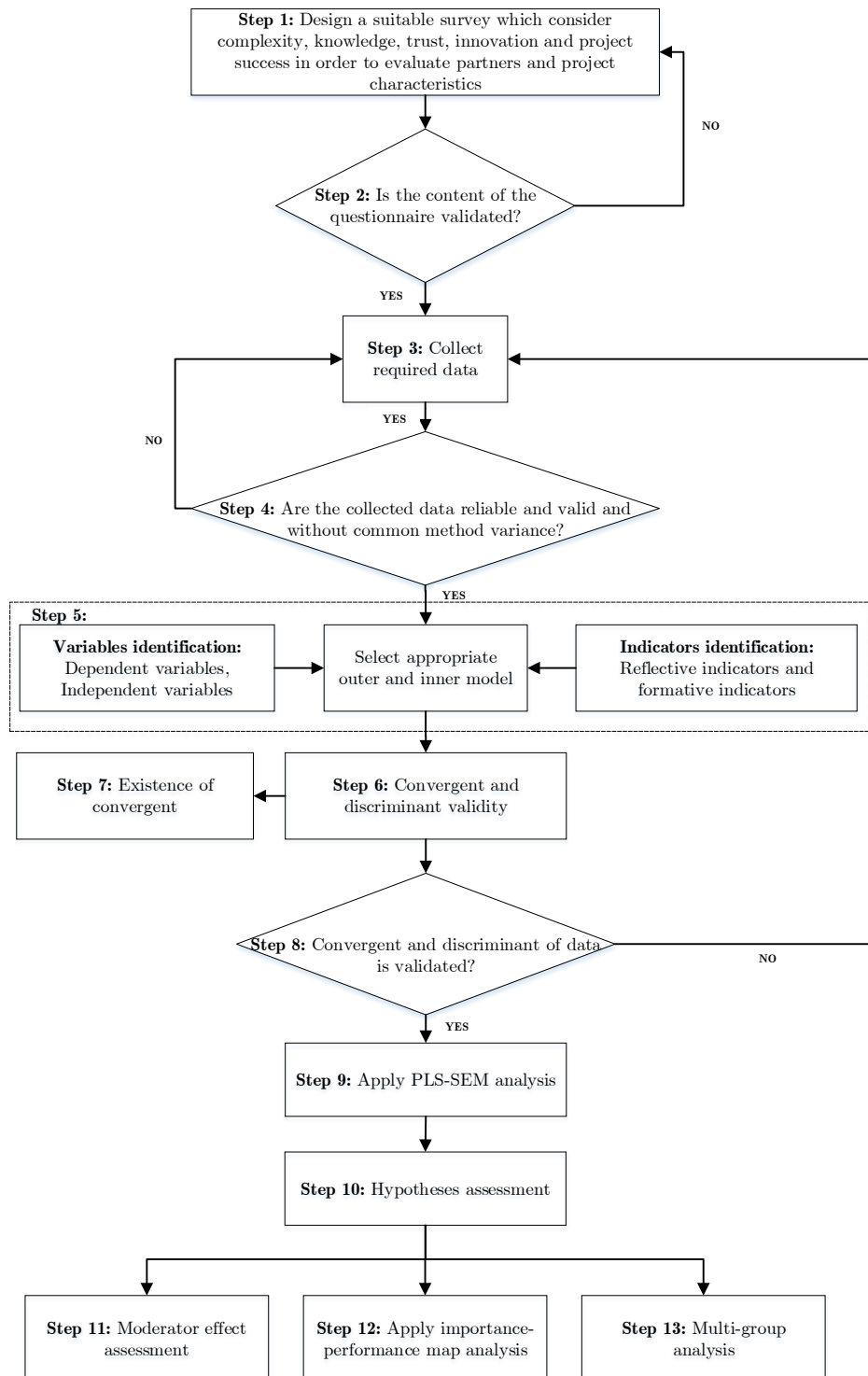
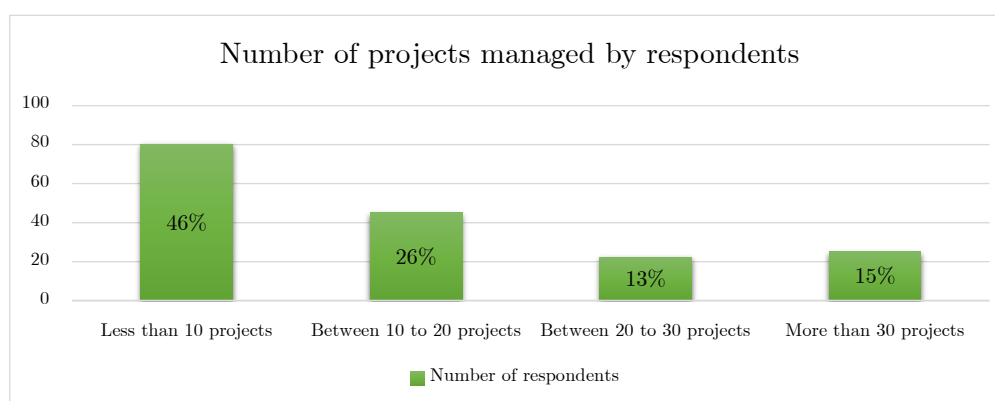


Figure 3.7 – A schematic view of all the steps of proposed approach for data analysis

Table 3.2 – Demographic characteristic of the respondents

Attributes	Type	Frequency	%
Gender	Male	128	74%
	Female	43	25%
	Prefer not to say	1	less than 1%
Ages	20 -29 years	7	4%
	30 - 39 years	33	19%
	40 - 49 years	61	35%
	50 -59 years	58	34%
	Above 60 years	13	7%
Educational level	High school degree or equivalent	1	less than 1%
	Bachelor's degree	3	5%
	Master's degree	11	17%
	Doctorate	47	78%
Work experience	Less than 5 years	11	6%
	Between 5 to 10 years	17	10%
	Between 11 to 15 years	28	16%
	Between 16 to 20 years	28	16%
	More than 20 years	88	50%
Job title	Professor	54	31%
	Associate professor	34	20%
	Researcher	32	19%
	Research director	11	6%
	Lecturer	3	2%
	Project manager	9	5%
	Lecturer	29	17%

**Figure 3.8** – Number of projects managed by respondents

Moreover, the number of projects that are managed by each respondent is asked in the survey and their answers are summarized in Figure 3.8. Out of total respondents, 46% of them managed less than 10 projects, whereas 54% managed more than 10 projects. The majority of respondents were from France (76%) and the majority of projects were research projects (80%) based on Figure 3.9 and Figure 3.10 respectively.

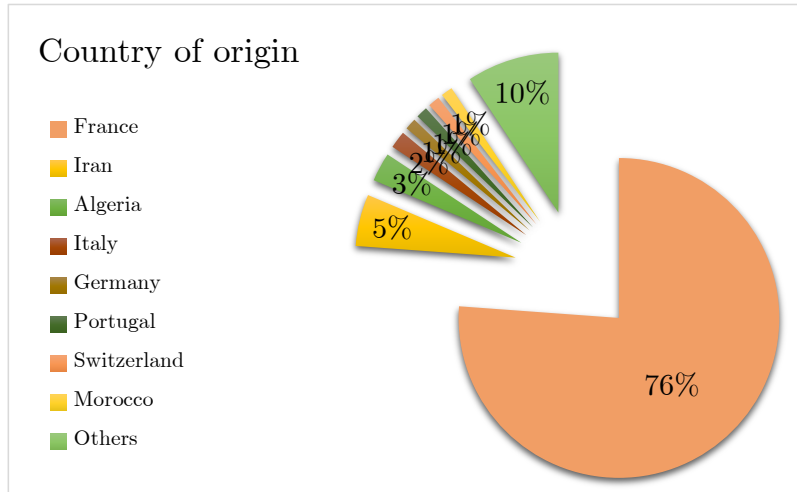


Figure 3.9 – Respondents' country of origin

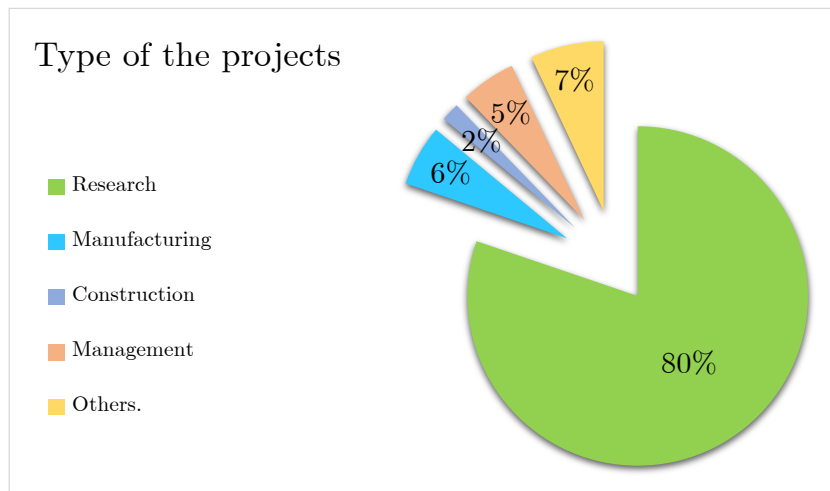


Figure 3.10 – Type of the projects that respondents filled the survey based on

3.4.2 Common-method variance bias test

The survey is mostly used for data collection in the different research domains. Moreover, a survey often provides data that is used to measure both dependent and independent variables, and the same respondent reply to both variable questions. In this case, the estimated impact of the independent variable on the dependent variable is at risk of being bias owing to

common method variance (CMV) (Jakobsen et al., 2015), due to respondents' tendency to evaluate themselves in a positive way or their social desirability. According to Richardson et al. (2009), CMV is a systematic bias that is shared between variables that are measured with the same method and source.

In this study, test and control for CMV have been considered in two phases proposed by Tehseen et al. (2017). First, in the phase of designing the survey by 1) protecting the anonymity of the respondents, 2) counterbalancing the order of the independent and dependent questions in the survey. Second, by applying the Harman (1976) single-factor test on collected data to check if there is any CMV. In this method, all indicators from every variable are entered into a single factor analysis to investigate whether one single factor could be identified or whether a single factor results in the majority of the covariance among all the measures. If no single factor accounts for the majority of the covariance, this means that CMV is not an issue for the study.

This test is applied by using principal component analysis in SPSS. The results extracted 11 different factors from 44 items of measurement variables (i.e. Complex Project Success, Project Innovation, Organizational Complexity, Technological Complexity, Social Complexity, Relational Trust, Competence-Based Trust, Trust Capability, Similarity, Complementarity, and Coverage). The result of the test is shown in Appendix A Table A.2. The result disclosed 11 different factors accounting for 55% of the variance of collected data. The first unrotated factor accounts for only 16% of the total variance. Accordingly, it is confirmed that this study is not at risk of common method variance bias⁶ (Tehseen et al., 2017).

3.4.3 Reliability and validity of the data

Reliability in statistics refers to the overall consistency of a measure which means the integrity and consistency of the data (Bonett et al., 2015). Besides, Cronbach's alpha is the most widely used method for estimating internal consistency reliability and is performed in this chapter. In reliability tests, the total value of Cronbach's alpha for all 44 questions is 87.8%, which is admissible since the minimum acceptable number is 70% (Santos, 1999). Cronbach's alpha for each factor is reported in Table 3.3. According to Pallant (2013), for the factors that are measured with less than 10 questions, Cronbach's alpha above 0.5 is acceptable. Accordingly, the reliability test approves the reliability for all factors.

Validity in statistics refers to examine how a measure corresponds accurately to the real world. To test the validity of the collected data, it is most common to check if there is a significant difference between the responses of respondents (Armstrong et al., 1977). To do so, an independent t-test is applied using the first 50 and last 50 responses to compare if there is any significant difference between the means of answered of these two groups. The results of these analyses have shown that there is no significant difference in 0.05 level⁷ (all the p-values are above 0.05) between the means of the two groups. The result of the validity test is shown in Table 3.4. Hence, based on these findings, it is concluded that the collected data is reliable and validated.

3.4.4 Analysis of measurement model

A conceptual model with latent variables has two components. The first component is the "inner model" which shows the type of relationship between the latent variables. The relationship in conceptual models can only be in a single direction. Hence, in a structural model, there are two kinds of latent variables: dependent variable and independent variable.

⁶There is no problem with common method bias in this data since the total variance extracted by one factor is less than the recommended threshold of 50%.

⁷95% confidence interval

Table 3.3 – Reliability of latent variables

Latent variables	Cronbach's Alpha	
Complex project success	0.740	
Project innovation	0.577	
Complexity (all indicators)	0.849	
	Organizational complexity	0.722
	Technological complexity	0.637
	Social complexity	0.845
Knowledge (all indicators)	0.715	
	Similarity	0.702
	Complementarity	0.756
	Coverage	0.802
Trust (all indicators)	0.818	
	Relational Trust	0.856
	Competence-based Trust	0.642

Table 3.4 – Validity of indicators

Indicator	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value
<i>CPS</i> ₁ *	0.922	<i>OC</i> ₁₂	0.904	<i>SC</i> ₂₃	0.335	<i>Cov</i> ₃₄	0.690
<i>CPS</i> ₂	0.354	<i>OC</i> ₁₃	0.796	<i>Sim</i> ₂₄	0.487	<i>Cov</i> ₃₅	0.615
<i>CPS</i> ₃	0.064	<i>OC</i> ₁₄	0.435	<i>Sim</i> ₂₅	0.268	<i>TrC</i> ₃₆	0.391
<i>CPS</i> ₄	0.095	<i>OC</i> ₁₅	0.734	<i>Sim</i> ₂₆	0.677	<i>RT</i> ₃₇	0.524
<i>CPS</i> ₅	0.583	<i>TC</i> ₁₆	0.146	<i>Sim</i> ₂₇	0.812	<i>RT</i> ₃₈	0.940
<i>CPS</i> ₆	0.159	<i>TC</i> ₁₇	1.000	<i>Com</i> ₂₈	0.448	<i>RT</i> ₃₉	0.513
<i>PI</i> ₇	0.057	<i>TC</i> ₁₈	0.237	<i>Com</i> ₂₉	0.770	<i>RT</i> ₄₀	0.135
<i>PI</i> ₈	0.244	<i>TC</i> ₁₉	0.903	<i>Com</i> ₃₀	0.581	<i>CBT</i> ₄₁	0.301
<i>PI</i> ₉	0.892	<i>SC</i> ₂₀	0.764	<i>Com</i> ₃₁	0.962	<i>CBT</i> ₄₂	0.828
<i>PI</i> ₁₀	0.237	<i>SC</i> ₂₁	0.839	<i>Cov</i> ₃₂	0.544	<i>CBT</i> ₄₃	0.508
<i>OC</i> ₁₁	0.136	<i>SC</i> ₂₂	1.000	<i>Cov</i> ₃₃	0.851	<i>CBT</i> ₄₄	0.441

*i.e. *CPS*₁ refers to first question which measures Complex Project Success (CPS)

Independent variable refers to a latent variable that does not have any path relationships pointing at them. Thus, the dependent variable refers to the latent variables that are explained with other latent variables (Hair et al., 2011).

The second component is the “outer model” refers to the relationship between each latent variable and its related indicators. The outer model can be whether formative or reflective, which both can be handled by PLS-SEM. Reflective indicators are defined as a function of the latent variable, and formative indicators are considered to cause a latent variable (Hair et al., 2011). The PLS-SEM path modeling is also depicted in Figure 3.11.

In Figure 3.11, the inner model includes two latent variables which X is a formative independent variable and Y is a reflective dependent variable. The path coefficient between two latent variables is the direct effect of X assumed to be a cause on Y assumed to be an effect. In addition, the outer model includes one formative measurement model and one reflective measurement model. In the formative measurement model, X is a formative latent variable in which three indicators (X_1 , X_2 and X_3) are used to measure this formative variable with different weights. In the reflective measurement model, Y is a reflective latent variable in which three reflective indicators (Y_1 , Y_2 and Y_3) are used as functions of the latent variable with different loadings.

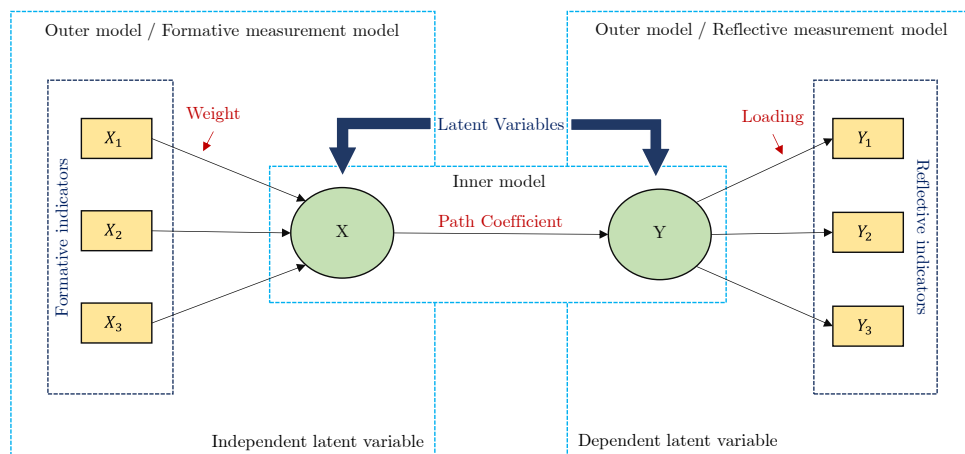


Figure 3.11 – PLS-SEM path modeling

Moreover, PLS-SEM mainly evaluates the direct relationship between latent variables. However, in theory, moderator variables are suggested to modify, strengthen or weaken the relationship between latent variables in conceptual models (J.-M. Becker et al., 2018). Figure 3.12 depicts a simple moderator model in which the moderator variable M is proposed to influence the relationship P_1 between latent variables X and Y .

According to the above discussion, regarding the hypothesized conceptual model of this chapter, out of eleven latent variables, six variables (i.e. organizational complexity, technological complexity, social complexity, similarity, complementarity, coverage) are independent variables, and four variables (i.e. complex project success, project innovation, relational trust, competence-based trust) are dependent variables. Moreover, there is one moderator variable (i.e. trust capability) to moderate the effect between some of the latent variables. Based on the nature of the variables and their related indicators (questions in the survey), all the latent variables in this study are formative.

According to the guideline which is presented by Hair Jr et al. (2016), the formative measurement model should be analyzed for convergent validity and discriminant validity.

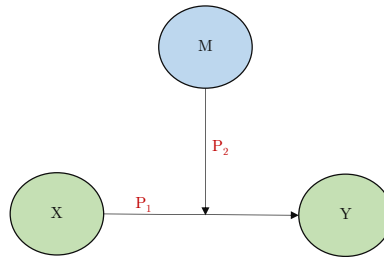


Figure 3.12 – Simple moderator model

The next section is focused on the evaluation of the formative measurement model of this chapter.

3.4.5 Analysis of formative measurement model

The structural model of this study is formative, and the assessment of the formative model is different from the reflective model. The idea behind the formative model is that all the indicators (questions) represent an independent cause for the latent variable. So, formative indicators do not need to have a high correlation, and omitting one indicator is omitting a part of variable (Hair et al., 2011; Hair Jr et al., 2016).

Since the indicators must be independent and non-inter-changeable, they should not have a significant overlap. The variance inflation factor (VIF) is checked through the collinearity statistics test. Table A.3 (in Appendix) shows that all the VIFs are less than 5 which is acceptable (Hair et al., 2011).⁸

In addition, considering the guideline of (Hair Jr et al., 2016) each indicator's outer weight is calculated to check if they have a significant effect on each latent variable. A summarized overview of these findings presented in Table 3.5. If the p -value is below 0.05 and T statistics above 1.95, the indicator has a significant effect on the latent variable (TrC_{36} has no value since trust capability is measured with one indicator). For the p -value above 0.05, it is advised to choose a more liberal approach for the formative measurement model, since statistically, it might have a low effect on the latent variable but deleting an indicator might delete a part of the variable in the formative measurement. Hence, we keep all the indicators for the PLS-SEM analysis.

3.4.6 Analysis of conceptual model

After all the pre-analysis phases are done, the conceptual model of this study is assessed for the comprehensive explanatory power of latent variables through R^2 value, predictive relevance through T statistics value and path coefficient β -value (Standardized regression weights). Findings of the conceptual model are presented in Figure 3.13.

These results demonstrate that proposed model have 12.3% of explanatory power for Complex Project Success (CPS) with $R^2 = 0.123$, 30.7% for Project Innovation (PI) with $R^2 = 0.307$, 30.1% for Relational Trust (RT) with $R^2 = 0.301$ and 40.1% for Competence-Based Trust (CBT) with $R^2 = 0.401$. These R^2 values illustrate the predictive validity of the conceptual model, which are significant (Hair Jr et al., 2016). According to the results, 8 out of 13 hypotheses are supported.

⁸since the VIFs more than 5 is a problematic correlation which shows the overlap between questions.

Table 3.5 – Outer weights

	Outer weights	T Statistics	<i>p</i> -value
$CPS_1 \rightarrow CPS$	0.37	1.42	0.12
$CPS_2 \rightarrow CPS$	0.46	2.06	0.04**
$CPS_3 \rightarrow CPS$	0.61	3.00	0.00***
$CPS_4 \rightarrow CPS$	0.85	4.00	0.00***
$CPS_5 \rightarrow CPS$	0.66	2.43	0.01**
$CPS_6 \rightarrow CPS$	0.53	2.43	0.01**
$PI_7 \rightarrow PI$	0.77	6.39	0.00***
$PI_8 \rightarrow PI$	0.67	6.40	0.00***
$PI_9 \rightarrow PI$	0.52	3.55	0.00***
$PI_{10} \rightarrow PI$	0.67	4.70	0.00***
$OC_{11} \rightarrow OC$	0.47	3.29	0.00***
$OC_{12} \rightarrow OC$	0.76	5.13	0.00***
$OC_{13} \rightarrow OC$	0.52	3.13	0.00***
$OC_{14} \rightarrow OC$	0.80	6.20	0.00***
$OC_{15} \rightarrow OC$	0.66	3.90	0.00***
$TC_{16} \rightarrow TC$	0.29	1.78	0.07*
$TC_{17} \rightarrow TC$	0.70	5.19	0.00***
$TC_{18} \rightarrow TC$	0.62	4.59	0.00***
$TC_{19} \rightarrow TC$	0.85	6.93	0.00***
$SC_{20} \rightarrow SC$	0.85	6.18	0.00***
$SC_{21} \rightarrow SC$	0.64	3.54	0.00***
$SC_{22} \rightarrow SC$	0.89	6.78	0.00***
$SC_{23} \rightarrow SC$	0.36	1.36	0.17
$Sim_{24} \rightarrow Sim$	0.91	9.46	0.00***
$Sim_{25} \rightarrow Sim$	0.82	5.46	0.00***
$Sim_{26} \rightarrow Sim$	0.65	3.43	0.00***
$Sim_{27} \rightarrow Sim$	0.47	2.53	0.01**
$Com_{28} \rightarrow Com$	0.87	5.44	0.00***
$Com_{29} \rightarrow Com$	0.77	4.43	0.00***
$Com_{30} \rightarrow Com$	0.84	5.49	0.00***
$Com_{31} \rightarrow Com$	0.59	2.23	0.02**
$Cov_{32} \rightarrow Cov$	0.31	1.80	0.06*
$Cov_{33} \rightarrow Cov$	0.60	2.24	0.02**
$Cov_{34} \rightarrow Cov$	0.39	1.45	0.10
$Cov_{35} \rightarrow Cov$	0.92	1.92	0.06*
$TrC_{36} \rightarrow TrC$	-	-	-
$RT_{37} \rightarrow RT$	0.85	5.81	0.00***
$RT_{38} \rightarrow RT$	0.88	7.87	0.00***
$RT_{39} \rightarrow RT$	0.81	6.62	0.00***
$RT_{40} \rightarrow RT$	0.74	4.52	0.00***
$CBT_{41} \rightarrow CBT$	0.51	3.30	0.00***
$CBT_{42} \rightarrow CBT$	0.79	5.63	0.00***
$CBT_{43} \rightarrow CBT$	0.38	3.00	0.00***
$CBT_{44} \rightarrow CBT$	0.87	7.80	0.00***

Note: *P < 0.1, **P < 0.05, ***P < 0.01

These results show Project Innovation (PI) and Coverage (Cov) have a significant positive effect on Complex Project Success (CPS) ($H1$ and $H9_c$ are supported). In addition, Organizational Complexity (OC), technological complexity (TC) by the nature of the project, and Relational Trust (RT) has a significant positive effect on project innovation (PI) ($H2$, $H3$ and $H5$ are supported). However, the effect of Social complexity (SC) and Competence-Based Trust (CBT) are not supported ($H4$ and $H6$ are not supported). Regarding similarity (Sim), complementarity (Com) and coverage (Cov) in knowledge, similarity has a significant positive effect on both relational trust and competence-based trust ($H7_a$ and $H7_b$ are supported). Furthermore, complementarity has a significant positive effect on competence-based trust ($H8_b$ is supported), but the effect of complementarity on relational trust is not supported ($H8_a$ is not supported). Also, no significant effect has been found from coverage on relational trust and competence-based trust ($H9_a$ and $H9_b$ are not supported). A summarized overview of these analyzes is presented in Table 3.6.

It is often the case that in the empirical research some of the hypotheses are not corroborated by data and hence are not statistically supported. Although regarding the unsupported hypotheses, there is not a definite explanation, there are some speculations and interpretations. Unsupported hypotheses may have happened due to methodological procedures, size and characteristics of the experimental sample, and so forth.

For the conceptual model of this study, one of the reasons behind not supporting some of the hypotheses might be the sample size considering the complexity of the conceptual model, and having more data might result in supporting more hypotheses. However, there some other interpretations for each unsupported hypothesis. Regarding the effect of social complexity on project innovation ($H4$), lack of the data from a variety of national and international projects in different countries might be the explanation. Concerning the effect of competence-based trust on project innovation ($H6$), an unsupported result might be the consequence of the high effect of relational trust on project innovation. Since based on the (we should cite the conference paper that we recently submitted), when the effect of competence-based trust on innovation is the single aspect of trust in the model then there is a significant positive effect on project innovation.

Moreover, regarding the unsupported effects of complementarity on relational trust ($H8_a$), and coverage on relational trust ($H9_a$) and coverage on competence-based trust ($H9_b$), the nature of the hypotheses or the characteristic of the sample data might be the reason.

Table 3.6 – hypotheses assessment

Proposed path	β -value	t -value	p -value	Decision
$H1$ $PI \Rightarrow CPS$	0.274	2.30	0.021**	Supported
$H2$ $TC \Rightarrow PI$	0.198	2.210	0.028**	Supported
$H3$ $OC \Rightarrow PI$	0.262	3.539	0.000***	Supported
$H4$ $SC \Rightarrow PI$	0.090	1.292	0.196	Unsupported
$H5$ $RT \Rightarrow PI$	0.201	1.807	0.071*	Supported
$H6$ $CBT \Rightarrow PI$	0.044	0.555	0.579	Unsupported
$H7_a$ $Sim \Rightarrow RT$	0.149	2.676	0.007***	Supported
$H7_b$ $Sim \Rightarrow CBT$	0.283	4.068	0.000***	Supported
$H8_a$ $Com \Rightarrow RT$	0.067	1.171	0.2420	Unsupported
$H8_b$ $Com \Rightarrow CBT$	0.319	4.468	0.000***	Supported
$H9_a$ $Cov \Rightarrow RT$	0.196	0.890	0.369	Unsupported
$H9_b$ $Cov \Rightarrow CBT$	0.229	0.954	0.341	Unsupported
$H9_c$ $Cov \Rightarrow CPS$	0.220	1.678	0.094*	Supported

Note: *P < 0.1, **P < 0.05, ***P < 0.01

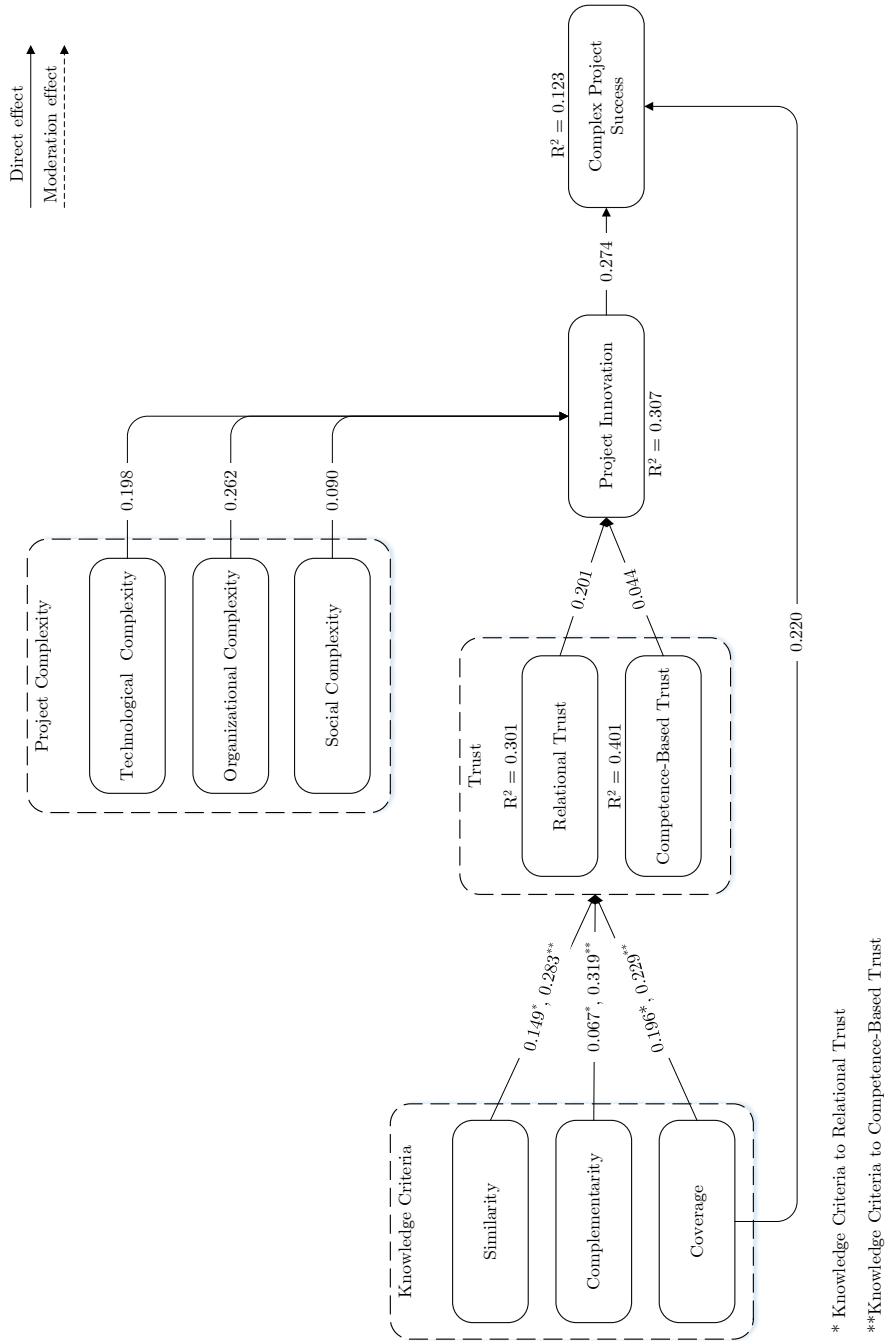


Figure 3.13 – Findings of proposed conceptual model

3.4.7 Moderator effect - Trust Capability of respondents

To test the significance of moderating role of the trust capability of respondents, we defined Trust Capability (TrC) as a continuous moderator affecting the relationship between knowledge criteria and trust using PLS-SEM. A summarized overview of these analyzes is presented in Table 3.7.

Trust capability has direct significant effect on Relational Trust (RT) and Competence-Based Trust (CBT) ($P10_a$ and $P10_b$ are supported). Regarding the moderating effect, the result shows that trust capability has moderated the effect of similarity on relational trust and competence-based trust ($P10_c$ and $P10_d$ are supported). However, the result is not supporting the hypothesis of the moderating effect of trust capability on the relationship of complementarity and coverage on relational trust and competence-based trust ($P10_e$, $P10_f$, $P10_g$ and $P10_h$ are not supported).

Table 3.7 – Moderator assessment

Proposed path	β -value ⁹	t -value	p -value	Decision
$H10_a$ $TrC \Rightarrow RT$	0.312	3.097	0.002***	Supported
$H10_b$ $TrC \Rightarrow CBT$	0.136	1.832	0.068*	Supported
$H10_c$ $Sim*TrC \Rightarrow RT$	-0.173	2.051	0.041**	Supported
$H10_d$ $Sim*TrC \Rightarrow CBT$	-0.157	1.750	0.080*	Supported
$H10_e$ $Com*TrC \Rightarrow RT$	0.075	0.670	0.503	Unsupported
$H10_f$ $Com*TrC \Rightarrow CBT$	-0.044	0.433	0.656	Unsupported
$H10_g$ $Cov*TrC \Rightarrow RT$	0.080	0.7821	0.434	Unsupported
$H10_h$ $Cov*TrC \Rightarrow CBT$	-0.042	0.541	0.588	Unsupported

Note: *P < 0.1, **P < 0.05, ***P < 0.01

Figure 3.14 shows the changes in the relationship between similarity and relational trust based on different values of trust capability. The blue line represents the relationship between similarity and relational trust at the lower level of trust capability. The red line represents this relationship at the mean level of trust capability, and the green line represents this relationship at the high level of trust capability. To interpret this figure, first, we start with the red line which indicates at the mean trust capability level increasing similarity has a positive effect on increasing the relational trust, then the blue line illustrates when the trust capability is low, the positive effect of similarity on relational trust has become stronger. However, when trust capability is high, not only similarity fails to positively impact the relational trust, but also it is modifying the nature of this effect. It can be concluded that in the high level of trust capability increasing in similarity is a negative effect of relational trust.

Figure 3.15 shows the changes in the relationship between similarity and competence-based trust based on different values of trust capability. Taking the same interpretation approach, this figure represents that similarity has a positive effect of competence-based trust in all the levels of trust capability. However, based on the diagram slope, in the low level of trust capability, this positive effect has become stronger, on the other hand in the high level of trust capability this positive effect has become weaker.

3.4.8 Importance-Performance Map Analysis (IPMA)

Importance-performance map analysis (IPMA; also known as importance-performance matrix analysis or priority map analysis) is an extremely useful tool in PLS-SEM for generating additional findings and gaining more insight from the conceptual model for managerial actions. IPMA extends the results of the estimated path coefficient (importance) by adding a

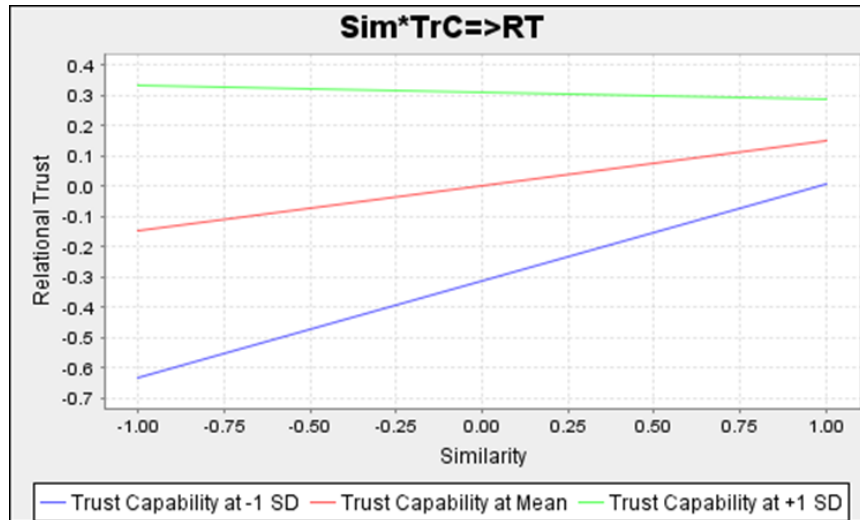


Figure 3.14 – Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship of Similarity (Sim) on Relational Trust (RT)

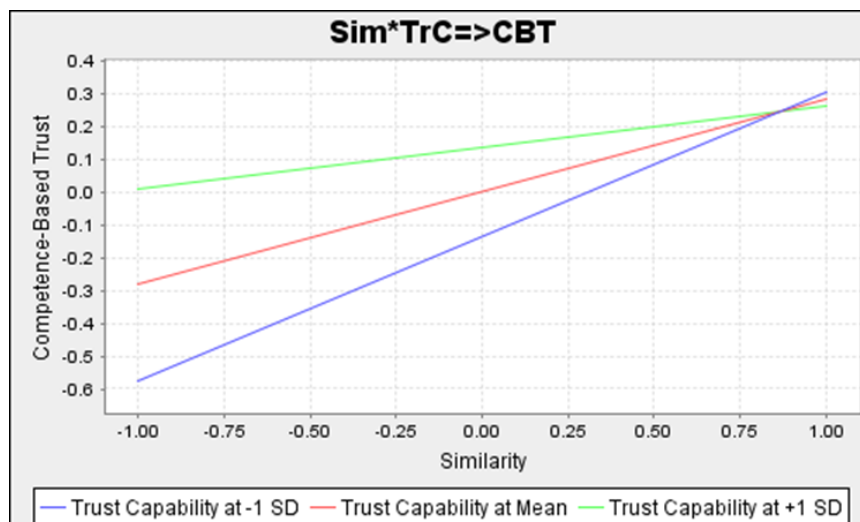


Figure 3.15 – Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship of Similarity (Sim) on Competence-Based Trust (CBT)

dimension that considers the average values of the latent variable scores (performance). (Hair Jr et al., 2017; Ringle et al., 2016). More precisely, the IPMA contrasts the unstandardized total effects (importance) in the structural and the average values of the latent variable scores on a scale from 0 to 100 (performance) in a graphical representation. The resulting importance-performance map permits the identification of determinants with relatively high importance and relatively low performance. These become major and high-priority improvement areas with the goal to in turn increase the performance of the selected key target construct in the PLS path model. The IPMA facilitates more elaborated interpretations of PLS-SEM results.

The goal of IPMA is to identify predecessors which have high importance (i.e. strong total effect), as well as have a low performance (i.e. low average latent variable scores). Finding these predecessors is very important because by increasing one-unit point in the performance of the predecessor variable, the performance of the dependent variable can be increased. IPMA can be performed for both indicators and latent variables. In this chapter, we performed the IPMA analysis for both latent variables and indicators, however for the sake of brevity the result of IPMA for latent variables is demonstrated as follows, and the IPMA analysis for indicators can be found in the Appendix A (Figure A.1 to Figure A.4, and Table A.4 to Table A.7).

In this chapter, the proposed conceptual model contains 4 dependent variables. Complex Project Success is one of the independent variables, which is predicted by 10 predecessors (i.e. Project Innovation, Organizational Complexity, Technological Complexity, Social Complexity, Relational Trust, Competence-Based Trust, Trust Capability, Similarity, Complementarity and Coverage); look at Figure 3.5. The IPMA is performed for the proposed conceptual model and the result is presented in Figure 3.16.

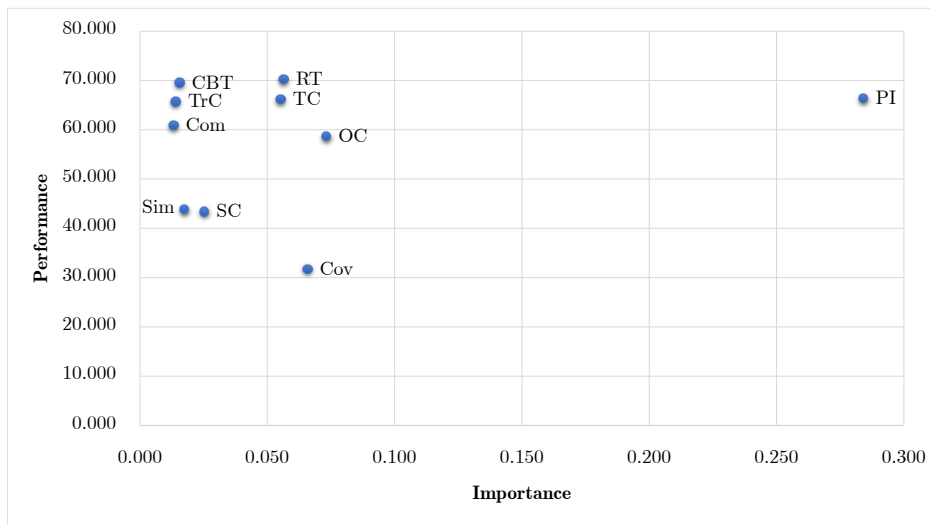


Figure 3.16 – Importance- performance map analysis for complex project success (vertical axis and horizontal axis represent performance and importance respectively)

In Figure 3.16, it is depicted that “Project Innovation” has the highest importance score (i.e. 0.274). Hence, if the project manager increases the project innovation for one-unit point, the overall complex project success will be increased by 0.274 (considering the other variable constant). In addition, findings reveal that the lowest performance is for coverage and similarity (i.e. 31.917 and 44.009 respectively), which means that there is great space for improvement in these areas. For ease of reading, all the performance and important values for all the predecessors are reported in Table 3.8.

Table 3.8 – Importance- performance map analysis for complex project success

Latent Variables	Importance	Performance
Project Innovation	0.274	66.660
Organizational Complexity	0.065	58.736
Technological Complexity	0.047	66.176
Social Complexity	0.013	43.502
Relational Trust	0.051	71.576
Competence-Based Trust	0.010	66.967
Trust Capability	0.014	65.795
Similarity	0.011	44.009
Complementarity	0.006	61.235
Coverage	0.147	31.917

Note: The bold values represent the highest importance (total effect) and highest performance value.

Project Innovation is another independent variable in this study, which also had the greatest importance on complex project success (refer to Figure 3.16). In the proposed conceptual model Project Innovation is predicted by 9 predecessors (i.e. Organizational Complexity, Technological Complexity, Social Complexity, Relational Trust, Competence-Based Trust, Trust Capability, Similarity, Complementarity and Coverage). The IPMA is performed for the proposed conceptual model and the result is presented in Figure 3.17.

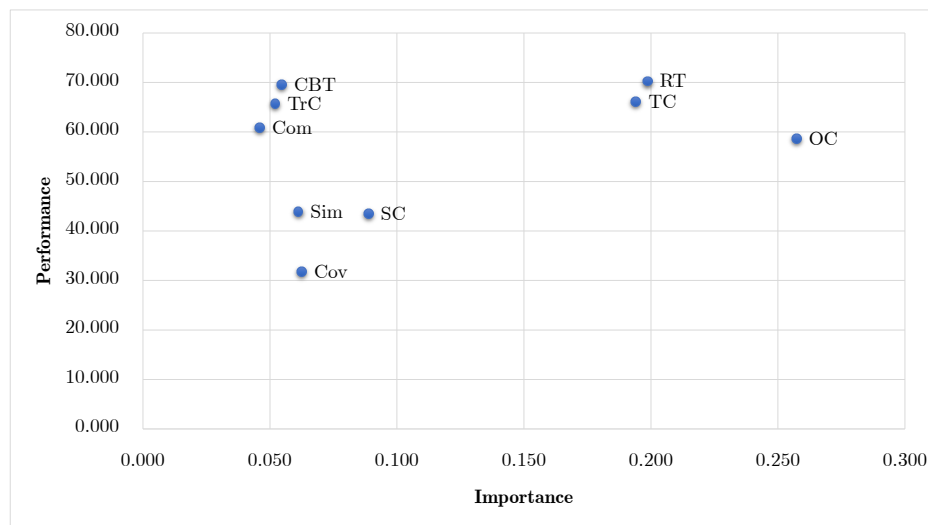


Figure 3.17 – Importance- performance map analysis for project innovation (vertical axis and horizontal axis represent performance and importance respectively)

Using the same interpretation method, it is demonstrated in Figure 3.17, that “Organizational Complexity” has the highest importance score (i.e. 0.237). Therefore, by increasing one-unit point point of organizational complexity, the project innovation can be increased by 0.237 (considering the other variable constant). The second importance score is related to “Relational Trust” (i.e. 0.187). The importance of relational trust on project innovation is rational and easy to interpret since higher relational trust leads to more knowledge sharing and collaboration which increases the innovation in the projects. However, it might be surprising

that the highest importance score for project innovation is related to organizational complexity. To explain this result, first we refer to the questions that measured organizational complexity in our survey (Table 3.9). By looking at the questions and the fact that increasing the organizational complexity means increasing all or some of its aspects, it is more rational to increase the innovation by the number of objectives, size of the investment, diversity of information system, etc.

Table 3.9 – Organizational complexity questions in the designed survey

Questions	My last project was complex in terms of ...
OC_{11}	Number of activities or objectives
OC_{12}	Duration of the project or size of capital investment
OC_{13}	Either diversity of staff, geographic location or information systems
OC_{14}	Inter-connectivity and feedback loops in the task and project networks
OC_{15}	Variety of cultural and institutional configurations

Note: Complete version of designed survey is available in the [Appendix A](#) (Table A.1)

Moreover, similarity and coverage are two latent variables with the lowest performance in this analysis (i.e. 44.031 and 31.789 respectively), accordingly, improvement in this area is needed. For ease of reading, all the performance and important values for all the predecessors are reported in Table 3.10.

Table 3.10 – Importance- performance map analysis for project innovation

Latent Variables	Importance	Performance
Organizational Complexity	0.237	58.721
Technological Complexity	0.170	66.212
Social Complexity	0.048	43.456
Relational Trust	0.187	71.507
Competence-Based Trust	0.039	66.036
Trust Capability	0.052	65.795
Similarity	0.031	44.031
Complementarity	0.021	61.217
Coverage	0.010	31.789

Note: The bold values represent the highest importance (total effect) and highest performance value.

Another dependent variable is “Relational Trust” which is predicted by 4 predecessors (i.e. Trust Capability, Similarity, Complementarity and Coverage). The IPMA is performed for relational trust and the result is presented in Figure 3.18.

In Figure 3.18, it is depicted that “Trust Capability” has the highest importance score (i.e. 0.313). However, controlling or making decisions based on trust capability is hard to achieve. The second score is related to “similarity” (i.e. 0.146), so if the project manager increases the similarity for one-unit point, the overall relational trust will be increased by 0.146 (considering the other variable constant). In addition, findings reveal that the lowest performance is for coverage and similarity (i.e. 31.789 and 44.031 respectively), which means that there is great space for improvement in these areas. For ease of reading, all the performance and important values for all the predecessors are reported in Table 3.8.

The last dependent variable is “Competence-Based Trust” which is predicted by 4 predecessors (i.e. Trust Capability, Similarity, Complementarity and Coverage).

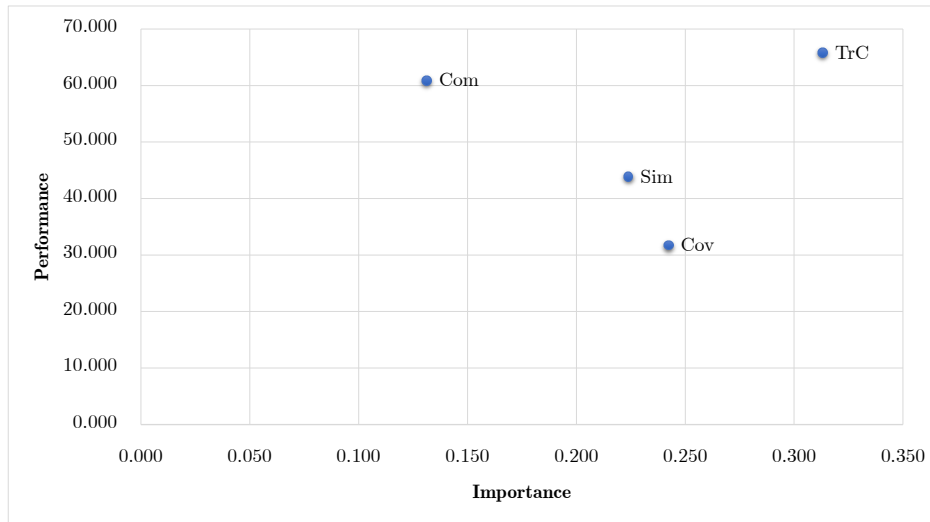


Figure 3.18 – Importance- performance map analysis for relational trust (vertical axis and horizontal axis represent performance and importance respectively)

Table 3.11 – Importance- performance map analysis for relational trust

Latent Variables	Importance	Performance
Trust Capability	0.313	65.795
Similarity	0.146	44.031
Complementarity	0.072	61.217
Coverage	0.210	31.789

Note: The bold values represent the highest importance (total effect) and highest performance value.

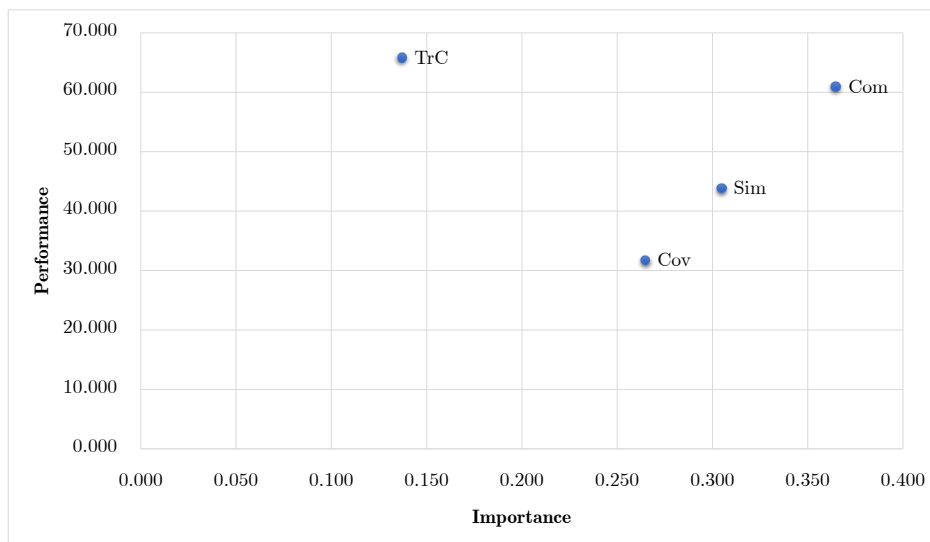


Figure 3.19 – Importance- performance map analysis for competence-based trust (vertical axis and horizontal axis represent performance and importance respectively)

In Figure 3.19, it is depicted that “Complementarity” has the highest importance score (i.e. 0.324). Therefore, by increasing one-unit point point of complementarity, the project innovation can be increased by 0.324 (considering the other variable constant). In addition, findings reveal that the lowest performance is for similarity (i.e. 44.031), which means that there is great space for improvement in this area. For ease of reading, all the performance and important values for all the predecessors are reported in Table 3.12.

Table 3.12 – Importance- performance map analysis for competence-based trust

Latent Variables	Importance	Performance
Trust Capability	0.137	65.795
Similarity	0.284	44.031
Complementarity	0.324	61.217
Coverage	0.234	31.789

Note: The bold values represent the highest importance (total effect) and highest performance value.

3.4.9 Multi-group analysis (MGA)

Multigroup analysis (MGA) or between-group analysis as applied using partial least squares structural equations modeling (PLS-SEM) is a tool for testing predefined data groups to determine if there are any significant differences in group-specific parameter estimates (e.g., outer weights, outer loadings, and path coefficients). By applying MGA, researchers are therefore able to test for differences between two identical models for different groups. The ability to identify the presence or absence of multi-group differences can be based on either a bootstrapping or permutation result for every group. Partial least squares structural equation modeling multi-group analysis (PLS-MGA) can be instrumental, therefore, in identifying differences among priori-specified groups within the dataset (Hair Jr et al., 2016; Henseler et al., 2010).

In this subsection, multiple binary groups have been considered for multi-group analysis of the conceptual model. First, trust capability (which has been considered a continuous moderator in the Subsection 3.4.7) is considered to divide the data into the two groups of people with low trust capability ($n = 61$) (people who had chosen 1, 2, 3, and 4 for the question 36 of the survey, look at Table A.1 in the Appendix A), and people with high trust capability ($n = 111$) (people who had chosen 5, 6, 7). The results of MGA of trust capability show that for people with higher trust capability, trust capability has a statistically significant higher effect on relational trust and competence-based trust (Path coefficients: 0.364 and 0.208 respectively) compared to people with lower trust capability (Path coefficients: -0.048 and -0.044 respectively). While the remaining path relationships between latent variables are found to be similar across the two groups. Table 3.13 shows the MGA for trust capability.

Moreover, in the survey that used to collect data from respondents, there are plenty of questions about information of respondents and the projects which they filled the question about (Look at Table A.1, Table 3.2, Figure 3.7, Figure 3.8 and Figure 3.9). However, considering the fact that the minimum number of data for the conceptual model of this study is 60, and the total number of data is 172, applying MGA for all the criteria was not possible due to lack of data for some groups. Hence, We conducted a multi-group analysis focusing age of respondents. Considering the respondents' age, the collected data are divided into two groups of the data related to the respondents who are below 50 years old ($n = 101$), and respondents equal and more than 50 years old ($n = 71$). The results of MGA of respondents' age show that for the group contains older respondents, coverage of knowledge

Table 3.13 – Multi-Group Analysis for Trust Capability (TrC)

Proposed path	Path coefficients-diff	<i>p</i> -value
<i>H1</i> <i>PI</i> ⇒ <i>CPS</i>	0.035	0.576
<i>H2</i> <i>TC</i> ⇒ <i>PI</i>	0.183	0.208
<i>H3</i> <i>OC</i> ⇒ <i>PI</i>	0.127	0.232
<i>H4</i> <i>SC</i> ⇒ <i>PI</i>	0.049	0.421
<i>H5</i> <i>RT</i> ⇒ <i>PI</i>	0.009	0.492
<i>H6</i> <i>CBT</i> ⇒ <i>PI</i>	0.271	0.879
<i>H7_a</i> <i>Sim</i> ⇒ <i>RT</i>	0.152	0.769
<i>H7_b</i> <i>Sim</i> ⇒ <i>CBT</i>	0.157	0.762
<i>H8_a</i> <i>Com</i> ⇒ <i>RT</i>	0.133	0.351
<i>H8_b</i> <i>Com</i> ⇒ <i>CBT</i>	0.165	0.268
<i>H9_a</i> <i>Cov</i> ⇒ <i>RT</i>	0.484	0.161
<i>H9_b</i> <i>Cov</i> ⇒ <i>CBT</i>	0.388	0.182
<i>H9_c</i> <i>Cov</i> ⇒ <i>CPS</i>	0.141	0.345
<i>H10_a</i> <i>TrC</i> ⇒ <i>RT</i>	0.412	0.021**
<i>H10_b</i> <i>TrC</i> ⇒ <i>CBT</i>	0.252	0.078*
<i>H10_c</i> <i>Sim*TrC</i> ⇒ <i>RT</i>	0.077	0.633
<i>H10_d</i> <i>Sim*TrC</i> ⇒ <i>CBT</i>	0.039	0.395
<i>H10_e</i> <i>Com*TrC</i> ⇒ <i>RT</i>	0.274	0.896
<i>H10_f</i> <i>Com*TrC</i> ⇒ <i>CBT</i>	0.370	0.976
<i>H10_g</i> <i>Cov*TrC</i> ⇒ <i>RT</i>	0.127	0.717
<i>H10_h</i> <i>Cov*TrC</i> ⇒ <i>CBT</i>	0.066	0.358

Note 1: *P < 0.1, **P < 0.05

Note 2: Path coefficients-diff = |(High trust capability) - (Low trust capability)|

has a statistically significant higher effect on relational trust and competence-based trust (Path coefficients: 0.579 and 0.486 respectively) compared to younger respondents (Path coefficients: 0.286 and 0.176 respectively). Also, competence-based trust has a higher effect on project innovation for the projects managed by older respondents (Path coefficient: 0.215), compared to the project managed by younger respondents (Path coefficient: -0.188). While the remaining path relationships between latent variables are found to be similar across the two groups. Table 3.14 shows the MGA for the age of the respondents.

Table 3.14 – Multi-Group Analysis for age of respondents

Proposed path	Path coefficients-diff	<i>p</i> -value
<i>H1</i> $PI \Rightarrow CPS$	0.152	0.311
<i>H2</i> $TC \Rightarrow PI$	0.159	0.825
<i>H3</i> $OC \Rightarrow PI$	0.033	0.422
<i>H4</i> $SC \Rightarrow PI$	0.158	0.832
<i>H5</i> $RT \Rightarrow PI$	0.009	0.497
<i>H6</i> $CBT \Rightarrow PI$	0.403	0.069*
<i>H7_a</i> $Sim \Rightarrow RT$	0.145	0.788
<i>H7_b</i> $Sim \Rightarrow CBT$	0.112	0.735
<i>H8_a</i> $Com \Rightarrow RT$	0.026	0.581
<i>H8_b</i> $Com \Rightarrow CBT$	0.107	0.305
<i>H9_a</i> $Cov \Rightarrow RT$	0.345	0.059*
<i>H9_b</i> $Cov \Rightarrow CBT$	0.332	0.025**
<i>H9_c</i> $Cov \Rightarrow CPS$	0.029	0.332
<i>H10_a</i> $TrC \Rightarrow RT$	0.423	0.889
<i>H10_b</i> $TrC \Rightarrow CBT$	0.564	0.929
<i>H10_c</i> $Sim*TrC \Rightarrow RT$	0.129	0.731
<i>H10_d</i> $Sim*TrC \Rightarrow CBT$	0.004	0.503
<i>H10_e</i> $Com*TrC \Rightarrow RT$	0.128	0.284
<i>H10_f</i> $Com*TrC \Rightarrow CBT$	0.005	0.487
<i>H10_g</i> $Cov*TrC \Rightarrow RT$	0.075	0.327
<i>H10_h</i> $Cov*TrC \Rightarrow CBT$	0.054	0.364

Note: *P < 0.1, **P < 0.05

Note: Path coefficients-diff = |(Age > 50 years) - (Age ≤ 50 years)|

Furthermore, multi-group PLS-SEM is conducted to investigate the role of respondents' experience and the number of projects that they have managed. Since these two criteria are correlated and MGA results are similar, for the sake of brevity, the MGA result of work experience of respondents is in the Appendix A (Table A.8). Based on the level of the number of projects managed by respondents, the data is split into two groups: data regarding the respondents who were involved in 20 projects or more (n = 64) and respondents who were involved in less than 20 projects (n = 108). The results of the MGA for the number of projects that respondents were involved show that for the group contains more experienced respondents, coverage of knowledge has a statistically significant higher effect on relational trust and competence-based trust (Path coefficients: 0.288 and 0.275 respectively) compared to less experienced respondents (Path coefficients: -0.193 and -0.286 respectively). While the remaining path relationships between latent variables are found to be similar across the two groups. Table 3.15 shows the MGA for the number of projects that respondents were involved.

In addition, there are two questions about the number of partners in the project. first, about the number of partners involved in the project, and second, about the number of partners involved in the project that the project managers had a past collaboration with them. We

Table 3.15 – Multi-Group Analysis for N. of projects

Proposed path	Path coefficients-diff	<i>p</i> -value
<i>H1</i> <i>PI</i> ⇒ <i>CPS</i>	0.290	0.865
<i>H2</i> <i>TC</i> ⇒ <i>PI</i>	0.006	0.393
<i>H3</i> <i>OC</i> ⇒ <i>PI</i>	0.100	0.300
<i>H4</i> <i>SC</i> ⇒ <i>PI</i>	0.005	0.436
<i>H5</i> <i>RT</i> ⇒ <i>PI</i>	0.225	0.202
<i>H6</i> <i>CBT</i> ⇒ <i>PI</i>	0.288	0.894
<i>H7_a</i> <i>Sim</i> ⇒ <i>RT</i>	0.106	0.312
<i>H7_b</i> <i>Sim</i> ⇒ <i>CBT</i>	0.060	0.622
<i>H8_a</i> <i>Com</i> ⇒ <i>RT</i>	0.031	0.437
<i>H8_b</i> <i>Com</i> ⇒ <i>CBT</i>	0.060	0.381
<i>H9_a</i> <i>Cov</i> ⇒ <i>RT</i>	0.563	0.029**
<i>H9_b</i> <i>Cov</i> ⇒ <i>CBT</i>	0.556	0.023**
<i>H9_c</i> <i>Cov</i> ⇒ <i>CPS</i>	0.224	0.873
<i>H10_a</i> <i>TrC</i> ⇒ <i>RT</i>	0.423	0.951
<i>H10_b</i> <i>TrC</i> ⇒ <i>CBT</i>	0.097	0.660
<i>H10_c</i> <i>Sim*TrC</i> ⇒ <i>RT</i>	0.133	0.289
<i>H10_d</i> <i>Sim*TrC</i> ⇒ <i>CBT</i>	0.080	0.337
<i>H10_e</i> <i>Com*TrC</i> ⇒ <i>RT</i>	0.116	0.313
<i>H10_f</i> <i>Com*TrC</i> ⇒ <i>CBT</i>	0.037	0.587
<i>H10_g</i> <i>Cov*TrC</i> ⇒ <i>RT</i>	0.210	0.855
<i>H10_h</i> <i>Cov*TrC</i> ⇒ <i>CBT</i>	0.176	0.852

Note: **P < 0.05

Note: Path coefficients-diff = |(N. of projects ≥ 20) - (N. of projects < 20)|

have defined criteria and named it “Familiarity rate” to calculate a ratio that indicates how familiar the project manager was with the partners. A formula to calculate Familiarity rate is shown in Equation 3.1.

$$\text{Familiarity rate} = \frac{\text{Number of partners with a previous collaboration in the project}}{\text{Total number of partners involved in the project}} \quad (3.1)$$

A multi-group analysis is applied to analyze the role of familiarity in a collaboration. Based on the Familiarity rate that is calculated for all the responses, the data is split into two groups: first group with Familiarity rate equal or more than 0.5 (n = 74), which means the project manager was familiar with half or more of the partners before the collaboration for the project, and the second group with Familiarity rate less than 0.5 (n = 98). The results of the MGA for Familiarity rate show that for the group contains more familiar partners, coverage of knowledge has a statistically significant higher effect on competence-based trust and complex project success (Path coefficients: 0.245 and 0.363 respectively) compared to less familiar partners (Path coefficients: -0.183 and -0.350 respectively). While the remaining path relationships between latent variables are found to be similar across the two groups. Table 3.16 shows the MGA for the Familiarity rate.

Table 3.16 – Multi-Group Analysis for familiarity rate

Proposed path	Path coefficients-diff	p-value
H1 $PI \Rightarrow CPS$	0.026	0.520
H2 $TC \Rightarrow PI$	0.004	0.483
H3 $OC \Rightarrow PI$	0.015	0.544
H4 $SC \Rightarrow PI$	0.127	0.224
H5 $RT \Rightarrow PI$	0.198	0.806
H6 $CBT \Rightarrow PI$	0.049	0.414
H7 _a $Sim \Rightarrow RT$	0.243	0.873
H7 _b $Sim \Rightarrow CBT$	0.047	0.379
H8 _a $Com \Rightarrow RT$	0.060	0.561
H8 _b $Com \Rightarrow CBT$	0.102	0.692
H9 _a $Cov \Rightarrow RT$	0.370	0.122
H9 _b $Cov \Rightarrow CBT$	0.429	0.089*
H9 _c $Cov \Rightarrow CPS$	0.713	0.057*
H10 _a $TrC \Rightarrow RT$	0.068	0.616
H10 _b $TrC \Rightarrow CBT$	0.078	0.666
H10 _c $Sim*TrC \Rightarrow RT$	0.114	0.285
H10 _d $Sim*TrC \Rightarrow CBT$	0.281	0.061
H10 _e $Com*TrC \Rightarrow RT$	0.013	0.543
H10 _f $Com*TrC \Rightarrow CBT$	0.170	0.815
H10 _g $Cov*TrC \Rightarrow RT$	0.238	0.868
H10 _h $Cov*TrC \Rightarrow CBT$	0.040	0.593

Note: *P < 0.1

Note: Path coefficients-diff = |(familiarity rate ≥ 0.5) - (familiarity rate < 0.5)|

3.5 Conclusion and discussion

Forming a partnership is one answer to the need for innovation and complex project barriers in this competitive world. Furthermore, it is critical to understand what is influencing innovative

complex project success in a partnership. In this chapter, we propose a new conceptual model based on several hypotheses extracted from the literature review, to comprehend the roles of different knowledge criteria in trust, trust and complexity on innovation in projects, innovation and coverage of knowledge effect on project success. In addition, the moderator role of trust capability is also considered to moderate the relationship between knowledge and mutual trust of partners.

To do so, eleven hypotheses were presented based on previous studies to build the conceptual model. Then, a survey was designed and completed by European project managers, and PLS-SEM was used to analyze the data and assess the hypotheses.

In this analysis firstly, evidence is provided for the fact that if a project is more innovative then it is more successful. Second, this study validates the positive role of coverage of knowledge (required for the project) in complex project success. Moreover, relational trust has a significant positive effect on project innovation. Furthermore, evidence is also provided for the fact that if a project is more technically complex by its nature, and organizationally complex in terms of diversity of staff and information systems then it is associated with more innovativeness. Considering the knowledge criteria, the effects of similarity and complementarity in the relational trust, and complementarity on competence-based trust shows a statistically significant effect, but the evidence does not validate the role of coverage on trust.

The finding of this chapter has also shown that the trust capability of each individual has a significant positive effect on relational trust and competence-based trust. Besides, trust capability operated as a moderator for the positive effect of similarity on both relational trust and competence-based trust. In the low level of trust capability, these positive effect has become stronger for both kinds of trust. On the other hand, in the high level of trust capability, the positive effect of similarity on relational trust has been modified to the negative effect, and the positive effect of similarity on competence-based trust has become weaker.

Although the research findings discussed in this study are based on a data sample from European projects, we believe due to the similar attributes of partnerships, the methodology and some of the results of this paper can be extended for other complex projects.

3.5.1 Implications for practice

In line with theoretical insights, this chapter brings into light several practical implications for innovative complex projects, their managers and partners. First of all, the findings of this chapter prove that in complex projects, innovation increases project success. Hence, project managers are advised to support innovative ideas, new management methods, and changes in organizational operations and production as much as innovation in the final product or service. In addition, the significant positive direct effect of coverage of knowledge in a partnership on the success of the project is verified in this chapter. Therefore, According to this finding, it is recommended that the selection of partners for complex projects be such that it covers all the knowledge necessary to complete the project.

Moreover, considering the positive effect of organizational complexity on project innovation, it can be concluded that conducting a complex project with high investment in a partnership can increase innovation due to the variety of staff, information systems and institutional configuration.

Furthermore, other results of this chapter show that relational trust, which is a kind of trust that is forming during communication, has a significant positive effect on project innovation. While, no such effect is shown regarding the competence-based trust, which is a kind of trust that firms at the beginning of collaboration based on tangible information. Considering these results we invite decision-makers in innovative complex projects to invest in increasing relational trust between partners in the partnership. Also, considering the

result of moderating effect, especially for the people who have a low level of trust capability, the increasing similarity of knowledge can highly increase the trust between them. Hence, we draw the attention of decision-makers to the fact that increasing the similarity in knowledge between partners can increase trust between them and thus have a positive impact on the innovation and success of the project.

As mentioned in the findings of importance-performance map analysis for project success, the lowest performance in the project that we gathered data from them was related to the similarity and coverage of knowledge between partners in projects. These results show a great space for improvement, thus project managers should focus on increasing the similarity and coverage for their future projects to increase project success. Additionally, the highest importance score is related to project innovation, which again reminds the importance of innovation in the success of the project. Accordingly, since innovation has a significant positive effect on project success, and rational trust has a positive effect on innovation, we recommend choosing the partners of future projects considering the similarity and well as complementarity of knowledge to increase their relational trust.

Finally, the multi-group analysis results show that the role of coverage on relational trust and competence-based trust is more significant by the evaluation of project managers with more experience. Also, for the project that there were some past collaborations with more than half of partners, the role of coverage on competence-based trust and complex project success is significantly higher. These findings support the idea that in selecting the partners of a project, especially if there is a previous familiarity between the potential partners of the partnerships, alongside the consideration of the similarity and complementarity of knowledge between partners, more weight should be given to the coverage of knowledge in the partnership.

3.5.2 Limitation and future research direction

Although the findings of this study have revealed several important causes and effects about factors related to the complex project success and its managerial aspects, yet there are some limitations in different steps of this chapter that need to be considered.

Firstly, there are some limitations considering the proposed hypothesized conceptual model of this chapter. The model for measuring trust and its different dimensions in this study is one of the several models in the literature. Considering other classifications in future studies and compare them with the results of this chapter might clarify other aspects. This consideration is also related to the classification of the innovation. According to the limitations in designing a survey to make it as short as possible and easy to answer, it was not possible to ask about other aspects of innovation in a project (i.e. radical and incremental innovation). Hence, there are other classifications and relationships between factors that can be considered in future studies.

Secondly, the data of this chapter are collected mostly from European projects and research projects. Hence, there is hesitation to generalize the conclusion of this study to countries and projects with different domains and configurations. Future studies with the possibility of gathering data from other kinds of projects and countries might indicate if it is a significant difference in complex project success factors in different project domains.

In addition of the biggest constraint of this study was the low sample size due to the limited resources and time as well as the Covid-19 confinement period. In this chapter, we used the snowball sampling technique with an online survey. Further studies can overcome these limitations by changing the other sampling technique (i.e. face-to-face interviews).

4

The role of project managers experience

4.1	Introduction	67
4.2	Theoretical background	68
4.2.1	The role of work experience	68
4.3	Current chapter and research questions	69
4.4	Materials and methods	71
4.4.1	Survey design and data collection	71
4.5	Data analysis	71
4.5.1	Data screening and pre-analysis	73
4.5.2	Validation of the collected data	73
4.5.3	Hypothesis assessment	75
4.5.4	Descriptive statistical analysis	75
4.5.5	Correlation analysis between variables	77
4.6	Conclusion and discussion	82
4.6.1	Practical implications	83
4.6.2	Limitation and future research direction	83

“Science means constantly walking a tightrope between blind faith and curiosity; between expertise and creativity; between bias and openness; between experience and epiphany; between ambition and passion; and between arrogance and conviction – in short, between old today and a new tomorrow.”

Henrich Rohrer

4.1 Introduction

Human capital obtains from experience and has been described as “knowledge, skills and other acquired personal characteristics” possessed individually and collectively by individuals in a population. Human capital scholars are increasingly identifying the importance of human capital deficiency for explaining individual and firm outcomes (Mackey et al., 2014). Considerable empirical studies found a connection between experience and improvement over time (i.e., learning-by-doing) through a wide variety of domain (see, for example, Child et al. (2017), Easton et al. (2012), Lapre et al. (2000), Lapre et al. (2001), Thompson (2010), and

Yi et al. (2021)). As time goes by, individuals' judgment and performance on their activity do not remain the same, because they are aging, and because they are gaining experience. The experience itself can be modified because of increased age since individuals gain a kind of self-knowledge, a more or less aware evaluation of their own evolving capacities, faced working situations (Pueyo et al., 2011a).

Work experience is a key noticeable productivity characteristic in project management. Since a lot of managers' learning occurs on the job, this informal learning on their job is of major importance in the development of managers in complex careers who have to deal with new and unanticipated challenges in the environment (Eraut, 2004; Savelsbergh et al., 2016). Due to various reasons, this might mainly be verifiable for project managers, who often seem to "learn by doing" from their work experiences, rather than learn by their education. For instance, most project managers perform their project responsibilities besides another job; a more permanent career for which they have been educated. Moreover, even if being a project manager is their primary job, most project managers did not set out to work towards this role when they first entered the job market, but have been promoted at a later stage in their career (Savelsbergh et al., 2016). Hence, past events play an important role in determining current strategic decisions. The influence of work experience on decision-makers' opinion has received a lot of attention particularly within the domain of risky decision-making and financial markets (Bartelink et al., 2018; Thaler, 1980).

In this chapter, we examine the correlation between project managers' work experience and their opinion about the success of a complex project conducted with partnerships. Since this chapter is a complement of the previous chapter (Chapter 3), we applied our analysis based on the same variables identified in Figure 3.6, but with a different set of data gathered by the survey. The objectives of this chapter are: first to analyze the relationship between project managers' experience and success in their project. Second, to analyze if the experience of project managers has an influence on their judgment about project success six dimensions (cost, time, quality, reputation, team satisfaction, and stakeholder satisfaction). Third, to investigate the relationship between project managers' experience and their judgment about important variables in complex project success. In particular, to investigate if the work experience of project managers will change their opinion about the importance of knowledge criteria between partners, complexity dimensions, trust, and project innovation. Forth, to look into the correlation between project managers' opinion and their judgment about all the variables indicators (all the questions in the survey), to have a more global view. Finally, to provide some practical and academic implications in this domain.

The remaining sections of this chapter are organized as follows: Section 4.2 presents the relevant literature and theoretical background. Section 4.3 includes research questions of this chapter. Section 4.4 provides the research design which includes survey design, data collection and data analysis methodology. Section 4.5 demonstrates data analysis results. The chapter ends with discussion and conclusion in Section 4.6.

4.2 Theoretical background

4.2.1 The role of work experience

Research suggests that prior experience plays a significant role in learning and is an important noticeable characteristic in human performance. A growing number of learning-by-doing research investigates the role of multiple measurements of experience in work in different domains and organizations (Cohen et al., 1997). Such studies have provided empirical proof that various types of experience come up with different contributions to work performance (i.e. individual experience, organizational experience, team leader experience, ...) (Easton et al., 2012).

Experience has been considered in different domains in the literature. Pueyo et al. (2011b) investigated the role of worker experience in night work. It is indicated in their research that experience help workers to gain familiarity with their tasks, ability to identify the acute situation, having more self-knowledge and awareness of cause and effect in a difficult situation. They concluded that such experience is more valuable at night, considering the fatigue and lack of supervision. Bawack et al. (2021) explored how prior experience affects customer experience performance perceptions. They have examined survey data from US-based voice shoppers to check if the prior experience with smart speakers will increase the trust of customers in their smart speaker manufacture. Their results proved the significant positive effect of customer prior experience on their trust. Aida (2021) indicated that work experience has a significant effect on audit judgment. The result of this research showed that with work experience, auditors can reduce the influence of irrelevant information in the consideration to be taken. Also, it is concluded that the more experienced an auditor is, the greater the auditor's ability to deal with any existing problems and can help the auditor predict and detect problems professionally.

Multiple research investigates the role of experience in the context of managers and projects. For instance, Buckenmaier et al. (2021) examined the influence of positive and negative experiences on trust and cooperation. Their results revealed that the effect of prior experience depends on the similarity of tasks. Easton et al. (2012) analyzed the role of individual experience, team leader experience, organizational experience, and experience of working together. They have used archived data generated by successful and unsuccessful six sigma improvement projects. The analysis showed that the most significant relationship is the positive effect of team leader experience on project success. Also, the effect of organizational experience is positive on project success. However, they could not find any significant relationship between individual experience or team familiarity and project success.

Moreover, Matemilola et al. (2018) applied trade-off theory to examine the managerial experience of top-level management as a determinant of capital structure. Their result revealed that top managers' experience can maximize the benefits and increase firm value. Majocchi et al. (2018) expressed that the international work experience of decision-makers significantly contributes to better differentiation between the business models that they pursue.

4.3 Current chapter and research questions

Based on the above theoretical background and related studies, the current chapter examines the relationship between project managers' work experience and complex project success, and also the relationship between project managers' experience and their judgment about important factors influencing project success.

Accordingly considering the literature review in Section 4.2 and the logical effect of project managers experience on complex project success, the following hypothesis proposed:

Hypothesis. The project managers experience has a positive effect on complex project success.

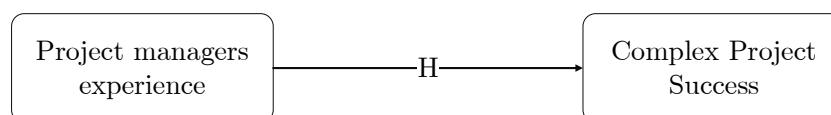


Figure 4.1 – Hypothesized relationship between project managers' experience and complex project success

In addition, as mentioned before, this chapter is a part of a larger study (Chapter 3 of this thesis) looking at a hypothesized conceptual model to investigate the relationship between different variables in complex projects. Our previous chapter revealed that based on the data we gathered from project managers, project innovation and coverage of knowledge have a significant positive direct effect on complex project success. Also, technological complexity, organizational complexity, relational trust, trust capability, similarity, and complementarity have a significant indirect effect on complex project success. The previous chapter's findings were based on the actual experience of project managers on their last project. In this chapter, We are using the same variables that are driven by a comprehensive literature review and presented in the hypothesized conceptual model as shown in 3.6. Figure 4.2 recalls the factors related to the innovative complex project.

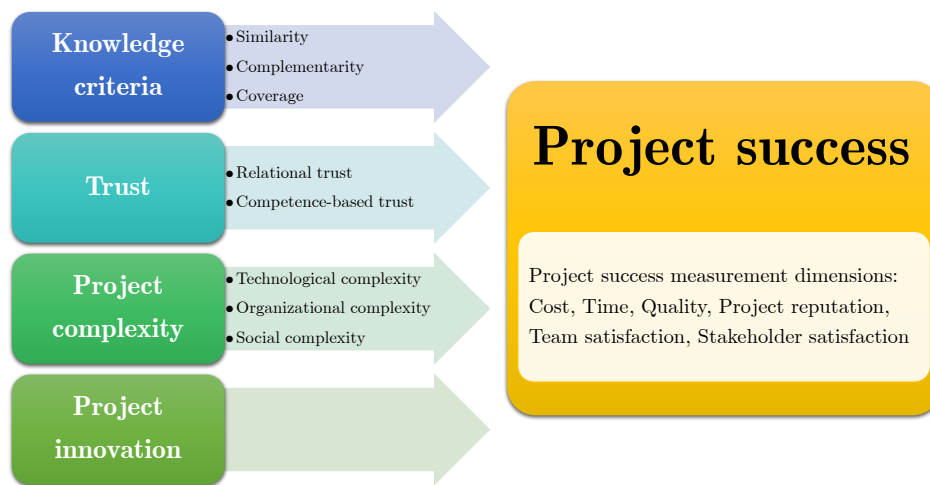


Figure 4.2 – Factors related to the innovative complex project from Chapter 3 of this thesis

What has not been done in the previous chapter is to investigate the role of project managers' work experience on their opinion about project success factors. We hope that this study provides insights in this regard. The following research questions guided this study:

1. Are projects managed by experienced managers more successful?
2. Considering the six dimensions of measuring project success (cost, time, quality, reputation, team satisfaction and stakeholder satisfaction), what is the impact of experience on project managers' opinion about the importance of each dimension?
3. Does project managers' work experience have an impact on their judgment about the importance of different variables (knowledge criteria between partners, complexity dimensions, trust and project innovation)?
4. Does project managers' work experience have an impact on their judgment about the importance of all the indicators used to measure the different variables?

We believe that answering the above questions can help especially younger project managers in their tough decisions regarding complex projects.

4.4 Materials and methods

This chapter uses correlation analysis to test the relationship between project managers' work experience and their judgment about project success. Correlation analysis is commonly used as a data analysis method in social science. A survey was created out of concepts that are drawn from the literature review of this chapter and Chapter 3. Spearman rank-order correlation coefficient (Spearman's correlation, for short) used in this chapter to verify the mentioned relationships (Kirch, 2008; Wayne W, 2008). The importance of the characteristic of innovative complex projects and participants in these projects, in addition to the work experience of the respondents of the survey, are the units of our analysis. Moreover, the project managers who at least have participated in managing one innovative complex project with more than one partner are the unit of our observation.

4.4.1 Survey design and data collection

In order to examine the correlation between project managers' experience and their judgment on project success factors, a research survey was designed adopted from (Wang et al., 2019) to collect data from innovative project managers. The survey was first designed, then validated by expert opinion in project management and innovation, and finally pre-tested with a small sample before sending it to the final respondents.

The final survey includes 43 questions categorized into 11 groups, out of which six of questions belonged to Complex Project Success (CPS), four questions belonged to Project Innovation (PI), four questions belonged to Technological Complexity (TC), five questions belonged to Organizational Complexity (OC), four questions belonged to Social Complexity (SC), four questions belonged to Similarity (Sim), four questions belonged to Complementarity (Com), four questions belonged to Coverage (Cov), four questions belonged to Relational Trust (RT) and four questions belonged to Competence-Based Trust (CBT). The complete survey is available in Table A.1 (Appendix A).

An ordinal scale is used in order to measure the degree of importance (High importance, medium importance, Low importance, Neutral or Undecided). Furthermore, to validate the questions in the survey, first, the expert opinion was taken into account, and second, a pilot test round was conducted with a small sample of 15 volunteers among colleagues. Some minor modifications were made in the survey to be reliable and valid for data collection. Figure 4.3 shows the first question in the survey as an example. To obtain the work experience of respondents, we asked them to choose between the work experience years interval as it is shown in Figure 4.4.

The data collection tool was a web survey, developed with the use of the "SurveyMonkey" website. It was addressed to the response of project managers mostly from European projects (survey is accessible in the following link: <https://www.surveymonkey.com/r/X6WMSPV>). First, we have selected European project managers from the ANR website and the survey link has been sent to them by email. Then we asked the receptions of email to send the survey to their related network, so it is not possible to know the exact response rate, but we estimate less than 10%. Finally, the total number of valid responses to the survey is 172 complete responses.

4.5 Data analysis

As explained in the last section, Spearman's correlation is performed in this chapter. The Spearman rank correlation coefficient (Spearman ρ) is a non-parametric measurement correlation. It is used to determine the relationship existing between two sets of data (Baak et al., 2020; Wayne W, 2008). This test is used for both ordinal variables and continuous data unlike

* How important do you think is to respect the allocated budget for the success of innovative complex projects?

- High importance
- Medium importance
- Low importance
- Neutral or Undecided

Figure 4.3 – An example of questions related to the project managers opinion (degree of importance for respect the allocated budget)

* Work experience

- Less than 5 years
- Between 5 to 10 years
- Between 11 to 15 years
- Between 16 to 20 years
- More than 20 years
- Other (please specify)

Figure 4.4 – Work experience question in the survey

the necessary assumptions for conducting the Pearson's product-moment correlation (Kirch, 2008; Zar, 2014). Accordingly, Spearman's correlation is the best statistical correlation method for this chapter. However, it is essential to apply prior data analysis tests to ensure the quality, reliability, and validity of the data.

In this study, we use SPSS 28.0 software to analyze the collected data including reliability analysis, validity analysis, and correlation analysis.

4.5.1 Data screening and pre-analysis

In this study, all the 172 responses were complete, since it was not possible to submit the online survey without answering all the questions. Therefore, the data analysis begins with an analysis of the demographic characteristic of respondents. The complete details of respondents' characteristics have shown in Table 3.2. Table 4.1 shows the information about the work experience of respondents which is more related to this chapter.

Table 4.1 – Work experience of the respondents (project managers)

Attributes	Type	Frequency	%
Work experience	Less than 5 years	11	6%
	Between 5 to 10 years	17	10%
	Between 11 to 15 years	28	16%
	Between 16 to 20 years	28	16%
	More than 20 years	88	50%

In order to do the statistical analysis, we need to re-scale ordinal data to numerical equivalent. Table 4.2 and Table 4.3 show the measurement scales in the survey and their replacement in the statistical analysis.

Table 4.2 – Importance measurement scale

Importance measurement scale	Replaced by
Neutral or undecided	1
Low important	2
Medium important	3
High important	4

Table 4.3 – Work experience measurement scale

Work experience measurement scale	Replaced by
Less than 5 years	1
Between 5 to 10 years	2
Between 11 to 15 years	3
Between 16 to 20 years	4
More than 20 years	5

4.5.2 Validation of the collected data

Reliability in statistics refers to the overall consistency of a measure which means the integrity and consistency of the data (Bonett et al., 2015). This chapter chooses the most frequently

used method that is Cronbach's Alpha testing to test the overall reliability of the statistics. In reliability tests, the total value of Cronbach's alpha for all 43 questions is 89.4%, which is admissible since the minimum acceptable number is 70% (Santos, 1999). The Cronbach's alpha for each factor is reported in Table 4.4. According to Pallant (2013), for the factors that are measured with less than 10 questions, Cronbach's alpha above 0.5 is acceptable. Accordingly, the reliability test approves the reliability for all factors.

Table 4.4 – Reliability of latent variables

Latent variables	Cronbach's Alpha
Complex project success	0.539
Project innovation	0.599
Complexity (all indicators)	0.810
Organizational complexity	0.618
Technological complexity	0.657
Social complexity	0.817
Knowledge (all indicators)	0.747
Similarity	0.706
Complementarity	0.719
Coverage	0.545
Trust (all indicators)	0.696
Relational Trust	0.699
Competence-based Trust	0.610

Validity in statistics refers to examining how a measure corresponds accurately to the real world. To test the validity of the collected data, it is most common to check if there is a significant difference between the responses of respondents (Armstrong et al., 1977). To do so, an independent t-test is applied using the first 50 and last 50 responses to compare if there is any significant difference between the means of answered of these two groups. The results of these analyses have shown that there is no significant difference in 0.05 level¹ (all the p-values are above 0.05) between the means of the two groups. The result of the validity test is shown in Table 4.5. Hence, based on these findings, it is concluded that the collected data is reliable and validated.

Table 4.5 – Validity of indicators

Questions	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value
<i>CPS</i> ₁ *	0.776	<i>OC</i> ₁₂	0.582	<i>SC</i> ₂₃	0.247	<i>Cov</i> ₃₄	0.835
<i>CPS</i> ₂	0.379	<i>OC</i> ₁₃	0.0700	<i>Sim</i> ₂₄	0.474	<i>Cov</i> ₃₅	0.314
<i>CPS</i> ₃	0.872	<i>OC</i> ₁₄	1.000	<i>Sim</i> ₂₅	0.229	<i>TrC</i> ₃₆	-
<i>CPS</i> ₄	0.155	<i>OC</i> ₁₅	0.056	<i>Sim</i> ₂₆	0.056	<i>RT</i> ₃₇	0.545
<i>CPS</i> ₅	0.209	<i>TC</i> ₁₆	0.051	<i>Sim</i> ₂₇	0.900	<i>RT</i> ₃₈	0.377
<i>CPS</i> ₆	0.219	<i>TC</i> ₁₇	0.252	<i>Com</i> ₂₈	0.195	<i>RT</i> ₃₉	0.589
<i>PI</i> ₇	0.743	<i>TC</i> ₁₈	0.079	<i>Com</i> ₂₉	0.116	<i>RT</i> ₄₀	0.469
<i>PI</i> ₈	0.133	<i>TC</i> ₁₉	0.655	<i>Com</i> ₃₀	0.275	<i>CBT</i> ₄₁	0.857
<i>PI</i> ₉	0.387	<i>SC</i> ₂₀	0.141	<i>Com</i> ₃₁	0.053	<i>CBT</i> ₄₂	0.280
<i>PI</i> ₁₀	0.100	<i>SC</i> ₂₁	0.064	<i>Cov</i> ₃₂	0.367	<i>CBT</i> ₄₃	0.180
<i>OC</i> ₁₁	0.910	<i>SC</i> ₂₂	0.334	<i>Cov</i> ₃₃	0.555	<i>CBT</i> ₄₄	0.408

*i.e. *CPS*₁ refers to first question which measures Complex Project Success (CPS)

¹95% confidence interval

4.5.3 Hypothesis assessment

In order to analyze the relationship in the hypothesis, bootstrapping is used and performed by SmartPLS version 3 (Hall et al., 1991). Table 4.6 shows the result of this analysis. According to the result, increasing the work experience of project managers will increase complex project success.

Table 4.6 – Path coefficients between work experience and complex project success

Path	β -value	p -value
Project managers' work experience \Rightarrow Complex project success	0.320	0.001***

Note: ***P < 0.01

Considering the significant positive effect of project managers' experience on the success of complex projects. In the following subsection, we investigate how this experience changes their opinion about different factors in the project.

4.5.4 Descriptive statistical analysis

Table 4.7 presents a summary of the data descriptive statistics analysis. Based on it, it can be said that most of the survey questions had a high "Average", with a value greater than 2.5, within the range of one (Neutral or Undecided) to four (High importance). The highest importance average (> 3.9) is for two questions related to the relational trust between partners; the importance of honesty of the partner (RT_{37}) and the importance of having a partner who consider others benefits (RT_{39}).

The lowest importance average (< 2.5) is for all the questions related to the social complexity; the importance of having different legal systems involved in the project (SC_{20}), the importance of having variety in local laws and regulation (SC_{21}), the importance of having interdependency between different institutional configurations (SC_{22}) and importance of having local environmental complexity (SC_{23}). Moreover, the other lowest importance average is for the third question related to the similarity; the importance of having a partner who has a similar service (Sim_{26}). Eventually, the last lowest important average is for the third question related to competence-based trust; the importance of having partners who are known to be accredited with a quality control standard (CBT_{43}).

Regarding the "Standard deviation", the highest values (> 1) are for the questions: the fourth question of project innovation (importance of changes in staffing levels, job roles and behaviors (PI_9)), the fourth question of knowledge complementarity (importance of having partners who can provide the service that we can not (Com_{31})), the third question of knowledge coverage (to cover all the services that require for the project with the partnership (Cov_{34})).

It is also worth mentioning that almost all the questions contain the minimum (1 = Neutral or Undecided) and maximum (4 = High importance) of data. However, for two of the questions regarding project success (importance of meeting project objectives (CPS_2) and achieving objective on time (CPS_3)), the minimum data is 2 (Low importance).

In addition, the high average (> 3.5) and standard deviation (> 1) of the data related to the work experience of the respondents show the majority of people who answered the survey had a high work experience, but also there is a high dispersion between work experience of respondents (this information is also available in percentage form in 4.1).

Although based on the ordinary nature of the scales in this survey, average and the standard deviation is not the most exact measure to interpret the data, it can give us a first look at the concentration and dispersion of data.

Table 4.7 – Results of descriptive statistics

Questions	Average	Standard deviation	Minimum	Maximum
<i>CPS</i> ₁	3.4070	0.71538	1	4
<i>CPS</i> ₂	3.7733	0.43365	2	4
<i>CPS</i> ₃	3.3488	0.61687	2	4
<i>CPS</i> ₄	3.2267	0.83826	1	4
<i>CPS</i> ₅	3.2267	0.96778	1	4
<i>CPS</i> ₆	3.7616	0.44080	1	4
<i>PI</i> ₇	3.3488	0.93992	1	4
<i>PI</i> ₈	3.2907	0.83584	1	4
<i>PI</i> ₉	3.6163	0.72819	1	4
<i>PI</i> ₁₀	2.6686	1.03763	1	4
<i>OC</i> ₁₁	2.5116	0.86172	1	4
<i>OC</i> ₁₂	2.7209	0.98112	1	4
<i>OC</i> ₁₃	2.7907	0.96265	1	4
<i>OC</i> ₁₄	3.5930	0.66452	1	4
<i>OC</i> ₁₅	2.6977	0.95599	1	4
<i>TC</i> ₁₆	2.7326	0.97242	1	4
<i>TC</i> ₁₇	3.2674	0.94187	1	4
<i>TC</i> ₁₈	2.9360	0.97422	1	4
<i>TC</i> ₁₉	3.3779	0.90624	1	4
<i>SC</i> ₂₀	2.2500	0.94976	1	4
<i>SC</i> ₂₁	2.1163	0.95414	1	4
<i>SC</i> ₂₂	2.3140	0.99427	1	4
<i>SC</i> ₂₃	2.1686	0.88559	1	4
<i>Sim</i> ₂₄	2.6802	0.86319	1	4
<i>Sim</i> ₂₅	2.5174	0.86838	1	4
<i>Sim</i> ₂₆	2.3488	0.87549	1	4
<i>Sim</i> ₂₇	2.6279	0.84530	1	4
<i>Com</i> ₂₈	3.6686	0.64938	1	4
<i>Com</i> ₂₉	3.3953	0.98265	1	4
<i>Com</i> ₃₀	3.4535	0.91328	1	4
<i>Com</i> ₃₁	2.5756	1.04299	1	4
<i>Cov</i> ₃₂	3.5233	0.66186	1	4
<i>Cov</i> ₃₃	3.5814	0.75649	1	4
<i>Cov</i> ₃₄	3.0872	1.01363	1	4
<i>Cov</i> ₃₅	3.5988	0.77731	1	4
<i>TrC</i> ₃₆	-	-	-	-
<i>RT</i> ₃₇	3.9302	0.33476	1	4
<i>RT</i> ₃₈	3.8372	0.45526	1	4
<i>RT</i> ₃₉	3.9012	0.39971	1	4
<i>RT</i> ₄₀	3.4767	0.81257	1	4
<i>CBT</i> ₄₁	3.5000	0.66227	1	4
<i>CBT</i> ₄₂	3.5872	0.77116	1	4
<i>CBT</i> ₄₃	2.1628	0.98361	1	4
<i>CBT</i> ₄₄	3.3198	0.90293	1	4
Work experience	3.9593	1.28581	1	5

4.5.5 Correlation analysis between variables

Project success measurement dimensions

Considering the six dimensions of measuring project success, as a part of the analysis, we analyzed the data in terms of the number of responses for each question. Figure 4.5 to Figure 4.10 show the bar charts for the responses of all the six questions regarding the importance of project success dimensions. Based on this figure, meeting organizational objectives and stakeholder satisfaction received the highest number of “high importance” responses.

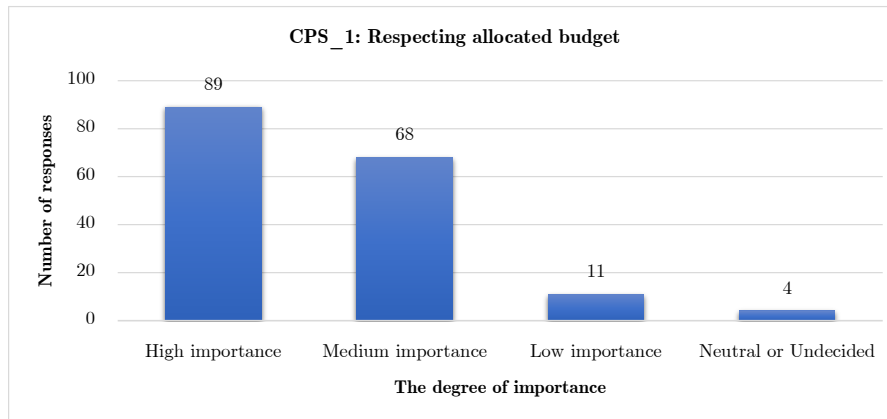


Figure 4.5 – Responses of first question of CPS

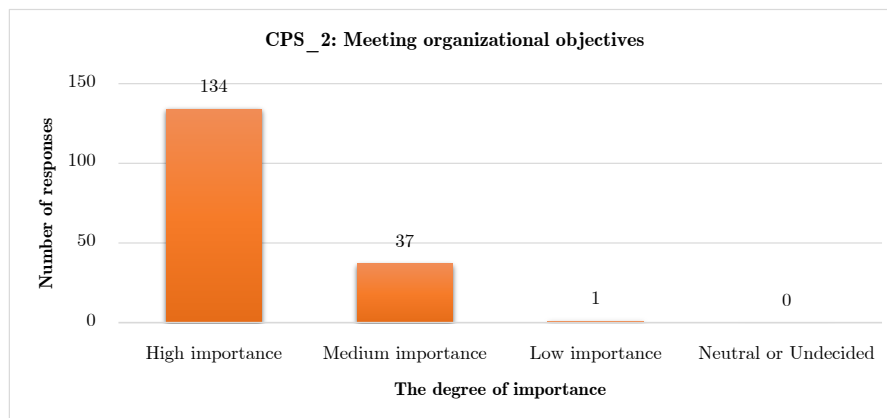


Figure 4.6 – Responses of second question of CPS

In addition, to analyze the relationship between project managers’ work experience and their judgment about the importance of project success dimensions, we proceeded to the analysis of the correlation. Since each item was evaluated with ordinal variables, Spearman’s correlation coefficient was used to evaluate the relationships between single items from each variable.

Table 4.8 shows the correlation matrix between the work experience and importance of each project success dimension. The bolded values show a significant correlation. According to this result, by having more experience, project managers think that “meeting organizational

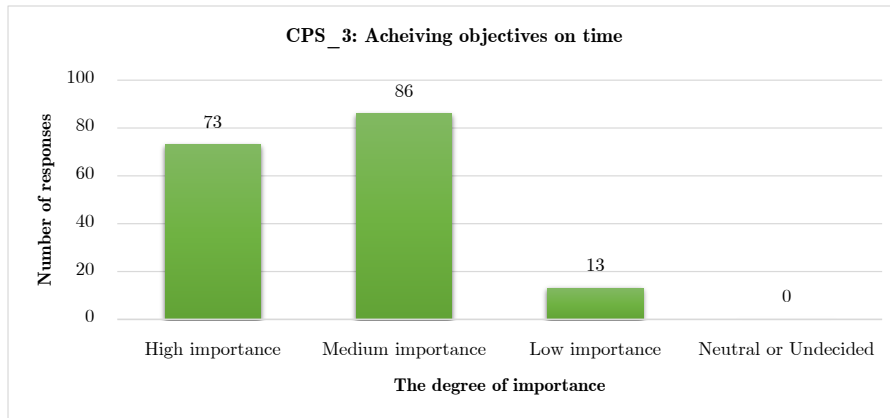


Figure 4.7 – Responses of third question of CPS

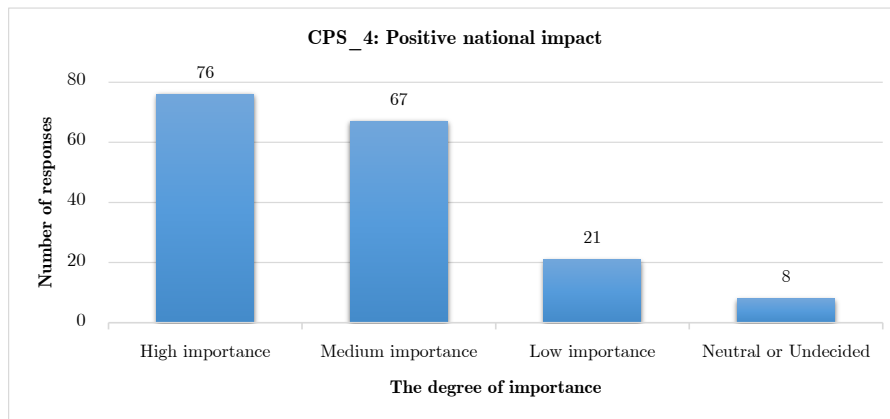


Figure 4.8 – Responses of fourth question of CPS

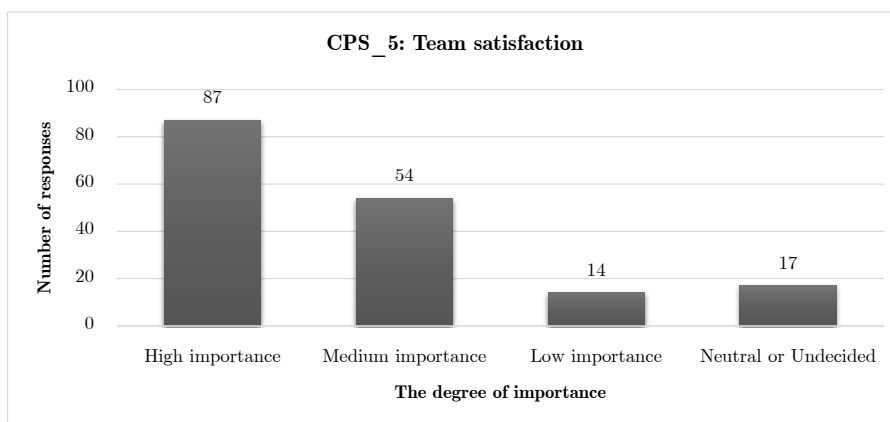


Figure 4.9 – Responses of fifth question of CPS

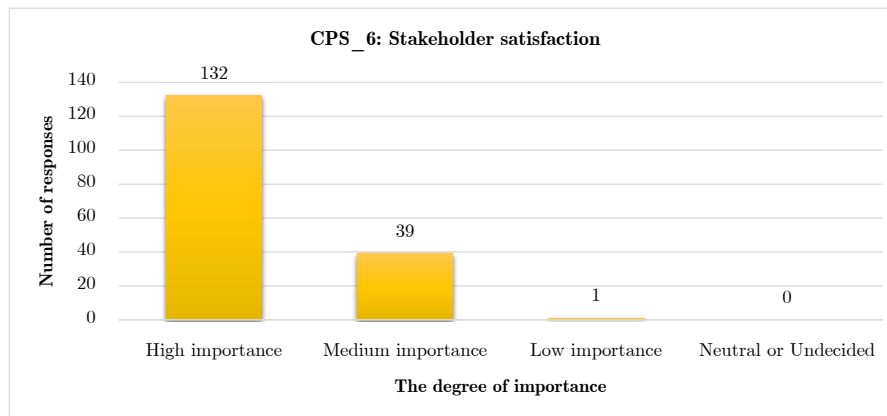


Figure 4.10 – Responses of sixth question of CPS

objectives, project team satisfaction, and stakeholder satisfaction” are more important. In addition, these result shows that by having more experience, there is no significant difference in project managers’ opinion about the importance of “respecting allocated budget, achieving objectives on time and have a positive national impact”.

Table 4.8 – Correlation between work experience and their judgement about project success dimensions

		CPS_1	CPS_2	CPS_3	CPS_4	CPS_5	CPS_6
WE	Spearman’s Correlation	-0.090	0.193**	0.070	0.068	0.163**	0.179**
	Sig. (2-tailed)	0.241	0.011	0.364	0.373	0.033	0.019

Note 1: **P < 0.05

Note 2: WE = Work Experience

Factors influencing project success

In this chapter, other factors influencing the project success is also considered to analyze if project managers opinion will change about them by having more work experience. These factors are project innovation, technological complexity, organizational complexity, social complexity, similarity, complementarity, coverage, relational trust, and competence-based trust. To do so, Partial Least Square (PLS) method is applied to identify the significant relationships between project managers’ work experience and the factors affecting the project success (Hair Jr et al., 2016).

Table 4.9 shows the result of the bootstrap in PLS to test the significance of estimated path coefficients in PLS. According to the result, increasing the work experience of project managers will increase the importance of coverage, relational trust, and competence-based trust in their opinion. Therefore, more experienced project managers think that trust and knowledge coverage plays an important role in project success. Also, these result shows that by having more experience, there is no significant difference in project managers’ opinion about other factors (project innovation, technological complexity, organizational complexity, social complexity, similarity, and complementarity).

Table 4.9 – Path coefficients between work experience and judgment about importance of factors related to project success

Path	β -value	p -value
Work experience \Rightarrow Project innovation	0.141	0.344
Work experience \Rightarrow Technological complexity	0.027	0.453
Work experience \Rightarrow Organizational complexity	0.167	0.376
Work experience \Rightarrow Social complexity	0.006	0.343
Work experience \Rightarrow Similarity	0.034	0.610
Work experience \Rightarrow Complementarity	0.150	0.228
Work experience \Rightarrow Coverage	0.339	0.000***
Work experience \Rightarrow Relational trust	0.254	0.006***
Work experience \Rightarrow Competence-based trust	0.334	0.000***

Note: ***P < 0.01

Indicators influencing project success

Each factor is measured with some questions (indicators) in the survey. In order to have more insight and a general conclusion, the analysis of correlation is also applied between the work experience of respondents each indicator in the survey. Due to the nature of scaling in the survey, Spearman's correlation coefficient was used to evaluate the relationships between experience and each indicator. There is no significant correlation between work experience and project innovation indicators, technological complexity indicators, organizational complexity indicators, and similarity indicators. For brevity, the results without significant value are available in [Appendix B](#) (Table B.1 to Table B.4).

Table 4.10 shows Spearman's correlation results between work experience and project managers' judgment about social complexity dimensions. There is a significant negative correlation between work experience and the fourth question of social complexity (local environmental complexity (SC_{23})). Based on this result, it can be concluded that more experienced project managers have less inclined to have a partnership with an organization with the different administrative processes, working hours, etc. Also, this result shows that by having more experience, there is no significant difference in project managers' opinion about the other three indicators (number of legal systems involved, variety in rules, and regulations and inter-dependency between different institutional configurations).

Table 4.10 – Correlation between work experience and their judgement about social complexity dimensions

		SC_{20}	SC_{21}	SC_{22}	SC_{23}
WE	Spearman's Correlation	0.018	0.047	0.102	-0.163**
	Sig. (2-tailed)	0.815	0.542	0.185	0.032

Note: **P < 0.05

Table 4.11 presents the result of Spearman's correlation between work experience and project managers' judgment about knowledge complementarity dimensions. This result shows a significant positive correlation between work experience and the first question of knowledge complementarity (to have a partner who has skills or technologies that compensate our deficiencies (Com_{28})). Based on this result, it can be concluded that more experienced project managers have more desire to have a partnership with a partner who has skills and technologies that compensate their deficiencies. Additionally, these result shows that by

having more experience, there is no significant difference in project managers' opinion about other three indicators (compensating resources and equipment, services, and language).

Table 4.11 – Correlation between work experience and their judgement about knowledge complementarity dimensions

		<i>Com₂₈</i>	<i>Com₂₉</i>	<i>Com₃₀</i>	<i>Com₃₁</i>
<i>WE</i>	Spearman's Correlation	0.138*	0.068	0.081	0.031
	Sig. (2-tailed)	0.071	0.373	0.294	0.960

Note: *P < 0.1

Table 4.12 shows the result of Spearman's correlation between work experience and project managers' judgment about knowledge coverage dimensions. This result shows a significant positive correlation between work experience and the first and second questions of knowledge coverage (to provide all the skills and technologies needed for the project with the partnerships (*Cov₃₂*), and to provide all the resources and equipment needed for the project with the partnerships (*Cov₃₃*)). Based on this result, it can be concluded that more experienced project managers have more inclined to have a partnership to provide all the skills, technologies, resources, and equipment to complete the project. Moreover, these result shows that by having more experience, there is no significant difference in project managers' opinion about two other indicators (coverage in services, and communication skills).

Table 4.12 – Correlation between work experience and their judgement about knowledge coverage dimensions

		<i>Cov₃₂</i>	<i>Cov₃₃</i>	<i>Cov₃₄</i>	<i>Cov₃₅</i>
<i>WE</i>	Spearman's Correlation	0.293***	0.241***	0.007	0.036
	Sig. (2-tailed)	0.000	0.001	0.925	0.637

Note: ***P < 0.01

Table 4.13 presents the result of Spearman's correlation between work experience and project managers' judgment about relational trust dimensions. This result shows a significant positive correlation between work experience and the first and third questions of relational trust (to have very honest partners (*RT₃₇*), trustworthy (*RT₃₉*)). Based on this result, it can be concluded for more experienced project managers, it is more important to have honest and trustworthy partners. Also, these result shows that by having more experience, there is no significant difference in project managers' opinion about two other relational trust indicators (keeping the promises, and considering others benefits).

Table 4.13 – Correlation between work experience and their judgement about relational trust dimensions

		<i>RT₃₇</i>	<i>RT₃₈</i>	<i>RT₃₉</i>	<i>RT₄₀</i>
<i>WE</i>	Spearman's Correlation	0.252***	0.128	0.186**	0.035
	Sig. (2-tailed)	0.001	0.093	0.015	0.644

Note: **P < 0.05, ***P < 0.01

Table 4.14 presents the result of Spearman's correlation between work experience and project managers' judgment about competence-based trust dimensions. This result shows a

significant positive correlation between work experience and the first and second questions of competence-based trust (to have partners who have a good reputation in their domain (CBT_{41}), and undeniable capabilities based on their reputation and qualifications (CBT_{42})). Based on this result, it can be concluded for more experienced project managers, it is more important to have partnered with a good reputation and qualification in their domain. Also, these result shows that by having more experience, there is no significant difference in project managers' opinion about two other competence-based trust indicators (be accredited with quality control standards, and proof of resources and certificates).

Table 4.14 – Correlation between work experience and their judgement about competence-based trust dimensions

		CBT_{41}	CBT_{42}	CBT_{43}	CBT_{44}
<i>WE</i>	Spearman's Correlation	0.319***	0.219***	0.047	0.072
	Sig. (2-tailed)	0.000	0.004	0.541	0.350
Note: ***P < 0.01					

4.6 Conclusion and discussion

This chapter is a part of a larger study looking at a hypothesized conceptual model to investigate the relationship between different variables in complex projects. As a complementary analysis, in this chapter, first, we analyzed the relationship between the project managers' work experience and complex project success, and then the effect of project managers' work experience on their judgment about the importance of variables in innovative complex projects. These variables are the same variables that were identified in the previous chapter. For the analysis of this chapter, we used the data gathered by a validated survey filled by project managers who were at least involved with one complex project with more than one partner. In the first part of the survey, we asked the project managers about the success of their previous project (based on six dimensions of project success). To examine the effect of project managers' work experience on project success, we analyzed the data to see if we can find any significant effect. The result shows the significant positive effect of project managers' work experience on the success of their projects. Hence, the project that was managed by more experienced managers was more successful.

In the second part of the survey, we asked the respondents to indicate the importance of each factor in the success of the project. Furthermore, the reliability and validity of the data are checked. To examine the effect of work experience on project managers' opinions, we used Spearman's correlation analysis to check if there is any significant correlation between the work experience of respondents and their opinion about the importance of different variables.

This analysis is applied in three steps: To begin with, we performed Spearman's correlation analysis between work experience and project success six measurement dimensions. The result of this analysis shows that increasing the work experience of project managers affects their judgment by increasing the importance level of meeting organizational objectives, team satisfaction, and stakeholders satisfaction. Based on this analysis, there is no significant correlation between work experience and the importance of other dimensions of project success measurement (respecting allocated budget, achieving objective on time, and having a positive national impact).

In addition, we examined the relationship between work experience and respondents' judgment about the importance of different variables in project success (Project innovation, technological complexity, organizational complexity, social complexity, relational trust, competence-based

trust, similarity, complementarity, and coverage). The result of this analysis shows the significant positive relationship between the work experience of project managers and their opinion about the importance of knowledge coverage and both type of trust between partners in the project.

Lastly, we performed correlation analysis between work experience and each indicator of variables. The result of this analysis shows several significant effects: by increasing the work experience of project managers, they think it is more important to work with partners who are honest and trustworthy, have a good reputation and qualification in their domain. They also think it is more important to have a partnership that can compensate for their skills and technology deficiency and also cover all the skills, technology, resources, and equipment that are required in the project.

4.6.1 Practical implications

Considering an emerging stream of empirical research within the learning-by-doing literature, it can be concluded that paying attention to the experience findings can be practical in avoiding mistakes. Moreover, a part of the result in this chapter shows that the work experience of project managers has a significant positive effect on the success of the project. Hence, we believe that the results of this chapter can be helpful for decision-makers –especially decision-makers with less experience– to have a general view of different aspects affecting project success. Some of the practical implication of this chapter is explained as follows:

Firstly, the result of this chapter shows that the work experience of project managers increases the importance of some dimensions of project success for them. Among six dimensions of measuring project success, experience makes the "organizational objectives, team satisfaction, stakeholder satisfaction" more important for the project managers. This result can brighten this horizon for less experienced project managers. Based on these arguments, we encourage less experienced project managers to invest in the satisfaction of the team member and stakeholders as well as the organizational objectives of the project.

Secondly, we suggest the decision-makers who choose the partners at the beginning of the project to pay attention to the coverage of knowledge that they can provide with the selected partnership. Since the more experienced project managers have, the more important coverage of knowledge in partnership becomes to them. In particular, it is become more important to them to provide all the skills, technologies, resources, and equipment needed to complete the project.

Thirdly, we draw the attention of less experienced decision-makers to the fact that since the importance of trust between partners also increases with the experience of managers, the good reputation, qualification, and honesty of the partners in a partnership might be more important than what they think.

Finally, it is worth mentioning that more experienced project managers have less desire to work with firms with different organizational processes, legal systems, and working hours. Hence, we suggest decision-makers consider these findings in their partner selection process.

4.6.2 Limitation and future research direction

Besides all the contributions and findings of this chapter, there are some limitations in different steps of this research that need to be considered. First of all, since this study is a complementarity part of a larger study, the variables and the related survey were designed based on other criteria rather than work experience. By performing a more comprehensive literature review with a focus on work experience and its effect on managing projects, other variables might need to be considered. For instance, studying the effects of project managers'

work experience on their leadership method, policies and strategies, stakeholder management and resources management may provide a deeper understanding of the role of experience.

Secondly, when it comes to project experience, it's not just the project manager's experience that matters. Many studies in the literature suggest that a more fine-grained, multidimensional view of experience is warranted in the context of teams. For instance, individual, organizational, managers, and team experience influence on project players' performance (Huckman et al., 2006; Reagans et al., 2005). Moreover, distinguishing between experiences may make a difference in the final analysis. For example: successful and some unsuccessful project experiences or international and national project experiences. In this chapter, considering the limitation we had for the number of questions in the survey, we only ask project managers about their work experience and we did not consider other dimensions of experience in projects.

Finally, because data on actual work experience is rare, studies commonly use the potential experience to proxy for actual experience. Hence, in this chapter, we used the years of total work experience that respondents filled in the survey. However, this potential work experience might be different from their actual work experience in the project management field. Considering the actual work experience of people in project management can give more specific insights (Zveglic et al., 2019).

III

Third part—Partner selection in complex projects

Purpose: in strategic alliances, partner selection is one of the critical steps. It consists of assessing and choosing the partners, who have the required knowledge, skills, and resources to increase the success rate of the collaboration in projects. The first chapter of this part is focused on proposing a novel partner selection framework that aims at enhancing the collaboration efficiency considering project complexity degree, project knowledge requirement, and partners' past experiences. Increasing mutual trust between partners is a vital consideration in designing this framework. In the second chapter of this part, the goal is to demonstrate the application of the proposed framework by using the data of a European project in the aeronautics field named Knowledge Alliance in Air Transport (KAAT).

Design/methodology/approach: in the first chapter of this part, firstly a literature review is applied on influential factors of alliance formation and partners selection. Then, based on the findings of the previous parts and the conducted literature review, four hypotheses are proposed to help decision-makers weigh different knowledge criteria of each potential set of partners. Finally, a partner selection framework is applied to choose the best set of partners in alliance formation. In the second chapter of this part, the data of a European project conducted by a collaboration of 17 partners are used to demonstrate how to use the proposed framework.

Findings: this part of the thesis proposed a novel framework that could help decision-makers of partner selection in alliance formation. The framework also presents potentials for future studies.

Originality/value: our research in this part focuses on the evaluation part of the alliance formation. To decrease the challenges in collaboration, partner selection must take place among organizations that are able to trust each other and communicate well while at the same time having the required knowledge to achieve their objective. In the novel framework proposed in this part, projects are evaluated from a technological point of view to estimate their challenging degrees, and partners are evaluated in terms of their background in past projects or partnerships. Hence, this framework allows us to characterize partners selection using a new typology that weights the knowledge criteria for different potential sets of partners.

Research implications: this part contains practical application as well as theoretical implications. Considering the vital role of trust between partners in strategic alliances, we believe that this proposed framework can help select partners who can have more mutual trust. Moreover, coverage of knowledge (providing all the knowledge required to finish the project) has not received much in alliance partner selection. Hence our proposed framework highlights the critical role of coverage of knowledge especially when the project is highly complex or when partners are familiar with each other from a past experience. Unfortunately, considering the fact that projects that are managed by strategic alliances are long projects in terms of time, and due to the time limitation of the research, we could not test our framework on a real partner selection of alliance formation to see the possible improvement. However, by using the data of a conducted project, we were able to show the application of this framework. Hence, we believe that this part of the thesis can bring more related future studies to show the effectiveness of this work.

5

A partner selection framework

5.1	Introduction	87
5.2	Literature review	89
5.2.1	Partner selection problem and most commonly used criteria	89
5.2.2	Influential factors in strategic alliances	90
5.3	Proposed hypotheses	97
5.4	Proposed framework	98
5.5	Conclusion and discussion	102
5.5.1	Conclusion	102
5.5.2	Managerial insight	102
5.5.3	Limitations and future research	102

“We cannot solve problems with the same thinking we used to create them.”

Albert Einstein

This chapter is based on an article published in “Maliheh Vaez-Alaei, Ioana Deniaud, François Marmier, Didier Gourc & Robin Cowan (2021) A partner selection framework for strategic alliances based on project complexity and partner’s past experience, Enterprise Information Systems, DOI: 10.1080/17517575.2021.1889038” (Vaez-Alaei et al., 2021).

5.1 Introduction

Today, faced with the global reorganization of production structures and increased competition due to the ongoing reduction of trade barriers, it is even harder for firms to compete. A standard solution to that problem is innovation. But as technology changes, products and processes become more complex, involving more and different types of knowledge. Very often firms are faced with a situation where the knowledge, competence or technology they need to make the next competitive step is not available in-house. In response, firms collaborate with other firms: since the late 1970s we have seen an impressive increase in firms making “strategic alliances”. An alliance permits partnering firms to share knowledge, technology, and possibly other resources, without losing independence (W. Chen et al., 2019; Chung et al., 2000; Furlotti et al., 2018), and successful partnerships combine diverse skills and resources to achieve a predetermined set of objectives. While there has been considerable literature extolling the virtues of strategic alliances, it must be observed that the majority of alliances (some measure up to 60 percent) are considered failures by the partnering firms

(Bruner et al., 1998). While acknowledging that failure is an inseparable part of innovation, and sharing knowledge and technology between partners is not immune to risk (Rosas et al., 2017), to a great extent poor performance of an alliance can be ascribed to a lack of “fit” between or among partners. In particular, a lack of trust, but also miscommunication, cultural discrepancies, or hidden objectives all arise to inhibit cooperation (Kramer et al., 1995; P. S.-P. Wong et al., 2004). Thus, while technological complementarity is a necessary condition for a successful alliance, another important factor in the search for a good partner, in particular when thinking about the risks inherent in any cooperation is whether the partners can work together.

Given that entering an alliance implies giving up a certain amount of control, it seems clear that trust would be a dominant factor in alliance success. Working in an alliance creates dependency among the partners: each has invested in the partnership, but by the very nature (and *raison d’être*) of an alliance, the success of any partner depends on the actions of the others. Consequently, the initial and ongoing investments (financial, technological, knowledge ...) are predicated on the assumption that other partners will not cheat. Partnership relationships then, tend to be deeper than pure market-based relationships and this is necessary to induce effective knowledge sharing (Q. Xu et al., 2008), and when trust is evident, the quality of communication and dialogue are greatly improved (Sarker et al., 2005). Creation and maintenance of trust are facilitated by common mutual expectations with regard to the content of the project, but (Park et al., 2014) also observe that the creation of trust is easier when partners have a similar view on the value of the partnership and how knowledge should be shared.

The latter issue is now widely discussed in the literature; Lai et al. (2000) for example argue that collaborators with more similarity along different dimensions — culture, learning ability, geographic distance and threat — are more likely to cooperate with each other. But, recalling that firms engage in alliances to access resources (broadly defined) that they do not have in-house, partnerships are more likely to exist between firms that have complementary resources, skills or technologies (Ahuja et al., 2001; Chung et al., 2000; Mowery et al., 1996; Mowery et al., 1998; Stuart, 1998). But other dimensions also matter: Rosenkopf et al. (2003) explored the relationship between partner similarity (in terms both of geography and technology) and alliance success or firms’ willingness to participate. Both axes are critical in understanding partner selection and alliance formation. The complementarity and similarity of these characteristics should be considered when trying to understand partner selection and alliance success (Capaldo et al., 2014). Success also depends on the partnership being structured such that there is a fit among tasks, actors and resources. A better match between task assignment and actors’ resources increases the probability of allying (Furlotti et al., 2018).

Several papers have looked at various aspects of alliance formation. For example, Gulati et al. (2012) observe the importance of past collaboration experiences, resource compatibility, and partners’ status. Kim et al. (2009) model alliance formation based on cooperating and competing similarities (which also appear in (Gulati et al., 2012)) finding empirically that the former has a positive, and the latter a negative impact on alliance outcomes. Mudambi et al. (2010) argue that basing alliance partner selection on knowledge similarity and close geographic distance has positive effects on innovation performance. Deniaud et al. (2017) argue that evaluating projects to rank them as technologically simple or challenging plays an effective role in the partner selection phase.

The literature identifies several different axes which are relevant for alliance success and thus (implicitly or explicitly) finding and selecting partners. The two broad axes are knowledge and trust but within each of these, there are a variety of more fine-grained considerations. That said, an over-arching framework that covers these considerations in partner selection is missing from the general literature. Given the continued increase in alliances as part of the strategy space of many firms, such a framework could serve as the basis for a decision-making

tool that would assist firms in finding partners that fit best with themselves and with the project they want to undertake.

In this chapter, which is an extended version of an IESM 2019 conference paper (Vaez-Alaei et al., 2019), the contribution is to propose a partner selection framework, based on a new typology, that aims to maximize the success probability of an alliance. The first novelty of the proposed framework is to consider both partner's history and project technological complexity to find a basis to evaluate the set of partnerships based on their knowledge and competencies. We also define different levels of trust in the proposed framework as a variable to consider in choosing the best set of partners. The remaining sections of this chapter are organized as follows: Section 5.2 presents a literature review on some of the previous research on partner selection and project success factors; in Section 5.3, proposed theory and hypotheses regarding partner selection in alliances are provided; the proposed framework approach is explained in Section 5.4; this chapter ends with conclusion and discussions in Section 5.5.

5.2 Literature review

A partnership has a life cycle which is divided into major phases. L. Camarinha-Matos et al. (2012) indicate that the evolution of a CN may be divided into three major phases: creation phase, phase of daily business and a phase of changing nature (L. M. Camarinha-Matos et al., 2018; L. M. Camarinha-Matos et al., 2019).

The creation phase also named formation phase is divided into four steps according to (Harbison et al., 1997) and each of these steps or a combination of some of them has been studied in numerous research in the literature. The first step is the identification of the potential partners based on the objective of the collaboration (P. L.-K. Wong et al., 2002). The second step is evaluation of potential partners to select the best fit based on different criteria (Furlotti et al., 2018; Polyantchikov et al., 2017); negotiation with the selected partners to determine terms of collaboration and to finalize the partner selection (Afsarmanesh et al., 2010; L. M. Camarinha-Matos et al., 2009b; Oliveiral et al., 2008); and implementing the strategic alliance (Gou et al., 2019; Osório et al., 2019). In this study, we focus on the evaluation step and partner selection based on some of the influential criteria. In the following subsections first partner selection problem is discussed and then we focus on its influential criteria.

5.2.1 Partner selection problem and most commonly used criteria

Partner Selection (PS) is a crucial step of the strategic alliance formation (Crispim et al., 2015; Durugbo, 2016). It consists of evaluating and selecting the partners, who have the required knowledge, skills and resources to maximize the success rate of the collaboration or the project.

Ben Salah et al. (2018) divided the PS process into four activities: criteria formulation, partners qualification, final selection of qualified partners and application feedback in which the decision-makers (DMs) evaluate the members to improve the effectiveness of the network by ensuring that the most suitable partners are selected at all times.

Determining the right set of criteria for partner selection is not an easy task. Polyantchikov et al. (2017) focused on sustainable partner networks in which based on the interviews of managers of companies ranked the partner selection criteria. Their result showed that it is critical to consider quality, delivery and cost in partner selection. Based on an online survey that targeted organizations from Malaysia, Australia and other countries (such as

India, Singapore and the Philippines), the authors propose a ranked list of criteria for selecting partners. Some of the most used PS criteria are, similarity in objectives, project management experience, ability to negotiate, previous successful collaboration and cultural similarity. According to Mat et al. (2009), in strategic alliances, for example, intangible factors of potential partners have a significant impact on the long-term viability of the alliance". Examples of such factors are culture, trust, managerial know-how, reputation or other soft aspects that could aid in partner selection.

Current globalization and competitive pressures are pushing firms to bring forward innovation in products, processes and services. It is becoming more and more critical to innovate due to the evolution of customer demand towards more and more sophisticated products and services. The whole idea behind the strategic alliance is that sharing knowledge among firms during collaboration facilitates innovation. Nevertheless, firms' collaborations are often very complex, and it is well-known that many alliances do not achieve their predefined objectives (Bruner et al., 1998; Gulati et al., 2012). Hence, it is important to study factors of success in collaborations.

Interactions and exchanges between partners is a key factor in sharing knowledge and driving innovation, especially in complex projects with various partners involved. Sharing knowledge can be increased through incentives and IT support, but possibly more importantly, through organizational culture and trust (Lyu et al., 2017; Moorman et al., 1993). It is also the case that there is a potential virtuous cycle: authors point out the positive effect of information sharing on trust between partners (Aulakh et al., 1996), which illustrates a two-way (causal) relationship between mutual trust between partners and their willingness to share information.

According to the literature, trust is a psychological condition of individual partners in the project partnership (Kadefors, 2004). To trust someone (or something) is often characterized as a willingness to take certain types of risks, thereby making oneself vulnerable (L. C. Becker, 1996). In principle, trust is a way of mitigating the risks involved in any investment or any joint venture. An increase in trust increases the willingness to make investments where part of the risk lies in the partner's future behavior. One can expect then that the more trust involved, the more enthusiasm in participating in the project, and so the more likely is project success (Cook et al., 2005).

Several authors have drawn attention to the role of the level of trust on the commitment to collaborate. Kamel et al. (2007) presented the need to build a group of agents who trust each other which allows them to open their information systems while maintaining control of their critical resources. Belkadi et al. (2017) proposed a framework to define a trust level to choose collaboration strategy in alliances, and described different collaboration modes based on different levels of trust. Similarly, Ferrada et al. (2019) studied different collaborative networks and proposed a novel approach based on players' emotional criteria closely related to trust. They argued that this approach could help in establishing mutual trust between partners.

5.2.2 Influential factors in strategic alliances

Based on the importance of partner selection and the gap we have observed in the literature, this chapter focuses on alliance formation and investigates the central role played by trust in partner selection. The literature on partner selection has identified a large variety of critical criteria and frameworks. In the following subsections we present a review of different factors affecting trust, knowledge sharing between partners and project success in alliance formation.

Partners' past experiences

"The more alliances you do, The better you get at them"(Harbison, 1998). This sentence encapsulates the results of many studies in this field.

Partnership leads to learning and learning leads to growing knowledge, and increasing knowledge is a way to decrease the chance of failure in alliances (Braunerhjelm, 2010). But it is important to note that increasing knowledge is not enough to be successful, the important point is to be motivated to convert existing or new knowledge into something that can be communicated or can be used for managerial or technological aspects of a partnership. This conversion is non-trivial and is typically an activity that involves both partners, which implies, again, that past experience working in alliances can be beneficial, provided current partners are motivated to work together. Sampson (2002) used a sample data of R&D alliances of organizations in the telecom equipment industry to discuss the ability of firms to learn to collaborate, and its effect on future partnerships. The results showed that although all organizations learn from cooperation and increase their knowledge, not all the knowledge gained is productive for future alliances. Acquired knowledge mostly has a positive effect on future allies, but only for a short time after the alliance at issue, due to knowledge obsolescence.

Di Guardo et al. (2016) asked whether a firm's past alliance experiences have a positive influence on the degree of innovativeness in future alliances. They found that past learning is more effective when a firm displays a wide diversity of R&D alliances. Emden et al. (2005) concluded that learning orientation and organizational commitment to the partnership are two criteria that affect firms' abilities to learn during an alliance. Thus these factors can be considered central in determining the success of an alliance, and shape the way learning from past alliances feeds into future success.

The important role of trust and its relation to the past and present has been studied. A history of collaboration represents a sort of knowledge to each partner representing the history of performance and cooperation in a collaborative network which also shows the trust level (Afsarmanesh et al., 2009; S. S. Msanjila et al., 2011). Tenera et al. (2019) presented a novel perspective of constraints in the management of collaborative networks in which partners have been evaluated in terms of, past collaboration, trustworthiness and reliability. Typically, any collaboration starts with a low level of trust and integration between partners. If all goes well, as the result of successful interaction trust levels increase. As a consequence of the growth in trust, the partnership can move to a more complex project and coordination (Belkadi et al., 2017). This will carry over from one project to the next, so that partners that have already successfully collaborated with each other have more willingness to trust each other. Meier et al. (2016) proposed a hypothesis about the positive effect of cooperative history on mutual trust in strategic alliances. They have used a meta-analysis approach to systematically collect, summarize and integrate the results of the past 20 years of empirical studies on the antecedents and implications of trust in strategic alliances. Using a database of social science research network, they showed that a cooperative history has a significant positive effect on mutual trust in alliances.

There is a consensus in the literature that there is a significant relationship between firms' past experiences and their future performance in collaborations. It is clear that this relationship is not direct, and it can be affected by many different factors. Some of these factors, such as complexity and knowledge, are considered in this chapter and discussed in the following subsection.

Project complexity

The nature and degree of its complexity are central to determining the appropriate style for managing a project, and this has been widely discussed in the literature. Project complexity has effects on the selection due to the effect of organizational complexity in project management, since managing projects goals (such as time and cost) with higher organizational complexity is more complicated (Baccarini, 1996). Every project is complex to a greater or lesser extent, and the inability to deal with it is often cited as a reason for project failure (Bakhshi et al., 2016). One element that makes a project complex is unexpected events

that arise either due to the actor's behavior or to project characteristics, and the potential for these surprises creates difficulties in estimating completion time, cost and quality (Vidal et al., 2008), and consequently contributes to a project failing to achieve its expected objectives. Relich et al. (2018) studied the relationships between past New Project Development (NPD) time and cost estimation, and developing new products. Previous data in organizational databases were considered as potential sources of information, and a neural network model was used to estimate the cost of a new product based on the past data (Nguyen et al., 2019). Bernus et al. (2016) identified four different challenges in information systems: scope, scale and complexity, sustainability and viability, and finding survival modes. In terms of resource allocation and project scheduling, they concluded that project complexity has a direct relation with risks of failure.

The most commonly observed forms of complexity in the project management literature are organizational complexity and technological complexity (Baccarini, 1996; Mintzberg, 1989). The former includes the relationships in respect of reporting, communicating between partners, task allocation, etc. The latter can be defined as the degree of challenge in processing inputs to outputs, as this process can include complicated combinations of skills, material, knowledge and techniques.

Project complexity has been seen as a moderator in models of alliance governance, and theoretically has been implemented in different ways. Benitez-Avila et al. (2018) include in their model that relational norms, partners' trust and partners' contribution are affected by this complexity. Causality, complexity, transparency, and fairness has been identified as the main challenges of trust in virtual organization breeding environments (S. S. Msanjila et al., 2006; S. Msanjila et al., 2008). Alsaad et al. (2017) used complexity as an independent variable affecting perceived desirability. For Sunardi et al. (2015), cultural discrepancies increase a project's organizational complexity, which negatively affects knowledge sharing between partners. Finally, complexity creates a space in which innovation is comparatively hard to understand, achieve and use. It is related to the idea that complexity is a deterrent to innovation adoption because it raises uncertainty and the risk of failure (Hameed et al., 2014). The less complex is a project, the easier it is to evaluate, and so the faster the growth in trust which facilitates innovation (Robson et al., 2008).

Knowledge criteria

Creating new knowledge is an important activity for all firms, especially those in industries in which technologies are changing. But even in old and technologically stable industries, new knowledge can still be a source of competitive advantage (Inkpen, 1998). Naturally, as innovation is nothing more than the creation of new knowledge, typically out of existing knowledge, appropriate knowledge management has a great positive effect on innovative activities (Li et al., 2019). Any competence of a firm can be characterized as some kind of knowledge, and one of the important goals of an alliance is to share knowledge among partners. Accordingly, when partners are being selected, it is necessary to evaluate their knowledge (broadly defined) to look for cases of good knowledge fit and complementarity. In the current study, firms' knowledge positions can be characterized along three dimensions: similarity, complementarity and coverage (Vaez-Alaei et al., 2019), which are explained below and shown in Figure 3.5.

Similarity and complementarity

The need for similarity and complementarity in knowledge, and their role in partnerships are not new subjects, and both have been broadly discussed in recent years. In this section we recall some of this discussion to lay the groundwork for our development of the general framework, and the introduction of a third knowledge concern appropriate to partner selection.

Effective communication is a basic foundation for successful cooperation between partners. This is particularly the case as projects become more complex. When firms hold similar

knowledge stocks (in terms of the type of knowledge) communication is simplified, as each can easily understand the other; miscommunication is minimized and the risk of failure for that reason is reduced.

Rosenkopf et al. (2003) discussed knowledge localization in both geographical and technological aspects. They suggested that similarity in knowledge can defeat the communication constraint in alliances. Further, though, cognitive similarity facilitates interaction, and thereby helps to build trust between partners (Capaldo et al., 2014). Kim et al. (2009) differentiate between competing similarity and cooperating similarity. By using data from US firms' cross-border alliances, they found negative effects of competing similarity and positive effects of cooperating similarity on alliance success. Similarity in foreign policies of firms and geographic configuration localization can also be a motivation for partners to form alliances (Fordham et al., 2016). L. M. Camarinha-Matos et al. (2009b) studied the partner selection and negotiation in VBE considering identification of weakness in collaborations, such as: lack of reliable information of potential partners and maladjustment due to the different infrastructure. So they considered collaboration history, trust and similarity of infrastructures in partner selection phase. In addition to cognitive similarity, many scholars have observed that similarity along other dimensions can be valuable: as variables that affect trust between partners, or that ease interpersonal communications (Ahlf et al., 2019; Doloi, 2009), similarity in shared values (Wu et al., 2010) and similarity in shared goals (Y.-H. Chen et al., 2014) have been noted.

Alliances will be created when there is an idea that firms in combination will have a greater effect than they will separately. Knowledge complementarity exists when the knowledge stocks of the partners are different from each other, but in addition, the stocks are different in ways that mean that when they combine, they are greater than the sum of the parts. There are several papers that have identified the important role of complementarity in partnerships.

Cobeña et al. (2017), for example, analyzed the role of diversity in resources by considering data on airline alliances: Computational results showed that having recourse to complementarity causes a better operational level performance. Furlotti et al. (2018) studied complementarity and similarity in alliance formation generally. Their results showed that there is a direct relation between the probability of firms allying, and adjustment among tasks and resources. They also noted that not just knowledge stocks but also tasks should be considered in evaluating resource complementarity. Mostly it is indicated in the literature that sharing knowledge and learning between partners has a direct influence on enhancing new product performance (Deniaud et al., 2017; Relich et al., 2018). Uwizeyemungu et al. (2018) studied the importance of complementarities between information technology and non-information technology capabilities. They checked the effect of different combinations of these resources on competitive performance in small and medium-sized enterprises. A previous study, which used data from international mutual investment in China, suggested that knowledge absorption of partners plays a critical role in learning and innovation (Yao et al., 2013).

It can be concluded from previous research that cooperating similarity between partners causes a higher level of alliance capability and more effective relationships (Bruner et al., 1998; Kim et al., 2009). Also resource complementarity was identified as a very influential factor in enhancing stability and trust in on-going collaboration (Deitz et al., 2010). Huang et al. (2015) studied joint venture performance. Value gap and information asymmetry mediate the relationship between control variables and performance. So the importance of knowledge complementarity is related to both project and partner characteristics.

The discussion of similarity and complementarity in knowledge stocks suggests that there would be an inverted-U relationship between distance and knowledge space, and either the success of an alliance or the likelihood that two firms would ally. Indeed this has been observed empirically (Mowery et al., 1996; Mowery et al., 1998). But is this enough? We

propose below that there is a third aspect of knowledge stocks relevant to alliance formation and success, namely coverage. Further, though, where the peak of the inverted-U is located may be dependent on other characteristics of the firms, the partnership and the project. These are the issues we take up in the following sections.

Coverage

The needs of the project are a reason for different partners to ally — to use others' knowledge, or to learn from knowledge sharing. So, learning is assumed as one of the most important reasons for allying (Muthusamy et al., 2005). There are two factors which are important in selecting partners, first the desire of partners to work with each other, and second is the availability of the resources relevant to the project, which we refer to as “coverage”. The latter idea is not much discussed in the literature, but does seem central to the entire operation of an alliance. One way to operationalize coverage is as the ratio of total knowledge available in the partnership to the knowledge required to perform the project successfully. Coverage contains both similarity and complementarity in knowledge and is defined by Equation 5.1.

$$Coverage = \frac{Similarity+Complementarity}{Similarity+Complementarity+Non\ covered\ knowledge} \quad (5.1)$$

The difference between similarity, complementarity and coverage are shown in Figure 3.5, which serves as a schema for understanding how potential partners can position each other and the project's needs using these criteria, at the beginning of the project.

As a conclusion to the literature review, although the research in this field is so rich, a partner selection framework which has a closer look at the link between partner's history of collaboration and projects degree of complexity is missing. Considering all the mentioned scholars, two gaps in the existing literature can be identified on alliance partner selection. The first gap concerns different knowledge criteria (similarity, complementarity and coverage) and their relationships with partners and project characteristics. Second, differences in trust level considering the degree of project complexity and history of collaboration have not yet received much attention. Table 5.1 shows the criteria considered in some of the reviewed research and current study.

Table 5.1 – Criteria in partnership literature

Publication	Type of partnership	partner's past experience	Trust	Knowledge	Similarity			Complexity
					Complementarity	Coverage	Others	
1 Chung et al. (2000)	Alliance	✓	✓	✓	–	–	–	–
2 P. S.-P. Wong et al. (2004)	Partnering	✓	✓	–	–	–	–	–
3 Emden et al. (2005)	International Alliances	✓	–	–	–	Transferring knowledge	–	–
4 Robson et al. (2008)	International Strategic Alliances	✓	✓	✓	–	–	✓	–
5 Kim et al. (2009)	Global Strategic Alliances	–	✓	✓	–	–	–	–
6 L. M. Camarinha-Matos et al. (2009b)	Virtual Breeding Environment	✓	✓	–	–	–	–	✓
7 Gulati et al. (2012)	Strategic alliances	✓	✓	✓	–	Knowledge leakage	✓	–
8 Yao et al. (2013)	International joint ventures	–	–	✓	–	Knowledge absorption	–	–
9 Capaldo et al. (2014)	Knowledge-Creating Alliances	–	✓	✓	–	–	–	–
10 Di Guardo et al. (2016)	R&D alliances	✓	–	–	–	Diversity	✓	–
11 Fordham et al. (2016)	Alliance	–	–	✓	–	–	–	–
12 Meier et al. (2016)	Strategic Alliance	✓	✓	✓	–	–	–	–
13 Belkadi et al. (2017)	Suppliers relationship	–	✓	–	–	–	–	✓
14 Lyu et al. (2017)	Cooperative organization	✓	–	✓	–	–	–	–
15 Cobeña et al. (2017)	alliance portfolios	–	–	✓	–	Heterogeneity, diversity	–	–
16 Benitez-Avila et al. (2018)	public-private partnerships	–	✓	–	–	Substitution	–	✓
17 Furlotti et al. (2018)	Alliance	–	–	✓	–	Asymmetry	–	–

Continued on next page

Continued from previous page

Publication	Type of partnership	partner's past experience	Trust	Knowledge			Complexity		
				Similarity	Complementarity	Coverage	Others	Organizational	Technological
18 Uwizeyemungu et al. (2018)	small and medium-sized enterprises	–	–	–	✓	–	–	–	–
19 W. Chen et al. (2019)	Cooperation	✓	✓	–	✓	–	–	–	–
20 Ferrada et al. (2019)	collaborative network	✓	✓	–	–	–	Internal knowledge	–	–
21 Tenera et al. (2019)	collaborative network	✓	✓	–	–	–	reliability	–	–
22 This study 2020	strategic alliances	✓	✓	✓	✓	✓	–	–	✓

5.3 Proposed hypotheses

This research is conducted based on the findings of the previous to establish a framework for a better understanding of the collaboration aspects in alliances. In this chapter, considering the classification in the literature review section, two important factors are used to define a framework for partner selection. First is whether the project is technologically simple or challenging (complex). The knowledge complexity of a project arises not only in the technology itself, but also in how the technology fits into the knowledge competence of each other the partners and how those competences interact. Second, is whether partners know each other or if it is their first collaboration, which leads directly to the issue of trust. Besides partner selection, this evaluation would help participants to estimate project objectives like time and cost. Figure 5.1 shows the schematic view of alliance formation steps by (Harbison et al., 1997) and our proposed framework which is the development of its second step.

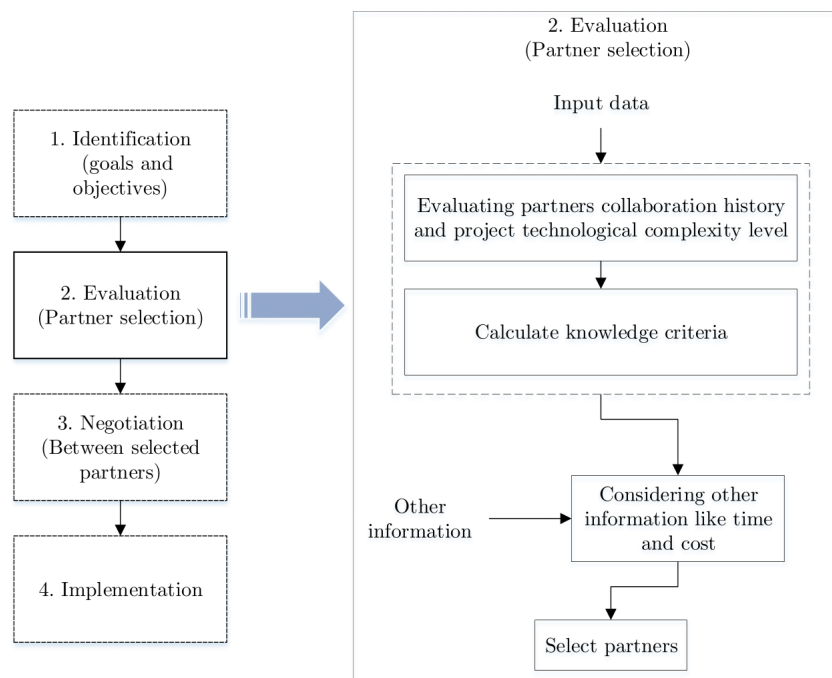


Figure 5.1 – A schematic overview of the proposed framework

Based on the literature review indicated in Section 5.2, summarized in Table 5.1, the results of previous chapters, and our contributions about selecting partners in network of alliances, four hypotheses are proposed to design a framework in this research.

Hypothesis 1: If the project is technologically simple and partners knew each other (or their past projects were successful), then the mutual trust level is high; budget and time can be estimated with confidence and complementarity is more important.

Hypothesis 2: If the project is technologically simple but it is the first collaboration of partners (or past projects had difficulties), then the mutual trust would have an intermediate level (since technological simplicity would argue for high trust but partner non-familiarity

would argue for low trust); budget and time can be estimated with confidence, and relative to coverage, similarity and complementarity have more weight in partner selection.

Hypothesis 3: If the project is technologically challenging and partners knew each other (or their past projects were successful), then we expect intermediate levels of mutual trust; budget and time cannot be estimated with confidence, and complementarity and coverage are more important.

Hypothesis 4: If the project is technologically challenging and it is the first collaboration between partners (or past projects had difficulties), then the mutual trust level is low; budget and time cannot be estimated with confidence, and similarity, complementarity and coverage are all important in partner selection.

The above hypotheses (summarized in Table 5.2) provide a starting point to design a partner selection decision-making tool to maximize the chance of success in a complex project.

Table 5.2 – Summary of hypotheses

		Alliance	
		Partner has known each other or past project succeeded	First collaboration or past project with difficulties
Technological complexity of the project	Project technologically simple	Confident with the optimistic estimation for the project Select partners knowing that complementarity is more important	Confident with the optimistic estimation for the project Select partners knowing that similarity and complementarity are more important
	High technological challenges	Considering the pessimistically estimation for the project Select partners knowing that complementarity and coverage are more important	Considering the pessimistically estimation for the project Select partners knowing that similarity, complementarity and coverage are important

5.4 Proposed framework

Each project is a context presenting specificities. A new project can be evaluated from the technological point of view to see whether it is simple or difficult. Moreover, a project can be done by partners having had (successful or unsuccessful) collaboration in the past, or it could be their first collaboration. These factors can influence the level of trust between partners. Given a project context, similarity, complementarity and coverage are used as criteria to choose partners (Figure 5.1). This suggested framework is presented in Table 5.2. This framework is constructed based on the literature review and proposed hypotheses in (Section 5.2 and Section 5.3).

The idea is to consider similarity, complementarity and coverage simultaneously but weighting them based on partners' characteristics. This criteria weighting based on knowledge is depicted in Figure 5.2. As an example, similarity and coverage are more important than complementarity when we are describing a challenging project with new partners, whereas similarity is a critical criterion for communication between partners without past experiences. In addition, broad "coverage" creates more flexibility in management when the project is

technologically complex because with broader coverage, firms will have a wider spectrum of knowledge (and possibly also a larger quantity) with which to address the problems (and surprises) that arise during the project (Duncan, 1995).

An interpretation for Figure 5.2 is that if partners are familiar with each other, they can avoid the need for similarity and can work well with more complementary knowledge bases. By contrast, if they are relative strangers, to create the trust they need, more similar knowledge bases facilitate easier collaboration which will help build trust. In addition, we should look to the complexity level of the project, since for a simple project the need for complementarity and coverage is reduced. Even if knowledge coverage of the partnership is not complete vis-a-vis the project, if the project is simple, it is likely that the partners can either create the new knowledge they need or find it outside the partnership. Incomplete coverage does not necessarily erode trust. By contrast, if the project is complex, complementarity and coverage play more critical roles in establishing trust and finishing the project.

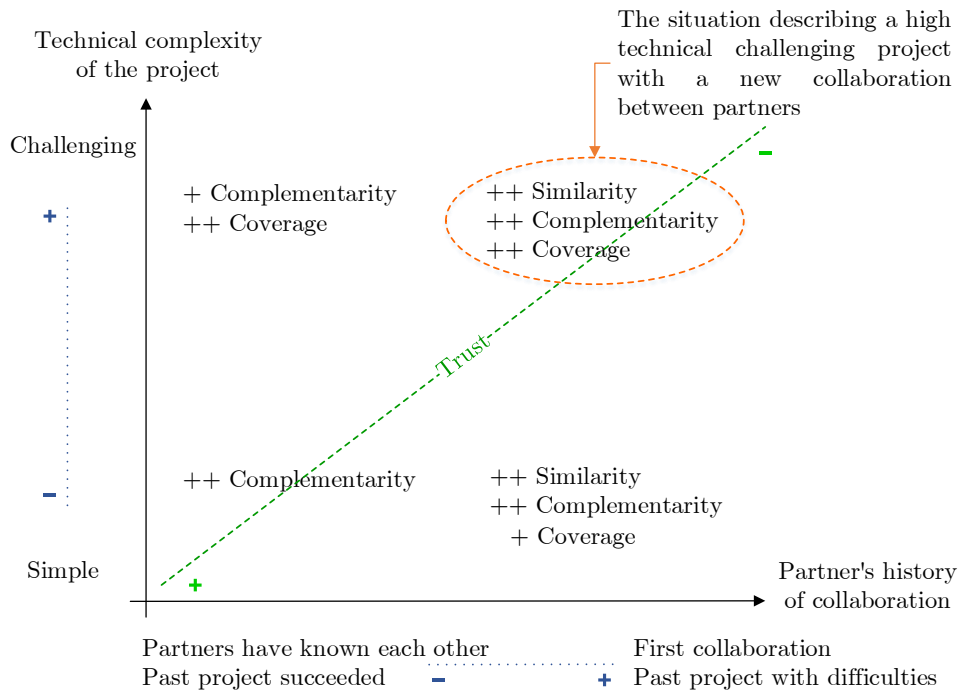


Figure 5.2 – An overview of criteria weighting based on knowledge

A mathematical model to calculate partnership score for each set of partners is proposed based on their knowledge criteria, and shown in Equation (5.2) (This equation is inspired by the equation that Deniaud et al. (2017) proposed to calculate the potential for innovation). Where α , β and γ are three coefficients that weight knowledge criteria (5.3).

$$Partnership\ score = \alpha \times Similarity + \beta \times Complementarity + \gamma \times Coverage \quad (5.2)$$

$$\alpha + \beta + \gamma = 1 \quad (5.3)$$

In the partner selection phase of alliance formation, there will be in principle many potential partners, and for each set of partners similarity, complementarity and coverage of knowledge can be assessed. We have argued that in different circumstances the three components should be weighted differently, and this is where the experience of the manager is important. The presented framework can be used by an experienced manager to determine suitable weights (α , β , γ) for knowledge similarity, complementarity and coverage. α , β , γ can be determined differently from one situation to another, and project managers can use the consideration proposed in Table 5.2 to determine these weights. Equation 5.2 provides the abstract structure for generating a partnership score for each of the possible set of partners, and that score should indicate the quality of fit for each potential partnership. Looking for partnerships with high scores is likely to increase mutual trust and also the chance of success in alliances. We have argued that it is important to treat these two axes of evaluation simultaneously, as they cannot be disentangled.

Figure 5.3 shows an example of using the proposed framework. At the starting point of the framework, we have a panel of potential partners. These potential partners can be selected among many organizations. This selection can be made by a qualitative judgment based on technological competences, social competencies, and prestige evaluation as explained in (L. M. Camarinha-Matos et al., 2010a). Also, due to the importance of project objectives, it can be considered as an input of the framework. Then different possible combinations of partnerships can be made to be evaluated. There are two situations to make different combinations, situation 1 is when there is no preference in having a special partner in alliance and all the possible combinations are taken to account, and situation 2 is related to making different combinations when some of the partners are already chosen based on previous contracts or policies. The next step is to evaluate the partner's past experiences and the degree of complexity of the project. Then all the knowledge criteria for each set of partnerships need to be calculated using Figure 3.5 and Equation 5.1. In the next step, the decision-maker can use Table 5.2 to make a judgment regarding appropriate knowledge weight (α , β and γ). Afterward, the partnership score using Equation 5.2 should be calculated for all the possible combinations of partners. The last step is to check other information and limitation like the cost and time of the partnership with the highest score. Finally, the partnership with the highest partnership score can be selected as the best fit.

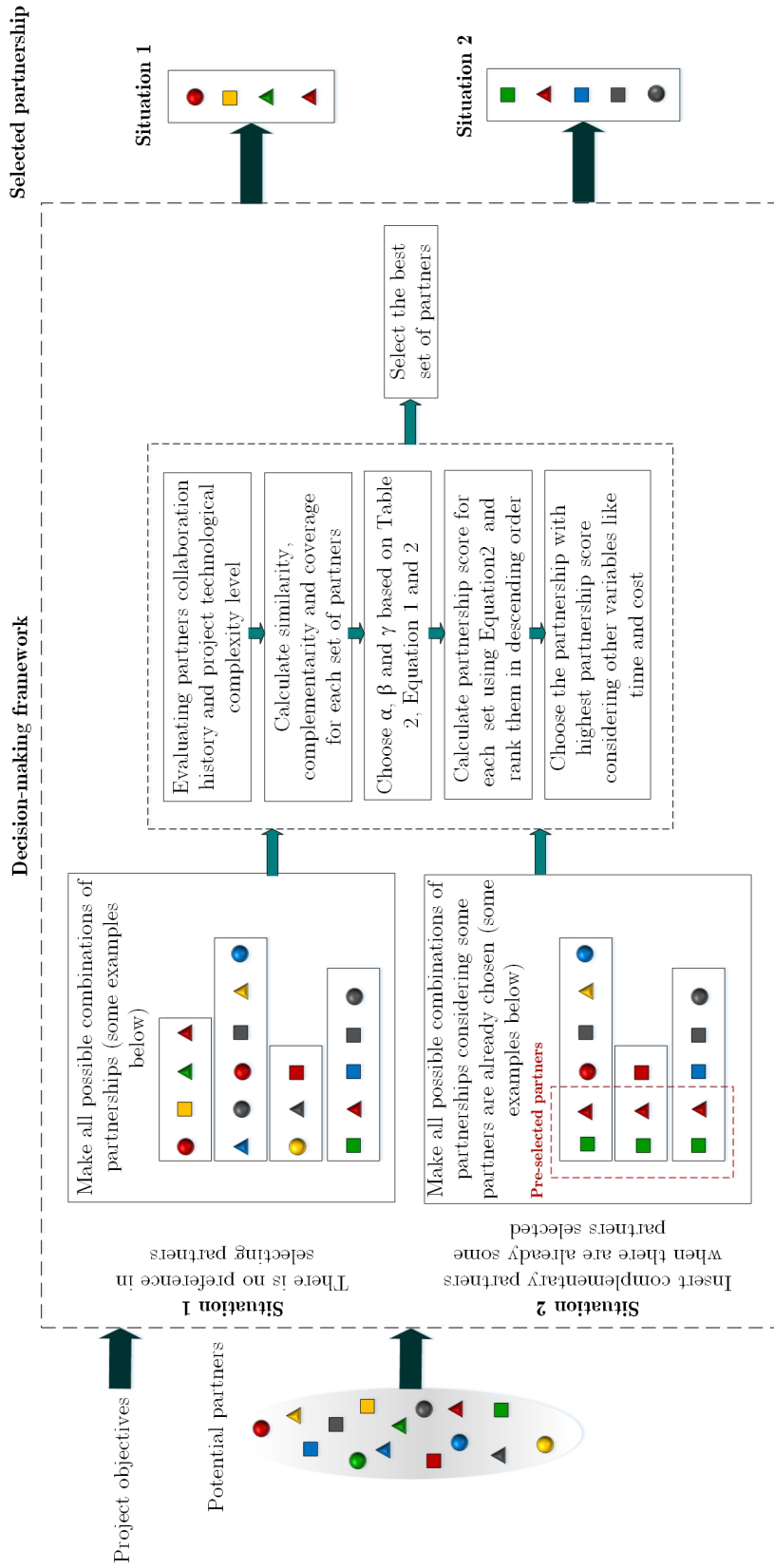


Figure 5.3 – Example of using the proposed framework

5.5 Conclusion and discussion

In this chapter, we have proposed a novel framework for strategic alliance partner selection based on the joint characteristics of projects and partners. This research is relying on a systematic review of previous studies in partner selection of different collaboration communities such as collaborative network, virtual breeding environment and strategic alliance. A lack of trust is the source of many alliance failures, and having reasonable expectations based on an accurate reflection of partners' resources and abilities as they relate to this particular project goes a long way to creating maintainable trust.

5.5.1 Conclusion

Based on generalizations from the literature, this chapter has developed a novel framework that permits decision-making to adapt to the needs of the project in order to help decision-makers maximize the chances of project's success. The contribution of this study is that in this framework two aspects of the project and partnership are considered before selecting partners for alliances. First, it is important to examine past experiences of potential partners to know whether they have (successfully) collaborated in the past. This part of the evaluation helps to determine which criteria will drive the next part of the process of partner selection, which looks at knowledge fit — complementarity, similarity or coverage. Second, it is also critical to evaluate the complexity of the project. Project complexity interacts with partners' knowledge stocks and with the partnership's knowledge fit. A successful use of this framework is likely to invest the project with a fundamental necessity, namely trust among the partners.

5.5.2 Managerial insight

The presented framework can be a useful tool for decision-makers in real world projects, since it provides managers a concrete, evidence-based path with which to evaluate candidate alliance partners, to calculate a partnership score based on defined criteria, to choose the best combination of partners for alliance formation, and to estimate the time and budget of a project more realistically.

Our purpose is that the proposed integrated framework can help in better understanding the relationship between project complexity, past experience of partners and their knowledge, the innovation potential of alliances and their chances of success. This should permit a stronger ability to form pertinent goals and also to decrease the risk of failure in strategic alliances.

5.5.3 Limitations and future research

There are some limitations in this study that need to be considered. Therefore, this research can be seen as a starting point for future studies on the relationships between trust, knowledge criteria, project complexity and partner familiarity, when considering selection of partners in strategic alliances. We have proposed four hypotheses based on a close reading of the literature, and they could each be studied empirically to examine their veracity. Equally, they could be implemented through a simulation model to examine their effects on alliance formation and innovation success. The current version of the framework can of course be further elaborated and customized to fit particular circumstances, adding further criteria that may be relevant for alliance partner selection.

6

A case study-Test the framework on real collaboration

6.1	Motivation	103
6.2	Presentation of the case study	104
6.3	Data preparation	105
6.3.1	Project technological complexity degree	105
6.3.2	Partners' collaboration history	106
6.3.3	Project required knowledge and partners' knowledge	110
6.4	Design the proposed framework	111
6.4.1	Results of the proposed framework	114
6.4.2	Robustness check of the proposed approach	117
6.4.3	Application of the proposed framework	120
6.5	Discussion	120
6.5.1	Future research	121

“Everything is theoretically impossible, until it is done.”

Robert A. Heinlein

6.1 Motivation

In this chapter, the framework outlined in chapter 5 in Figure 5.3 is applied to compute the partnership score of a European project in the aeronautics field.

The objective of the presented case study in this chapter is to illustrate the applicability of the proposed methods within this research work. This chapter presents the experimental results related to:

- extracting the total knowledge required to achieve project objectives,
- extracting the knowledge that each partner can bring to the project,
- calculate the knowledge criteria (similarity, complementarity, and coverage) of the partnership in the KAAT project,
- calculate the partnership score for the KAAT project partnership,

- demonstrate the application of the proposed framework in the evaluation phase of alliance formation.

In addition to these general objectives, some specific limitations of this chapter are as follows:

- the proposed framework of the last chapter is related to the partner selection phase of alliance formation when there are set of potential partners and a decision-maker is about to evaluate these potential partners in order to choose the best set of partners for the negotiation and the implementation phase of alliance formation. However, in this research work, such data of a project were not accessible to work on. Hence, in this chapter, the proposed method is applied to data of a project that is in the process of completion in order to show the applicability of the method,
- although we believe this methodology of partner selection will increase the collaboration efficiency in strategic alliances, the result of this chapter could not prove it. As the partner of the case study has been already chosen based on other considerations. In addition, considering the fact that projects that are managed by strategic alliances are long-term projects, and due to the time limitation of this research, we could not test our framework on a real partner selection of alliance formation to see the possible improvement. That said, in [Section 6.5.1](#), we propose suggestions for future research to provide more evidence for the effectiveness of the proposed framework.

These limitations make it challenging to assess the applicability of this partner selection framework alliance formation. However, at the same time, our access to the data of the KAAT project provides the opportunity to represent the steps of this framework in detail. At the end of this chapter, we will discuss more the effect of these limitations on the results.

6.2 Presentation of the case study

Currently, in aeronautics, there are 2 principal pathways for education and training:

- **Academic:** bachelor, master and doctorate;
- **Vocational:** training courses that are given by professionals such as airlines organizations, handling organizations, administrative firms, trainers, etc.

Knowledge Alliance in Air Transport (KAAT) is a project that is funded by Erasmus+. The main objective of the KAAT project is to fill the need that is identified in the aeronautics field. The need that is recognized by the project is to ensure the link between the two aforementioned pathways, since in many situations the lack of schemes for the identification of prior learning and/or gained experience makes the transition from academia to vocational occupations difficult. In many cases, graduates require to participate in new training with an important retake of learning outcomes in order to be ready for their duties in vocational occupations.

The project built up European study programs by application of innovative approaches for teaching and learning based on Information Communication Technology (ICT) tools using the co-creation knowledge of 17 partners from education and business of 7 countries: Croatia, France, Italy, Latvia, Portugal, Romania, and Slovakia.

These 17 partners include 7 universities, 3 training providers, and 7 aviation companies. This project pursues three main goals: to develop a new viewpoint towards (1) university-business cooperation in aviation, (2) university study programs, and (3) anticipating the future demand of the aviation labor market in terms of skills and competencies.

These goals ensure students simultaneously acquire sufficient competencies in ICT and aviation. The final beneficiaries of this project are recruiters who have the manpower with sufficient capabilities to meet the challenges of a competitive market. Based on these arguments KAAT project seeks to achieve the following results:

- a new study program (IT applied in aviation),
- innovative training methods,
- development of new bachelor and master program,
- a new learning pathway
- A methodology for the sectoral qualification framework for air transport.

More information about this project can be found at: <http://www.kaat.upb.ro>.

6.3 Data preparation

The proposed partner selection framework in [Chapter 5](#) is focused on the idea of considering the degree of project complexity and history of collaboration of potential partners in order to choose weights for similarity, complementarity, and coverage of knowledge in potential partnerships. The presented framework of this thesis requires several data inputs based on [Figure 5.2](#), [Figure 5.3](#), [Equation 5.2](#), and [Equation 5.3](#). For the ease of reading, a schematic view of the inputs, the steps of the partner selection algorithm, and its output is shown in [Figure 6.1](#). According to this figure, four different inputs are required. The rest of this section is dedicated to illustrating the extraction and preparation of these inputs from the KAAT project documentation.

However, it should be declared that although in the first year of this doctorate, several meetings were held with the partners of the KAAT project, since this chapter of this thesis was executed in the last months of this doctorate, there was not enough time to interview all project partners to verify the data. Therefore, all the data was extracted from the file that was available related to the KAAT project description.

6.3.1 Project technological complexity degree

One of the key inputs for the partner selection framework is the technological complexity of the project. This data helps to decide about the weights of complementarity and coverage of knowledge in the partner selection framework. This is critical because, in simple terms, the framework is based on the logic that the more complex the project, the more important is the coverage of knowledge in the success of the project.

In this chapter, for evaluating the technological complexity degree of the KAAT project, we asked two expert project managers involved in the KAAT project to rank this project in terms of complexity degree on a 10 point Likert scale. Given the number of resources or domains involved in the project, variety of resources and technological skills needed, inter-dependency between the components of the project or technological process, and demand for creativity and scope of development (these criteria are the same criteria that we used in the survey in [Table A.1](#) in [Appendix A](#)). The average ranking of the experts' opinions was to consider the degree of complexity of this project as 4 out of 10.

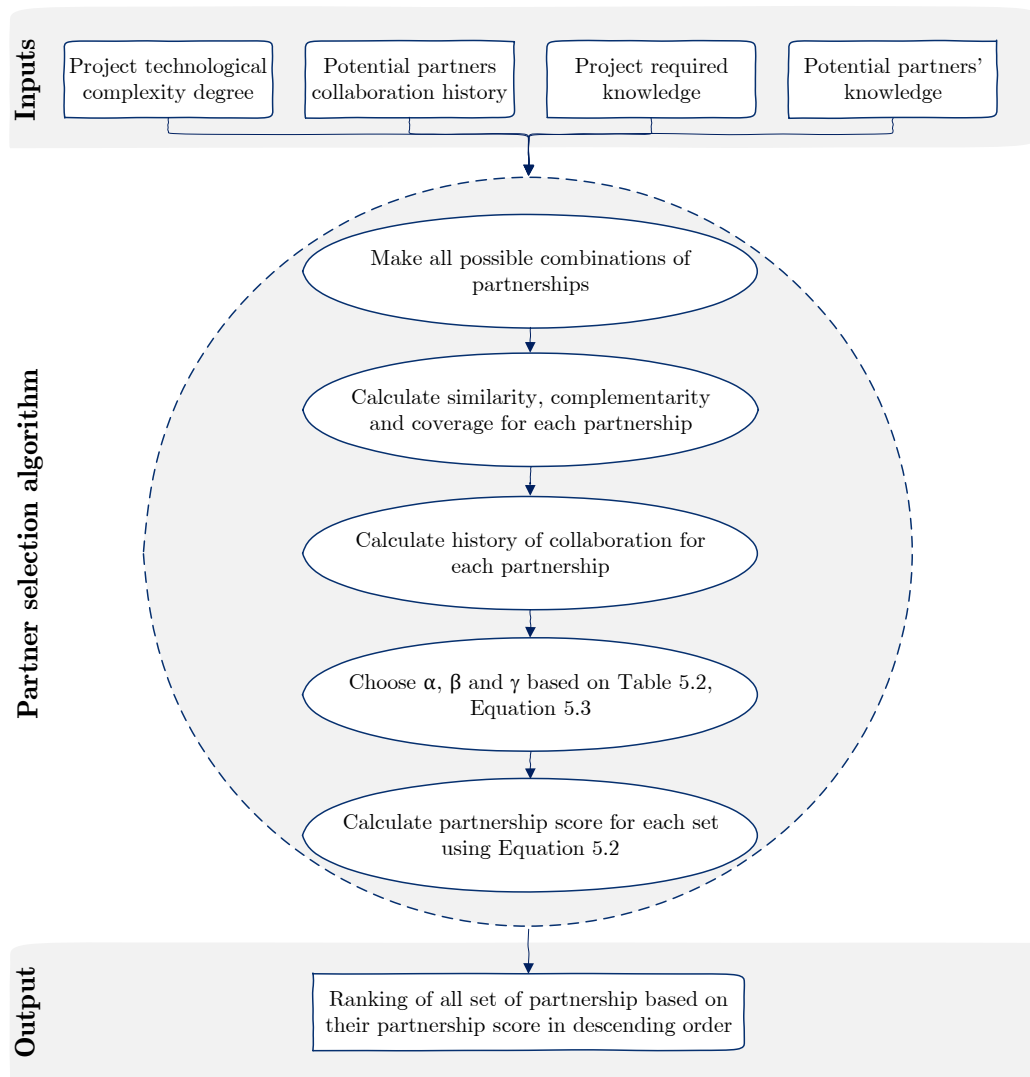


Figure 6.1 – Inputs, outputs and steps of the partner selection algorithm

6.3.2 Partners' collaboration history

The second input data that is required for the proposed framework is the collaboration history of partners. This data helps to decide about the weight of similarity and complementarity of knowledge in the partner selection framework. As the framework is based on the logic that if partners are familiar with each other before the current project or if they had a past successful collaboration, they have already built some trust and the weight of similarity of knowledge can be lower in partner selection and more weight can be considered for complementarity of knowledge. On the other hand, if the partners are not familiar with each other or they had a past unsuccessful collaboration, the weight of similarity of knowledge must be higher to help them build mutual trust in their collaboration.

In this study, we can consider four different degrees of history of collaboration: (1) partners are familiar with each other and had a successful collaboration, (2) partners are familiar¹ with each other, (3) partner are not familiar with each other, and (4) partner are familiar with each other but had an unsuccessful collaboration in the past.

In the KAAT project, 17 partners from 7 different European countries were involved. In order to prepare the data of the history of collaboration, first, we need to survey the background of each partner in the description file of the project. In the KAAT project, 7 universities are involved and the industrial partner in each country is introduced to the project by the university of its country. Table 6.1 shows the result of this study about the KAAT project history of collaboration. Then, we need to assign a number to each situation of partners' history of collaboration. Accordingly, based on this information, a partners' history of collaboration matrix is generated in Table 6.2. This matrix is used as the input of the partner selection algorithm in the following section.

¹The familiarity between two partners without past collaboration refers to any other types of interaction between two partners or staff members from an organization who will be responsible on behalf of the organization in the project.

Table 6.1 – Partners' history of collaboration

Partners	Country	was familiar with	had a past successful collaboration with	had a past unsuccessful collaboration with
P1	Romania	P2, P3, P4, P5, P8, P9, P11, P13, P16, P17	-	-
P2	Croatia	P1, P10, P14, P15	-	-
P3	Portugal	P1, P6, P7	-	-
P4	Latvia	P1	-	-
P5	France	P1, P16	P16	-
P6	Portugal	P3	-	-
P7	Portugal	P3	-	-
P8	Italy	P1	-	-
P9	Slovakia	P1	-	-
P10	Croatia	P2	-	-
P11	Romania	P1	-	-
P12	France	P16	-	-
P13	Romania	P1	-	-
P14	Croatia	P2	-	-
P15	Croatia	P2	-	-
P16	France	P1, P5, P12	P5	-
P17	Romania	P1	-	-

Table 6.2 – Partners’ history of collaboration matrix

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P1		1	1	1	1	2	2	1	1	2	1	2	1	2	2	1	1
P2			2	2	2	2	2	2	2	1	2	2	2	1	1	2	2
P3				2	2	1	1	2	2	2	2	2	2	2	2	2	2
P4					2	2	2	2	2	2	2	2	2	2	2	2	2
P5						2	2	2	2	2	2	2	2	2	2	0	2
P6							2	2	2	2	2	2	2	2	2	2	2
P7								2	2	2	2	2	2	2	2	2	2
P8									2	2	2	2	2	2	2	2	2
P9										2	2	2	2	2	2	2	2
P10											2	2	2	2	2	2	2
P11												2	2	2	2	2	2
P12													2	2	2	1	2
P13														2	2	2	2
P14															2	2	2
P15																2	2
P16																	2
P17																	

Note: Familiar & Successful collaboration = 0

Familiar = 1

Not familiar with = 2

Familiar & Unsuccessful collaboration = 3

6.3.3 Project required knowledge and partners' knowledge

In this step, first, we need to take an inventory of all the knowledge that is required to accomplish the KAAT project objectives. To do so, a deep review is done on the description file of the project and also the project website. As is mentioned previously, the main objective of the KAAT project is: (1) Develop new, innovative, and multidisciplinary approaches to teaching and learning in the aviation domain, and (2) Facilitate the exchange, flow, and co-creation of knowledge among the partners and the stakeholders involved in KAAT. Based on these objectives and other complementarity information that we could find in the description of the project we have classified the required knowledge of this project as follows:

- **Soft skills:** Soft skills required in the project are a collection of productive characteristic traits that characterize partners' relationships in the project life cycle. In the KAAT project, according to the objectives of the project, the existence of several soft skills such as leadership, coordination, teamwork, relational/technical problem solving, etc. was vital.
- **Hard skills:** Hard skills are skills that can be learned and actively employed. These skills are usually easy to prove or illustrate. In the KAAT project, besides the required hard skills in the aviation domain, several hard skills in other fields such as teaching, research, financial reporting, project management, etc were essential.
- **Resources:** Although resources might not be defined directly as knowledge, it is a source of supply or support which is crucial in the projects. In the KAAT project, one of the important required support is having different networks such as industrial networks, academic networks, political networks, etc.
- **Services:** Services can be defined as a system supplying a need in the project. However services might not be categorized as knowledge in definition, it is critical to consider it when it is required in a project. In the KAAT project, based on the educational nature of this project in the aviation industry, there was a need of having partners who give services in different aviation sectors such as handling, maintenance, flight, etc.
- **Organizational culture:** Organizational culture can be defined as the beliefs, values, and modes of interaction that build the unique social environment of an organization. In the KAAT project, considering the fact that different organizations from different countries are involved and also the project needs partners who are open-minded about innovative ideas, some organizational cultures are pointed out as essential requirements of the project. For instance: being multi-cultural, open-minded, aware of innovation, having internal/external communication ability, etc.
- **Language:** Language proficiency ability could be categorized in both hard or soft skills. However, considering the importance of language barriers in the flow of knowledge, and also participating in 7 different countries in the project, we decided to highlight the role of language in an individual category. Hence, in this chapter, we have considered 7 languages that are spoken in these 7 countries (Croatian, French, Italian, Latvian, Portuguese, Romanian, and Slovakian), English as a common necessary language for having effective communication in the KAAT project, and also a category called multi-language for the partners who are able to communicate with more than two of the mentioned languages.
- **Others:** This category is dedicated to all the features of partners that could not be fitted in one of the above categories but we observed them needed in the project description file. For instance: experience in similar projects, good reputation, availability to teach in the educational program, etc.

The above classification can be modified and used based on various aspects of other projects. Afterward, we need to find out what is the set of knowledge that each partner possesses and can bring to the project. This information is helpful in calculating the amount of similarity, complementarity, and coverage of knowledge of the partnership as it is shown in Figure 3.5. To do so, we studied the presentation of each partner in the description file of the KAAT project as well as the website of each partner. For the sake of brevity, the result of this study on the knowledge in possession of each partner is presented in Table C.1, Table C.2, and Table C.3 in the Appendix C.

It should be mentioned again that we have performed this study through the KAAT project information to demonstrate the steps of the proposed framework, there is not a real partner selection in the findings of our analysis (since the partners of the KAAT project have been already chosen and the project is ongoing). Moreover, due to the limitation of time, the information regarding the required knowledge of the project and partners' possessed knowledge are not confirmed by the KAAT project manager or partners. Hence, we strongly encourage future researchers to check and verify their extracted input data through meetings and individual interviews with the potential partners before applying the proposed framework.

6.4 Design the proposed framework

According to Figure 6.1, after the data preparation phase, the partner selection algorithm (based on the proposed framework in Chapter 5) consists of five steps. The logic of these partner selection algorithms is also presented in Algorithm 1. The first step is to make all the possible combinations of the partnerships. The second step is to calculate the similarity, complementarity, and coverage of knowledge for all the combinations of partnerships. To calculate the knowledge criteria we have used the idea of Figure 3.5, and below equations (Equation 6.1, Equation 6.2, and Equation 6.3). K_{P_N} refers to the set of knowledge of partnership number N.

$$\textit{Similarity} = K_{P_1} \cap \dots \cap K_{P_N} \quad (6.1)$$

$$\textit{Complementarity} = (K_{P_1} \cup \dots \cup K_{P_N}) - (K_{P_1} \cap \dots \cap K_{P_N}) \quad (6.2)$$

$$\textit{Coverage} = K_{P_1} \cup \dots \cup K_{P_N} \quad (6.3)$$

Then, in the third step, the history of collaboration for all the combinations of partnership needs to be calculated based on the Equation 6.4. *Sum of history of collaboration* is calculated using the matrix in Table 6.2 for each partnership.

$$\textit{Partnership history of collaboration} = \frac{\textit{Sum of history of collaboration}}{\textit{Number of partners in the partnership}} \quad (6.4)$$

The next step is to choose weights for knowledge criteria (α , β , and γ) based on the technological complexity of the project and the history of collaboration of each set of partnership. In Chapter 5, we have recommended decision-makers to use the proposed framework to choose weights for knowledge criteria. The proposed framework is based on four assumptions (these assumptions are also shown in Figure 6.2): (1) If the project is technologically simple and partners knew each other (or their past projects were successful), then complementarity of knowledge is more important (see point A in Figure 6.2), (2) If the project is technologically simple but it is the first collaboration of partners (or past projects

were unsuccessful), then relative to coverage, similarity and complementarity have more weight in partner selection (see point B in Figure 6.2), (3) If the project is technologically challenging and partners knew each other (or their past projects were successful), then complementarity and coverage are more important (see point C in Figure 6.2), (4) If the project is technologically challenging and it is the first collaboration between partners (or past projects were unsuccessful), then similarity, complementarity, and coverage are all important in partner selection (see point D in Figure 6.2).

In this chapter, to satisfy above assumption in partner selection algorithm, we have used Equation 6.5, Equation 6.6, and Equation 6.7 to calculate α , β , and γ for each partnership. These equations guarantee that α increases along the axis “Partners’ history of collaboration”, and γ increase along the axis “Technological complexity degree of project” (see Figure 6.2).

$$\alpha = \frac{\textit{Partnership history of collaboration}}{6} \quad (6.5)$$

$$\gamma = \frac{\textit{Project technological complexity degree}}{30} \quad (6.6)$$

$$\beta = 1 - \alpha - \gamma \quad (6.7)$$

Finally, the last step is to calculate the partnership score for all the sets of partnerships using Equation 6.8.

$$\textit{Partnership score} = \alpha \times \textit{Similarity} + \beta \times \textit{Complementarity} + \gamma \times \textit{Coverage} \quad (6.8)$$

The output of this partner selection algorithm is a ranking of all possible combinations of partnerships based on their partnership scores.

Algorithm 1 Algorithm of ranking the set of partnerships based on proposed partner selection framework

Input “Partners knowledge matrix”
Input “Partners history of collaboration matrix”
Input “Project technological complexity degree” ▷ For the KAAT project is “4”

- 1: **procedure** PARTNER SELECTION ALGORITHM
- 2: **for** All the partners **do**
- 3: making all the possible combination of partnership
- 4: **end for**
- 5: **for** All the combination of partnership **do**
- 6: Calculation of knowledge criteria of partnership ▷ Eqn. 6.1, 6.2, and 6.3
- 7: Calculation of partnership history of collaboration ▷ Eqn. 6.4
- 8: Calculation of α , β , and γ ▷ Eqn. 6.5, 6.6, and 6.7
- 9: Calculation of partnership score ▷ Eqn. 6.8
- 10: **end for**
- 11: Sort the partnerships based on their partnership scores in descending order
- 12: **end procedure**

Output “Ranking of partnerships”

This algorithm is coded in MATLAB software version R2016b. The programming script is available in Figure C.1 in Appendix C.

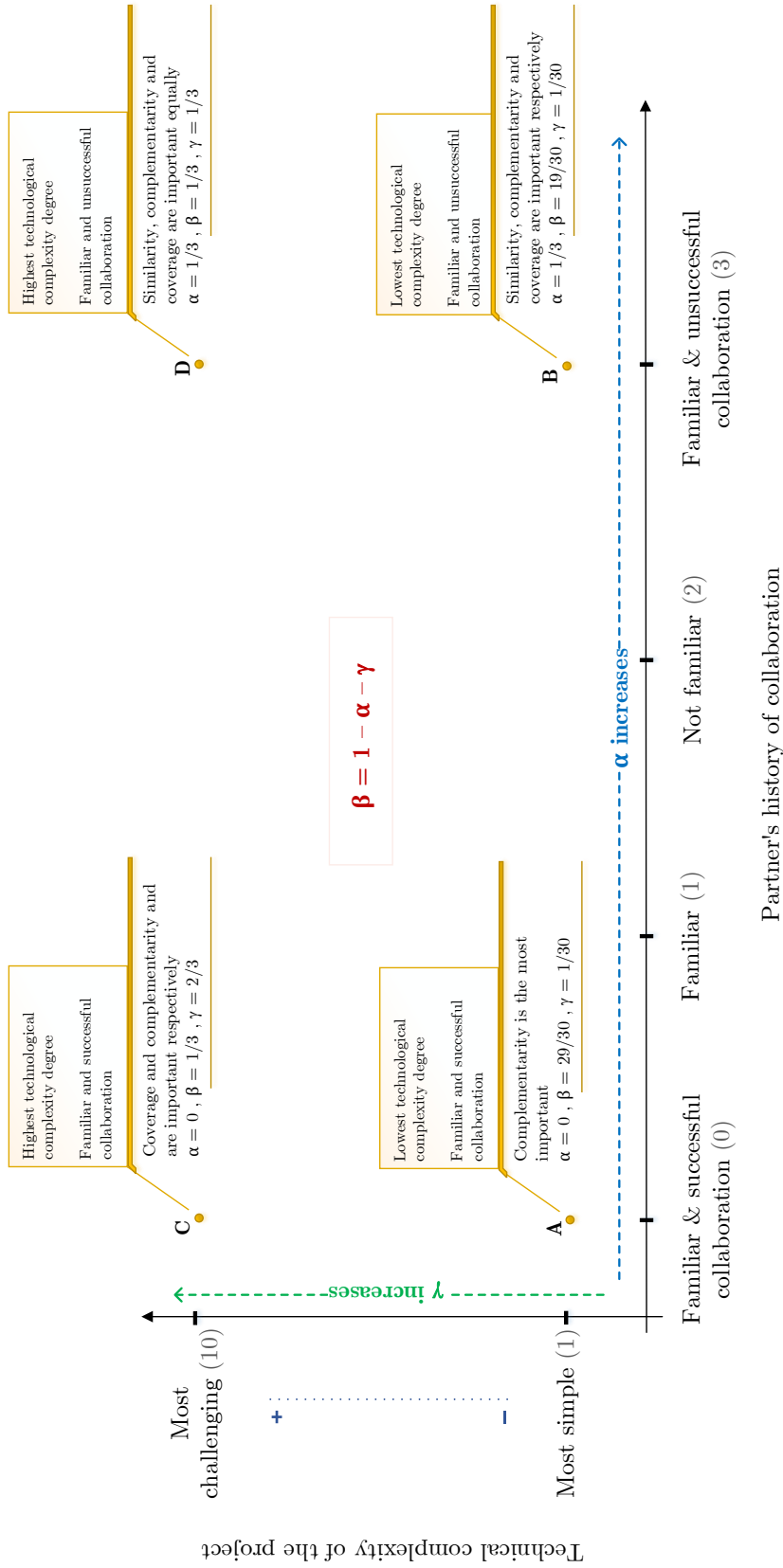


Figure 6.2 – Knowledge weight calculation approach

6.4.1 Results of the proposed framework

The algorithm sorts all the sets of partnerships based on their partnership scores in descending order. In this subsection, we discuss the results in two steps, first the actual state of the KAAT project, second, assuming that we are choosing partners among 17 potential partners to participate in the KAAT project.

Evaluating the KAAT projects actual partnership score:

Since the KAAT project is not in the partner selection phase, all the partners that we have in this chapter, have been chosen to participate in this project. As we have the actual state of the KAAT project, we know that shortly after the start of the project, Panther 12 refused to continue participating in the project, and the project proceeded with 16 partners. Hence, we calculated the partnership score of partnership for two different scenarios:

- **Scenario 1 (initial situation):** all the 17 partners are involved in the KAAT project.
- **Scenario 2 (actual situation):** 16 partners are involved in the KAAT project (all the partners except the partner 12 (who quit the project)).

Table 6.3 shows the result of calculation of partnership score, similarity weight (α), complementarity weight (β), and coverage weight (γ) for the two scenarios.

Table 6.3 – The partnership score, and the weight of similarity, complementarity and coverage of the actual state of the KAAT project

Set of partners	partnership score	α	β	γ
All the partners (P1, P2, ..., P17)	73.2054	0.3113	0.5554	0.1333
All the partners without P12	73.3653	0.3097	0.5569	0.1333

This result shows that the partnership score for conducting the KAAT project with all the partners except partner 12 is higher than conducting it with all 17 partners. Looking at the knowledge wights (α, β, γ) gives us the reasons behind these findings. The weight of similarity in knowledge is higher and the weight of complementarity is lower in the first scenario. Moreover, we know that partner 12 only has familiarity with one other partner (see Table 6.1). Hence, the algorithm calculated the weight of similarity higher in the first scenario to compensate for the lack of familiarity between partners. However, the results show that the amount of knowledge that partner 12 could bring to the project was almost accessible with other partners.

Assuming that we are choosing partners among 17 potential partners for the KAAT project:

In this scenario, we ask the algorithm to plot the ranking of all the possible partnerships based on their partnership scores in descending order and also to print the 10 partnerships with the highest partnership score with details. The result of this calculation is shown in Figure 6.3 and Table 6.4. As it is shown in Figure 6.3, the decreasing slope of partnership score from one partnership to another is quite low. Hence, we can conclude that the partnership scores of *Rank i* to *Rank i+1* are somewhat similar. Moreover, the result in Table 6.4 shows that based on the proposed algorithm the best set of partners is {P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, -, P16, P17}. As it is shown in Table 6.4, the partnership scores for the 10 best partnerships are close to each other.

Therefore, the question that arises here is that “*how significant is the difference between Rank i and Rank i+1?*”

Attempts have been made to respond to this question in the next subsection.

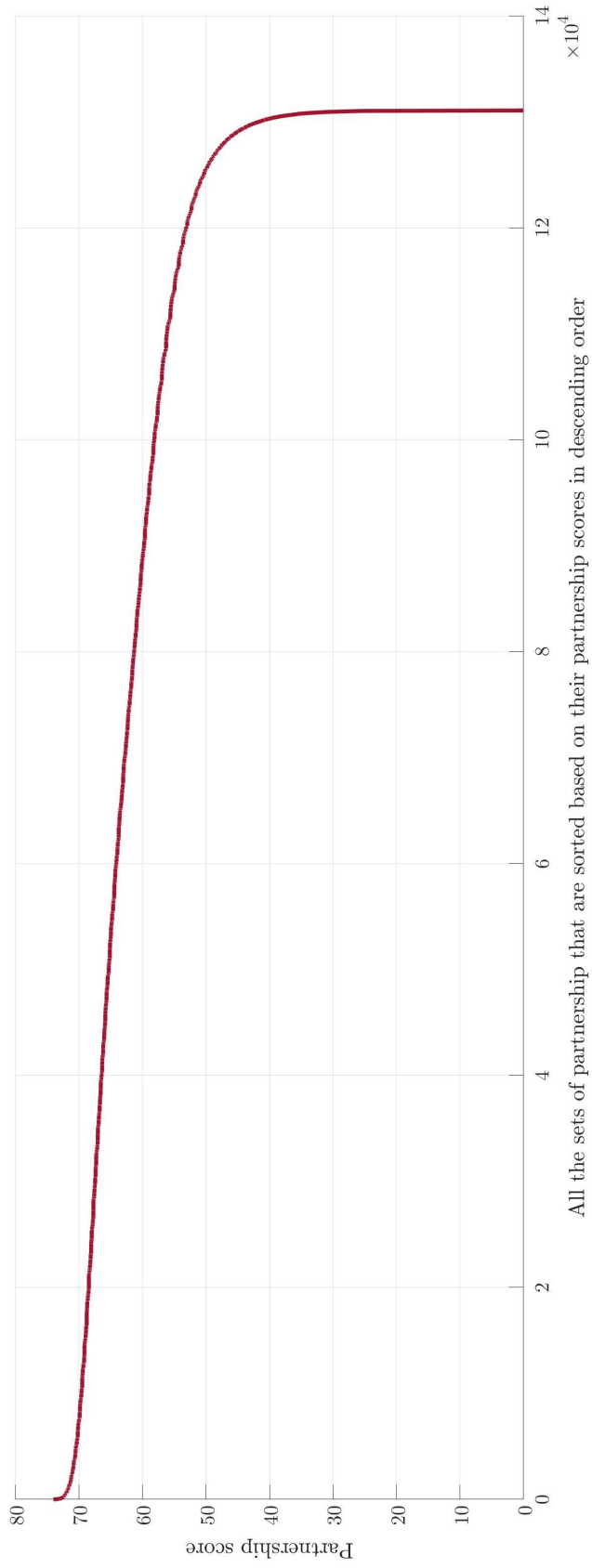


Figure 6.3 – Plot of partnership scores for all the possible partnerships

Table 6.4 – The result of algorithm for the 10 last set of partnership with highest partnership score

Rank	Set of partners	partnership score	$alpha(\alpha)$	$beta(\beta)$	$gamma(\gamma)$
1	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)	74.0145	0.3034	0.5632	0.1333
2	(P1, P2, -, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)	73.7944	0.3056	0.5611	0.1333
3	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, P15, P16, P17)	73.7630	0.3059	0.5608	0.1333
4	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, P14, -, P16, P17)	73.7630	0.3059	0.5608	0.1333
5	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, P12, P13, -, -, P16, P17)	73.7630	0.3059	0.5608	0.1333
6	(P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, -, P13, -, -, P16, P17)	73.7630	0.3059	0.5608	0.1333
7	(P1, P2, -, P4, P5, -, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)	73.6667	0.3000	0.5667	0.1333
8	(P1, P2, P3, P4, P5, -, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)	73.6152	0.3005	0.5662	0.1333
9	(P1, P2, -, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, P15, P16, P17)	73.5744	0.3077	0.5590	0.1333
10	(P1, P2, -, P4, P5, P6, P7, P8, P9, -, P11, -, P13, P14, -, P16, P17)	73.5744	0.3077	0.5590	0.1333

6.4.2 Robustness check of the proposed approach

According to the results of the partner selection algorithm, we have a ranking of partnerships based on their partnership scores. However, first, due to the low difference between the partnership score of *Rank i* and *Rank i+1*, we need to check how significantly *Rank i* is a better partnership than *Rank i+1*. Second, there is plenty of uncertainty in measuring similarity, complementarity, and coverage of knowledge as well as calculating α, β, γ . Although we believe more interviews and meetings with potential partners help decision-makers to measure knowledge of each potential partner more accurately, the complexity and breadth of the subject make it impossible to do these measurements 100% accurately. Moreover, regarding the α, β, γ , they cannot be given precise magnitudes. That means the inputs of this partner selection algorithm might create a statistical artifact.

Accordingly, to make this proposed approach more robust, we simulate the distribution of these 6 values (similarity, complementarity, coverage, α, β , and γ), using uniform distributions of the point estimate plus and minus 10%. It means that we are assuming that the real value lies somewhere in the hyper-sphere around the point estimate. Then, we set the algorithm to run for 1000 iteration and save the outputs. Afterward, we used two scenarios to rank the outputs: (1) based on the exact results (Figure 6.3, and Table 6.4), (2) based on the average of partnership values in descending order.

The ranking of exact for 10 partnerships with the highest partnership scores are available in Table 6.4. Furthermore, the 10 partnerships with the highest average of partnership scores in 1000 iterations are available in Table 6.5. The comparison between these two rankings shows that partnership with *Rank 1* and partnership with *Rank 2* is the same in both scenarios, however, the rest of the rankings are different. According to our investigation, out of the first ten partnerships in both scenarios, 6 of them are common (in a different order), and out of the first twenty partnerships, 16 partnerships are common (in a different order).

Table 6.5 – The result of algorithm for the 10 partnerships with highest average of partnership scores in 1000 iterations

Rank	Set of partners
1	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)
2	(P1, P2, -, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)
3	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, P12, P13, -, -, P16, P17)
4	(P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, -, P13, -, -, P16, P17)
5	(P1, P2, -, P4, P5, -, P7, P8, P9, -, P11, -, P13, -, -, P16, P17)
6	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, P12, P13, P14, -, P16, P17)
7	(P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, -, -, P16, P17)
8	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, -, P13, -, P15, P16, P17)
9	(P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, -, P13, -, P15, P16, P17)
10	(P1, P2, P3, P4, P5, P6, P7, P8, P9, -, P11, P12, P13, -, P15, P16, P17)

In addition, in order to check how significant is the difference between the *Rank i* and *Rank i+1* paired-sample t-test² is performed for both scenarios twice. First, the paired sample t-test is performed between *Rank 1* of both scenarios and the rest of the rankings in descending order. Second, the paired sample t-test is performed in both scenarios between *Rank i* and *Rank i+1*. We have interpreted the results of these paired sample t-test based on P-values. It should be noted that the p-value presents the probability of observing the test results under the null hypothesis (equal means of two groups of data). The lower the p-value, the lower the probability of the null hypothesis is true. Therefore, a low p-value

²The paired sample t-test is a statistical procedure used to determine whether the mean difference between two sets of observations is zero

means decreased support for accepting the null hypothesis. Thus, p-values higher than 0.05 mean the means of two groups of data are statistically equal, and p-values less than 0.05 (typically ≤ 0.05) means the means of two groups of data are significantly different in the 95% confidence intervals.

Figure 6.4 shows the p-values of paired sample t-test between *Rank 1* and others when the partnerships are sorted based on the exact solution. According to this figure, the means of the *Rank 1* and *Rank 2* are not significantly different ($p - value = 0.7376$). It is the same for the *Rank 1* and *Rank 3* ($p - value = 0.0528$), and the *Rank 1* and *Rank 4* ($p - value = 0.1124$). However, all the p-values of paired sample t-test between *Rank 1* and other rankings from *Rank 5* and so on, are below 0.05, which show the significant difference.

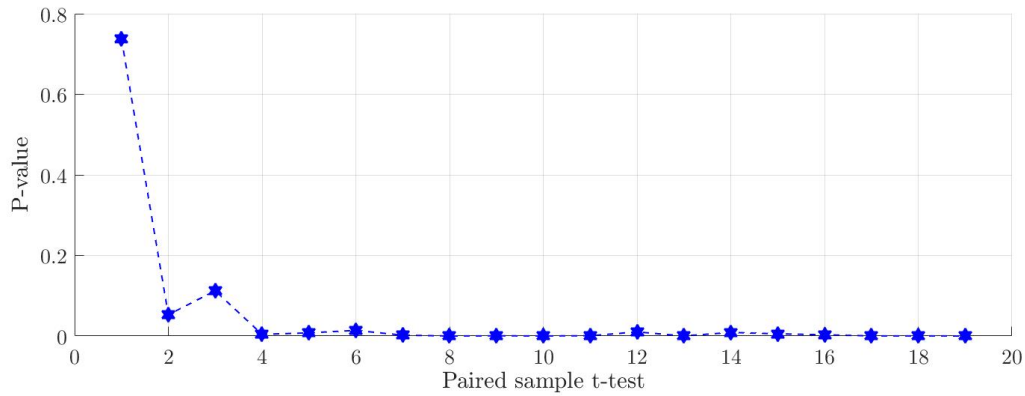


Figure 6.4 – Paired sample t-test between rank 1 and other rankings when they are sorted based on the exact solution

Figure 6.5 shows the p-values of paired sample t-test between *Rank 1* and others when they are sorted based on the average of the partnership scores of 1000 iterations. According to this figure, the means of the *Rank 1* and *Rank 2* are not significantly different ($p - value = 0.7376$). It is the same for the *Rank 1* and *Rank 3* ($p - value = 0.1124$), and the *Rank 1* and *Rank 4* ($p - value = 0.0528$). However, all the p-values of paired sample t-test between *Rank 1* and other rankings from *Rank 5* and so on, are below 0.05, which show the significant difference.

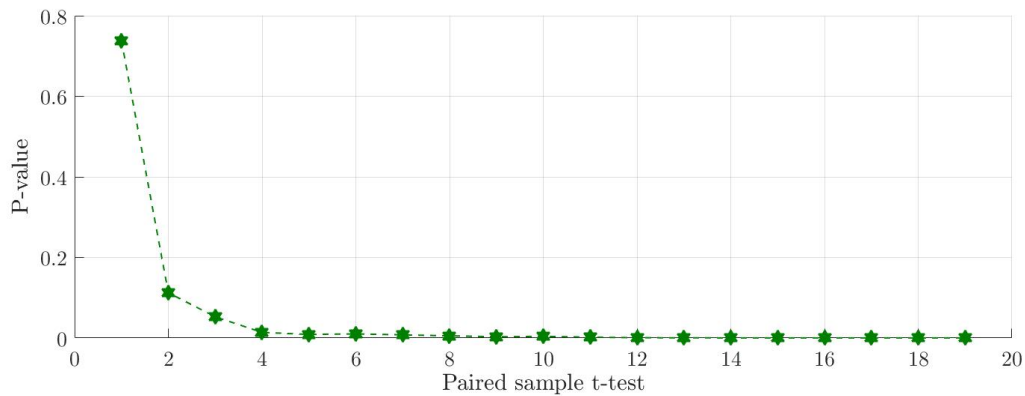


Figure 6.5 – Paired sample t-test between rank 1 and other rankings when they are sorted based on the average of the partnership scores of 1000 iterations

These results means that in the both scenarios there is no significant different between choosing partnership with *Rank 1* and *Rank 2*, *Rank 3* or *Rank 4*.

Figure 6.6 shows the p-values of paired sample t-test between *Rank i* and *Rank i+1* when the partnerships are sorted based on the exact solution. According to this figure, there is no significant difference between the means of *Rank i* and *Rank i+1*.

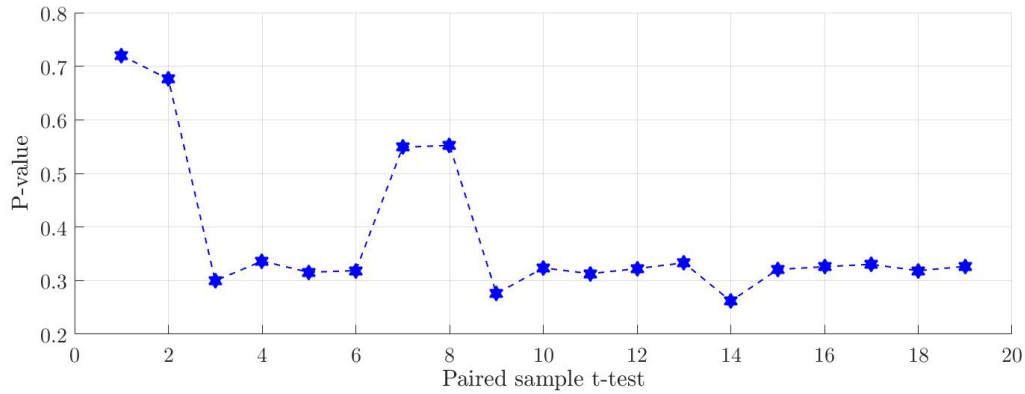


Figure 6.6 – Paired sample t-test between rank i and rank $i+1$ when they are sorted based on the exact solution

Figure 6.7 shows the p-values of paired sample t-test between *Rank i* and *Rank i+1* when they are sorted based on the average of the partnership scores of 1000 iterations. According to this figure, there is no significant difference between the means of *Rank i* and *Rank i+1*.

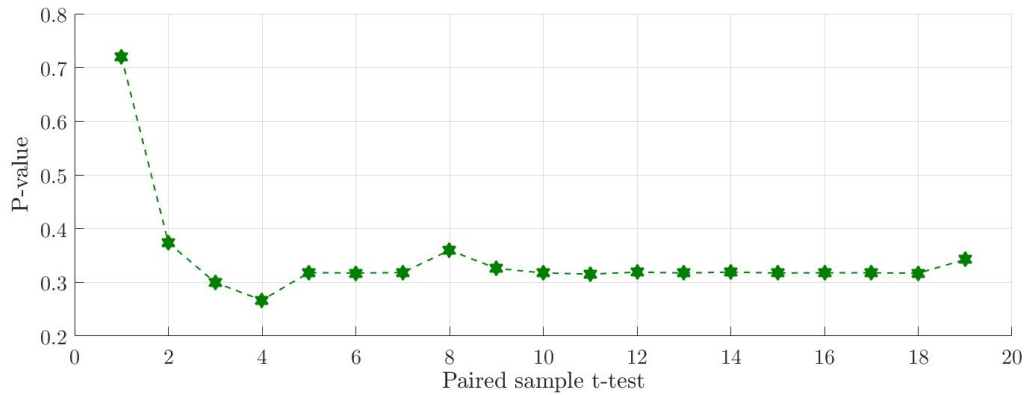


Figure 6.7 – Paired sample t-test between rank i and rank $i+1$ when they are sorted based on the average of the partnership scores of 1000 iterations

According to the above results, first, we believe the reliability of results is higher in the second scenario. Second, we can conclude that we cannot choose among the first 4 partnerships, since they are statistically the same. But we can choose between *Rank 1* and *Rank 5*, since they are statistically different (Figure 6.5). However, if the first ranking is unacceptable for some reason, we are unlikely to be able to choose between ranks 2 and 5 (Figure 6.7). One of the reasons behind this could be the fact that this analysis is done based on the data of a strategic alliance after its formation. So the partners of this partnership have been chosen carefully so partners will fit together well. Hence, considering Figure 6.2, there is no surprise that the curve is smooth, with a fairly small slope. Therefore, we might expect a larger gradient on the curve of partnership scores, if we use this approach in the partner selection phase of alliance formation, and so the choices could be clearer.

6.4.3 Application of the proposed framework

The proposed framework could serve as a tool for a decision-maker in the partner selection phase of an alliance formation. Although there are several determinant factors in selecting the partner in a complex project which is not considered in the proposed framework, it provides a credible vision of the ranking of different sets of partnerships. In case that the input data for the algorithm written based on the proposed framework is correctly extracted, the results of this algorithm can provide an efficient illustration of the partnerships that provide the required knowledge of the project and at the same time, its partners have the basis for building mutual trust. Moreover, the framework is also practical when some of the partners are chosen but there is hesitation among other potential partners to ally.

6.5 Discussion

In this chapter which is a complementarity chapter to the [Chapter 5](#), data of a European strategic alliance (KAAT) is used to demonstrate the application of the proposed partner selection framework. This chapter is aimed at (1) illustrating the approach for measuring similarity, complementarity, and coverage of knowledge, (2) illustrating the approach for evaluating the partners' history of collaboration, (3) demonstrating the proposed framework using the actual data, (4) checking the robustness of proposed approach and suggest more robust partner-selection algorithm, and (5) investigating the position of this framework in the forthcoming research as well as in the selection of partners in complex projects in practice.

To do so, firstly, the case study has been introduced in terms of a summary of the main features and output of the project, aims and objectives, and a brief description of the partners involved. Secondly, the steps of performing the framework on the project data are clarified. Thirdly, all the required input data is represented as well as the steps to extract them from the project information. The required inputs are the project complexity degree, partners' history of collaboration, project required knowledge, and the knowledge that each partner has to bring to the project. Then, the steps of the partner selection algorithm are discussed. In addition, programming the algorithm in MATLAB software is illustrated. Afterward, the results of the partner selection algorithm are discussed as well as its limitations and shortcomings. Moreover, we have simulated the distribution of these 6 values (similarity, complementarity, coverage, α , β , and γ), using uniform distributions of the point estimate plus and minus 10%, to check the statistical difference between rankings. Finally, the practical application of the proposed framework is discussed.

The findings of this chapter indicate that although all the 17 partners of the KAAT project are valuable especially in terms of the reputation and credibility of the project, the objectives of the KAAT project was possible to achieve even with 13 partners instead of 17 in terms of the required skills, services, organizational culture, and language. The reason behind this finding is that we have performed this analysis on data of a partnership which its partners have been already chosen. Moreover, the data extracted from the project when it is nearing its end, so all the required knowledge of the project has been covered by the partners (the uncertainty and lack of knowledge are near very low in this stage). In addition, the extracted data is not confirmed with the partners or the project managers, thus there is a possibility of missing some of the determinant knowledge of some of the partners. Above all, in this chapter, we focused on the required knowledge for achieving the objectives of the project, hence other valuable aspects of partners such as their credibility or their role in the domain of the project which highlights the importance of their presence in the project are not considered. Moreover, one other thing that our analysis does not take into account is the commitment of resources by each partner. It may be true that we could do KAAT with only 13 partners. But this is true only in case that all the 13 partners are committed to using all the knowledge that they have in the project. Hence, by simulating the inputs of the algorithm using uniform

distributions of the point estimate plus and minus 10%, we have tried to cover a part of this uncertainty. The results of this simulation show that although there is no significant difference between the first 4 rankings, there will be a significant difference if we choose *Rank 5* instead of *Rank 1* as a partnership in the KAAT project.

6.5.1 Future research

The outcomes of this chapter highlight the potential of future research. This research strongly encourages scholars to study the following suggestions: first, in order to examine the effectiveness of the proposed framework, we recommend calculating the partnership score for several finished projects and comparing their partnership score with their success level. This comparison gives an overall view of how efficient the proposed framework is. Second, we suggest comparing the result of other partner selection approach with this framework. Third, we assume the proposed framework of this research work provides the basis for designing a more comprehensive partner selection approach by supplementing complementarity constraints such as communications, branding, networking, and partner financial situation and etc, so we recommend that researchers use this research work as one of the possible potential start points for their contributions.

Conclusion

“Reasoning draws a conclusion, but does not make the conclusion certain, unless the mind discovers it by the path of experience.”

Roger Bacon

It is impossible to address the current level of development of our economy without using the notion of innovation. The connection between economic growth, progress, development, and innovation in projects is inevitable these days. Moreover, competitive pressures and the necessity for innovation increase the need for complex projects. However, in innovative complex projects, an organization is usually not capable to manage all aspects individually, since it does not have all the needed competencies, skills, or resources. In this case, the formation of a strategic alliance can be a solution for the development of innovative projects. There are several benefits that strategic alliances provide for managing complex innovative projects, such as: allowing all parties to reach their goals faster, expanding your customer base, giving you access to greater levels of innovation, involving financial assistance, expanding networking opportunities, etc.

On the other hand, there are also downsides to strategic alliances. While accepting that failure is an essential part of innovation, sharing knowledge and technology between partners is not immune to risk. It is also necessary to note that the failure rate of strategic alliances is very high. Some of the frequent challenges in achieving effective collaboration are lack of information sharing, delays in implementation, conflicts in ownership, employees cross-over, miscommunication, missing skills, missing resources, hidden objectives, and lack of trust which create a high risk of failure.

Therefore, identifying the causes of these challenges, the success factors of such projects, and paying attention to proposing approaches that can increase the success of complex innovative projects in strategic alliances are very demanded. To improve the collaboration efficiency and push complex innovative projects forward, the risk of projects including both relational risk and performance risk should be reduced. This thesis has aimed to identify some of the causes of this risk as well as factors that increase success in these projects. To do so following steps in different parts of the thesis have been taken.

In the first part, first we demonstrated the research problem and a guideline for readers. Then we presented an overview on the increasing need for research regarding complex innovative projects as well as their common challenges and solutions. We described the difficulties of project management in complex innovative projects in terms of its breadth and diversity. We distinguished between traditional project management and innovative project management by highlighting the idea that innovative project managers need to replace their concentration

on predictability, evaluation assessment, and control by concentration on change, creative ideas, and breaking the existing situation in innovative complex projects.

To better understand challenges and problems when facing risk in innovative complex projects, we have reviewed the notion of risk and risk management. Through a detailed study, we pointed out that several outcomes. First, forming strategic alliances in innovative complex projects allows partners to manage the risk and uncertainty of complex projects mutually, in addition to sharing their knowledge and resources. Second, despite the previous point, the existence of strategic alliances also adds relational risk to the performance risk of projects. Third, although several valuable solutions for risk management have been proposed in related literature, many of these theoretical risk management methods might not be efficient due to the high cost and competencies they need for implementation.

Moreover, we underlined two other approaches for managing risk and uncertainty in innovative complex projects: managing the knowledge and forming strategic alliances. Since innovation is remarkably related to the availability of knowledge, the complexity caused by the flow and attain of the knowledge has to be recognized and managed to assure successful innovation in projects. Therewith, it is worth mentioning that risk management and knowledge management share many of the same objectives. One of the basic goals of knowledge management is to give the proper information, to the proper person, at the proper moment to make a proper decision. This goal of knowledge management can relatively increase understanding, decrease uncertainty and risk in projects.

We have reviewed the notion of collaboration in innovative complex projects. We observed that collaboration is increasingly seen as a preferable form of performing complex projects involving many partners, suppliers, and customers. Moreover, we concluded that different innovation levels in innovative projects are significantly related to the selected partners of the project. However, a platform of trust between project partners, which depends on the similarities and complementarity of knowledge between them, is needed to achieve the best level of innovation in the project by sharing the knowledge required for the project.

This review led us to address an important question “How to increase the complex innovative project success conducted with strategic alliances?” Many affords have been made to contribute to this question in the second and third parts of this thesis.

In the second part, first, we took a more profound look at research into the success of complex projects, concentrating on the relationships between partners of the project and the knowledge sharing flow between them, in order to identify several factors affecting the success of complex projects. This review led us to propose a novel conceptual model based on several hypotheses extracted from the literature review. This conceptual model proposed to investigate the effect of different knowledge criteria on trust between partners, the effect of trust on project innovation, the effect of complexity on innovation, and the effect of innovation on the success of complex projects. We have also considered the trust capability of the project players as a moderator of the relationship between knowledge criteria and trust between project partners. Then a survey is designed and filled by project managers to provide the required data to analyze the conceptual model.

In this analysis, at the first level, PLS-SEM is used to analyze the data and investigate the relationship between different variables in the proposed conceptual model. Some of the most remarkable results of this analysis are: firstly, enough evidence was provided for the fact that if a project is more innovative then it is more successful. Then, this analysis confirmed the positive role of coverage of knowledge (required for the project) in the success of complex projects. In addition, relational trust has a significant positive effect on project innovation. Moreover, the proof is also provided for the fact that if a project is more technically complex by its nature, and organizationally complex in terms of diversity of staff and information systems then it is correlated with more innovativeness. Regarding the knowledge criteria, the effects of similarity and complementarity in the relational trust, and complementarity

on competence-based trust show a significant positive effect. Besides, the findings have also shown that the slope of increasing the trust between partners in the project depends on their trust capability.

According to these findings, we propose some recommendations for decision-makers: (1) we recommend selecting partners for complex projects be such that it covers all the knowledge necessary to complete the project, (2) as increasing the similarity in knowledge between partners can increase trust between them and thus have a positive impact on the innovation and success of the project, we recommend choosing the partners of future projects considering the similarity as well as complementarity of knowledge to increase their relational trust, and (3) we also suggest, especially if there is a previous familiarity between the potential partners of the partnerships, alongside the consideration of the similarity and complementarity of knowledge between partners, more weight should be given to the coverage of knowledge in partner selection.

Then to take one more step, the role of project managers' work experience was taken to account to analyze its correlation with the success of the project that their managed and their opinion about the success factor of complex projects. Spearman's correlation coefficient analysis was performed for this purpose. The result of our analysis proved that the project that was managed by more experienced managers was more successful. Moreover, increasing the work experience of project managers affects their judgment by increasing the importance level of meeting organizational objectives, team satisfaction, and stakeholders satisfaction in the success of projects. Besides, the result of this analysis shows that more experienced project managers value more for knowledge coverage of knowledge in projects and trust between partners. Finally, it is proven that more experienced project managers have more inclined to work with partners who are honest and trustworthy, have a good reputation and qualification in their domain.

According to these findings, we demonstrate some highlights for decision-makers: (1) we encourage less experienced project managers to invest in the satisfaction of the team member and stakeholders as long as the organizational objectives of the project, (2) we draw the attention of less experienced decision-makers to the fact that since the importance of trust between partners also increases with the experience of managers, the good reputation, qualification, and honesty of the partners in a partnership are important in project success, and (3) it is worth mentioning that more experienced project managers have less desire to work with firms with different organizational processes, legal systems, and working hours. Hence, we suggest decision-makers consider these findings in their partner selection process.

The third part focused on proposing a novel partner selection framework based on the findings of the last parts and also a literature review on influential factors of alliance formation and partners selection. The framework aims at enhancing the collaboration efficiency considering project complexity degree, project knowledge requirement, and partners' past experiences.

This partner selection framework draws the attention of decision-makers of alliance formation to the fact that when partners are familiar with each other and the project is simply the weight of complementarity in knowledge must be higher. Whereas by having a more complicated project the weight of coverage of knowledge must be considered higher, and in case of having unfamiliar potential partners or unsuccessful collaboration in the past the weight of similarity between partners must be higher in order to help them build trust. To do so, a partnership score could be calculated for each set of potential partners based on the proposed formula to help to choose the best set of partners with a higher partnership score.

Finally, data of a European project in the aeronautics field named Knowledge Alliance in Air Transport (KAAT) which conducted in form of strategic alliances are used to (1) demonstrate the applicability of the proposed framework on real data, and (2) to provide a novel foundation for future research in this field.

In sum, this thesis contributes to:

- highlighting the important role of knowledge management and effective collaboration via effective knowledge sharing in both decreasing the risk and increasing the innovation and success of complex projects (Chapter 2),
- distinguishing between the two aspects of organizational complexity and social complexity, since we realized the relationship between organizational complexity on innovation has been debated differently by the related research. Hence, complexities in terms of the number of activities, size of the investment, diversity of staff, etc. are considered as organizational complexity. In addition, complexities in terms of the number of different legal systems involved, local environmental complexity and etc. are considered as social complexity. This distinguishment helps in understanding the different levels of complexity in projects more clearly (Chapter 3),
- identifying the coverage of knowledge as a new aspect of knowledge criteria besides similarity and complementarity of knowledge. The coverage of knowledge refers to the knowledge required to finish the project which is covered by a partnership. We believe that the more complex a project is and the more resources and knowledge it needs to achieve its goals, the more important it is to highlight the role of knowledge coverage. Because in forming an alliance for complex projects, often organizations evaluate their own or their partner's abilities optimistically or based on previous experience and reputations. While each project is unique and needs to be reviewed in detail with the knowledge and resources required before starting the project (Chapter 3),
- proposing a novel conceptual model for complex project success in which different knowledge criteria and project complexity aspects are considered as well as trust and project innovation. Based on this conceptual model, the groundwork was laid for designing a questionnaire and collecting data from project managers to identify effective factors in complex project success. Another contribution of this conceptual model is the consideration of the trust capability of respondents as a moderator variable to moderate the relationship between different knowledge criteria and trust between partners in projects (Chapter 3),
- highlighting the role of project managers' work experience not only on the success of projects managed by them but also on their opinion about important factors affecting the success of projects. This helps in understanding which factors are more or less important to project managers as they gain more experience. We believe this analysis can be especially valuable for less experienced project managers and decision-makers (Chapter 4),
- designing a partner selection framework based on evaluating the complexity degree of the project and the history of collaboration of the potential partners. This partnership framework has designed based on the idea that the project complexity degree and partners' past experience creates a decisive role in the amount of similarity, complementarity, and coverage that need to be considered in forming an alliance to increase the trust between partners, enhance the knowledge sharing quality as well as providing the knowledge needed to successfully complete the project (Chapter 5),
- applying the proposed partner selection framework on a real case study to explain its required notion and its function. Although the case study that was used to test a data was for a project which was already conducted by a strategic alliance, and the application of the proposed framework could not be demonstrated clearly, we believe this demonstration would clarify the applicability of the proposed as well as brightening many horizons for the future research (Chapter 6).

Limitations

Although the findings of this thesis have revealed several achievements, There is also a need to highlight the shortcomings of the presented research work. Similar to most research, the outcomes of this research were affected by many limitations. These limitations are listed and discussed as follows:

- this thesis concentrates on complex innovative projects, and by highlighting the role of strategic collaboration in the management of these projects and their challenges, seeks to reduce the risk of failure in these collaborations, and increases the success of these projects. However, there are different keywords in the literature referring to partnership and collaboration between independent organizations such as Collaborative Network (CN), Virtual Organization (VO), Virtual Breeding Environment (VBE), Supply Chain Network (SCN), strategic alliance, partnership, collaborative project, etc. In spite of the fact that it is confirmed that due to cross-disciplinary essence of collaboration, these concepts can be used interchangeably, and also considering the effort that has been made in this thesis to cover related research with different keywords, the main concentration stayed in “strategic alliance”, there is a risk of lacking some valuable related work this research. Moreover, there are also different types of collaboration with different scopes of authorities of each partner. Nonetheless, this research focuses on strategic alliances that include at least two partners that stay legally independent, share managerial power and benefits, and make ongoing contributions. Hence, the result of this thesis might not be applicable for other types of collaborations (in almost all chapters).
- there are also several limitations in proposing the conceptual model of thesis research as well as designing the survey to collect the data. The classification of trust between partners that are considered in this research is one of the several classifications discussed in the literature. This is the same consideration related to the innovation and complexity of the projects. Considering other classification and other classification might reveal other findings, however in this research due to the limitations of designing the survey to make it concise and effortless to answer, we could not consider other dimensions and questions (Chapter 3).
- additionally, since the role of project managers’ work experience has been considered based on the proposed conceptual model and its designed survey, there is a lack of a more comprehensive literature review on the work experience of project managers in this thesis. In addition, the focus of this research is on project managers years of work experience, and other dimensions of experience such as successful/unsuccessful experience, potential/actual work experience, and organizational/teamwork experience are not considered in this research work (Chapter 4).
- there are also some limitations and considerations regarding the gathered data in this research. Firstly, despite all our efforts to collect more data, in this research, due to the coincidence of this data collection process with the Covid 19 confinement period and also the high preoccupation of the target population of this research survey (complex project managers), we could not collect more data. Although the number of our data met the requirements for the statistical analysis, we believe that more data could lead to more reliable results and deeper analysis. Secondly, the data are mostly collected from European research projects, so there is a need for caution in generalizing the results of this research to all kinds of projects and all countries (Chapter 3, and Chapter 4).
- the framework proposed in this thesis for selecting partners in a strategic alliance is only a tool to assist decision-makers in the alliance formation phase. Therefore, there is no claim to consider all the complexities and limitations of choice in such decisions. We believe this proposed framework will provide better insight for decision-makers to

select partners for selecting partners with more confidence, but we know that other circumstances such as communications, branding, networking, and partner financial and credit issues impose a heavyweight on the selection of partners in strategic alliances which are not considered in this research work (Chapter 5).

- this research uses data from an ongoing project to demonstrate the application of the proposed framework. The idea is to clarify the steps for selecting partners based on this framework. However, there are several limitations, firstly because partners of this strategic alliance had already been selected, so no real choice has been made between several potential partners. Secondly, in order to prove the effectiveness of this framework, it is necessary to calculate the partnership score by this framework and the success rate of the project in several projects to check if the projects with higher partnership scores were more successful or not, which time limitations of a doctoral thesis did not give the researchers of this thesis this opportunity (Chapter 6).

Future research

Possible future research in this study includes overcoming all of the above limitations. However, this research work strongly encourages researchers to study these issues in particular: first, developing a multiple-choice survey on the key factors identified to distinguish between radical and incremental innovation in the success of projects. Secondly, we suggest that researchers who have the abilities and accesses, by expanding the data collection target community, collect more data from different types of complex projects in different countries so that by analyzing that data, a more comprehensive picture can be obtained from success factors of complex projects with different characteristics. Thirdly, we suggest future research to calculate several strategic alliances partnership scores based on this research work and compare the scores with the success rate of projects to measure the effectiveness of the proposed approach. Fourthly, we suggest applying the proposed partner selection framework in the partner selection phase of an alliance formation and making a comparison with other partner selection methodologies in the literature. The least but not last, we believe the proposed partner selection framework of this thesis provides the basis for designing a comprehensive partner selection framework by adding complementarity constraints such as communications, branding, networking, and partner financial situation, etc, so we suggest that researchers use this research work as one of the potential start points for their contributions.

Résumé long en français

“La langue anglaise est un fusil à plombs : le tir est dispersé. La langue française est un fusil qui tire à balle, de façon précise.”

De Otto von Habsburg

En raison de la mondialisation et des pressions concurrentielles actuelles, il est de plus en plus crucial d'innover afin de maintenir la satisfaction des clients. Un lien entre croissance économique, développement et innovation dans les projets est de nos jours inévitable. De plus, les pressions concurrentielles et la nécessité d'innover augmentent le besoin de projets complexes. Cependant, dans le cadre de projets innovants complexes, une organisation n'est généralement pas capable de gérer seule tous les aspects du projet. En effet, il est possible qu'elle ne dispose pas de toutes les compétences, aptitudes ou ressources nécessaires. Dans de tels cas, la formation d'une alliance stratégique peut être une solution permettant le développement de projets innovants. Les alliances stratégiques présentent plusieurs avantages pour la gestion de projets innovants complexes : elles permettent à toutes les parties d'atteindre leurs objectifs plus rapidement, elles élargissent la base de clients, elles donnent accès à des niveaux d'innovation plus élevés, elles impliquent une aide financière, elles élargissent les possibilités de mise en réseau, etc.

D'un autre côté, les alliances stratégiques présentent également des inconvénients. Tout en admettant que l'échec est étroitement lié à l'innovation, le partage des connaissances et des technologies entre partenaires n'est pas sans risque. Il faut noter que le taux d'échec des alliances stratégiques est très élevé. Le manque de partage d'information, les retards dans la mise en œuvre, les conflits de propriété, le transfert d'employés, la mauvaise communication, les compétences manquantes, les ressources manquantes, les objectifs cachés et le manque de confiance représentent quelques-uns des défis fréquents à surmonter afin de parvenir à une collaboration efficace, ce qui crée un risque élevé d'échec.

Il est donc indispensable d'identifier les causes de ces difficultés, les facteurs de réussite de ces projets, et de proposer des approches susceptibles d'accroître les taux de réussite des projets innovants complexes dans le cadre d'alliances stratégiques. Afin d'améliorer l'efficacité de la collaboration et de faire avancer les projets innovants complexes, le risque des projets, y compris le risque relationnel et le risque de performance, doit être réduit.

À cet égard, cette thèse vise à identifier les facteurs permettant d'augmenter l'innovation et le succès des projets complexes innovants menés par des alliances stratégiques. De plus, elle propose une méthodologie permettant de choisir le meilleur ensemble de partenaires dans la formation d'une alliance, afin d'augmenter la confiance entre les partenaires ainsi que la qualité du partage des connaissances et le succès des projets. Cette recherche a utilisé des

données collectées lors d'une enquête auprès de gestionnaires de projets Européens ayant pour but d'étudier les facteurs influençant la réussite des projets. En outre, en analysant de façon détaillée des données historiques d'un projet Européen dans le domaine de l'aéronautique appelé Knowledge Alliance in Air Transport (KAAT), le cadre de sélection de partenaires proposé dans cette thèse est examiné. Cette thèse comprend trois parties principales, six chapitres et une conclusion générale présentés comme suit:

Partie I: La première partie de cette thèse se concentre sur l'introduction du contexte de la recherche, ainsi que sur l'état de l'art de cette recherche, qui sont présentés en deux chapitres.

Chapitre 1: Le premier chapitre propose une introduction à la collaboration dans les projets complexes innovants, présente le concept et sa définition, décrit la problématique et la méthodologie de recherche, et souligne les contributions et les grandes lignes de cette thèse.

Chapitre 2: Le deuxième chapitre présente l'état de l'art du projet complexe innovant, la gestion des risques et des connaissances, le rôle de la collaboration dans le projet complexe innovant, ainsi que les défis et problèmes de recherche les plus rencontrés dans ce domaine.

Partie II: La deuxième partie se concentre sur les facteurs qui affectent la réussite d'un projet complexe innovant dans le cadre d'alliances stratégiques.

Chapitre 3: Le troisième chapitre présente un modèle conceptuel basé sur plusieurs hypothèses afin d'analyser l'effet des facteurs sélectionnés sur le succès des projets innovants.

Chapitre 4: Le quatrième chapitre examine le rôle de l'expérience des chefs de projet sur leur jugement concernant les facteurs importants pour le succès des projets complexes innovants.

Partie III: La troisième partie se concentre sur la phase de sélection des partenaires formant l'alliance.

Chapitre 5: Le cinquième chapitre propose un cadre de sélection des partenaires qui vise à maximiser la probabilité de réussite d'une collaboration.

Chapitre 6: Le sixième chapitre présente une étude de cas au sein de laquelle le cadre de sélection des partenaires proposé dans cette thèse est testé.

En plus des chapitres présentés ci-dessus qui constituent les trois principales parties, cette thèse se termine par une conclusion générale.

Contexte et problématique

Dans la littérature académique, le nombre d'articles sur les projets complexes innovants est en augmentation ces derniers temps. Plus la faisabilité d'un projet est complexe, moins une seule entreprise aura toutes les compétences ou les moyens de mener à bien seule le développement du projet. Une conséquence majeure est que des alliances doivent être formées afin de mener à bien le projet. Parmi les éléments mis en place pour soutenir ces alliances, des plans de gestion de la qualité et des risques sont mis en œuvre pour maximiser les chances de réussite des projets. Cependant, malgré cela, les alliances rencontrent des difficultés pour atteindre leurs objectifs. Plus de 60 % des alliances de développement de nouveaux produits (NPD) échouent en raison de difficultés de communication entre les partenaires, d'objectifs cachés ou de compétences manquantes (Bruner et al., 1998).

Certaines des raisons d'échec dans les alliances stratégiques peuvent être classées comme suit (Elmuti et al., 2001) :

- **Choc des cultures:** Le choc des cultures est probablement l'un des plus grands défi des alliances stratégiques qui se compose de : égos des partenaires, barrières linguistiques, chauvinisme, etc.
- **Manque de confiance:** L'établissement d'une confiance mutuelle est l'un des aspects les plus difficiles de la formation d'une alliance. De nombreuses alliances échouent en raison du manque de confiance qui entraîne la dissimulation d'informations, des problèmes non résolus et un manque de compréhension.
- **Manque d'objectifs clairs:** Avoir des objectifs qui ne sont pas similaires, être dans l'incapacité de partager les risques, et former une alliance pour de mauvaises raisons sont aussi souvent des causes d'échecs dans les alliances.
- **Manque de coordination entre les gestionnaires:** La coordination peut être un énorme problème dans les alliances stratégiques, surtout si les organisations restent des concurrents au lieu de collaborer.
- **Différence dans les opérations et les attitudes des partenaires:** Les organisations impliquées dans l'alliance stratégique peuvent avoir des attitudes et des programmes de fonctionnement différents, ce qui peut entraîner des conflits.

En outre, la littérature traite de l'importance de différents aspects dans le processus de sélection des partenaires. Parmi eux, les "difficultés de communication" entre les partenaires impliqués sont considérées comme l'aspect le plus critique dans le processus de sélection des partenaires (Doloi, 2009).

Ainsi, comme nous l'avons vu dans le paragraphe précédent, notre recherche est motivée par l'identification du projet ainsi que par les caractéristiques des partenaires qui peuvent affecter le résultat du projet. De plus, comme indiqué dans la littérature académique, la majorité des recherches dans ce domaine ont adopté des solutions complexes pour diminuer le risque d'échec dans les projets complexes, mais ces solutions ne sont souvent pas applicables en pratique, en raison du besoin de compétences diverses (Firmenich, 2017). Par conséquent, il y a un besoin urgent de solutions pratiques permettant d'aider les décideurs dans les projets complexes innovants.

Partie 1 : Contexte, problématique et historique de la thèse

Le Project Management Institute (PMI) a proposé une nouvelle définition du projet qui devrait être à la fois inclusive (il ne devrait pas être possible d'identifier un accord généralement considéré comme un projet qui ne soit pas conforme à la définition.) et exclusive (il ne devrait pas être possible de décrire un accord qui réponde à la définition et qui ne soit pas généralement considéré comme un projet). Selon la PMI, un projet est une entreprise temporaire entreprise dans le but de créer un produit ou un service unique (PMI, 2013).

Le mot le plus populaire pour n'importe quel membre du projet est sans doute "succès" (Howsawi et al., 2014). Lorsqu'on parle de projets, il existe deux concepts principaux de réussite : la réussite du projet et la réussite de la gestion du projet. Il existe des similitudes et des différences entre ces deux concepts de réussite de projet. La principale différence est que le succès du projet est lié au résultat de la réalisation des objectifs globaux du projet, tandis que le succès de la gestion du projet est lié aux mesures traditionnelles de temps, de coût et de qualité (Cooke-Davies, 2002; de Wit, 1988; Ika, 2009). Cependant, en raison des différents modèles de projet et de réussite de projet, il est difficile de les différencier fortement, principalement en raison de leurs interrelations.

D'autre part, le risque de projet est défini comme "l'effet de l'incertitude sur les objectifs" ou "un événement ou une condition incertaine qui, s'il se produit, a un effet positif ou négatif sur un ou plusieurs objectifs du projet" (PMI, 2013). Si les risques d'un projet ne peuvent pas être gérés de manière efficace et efficiente en utilisant une approche systématique, il est difficile d'atteindre les objectifs du projet et cela peut conduire à son échec. Tout au long du cycle de vie d'un projet, le processus de gestion des risques comprend principalement l'évaluation des risques (impliquant l'identification, l'analyse et l'évaluation des risques, le traitement des risques, ainsi que la surveillance et l'examen des risques). Parmi ces étapes, l'évaluation des risques est une activité essentielle qui permet aux décideurs de développer une perception globale des risques d'un projet et ainsi de prendre des décisions de réponse adéquates de manière préventive (Guan et al., 2020).

Le risque d'échec des projets est élevé dans les projets complexes innovants, surtout lorsque différentes organisations sont impliquées dans la gestion conjointe de ces projets. Récemment, de nombreuses recherches ont été développées afin de réduire le risque des alliances stratégiques tout en permettant leur réussite.

Dans la première partie de la thèse, le problème de recherche et une ligne directrice pour les lecteurs sont exposés. Ensuite, un aperçu sur le besoin croissant de recherche concernant les projets innovants complexes, ainsi que leurs défis communs et leurs solutions, est présenté. Les difficultés de la gestion de projet dans les projets innovants complexes (en termes d'ampleur et de diversité) sont décrites. Nous faisons la distinction entre la gestion de projet traditionnelle et la gestion de projet innovante, en soulignant l'idée que la concentration de la gestion de projet sur la prévisibilité, l'évaluation et le contrôle doit être remplacée par une concentration sur le changement, les idées créatives et la rupture par rapport à la situation existante dans les projets complexes innovants.

Afin de mieux comprendre les défis et les problèmes qui se posent lorsque l'on est confronté au risque dans le cadre de projets complexes innovants, les notions de risque et de gestion du risque sont passées en revue. À travers une étude détaillée, nous avons mis en évidence plusieurs résultats. Premièrement, la formation d'alliances stratégiques dans les projets complexes innovants permet aux partenaires de gérer mutuellement le risque et l'incertitude des projets complexes, en plus de partager leurs connaissances et leurs ressources. Deuxièmement, malgré le point précédent, l'existence d'alliances stratégiques ajoute également un risque relationnel au risque de performance des projets. Troisièmement, bien que plusieurs solutions valables pour la gestion des risques aient été proposées dans la littérature, beaucoup de ces méthodes théoriques de gestion des risques pourraient ne pas être efficaces en raison d'un coût élevé et des compétences qu'elles nécessitent pour leur mise en œuvre.

Ensuite, nous avons souligné deux autres approches pour gérer le risque et l'incertitude dans les projets complexes innovants : la gestion des connaissances et la formation d'alliances stratégiques. Puisque l'innovation est remarquablement liée à la disponibilité de la connaissance, la complexité causée par le flux et la portée de la connaissance doit être reconnue et gérée afin d'assurer une innovation réussie dans les projets. Par conséquent, il convient de mentionner que la gestion des risques et la gestion des connaissances partagent de nombreux objectifs communs. L'un des objectifs fondamentaux de la gestion des connaissances est de procurer les bonnes informations, à la bonne personne, au bon moment, afin de prendre une bonne décision. Cet objectif de gestion des connaissances peut accroître la compréhension, réduire l'incertitude et le risque dans les projets.

Nous avons également examiné la notion de collaboration dans les projets complexes innovants. Nous avons observé que la collaboration est de plus en plus considérée comme une forme préférable de réalisation de projets complexes impliquant de nombreux partenaires, fournisseurs et clients. De plus, nous avons conclu que les différents niveaux d'innovation dans les projets innovants sont significativement liés aux partenaires sélectionnés pour le projet. Cependant, une plateforme de confiance entre les partenaires du projet, qui dépend

des similitudes et de la complémentarité des connaissances entre eux, est nécessaire afin d'atteindre le niveau optimal d'innovation au sein du projet en partageant les connaissances requises pour le projet.

Cette revue nous a conduit à nous poser une question importante : “Comment augmenter le succès des projets innovants complexes menés avec des alliances stratégiques ?”. De nombreuses propositions ont été faites dans l'optique de répondre à cette question dans les deuxième et troisième parties de cette thèse.

Partie 2 : Un modèle conceptuel hypothétique proposé

Le fait qu'un projet débouche ou non sur une innovation significative est étroitement lié aux connaissances impliquées, et l'intégration de différents types de connaissances affecte les performances en matière d'innovation. C'est pourquoi les relations entre la capacité d'innovation d'une entreprise et ses connaissances, aptitudes et compétences font l'objet d'une attention croissante. Par exemple, Robertson et al. (2021) a étudié l'effet de quatre variables, à savoir la création de connaissances, la diffusion de connaissances, l'absorption de connaissances et l'impact des connaissances sur la performance en matière d'innovation dans les économies de marché développées et en développement. Parmi les quatre variables, la création de connaissances a eu l'effet le plus important sur la performance d'innovation. Islam et al. (2021) ont proposé un modèle pour analyser le rôle des connaissances tacites et explicites sur l'innovation des fournisseurs des pays en développement dans les chaînes de valeur. Leurs résultats indiquent que les connaissances tacites et explicites contribuent toutes deux à l'innovation. Freel (2005) a démontré empiriquement qu'il existe une forte relation entre les caractéristiques d'une entreprise (taille, âge, compétences financières et technologiques) et sa capacité d'innovation.

Park et al. (2014) ont étudié le rôle de la confiance et de la dépendance dans le partage des connaissances, concluant que les collaborateurs partagent leurs connaissances lorsqu'ils se font confiance et se sentent dépendants. Ils ont également constaté que les sentiments de confiance sont influencés par la fréquence de la communication, la similitude de la valeur accordée aux projets par les partenaires, ainsi que la similitude de leurs compétences. Il existe une relation forte entre le partage des connaissances et la confiance mutuelle dans les systèmes d'information qui développent la collaboration entre les partenaires pour atteindre leurs objectifs (Q. Xu et al., 2008).

Dans la deuxième partie de la thèse, nous examinons tout d'abord plus en profondeur la recherche sur le succès des projets complexes, en nous concentrant sur les relations entre les partenaires du projet et le flux de partage des connaissances entre eux, afin d'identifier plusieurs facteurs affectant le succès des projets complexes. Cette revue nous a conduit à proposer un nouveau modèle conceptuel basé sur plusieurs hypothèses extraites de la revue de la littérature. Ce modèle conceptuel propose d'étudier l'effet de différents critères de connaissance sur la confiance entre les partenaires, l'effet de la confiance sur l'innovation du projet, l'effet de la complexité sur l'innovation, et l'effet de l'innovation sur le succès des projets complexes. Nous avons également considéré la capacité de confiance de l'acteur du projet comme un modérateur de la relation entre les critères de connaissance et la confiance entre les partenaires du projet. Ensuite, une enquête a été conduite auprès de chefs de projet afin d'obtenir les données nécessaires à l'analyse du modèle conceptuel.

Dans cette analyse, au premier niveau, PLS-SEM est utilisé afin d'analyser les données et étudier la relation entre les différentes variables du modèle conceptuel proposé. Certains des résultats les plus remarquables de cette analyse sont les suivants : suffisamment de preuves ont été fournies pour le fait que si un projet est plus innovant, il est plus réussi.

Ensuite, cette analyse a confirmé le rôle positif de la couverture des connaissances (nécessaires au projet) dans la réussite des projets complexes. En outre, la confiance relationnelle a un effet positif significatif sur l'innovation du projet. De plus, il est montré que si un projet est plus complexe techniquement par nature, et organisationnellement complexe en termes de diversité du personnel et des systèmes d'information, alors il est corrélé avec plus d'innovativité. En ce qui concerne les critères de connaissance, les effets de la similarité et de la complémentarité sur la confiance relationnelle, et de la complémentarité sur la confiance basée sur la compétence, montrent un effet significatif. En outre, les résultats ont également montré que l'augmentation de la confiance entre les partenaires du projet dépend de leur capacité de confiance.

En fonction de ces résultats, nous proposons quelques recommandations aux décideurs : (1) nous recommandons que la sélection des partenaires pour les projets complexes soit telle qu'elle couvre toutes les connaissances nécessaires à la réalisation du projet, (2) car l'augmentation de la similarité des connaissances entre les partenaires peut augmenter la confiance entre eux et ainsi avoir un impact positif sur l'innovation et le succès du projet, nous recommandons de choisir les partenaires des futurs projets en tenant compte de la similarité et de la complémentarité des connaissances afin d'accroître leur confiance relationnelle et (3) nous suggérons également, surtout s'il existe une familiarité antérieure entre les partenaires potentiels, qu'en plus de la prise en compte de la similarité et de la complémentarité des connaissances entre les partenaires, un poids plus important soit accordé à la couverture des connaissances dans la sélection des partenaires.

L'expérience professionnelle est une caractéristique essentielle de productivité perceptible dans la gestion de projet. Étant donné qu'une grande partie de l'apprentissage des managers se fait sur le lieu de travail, cet apprentissage informel sur le lieu de travail est d'une importance majeure dans le développement des managers dans des carrières complexes qui doivent faire face à des défis nouveaux et imprévus dans l'environnement (Eraut, 2004; Savelsbergh et al., 2016). Pour diverses raisons, cela peut être vérifiable principalement pour les chefs de projet, qui semblent souvent "apprendre en faisant" à partir de leurs expériences professionnelles, plutôt que d'apprendre par leur éducation. Par exemple, la plupart des chefs de projet assument leurs responsabilités en plus d'un autre emploi, une carrière plus permanente pour laquelle ils ont été formés. En outre, même si le poste de chef de projet est leur emploi principal, la plupart des chefs de projet n'ont pas cherché à occuper ce poste lorsqu'ils sont entrés sur le marché du travail, mais ont été promus à un stade ultérieur de leur carrière. Par conséquent, les événements passés jouent un rôle important dans la détermination des décisions stratégiques actuelles. L'influence de l'expérience professionnelle sur l'opinion des décideurs a fait l'objet d'une grande attention, notamment dans le domaine de la prise de décision à risque et des marchés financiers (Bartelink et al., 2018; Thaler, 1980).

Ensuite, pour aller plus loin, le rôle de l'expérience professionnelle des chefs de projet a été pris en compte afin d'analyser sa corrélation avec le succès du projet qu'ils ont géré et leur opinion sur le facteur de succès des projets complexes. L'analyse du coefficient de corrélation de Spearman a été réalisée à cette fin. Le résultat de notre analyse a montré que le projet qui est géré par des managers plus expérimentés est plus réussi. De plus, l'augmentation de l'expérience professionnelle des gestionnaires de projet affecte leur jugement en augmentant le niveau d'importance de l'atteinte des objectifs organisationnels, de la satisfaction de l'équipe et de la satisfaction des parties prenantes dans la réussite des projets. En outre, le résultat de cette analyse montre que les chefs de projet plus expérimentés accordent plus d'importance à la couverture des connaissances dans les projets et à la confiance entre les partenaires. Enfin, il est montré que les chefs de projet plus expérimentés sont plus enclins à travailler avec des partenaires qui sont honnêtes et dignes de confiance, qui ont une bonne réputation et une bonne qualification dans leur domaine.

En fonction de ces résultats, nous présentons quelques points pour les décideurs : (1) nous encourageons les chefs de projet moins expérimentés à investir dans la satisfaction des

membres de l'équipe et des parties prenantes autant que dans les objectifs organisationnels du projet, (2) nous attirons l'attention des décideurs moins expérimentés sur le fait que, puisque l'importance de la confiance entre les partenaires augmente également avec l'expérience des gestionnaires, la bonne réputation, la qualification et l'honnêteté des partenaires pourraient être plus importantes que ce qu'ils peuvent penser, et (3) il convient de mentionner que les chefs de projet plus expérimentés ont moins envie de travailler avec des entreprises ayant des processus organisationnels, des systèmes juridiques et des horaires de travail différents. Nous suggérons donc aux décideurs de tenir compte de ces résultats dans leur processus de sélection des partenaires.

Partie 3 : Sélection des partenaires dans les projets complexes

La sélection des partenaires (SP) est une étape cruciale de la formation d'une alliance stratégique. Elle consiste à évaluer et à sélectionner les partenaires qui possèdent les connaissances, les compétences et les ressources nécessaires pour maximiser le taux de réussite de la collaboration ou du projet.

Ben Salah et al. (2018) a divisé le processus de SP en quatre activités : la formulation des critères, la qualification des partenaires, la sélection finale des partenaires qualifiés et le retour d'application dans lequel les décideurs évaluent les membres pour améliorer l'efficacité du réseau en s'assurant que les partenaires les plus appropriés sont sélectionnés à tout moment.

Déterminer le bon ensemble de critères pour la sélection des partenaires n'est pas une tâche facile. Polyantchikov et al. (2017) se sont penchés sur les réseaux de partenaires durables dans lesquels, sur la base d'entretiens avec des responsables d'entreprises, ils ont classé les critères de sélection des partenaires. Leur résultat a montré qu'il est essentiel de prendre en compte la qualité, la livraison et le coût dans la sélection des partenaires. Sur la base d'une enquête en ligne qui a ciblé des organisations de Malaisie, d'Australie et d'autres pays (comme l'Inde, Singapour et les Philippines), les auteurs proposent une liste classée de critères de sélection des partenaires. Parmi les critères de SP les plus utilisés figurent la similitude des objectifs, l'expérience en matière de gestion de projet, la capacité à négocier, une collaboration antérieure réussie et la similitude culturelle. Selon Mat et al. (2009), dans les alliances stratégiques, par exemple, les facteurs intangibles des partenaires potentiels ont un impact significatif sur la viabilité à long terme de l'alliance. Parmi ces facteurs, on peut citer la culture, la confiance, le savoir-faire managérial, la réputation ou d'autres aspects non techniques qui pourraient aider à la sélection du partenaire.

La mondialisation et les pressions concurrentielles actuelles poussent les entreprises à innover en matière de produits, de processus et de services. Il devient de plus en plus critique d'innover en raison de l'évolution de la demande des clients vers des produits et services de plus en plus sophistiqués. L'idée générale de l'alliance stratégique est que le partage des connaissances entre les entreprises au cours de la collaboration facilite l'innovation. Néanmoins, les collaborations des entreprises sont souvent très complexes, et il est bien connu que de nombreuses alliances n'atteignent pas leurs objectifs prédéfinis (Bruner et al., 1998; Gulati et al., 2012). D'où l'importance d'étudier les facteurs de succès des collaborations.

La troisième partie se concentre sur la proposition d'un nouveau cadre de sélection des partenaires basé sur les résultats des dernières parties et sur une revue de la littérature sur les facteurs influençant la formation d'alliances et la sélection des partenaires. Le cadre vise à améliorer l'efficacité de la collaboration en tenant compte du degré de complexité du projet, des connaissances requises pour le projet et des expériences passées des partenaires.

Ce cadre de sélection des partenaires attire l'attention des décideurs de la formation d'alliances sur le fait que lorsque les partenaires se connaissent bien et que le projet est simple, le poids

de la complémentarité des connaissances doit être plus élevé. Dans le cas d'un projet plus compliqué, le poids de la couverture des connaissances doit être considéré comme plus élevé, et en cas de partenaires potentiels peu familiers ou de collaboration infructueuse dans le passé, le poids de la similarité entre les partenaires doit être plus élevé afin de les aider à établir la confiance. Pour ce faire, un score de partenariat pourrait être calculé pour chaque ensemble de partenaires potentiels sur la base de la formule proposée pour aider à choisir le meilleur ensemble de partenaires avec un score de partenariat plus élevé. Nous pensons que le cadre proposé peut être utilisé comme un outil efficace pour aider les décideurs à sélectionner les partenaires dans la formation d'alliances. Le cadre présente également des possibilités d'études futures.

Enfin, les données d'un projet européen dans le domaine de l'aéronautique, appelé Knowledge Alliance in Air Transport (KAAT), qui s'est déroulé sous la forme d'alliances stratégiques, sont utilisées pour (1) démontrer l'applicabilité du cadre proposé sur des données réelles, et (2) fournir une nouvelle base pour les recherches futures dans ce domaine.

Les contributions de la thèse

Conformément aux défis scientifiques mentionnés ci-dessus, cette section mentionne brièvement les solutions proposées dans cette thèse. Ces solutions représentent les contributions de ce travail. Elles sont répertoriées comme :

- Soulignant le rôle important de la gestion des connaissances et de la collaboration efficace via un partage efficace des connaissances, à la fois pour réduire les risques et augmenter l'innovation et le succès des projets complexes ([Chapitre 2](#)).
- Distinguant les deux aspects de la complexité organisationnelle et de la complexité sociale, puisque nous avons remarqué que la relation entre la complexité organisationnelle et l'innovation a été débattue dans la littérature. Par conséquent, les complexités en termes de nombre d'activités, de taille de l'investissement, de diversité du personnel, etc. sont considérées comme une complexité organisationnelle. De même, les complexités en termes de nombre de systèmes juridiques différents impliqués, de complexité de l'environnement local, etc. sont considérées comme une complexité sociale. Cette distinction permet de mieux comprendre les différents niveaux de complexité des projets ([Chapitre 3](#)).
- Identifiant la couverture des connaissances comme un nouvel aspect des critères de connaissance, en plus de la similarité et de la complémentarité des connaissances. La couverture des connaissances fait référence aux connaissances nécessaires pour terminer le projet qui est couvert par un partenariat. Nous pensons que plus un projet est complexe et plus il a besoin de ressources et de connaissances pour atteindre ses objectifs, plus il est important de souligner le rôle de la couverture des connaissances. Parce qu'en formant une alliance pour des projets complexes, les organisations évaluent souvent leurs propres capacités ou celles de leurs partenaires avec optimisme ou sur la base de l'expérience et de la réputation antérieure, alors que chaque projet est unique et doit être revu en détail avec les connaissances et les ressources nécessaires avant d'être démarré ([Chapitre 3](#)).
- Proposant un nouveau modèle conceptuel pour la réussite d'un projet complexe dans lequel différents critères de connaissance et aspects de complexité du projet sont pris en compte, ainsi que la confiance et l'innovation du projet. Sur la base de ce modèle conceptuel, les bases ont été posées pour la conception d'un questionnaire et la collecte de données auprès des chefs de projet afin d'identifier les facteurs efficaces de réussite d'un projet complexe. Une autre contribution de ce modèle conceptuel est la prise

en compte de la capacité de confiance des répondants comme variable modératrice influençant la relation entre les différents critères de connaissance et la confiance entre partenaires dans les projets (Chapitre 3).

- Mettant en évidence le rôle de l'expérience professionnelle des chefs de projet non seulement sur la réussite des projets qu'ils gèrent mais aussi sur leur opinion sur les facteurs importants affectant la réussite des projets. Cela aide à comprendre quels facteurs sont plus ou moins importants pour les chefs de projet à mesure qu'ils acquièrent plus d'expérience. Nous pensons que cette analyse peut être particulièrement utile pour les chefs de projet et les décideurs moins expérimentés (Chapitre 4).
- Concevant un cadre de sélection de partenaires basé sur l'évaluation du degré de complexité du projet et l'historique de collaboration des partenaires potentiels. Ce cadre de partenariat a été conçu à partir de l'idée que le degré de complexité du projet et l'expérience passée des partenaires créent un rôle décisif dans le degré de similitude, de complémentarité et de couverture qui doivent être pris en compte dans la formation d'une alliance, pour accroître la confiance entre les partenaires, améliorer la qualité du partage des connaissances ainsi que la fourniture des connaissances nécessaires pour mener à bien le projet (Chapitre 5).
- Appliquant le cadre de sélection de partenaire proposé sur une étude de cas réelle afin de tester son applicabilité. Bien que l'étude de cas ne concernait qu'un projet qui était déjà mené par une alliance stratégique, et que l'application du cadre proposé n'a pas pu être démontrée clairement, nous pensons que cette démonstration clarifie l'applicabilité du cadre proposé et permet d'ouvrir de nouveaux horizons pour la recherche future (Chapitre 6).

Limitation de la recherche

Bien que les résultats de cette thèse aient été révélateurs, il est également nécessaire de souligner les limites des travaux de recherche présentés. Ces limitations sont énumérées et discutées comme suit :

- Cette thèse se concentre sur des projets innovants complexes, et en mettant en évidence le rôle de la collaboration stratégique dans la gestion de ces projets et de leurs enjeux, cherche à réduire le risque d'échec dans ces collaborations, et à augmenter la réussite de ces projets. Cependant, il existe différents termes dans la littérature faisant référence au partenariat et à la collaboration entre des organisations indépendantes tels que Collaborative Network (CN), Virtual Organization (VO), Virtual Breeding Environment (VBE), Supply Chain Network (SCN), alliance stratégique, partenariat, projet collaboratif, etc. Malgré le fait qu'il soit accepté qu'en raison de l'essence interdisciplinaire de la collaboration, ces concepts peuvent être utilisés de manière interchangeable, et compte tenu également de l'effort qui a été fait dans cette thèse pour couvrir la recherche liée avec différents mots-clés, la concentration principale étant restée dans "l'alliance stratégique", le risque existe de n'avoir pas pris en compte de précieux travaux connexes à cette recherche. De plus, il existe également différents types de collaboration avec différents champs d'autorité de chaque partenaire. Néanmoins, cette recherche se concentre sur les alliances stratégiques qui incluent au moins deux partenaires qui restent juridiquement indépendants, partagent le pouvoir de gestion et les avantages, et apportent des contributions continues. Par conséquent, le résultat de cette thèse pourrait ne pas être applicable pour d'autres types de collaborations.
- Il existe également plusieurs limites dans la proposition du modèle conceptuel ainsi que dans la conception de l'enquête pour collecter les données. La classification de

la confiance entre les partenaires qui est considérée dans cette recherche est l'une des nombreuses classifications discutées dans la littérature. Une autre classification aurait pu révéler d'autres résultats. Cependant dans cette recherche, en raison des limites sur la conception de l'enquête (pour la rendre concise et sans effort), nous n'avons pas pu considérer d'autres dimensions et questions ([Chapitre 3](#)).

- En outre, étant donné que le rôle de l'expérience professionnelle des chefs de projet a été considérée sur la base du modèle conceptuel et de l'enquête, il manque une revue de la littérature plus complète sur l'expérience professionnelle des chefs de projet dans cette thèse. De plus, cette recherche se concentre sur les années d'expérience professionnelle des chefs de projet, et d'autres dimensions de l'expérience telles que l'expérience réussie/infructueuse, l'expérience professionnelle potentielle/réelle et l'expérience organisationnelle/de travail en équipe ne sont pas prises en compte dans ce travail de recherche ([Chapitre 4](#)).
- Il existe également certaines limitations et considérations concernant les données recueillies dans cette recherche. Premièrement, malgré tous nos efforts pour collecter plus de données, en raison de la coïncidence de ce processus de collecte de données avec la période de confinement liée à la Covid-19 et la forte préoccupation de la population cible de cette enquête de recherche (chefs de projet complexes), nous n'avons pas pu collecter davantage de données. Bien que le nombre de nos données satisfasse les exigences de l'analyse statistique, nous pensons que davantage de données pourraient conduire à des résultats plus fiables et à une analyse plus approfondie. Deuxièmement, les données sont principalement collectées à partir de projets de recherche Européens, et il faut donc être prudent en généralisant les résultats de cette recherche à toutes sortes de projets et à tous les pays ([Chapitre 3](#), et [Chapitre 4](#)).
- Le cadre proposé dans cette thèse pour la sélection des partenaires dans une alliance stratégique n'est qu'un outil d'aide aux décideurs dans la phase de formation de l'alliance. Par conséquent, il n'y a aucune prétention à considérer toutes les complexités et les limites du choix dans de telles décisions. Nous pensons que ce cadre proposé fournira aux décideurs une meilleure idée de la sélection des partenaires avec plus de confiance, mais nous savons que d'autres circonstances telles que les communications, l'image de marque, le réseautage et les problèmes financiers et de crédit des partenaires imposent un poids important sur la sélection de partenaires dans des alliances stratégiques, qui ne sont pas pris en compte dans ce travail de recherche ([Chapitre 5](#)).
- Cette recherche utilise les données d'un projet en cours pour démontrer l'application du cadre proposé. L'idée est de clarifier les étapes de sélection des partenaires en fonction de ce cadre. Cependant, il existe plusieurs limites, d'une part parce que les partenaires de cette alliance stratégique avaient déjà été sélectionnés, de sorte qu'aucun véritable choix n'a été fait entre plusieurs partenaires potentiels. Deuxièmement, afin de prouver l'efficacité de ce cadre, il est nécessaire de calculer le score de partenariat et le taux de réussite du projet dans plusieurs projets, afin de vérifier si les projets avec les scores de partenariat les plus élevés ont eu plus de succès ou non, ce qui n'a pas pu être réalisé dans cette thèse ([Chapitre 6](#)).

La recherche future

Les recherches futures devraient surmonter toutes les limitations énumérées ci-dessus. Cependant, ce travail de recherche incite fortement les chercheurs à étudier certaines questions en particulier : dans un premier temps, développer une enquête à choix multiples sur les facteurs clés identifiés, afin de distinguer innovation radicale et innovation incrémentale dans la réussite des projets. Deuxièmement, nous suggérons que les chercheurs qui en ont

les capacités, en élargissant la communauté cible de collecte de données, collectent plus de données de différents types de projets complexes dans différents pays afin qu'une image plus complète puisse être obtenue quant aux facteurs de succès de projets complexes aux caractéristiques différentes. Troisièmement, nous suggérons de calculer plusieurs scores de partenariat d'alliances stratégiques sur la base de ce travail de recherche et de comparer ces scores avec le taux de réussite des projets afin de mesurer leur efficacité. Quatrièmement, nous suggérons d'appliquer le cadre de sélection des partenaires proposé dans la phase de sélection des partenaires d'une formation d'alliance et de faire une comparaison avec d'autres méthodologies de sélection des partenaires dans la littérature. Enfin, nous pensons que le cadre de sélection des partenaires proposé dans cette thèse peut fournir la base pour la conception d'un cadre plus complet de sélection des partenaires, en y ajoutant des contraintes de complémentarité telles que les communications, l'image de marque, le réseautage et la situation financière des partenaires, etc.

A

First appendix

In this appendix, first, the designed survey of this research work is available in Table [A.1](#). Second, the result of Harman's single-Factor test on collected data to check if there is any common method variance is shown in [A.2](#). Third, The variance inflation factor (VIF) results through the collinearity statistics test are available in Table [A.3](#). Forth, the importance-performance map analysis results for for indicators can be found in Figure [A.1](#) to Figure [A.4](#), and Table [A.4](#) to Table [A.7](#). Finally, the multi-group analysis result of the work experience of respondents is in Table [A.8](#). This appendix is related to Chapter [3](#) of this thesis.

Table A.1 – A survey on impact of knowledge criteria and complexity level on success of innovative complex projects

Respondent information												
Age:												
Gender:												
Educational background:												
Country of origin:												
Work experience (years):												
Job title:												
Institution:												
Number of projects you have been involved in so far:												
Project Information												
Field of the last project you were involved in:												
Type of the last project you were involved in: (Research, Manufacturing,...)												
Most important objective of the last project you were involved in:												
In the last project you were involved in the number of partners was With how many of them you had a previous collaboration in last 5 years?												
Please respond to the following statements by indicating the extent to which you agree or disagree with the statement based on the experience in your last project. Circle the appropriate number that most closely corresponds to your choice:												
1 Strongly Disagree												
2 Disagree												
3 Somewhat Disagree												
4 Neutral or Undecided												
5 Somewhat Agree												
6 Agree												
7 Strongly Agree												
After choosing your response, please indicate how important you think this issue is in determining success of innovative complex projects. Circle the appropriate response that most closely corresponds to your evaluation:												
A High Importance												
B Medium Importance												
C Low Importance												
N Neutral or Undecided												
Project success: My last project was successful in terms of ...												
1	Respecting the allocated budget	1	2	3	4	5	6	7	A	B	C	N
2	Meeting organizational objectives	1	2	3	4	5	6	7	A	B	C	N
3	Achieving objectives on time	1	2	3	4	5	6	7	A	B	C	N
4	The project had a positive national impact	1	2	3	4	5	6	7	A	B	C	N
5	Project team satisfaction	1	2	3	4	5	6	7	A	B	C	N
6	Stakeholders receiving satisfactory benefits	1	2	3	4	5	6	7	A	B	C	N
Project innovation: In the last project I was involved with ...												
7	Our new products/ services were often considered as very novel by customers	1	2	3	4	5	6	7	A	B	C	N
8	New tools/ technologies and approaches were used to reach project objectives	1	2	3	4	5	6	7	A	B	C	N
9	Project managers supported innovative ideas, experimentation and creative processes	1	2	3	4	5	6	7	A	B	C	N
10	Changes in staffing levels, job roles and behaviours were welcomed in the project	1	2	3	4	5	6	7	A	B	C	N
Project complexity: My last project was complex in terms of ...												

Continued on next page

Continued from previous page

<i>Organisational complexity</i>												
11	Number of activities or objectives	1	2	3	4	5	6	7	A	B	C	N
12	Duration of the project or size of capital investment	1	2	3	4	5	6	7	A	B	C	N
13	Either diversity of staff, geographic location or information systems	1	2	3	4	5	6	7	A	B	C	N
14	Interconnectivity and feedback loops in the task and project networks	1	2	3	4	5	6	7	A	B	C	N
15	Variety of cultural and institutional configurations	1	2	3	4	5	6	7	A	B	C	N
<i>Technological complexity</i>												
16	Number of resources or domains involved (manufacturing, R&D, marketing etc.)	1	2	3	4	5	6	7	A	B	C	N
17	Variety of resources and technological skills needed	1	2	3	4	5	6	7	A	B	C	N
18	Interdependency between the components of the project or technological process	1	2	3	4	5	6	7	A	B	C	N
19	Demand for creativity and scope of development	1	2	3	4	5	6	7	A	B	C	N
<i>Social complexity</i>												
20	Number of different legal systems involved (Countries, cities etc.)	1	2	3	4	5	6	7	A	B	C	N
21	Variety in local laws and regulation	1	2	3	4	5	6	7	A	B	C	N
22	Interdependency between different institutional configurations	1	2	3	4	5	6	7	A	B	C	N
23	Local environment complexity (working hours, administrative process etc.)	1	2	3	4	5	6	7	A	B	C	N
Knowledge criteria: Considering knowledge that was needed in the project, in the last project I was involved with ...												
<i>Similarity</i>												
24	The set of our partners skills and technologies was similar to our own	1	2	3	4	5	6	7	A	B	C	N
25	The set of our partners resources and equipment was similar to our own	1	2	3	4	5	6	7	A	B	C	N
26	The set of our partners services was similar to our own	1	2	3	4	5	6	7	A	B	C	N
27	Our partner had the same language/ culture as we do	1	2	3	4	5	6	7	A	B	C	N
<i>Complementarity</i>												
28	Our partners had skills or technologies that compensated for our deficiencies	1	2	3	4	5	6	7	A	B	C	N
29	Our partners had resources or equipment that compensated for our deficiencies	1	2	3	4	5	6	7	A	B	C	N
30	Our partner could provide services that we could not	1	2	3	4	5	6	7	A	B	C	N
31	The difference between language and culture between our partner and us was helpful in some ways	1	2	3	4	5	6	7	A	B	C	N
<i>Coverage</i>												
32	There were some skills/ technology needed which none of us could provide	1	2	3	4	5	6	7	A	B	C	N

Continued on next page

Continued from previous page

33	There were some resources and equipment needed which none of us could provide	1	2	3	4	5	6	7	A	B	C	N
34	There were some services needed which none of us could provide	1	2	3	4	5	6	7	A	B	C	N
35	We had some difficulty to communicate with our partner	1	2	3	4	5	6	7	A	B	C	N
Trust capability												
36	Generally speaking, most people can be trusted?	1	2	3	4	5	6	7	A	B	C	N
Trust: In the last project I was involved with ...												
<i>Relational trust</i>												
37	Our partners were very honest	1	2	3	4	5	6	7	A	B	C	N
38	Our partners kept their promises all the time	1	2	3	4	5	6	7	A	B	C	N
39	Our partners were trustworthy	1	2	3	4	5	6	7	A	B	C	N
40	Our partners considered our benefits when making decisions	1	2	3	4	5	6	7	A	B	C	N
<i>Calculus based-trust</i>												
41	Our partners had a good reputation in their domain	1	2	3	4	5	6	7	A	B	C	N
42	I did not doubt capabilities of our partners because of their reputation and qualifications	1	2	3	4	5	6	7	A	B	C	N
43	Our partners are known to be accredited with quality control standards (e.g. ISO 9000 etc.)	1	2	3	4	5	6	7	A	B	C	N
44	I felt very confident about the skills, personnel, and capital of our partners based on some tangible information (proof of resources, certificates etc.)	1	2	3	4	5	6	7	A	B	C	N

Table A.2 – Harman’s single-Factor Test

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	7.628	17.337	17.337	7.204	16.372	16.372	
2	4.690	10.660	27.997	4.314	9.805	26.177	
3	2.939	6.680	34.677	2.597	5.903	32.080	
4	2.565	5.831	40.508	2.231	5.069	37.149	
5	2.105	4.784	45.292	1.660	3.773	40.922	
6	2.036	4.628	49.919	1.614	3.668	44.591	
7	1.705	3.876	53.795	1.287	2.924	47.515	
8	1.503	3.417	57.212	1.053	2.392	49.907	
9	1.359	3.089	60.300	0.842	1.915	51.821	
10	1.272	2.890	63.190	0.782	1.777	53.598	
11	1.150	2.613	65.803	0.638	1.451	55.050	
12	1.031	2.342	68.145				
13	0.928	2.109	70.254				
14	0.909	2.066	72.320				
15	0.865	1.967	74.287				
16	0.846	1.922	76.209				
17	0.750	1.703	77.913				
18	0.733	1.665	79.578				
19	0.672	1.526	81.104				
20	0.647	1.471	82.575				
21	0.636	1.445	84.020				
22	0.582	1.324	85.343				
23	0.548	1.246	86.590				
24	0.524	1.190	87.780				
25	0.484	1.101	88.881				
26	0.469	1.067	89.948				
27	0.441	1.002	90.950				
28	0.391	0.889	91.839				
29	0.375	0.853	92.692				
30	0.354	0.805	93.497				
31	0.353	0.801	94.299				
32	0.310	0.705	95.004				
33	0.296	0.673	95.677				
34	0.267	0.607	96.284				
35	0.239	0.544	96.828				
36	0.220	0.501	97.329				
37	0.209	0.475	97.804				
38	0.191	0.434	98.238				
39	0.178	0.405	98.643				
40	0.162	0.369	99.012				
41	0.149	0.339	99.350				
42	0.114	0.258	99.609				
43	0.089	0.203	99.812				
44	0.083	0.188	100.000				

Table A.3 – Collinearity statistics (VIF) of indicators

Question	VIF	Question	VIF	Question	VIF	Question	VIF
<i>CPS</i> ₁	1.240	<i>OC</i> ₁₂	1.389	<i>SC</i> ₂₃	1.336	<i>Cov</i> ₃₄	3.579
<i>CPS</i> ₂	1.992	<i>OC</i> ₁₃	1.536	<i>Sim</i> ₂₄	1.763	<i>Cov</i> ₃₅	1.082
<i>CPS</i> ₃	1.473	<i>OC</i> ₁₄	1.247	<i>Sim</i> ₂₅	2.464	<i>TrC</i> ₃₆	1.000
<i>CPS</i> ₄	1.304	<i>OC</i> ₁₅	1.492	<i>Sim</i> ₂₆	1.952	<i>RT</i> ₃₇	3.416
<i>CPS</i> ₅	1.905	<i>TC</i> ₁₆	1.190	<i>Sim</i> ₂₇	1.060	<i>RT</i> ₃₈	2.556
<i>CPS</i> ₆	1.321	<i>TC</i> ₁₇	1.534	<i>Com</i> ₂₈	2.486	<i>RT</i> ₃₉	4.353
<i>PI</i> ₇	1.239	<i>TC</i> ₁₈	1.325	<i>Com</i> ₂₉	2.228	<i>RT</i> ₄₀	1.410
<i>PI</i> ₈	1.246	<i>TC</i> ₁₉	1.212	<i>Com</i> ₃₀	2.139	<i>CBT</i> ₄₁	1.572
<i>PI</i> ₉	1.181	<i>SC</i> ₂₀	2.837	<i>Com</i> ₃₁	1.099	<i>CBT</i> ₄₂	1.760
<i>PI</i> ₁₀	1.149	<i>SC</i> ₂₁	3.055	<i>Cov</i> ₃₂	2.219	<i>CBT</i> ₄₃	1.161
<i>OC</i> ₁₁	1.291	<i>SC</i> ₂₂	2.032	<i>Cov</i> ₃₃	3.952	<i>CBT</i> ₄₄	1.287

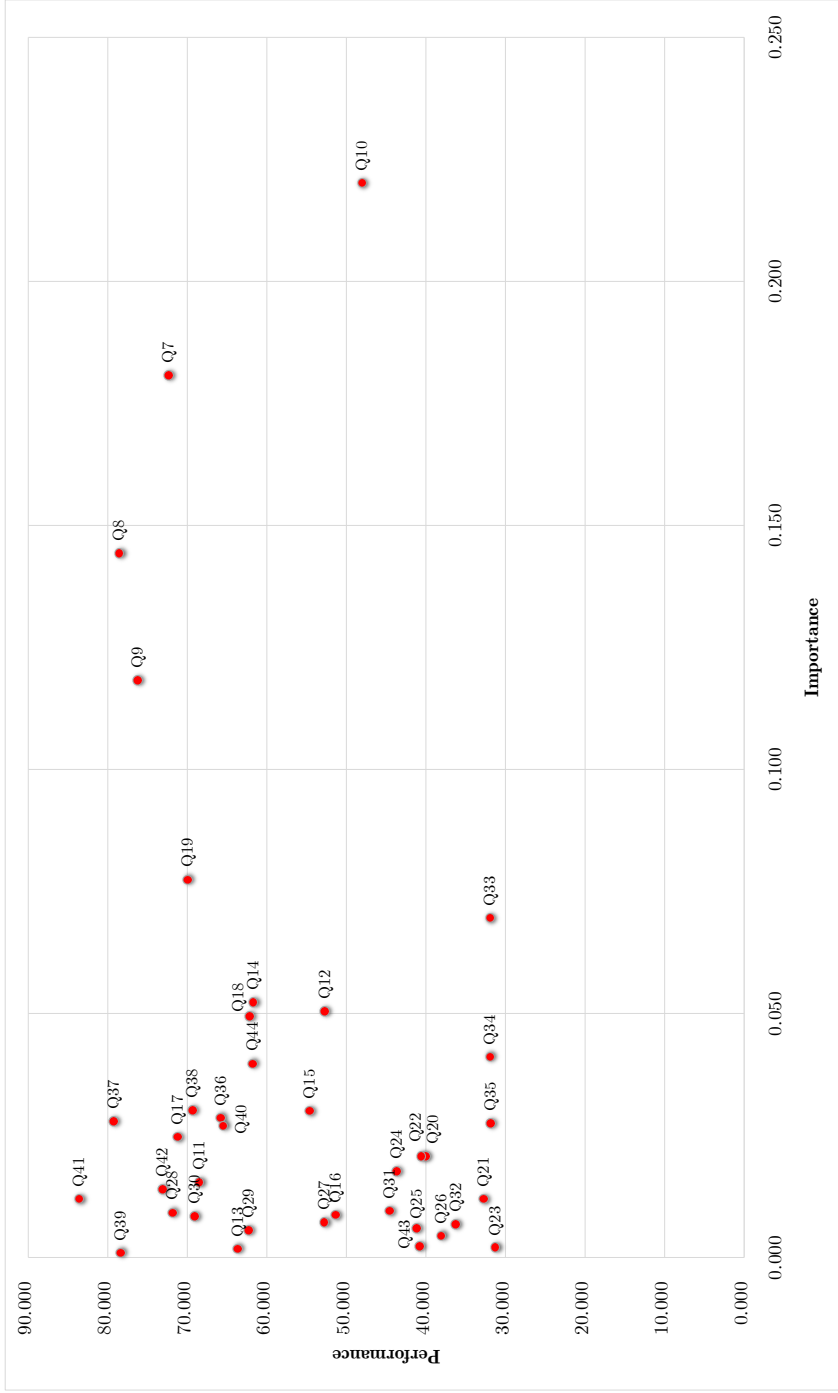


Figure A.1 – Importance- performance map analysis for complex project success - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)

Table A.4 – Importance-performance map analysis for complex project success - indicators

Indicators	Importance	Performance
Q7 (PI_7)	0.181	72.384
Q8 (PI_8)	0.144	78.585
Q9 (PI_9)	0.118	76.260
Q10 (PI_{10})	0.220	48.062
Q11 (OC_{11})	0.015	68.508
Q12 (OC_{12})	0.050	52.713
Q13 (OC_{13})	0.002	63.663
Q14 (OC_{14})	0.052	61.725
Q15 (OC_{15})	0.030	54.651
Q16 (TC_{16})	0.009	51.357
Q17 (TC_{17})	0.025	71.221
Q18 (TC_{18})	0.049	62.209
Q19 (TC_{19})	0.077	69.961
Q20 (SC_{20})	0.021	40.019
Q21 (SC_{21})	0.012	32.752
Q22 (SC_{22})	0.021	40.601
Q23 (SC_{23})	0.002	31.298
Q24 (Sim_{24})	0.018	43.702
Q25 (Sim_{25})	0.006	41.182
Q26 (Sim_{26})	0.004	38.081
Q27 (Sim_{27})	0.007	52.810
Q28 (Com_{28})	0.009	71.899
Q29 (Com_{29})	0.006	62.306
Q30 (Com_{30})	0.008	69.089
Q31 (Com_{31})	0.010	44.574
Q32 (Cov_{32})	0.007	36.240
Q33 (Cov_{33})	0.070	31.977
Q34 (Cov_{34})	0.041	31.977
Q35 (Cov_{35})	0.027	31.880
Q36 (TrC_{36})	0.029	65.795
Q37 (RT_{37})	0.028	79.264
Q38 (RT_{38})	0.030	69.380
Q39 (RT_{39})	0.001	78.391
Q40 (RT_{40})	0.027	65.504
Q41 (CBT_{41})	0.012	83.624
Q42 (CBT_{42})	0.014	73.159
Q43 (CBT_{43})	0.002	40.795
Q44 (CBT_{44})	0.040	61.822

Note: The bold values represent the highest importance (total effect) and highest performance value.

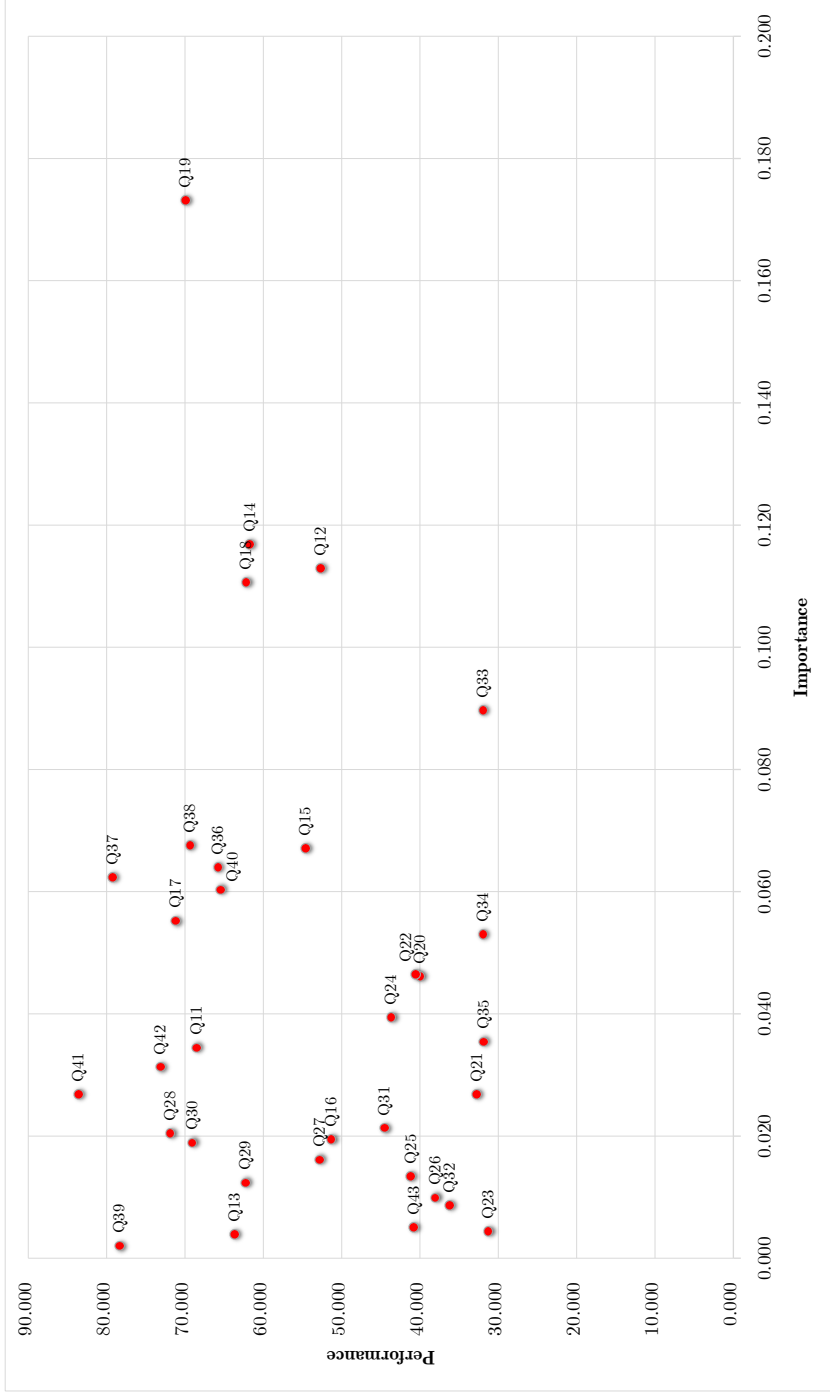


Figure A.2 – Importance–performance map analysis for project innovation - all the indicators (vertical axis represent performance and importance respectively)

Table A.5 – Importance-performance map analysis for project innovation - indicators

Indicators	Importance	Performance
Q11 (OC_{11})	0.034	68.508
Q12 (OC_{12})	0.113	52.713
Q13 (OC_{13})	0.004	63.663
Q14 (OC_{14})	0.117	61.725
Q15 (OC_{15})	0.067	54.651
Q16 (TC_{16})	0.019	51.357
Q17 (TC_{17})	0.055	71.221
Q18 (TC_{18})	0.111	62.209
Q19 (TC_{19})	0.173	69.961
Q20 (SC_{20})	0.046	40.019
Q21 (SC_{21})	0.027	32.752
Q22 (SC_{22})	0.046	40.601
Q23 (SC_{23})	0.004	31.298
Q24 (Sim_{24})	0.039	43.702
Q25 (Sim_{25})	0.013	41.182
Q26 (Sim_{26})	0.010	38.081
Q27 (Sim_{27})	0.016	52.810
Q28 (Com_{28})	0.020	71.899
Q29 (Com_{29})	0.012	62.306
Q30 (Com_{30})	0.019	69.089
Q31 (Com_{31})	0.021	44.574
Q32 (Cov_{32})	0.009	36.240
Q33 (Cov_{33})	0.090	31.977
Q34 (Cov_{34})	0.053	31.977
Q35 (Cov_{35})	0.035	31.880
Q36 (TrC_{36})	0.064	65.795
Q37 (RT_{37})	0.062	79.264
Q38 (RT_{38})	0.068	69.380
Q39 (RT_{39})	0.002	78.391
Q40 (RT_{41})	0.060	65.504
Q41 (CBT_{41})	0.027	83.624
Q42 (CBT_{42})	0.031	73.159
Q43 (CBT_{43})	0.005	40.795
Q44 (CBT_{44})	0.089	61.822

Note: The bold values represent the highest importance (total effect) and highest performance value.

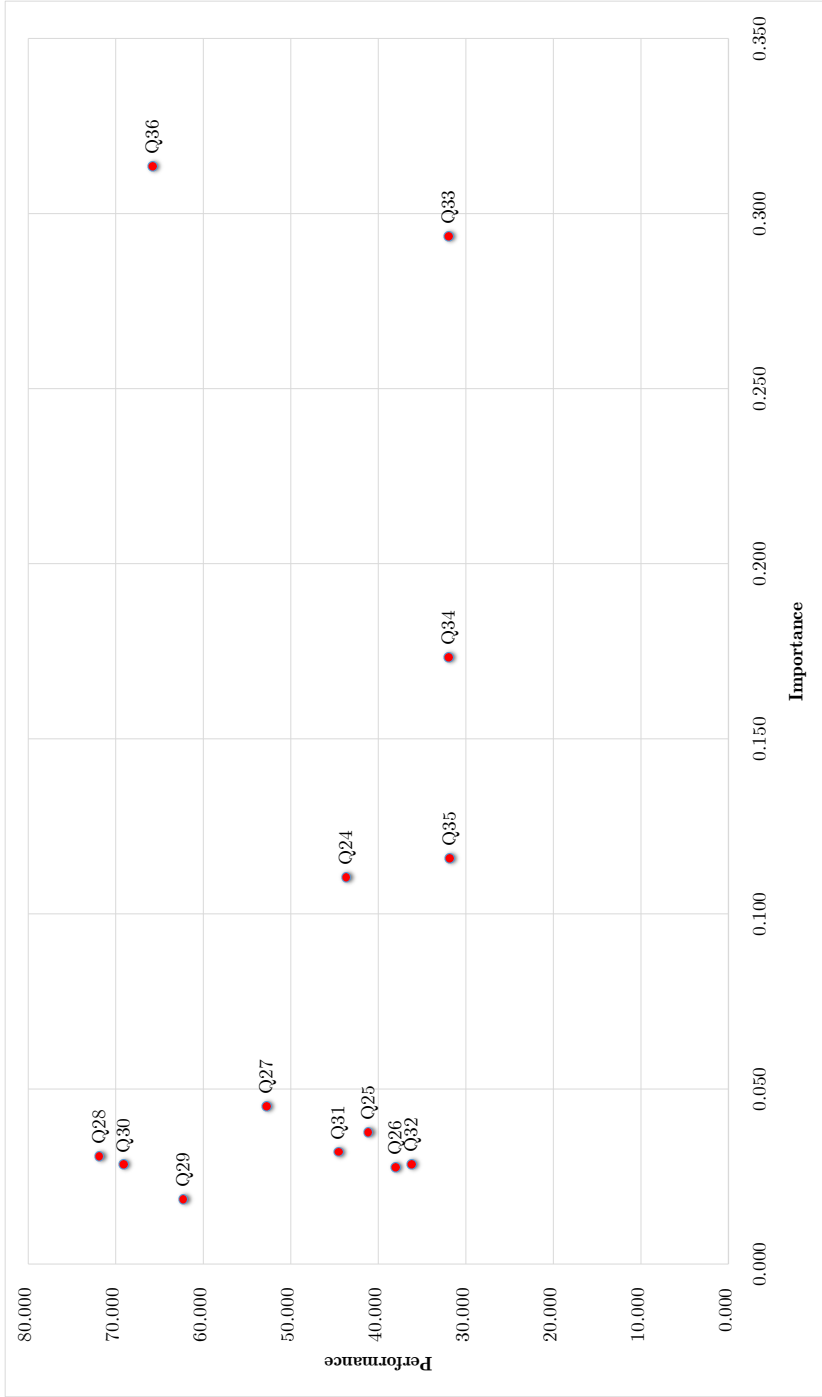


Figure A.3 – Importance- performance map analysis for relational trust - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)

Table A.6 – Importance-performance map analysis for relational trust - indicators

Indicators	Importance	Performance
Q24 (<i>Sim</i> ₂₄)	0.110	43.702
Q25 (<i>Sim</i> ₂₅)	0.038	41.182
Q26 (<i>Sim</i> ₂₆)	0.028	38.081
Q27 (<i>Sim</i> ₂₇)	0.045	52.810
Q28 (<i>Com</i> ₂₈)	0.031	71.899
Q29 (<i>Com</i> ₂₉)	0.018	62.306
Q30 (<i>Com</i> ₃₀)	0.028	69.089
Q31 (<i>Com</i> ₃₁)	0.032	44.574
Q32 (<i>Cov</i> ₃₂)	0.028	36.240
Q33 (<i>Cov</i> ₃₃)	0.293	31.977
Q34 (<i>Cov</i> ₃₄)	0.173	31.977
Q35 (<i>Cov</i> ₃₅)	0.116	31.880
Q36 (<i>TrC</i> ₃₆)	0.313	65.795

Note: The bold values represent the highest importance (total effect) and highest performance value.



Figure A.4 – Importance- performance map analysis for competence-based trust - all the indicators (vertical axis and horizontal axis represent performance and importance respectively)

Table A.7 – Importance-performance map analysis for competence-based trust - indicators

Indicators	Importance	Performance
Q24 (<i>Sim</i> ₂₄)	0.183	43.702
Q25 (<i>Sim</i> ₂₅)	0.062	41.182
Q26 (<i>Sim</i> ₂₆)	0.046	38.081
Q27 (<i>Sim</i> ₂₇)	0.075	52.810
Q28 (<i>Com</i> ₂₈)	0.129	71.899
Q29 (<i>Com</i> ₂₉)	0.078	62.306
Q30 (<i>Com</i> ₃₀)	0.119	69.089
Q31 (<i>Com</i> ₃₁)	0.135	44.574
Q32 (<i>Cov</i> ₃₂)	0.035	36.240
Q33 (<i>Cov</i> ₃₃)	0.362	31.977
Q34 (<i>Cov</i> ₃₄)	0.214	31.977
Q35 (<i>Cov</i> ₃₅)	0.143	31.880
Q36 (<i>TrC</i> ₃₆)	0.124	65.795

Note: The bold values represent the highest importance (total effect) and highest performance value.

Table A.8 – Multi-Group Analysis for work experience of respondents

Proposed path	Path coefficients-diff	<i>p</i> -value
<i>H1</i> <i>PI</i> ⇒ <i>CPS</i>	0.348	0.877
<i>H2</i> <i>TC</i> ⇒ <i>PI</i>	0.157	0.240
<i>H3</i> <i>OC</i> ⇒ <i>PI</i>	0.204	0.827
<i>H4</i> <i>SC</i> ⇒ <i>PI</i>	0.173	0.191
<i>H5</i> <i>RT</i> ⇒ <i>PI</i>	0.369	0.147
<i>H6</i> <i>CBT</i> ⇒ <i>PI</i>	0.312	0.879
<i>H7_a</i> <i>Sim</i> ⇒ <i>RT</i>	0.128	0.311
<i>H7_b</i> <i>Sim</i> ⇒ <i>CBT</i>	0.133	0.720
<i>H8_a</i> <i>Com</i> ⇒ <i>RT</i>	0.089	0.663
<i>H8_b</i> <i>Com</i> ⇒ <i>CBT</i>	0.017	0.565
<i>H9_a</i> <i>Cov</i> ⇒ <i>RT</i>	0.536	0.084*
<i>H9_b</i> <i>Cov</i> ⇒ <i>CBT</i>	0.510	0.089*
<i>H9_c</i> <i>Cov</i> ⇒ <i>CPS</i>	0.005	0.521
<i>H10_a</i> <i>TrC</i> ⇒ <i>RT</i>	0.254	0.844
<i>H10_b</i> <i>TrC</i> ⇒ <i>CBT</i>	0.202	0.845
<i>H10_c</i> <i>Sim*TrC</i> ⇒ <i>RT</i>	0.098	0.336
<i>H10_d</i> <i>Sim*TrC</i> ⇒ <i>CBT</i>	0.051	0.622
<i>H10_e</i> <i>Com*TrC</i> ⇒ <i>RT</i>	0.207	0.203
<i>H10_f</i> <i>Com*TrC</i> ⇒ <i>CBT</i>	0.099	0.303
<i>H10_g</i> <i>Cov*TrC</i> ⇒ <i>RT</i>	0.005	0.506
<i>H10_h</i> <i>Cov*TrC</i> ⇒ <i>CBT</i>	0.000	0.492

Note: *P < 0.1

Note: Path coefficients-diff = |(Work experience > 10 years) - (Work experience ≤ 10 years)|

B

Second appendix

In this appendix, Table [B.1](#) to Table [B.4](#) show the results of Spearman's correlation coefficient that was used to evaluate the relationships between project managers work experience and project innovation indicators, technological complexity indicators, organizational complexity indicators, and similarity indicators which are related to the [Chapter 4](#) of this thesis.

Table B.1 – Correlation between work experience and their judgement about project innovation dimensions

		PI_7	PI_8	PI_9	PI_{10}
WE	Spearman's Correlation	0.055	0.120	0.004	-0.015
	Sig. (2-tailed)	0.471	0.117	0.608	0.850

Note: WE = Work Experience

Table B.2 – Correlation between work experience and their judgement about organizational complexity dimensions

		OC_{11}	OC_{12}	OC_{13}	OC_{14}	OC_{15}
WE	Spearman's Correlation	0.082	0.000	0.144	0.121	0.118
	Sig. (2-tailed)	0.284	0.998	0.059	0.116	0.122

Note: WE = Work Experience

Table B.3 – Correlation between work experience and their judgement about technological complexity dimensions

		TC_{16}	TC_{17}	TC_{18}	TC_{19}
WE	Spearman's Correlation	0.005	-0.083	0.035	0.073
	Sig. (2-tailed)	0.945	0.281	0.646	0.338

Note: WE = Work Experience

Table B.4 – Correlation between work experience and their judgement about knowledge similarity dimensions

		Sim_{24}	Sim_{25}	Sim_{26}	Sim_{27}
WE	Spearman's Correlation	0.041	0.029	-0.024	0.018
	Sig. (2-tailed)	0.594	0.701	0.758	0.812

Note: WE = Work Experience

C

Third appendix

In this appendix, the results of the study on the knowledge in possession of each partner in the KAAT project are presented in Table C.1, Table C.2, and Table C.3. Moreover, the programming script of the partner selection algorithm that is coded in MATLAB software version R2016b is available in Figure C.1. This appendix is related to Chapter 6 of this thesis.

Table C.1 – Project required knowledge: Soft skills and Hard skills

Project required knowledge	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Soft skills																	
Leadership	*	*			*		*		*					*		*	
Coordination	*	*	*		*				*					*		*	
Teamwork	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Relational problem solving	*						*		*			*					
Technical problem solving	*				*				*						*		
Partnering	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Influence in his organization	*	*						*			*	*					
Hard skills																	
Innovation implementation	*		*		*	*		*	*	*	*	*	*	*	*	*	*
Project implementation	*	*		*	*	*		*	*	*	*	*	*	*	*	*	*
Project evaluation	*		*	*	*	*		*	*	*	*	*	*	*	*	*	*
Project management	*	*		*	*	*		*	*	*	*	*	*	*	*	*	*
Project management in education	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
Financial monitoring	*			*	*	*								*			
Financial reporting	*			*	*	*								*			
Dissemination & exploitation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Research	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
Teaching	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
International relation management	*		*	*	*	*		*	*	*	*	*	*	*	*	*	*
Human resource management	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Security management								*						*			
Airport management													*				
Innovation management	*			*	*	*		*	*	*	*	*	*	*	*	*	*
Risk management	*									*					*	*	*
Quality assurance		*		*	*	*		*	*	*	*	*	*	*	*	*	*
Describe occupation & qualification	*	*						*	*	*	*	*	*	*	*	*	*
Describe the relation in aviation	*	*						*	*	*	*	*	*	*	*	*	*

Continued on next page

Continued from previous page

Project required knowledge	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Occupational analysis				*	*			*	*		*	*	*	*			*
Analyze the qualification		*	*	*	*				*				*				
Quality assurance procedure					*		*		*	*						*	
Specialized recruitment		*					*										
Computer science	*	*	*	*	*				*							*	
Transport & traffic engineering		*		*					*		*		*	*			
Traffic logistics		*		*					*		*		*	*	*		
Aerodynamics	*								*		*						
Aerospace engineering	*					*	*		*	*			*			*	
Logistics	*			*	*											*	
Maintenance	*			*			*		*	*					*	*	
Aeronautical meteorology									*		*			*			
Air traffic communication		*							*		*			*	*		
Civil pilot education		*					*			*				*	*		*
Aviation safety investigation								*			*		*	*	*		*
ECCAIRS software																	*
ECCAIRS software installation																	*
Marketing & commercial							*										
Legal & financial affairs	*												*	*			
Design the study programs	*	*	*	*	*				*						*	*	
Dynamic flights and control	*														*		
Discipline of freight transport			*	*							*	*		*			
Aviation technical division						*	*		*					*			
Prediction of trend in aviation	*																*
Modeling of transport system	*			*												*	
IT and computer in aviation	*	*	*	*						*		*	*		*		*
SQF in aviation sector		*		*	*	*		*									
Dynamics of rockets	*																
Aviation English language		*											*				

Continued on next page

Continued from previous page

Project required knowledge	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Recognize prior learning		*		*	*				*	*							*
Identification of key issues	*								*			*					
Contextualize the information	*			*					*								
Define regulation & standard		*															
Understand the preoccupation	*								*			*			*		
Design questionnaire & reports	*	*		*	*	*			*					*	*	*	*
Higher education planning	*	*	*	*	*	*			*					*	*	*	*
Develop information system	*		*													*	*
Aviation human resource	*	*				*	*	*					*	*	*		
Integration of ICT	*					*											

Table C.2 – Project required knowledge: Resources and Services

Project required knowledge	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Resources																	
International students	*		*	*	*				*							*	
Aviation department	*	*							*								
National industrial networks	*	*	*	*	*	*			*			*	*			*	
International industrial networks	*		*	*	*	*			*		*	*	*				
National academic network	*	*	*		*	*	*			*			*			*	
International academic network	*		*	*	*	*			*							*	
Political networks	*																
European institutes connections	*																
Services																	
Vocational training	*	*		*	*	*				*	*	*		*	*		*
Academic training	*	*	*	*	*				*							*	
Aviation training	*					*			*			*			*		
Management courses	*	*	*	*	*				*							*	
Aviation handling											*						
Aviation maintenance									*	*	*				*		
Aviation catering										*	*						
Flight and cabin crew training											*	*			*		

Table C.3 – Project required knowledge: Organizational culture, Language and Others

Project required knowledge	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	
Organizational culture																		
Multi-culture	*		*		*				*				*					
Awareness of innovation open minded	*	*	*		*	*		*			*		*			*		
Dynamic internal communication	*	*	*	*	*	*	*	*	*			*			*	*	*	
Dynamic external communication	*		*	*	*											*		
Language																		
Multi-language	*				*					*				*				
Croatian		*								*				*	*			
English	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
French	*				*							*				*		
Italian								*										
Latvian				*														
Portuguese			*			*	*											
Romanian	*				*						*		*				*	
Slovak									*									
Others																		
Experience in similar projects	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Experience in academic aviation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Experience in vocational aviation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Experience in leadership	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Experience in teaching	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Experience in double degrees	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
High reputation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
High administrative experience	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Availability to teach	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

```

1-   clc
2-   clear
3-   close all
4-   warning('off')
5-   load('Partners.mat')
6-   load('Relation.mat')
7-
8-   All=PartnerData;
9-   NumberOfFirms=size(All,1);
10-  Arr=(0:2^NumberOfFirms-1);
11-  ycoor=4;
12-  ArrB2=de2bi(Arr,NumberOfFirms);
13-  AsliB=zeros(size(ArrB2,1),NumberOfFirms+4);
14-  for i=1:size(ArrB2,1)
15-      if sum(ArrB2(i,:))>1
16-          ArrB2(i,:);
17-          [aa,ff]=find(ArrB2(i,')==1);
18-          %%% finding the coordinate:
19-          combos=combnats(ff,2);
20-          coor=0;
21-          for j=1:size(combos,1)
22-              coor=coor+relationship(combos(j,1),combos(j,2));
23-          end
24-          xcoor=coor/size(combos,1);
25-          alpha=xcoor/6;
26-          gama=ycoor/30;
27-          beta=1-alpha-gama;
28-          Maj=All(ff,:);
29-          %%% finding similarities
30-          MajUn=Maj(1,:);
31-          for k=1:size(Maj,1)-1
32-              MajUn=MajUn.*Maj(k+1,:);
33-          end
34-          simil=sum(MajUn);
35-          %%%
36-          %%% finding coverage
37-          MatCouv=sum(Maj);
38-          Coverage=length(find(MatCouv~=0));
39-          %%%
40-          %%% finding completeness
41-          MatCouv(find(MatCouv>=1))=1;
42-          comp=MatCouv-MajUn;
43-          comp(find(comp<0))=0;
44-          comp=sum(comp);
45-          score=alpha*simil+beta*comp+gama*Coverage;
46-          AsliB(i,1)=score;
47-          AsliB(i,2:NumberOfFirms+1)=ArrB2(i,:).*(1:NumberOfFirms);
48-          AsliB(i,NumberOfFirms+2)=alpha;
49-          AsliB(i,NumberOfFirms+3)=beta;
50-          AsliB(i,NumberOfFirms+4)=gama;
51-      end
52-  end

```

Figure C.1 – Partnership ranking algorithm

Bibliography

- (Abu-Shanab, 2014) E. Abu-Shanab. “Antecedents of trust in e-government services: an empirical test in Jordan.” In: *Transforming Government: People, Process and Policy* 8.4 (2014), pp. 480–499 (cit. on p. 41).
- (Afsarmanesh et al., 2009) H. Afsarmanesh, L. M. Camarinha-Matos, and S. S. Msanjila. “[On management of 2nd generation virtual organizations breeding environments.](#)” In: *Annual Reviews in Control* 33.2 (2009), pp. 209–219 (cit. on p. 91).
- (Afsarmanesh et al., 2010) H. Afsarmanesh, L. M. Camarinha-Matos, and S. S. Msanjila. “Models, methodologies, and tools supporting establishment and management of second-generation VBEs.” In: *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)* 41.5 (2010), pp. 692–710 (cit. on p. 89).
- (Ahlf et al., 2019) H. Ahlf, S. Horak, A. Klein, and S.-W. Yoon. “Demographic homophily, communication and trust in intra-organizational business relationships.” In: *Journal of Business & Industrial Marketing* 34.2 (2019), pp. 474–487 (cit. on pp. 41, 93).
- (Ahmed et al., 2016) R. Ahmed and N. Azmi bin Mohamad. “Exploring the relationship between multi-dimensional top management support and project success: An international study.” In: *Engineering Management Journal* 28.1 (2016), pp. 54–67 (cit. on p. 31).
- (Ahuja et al., 2001) G. Ahuja and R. Katila. “Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study.” In: *Strategic management journal* 22.3 (2001), pp. 197–220 (cit. on p. 88).
- (Aida, 2021) N. Aida. “[Work Experience, Obedience Pressure and Task Complexity on Audit Judgment.](#)” In: *Golden Ratio of Auditing Research* 1.2 (2021), pp. 1–8 (cit. on p. 69).
- (Alavi et al., 2001) M. Alavi and D. E. Leidner. “[Knowledge management and knowledge management systems: Conceptual foundations and research issues.](#)” In: *MIS quarterly* (2001), pp. 107–136 (cit. on pp. 18, 19).
- (Alharbi, 2017) S. Alharbi. “An extended UTAUT model for understanding of the effect of trust on users’ acceptance of cloud computing.” In: *International Journal of Computer Applications in Technology* 56.1 (2017), pp. 65–76 (cit. on p. 41).
- (Alsaad et al., 2017) A. Alsaad, R. Mohamad, and N. A. Ismail. “The moderating role of trust in business to business electronic commerce (B2B EC) adoption.” In: *Computers in Human Behavior* 68 (2017), pp. 157–169 (cit. on pp. 34, 41, 92).
- (Aragón-Correa et al., 2007) J. A. Aragón-Correa, V. J. García-Morales, and E. Córdón-Pozo. “[Leadership and organizational learning’s role on innovation and performance: Lessons from Spain.](#)” In: *Industrial Marketing Management* 36.3 (2007), pp. 349–359 (cit. on p. 32).
- (Armstrong et al., 1977) J. S. Armstrong and T. S. Overton. “Estimating nonresponse bias in mail surveys.” In: *Journal of marketing research* 14.3 (1977), pp. 396–402 (cit. on pp. 47, 74).

- (Atkinson, 1999) R. Atkinson. "Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria." In: *International journal of project management* 17.6 (1999), pp. 337–342 (cit. on p. 31).
- (Aulakh et al., 1996) P. S. Aulakh, M. Kotabe, and A. Sahay. "Trust and performance in cross-border marketing partnerships: A behavioral approach." In: *Journal of international business studies* 27.5 (1996), pp. 1005–1032 (cit. on pp. 40, 90).
- (Baak et al., 2020) M. Baak, R. Koopman, H. Snoek, and S. Klous. "[A new correlation coefficient between categorical, ordinal and interval variables with Pearson characteristics.](#)" In: *Computational Statistics & Data Analysis* 152 (2020), p. 107043 (cit. on p. 71).
- (Baccarini, 1996) D. Baccarini. "The concept of project complexity—a review." In: *International journal of project management* 14.4 (1996), pp. 201–204 (cit. on pp. 33, 91, 92).
- (Baccarini, 1999) D. Baccarini. "The logical framework method for defining project success." In: *Project management journal* 30.4 (1999), pp. 25–32 (cit. on p. 31).
- (Bakhshi et al., 2016) J. Bakhshi, V. Ireland, and A. Gorod. "[Clarifying the project complexity construct: Past, present and future.](#)" In: *International Journal of Project Management* 34.7 (2016), pp. 1199–1213 (cit. on p. 91).
- (Barlow, 2000) J. Barlow. "Innovation and learning in complex offshore construction projects." In: *Research policy* 29.7-8 (2000), pp. 973–989 (cit. on p. 33).
- (Bartelink et al., 2018) C. Bartelink, E. J. Knorth, M. L. López, C. Koopmans, J. Ingrid, C. L. Witteman, and T. A. van Yperen. "Reasons for placement decisions in a case of suspected child abuse: The role of reasoning, work experience and attitudes in decision-making." In: *Child abuse & neglect* 83 (2018), pp. 129–141 (cit. on pp. 68, 134).
- (Bawack et al., 2021) R. E. Bawack, S. F. Wamba, and K. D. A. Carillo. "Exploring the role of personality, trust, and privacy in customer experience performance during voice shopping: Evidence from SEM and fuzzy set qualitative comparative analysis." In: *International Journal of Information Management* 58 (2021), p. 102309 (cit. on p. 69).
- (Bazerman et al., 2013) M. Bazerman and D. A. Moore. *Judgment in Managerial Decision Making*. John Wiley & Sons, 2013 (cit. on p. 18).
- (Bazyar et al., 2013) A. Bazyar, E. Teimoury, M. Fesharaki, A. Moini, and S. Mohammadi. "Linking power, risk, and governance: a survey research in new product development relationships." In: *Journal of Business & Industrial Marketing* 28.5 (2013), pp. 371–382 (cit. on p. 40).
- (J.-M. Becker et al., 2018) J.-M. Becker, C. M. Ringle, and M. Sarstedt. "ESTIMATING MODERATING EFFECTS IN PLS-SEM AND PLS_c-SEM: INTERACTION TERM GENERATION*DATA TREATMENT." In: 2018 (cit. on p. 49).
- (L. C. Becker, 1996) L. C. Becker. "Trust as noncognitive security about motives." In: *Ethics* 107.1 (1996), pp. 43–61 (cit. on pp. 35, 37, 90).
- (Belderbos et al., 2004) R. Belderbos, M. Carree, and B. Lokshin. "Cooperative R&D and firm performance." In: *Research policy* 33.10 (2004), pp. 1477–1492 (cit. on p. 30).
- (Belkadi et al., 2017) F. Belkadi, M. Messaadia, A. Bernard, and D. Baudry. "[Collaboration management framework for OEM–suppliers relationships: a trust-based conceptual approach.](#)" In: *Enterprise Information Systems* 11.7 (2017), pp. 1018–1042 (cit. on pp. 90, 91, 95).
- (Ben Salah et al., 2018) S. Ben Salah, W. Ben Yahia, O. Ayadi, and F. Masmoudi. "[Definition and Classification of Collaborative Network: MCDM Approaches for Partner Selection Problem.](#)" In: *Design and Modeling of Mechanical Systems—III*. Ed. by M. Haddar, F. Chaari, A. Benamara, M. Chouchane, C. Karra, and N. Aifaoui. Cham: Springer International Publishing, 2018, pp. 733–744 (cit. on pp. 24, 89, 135).

-
- (Benitez-Avila et al., 2018) C. Benitez-Avila, A. Hartmann, G. Dewulf, and J. Henseler. “Interplay of relational and contractual governance in public-private partnerships: The mediating role of relational norms, trust and partners’ contribution.” In: *International journal of project management* 36.3 (2018), pp. 429–443 (cit. on pp. 33, 34, 37, 41, 92, 95).
- (Bernus et al., 2016) P. Bernus, T. Goranson, J. Götze, A. Jensen-Waud, H. Kandjani, A. Molina, O. Noran, R. J. Rabelo, D. Romero, P. Saha, et al. “Enterprise engineering and management at the crossroads.” In: *Computers in Industry* 79 (2016), pp. 87–102 (cit. on p. 92).
- (Blindenbach-Driessen et al., 2006) F. Blindenbach-Driessen and J. van den Ende. “Innovation in project-based firms: The context dependency of success factors.” In: *RESEARCH POLICY* 35.4 (MAY 2006), 545–561 (cit. on p. 19).
- (Bonett et al., 2015) D. G. Bonett and T. A. Wright. “Cronbach’s alpha reliability: Interval estimation, hypothesis testing, and sample size planning.” In: *Journal of organizational behavior* 36.1 (2015), pp. 3–15 (cit. on pp. 47, 73).
- (Boons et al., 2013) F. Boons, C. Montalvo, J. Quist, and M. Wagner. “Sustainable innovation, business models and economic performance: an overview.” In: *Journal of Cleaner Production* 45 (2013). Sustainable Innovation and Business Models, pp. 1–8 (cit. on p. 10).
- (Braunerhjelm, 2010) P. Braunerhjelm. *Entrepreneurship, Innovation and Economic Growth - past experience, current knowledge and policy implications*. Working Paper Series in Economics and Institutions of Innovation 224. Royal Institute of Technology, CESIS - Centre of Excellence for Science and Innovation Studies, Apr. 2010 (cit. on p. 91).
- (Bruner et al., 1998) R. Bruner and R. Spekman. “The dark side of alliances: Lessons from Volvo–Renault.” In: *European Management Journal* 16.2 (1998), pp. 136–150 (cit. on pp. 4, 30, 88, 90, 93, 130, 135).
- (Buckenmaier et al., 2021) J. Buckenmaier and E. Dimant. “The experience is (not) everything: Sequential outcomes and social decision-making.” In: *Economics Letters* (2021), p. 109916 (cit. on p. 69).
- (Cai et al., 2013) S. Cai, M. Goh, R. De Souza, and G. Li. “Knowledge sharing in collaborative supply chains: twin effects of trust and power.” In: *International Journal of Production Research* 51.7 (2013), pp. 2060–2076 (cit. on pp. 35, 40).
- (L. Camarinha-Matos et al., 2012) L. Camarinha-Matos, H. Afsarmanesh, et al. “Taxonomy of collaborative networks forms: FInES Task Force on Collaborative Networks and SOCOLNET-Society of Collaborative Networks.” In: (2012) (cit. on p. 89).
- (L. M. Camarinha-Matos et al., 2005) L. M. Camarinha-Matos and H. Afsarmanesh. “Collaborative networks: a new scientific discipline.” In: *Journal of intelligent manufacturing* 16.4-5 (2005), pp. 439–452 (cit. on p. 24).
- (L. M. Camarinha-Matos et al., 2018) L. M. Camarinha-Matos and H. Afsarmanesh. “Roots of collaboration: nature-inspired solutions for collaborative networks.” In: *IEEE Access* 6 (2018), pp. 30829–30843 (cit. on p. 89).
- (L. M. Camarinha-Matos et al., 2009a) L. M. Camarinha-Matos, H. Afsarmanesh, N. Galeano, and A. Molina. “Collaborative networked organizations—Concepts and practice in manufacturing enterprises.” In: *Computers & Industrial Engineering* 57.1 (2009), pp. 46–60 (cit. on p. 24).
- (L. M. Camarinha-Matos et al., 2019) L. M. Camarinha-Matos, R. Fornasiero, J. Ramezani, and F. Ferrada. “Collaborative Networks: A Pillar of Digital Transformation.” In: *Applied Sciences* 9.24 (2019), p. 5431 (cit. on p. 89).
- (L. M. Camarinha-Matos et al., 2010a) L. M. Camarinha-Matos and P. Macedo. “A conceptual model of value systems in collaborative networks.” In: *Journal of Intelligent Manufacturing* 21.3 (2010), pp. 287–299 (cit. on p. 100).

- (L. M. Camarinha-Matos et al., 2009b) L. M. Camarinha-Matos, A. I. Oliveira, M. Sesana, N. Galeano, D. Demsar, F. Baldo, and T. Jarimo. “A framework for computer-assisted creation of dynamic virtual organisations.” In: *International Journal of Production Research* 47.17 (2009), pp. 4661–4690 (cit. on pp. 24, 89, 93, 95).
- (L. M. Camarinha-Matos et al., 2010b) L. M. Camarinha-Matos, H. Afsarmanesh, and X. Boucher. “[The Role of Collaborative Networks in Sustainability](#).” In: *Collaborative Networks for a Sustainable World*. Ed. by L. M. Camarinha-Matos, X. Boucher, and H. Afsarmanesh. Berlin, Heidelberg: Springer Berlin Heidelberg, 2010, pp. 1–16 (cit. on p. 25).
- (L. M. Camarinha-Matos et al., 2012) L. M. Camarinha-Matos and X. Boucher. “Sustainable collaborative networks – case studies.” In: *Production Planning & Control* 23.4 (2012), pp. 237–239 (cit. on p. 25).
- (Camisón-Zornoza et al., 2004) C. Camisón-Zornoza, R. Lapiedra-Alcamí, M. Segarra-Ciprés, and M. Boronat-Navarro. “A meta-analysis of innovation and organizational size.” In: *Organization studies* 25.3 (2004), pp. 331–361 (cit. on p. 34).
- (Capaldo et al., 2015) A. Capaldo and I. Giannoccaro. “How does trust affect performance in the supply chain? The moderating role of interdependence.” In: *International Journal of Production Economics* 166 (2015), pp. 36–49 (cit. on p. 41).
- (Capaldo et al., 2014) A. Capaldo and A. M. Petruzzelli. “Partner geographic and organizational proximity and the innovative performance of knowledge-creating alliances.” In: *European Management Review* 11.1 (2014), pp. 63–84 (cit. on pp. 88, 93, 95).
- (Castaneda et al., 2020) D. I. Castaneda and S. Cuellar. “[Knowledge sharing and innovation: A systematic review](#).” In: *Knowledge and Process Management* 27.3 (2020), pp. 159–173 (cit. on p. 14).
- (Cerezo-Narváez et al., 2021) A. Cerezo-Narváez, A. Pastor-Fernández, M. Otero-Mateo, P. Ballesteros-Pérez, and F. Rodríguez-Pecchi. “[Knowledge as an Organizational Asset for Managing Complex Projects: The Case of Naval Platforms](#).” In: *Sustainability* 13.2 (2021) (cit. on p. 20).
- (Chakkol et al., 2018) M. Chakkol, K. Selviaridis, and M. Finne. “The governance of collaboration in complex projects.” In: *International journal of operations & production management* (2018) (cit. on p. 22).
- (Chancellor et al., 2015) W. Chancellor, M. Abbott, C. Carson, et al. “Factors promoting innovation and efficiency in the construction industry: a comparative study of New Zealand and Australia.” In: *Construction Economics and Building* 15.2 (2015), p. 63 (cit. on p. 33).
- (Chapman et al., 2004) R. Chapman and P. Hyland. “Complexity and learning behaviors in product innovation.” In: *Technovation* 24.7 (2004), pp. 553–561 (cit. on p. 34).
- (Charyton, 2015) C. Charyton. “Creative engineering design: The meaning of creativity and innovation in engineering.” In: *Creativity and innovation among science and art*. Springer, 2015, pp. 135–152 (cit. on p. 32).
- (W. Chen et al., 2019) W. Chen and M. Goh. “Mechanism for cooperative partner selection: Dual-factor theory perspective.” In: *Computers & Industrial Engineering* 128 (2019), pp. 254–263 (cit. on pp. 30, 87, 96).
- (Y.-H. Chen et al., 2014) Y.-H. Chen, T.-P. Lin, and D. C. Yen. “How to facilitate inter-organizational knowledge sharing: The impact of trust.” In: *Information & Management* 51.5 (2014), pp. 568–578 (cit. on pp. 41, 93).
- (Child et al., 2017) J. Child, L. Hsieh, S. Elbanna, J. Karmowska, S. Marinova, P. Puthusserry, T. Tsai, R. Narooz, and Y. Zhang. “[SME international business models: The role of context and experience](#).” In: *Journal of World Business* 52.5 (2017), pp. 664–679 (cit. on p. 67).
- (Chung et al., 2000) S. Chung, H. Singh, and K. Lee. “Complementarity, status similarity and social capital as drivers of alliance formation.” In: *Strategic management journal* 21.1 (2000), pp. 1–22 (cit. on pp. 30, 87, 88, 95).

-
- (Claire et al., 2014) J. Claire, D. Galvez, V. Boly, M. Camargo, and J. C. Moselle. “A new innovation project maturity assessment methodology based on innovation degree.” In: *2014 International Conference on Engineering, Technology and Innovation (ICE)*. 2014, pp. 1–8 (cit. on p. 13).
- (Cobeña et al., 2017) M. Cobeña, Á. Gallego, and C. Casanueva. “Heterogeneity, diversity and complementarity in alliance portfolios.” In: *European Management Journal* 35.4 (2017), pp. 464–476 (cit. on pp. 93, 95).
- (Cohen et al., 1997) S. G. Cohen and D. E. Bailey. “What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite.” In: *Journal of Management* 23.3 (1997), pp. 239–290. eprint: <https://doi.org/10.1177/014920639702300303> (cit. on p. 68).
- (Cook et al., 2005) K. S. Cook, R. Hardin, and M. Levi. *Cooperation Without Trust?* Russell Sage Foundation, 2005 (cit. on p. 90).
- (Cooke-Davies, 2002) T. Cooke-Davies. “The “real” success factors on projects.” In: *International Journal of Project Management* 20.3 (2002), pp. 185–190 (cit. on pp. 10, 131).
- (Cowan et al., 2008) R. Cowan and N. Jonard. “If the alliance fits.” In: *Network Strategy*. Emerald Group Publishing Limited, 2008, pp. 427–455 (cit. on p. 30).
- (Cowan et al., 2009) R. Cowan and N. Jonard. “Knowledge portfolios and the organization of innovation networks.” In: *Academy of Management Review* 34.2 (2009), pp. 320–342 (cit. on p. 23).
- (Cowan et al., 2001) R. Cowan, L. Soete, and O. Chervonnaya. “Knowledge transfer and the services sector in the context of the new economy.” In: (2001) (cit. on p. 19).
- (Crispim et al., 2015) J. Crispim, N. Rego, and J. Pinho de Sousa. “Stochastic partner selection for virtual enterprises: a chance-constrained approach.” In: *International Journal of Production Research* 53.12 (2015), pp. 3661–3677 (cit. on p. 89).
- (Damanpour et al., 1984) F. Damanpour and W. M. Evan. “Organizational Innovation and Performance: The Problem of “Organizational Lag”.” In: *Administrative Science Quarterly* 29.3 (1984), pp. 392–409 (cit. on p. 32).
- (T. K. Das et al., 1998) T. K. Das and B.-S. Teng. “Resource and risk management in the strategic alliance making process.” In: *Journal of management* 24.1 (1998), pp. 21–42 (cit. on pp. 16, 30).
- (T. Das et al., 2001) T. Das and B.-S. Teng. “A risk perception model of alliance structuring.” In: *Journal of International Management* 7.1 (2001), pp. 1–29 (cit. on pp. 15, 30, 40).
- (T. K. Das et al., 2001) T. K. Das and B.-S. Teng. “Trust, control, and risk in strategic alliances: An integrated framework.” In: *Organization studies* 22.2 (2001), pp. 251–283 (cit. on pp. 15, 35).
- (Davenport et al., 1998) T. H. Davenport, L. Prusak, et al. *Working knowledge: How organizations manage what they know*. Harvard Business Press, 1998 (cit. on p. 19).
- (Davies et al., 2005) A. Davies and M. Hobday. *The business of projects: managing innovation in complex products and systems*. Cambridge University Press, 2005 (cit. on p. 33).
- (De Wit, 1988) A. De Wit. “Measurement of project success.” In: *International journal of project management* 6.3 (1988), pp. 164–170 (cit. on p. 31).
- (de Wit, 1988) A. de Wit. “Measurement of project success.” In: *International Journal of Project Management* 6.3 (1988), pp. 164–170 (cit. on pp. 10, 131).
- (Deitz et al., 2010) G. D. Deitz, M. Tokman, R. G. Richey, and R. M. Morgan. “Joint venture stability and cooperation: Direct, indirect and contingent effects of resource complementarity and trust.” In: *Industrial Marketing Management* 39.5 (2010), pp. 862–873 (cit. on pp. 36, 40, 93).

- (Deniaud et al., 2015) I. F. Deniaud, F. Marmier, and D. Gourc. “Alliances decision-making in NPD: A risk point of view.” In: *IFAC-PapersOnLine* 48.3 (2015). 15th IFAC Symposium on Information Control Problems in Manufacturing, pp. 942–947 (cit. on p. 17).
- (Deniaud et al., 2016) I. F. Deniaud, F. Marmier, D. Gourc, and S. Bougaret. “A risk management approach for collaborative NPD project.” In: *2016 INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING, MANAGEMENT SCIENCE AND APPLICATIONS (ICIMSA)*. International Conference on Industrial Engineering, Management Science and Applications (ICIMSA), Jeju Island, SOUTH KOREA, MAY 23-26, 2016-2106. IEEE; IEEE Changwon Sect. 2016 (cit. on p. 23).
- (Deniaud et al., 2017) I. F. Deniaud, F. Marmier, D. Gourc, and X. Labaume. “How risks and innovativeness influence the selection of partner in NPD alliances.” In: *2017 IEEE 19th Conference on Business Informatics (CBI)*. Vol. 1. Conference of 19th IEEE Conference on Business Informatics, CBI 2017. Thessaloniki, Greece: Institute of Electrical and Electronics Engineers Inc., July 2017, pp. 62–69 (cit. on pp. 36, 88, 93, 99).
- (Dewar et al., 1986) R. Dewar and J. Dutton. “The Adoption of Radical and Incremental Innovations: An Empirical Analysis.” In: *Management Science* 32 (Nov. 1986), pp. 1422–1433 (cit. on p. 32).
- (Di Guardo et al., 2016) M. C. Di Guardo and K. Harrigan. “Shaping the path to inventive activity: The role of past experience in R&D alliances.” In: *The Journal of Technology Transfer* 41.2 (2016), pp. 250–269 (cit. on pp. 91, 95).
- (Doloi, 2009) H. Doloi. “Relational partnerships: the importance of communication, trust and confidence and joint risk management in achieving project success.” In: *Construction Management and Economics* 27.11 (2009), pp. 1099–1109 (cit. on pp. 5, 15, 40, 93, 131).
- (Dorogovtsev et al., 2013) S. N. Dorogovtsev and J. F. Mendes. *Evolution of networks: From biological nets to the Internet and WWW*. OUP Oxford, 2013 (cit. on p. 24).
- (Drejer et al., 2005) I. Drejer and B. H. Jørgensen. “The dynamic creation of knowledge: Analysing public–private collaborations.” In: *Technovation* 25.2 (2005), pp. 83–94 (cit. on p. 30).
- (Du Plessis, 2007) M. Du Plessis. “The role of knowledge management in innovation.” In: *Journal of knowledge management* (2007) (cit. on p. 19).
- (Duncan, 1995) N. B. Duncan. “Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure.” In: *Journal of management information systems* 12.2 (1995), pp. 37–57 (cit. on p. 99).
- (Durst et al., 2019) S. Durst and M. Zieba. “Mapping knowledge risks: towards a better understanding of knowledge management.” In: *Knowledge Management Research & Practice* 17.1 (2019), pp. 1–13 (cit. on p. 21).
- (Durugbo, 2016) C. Durugbo. “Collaborative networks: A systematic review and multi-level framework.” In: *International Journal of Production Research* 54.12 (2016), pp. 3749–3776 (cit. on pp. 22, 25, 89).
- (Easton et al., 2012) G. S. Easton and E. D. Rosenzweig. “The role of experience in six sigma project success: An empirical analysis of improvement projects.” In: *Journal of Operations Management* 30.7 (2012), pp. 481–493 (cit. on pp. 67–69).
- (Elhabib et al., 2010) N. Elhabib, X. Boucher, and S. Peillon. “Engineering of service oriented collaborative network.” In: *Working Conference on Virtual Enterprises*. Springer, 2010, pp. 461–468 (cit. on p. 25).
- (Ellinas et al., 2016) C. Ellinas, N. Allan, and A. Johansson. “Project systemic risk: Application examples of a network model.” In: *INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS* 182 (DEC 2016), 50–62 (cit. on p. 14).
- (Elmuti et al., 2001) D. Elmuti and Y. Kathawala. “An overview of strategic alliances.” In: *Management decision* (2001) (cit. on pp. 4, 130).

-
- (Emden et al., 2005) Z. Emden, A. Yaprak, and S. T. Cavusgil. “Learning from experience in international alliances: antecedents and firm performance implications.” In: *Journal of Business Research* 58.7 (2005), pp. 883–892 (cit. on pp. 91, 95).
- (Eraut, 2004) M. Eraut. “Informal learning in the workplace.” In: *Studies in Continuing Education* 26.2 (2004), pp. 247–273. eprint: <https://doi.org/10.1080/158037042000225245> (cit. on pp. 68, 134).
- (Ewens et al., 2019) H. Ewens and J. van der Voet. “Organizational complexity and participatory innovation: participatory budgeting in local government.” In: *Public Management Review* 21.12 (2019), pp. 1848–1866 (cit. on p. 34).
- (M. Farooq et al., 2016) M. Farooq and M. Radovic-Markovic. “Modeling entrepreneurial education and entrepreneurial skills as antecedents of intention towards entrepreneurial behaviour in single mothers: a PLS-SEM approach.” In: *Entrepreneurship: Types, Current Trends and Future Perspectives* (2016) (cit. on p. 42).
- (M. S. Farooq et al., 2018) M. S. Farooq, M. Salam, A. Fayolle, N. Jaafar, and K. Ayupp. “Impact of service quality on customer satisfaction in Malaysia airlines: A PLS-SEM approach.” In: *Journal of Air Transport Management* 67 (2018), pp. 169–180 (cit. on p. 42).
- (Fernandez et al., 2018) A.-S. Fernandez, F. Le Roy, and P. Chiambaretto. “Implementing the right project structure to achieve cooperative innovation projects.” In: *LONG RANGE PLANNING* 51.2 (APR 2018), 384–405 (cit. on pp. 10, 23).
- (Ferrada et al., 2019) F. Ferrada and L. M. Camarinha-Matos. “A modelling framework for collaborative network emotions.” In: *Enterprise Information Systems* 13.7-8 (2019), pp. 1164–1194 (cit. on pp. 24, 90, 96).
- (Firmenich, 2017) J. Firmenich. “Customisable framework for project risk management.” In: *CONSTRUCTION INNOVATION-ENGLAND* 17.1 (2017), 68–89 (cit. on pp. 5, 17, 131).
- (Fleming, 2001) L. Fleming. “Recombinant uncertainty in technological search.” In: *Management science* 47.1 (2001), pp. 117–132 (cit. on p. 30).
- (Flyvbjerg, 2014) B. Flyvbjerg. “What you should know about megaprojects and why: An overview.” In: *Project management journal* 45.2 (2014), pp. 6–19 (cit. on p. 30).
- (Flyvbjerg et al., 2003) B. Flyvbjerg, N. Bruzelius, and W. Rothengatter. *Megaprojects and Risk: An Anatomy of Ambition*. Cambridge: Cambridge University Press, 2003 (cit. on p. 18).
- (Fordham et al., 2016) B. Fordham and P. Poast. “All alliances are multilateral: Rethinking alliance formation.” In: *Journal of Conflict Resolution* 60.5 (2016), pp. 840–865 (cit. on pp. 93, 95).
- (Freel, 2005) M. S. Freel. “Patterns of innovation and skills in small firms.” In: *Technovation* 25.2 (2005), pp. 123–134 (cit. on pp. 30, 133).
- (Frenken, 2006) K. Frenken. “Technological innovation and complexity theory.” In: *Economics of Innovation and New Technology* 15.2 (2006), pp. 137–155 (cit. on p. 34).
- (Furlotti et al., 2018) M. Furlotti and G. Soda. “Fit for the task: complementarity, asymmetry, and partner selection in alliances.” In: *Organization Science* 29.5 (2018), pp. 837–854 (cit. on pp. 87–89, 93, 95).
- (Galvez et al., 2018) D. Galvez, M. Enjolras, M. Camargo, V. Boly, and J. Claire. “Firm Readiness Level for Innovation Projects: A New Decision-Making Tool for Innovation Managers.” In: *Administrative Sciences* 8.1 (2018) (cit. on p. 13).
- (Gemünden et al., 2005) H. G. Gemünden, S. Salomo, and A. Krieger. “The influence of project autonomy on project success.” In: *International Journal of Project Management* 23.5 (2005), pp. 366–373 (cit. on p. 37).

- (Glaeser et al., 2000) E. L. Glaeser, D. I. Laibson, J. A. Scheinkman, and C. L. Soutter. “Measuring trust.” In: *The quarterly journal of economics* 115.3 (2000), pp. 811–846 (cit. on p. 37).
- (Gou et al., 2019) J. Gou, Q. Liu, W. Mu, W. Ying, H. Afsarmanesh, and F. Benaben. “A digital-enabled framework for intelligent collaboration in small teams.” In: *Working Conference on Virtual Enterprises*. Springer. 2019, pp. 193–202 (cit. on p. 89).
- (Guan et al., 2020) L. Guan, Q. LIU, A. ABBASI, and M. J. RYAN. “[Developing a comprehensive risk assessment model based on fuzzy Bayesian belief network \(FBBN\)](#).” In: *Journal of Civil Engineering and Management* 26.7 (2020), pp. 614–634 (cit. on pp. 10, 132).
- (Gulati et al., 2012) R. Gulati, F. Wohlgezogen, and P. Zhelyazkov. “The two facets of collaboration: Cooperation and coordination in strategic alliances.” In: *The Academy of Management Annals* 6.1 (2012), pp. 531–583 (cit. on pp. 88, 90, 95, 135).
- (Gunduz et al., 2018) M. Gunduz and A. M. A. Yahya. “Analysis of project success factors in construction industry.” In: *Technological and Economic Development of Economy* 24.1 (2018), pp. 67–80 (cit. on p. 31).
- (Guo et al., 2013) N.-s. Guo and X. Qin. “[A Priority Analysis Algorithm for Technology Innovation Risks of Research Solutions for Complex Project](#).” In: *19TH INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT: MANAGEMENT SYSTEM INNOVATION*. Ed. by Qi, E and Shen, J and Dou, R. 19th International Conference on Industrial Engineering and Engineering Management, Changsha, PEOPLES R CHINA, OCT 27-29, 2012. 2013, 19–24 (cit. on p. 16).
- (Haghbin et al., 2014) S. Haghbin and P. Davoudi. “Investigation of Similarities between Collaborative Network and General Contractors-Literature Review.” In: *Procedia Technology* 16 (2014), pp. 979–987 (cit. on pp. 24, 25).
- (Hair et al., 2011) J. F. Hair, C. M. Ringle, and M. Sarstedt. “PLS-SEM: Indeed a silver bullet.” In: *Journal of Marketing theory and Practice* 19.2 (2011), pp. 139–152 (cit. on pp. 42, 43, 49, 50).
- (Hair Jr et al., 2016) J. F. Hair Jr, G. T. M. Hult, C. Ringle, and M. Sarstedt. *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage publications, 2016 (cit. on pp. 43, 49, 50, 60, 79).
- (Hair Jr et al., 2017) J. F. Hair Jr, M. Sarstedt, C. M. Ringle, and S. P. Gudergan. *Advanced issues in partial least squares structural equation modeling*. saGe publications, 2017 (cit. on p. 56).
- (Hall et al., 1991) P. Hall and S. R. Wilson. “Two guidelines for bootstrap hypothesis testing.” In: *Biometrics* (1991), pp. 757–762 (cit. on p. 75).
- (Haltiwanger et al., 2010) G. Haltiwanger, R. E. Landaeta, C. A. Pinto, and A. Tolk. “[Understanding the relationship between Risk Management and Knowledge Management: a literature review and extension](#).” In: *International Journal of Knowledge Management Studies* 4.3 (2010), pp. 281–300 (cit. on pp. 10, 22).
- (Hameed et al., 2014) M. A. Hameed and S. Counsell. “[Establishing relationships between innovation characteristics and IT innovation adoption in organisations: A meta-analysis approach](#).” In: *International Journal of Innovation Management* 18.01 (2014), p. 1450007 (cit. on p. 92).
- (Harbison, 1998) J. R. Harbison. *Smart alliances : a practical guide to repeatable success*. eng. 1st ed. The Jossey-Bass business & management series. San Francisco: Jossey-Bass, 1998 (cit. on p. 90).
- (Harbison et al., 1997) J. R. Harbison and P. Pekar. “Cross-Border Alliances in the Age of Collaboration.” In: BoozAllen & Hamilton, 1997 (cit. on pp. 89, 97).
- (Harman, 1976) H. H. Harman. *Modern factor analysis*. University of Chicago press, 1976 (cit. on p. 47).

-
- (Henseler et al., 2010) J. Henseler and W. W. Chin. “A Comparison of Approaches for the Analysis of Interaction Effects Between Latent Variables Using Partial Least Squares Path Modeling.” In: *Structural Equation Modeling: A Multidisciplinary Journal* 17.1 (2010), pp. 82–109. eprint: <https://doi.org/10.1080/10705510903439003> (cit. on p. 60).
- (Hernandez-Ortega, 2011) B. Hernandez-Ortega. “The role of post-use trust in the acceptance of a technology: Drivers and consequences.” In: *Technovation* 31.10-11 (2011), pp. 523–538 (cit. on p. 40).
- (Holti, 2011) R. Holti. “Understanding Institutional Change in Project-Based Organizing.” In: *The Journal of Applied Behavioral Science* 47.3 (2011), pp. 360–394. eprint: <https://doi.org/10.1177/0021886311405145> (cit. on p. 11).
- (Howsawi et al., 2014) E. M. Howsawi, D. Eager, R. Bagia, and K. Niebecker. “The four-level project success framework: application and assessment.” In: 2014 (cit. on pp. 9, 131).
- (Hu et al., 2015) Y. Hu, A. P. Chan, Y. Le, and R.-z. Jin. “From construction megaproject management to complex project management: Bibliographic analysis.” In: *Journal of management in engineering* 31.4 (2015), p. 04014052 (cit. on p. 12).
- (Huang et al., 2015) M.-C. Huang, H.-H. Hsiung, and T.-C. Lu. “Reexamining the relationship between control mechanisms and international joint venture performance: The mediating roles of perceived value gap and information asymmetry.” In: *Asia Pacific Management Review* 20.1 (2015), pp. 32–43 (cit. on pp. 36, 93).
- (Huckman et al., 2006) R. S. Huckman and G. P. Pisano. “The firm specificity of individual performance: Evidence from cardiac surgery.” In: *Management Science* 52.4 (2006), pp. 473–488 (cit. on p. 84).
- (Huo et al., 2015) B. Huo, Y. Ye, and X. Zhao. “The impacts of trust and contracts on opportunism in the 3PL industry: The moderating role of demand uncertainty.” In: *International Journal of Production Economics* 170 (2015), pp. 160–170 (cit. on p. 41).
- (Huotari et al., 2004) M.-L. Huotari and M. Iivonen, eds. *Trust in Knowledge Management and Systems in Organizations*. USA: IGI Global, 2004 (cit. on p. 18).
- (Ika, 2009) L. A. Ika. “Project Success as a Topic in Project Management Journals.” In: *Project Management Journal* 40.4 (2009), pp. 6–19. eprint: <https://doi.org/10.1002/pmj.20137> (cit. on pp. 10, 131).
- (Inkpen, 1998) A. Inkpen. “Learning, knowledge acquisition, and strategic alliances.” In: *European Management Journal* 16.2 (1998), pp. 223–229 (cit. on p. 92).
- (Islam et al., 2021) M. T. Islam and D. Chadee. “Stuck at the bottom: Role of tacit and explicit knowledge on innovation of developing-country suppliers in global value chains.” In: *International Business Review* (2021), p. 101898 (cit. on pp. 30, 133).
- (Ivan et al., 2014) I. Ivan and M. L. Despa. “Statistical Indicators for Measuring Innovation in IT Project Management.” In: *Procedia Economics and Finance* 10 (2014). International Conference on Applied Statistics (ICAS) 2013, pp. 167–177 (cit. on p. 14).
- (Jakobsen et al., 2015) M. Jakobsen and R. Jensen. “Common method bias in public management studies.” In: *International Public Management Journal* 18.1 (2015), pp. 3–30 (cit. on p. 47).
- (Jimenez-Jimenez et al., 2011) D. Jimenez-Jimenez and R. Sanz Valle. “Innovation, organizational learning, and performance.” In: *Journal of Business Research* 64 (Apr. 2011), pp. 408–417 (cit. on p. 32).
- (Jin, 2010) X.-H. Jin. “Neurofuzzy decision support system for efficient risk allocation in public-private partnership infrastructure projects.” In: *Journal of Computing in Civil Engineering* 24.7 (2010), 525–538 (cit. on p. 17).
- (Jin et al., 2011) X.-H. Jin and G. Zhang. “Modelling optimal risk allocation in PPP projects using artificial neural networks.” In: *International Journal of Project Management* 29.5 (2011), pp. 591–603 (cit. on p. 17).

- (Jones et al., 2008) C. Jones and B. B. Lichtenstein. "Temporary inter-organizational projects." In: *The Oxford handbook of inter-organizational relations*. 2008 (cit. on p. 11).
- (Kadefors, 2004) A. Kadefors. "Trust in project relationships—inside the black box." In: *International Journal of project management* 22.3 (2004), pp. 175–182 (cit. on pp. 35, 90).
- (Kamel et al., 2007) M. Kamel, A. Benzekri, F. Barrère, and R. Laborde. "[Evaluating the Virtual Organizations security solutions using the ISO/IEC 17799 standard.](#)" In: *2007 IEEE International Technology Management Conference (ICE)*. IEEE. 2007, pp. 1–8 (cit. on p. 90).
- (Ke et al., 2009) W. Ke, H. Liu, K. K. Wei, J. Gu, and H. Chen. "How do mediated and non-mediated power affect electronic supply chain management system adoption? The mediating effects of trust and institutional pressures." In: *Decision Support Systems* 46.4 (2009), pp. 839–851 (cit. on p. 40).
- (Kermanshachi et al., 2016) S. Kermanshachi, B. Dao, J. Shane, and S. Anderson. "[Project Complexity Indicators and Management Strategies – A Delphi Study.](#)" In: *Procedia Engineering* 145 (2016). ICSDEC 2016 – Integrating Data Science, Construction and Sustainability, pp. 587–594 (cit. on p. 10).
- (Khan et al., 2013) K. Khan, J. R. Turner, and T. Maqsood. "Factors that influence the success of public sector projects in Pakistan." In: *Proceedings of IRNOP 2013 Conference*. 2013, pp. 17–19 (cit. on p. 31).
- (Kim et al., 2009) J. Kim and A. Parkhe. "Competing and cooperating similarity in global strategic alliances: an exploratory examination." In: *British Journal of Management* 20.3 (2009), pp. 363–376 (cit. on pp. 88, 93, 95).
- (Kirch, 2008). "[Pearson's Correlation Coefficient.](#)" In: *Encyclopedia of Public Health*. Ed. by W. Kirch. Dordrecht: Springer Netherlands, 2008, pp. 1090–1091 (cit. on pp. 71, 73).
- (Knight, 1967) K. E. Knight. "A descriptive model of the intra-firm innovation process." In: *The journal of business* 40.4 (1967), pp. 478–496 (cit. on p. 32).
- (Koh, 2010) T. Y. Koh. "[The effects of social capital on construction project success: exploring the mediating role of projectlearning.](#)" In: *HKU Theses Online (HKUTO)* (2010) (cit. on p. 12).
- (Kohl et al., 2015) H. Kohl, R. Orth, O. Riebartsch, M. Galeitzke, and J.-P. Cap. "Support of innovation networks in manufacturing industries through identification of sustainable collaboration potential and best-practice transfer." In: *Procedia CIRP* 26 (2015), pp. 185–189 (cit. on p. 25).
- (Kramer et al., 1995) R. M. Kramer and T. R. Tyler. *Trust in organizations: Frontiers of theory and research*. Sage Publications, 1995 (cit. on p. 88).
- (Lai et al., 2000) B. Lai and D. Reiter. "Democracy, political similarity, and international alliances, 1816-1992." In: *Journal of Conflict Resolution* 44.2 (2000), pp. 203–227 (cit. on p. 88).
- (Lapre et al., 2000) M. Lapre, A. Mukherjee, and L. Van Wassenhove. "[Behind the Learning Curve: Linking Learning Activities to Waste Reduction.](#)" In: *Management Science* 46 (May 2000), pp. 597–611 (cit. on p. 67).
- (Lapre et al., 2001) M. Lapre and L. Van Wassenhove. "[Creating and Transferring Knowledge for Productivity Improvement in Factories.](#)" In: *Management Science* 47 (Oct. 2001), pp. 1311–1325 (cit. on p. 67).
- (Lauria et al., 2014) E. Lauria, T. Moore, C. O'Brien, R. Staunton, and S. Samaddar. "The Influence of Knowledge Management on Managing Organizational Risk." In: *American International Journal of Contemporary Research* 4.11 (2014), pp. 11–23 (cit. on p. 21).
- (Leonidou et al., 2008) L. C. Leonidou, M. A. Talias, and C. N. Leonidou. "Exercised power as a driver of trust and commitment in cross-border industrial buyer–seller relationships." In: *Industrial Marketing Management* 37.1 (2008), pp. 92–103 (cit. on p. 40).

-
- (Li et al., 2019) H. Li, Q. Zhang, and Z. Zheng. “A Mediating Effect of Knowledge Integration and Moderating Effect of Organizational Task Environment.” In: *Enterprise Information Systems* 13.9 (2019), pp. 1323–1346 (cit. on p. 92).
- (Lipa et al., 2020) M. Lipa, K. O’Donnell, and A. Greene. “Managing Knowledge and Risk: a Literature Review on the Interdependency of QRM and KM as ICH Q10 Enablers.” In: *Level 3* 15.2 (2020), p. 3 (cit. on p. 20).
- (Loichate, 2012) M. Loichate. “State of the Art of collaborative networks for service-based innovation ecosystems.” In: *Service based Innovation Ecosystems of the MSEE project - Manufacturing Services Ecosystem*. 2012 (cit. on p. 24).
- (Lundin et al., 2015) R. Lundin, N. Arvidsson, T. Brady, E. Ekstedt, C. Midler, and J. Sydow. *Managing and working in project society: institutional challenges of temporary organizations*. English. Cambridge University Press, July 2015 (cit. on p. 11).
- (Lyu et al., 2017) H. Lyu and Z. Zhang. “Incentives for knowledge sharing: impact of organisational culture and information technology.” In: *Enterprise Information Systems* 11.9 (2017), pp. 1416–1435 (cit. on pp. 90, 95).
- (Mackey et al., 2014) A. Mackey, J. C. Molloy, and S. S. Morris. “Scarce human capital in managerial labor markets.” In: *Journal of Management* 40.2 (2014), pp. 399–421 (cit. on p. 67).
- (Majocchi et al., 2018) A. Majocchi, A. D’Angelo, E. Forlani, and T. Buck. “Bifurcation bias and exporting: Can foreign work experience be an answer? Insight from European family SMEs.” In: *Journal of World Business* 53.2 (2018), pp. 237–247 (cit. on p. 69).
- (Malhotra, 1997) Y. Malhotra. “Knowledge management in inquiring organizations.” In: (1997) (cit. on p. 18).
- (Manual, 2018) O. Manual. “Guidelines for Collecting, Reporting and Using Data on Innovation, The Measurement of Scientific, Technological and Innovation Activities.” In: *Paris: OECD Publishing* 2018 (2018), pp. 85–102 (cit. on p. 32).
- (Mat et al., 2009) N. A. C. Mat, Y. Cheung, and H. Scheepers. “Partner selection: Criteria for successful collaborative network.” In: *20th Australian conference on information systems*. Vol. 2. 4. 2009 (cit. on pp. 90, 135).
- (Matemilola et al., 2018) B. Matemilola, A. Bany-Arifin, W. Azman-Saini, and A. M. Nassir. “Does top managers’ experience affect firms’ capital structure?” In: *Research in International Business and Finance* 45 (2018), pp. 488–498 (cit. on p. 69).
- (Maurer, 2010) I. Maurer. “How to build trust in inter-organizational projects: The impact of project staffing and project rewards on the formation of trust, knowledge acquisition and product innovation.” In: *International journal of project management* 28.7 (2010), pp. 629–637 (cit. on p. 30).
- (Meier et al., 2016) M. Meier, M. Lütkewitt, T. Mellewigt, and C. Decker. “How managers can build trust in strategic alliances: a meta-analysis on the central trust-building mechanisms.” In: *Journal of Business Economics* 86.3 (2016), pp. 229–257 (cit. on pp. 91, 95).
- (Michaelides et al., 2016) R. Michaelides, D. Bryde, J. Simango, C. Unterhitzberger, and M. Argyropoulou. “A Systematic Meta-analysis on Managing Innovation Projects in Uncertain and Complex Environments.” In: *2016 IEEE INTERNATIONAL CONFERENCE ON MANAGEMENT OF INNOVATION AND TECHNOLOGY (ICMIT)*. IEEE International Conference on Management of Innovation and Technology (ICMIT), Bangkok, THAILAND, SEP 19–22, 2016. IEEE. 2016, 286–291 (cit. on p. 14).
- (Mihic et al., 2018) M. M. Mihic, Z. A. Dodevska, M. L. Todorovic, V. L. Obradovic, and D. C. Petrovic. “Reducing Risks in Energy Innovation Projects: Complexity Theory Perspective.” In: *SUSTAINABILITY* 10.9 (SEP 2018) (cit. on p. 17).
- (Mintzberg, 1989) H. Mintzberg. “The structuring of organizations.” In: *Readings in strategic management*. Springer, 1989, pp. 322–352 (cit. on p. 92).

- (Moorman et al., 1993) C. Moorman, R. Deshpande, and G. Zaltman. “Factors affecting trust in market research relationships.” In: *Journal of marketing* 57.1 (1993), pp. 81–101 (cit. on pp. 40, 90).
- (Mowery et al., 1996) D. C. Mowery, J. E. Oxley, and B. S. Silverman. “Strategic alliances and interfirm knowledge transfer.” In: *Strategic management journal* 17.S2 (1996), pp. 77–91 (cit. on pp. 88, 93).
- (Mowery et al., 1998) D. C. Mowery, J. E. Oxley, and B. S. Silverman. “Technological overlap and interfirm cooperation: implications for the resource-based view of the firm.” In: *Research policy* 27.5 (1998), pp. 507–523 (cit. on pp. 88, 93).
- (S. S. Msanjila et al., 2011) S. S. Msanjila and H. Afsarmanesh. “[On modelling evolution of trust in organisations towards mediating collaboration.](#)” In: *Production Planning & Control* 22.5-6 (2011), pp. 518–537 (cit. on p. 91).
- (S. S. Msanjila et al., 2006) S. S. Msanjila and H. Afsarmanesh. “Assessment and creation of trust in VBEs.” In: *Working Conference on Virtual Enterprises*. Springer. 2006, pp. 161–172 (cit. on p. 92).
- (S. Msanjila et al., 2008) S. Msanjila and H. Afsarmanesh. “[Trust analysis and assessment in virtual organization breeding environments.](#)” In: *International Journal of Production Research* 46.5 (2008), pp. 1253–1295 (cit. on p. 92).
- (Mudambi et al., 2010) S. M. Mudambi and S. Tallman. “Make, buy or ally? Theoretical perspectives on knowledge process outsourcing through alliances.” In: *Journal of management studies* 47.8 (2010), pp. 1434–1456 (cit. on p. 88).
- (Muthusamy et al., 2005) S. K. Muthusamy and M. A. White. “[Learning and knowledge transfer in strategic alliances: A social exchange view.](#)” In: *Organization studies* 26.3 (2005), pp. 415–441 (cit. on p. 94).
- (Nai-ping et al., 2013) S. Nai-ping, W. Xian-bin, Z. Wei-cong, and H. Ai-qin. “[Study on Industry Manufacturing with BN-based Risk Assessment on the Technology Innovation of the Complex Product System.](#)” In: *ADVANCED RESEARCH ON INDUSTRY, INFORMATION SYSTEM AND MATERIAL ENGINEERING*. Ed. by Zhang, H and Jin, D and Zhao, XJ. Vol. 675. Advanced Materials Research. 3rd International Conference on Industry, Information System and Material Engineering (IISME 2013), Changsha, PEOPLES R CHINA, MAR 01-17, 2013. ISER Assoc; Beijing Gireida Educ Res Ctr; VIP Informat Conf Ctr. 2013, pp. 8+ (cit. on pp. 16, 17).
- (Neef, 2005) D. Neef. “Managing corporate risk through better knowledge management.” In: *The Learning Organization* (2005) (cit. on p. 21).
- (Nguyen et al., 2019) L. D. Nguyen, L. Le-Hoai, D. Q. Tran, C. N. Dang, and C. V. Nguyen. “[Effect of project complexity on cost and schedule performance in transportation projects.](#)” In: *Construction Management and Economics* 37.7 (2019), pp. 384–399 (cit. on p. 92).
- (Nicolaou et al., 2013) A. I. Nicolaou, M. Ibrahim, and E. Van Heck. “Information quality, trust, and risk perceptions in electronic data exchanges.” In: *Decision support systems* 54.2 (2013), pp. 986–996 (cit. on pp. 35, 40).
- (Nunes et al., 2020) M. Nunes and A. Abreu. “[Managing Open Innovation Project Risks Based on a Social Network Analysis Perspective.](#)” In: *SUSTAINABILITY* 12.8 (APR 2020) (cit. on p. 23).
- (Okudan et al., 2020) O. Okudan and C. Budayan. “[ASSESSMENT OF PROJECT CHARACTERISTICS AFFECTING RISK OCCURRENCES IN CONSTRUCTION PROJECTS USING FUZZY AHP.](#)” In: *Sigma: Journal of Engineering & Natural Sciences/Mühendislik ve Fen Bilimleri Dergisi* 38.3 (2020) (cit. on p. 17).
- (Oliveiral et al., 2008) A. I. Oliveiral, L. M. Camarinha-Matos, and M. Pouly. “Agreement negotiation support in VO creation.” In: *Working Conference on Virtual Enterprises*. Springer. 2008, pp. 107–118 (cit. on p. 89).

-
- (Osborn et al., 1997) R. N. Osborn and J. Hagedoorn. “The institutionalization and evolutionary dynamics of interorganizational alliances and networks.” In: *Academy of Management Journal* 40.2 (1997), pp. 261–278 (cit. on p. 25).
- (Osório et al., 2019) A. L. Osório, L. M. Camarinha-Matos, H. Afsarmanesh, and A. Belloum. “Towards a Mobility Payment Service Based on Collaborative Open Systems.” In: *Working Conference on Virtual Enterprises*. Springer. 2019, pp. 379–392 (cit. on p. 89).
- (Pallant, 2013) J. Pallant. “SPSS survival manual: McGraw-hill education (UK).” In: (2013) (cit. on pp. 47, 74).
- (Park et al., 2014) J.-G. Park and J. Lee. “Knowledge sharing in information systems development projects: Explicating the role of dependence and trust.” In: *International Journal of Project Management* 32.1 (2014), pp. 153–165 (cit. on pp. 30, 88, 133).
- (Parkin, 1996) J. Parkin. “Organizational decision making and the project manager.” In: *International Journal of Project Management* 14.5 (1996), pp. 257–263 (cit. on p. 18).
- (Piranfar, 2009) H. Piranfar. “Managing Risk in Innovation Projects.” In: *PROCEEDINGS OF THE 4TH EUROPEAN CONFERENCE ON ENTREPRENEURSHIP AND INNOVATION*. Ed. by Braet, J. 4th European Conference on Entrepreneurship and Innovation, Univ Antwerp, Antwerp, BELGIUM, SEP 10-11, 2009. 2009, 359–368 (cit. on p. 22).
- (PMI, 2013) PMI, ed. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*. 5th ed. Newtown Square, PA: Project Management Institute, 2013 (cit. on pp. 9, 10, 131, 132).
- (Polyantchikov et al., 2017) I. Polyantchikov, E. Shevtshenko, T. Karaulova, T. Kangilaski, and L. M. Camarinha-Matos. “Virtual enterprise formation in the context of a sustainable partner network.” In: *Industrial management & data systems* 117.7 (2017), pp. 1446–1468 (cit. on pp. 89, 135).
- (Porter, 1998) M. E. Porter. *Introduction, 1998]: Competitive Advantage-Creating and Sustaining Superior Performance, with a new introduction*. 1998 (cit. on p. 29).
- (Pueyo et al., 2011a) V. Pueyo, C. Toupin, and S. Volkoff. “The role of experience in night work: Lessons from two ergonomic studies.” In: *Applied Ergonomics* 42.2 (2011). Special Section: Ergonomics, health and working time organization, pp. 251–255 (cit. on p. 68).
- (Pueyo et al., 2011b) V. Pueyo, C. Toupin, and S. Volkoff. “The role of experience in night work: Lessons from two ergonomic studies.” In: *Applied ergonomics* 42.2 (2011), pp. 251–255 (cit. on p. 69).
- (Qazi et al., 2016) A. Qazi, J. Quigley, A. Dickson, and K. Kirytopoulos. “Project Complexity and Risk Management (ProCRiM): Towards modelling project complexity driven risk paths in construction projects.” In: *International Journal of Project Management* 34.7 (2016), pp. 1183–1198 (cit. on p. 10).
- (Reagans et al., 2005) R. Reagans, L. Argote, and D. Brooks. “Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together.” In: *Management science* 51.6 (2005), pp. 869–881 (cit. on p. 84).
- (Relich et al., 2018) M. Relich and P. Pawlewski. “A case-based reasoning approach to cost estimation of new product development.” In: *Neurocomputing* 272 (2018), pp. 40–45 (cit. on pp. 92, 93).
- (Richardson et al., 2009) H. A. Richardson, M. J. Simmering, and M. C. Sturman. “A tale of three perspectives: Examining post hoc statistical techniques for detection and correction of common method variance.” In: *Organizational Research Methods* 12.4 (2009), pp. 762–800 (cit. on p. 47).
- (Ring, 1996) P. S. Ring. “Fragile and resilient trust and their roles in economic exchange.” In: *Business & Society* 35.2 (1996), pp. 148–175 (cit. on p. 35).

- (Ringle et al., 2016) C. M. Ringle and M. Sarstedt. “Gain more insight from your PLS-SEM results.” In: *Industrial management & data systems* (2016) (cit. on p. 56).
- (Robertson et al., 2021) J. Robertson, A. Caruana, and C. Ferreira. “[Innovation performance: The effect of knowledge-based dynamic capabilities in cross-country innovation ecosystems.](#)” In: *International Business Review* (2021), p. 101866 (cit. on pp. 30, 133).
- (Robson et al., 2008) M. J. Robson, C. S. Katsikeas, and D. C. Bello. “[Drivers and performance outcomes of trust in international strategic alliances: The role of organizational complexity.](#)” In: *Organization science* 19.4 (2008), pp. 647–665 (cit. on pp. 92, 95).
- (Rodriguez et al., 2015) E. Rodriguez and J. S. Edwards. “Knowledge management in support of enterprise risk management.” In: *Transportation systems and engineering: Concepts, methodologies, tools, and applications* (2015), pp. 108–127 (cit. on p. 21).
- (Romero et al., 2011) D. Romero and A. Molina. “[Green Virtual Enterprise Breeding Environment Reference Framework.](#)” In: *Adaptation and Value Creating Collaborative Networks*. Ed. by L. M. Camarinha-Matos, A. Pereira-Klen, and H. Afsarmanesh. Berlin, Heidelberg: Springer Berlin Heidelberg, 2011, pp. 545–555 (cit. on p. 25).
- (Rosas et al., 2015) J. Rosas, P. Macedo, A. Tenera, A. Abreu, and P. Urze. “[Risk Assessment in Open Innovation Networks.](#)” In: *RISKS AND RESILIENCE OF COLLABORATIVE NETWORKS*. Ed. by CamarinhaMatos, LM and Benaben, F and Picard, W. Vol. 463. IFIP Advances in Information and Communication Technology. 16th IFIP WG 5.5 Working Conference on Virtual Enterprises (PRO-VE), Albi, FRANCE, OCT 05-07, 2015. IFIP WG 5 5 Co Operat Infrastructure Virtual Enterprises & Elect Business; Soc Collaborat Networks; Mines Albi Carmaux; Nova Univ Lisbon; UNINOVA; Univ Econ. 2015, 27–38 (cit. on p. 23).
- (Rosas et al., 2017) J. Rosas, P. Urze, A. Tenera, A. Abreu, and L. M. Camarinha-Matos. “[Exploratory Study on Risk Management in Open Innovation.](#)” In: *18th Working Conference on Virtual Enterprises (PROVE)*. Ed. by L. M. Camarinha-Matos, H. Afsarmanesh, and R. Fornasiero. Vol. AICT-506. Collaboration in a Data-Rich World. Part 14: Risk and Trust Analysis in CNs. Vicenza, Italy: Springer International Publishing, Sept. 2017, pp. 527–540 (cit. on pp. 30, 88).
- (Rosenkopf et al., 2003) L. Rosenkopf and P. Almeida. “Overcoming local search through alliances and mobility.” In: *Management science* 49.6 (2003), pp. 751–766 (cit. on pp. 88, 93).
- (Rousseau et al., 1998) D. M. Rousseau, S. B. Sitkin, R. S. Burt, and C. Camerer. “Not so different after all: A cross-discipline view of trust.” In: *Academy of management review* 23.3 (1998), pp. 393–404 (cit. on p. 35).
- (Rowley et al., 2011) J. Rowley, A. Baregheh, and S. Sambrook. “Towards an innovation-type mapping tool.” In: *Management Decision* 49.1 (2011), pp. 73–86 (cit. on pp. 32, 34).
- (Rundquist, 2012) J. Rundquist. “The ability to integrate different types of knowledge and its effect on innovation performance.” In: *International Journal of Innovation Management* 16.02 (2012), p. 1250014 (cit. on p. 30).
- (Ruuska et al., 2011) I. Ruuska, T. Ahola, K. Artto, G. Locatelli, and M. Mancini. “[A new governance approach for multi-firm projects: Lessons from Olkiluoto 3 and Flamanville 3 nuclear power plant projects.](#)” In: *International Journal of Project Management* 29.6 (2011), pp. 647–660 (cit. on p. 12).
- (Sampson, 2002) R. C. Sampson. *Experience, Learning & Collaborative Returns in R&D Alliances*. en. SSRN Scholarly Paper ID 309944. Rochester, NY: Social Science Research Network, Apr. 2002 (cit. on p. 91).
- (Santos, 1999) J. R. A. Santos. “Cronbach’s alpha: A tool for assessing the reliability of scales.” In: *Journal of extension* 37.2 (1999), pp. 1–5 (cit. on pp. 47, 74).
- (Sarker et al., 2005) S. Sarker, D. Nicholson, and K. D. Joshi. “Knowledge transfer in virtual systems development teams: An exploratory study of four key enablers.” In: *IEEE transactions on professional communication* 48.2 (2005), pp. 201–218 (cit. on p. 88).

-
- (Savelsbergh et al., 2016) C. M. Savelsbergh, L. A. Havermans, and P. Storm. “Development paths of project managers: What and how do project managers learn from their experiences?” In: *International Journal of Project Management* 34.4 (2016), pp. 559–569 (cit. on pp. 68, 134).
- (Schneider et al., 2013) S. Schneider and P. Spieth. “BUSINESS MODEL INNOVATION: TOWARDS AN INTEGRATED FUTURE RESEARCH AGENDA.” In: *International Journal of Innovation Management (ijim)* 17.01 (2013), pp. 1–34 (cit. on p. 10).
- (Schumpeter, 1939) J. Schumpeter. *Business Cycles: a Theoretical, Historical and Statistical Analysis of the Capitalist Process*. McGraw-Hill, New York, 1939 (cit. on p. 10).
- (Seufert et al., 2003) A. Seufert, A. Back, and G. von Krogh. “Unleashing the power of networks for knowledge management: putting knowledge networks into action.” In: *Knowledge management and networked environments: leveraging intellectual capital in virtual business communities*. 2003, pp. 99–136 (cit. on p. 19).
- (Shahmehr et al., 2015) F. S. Shahmehr, S. M. S. Khaksar, R. Zaefarian, and K. Talebi. “How relational embeddedness affects business performance through trust: empirical research on emerging SMEs.” In: *International Journal of Entrepreneurship and Small Business* 26.1 (2015), pp. 61–77 (cit. on p. 41).
- (Shenhar et al., 2016) A. J. Shenhar, V. Holzmann, B. Melamed, and Y. Zhao. “The Challenge of Innovation in Highly Complex Projects: What Can We Learn from Boeing’s Dreamliner Experience?” In: *PROJECT MANAGEMENT JOURNAL* 47.2, SI (APR-MAY 2016), 62–78 (cit. on p. 12).
- (Shevtshenko et al., 2015) E. Shevtshenko, I. Poljantchikov, K. Mahmooda, T. Kangilasski, and A. Norta. “Collaborative project management framework for partner network initiation.” In: *Procedia Engineering* 100 (2015), pp. 159–168 (cit. on p. 25).
- (A. Singh et al., 2016) A. Singh and J. T. Teng. “Enhancing supply chain outcomes through Information Technology and Trust.” In: *Computers in human behavior* 54 (2016), pp. 290–300 (cit. on p. 41).
- (S. K. Singh et al., 2021) S. K. Singh, S. Gupta, D. Busso, and S. Kamboj. “Top management knowledge value, knowledge sharing practices, open innovation and organizational performance.” In: *Journal of Business Research* 128 (2021), pp. 788–798 (cit. on p. 20).
- (Slaughter, 1998) E. Slaughter. “Models of Construction Innovation.” In: *Journal of Construction Engineering and Management* 124.3 (1998), pp. 226–231 (cit. on p. 10).
- (Son et al., 2011) J. Son and E. M. Rojas. “Evolution of collaboration in temporary project teams: An agent-based modeling and simulation approach.” In: *Journal of construction engineering and management* 137.8 (2011), pp. 619–628 (cit. on p. 11).
- (Sousa et al., 2012) F. Sousa, R. Pellissier, and I. P. Monteiro. “Creativity, innovation and collaborative organizations.” In: *The International Journal of Organizational Innovation* 5.1 (2012), pp. 26–64 (cit. on p. 32).
- (Sridharan et al., 2013) R. Sridharan and T. M. Simatupang. “Power and trust in supply chain collaboration.” In: *International journal of value chain management* 7.1 (2013), pp. 76–96 (cit. on pp. 35, 40).
- (Stuart, 1998) T. E. Stuart. “Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry.” In: *Administrative science quarterly* (1998), pp. 668–698 (cit. on p. 88).
- (Sunardi et al., 2015) O. Sunardi, J. H. Tjakraatmadja, and Y. R. Bangun. “Human capital traits and informal knowledge sharing: the role of reciprocity norm, mutual trust, and cultural interpretation perspective.” In: *International Journal of Knowledge Management Studies* 6.2 (2015), pp. 123–135 (cit. on pp. 19, 34, 35, 41, 92).
- (Tehseen et al., 2017) S. Tehseen, T. Ramayah, S. Sajilan, et al. “Testing and controlling for common method variance: A review of available methods.” In: *Journal of Management Sciences* 4.2 (2017), pp. 142–168 (cit. on p. 47).

- (Tenera et al., 2019) A. Tenera and J. Rosas. “Collaborative Networks Management from a Theory of Constraints Perspective.” In: *20th Working Conference on Virtual Enterprises (PRO-VE)*. Ed. by L. M. Camarinha-Matos, H. Afsarmanesh, and D. Antonelli. Vol. AICT-568. Collaborative Networks and Digital Transformation. Part 7: Collaborative Business Ecosystems and Processes. Turin, Italy: Springer International Publishing, Sept. 2019, pp. 271–282 (cit. on pp. 91, 96).
- (Tepic et al., 2013) M. Tepic, R. Kemp, S. Omta, and F. Fortuin. “Complexities in innovation management in companies from the European industry. A path model of innovation project performance determinants.” English. In: *European Journal of Innovation Management* 16.4 (2013), pp. 517–550 (cit. on p. 12).
- (Thaler, 1980) R. Thaler. “Toward a positive theory of consumer choice.” In: *Journal of Economic Behavior & Organization* 1.1 (1980), pp. 39–60 (cit. on pp. 68, 134).
- (Thamhain, 2013) H. Thamhain. “Managing Risks in Complex Projects.” In: *Project Management Journal* 44.2 (2013), pp. 20–35. eprint: <https://doi.org/10.1002/pmj.21325> (cit. on p. 15).
- (Thompson, 2010) P. Thompson. “Chapter 10 - Learning by Doing.” In: *Handbook of The Economics of Innovation, Vol. 1*. Ed. by B. H. Hall and N. Rosenberg. Vol. 1. Handbook of the Economics of Innovation. North-Holland, 2010, pp. 429–476 (cit. on p. 67).
- (Tidd et al., 2001) J. Tidd, J. Bessant, and K. Pavitt. *Managing Innovation: Integrating technological, market and organizational change. 2nd Edition*. English. John Wiley, 2001 (cit. on p. 10).
- (Todeva et al., 2005) E. Todeva and D. Knoke. “Strategic alliances and models of collaboration.” In: *Management decision* 43.1 (2005), pp. 123–148 (cit. on pp. 14, 25).
- (Todorović et al., 2015) M. L. Todorović, D. Č. Petrović, M. M. Mihić, V. L. Obradović, and S. D. Bushuyev. “Project success analysis framework: A knowledge-based approach in project management.” In: *International Journal of Project Management* 33.4 (2015), pp. 772–783 (cit. on p. 31).
- (Trimi et al., 2012) S. Trimi and J. Berbegal-Mirabent. “Business model innovation in entrepreneurship.” In: *International Entrepreneurship and Management Journal* 8.4 (2012), pp. 449–465 (cit. on p. 33).
- (Unterhitzenberger et al., 2019) C. Unterhitzenberger and D. J. Bryde. “Organizational justice, project performance, and the mediating effects of key success factors.” In: *Project Management Journal* 50.1 (2019), pp. 57–70 (cit. on p. 31).
- (Urgilés et al., 2019) P. Urgilés, J. Claver, and M. A. Sebastián. “Methods for quantitative risks analysis of cost and deadline overruns in complex projects.” In: *Procedia Manufacturing* 41 (2019). 8th Manufacturing Engineering Society International Conference, MESIC 2019, 19-21 June 2019, Madrid, Spain, pp. 658–665 (cit. on p. 10).
- (Uwizeyemungu et al., 2018) S. Uwizeyemungu, L. Raymond, P. Poba-Nzaou, and J. St-Pierre. “The complementarity of IT and HRM capabilities for competitive performance: a configurational analysis of manufacturing and industrial service SMEs.” In: *Enterprise Information Systems* 12.10 (2018), pp. 1336–1358 (cit. on pp. 93, 96).
- (Vaez-Alaei et al., 2021) M. Vaez-Alaei, I. Deniaud, F. Marmier, D. Gourc, and R. Cowan. “A partner selection framework for strategic alliances based on project complexity and partner’s past experience.” In: *Enterprise Information Systems* (2021), pp. 1–25 (cit. on pp. 36, 87).
- (Vaez-Alaei et al., 2019) M. Vaez-Alaei, I. Deniaud, F. Marmier, D. Gourc, and R. Cowan. “A decision-making framework based on knowledge criteria for network partner selection.” In: *2019 International Conference on Industrial Engineering and Systems Management (IESM)*. IEEE. 2019, pp. 1–6 (cit. on pp. 36, 89, 92).

-
- (Van Der Westhuizen et al., 2005) D. Van Der Westhuizen and E. P. Fitzgerald. “Defining and measuring project success.” In: *Proceedings of the European Conference on IS Management, Leadership and Governance 2005*. Academic Conferences Limited. 2005, pp. 157–163 (cit. on p. 31).
- (Vereijssen et al., 2017) J. Vereijssen, M. Srinivasan, S. Dirks, S. Fielke, C. Jongmans, N. Agnew, L. Klerkx, I. Pinxterhuis, J. Moore, P. Edwards, et al. “Addressing complex challenges using a co-innovation approach: Lessons from five case studies in the New Zealand primary sector.” In: *Outlook on Agriculture* 46.2 (2017), pp. 108–116 (cit. on p. 33).
- (Vidal et al., 2008) L.-A. Vidal and F. Marle. “[Understanding project complexity: implications on project management](#).” In: *Kybernetes* 37.8 (2008), pp. 1094–1110 (cit. on pp. 33, 34, 92).
- (Walker et al., 2016) D. Walker and B. Lloyd-Walker. “[Understanding Collaboration in Integrated Forms of Project Delivery by Taking a Risk-Uncertainty Based Perspective](#).” In: *ADMINISTRATIVE SCIENCES* 6.3 (SEP 2016) (cit. on p. 17).
- (Wang et al., 2019) D. Wang, H. Fu, and S. Fang. “The Relationship Between Relational Quality and Megaproject Success: The Moderating Role of Incentives.” In: *Engineering Management Journal* (2019), pp. 1–13 (cit. on pp. 31, 35, 41, 42, 71).
- (Wayne W, 2008). “[Spearman Rank Correlation Coefficient](#).” In: *The Concise Encyclopedia of Statistics*. Ed. by D. Wayne W. New York, NY: Springer New York, 2008, pp. 502–505 (cit. on p. 71).
- (G. Wilson et al., 2007) G. Wilson and H. Johnson. “Knowledge, learning and practice in North–South practitioner-to-practitioner municipal partnerships.” In: *Local government studies* 33.2 (2007), pp. 253–269 (cit. on p. 36).
- (K. B. Wilson et al., 2018) K. B. Wilson, V. Bhakoo, and D. Samson. “Crowdsourcing: A contemporary form of project management with linkages to open innovation and novel operations.” In: *International Journal of Operations & Production Management* (2018) (cit. on p. 19).
- (P. L.-K. Wong et al., 2002) P. L.-K. Wong and P. Ellis. “Social ties and partner identification in Sino-Hong Kong international joint ventures.” In: *Journal of International business studies* 33.2 (2002), pp. 267–289 (cit. on p. 89).
- (P. S.-P. Wong et al., 2004) P. S.-P. Wong and S.-O. Cheung. “Trust in construction partnering: views from parties of the partnering dance.” In: *International Journal of Project Management* 22.6 (2004), pp. 437–446 (cit. on pp. 88, 95).
- (Wu et al., 2010) J.-J. Wu, Y.-H. Chen, and Y.-S. Chung. “Trust factors influencing virtual community members: A study of transaction communities.” In: *Journal of Business Research* 63.9-10 (2010), pp. 1025–1032 (cit. on pp. 40, 93).
- (Q. Xu et al., 2008) Q. Xu and Q. Ma. “Determinants of ERP implementation knowledge transfer.” In: *Information & Management* 45.8 (2008), pp. 528–539 (cit. on pp. 30, 88, 133).
- (Z. Xu et al., 2014) Z. Xu, J. Yu, and H. Li. “[Analyzing Integrated Cost-Schedule Risk for Complex Product Systems R&D Projects](#).” In: *JOURNAL OF APPLIED MATHEMATICS* (2014) (cit. on p. 17).
- (Xue et al., 2018) X. Xue, R. Zhang, L. Wang, H. Fan, R. J. Yang, and J. Dai. “[Collaborative innovation in construction project: A social network perspective](#).” In: *KSCE Journal of Civil Engineering* 22.2 (2018), pp. 417–427 (cit. on p. 10).
- (Yao et al., 2013) Z. Yao, Z. Yang, G. J. Fisher, C. Ma, and E. E. Fang. “[Knowledge complementarity, knowledge absorption effectiveness, and new product performance: The exploration of international joint ventures in China](#).” In: *International Business Review* 22.1 (2013), pp. 216–227 (cit. on pp. 93, 95).

- (Yayavaram et al., 2015) S. Yayavaram and W.-R. Chen. “Changes in firm knowledge couplings and firm innovation performance: The moderating role of technological complexity.” In: *Strategic Management Journal* 36.3 (2015), pp. 377–396 (cit. on p. 34).
- (Yeong et al., 2010) A. Yeong and T. T. Lim. “Integrating knowledge management with project management for project success.” In: *Journal of Project, Program & Portfolio Management* 1.2 (2010), pp. 8–19 (cit. on p. 20).
- (Yi et al., 2021) C. Yi, J. Zhang, Y. Zhan, X. Yan, and C. Chen. “Internationalization speed and subsidiary survival of EMNCs: The moderating roles of CEO international experience and state ownership.” In: *Journal of Asian Economics* (2021), p. 101340 (cit. on p. 67).
- (Yuan et al., 2018) Y. Yuan, B. Feng, F. Lai, and B. J. Collins. “The role of trust, commitment, and learning orientation on logistic service effectiveness.” In: *Journal of Business Research* 93 (2018), pp. 37–50 (cit. on p. 41).
- (Yun et al., 2008) C. Yun and T. Wei. “The Model of Risk Allocation in BOT Expressway Project.” In: *2008 International Conference on Information Management, Innovation Management and Industrial Engineering*. Vol. 3. 2008, pp. 283–286 (cit. on p. 17).
- (Zar, 2014) J. H. Zar. “Spearman Rank Correlation: Overview.” In: *Wiley StatsRef: Statistics Reference Online*. American Cancer Society, 2014. eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781118445112.stat05964> (cit. on p. 73).
- (Zveglic et al., 2019) J. E. Zveglic, Y. van der Meulen Rodgers, and E. A. Laviña. “Expected work experience and the gender wage gap: A new human capital measure.” In: *Economic Modelling* 83 (2019), pp. 372–383 (cit. on p. 84).

Résumé

Analyse des facteurs favorisant l'innovation et la réussite des projets complexes afin de proposer un cadre de sélection des partenaires

Les pressions concurrentielles et le besoin d'innovation façonnent les partenariats stratégiques. Ces partenariats partagent des connaissances, collaborent à des activités de projet et prennent des décisions conjointes pour atteindre des objectifs de projet complexes. Cependant, dans les alliances, l'une des difficultés est de parvenir à une collaboration efficace : une mauvaise communication, des ressources et des compétences manquantes et un manque de confiance génèrent un risque. Pour diminuer ce risque, et pour surmonter une inefficacité de la collaboration, la sélection des partenaires doit se faire parmi des entreprises capables de se faire confiance et de bien communiquer tout en ayant les connaissances requises pour atteindre leurs objectifs. Cette thèse propose un nouveau modèle conceptuel basé sur des hypothèses extraites de la revue de la littérature. Elle étudie d'abord l'effet de différents critères de connaissance sur la confiance entre partenaires puis l'effet de la confiance sur l'innovation du projet. Nous avons également considéré le rôle de la complexité du projet dans l'innovation du projet. Une enquête réalisée auprès de gestionnaires de projets européens complexes, réalisés en partenariats, a permis d'analyser le modèle que nous proposons. La modélisation des équations structurelles par les moindres carrés partiels (PLS-SEM) est utilisée pour analyser le modèle structurel proposé. Ensuite, la corrélation entre l'expérience professionnelle des chefs de projet et leur opinion sur le succès d'un projet complexe est analysée. Enfin, compte tenu des résultats de nos analyses et d'un examen plus approfondi de la recherche sur la sélection des partenaires, nous proposons un nouveau cadre permettant d'aider les décideurs à sélectionner les partenaires dans la formation d'alliances. Ce cadre présente également des possibilités d'études futures.

MOTS-CLÉS : Partenariat, Alliance stratégique, Projet complexe, Innovation, Confiance, Sélection de partenaires

Abstract

Analysis of the factors that increase innovation and success in complex projects to propose a partner selection framework

Competitive pressures and the need for innovation are shaping strategic partnerships. These partnerships share knowledge, collaborate in project activities, and make joint decisions to achieve complex project objectives. However, in alliances one of the difficulties is achieving effective collaboration: miscommunication, missing skills, missing resources, and lack of trust create a high risk of failure. To decrease this risk, and to overcome potential collaboration inefficiency, partner selection must take place among firms that are able to trust each other and communicate well while at the same time having the required knowledge to achieve their objectives. This thesis proposes a new conceptual model based on hypotheses extracted from the literature review, to investigate first the effect of different knowledge criteria on trust between partners and second the effect of trust on project innovation. We also considered the role of project complexity in project innovation. We analyzed our suggested model using a survey filled by managers of European complex projects conducted with partnerships. Partial Least Squares Structural Equation Modeling (PLS-SEM) is used to analyze the proposed structural model. Then, the correlation between project managers' work experience and their opinion about the success of a complex project is analyzed. Finally considering the result of our analyses and through a deeper look at the partner selection research, a novel framework is proposed that could help decision-makers of partner selection in alliance formation. The framework also presents potentials for future studies.

KEYWORDS: Partnership, Strategic alliance, Complex project, Innovation, Trust, Partner selection