The Impact of Contractual Language and Trust on the Successful Conduct of BIM-Enabled Projects

by

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In honor of my mother, whose extraordinary and inspiring spirit has always shed light on my life as if I have never lost her; May Rest in Peace.

And to all the suppressed voices in my country who deserve to be heard.

L'impact du Langage Contractuel et de la Confiance Sur la Réussite des Projets BIM

Sarah MAHBOD

RÉSUMÉ

La complexité sans cesse croissante de l'industrie AEC nécessite un environnement collaboratif pour la mise en œuvre efficace des projets de construction. La modélisation des informations du bâtiment (BIM), avec sa nature coopérative, a déplacé les transactions de construction fragmentées vers le partage d'informations, les objectifs communs et la communication entre les parties prenantes. Cependant, l'adoption du BIM n'a pas gagné sa place décente. Cela est principalement dû aux obstacles dans la mise en œuvre du BIM, y compris ses aspects juridiques. Diverses annexes BIM existantes ne répondent pas aux attentes. D'autre part, la confiance en tant que mécanisme complémentaire joue un rôle central dans les processus BIM. Alors que des études antérieures ont étudié les barrières juridiques du BIM et le rôle de la confiance, l'importance des fonctions contractuelles par rapport au langage contractuel et aux éléments de confiance dans l'amélioration de l'efficacité des contrats et le succès de la mise en œuvre du BIM est restée discutable. Cette étude vise donc à étudier les fonctions contractuelles, leur instanciation dans le langage contractuel et la confiance BIM, et leur impact potentiel sur la réussite des projets BIM. L'étude des mécanismes contractuels actuels et de leurs limites au Canada est un autre objectif de recherche. De plus, cette étude propose un cadre conceptuel de contractualisation. Pour atteindre ces objectifs, une approche d'analyse de contenu a été appliquée, au cours de laquelle un système de codage a été développé. Les données recueillies à partir d'une revue de la littérature et d'entretiens semi-structurés avec des professionnels du BIM ont été analysées pour identifier les éléments de réussite des projets ainsi que les problèmes juridiques liés au BIM et les facteurs de confiance. Selon les résultats, certaines recommandations pour modifier le langage contractuel des ententes de construction ont été présentées. De plus, un cadre conceptuel de confiance a été proposé, qui a ensuite été utilisé pour fournir un cadre contractuel. De plus, les résultats de l'exploration des CCDC et des annexes BIM ont mis en évidence certaines lacunes concernant les aspects juridiques du BIM. Par conséquent, des suggestions pour introduire le BIM dans les CCDC et pour mettre à jour le contrat IBC ont été fournies. Alors que la fiabilité du système de codage a été testée par un validateur, d'autres études pourraient valider le cadre de confiance et le cadre contractuel mis en avant par cette recherche.

Mots-clés : Building Information Modeling (BIM), Langage contractuel, Confiance, Enjeux juridiques

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ABSTRACT

The ever-increasing complexity of the AEC industry requires a collaborative environment for the efficient implementation of construction projects. Building Information Modeling (BIM), with its cooperative nature, has shifted the fragmented construction transactions to information sharing, common goals, and communication between the stakeholders. However, BIM adoption has not gained its decent place. It is primarily due to the barriers in BIM implementation, including its legal aspects. Various existing BIM appendixes do not satisfy the expectations. On the other hand, trust as a complementary mechanism plays a pivotal role in the BIM processes. While previous studies have investigated legal BIM barriers and the role of trust, the importance of contractual functions in relation to contractual language and trust elements in improving the efficiency of contracts and the success of BIM implementation has remained debatable. This study, therefore, aims at studying contractual functions, their instantiation within BIM contractual language and trust, and their potential impact on BIM projects' success. Investigation of current contractual mechanisms and their limitations in Canada is another research objective. Moreover, this study proposes a conceptual contracting framework. To achieve these objectives, a content analysis approach was applied, during which a coding system was developed. The data collected from literature review and semi-structured interviews with BIM professionals were analyzed to identify the success elements of projects as well as BIM-related legal issues and trust-building factors. According to the results, some recommendations to amend the contractual language of construction agreements were presented. Moreover, a conceptual trust framework was proposed, which then was utilized to provide a contractual framework. Furthermore, the outcomes of exploring CCDCs and BIM appendixes depicted some gaps regarding the BIM legal aspects. Therefore, suggestions to introduce BIM into the CCDCs and to update the IBC contract were provided. While the reliability of the coding system was tested by a validator, further studies could validate the trust framework and the contractual framework put forward by this research.

Keywords: Building Information Modeling (BIM), Contractual language, Trust, Legal issues

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LIST OF ABBREVIATIONS

CCDC	Canadian Construction Documents Committee
ACEC	Association of Consulting Engineering Companies
RAIC	Architecture Institute of Canada
BIM	Building Information Modeling
BEP	BIM Execution Plan
IPR	Intellectual Property Rights
IPD	Integrated Project Delivery
AEC	Architect Engineer Construction
CC	Construction Company
LF	Law Firm

INTRODUCTION

The construction industry has a reputation for always facing risks and uncertainties. In dealing with such risks and uncertainties, individuals and organizations typically take advantage of both formal structures, such as hierarchies, regulations, and contracts, and informal structures, such as communication, norms, and trust (Malhotra & Murnighan, 2002). Among all formal approaches, contracts are the most prevalent. The description of an appropriate construction contracting system, which fits the characteristics and goals of a project, is considered the first and foremost means to appropriately allocate risks, responsibilities, duties, and rights between all the stakeholders involved (De Marco, 2018). The numerous benefits of contracts include facilitating exchanges by reducing uncertainty, allocating risk, improving control, and mitigating agency problems (Malhotra & Murnighan, 2002).

Meanwhile, relying solely on the contract, even if it contains clear clauses, cannot warranty a project's success. As the quality of the relationship between all the stakeholders in a project is paramount, researchers argue that trust plays a significant role in comprehending the social mechanisms behind collaboration among parties (Zhang, 2016). Trust – a belief that someone is reliable and honest- is a determining factor in the success of a project (Jiang, Lu, & Le, 2016). In construction projects, in which collaboration between stakeholders is vital to carrying out tasks that require multi parties involvement, successful trust-building would boost projects' outcomes (Wong, Cheung, Yiu, & Pang, 2008). It is imaginable that a lack of trust can lead to projects' failure. The problem is that the construction industry has a poor record of trust due to the uncertainty and fragmentation of the construction process (Li, He, Li, Liu, & Qi, 2019). Thus, the need for developing trust within construction projects is essential.

As two effective mechanisms in achieving a project's goals, contract and trust, have caused much debate among scholars. Some believe that contracts with their controlling potential may diminish trust, while others hold the opposite view. These discrepancies in the studies might exist due to the ignorance of different contractual functions of an agreement namely safeguarding, controlling, and contingency adaptability. Each of these contractual functions can influence trust differently.

On the other hand, Building Information Modeling (BIM) has been widely acknowledged by the AEC industry. Adopting BIM is fast-paced nowadays due to its benefits, such as improved efficiency, opportunities to enhance collaboration, better visualization, and integration of conflict resolution (Fountain & Langar, 2018). Successful implementation of BIM is helping the industry move from traditional project delivery systems to integrated ones. This transition, however, requires reliable and concrete contractual mechanisms to provide guidance and structure. Risk allocation, role definition, and legal dimensions have been achieved through a series of contractual functions such as control, coordination, and contingency.

Although, many BIM protocols and agreements have been designed and published by various organizations such as Document E203 (AIA, 2013), Building Information Modeling addendum (ConsensusDocs, 2015), CIC BIM Protocol (CIC/BIM Pro, 2013), Complex Construction Contracts (CIOB, 2013), and Institute for BIM in Canada (IBC 100, 2014), the actual use of these protocols remains low (Fan, Chong, Liao, & Lee, 2019). In fact, instead of applying such BIM specific contracts as an addendum to the main agreement, parties opt for a standard document such as the Canadian Construction Documents Committee (CCDC) and add their specifications to that or even design customized contracts. It might be due to the uncertainty regarding legal issues that BIM may bring, which a concrete contract should generally avoid.

While past scientific publications have investigated the impact of contracts on the conduct of BIM projects and vice-versa, questions remain as to how the contractual functions (controlling, coordinating, contingency), interact with BIM requirements and legal issues. Moreover, the contractual language of such non-BIM-specific instruments may not well cover the legal aspects of BIM-enabled projects, and thus requires further investigation. In addition, the influence of contractual functions in developing trust in BIM projects has remained unstudied. Therefore, the objectives of this research are:

- To study contractual functions, their instantiation within BIM contractual language and their potential impact on BIM projects' success;
- To determine how trust among BIM-enabled project's stakeholders can be developed through contractual functions;
- To propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes;
- To investigate current contractual mechanisms and their limitations in Canada.

To achieve the research objectives above, a content analysis approach was applied as a qualitative research methodology. Data collection was accomplished through an in-depth literature review coupled with semi-structured interviews with lawyers and constructions professionals. A coding framework was then developed using NVivo 12 to analyze the data collected in the two-step data gathering process.

This report is organized into five chapters. It starts with the literature review, in which current knowledge of BIM agreements, their contractual language, and legal issues as well as trust-building elements are presented. The second chapter explains the methodology used in detail as to how the interviews were designed and performed, and how the coding system was developed. Chapter three, has been assigned to data analysis, explaining the codes identified in two dimensions: contractual language (including contractual elements of project success and BIM-related legal issues) and trust. Then a thick description of each code is put forward. Furthermore, a conceptual framework for trust in construction projects is presented. Moreover, CCDC contracts and BIM appendixes are analyzed regarding BIM legal issues. This chapter ends with proposing a contractual framework. Section four, contains the discussion as to how the findings can address the research objectives. The conclusion will be the last part of the study.

CHAPTER 1

LITERATURE REVIEW

In this chapter, past research is explored in three sections. Firstly, construction contracts with their different functions, complexity, and completeness will be presented. Moreover, various delivery systems with their respective Canadian construction contracts are included. Then, the application of BIM, its contractual documents, and legal issues will be put forward. Lastly, trust in construction contracts, trust frameworks, and trust elements will be discussed.

1.1 Construction Contracts

This section will review the definition and roles of agreements. Moreover, different contractual functions of provisions and their influence on the complexity and completeness of contracts will be explained. Then various delivery systems with their pertinent standard contracts are presented.

1.1.1 Contract's definition and roles

Contracts acknowledged as legal documents, specify the rights of projects' stakeholders, as well as their responsibilities. Such agreements define various issues, including cost, time, quality, and safety in projects. Moreover, they clarify issues relevant to responsibility and/or authority management, the information exchange schedule, and the final product (Alves & Shah, 2018). Contracts also play a vital role in risk allocation between parties and defining obligations to ensure stakeholders that the other party meets their expectations (Salbu, 1997).

In this regard, previous studies have suggested two different perspectives toward the relationship between parties. One class considers the formal contracts as a safeguard against the possibility of opportunism and conflict (Lumineau, 2017). With this approach, parties usually rely on the terms of the agreement about rights, obligations against breaches, and communication channels (Shi, Chen, You, & Yao, 2018).

However, others have instead focused on trust as another relational governance mechanism parallel to contracts (Lumineau, 2017). Trust promotes cooperation between parties, reduces ex-post transaction costs[1], improves relationship value, increases satisfaction, and assists in achieving required performance (Shi et al., 2018).

1.1.2 Types of contracts and realization modes

A contract is the reflection of the realization mode, which is chosen for the project; it is in a relation to the mode and specifies the requirements, roles and responsibilities depending on the selected mode. Therefore, there are two types of contracts for realization modes, in terms of the sequence between the construction processes in projects. Traditional contracts also known as transactional types involve a linear sequential from design to construction. The separation of design and construction processes, brings about some issues, including lack of contractor's influence in design decisions and failure of designers to consider the construction requirements, which may lead to delays and disputes (Mohd Nawi, Baluch, & Yusni Bahauddin, 2014). Moreover, Forgues and Koskela (2009), state that in a transaction, the seller delivers a certain outcome for an agreed price. The seller shoulders the risks and responsibilities of the results with no incentive for collaboration with other parties (Forgues & Koskela, 2009). Therefore, how to incorporate knowledge and construction requirements at the early stage of the project is essential and leads to better project performance (Mohd Nawi et al., 2014).

On the other hand, the collaborative delivery method or relational arrangement is another type of contract (Alves & Shah, 2018). Relational contracting is based on recognition for mutual benefits between stakeholders. This type of contract is usually long-term and involves substantial relationships between parties (Forgues & Koskela, 2009). According to Willis and da Alves (2020), contractual language in different delivery systems can impact the level of

[1] Ex-post construction costs include costs after signing the contract, but before the completion of the project, such as cost of governance and disputes (Guo, Li, Li, & Zhang, 2016)

collaboration in projects. Thus, owners are advised to carefully define the language of their contracts.

1.1.3 Contractual functions

Contractual provisions can include multiple functions (Lee, Chong, & Wang, 2018). An effective agreement includes provisions to clarify various dimensions in a transaction so that parties will accomplish their duties in tune with the other party's expectations (Salbu, 1997). Many researchers have mentioned safeguarding, coordination, and contingency adaptability as provisions' functions (e.g., Mellewigt, Decker, & Eckhard, 2012; Lee et al., 2018).

According to the safeguarding provisions, contracts can be applied to sanction a party if they fail in performing their legal responsibilities. They also define what is allowed and what is disallowed, formalize performance, and monitor the stakeholder's behavior (Lee et al., 2018). These provisions also set penalties and binding terms (Zhang, 2016). Moreover, when the uncertainties and complexity of agreements proliferate, more sophisticated contracts might be required, which could be designed by using safeguarding provisions (Lee et al., 2018). Safeguarding clauses deal with issues such as intellectual property rights, confidentiality, service scope and performance guarantees, early termination, and dispute resolution (Mellewigt et al., 2012).

Meanwhile, protecting the stakeholders' benefits is merely one aspect of contracts (Zhang, 2016). The coordination function is another element that defines each party's roles in increasing the collaboration level and decreasing the misinterpretation risk (Salbu, 1997). Contracts play a crucial role in decreasing coordination concerns through planning the collaboration and defining stakeholder's mutual expectations (Mellewigt et al., 2012). Due to uncertainties in complex projects, stakeholders may not predict all the contingencies. In such cases, coordination clauses provide the required flexibility in dealing with those situations (Zhang, 2016). This contractual dimension establishes information sharing and communication in order to facilitate goal achievement (Lumineau, 2017). Coordination clauses attempt to provide a collective understanding of objectives and the process of gaining them (Lumineau,

2017). These clauses define responsibilities and tasks, interfaces for partner interaction, reporting procedures, project schedules, and milestones (Mellewigt et al., 2012). Safeguarding and coordination functions are used to justify incentives and illuminate partners' responsibilities before signing the agreement (Mellewigt et al., 2012).

Contingency adaptability is another framework providing guidelines in adaptation to uncertainties that are likely to happen during the collaboration process (Lee et al., 2018). This dimension can be addressed through mutually agreed actions for dealing with unexpected situations or can act as procedures and guidelines as to how parties can handle certain circumstances or overcome conflicts (Mellewigt et al., 2012). For instance, provisions, pertinent to procedure changes and adjustments for price fluctuation, are contingency elements (Mellewigt et al., 2012).

1.1.4 Contractual Complexity

Contractual complexity is defined as the number, elaborateness, and stringency of provisions in a contract (Mellewigt et al., 2012). Lumineau (2017) argues that the level of complexity (relatively low or relatively high) should be based on the nature of the relationship. Some contracts need to have more controlling provisions because of the complexity of the transaction and the need to protect certain investments.

Shi et al. (2018) mention that a complex contract defines a set of standard behavior for contractors by carefully clarifying the contractor's rights and responsibilities. The influence of contractual complexity on contracts has been widely studied; however, there are controversial debates on the outcomes. Mellewigt et al. (2012) state that these differences might be due to ignoring the contractual functions and their impact on the contracts.

1.1.5 Contractual Completeness

Mellewigt et al. (2012) point out that a contract is complete when there is no possibility to elevate its efficiency by an ex-post action. However, it may not be rational to expect a fully complete contract as stakeholders cannot anticipate all the uncertainties.

Wang, Chen, Fu, and Zhang (2017) mention that contracts are more complete or detailed when firms have been involved in prior partnerships. On the other hand, other studies clarify that previous alliance makes room for less detailed contracts. The reason for these contradictory views is that previous studies have ignored different functions of contracts, including safeguarding, coordinating, and contingency (Mellewigt et al., 2012).

1.1.6 Construction Contracts and Delivery Systems

A project delivery option is defined as a method for procurement, by which the owner's risk of delivery and performance for design and construction, is transferred to another party (parties) (Mahdi & Alreshaid, 2005). Project delivery in the Design-Build Institute of America is defined as a holistic process, which includes planning, designing, and construction required to execute and complete a building facility or other types of projects. In most organizational forms, a delivery system is widely applied to facilitate building processes, and allocation of roles, jobs, and risks (Jamil & Fathi, 2019). Therefore, selecting a proper process for the successful implementation of the project is undeniably the most crucial decision for the owner, and comprises three areas to be considered thoroughly, including project delivery systems, procurement methods, and contract formats (Jamil & Fathi, 2019).

The owners must have sufficient knowledge of every choice due to their impact on contractual relationships, ownership, changes in the project, and cost. Thus, it is essential to select an option, which best meets all the stakeholders' requirements. In this regard, there are some considerations for the owner when embarking on a project, including control, relationship, budget, schedule, and risk.

Project delivery systems usually fall into some groups as follows. For each of these delivery systems, there is an attributable contract designed by the Canadian Construction Documents Committee, known as CCDC agreements. The targeted applicants of these contracts are owners and contractors. For contracting between owners and engineers, the Association of Consulting Engineering Companies (ACEC) offers another agreement. Moreover, the Royal Architecture Institute of Canada (RAIC) has issued a standard Canadian Contract Form for architecture

services. However, this research focuses on the CCDCs (2, 5, 14, 30) and the characteristics of BIM in different contractual procurement systems adopted in the industry.

1.1.6.1 DBB and CCDC 2

CCDC 2 (2008) called “Stipulated price”, is designed to be used for the Design-Bid-Built delivery system. The positive points of this approach are to promote the project quality and define roles and responsibilities clearly.

On the other hand, the longer duration of the project and the lack of relationship between designer, and contractor are considered its weaknesses (Mahdi & Alreshaid, 2005). The best application of this delivery system is when the owner is concerned with budget, timely completion, quality, and site safety. Furthermore, when project uncertainty exists primarily in the design, using DBB is recommended. BIM can offer parametric modeling, faster document generation, design coordination, and 4D/5D modeling in this type of delivery method.

However, this approach increases the competition aspect in the bidding process (Jamil & Fathi, 2019). Furthermore, as a transactional contract with a fragmented relationship between the stakeholders, DBB typically does not provide a proper setting to implement BIM.

1.1.6.2 Construction management and CCDC 5

CCDC 5B (2010) is published for construction management services. Among the benefits of this delivery method, faster process than DBB and earlier start of the construction process are worth mentioning. Applying BIM in this delivery system brings benefits such as sharing the model between different stakeholders, and including contractors and sub-contractors. Moreover, the BIM goals and expectations can be clearly defined.

1.1.6.3 Design-Build and CCDC 14

CCDC 14 (2013) is devised to be applied in the Design-Build (DB) projects. This delivery approach supports the fast track due to overlapping the design and construction processes. As a relational delivery system, DB could be well integrated with BIM. The required collaboration for BIM-enabled projects is met as a result of the relationship between all the parties. Despite

the transparency of data flow that this approach brings, there is no guarantee of flawless BIM transition from consultants to contractors or others (Jamil & Fathi, 2019).

1.1.6.4 Integrated Project Delivery (IPD) and CCDC 30

Integrated Project Delivery (IPD) refers to a contractual model where the owner, constructor, designer, and potentially others enter a single, multi-party contract. According to BIM Handbook (Sacks, Eastman, Lee, & Teicholz, 2018), the central concept of this delivery system is that the team members work together by applying the best collaborative tools to meet all the owner's requirements in a shorter time and lower cost. The early creation and agreement of the project's goals result in earlier project team engagement than other delivery methods. During the pre-design phase, the IPD team designates all the criteria bound under contract to deliver (CMAA, 2012).

BIM and IPD can change the traditionally linear and fragmented project delivery and lead to better results. The owner gains the main benefit of this combination if they understand the advantages and adopt this method. Moreover, the definition of Big Room is introduced by Sacks et al. (2018) as an expression of integrated organization comprising of IPD or other methods aiming at achieving well-integrated project information by applying BIM.

The relevant contract to this approach is CCDC 30 (2018). It is discussed by Jamil and Fathi (2019) that the implementation of BIM is the best fit for the IPD procurement method.

1.2 Building Information Modeling (BIM)

In this section, subjects such as the application of BIM, BIM contractual documents, and legal issues of BIM will be presented.

1.2.1 BIM application

Building Information Modeling (BIM) is among the most beneficial technologies in the construction industry. BIM is about the process of design, construction, and facility management (Sacks et al., 2018). Sacks et al. (2018) also suggest that BIM changes the way

buildings look, how they function, and the way they are built. BIM, which was previously called a "Technology", is now defined as a "Socio-Technical system" (Sacks et al., 2018), emphasizing further mutual communication, collaboration, and trust. However, Azouz et al. (2014), in their research-The BIM Utopia- argue that the goal of their article is challenging BIM. They emphasize that applying BIM-related technology without understanding the business model in AEC will, in contrast, increases the number of communications and consequently decrease the efficiency of BIM.

In the traditional AEC approach, communications are fragmented and vary; thus, the information flow is poor. Forgues and Koskela (2009) point out that the main problem is that transition to an integrated setting is attached to a fragmented approach in project management. For instance, implementations in temporary construction project networks like collaboration, communication, and sharing integrating information, are not relatively dealt with in that transition to BIM. If parties continue to conform to the traditional way of workflow, the BIM application does not fully support integrated project delivery (Azouz et al., 2014). Azouz et al. (2014) add that to elevate collaboration within organizational boundaries, we need more intense collaborative tasks and perhaps define new roles and responsibilities. They examine an organization as a case study using BIM for ten years through various departments. The results show that firstly, the use of BIM is more in the functional levels rather than managers, and secondly, BIM does not deliver its goal as a core of communication. In short, "effective use of BIM requires that changes be made to almost every aspect of a firm's business, not just doing the same things in a new way" (Sacks et al., 2018).

1.2.2 BIM Contractual Documents

Various organizations have created BIM contracts to be used as an addendum to the main agreements in BIM-enabled projects.

American Institute of Architects (AIA) published its addenda in two versions, namely E202 (2008) and E203 (AIA, 2013); however, these agreements are too architecture-based. Moreover, Associated General Contractors of America (AGC) crafted ConsensusDocs

(2015), which also includes the contractor's role. Design-Build Institute of America (DBIA) released Building Information Modeling Exhibit (E-BIMWD, 2010), which is designed based on the two previously mentioned addenda. Another contract is published by Construction Industry Council in the UK, which is known as CIC documents (CIC/BIM Pro, 2013). Finally, is the IBC 100 (2014) put forward by Institute for BIM in Canada. It is based on and derived from AIA Document E203-2013, Building Information and Digital Data Exhibit, and AIA Document G202-2013, Building Information Modeling Protocol Form. This appendix is created to be used with CCDC 2-2008, RAIC Six-2006, and ACEC 31-2009. These are called Principal Agreements, to which the IBC appendix is amended.

Another BIM-related document is BIM Execution Plan (BEP) as an additional document to the main agreements. It is based on the goals defined by the owner and team members in the contract. It is adapted for every project according to its requirements. Various forms of this guide are provided by different communities such as Penn State University, Autodesk, and AIA. However, the results of Jamil and Fathi's (2019) study indicate that one problem with the BIM Execution Plan is that it usually does not consider the fast-track requirements for different disciplines to coordinate with each other. The processes mentioned in the BIM Execution Plan usually are too theoretical, too general, and not adequately adapted to BIM projects (Jamil & Fathi, 2019).

Since the central aspect of BIM is generating, exchanging, and archiving information, standards such as ISO 19650 could be applied. This standard is becoming increasingly recognized for managing information over the whole project lifecycle using BIM. It contains all the same principles and high-level requirements as the UK BIM Framework and is closely aligned with the current UK 1192 standard. The key factors of ISO 19650, which are required to be clarified in the projects, include information delivery, responsible actors, and collaborative platform; however, often they are not properly acknowledged and applied by the stakeholders during the projects (Robitaille, Poirier, & Motamedi, 2021).

Despite various BIM contracts, the standard forms of agreements are merely being used as guidelines, and thus, they show poor performance, specifically regarding the BIM legal issues

(Jamil & Fathi, 2019). This study will investigate BIM agreements to identify their weaknesses.

1.2.3 BIM-related legal issues

The construction industry is moving toward BIM adoption due to its benefits, such as better modeling and design features, enhanced 3D rendering, and facilitation of team collaboration through a unique model. However, the slow adoption of BIM is related to several barriers, including technical problems, fragmentation of the project teams, resistance to change, lack of training, and business process-related issues (Alreshidi, Mourshed, & Rezgui, 2017). Alreshidi et al. (2017) add non-technical barriers, including people, culture, and processes. Legal issues are considered another barrier to the successful conduct of BIM projects.

Many scholars have studied the legal aspects of BIM. Jamil and Fathi (2019) state that the current law, regulations, and the contractual design suffer a lack of clauses for required integration and information flow among stakeholders to achieve the expected level of collaboration. Therefore, disputes will lead to legal implications in the BIM projects (Jamil & Fathi, 2019). Fan et al. (2019) classify the BIM legal aspects as contract structure and policy, contractual relationship and obligations, BIM model, and security. Alreshidi et al. (2017) identify the contractual and legal barriers of BIM as follows:

A) Contractual issues:

- Contractors benefit from confusion;
- BIM contracts are not yet mature;
- Lack of BIM-related aspects in current contracts;
- Failure to address BIM legal concerns in current contracts;
- Contracts need to accommodate changes in the BIM collaborative environment.

B) Legal issues

- BIM models' ownership, intellectual property, and copyright concerns;
- Unclear liability for wrong or incomplete data;
- Lack of legal considerations in existing BIM contracts;
- Lack of legal framework for adopting collaborative BIM.

Many scholars have studied BIM legal issues such as intellectual property, ownership, roles and responsibilities, and many others, which are crucial when working in a collaborative environment. Chong, Fan, Sutrisna, Hsieh, and Tsai (2017) emphasize that BIM brings about legal and contractual uncertainties such as allocation of responsibility and liability exposure, risks involved in sharing digital models, interoperability concerns, responsibility for the establishment and maintenance of networked file-sharing sites, and the way to address Intellectual Property Rights (IPR). Alreshidi et al. (2017) suggest that to overcome the legal issues, the agreements between the stakeholders should include clients' requirements, early team agreement, an overall legal framework for a BIM-based project, collaboration requirements, and governmental rules and regulations; they should enhance information sharing, improve trust, clarify ownership, and address IPR concerns.

In this research, BIM-related legal issues will be studied in depth in order to identify the most significant legal aspects in BIM-enabled projects.

1.3 Trust in construction projects

To investigate various aspects of trust, in this part, the definitions of trust, its elements as well as previously proposed frameworks, will be discussed. Moreover, the impact of trust on construction contracts is included.

1.3.1 General definitions of Trust

As Jiang et al. (2016) assert, the studies related to trust were initiated from social psychology in the 1950s. The American psychologist, Deutsch (1958) started research on interpersonal trust. Rousseau, Sitkin, Burt, and Camerer (1998) establish a definition for trust based

on those studies: "Trust is a psychological state involving the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another".

Das and Teng (1998) state that diverse definitions of trust exist. While some scholars argue that trust is one's belief and expectation about the possibility of performing the desirable action by the trustee, others consider it as one's assessment of others' goodwill and reliability (Das & Teng, 1998). One more narrow approach refers to trust as "positive expectations about another's motives concerning oneself in situations entailing risk" (Das & Teng, 1998). In addition, trust is the degree to which the trustor holds a positive attitude toward the trustee's goodwill and reliability in a risky exchange situation (Das & Teng, 1998).

Malhotra and Murnighan (2002) point out another definition that trust is "The willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party".

1.3.2 Trust and contracting

Trust is considered a critical factor in the relationship between the project's stakeholders by various scholars. It is alleged that trust reinforces the party's communication leading to the project's success (Rezvani, Khosravi, & Ashkanasy, 2018).

Since monitoring every detail in transactions is impossible, having a minimum trust in the other party is essential for the organizations (Das & Teng, 1998). However, some studies consider contracts as formal mechanisms to safeguard against opportunism and conflict (Lumineau, 2017). Since these two mechanisms-contract and trust- are often applied simultaneously by firms, there is a debate as to how contract and trust can influence each other (Lumineau, 2017). Some believe that a contract can reduce trust-related motivations and behavior (Lumineau, 2017), while others claim that a contract facilitates trust (Shen, Su, Zheng, & Zhuang, 2020). Malhotra and Murnighan (2002) argue that the reason for these divergent perspectives is the fact that prior research neglected different dimensions of contracts (control and coordinate) and forgot to examine the whole picture (Lumineau, 2017).

Regarding different functions of the contractual provisions, some researchers state that as the contract's goal is to specify the roles and relationships of the parties, developing trust, and promoting commitments within the coordinating clauses will consequently lead to increased cooperation. Other studies claim that contractual control signals distrust, which is detrimental to cooperation and brings about opportunistic behavior that the contract cannot specify (Wang et al., 2017). Lee et al. (2018) emphasize the destructive influence of opportunistic behavior on the stakeholders' relationship and trust. They also add that the stronger the controlling function is in the contract, the lower is trust between the parties.

Along with trust, Lumineau (2017) discusses distrust, and points out two different views toward these two phenomena. The unidimensional view considers trust and distrust as opposing ends of one continuum, while the bi-dimensional view believes that these two functions can vary separately. Lumineau (2017) studies the relations between trust and distrust with the controlling and coordinating functions of the contract. The controlling function, which focuses on defining the acceptable behavior in the relationships between stakeholders, and the penalties in case of breaches of contract, enables parties to make a more accurate assessment of the risks and payoffs. Thus, it improves the positive outcomes of trust; including creating confidence, decreasing uncertainties, fostering openness, encouraging knowledge sharing and joint problem solving, and reducing monitoring costs (Lumineau, 2017). However, a very strong emphasis on contractual control may foster the negative outcomes of distrust such as developing fear and skepticism, assumption of harmful motives, and increasing monitoring costs (Lumineau, 2017).

Moreover, coordination provisions can facilitate communication, and support the exchange of information through the specification of communication processes in the contract, for instance, frequency, relevance, and timeline of interactions. Therefore, such provisions strengthen the positive evaluation of the party’s faithfulness and enhance positive outcomes of trust (Lumineau, 2017). Meanwhile, since the coordinating clauses support communication channels, through which parties can resolve their disagreements, these provisions prevent misunderstandings about the intentions of partners. Accordingly, the coordinating function decreases the negative outcomes of distrust as well (Lumineau, 2017). However, Lumineau

(2017) points out that excessive coordination provisions with too much information sharing and confidence might increase the adverse outcomes of trust, as it may increase the risk of over-embedded relationships and an overlooking of evidence against the partner's trustworthiness. Thus, an adequate level of different contractual functions is required to improve the positive outcomes of trust and decrease the negative outcomes of distrust. It could be achieved through an appropriate level of risk allocation between the parties (Lee et al., 2018).

In this regard, Lee et al. (2018) add that trust does not necessarily provide benefits since it also has a dark side: excessive trust in a party. Trust would be beneficial up to a certain point, as too much trust would negatively affect the relationships between the parties (Lumineau, 2017). Extreme trust brings negative impacts, including 1) blind faith, which proliferates the risk of breaches, 2) excessive obligation for the relationships between parties and consuming resources without providing benefits, 3) passive actions in case of inadequate outcomes of communications (Lee et al., 2018). Therefore, Lee et al. (2018) discuss that optimal trust would decrease the information processing costs, higher satisfaction between the stakeholders, and a lower level of uncertainties in the exchanges.

On the other hand, Shen et al. (2020) allege that most previous studies considered contractual functions as a constant phenomenon during the project lifecycle; however, Shen et al. (2020) explore how the emphasis on different contractual functions would be related to stakeholders' trust in separate phases of their relationship. In addition, Das and Teng (1998) approach trust from the risk perspective and allege that risk is the core to trust. Scholars argue that trust is treated as a relevant criterion only in risky situations, and trust fundamentally means taking risks and being vulnerable to the actions of the other one (Das & Teng, 1998). Zhang (2016) also emphasizes that due to the high level of risky circumstances and uncertainty in the construction projects, there is immense importance in trust, and then he studies the influence of contract and trust on dispute negotiations.

Moreover, Laan, Voordijk, Noorderhaven, and Dewulf (2012) investigate the relation between tendering process and trust. The outcomes of their research revealed that the tender process

and delivery system do not affect trust from the client's perspective. However, for contractor organizations, nontraditional delivery systems bring about a higher level of trust.

Furthermore, unlike the studies related to leadership and organizations, Rezvani et al. (2018) focus on trust in the team. They add that specifically in large-scale construction projects, in which ambiguity and uncertainty, and interdependency have high levels, trust could act as a critical factor to increase the ability of team members to be exposed to the other party's actions, and to confide in teams to share information and greater cooperation.

1.3.3 Types of trust (Trust Frameworks)

Trust building is considered a requirement for a framework or an environment, in which trust can develop (Järvinen & Branders, 2020). Prior studies have identified various types of trust as follows:

- **Personal trust** involves an emotional bond between individuals (Williamson, 1981);
- **System trust** contains no emotions (Luhmann, 2018). It instead focuses on formalized and procedural arrangements (Wong et al., 2008). System-based trust develops as a result of effective organizational, communicational, and contractual strategies (Pishdad-Bozorgi & Beliveau, 2016);
- **Knowledge-based trust** occurs when we predict, specifically, that another party will behave cooperatively (Rousseau et al., 1998);
- **Identification-based trust** assumes that people in the same group behave trustworthy toward their team members rather than other people (Shapiro, Sheppard, & Cheraskin, 1992);
- **Deterrence-based trust** is introduced as a consideration that enables one party to believe that another will be trustworthy (Shapiro et al., 1992);
- **Contractual-based trust** arises from the explicit written or oral agreements that a party will stick to the contracts or initial understanding (Sako, 1992);
- **Competence-based trust** is based on the expectation that a party will perform its role competently (Sako, 1992);

- **Goodwill-based trust** is a less self-interested type of trust, in which there are no determined promises expected to be fulfilled (Sako, 1992);
- **Calculative trust** is based on rational choice, emerges when the trustor perceives that the trustee intends to perform a beneficial action (Rousseau et al., 1998);
- **Institutional trust** refers to the social and organizational context within which contracts are embedded (Williamson, 1981);
- **Cognition-based trust** develops through individuals' perceptions of their partner's level of trustworthiness based on their integrity, behavior, capabilities, and reputation (Pishdad-Bozorgi & Beliveau, 2016);
- **Affect-based trust** describes an emotional bond that ties individuals (Wong et al., 2008);
- **Relational trust** derives from repeated interaction over time between trustor and trustee. It is based on emotions and relationships (Rousseau et al., 1998);
- **Dispositional trust** develops based on the build-up of general belief on early trust-related experience (Kramer, 1999);
- **History-based trust** is based on individuals who develop trust based on previous interactional information and experience (Kramer, 1999);
- **Third parties as conduits of trust** are when individuals adopt second-hand knowledge to assess the other's trustworthiness (Kramer, 1999);
- **Category-based trust** develops according to knowledge acquired from one's membership in a social or organizational category (Kramer, 1999);
- **Role-based trust** grows based upon knowledge of role relations, rather than specific knowledge about one's capabilities, dispositions, motives, and intentions (Kramer, 1999);
- **Rule-based trust** is subject to shared understandings of the system of rules concerning appropriate behavior (Kramer, 1999);
- **Individual and Organizational level trust** is specific to the actors (Järvinen & Branders, 2020);
- **Rules of interactions** are the regulations that specify how actors expect others to behave and conduct the project (Järvinen & Branders, 2020).

Some of the prior proposed frameworks, including different trust dimensions and their elements, are summarized as well (see Appendix I, Table-A I-1).

1.3.4 Elements of trust

Many scholars have identified the elements of trust. Trust elements are the sources of trust, which can be used as the basis of trust-building frameworks. Das and Teng (1998) mention risk-taking, equity preservation, communication, and interfirm adaptation as trust factors. On the other hand, Wong et al. (2008) point out organizational policy, communication system, and being thoughtful. Cheung, Chow, and Wong (2014) identify commitment, risk-taking, knowledge, honesty, and benevolence. Elements observed by Pishdad-Bozorgi and Beliveau (2016) are team building, create a sense of belonging, set mutually shared goals, collective authority to make decisions, effective and open communication systems. Jiang et al. (2016) add commitment, risk-taking, knowledge, honesty, and benevolence. Rahman et al. (2020) mention motivation, competence, reputation, communication, shared values, and conflict handling. Järvinen and Branders (2020) state established structures, roles, and responsibilities, regulations & culture & processes, and forums of communication. Some trust-building factors are synthesized in Table 1.1 Trust Elements.

Table 1.1 Trust Elements

Researchers	Proposed Trust Elements
Das and Teng (1998)	Risk-taking Equity preservation Communication Inter-firm adaptation
Wong et al. (2008)	Organizational policy Communication system Being thoughtful
Cheung et al. (2014)	Commitment Risk-taking Knowledge Honesty Benevolence
Pishdad-Bozorgi and Beliveau (2016)	Team building Create a sense of belonging Set mutually shared goals Collective authority to make decisions Effective and open communication systems
Jiang et al. (2016)	Commitment Risk-taking Knowledge Honesty Benevolence
Rahman et al. (2020)	Motivation Competence Reputation Communication Shared values
Järvinen and Branders (2020)	Established structures Roles and responsibilities, Regulations & Culture & Processes Forums of communication

1.4 Summary

This chapter reviewed the impact of contractual functions on construction contracts and the complexity and completeness of the latter. Moreover, BIM documents were introduced, while the legal issues in BIM contracts were identified. Furthermore, various trust frameworks and trust-building elements were studied, which later in this research will be analyzed and combined to propose a trust framework. It was realized that the impact of contractual functions on BIM contractual language and trust development requires investigation. Moreover, legal issues in BIM projects should be identified and their proper contractual language should be defined.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Research objectives and their elements

In order to introduce the methodology of this research, it is first necessary to review the gaps in the literature, the objectives of this research, and their elements, as well as understanding how these elements could be connected.

As indicated in the previous sections of this study, contracts and trust are two mechanisms in achieving projects' goals. However, the impact of contractual functions (controlling, coordinating, contingency) on these two structures (contractual language and trust) has not been studied properly. Moreover, construction contracts (CCDCs) and BIM appendixes are not being applied in BIM-enabled projects appropriately. In this regard, the contractual language of those agreements requires further research. Therefore, the objectives of this research are:

- To study contractual functions, their instantiation within BIM contractual language and their potential impact on BIM projects' success;
- To determine how trust among BIM-enabled project's stakeholders can be developed through contractual functions;
- To propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes;
- To investigate current contractual mechanisms and their limitations in Canada.

In this regard, Figure 2.1 visualizes the connection between these objectives and their elements. The core of this circle is the success of a BIM project, which can be positively influenced through an effective trust-based contractual framework (layer 2). The third circle represents two dimensions of this research including contractual language and trust development. These elements are required in developing the contractual framework. Then the impact of contractual functions (controlling, coordinating, contingency) on BIM contractual language and trust as the outer elements of the circle will be explored by this research as well. To start the

investigation, those two elements- contractual language and trust- will be called dimensions of this study in the next chapters.

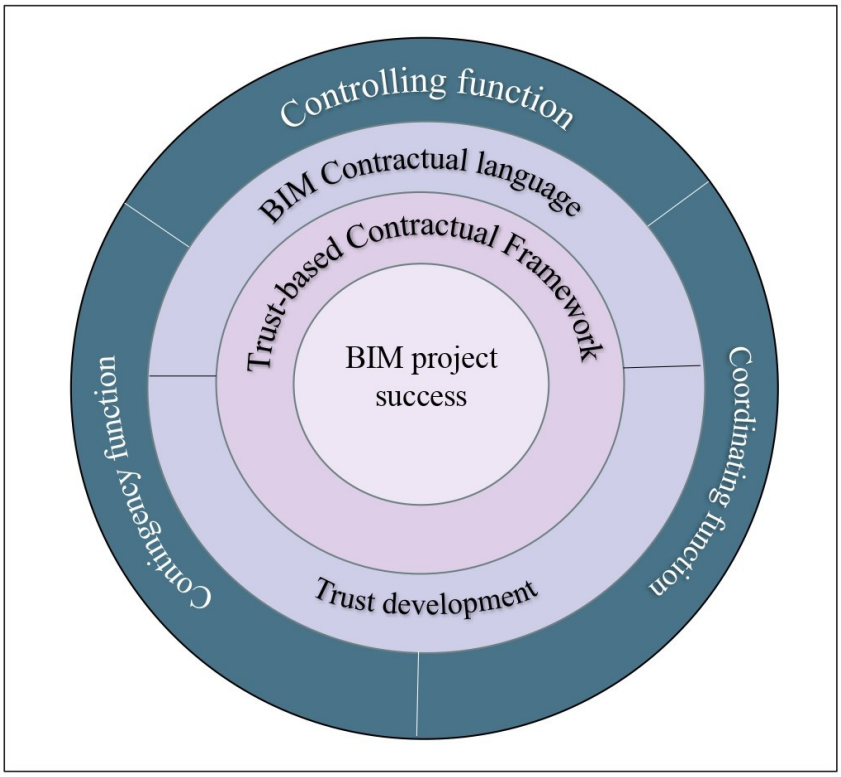


Figure 2.1 Research objectives' elements

2.2 Identification of research methodology

This study employs a qualitative approach, which has two general features. On the one hand, it focuses on phenomena occurring in the real world. Researchers, in this kind of study, try to investigate various dimensions and layers of such phenomena. On the other hand, qualitative research attempts to study the complexity of those issues (D.Leedy & Ormrod, 2015).

Among different types of qualitative methodology, content analysis was chosen for this research. According to D.Leedy and Ormrod (2015), content analysis is a detailed and systematic investigation of the content of a specific body of material in order to identify

patterns, themes, or biases. This type of methodology is commonly performed in human communication, including the transcription of conversations.

In some cases, even when the content analysis is the only methodology used, the quantitative components could also be included. It may simply involve counting the frequencies of elements being studies, as performed in this research. Some characteristics of content analysis according to D.Leedy and Ormrod (2015), are shown in Table 2.1.

Table 2.1 Content analysis characteristics
Taken from D.Leedy and Ormrod (2015)

Design	**Purpose**	**Focus**	**Methods of data collection**	**Methods of data analysis**
Content analysis	To identify the specific characteristics of a body of material	Any verbal, visual, or behavioral form of communication	Identification and possible sampling of the specific material to be analyzed Coding of the material in terms of predetermined and precisely defined characteristics	Tabulation of the frequency of each characteristic Descriptive or inferential statistical analyses as needed to answer the research question

Using content analysis, the research focuses on the characteristics of the language in communication regarding the content or meaning of the text (Hsieh & Shannon, 2005). Text data could be obtained in various forms, including interviews, questionnaires, focus groups, or books. It provides researchers with more than simply counting words, but rather to investigate language intensely, aiming to classify a large amount of text into an efficient number of

categories representing similar meanings (Hsieh & Shannon, 2005). The goal is "to provide knowledge and understanding of the phenomenon under study" (Hsieh & Shannon, 2005).

The content analysis methodology includes three different approaches: conventional, directed, summative (Hsieh & Shannon, 2005). This study applied the conventional approach to content analysis, whose aim is to describe a phenomenon, according to Hsieh and Shannon (2005). This type of research design is appropriate when existing theory on a specific issue is limited; thus, it enables researchers to develop the study further. It could also be described as inductive category development. The main features of this approach are shown in Table 2.2.

Table 2.2 Conventional content analysis characteristics
Taken from Hsieh and Shannon (2005)

Type of content analysis	**Study starts with**	**Timing of defining codes or keywords**	**Source of codes or keywords**
Conventional	Observation	Codes are defined during data analysis	Codes are derived from data
Directed	Theory	Codes are defined before and during data analysis	Codes are derived from theory or relevant research findings
Summative	Keywords	Keywords are identified before and during data analysis	Keywords are derived from the interest of researchers or review of literature

2.3 Identification of Codes

“A code is an abstract representation of an object or phenomenon”, and it is often a word or a short phrase that symbolically assigns a summative or attribute to a portion of data (Jackson & Bazeley, 2019). It is described as a way of identifying themes in a text. Coding in a qualitative

study simply indexes the data to facilitate later retrieval as singular concepts. Naming a concept or topic assists in the organization of data and helps in analytic thinking. Jackson and Bazeley (2019) state that codes do not emerge themselves, but they are generated by the researcher, using different strategies.

One common strategy is to identify general themes, and then break them down into more detailed codes. Moreover, codes could be categorized as "Issues", which are matters raised about which there might be some debates e.g., ownership, privacy, transparency (Jackson & Bazeley, 2019). This approach was applied in the present research by determining general ideas as parent nodes (e.g., Relational trust) and then their subcategories as child nodes (e.g., Honesty).

2.4 Strategies for naming codes

Jackson and Bazeley (2019) state several ways to determine the proper names for codes such as:

- Looking for repetitions and regulations;
- Using questions of the text to generate codes;
- Applying the compare and contrast approach for the context of data.

Moreover, there are some suggestions proposed by Jackson and Bazeley (2019) as to when to stop coding. First is taking breaks while coding, and then coming back more focused. Thus, there would be time to review and monitor codes. However, if coding all the material in the research project is necessary due to counting the frequency of occurrence of codes, the researcher may need to persist until the work is done. In this case, when the researcher has studied the data thoroughly with sufficient text to answer the research question, it is time to stop. Moreover, when repetition appears in the findings for codes, saturation is high enough to stop the coding process.

2.5 Interviews

A semi-structured approach was applied for designing the interviews. A semi-structured interview is a qualitative method of collecting data that includes a pre-determined set of open questions to provide the interviewees with the opportunity to explain their responses as they want, to explore particular themes or responses further (Alreshidi et al., 2017). Following the study of Alreshidi et al. (2017), semi-structured interviews were selected in particular for the following reasons: (1) more resources concerning BIM contractual language and the trust elements were needed; (2) part of the required information and knowledge, existed with the BIM experts; (3) the researcher intended to change the order of the questions, so in this approach depending on the flow of the conversation, it was possible to ask additional questions if BIM expert brings up issues other than those determined questions; (4) allow the BIM experts to speak in more details on the issues that the researcher raises as well as introduce new issues that are relevant to the research theme (Alreshidi et al., 2017). Regarding the interviews, one advantage of the conventional approach to content analysis is that researchers can obtain direct information from participants without imposing pre-determined perspectives (Hsieh & Shannon, 2005).

To develop the interview structure, an interview guide suggested by Oates (2005) was followed. The main guiding questions were as below:

Q 1: Do the current standard contract (CCDCs) cover BIM-related issues?
Moreover, what modifications do they require?
Q 2: Do BIM appendixes address legal aspects properly?
Q 3: How can we introduce BIM into current contracts?
Q 4: What factors can impact a project's success?
Q 5: How can trust be developed in projects?

To conduct the interviews, first, the sample group was defined. After reviewing various approaches to identify the sample group, it was realized that "purposive sampling" is most appropriate for this study. Such sampling involves selecting particular participants who can provide specific perspectives toward a subject or issue (D.Leedy & Ormrod, 2015). Thus, the

sample population was supposed to have experience pertinent to BIM projects and BIM contracts regarding the research topic. In order to cover the topic from two different viewpoints, both construction professionals and legal advisors (lawyers) were considered as objectives of the interviews.

Each interviewee is defined as a case in Nvivo. Cases are used as a unit of analysis. Each case includes all different qualitative and quantitative data gathered pertinent to each participant (Jackson & Bazeley, 2019). Thus, every transcription should be assigned to the relative case (person). This research contains 13 cases.

The data analysis process starts with reading all the collected data repeatedly to understand the issue entirely. The next step is reading the data word by word to extract codes and highlighting the key factors. Then for the keynotes repeated at least more than once, a code will be defined. These codes should then be categorized based on the linkages between them. For each category, a description will be provided. In reporting the outcomes, instances for each group are required.

Twenty-five people from different construction companies and law firms active in the construction field were targeted. The invitation was sent to them by emails containing a decent introduction of the research title and the purpose of the interview. These emails included both French and English versions to offer the participant to communicate in either language they may prefer.

From the total invitations, ten did not answer at all, two refused the invitation, while 13 people accepted to be interviewed. The positive aspect of this sample group is that a good balance between lawyers and BIM professionals was achieved, leading to consistency in the outcomes from two different perspectives. The interviewee's profiles are summarized in Table 2.3.

Table 2.3 Interviewees' profile

Case	Position	Expertise	Organizational code
1	Lawyer	Construction Law	LF-1
2	Lawyer	Construction/Infrastructure/ Procurement	LF-2
3	Lawyer	Litigation	LF-3
4	Lawyer	Intellectual Property	LF-4
5	Lawyer	Property & Buildings and Contract Management	CC-1
6	Lawyer	Director (Legal aspect)	CC-6
7	Construction professional	Innovation manager	CC-7
8	Construction professional	Innovation manager/R&D	CC-8
9	Construction professional	Innovation manager	CC-9
10	Construction professional	Innovation manager	CC-10
11	Construction professional	VDC Manager	CC-11
12	Construction professional	Director drawings department	CC-12
13	Construction professional	VDC Manager	CC-13

CC: Construction Company
LF: Law Frim

Law firms are referred to as "LF", and Construction companies are called "CC" in this research. Moreover, each interviewee was assigned a unique code based on their respective organizations coupled with their case number (e.g., LF-1 or CC-9), to respect the participants' privacy.

Due to the COVID situation, all the interviews were conducted online through the Zoom platform. Interviews lasted for 45 to 70 minutes on average. The meetings were recorded with the interviewees' permission. Each of the sessions was then transcribed using an online website. Next, all the transcriptions were imported to Nvivo for coding and analysis. The codes identified in the literature review (chapter 1), were assigned where appropriate. In other cases, additional codes were detected and added. Like reviewing the literature codes, the interview section was also revised and refined four times to decrease the possibility of misunderstanding the communications.

2.6 Analysis process

In every study, assumptions are required as a foundation of the research in an attempt to address the research questions; therefore, we assumed that:

- The contractual language is an influential factor in a project's success;
- There is a minimum level of trust between the parties leading them to enter into a contract.

The data were gathered using two strategies namely Literature review and Interviews. First, an in-depth literature review was performed. This stage started with searching the keywords in the related online databases such as Scopus and Science direct. Keywords included:

- ("BIM" OR "building information modeling") AND ("construction contract" OR contract*),
- ("BIM" OR "building information modeling") AND ("trust"),
- ("contract") AND ("trust"),
- ("BIM contract") AND ("trust"),
- ("trust antecedents") AND ("trust framework"),
- (“BIM legal issue” OR BIM legal barriers*).

The "snowballing" approach was followed to track down the references cited in the relevant articles. These two stages resulted in finding 70 articles.

For the first research objective, which is "To study contractual functions, their instantiation within BIM contractual language and their potential impact on BIM projects' success", it was required to identify the main factors involved and study them in-depth. While, contractual functions (controlling, coordinating, contingency) were discussed in the "Literature review" chapter, "BIM contractual language" was still unknown. Thus, this element was called dimension 1, in this research, which includes contractual elements of project success and BIM-related legal issues, as its sub-categories. Moreover, for the second research objective: "To determine how trust among BIM-enabled project's stakeholders can be developed through contractual functions", the second dimension was defined as "Trust development" to study trust-building factors.

By carefully reading the data accumulated from the existing literature, the issues related to the "Contractual language" and "Trust development" were identified and used as codes in NVivo 12, which is a helpful software for qualitative analysis when finding patterns (Jackson & Bazeley, 2019). The identified codes for the contractual language dimension including contractual success hampering issues and BIM-related legal issues are shown in Table 2.4. Furthermore, 13 trust-building elements were determined as codes as presented in Table 2.5.

Table 2.4 Contractual language codes

Dimension 1	Sub-category	Codes

Contractual language	Issues hampering Contractual success	Unclear roles & responsibilities
		Unclear BIM requirements
		Incomplete contractual documents
		Incomplete contractual provisions
		Inconsistent definitions
		Contractual complexity
		Too much emphasis on controlling clauses
		Lack of standard BIM-based contracts
	BIM-related legal issues	Clear BIM roles & responsibilities
		Intellectual property
		Model ownership
		Liability
		Model security
		Standard of care
		Model insurance

Table 2.5 Trust development codes

Dimension 2	**Codes**
Trust development	Fair risk allocation
	Contractual flexibility
	Clear requirements
	Good faith
	Honesty
	Information exchange
	Open conversation
	Transparency
	Competence
	Past common experience
	Reputation
	Integrity
	Reciprocity

One attribute of qualitative research, however, is that the methodology evolves during an iterative process. The researcher may move back and forth between data collection and data analysis called the constant comparative method (D.Leedy & Ormrod, 2015). The scholar

might collect some primary data, search for patterns, and return to the data collection, which could clarify or contradict those prior themes (D.Leedy & Ormrod, 2015). Accordingly, reviewing the data and defining codes was repeated four times in this research to ensure a higher level of accuracy.

2.6.1 Interviews analysis process

This research applies content analysis as its methodology for analyzing the data. In order to start analysis, it is necessary to categorize the collected data. All the data imported in Nvivo, are primarily saved and known as files, including the articles (for the literature review) and the transcriptions (for the interviews). Thus, for making comparisons, the articles remained as files, and interview transcriptions were defined as cases. Furthermore, the articles were divided into two dimensions (contractual language and trust) considering the elements of research objectives.

In addition, in Nvivo, demographic or quantitative variables such as occupation or gender are referred to as attributes. According to Jackson and Bazeley (2019), these attributes (variables) could have values like Nurse or Educator. Therefore, it was decided to assign relative attributes and values to the data. Two types of attributes were determined. Once, we assigned “Literature review” as the attribute for the articles and “Industry Professionals” as an attribute for interviewees. This provided us with the opportunity to compare the outcomes of the current literature with the opinions of the professionals in the field. Secondly, another type of attribute was identified for interviewees in particular. Since the participants had BIM-related experience in either law firms or construction companies, the attributes were defined as “Lawyer” and “BIM professional”.

In the first step, a crosstab query was used to compare the data according to different attributes assigned to them. A crosstab in Nvivo indicates a table of attribute values by nodes (codes) (Jackson & Bazeley, 2019). By using this feature, it is possible to enter two attributes of interest at the same time and provide the number of cases of files for each one. Then, the table was exported to Excel in order to draw an analytical chart.

These steps were applied once for comparing “Literature review” and “Industry professionals” and then for “Lawyers” and “BIM professionals.” Thus, the findings from the comparison between literature (46 articles) and industry (13 interviews) will be presented in different ways. First, a table for code frequency of issues based on the type of references (Literature review or Industry professionals) will be provided. Then, a figure showing the analysis for elements of each dimension based on the type of references will be put forward. These two steps (code frequency table and analytical chart) will be then provided for the points of view of the Lawyers (6) and the BIM professionals (7).

2.6.2 Contracts analysis process

For the third research objective: “To investigate current contractual mechanisms and their limitations in Canada”, a number of contracts; including CCDC 2, 5, 14, 30, and BIM appendixes namely AIA, CIC, Consensus Docs, and IBC were analyzed (see Chapter 3, Results) to identify the gaps in terms of BIM contractual language and legal issues. Some recommendations to introduce BIM to CCDCs and update the IBC were provided (see chapter 4, Discussion).

This analysis aims to understand how these contracts support BIM application regarding the BIM legal aspects. Figure 2.2, illustrates the analyzing process through an IDEF diagram, which is commonly used for describing processes[2].

[2] Each box represent a single process. The arrows before the boxes are inputs and the ones after boxes are the outputs.

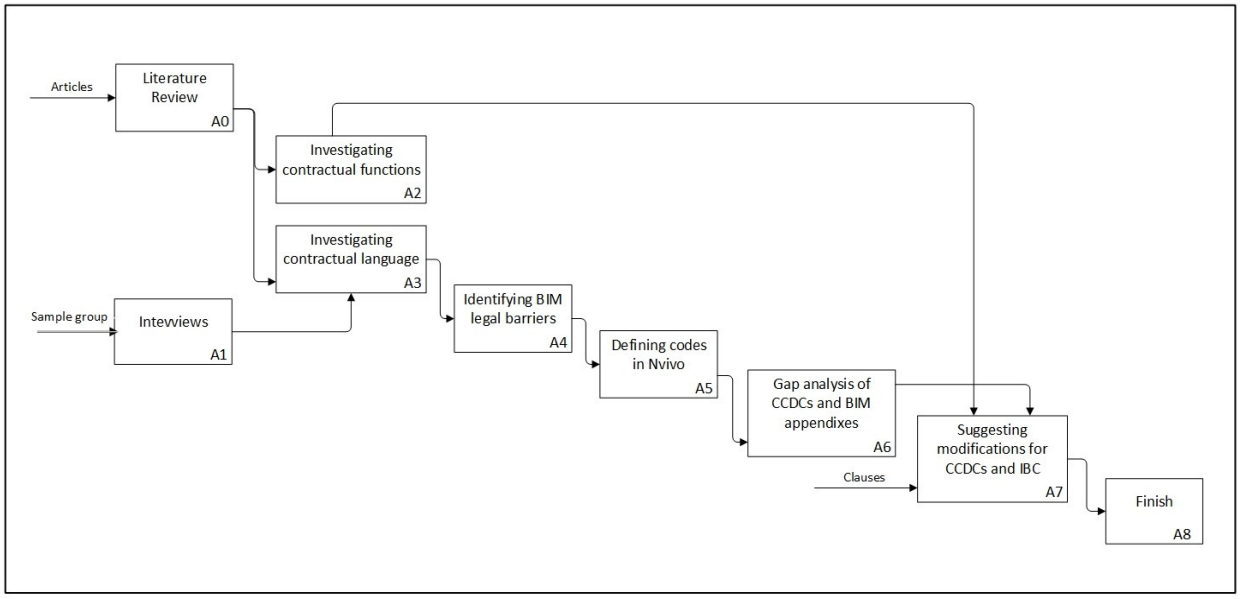


Figure 2.2 IDEF Diagram for the contract analysis process

Finally, the fourth research objective: "To propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes", will be addressed by proposing a conceptual framework based on contractual language and trust (see Chapter 3, Results).

2.7 Research Methodology Framework

To better illustrate the whole research process, a comprehensive diagram representing the research methodology is shown in Figure 2.3.

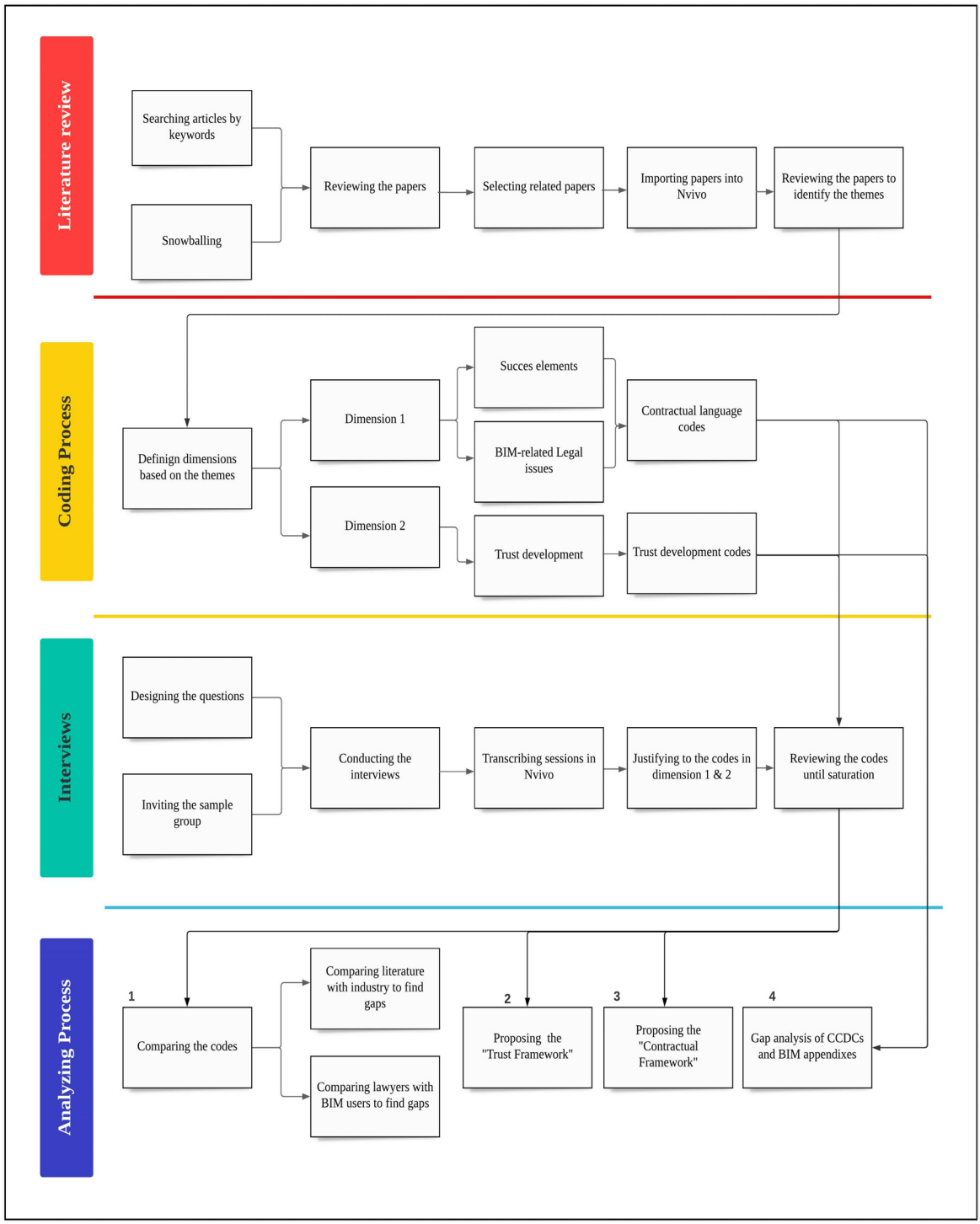


Figure 2.3 Research Methodology Framework

2.8 Validity and Credibility

One of the challenges of the conventional approach to content analysis is the possibility of failing to understand the context, which may lead to failure in identifying the key categories. This can consequently result in outcomes that do not accurately represent the data (Hsieh & Shannon, 2005). To diminish the influence of this issue on the research, and to enhance the reliability of the coding system, a validator checked the codes to ensure the proper comprehension of the material. The validator was a P.hD candidate with knowledge of BIM and contracts. After accomplishing the reliability test, a coding comparison query was conducted through Nvivo, which allows for comparing the results of coding from two coders. Some differences were identified, which then were resolved.

In addition, the credibility of the qualitative research can be examined through various ways such as peer debriefing, prolonged engagement, persistent observation, triangulation, negative case analysis, referential adequacy, and member checks (Hsieh & Shannon, 2005). To address this issue, three courses of action offered by D.Leedy and Ormrod (2015) were applied. First, triangulation was applied, which is defined as using multiple data sources to support the hypothesis. Therefore, the literature review, along with interviews, composed the sources of collecting the information. Secondly, the "Thick description" approach was applied, in which the researcher describes the situation in sufficiently rich detail, so that readers can draw their own conclusions. Such thick descriptions were provided for all the codes identified (see Chapter 3, Results). Lastly, instead of claiming to remain objective during the whole process, we acknowledge personal biases that may cast a shadow on our observations and interpretations.

2.9 Biases

Two biases may influence this study, including the response bias and the researcher bias. In cases that data is collected through interviews, researchers rely on self-report data (D.Leedy & Ormrod, 2015). Interviewees are likely to provide information that they believe is true or perhaps what they think we would like to hear. Thus, to the extent that people describe their

thoughts, beliefs, and experiences inaccurately, there is room for response bias (D.Leedy & Ormrod, 2015). Therefore, as the interviewees in this study mainly were asked about BIM and trust, which, based on the widespread belief, have potential positive influences on construction projects, the responses may be colored with this judgment.

Moreover, the possible effects of the researcher's expectations, values, and general belief might lead them to study certain aspects of a subject and no other variables, coupled with specific conclusions, known as researcher bias (D.Leedy & Ormrod, 2015). For the current study, several factors in contractual language and trust development were approached; however, another researcher may realize that there are other potential factors to study as well.

2.10 Ethical issues

To comply with the ethical issues, two practices were followed, including internal review board and right to privacy.

2.10.1 Internal review board (IRB)

In some countries, including Canada, any university has an internal review board to explore the proposals for conducting research involving humans (D.Leedy & Ormrod, 2015). Their responsibility is to ensure that the procedure does not cause any harm to the targeted group. To abide by this obligation, the list of questions to be asked to the interviewees was sent to the respective department of École de Technology Supérieure. It was investigated and confirmed within two weeks.

2.10.2 Right to Privacy

To appreciate participants' privacy, their permission to record the sessions was obtained before starting the interviews. In some cases, we received documents by email as complementary information for which a confidentiality respect form was signed by us beforehand.

CHAPTER 3

DATA ANALYSIS

This chapter aims at presenting the findings from the literature and interviews. First, the codes for each dimension and its sub-groups will be described in detail. The descriptive data for the codes were collected from both previous studies and interviews. Next, the results extracted from these two main streams (Literature review and Interviews) will be compared and discussed once between literature and industry and then between the lawyers and BIM professionals. Then, a conceptual trust-building framework will be provided, which was used to propose the contractual framework. Moreover, a gap analysis of CCDCs and BIM appendixes will be put forward. Finally, a contractual framework based on the contractual language and trust will be presented.

3.1 Dimension 1: Contractual language

This dimension attempts to investigate the first research objective in studying contractual functions, their instantiation within BIM contractual language, and their potential impact on BIM projects' success. To discover the answer, two aspects will be studied, namely contractual elements of projects' success and BIM-related legal issues.

3.1.1 Contractual elements and project success

The contractual language of agreements could be examined from various aspects. Each factor would influence the success of projects. Thus, this section serves to explore the most effective contractual elements. The lack of each success element may lead to a problematic issue (called "success hampering issues", in this research), which is used as a code in Nvivo (see Table 2.4 Contractual language codes).

3.1.1.1 Optimal level of detail in the contract

Including an adequate level of detail in agreements is a key element in achieving success through contracts. While the absence of certain clauses may cause a detrimental effect, excessive detail coverage might bring adverse outcomes, as will be discussed in what follows.

3.1.1.1.1 Contractual complexity (code)

Due to the complex nature of construction projects, numerous unexpected circumstances are unavoidable (Cheung & Pang, 2013). To deal with such situations, stakeholders sometimes attempt to cover every aspect of the project in the contract leading to drafting a too complicated agreement. Thus, understanding and performing such complicated contracts may not be straightforward for the stakeholders, and they are even likely to confuse critical elements, making room for opportunism (Lu, Zhang, & Zhang, 2016). Moreover, You, Chen, Wang, and Shi (2018) argue that despite the possible reduction in the ex-post cost[3] of complex contracts, there would be ex-ante[4] costs related to drafting, negotiating, and codifying provisions. Furthermore, since designing a complex contract is costly and developing trust among the project parties is difficult (Das & Teng, 1998), accomplishing these two goals simultaneously only serves to add to the project cost (Shi et al., 2018).

Moreover, despite the findings of some researchers, it is stated by Jiang et al. (2016) that drafting a complete contract in which the risk and responsibilities are clearly defined leads to lessening the mutual sharing and consequently affects relational trust negatively. A complete agreement comprising explicit penalty and incentive provisions is, in fact, a sign of distrust (Jiang et al., 2016). Lu et al. (2016) also emphasize that a too detailed contract causes opportunism and brings about distrust. According to Fan et al. (2019), IPD contracts are drafted in a complicated way, which might be the reason for their unpopularity among BIM

[3] Post-contract transaction costs incurred after signing the contract; including costs of governance structure (Guo et al., 2016).
[4] Pre-contract transaction costs incurred before a construction contract is signed; including cots of environmental impact assessment, feasibility study, preliminary design and bidding process (Guo et al., 2016).

project users. However, Wang et al. (2017) claim that prior interaction between the parties would lead to less contractual complexity.

3.1.1.1.2 Too much emphasis on controlling clauses (code)

Even though safeguarding provisions aim to diminish risks, and certify a fair value sharing between the stakeholders, a strong focus on them brings about the party's self-protective intentions, risk avoidance, and even a high level of distrust toward the other party (Shen et al., 2020). Including too many safeguarding provisions into the contract fosters the win-lose state of mind among stakeholders. Therefore, parties may consider their rights and interests as priorities (Zhang, 2016). Das and Teng (1998) emphasize that drafting excessive contractual controlling, namely lawsuit provisions, evokes a suspicious environment rather than a trusting one.

Moreover, scholars argue that extensive monitoring and penalty provisions reveal low trust and strengthen opportunistic behavior according to Wang et al. (2017). Meanwhile, You et al. (2018) state that due to the negative effect of contractual control on trust, parties should consider whether it is necessary to include many controlling provisions or choose other governance mechanisms such as trust in protecting the project.

3.1.1.2 Completeness of contractual provisions

The completeness and complexity of the contracts are pertinent to the degree of detail that they cover (Mellewigt et al., 2012). Lee et al. (2018) also emphasize that an adequate level of each contractual function should be considered when devising the provisions. However, incompleteness in contractual clauses might lead to negative consequences as follows.

3.1.1.2.1 Incomplete contractual provisions (code)

Due to numerous uncertainties in the construction projects, contracts are incomplete to include all necessary provisions to deal with these circumstances. This incompleteness may foster the desired environment for claims and disputes (Cheung & Pang, 2013). Moreover, Zhang (2016) argues that contractual incompleteness is inevitable due to two reasons. On the one

hand, designing highly detailed agreements is costly. On the other hand, humans are rationally bounded; thus, they cannot predict all possible circumstances.

Researchers have also studied BIM-enabled projects. Fountain and Langar (2018) claim that contractual risks would influence stakeholders of BIM projects. They add that as BIM is a new technology, the law is not yet protecting BIM users. Oraee et al. (2019) introduce traditional legal structure as a barrier to collaboration in BIM projects. In this regard, Alwash, Love, and Olatunji (2017) add that despite some contractual instruments such as contract conditions, contractual obligations, and contract forms and language, BIM-enabled projects are primarily implemented using traditional contracts, which are not in tune with the nature of BIM. Jiang et al. (2016) emphasize that an actual complete contract that can address all issues does not exist. While this lack of completeness makes room for mutual trust with positive or negative impacts on both partners.

Moreover, in the interviews, LF-1 pointed out this incompleteness of the contracts in terms of BIM-related issues, specifically CCDC 2. LF-1 also added that the industry has gotten used to this problem and deals with it. In another part of the discussion, LF-1 mentioned that: “There are always gaps in contracts. Some of it is intentional because you want to leave parties some room to have their freedom of contract and to have their own sake”.

3.1.1.3 Completeness of contractual documents

Certain contractual documents for BIM-enabled projects should be added as annexes to the standard ones. Disputes and claims can be among the consequences of the lack of such documents.

3.1.1.3.1 Incomplete contractual documents (code)

Scholars have noticed many cases of incomplete documents. Alwash et al. (2017) refer to the AIA document in which 2D drawings for BIM projects are among documents, however other types of representations such as models, specifications, and surveys are considered instruments of services. It is then obvious that merely considering 2D drawings as part of the documents is not sufficient. The models should be also included in the documents (Alwash et al., 2017).

Furthermore, as noted by several interviewees, BIM models are rarely considered as contractual documents. CC-12 stated that models are being used only as references for 2D drawings. It also leads the designers to include disclaimers for the models as they are unwilling to be responsible for something not mentioned in the contract. CC-13 pointed out: "But designers on many projects issue disclaimers, saying that they're not responsible for anything in the model because referring to official construction documentation, models are just for reference".

It was also mentioned by CC-1 that: "The CCDC contracts are a bit older in nature, so they don't contemplate the existence of BIM at all, I think, they're more rooted in a 2d design environment". CC-12 stated that if the 3D models are included in the agreement, it is due to the complexity of the project, for instance, a specific geometry: "When it is written on the contract, most of the time, it is because of the geometry, it is so complex, they don't know how to represent it on 2d drawings. So, they will set the model". CC-12 also emphasized that: "Still the PDF drawings are that source of truth, and the models are supplementary information to that".

3.1.1.4 Allocation of roles and responsibilities

Clear allocation of roles and responsibilities of the team actors is necessary for achieving the project's goals. In the BIM environment specifically, in which multi-disciplinary parties contribute to the project, the identification of their responsibilities is of great importance. It also alleviates many disputes and claims.

3.1.1.4.1 Unclear roles & responsibilities (code)

Defining the party's responsibilities increases the safeguarding of the owner's investment (You et al., 2018). Moreover, clarification of the role and responsibilities of the stakeholders can positively affect contracts since this specification is vital for cooperation (Järvinen & Branders, 2020). Meanwhile, realizing the duties expected from each actor will lead to a greater chance of mitigating conflicts (Kalach, Abdul-Malak, & Srour, 2020). Fan et al. (2019) emphasize this clarification and add that unclear roles and

responsibilities might cause legal liabilities. In addition, identifying specific duties within a contract promotes trust (Wong et al., 2008).

3.1.1.5 Standardization

Various benefits have been pointed out for the application of standard contracts. Since BIM technology is quite new in the industry, the importance of standardization should be taken into account.

3.1.1.5.1 Lack of standard BIM-based contracts (code)

Ashcraft (2008) argues that BIM should be treated as a project delivery system with its risks, rewards, and relationships. However, the lack of standard contracts hampers the adoption and development of BIM. According to Ashcraft (2008), standard contracts provide their users with triple benefits. Firstly, such standardized agreements offer a framework for practice as a business model, while a business model does not support BIM. Secondly, issues such as risk allocation, compensation, dispute resolution, and insurance are commonly covered by standard documents, whereas customized contracts may lack a balanced approach toward these subjects. Thirdly standard agreements with determining roles and responsibilities decrease effort made by the parties to define them.

On the other hand, designing customized contracts involve extra costs. Despite various appendixes and guidelines to incorporate BIM into the projects, there is still a lack of standardization of BIM issues. Moreover, the legal system has not tested these standards and protocols, proving a lack of case law to be used as guidance in practice (Eadie, McLernon, & Patton, 2015).

During the interviews, CC-1 mentioned the lack of a unanimous standard contract, which leads parties to confusion, while deciding what agreement to be used: “I don't think the issue is about the content. I think the issue is adoption. So almost all regulations, all of these BIM appendices, they all work fine, but it's deciding which one is actually going to be the prevailing standard”.

CC-11 added that: “If you are going to use like reality, as an example, there's three or four that we list on our BIM execution plan; which one are we going to use? You know, are we going to use AIA standards? Are we going to use BIM standards? Or which standards?”

Moreover, when we asked about standard guides, CC-9 referred to ISO 19650 as a proper standard for constructions contracts; however, Canada still has not adopted it as a standard. Furthermore, CC-13 added that these kinds of standards also are not incorporated in the contracts: “These new ISO standards 19650, etc., also, do you see contracts mentioning this as a reference for the deliverables? No, not yet”.

3.1.1.6 Consistency of definitions

Various BIM contractual documents exist such as BIM appendixes, guidelines, and standards, which have been published by different organizations. The uniformity of definitions put forward by such documents will diminish issues like misunderstandings between parties and disputes.

3.1.1.6.1 Inconsistent definitions (code)

Some of the interviewees identified the inconsistency in the term definitions in agreements, which causes misinterpretations by the stakeholders. CC-10 stated that: “We have the fact that we don't meet that standard center definition for each word. It's difficult to create the link with the client”.

CC-10 added that in order to have the same understanding of the issues by the stakeholders, it is necessary to reach a mutual comprehension of the definitions, but it also requires resources such as time. When we asked for an example, CC-10 explained:

> As an example, the definition of as-built models. In the majority of the contracts, they require an “As-built model” but it is not clear for everyone if it is supposed to be a “physical representation” of what is really done, or it is just a consultant model that integrates change order during the construction. So, it creates grey zones everywhere and leads to extra costs for sure. If we can have one standard definition through the industry, it can avoid issues of interpretation.

3.1.1.7 Clarity of BIM requirements

In a highly collaborative environment like BIM, in which various models are creating, the final desired deliverables should be determined at the project's beginning. Moreover, the party's expectations and project requirements should be considered as well.

3.1.1.7.1 Unclear BIM requirements (code)

Many interviewees mentioned this issue as a problem in BIM projects. Some owners do not clearly define their expectations. CC-13 stated: "Most clients that we work with, usually say that they don't know what they're looking for. So, they trust the builder, consultants, and other stakeholders on identifying correct deliverables". CC-13 also pointed out the issue with the documents: "Typically, standard documentation doesn't include the correct description of the expected deliverable".

In some other cases, clients may not be quite familiar with BIM as CC-1 stated: "So lately, you see a lot of contracts where owners say, I want BIM in my contract, I want my designers to do BIM, I want BIM, they do not even know what BIM is, but they want it. And so that isn't good for a successful contract". Moreover, LF-3 added that there might be differences between what is written in the contracts and what the stakeholders wish for.

3.1.2 BIM-related legal issues

Scholars have studied various legal issues for BIM-enabled projects. This section reviews the most significant issues, which should be considered while designing agreements.

3.1.2.1 Clear BIM roles & responsibilities (code)

Practically, the BIM Execution Plan defines the responsibilities of the BIM manager. The BIM manager introduced by the structural organization has a more general role linked to the project manager. An assistant known as the BIM coordinator responsible for internal BIM model management helps the BIM manager (Jamil & Fathi, 2019). While the responsibilities

of the BIM managers are different from one discipline to another, the unclear definition of their duties in the contractual clauses will lead to disputes (Jamil & Fathi, 2019).

Although according to Sacks et al. (2018) the law cases for issues related to the roles and responsibilities are fewer than expected, there is still a lack of clarity regarding the changing roles and legal liabilities in BIM projects (Chong et al., 2017). Moreover, this lack of clarification includes the party expected to allocate resources to maintain the BIM model through the entire project lifecycle (Oraee et al., 2019). For instance, in transactional contracts, primarily one party shoulders the responsibilities according to the agreement; however, in a collaborative environment such as BIM, in which multiple disciplines contribute to the project, the liabilities are jointly shared (Alwash et al., 2017). Arensman and Ozbek (2012) also add that while the current legal system is based on the determined responsibilities of the parties, these definite liabilities may not be clarified in a BIM project, in which various stakeholders work closely together. Since the unclear roles and responsibilities will lead to legal liabilities, the contractual relationship between the parties, especially for the BIM manager and key actors, should be distinctly defined (Fan et al., 2019). Moreover, lawyers advise stakeholders to include clear roles and responsibilities of the parties in the contract to avoid further disputes and claims (Sacks et al., 2018).

Interviewees also emphasized the importance of clear roles and responsibilities. CC-10 mentioned: “We definitely want to know what is coming from what and specify the details in terms of what model, what part of discipline comes from what party, and what exactly they're providing there”. More precisely on the role of BIM manager, CC-13 stated that this role is more evident in the US industry while in Canada, there is still room for improvement:

> For Canada, from our experience, that role could be anything from [something] similar to regular project coordination role to design, management, and field management, where the BIM person is both coordinating models and talking to the site team and making sure that they have live data. It varies wildly from project to project.

LF-1 added: “So it's a way to trigger people's minds to think about what needs to be done. I don't think any of the standard forms of contracts actually go so far as to tell you how to do it”.

Furthermore, to reduce uncertainties, LF-1 stated that: “One way to build some certainty into that relationship with anyone is for the people who are actually in it and using who have this responsibility of managing the model, and making sure all insurance, everything is there”.

In this regard, the crucial collaborative role in BIM projects was reviewed in contracts. Along with its responsibilities, this role is defined as BIM manager in Consensus Docs 301, the model manager in AIA, and the information manager in CIC. IBC contract mentions the model manager’s role; however, their responsibilities are not pre-defined and should be written upon the party's agreement. Moreover, CCDCs lack covering such a collaborative role and its responsibilities in case of utilizing BIM.

3.1.2.2 Intellectual Property (code)

According to Hsu, Hsieh, and Chen (2015) intellectual property (IP) “is a term referring to a number of distinct types of creations of the mind, for which a set of exclusive rights is recognized, and the corresponding fields of law as a matter of law”. Common intellectual property rights include copyrights, trademarks, patents, and industrial design rights. While using BIM provides users with a collaborative platform to modify the model elements and information, disputes may arise regarding the ownership of the copyright when such elements might be used in other projects later on (Hsu et al., 2015). The concern of IP rights is not limited to the construction period, but instead, it extends to the whole project lifecycle due to the application of the model for project maintenance (if this is the case). Ashcraft (2008) adds that the IP issues pertinent to BIM are similar to the ones that existed before; however, they are enlarged due to intense information in the BIM model, and the slight possibility of transferring data among the stakeholders. Thus, the IP rights should be determined at the beginning of the project development (Chong et al., 2017). Kuiper and Holzer (2013) highlight the need for identifying IP rights and any licensing arrangements, whether actual or implied in BIM transactions. Meanwhile, Jamil and Fathi (2019) suggest that the best solution for disagreements over copyright issues is defining the ownership rights and responsibilities into the IPD context. In this regard, Di Giuda, Pattini, Seghezzi, Schievano, and Paleari (2020) offer to integrate BIM and block-chain in dealing with such legal issues.

The IP issue is of great importance; however, it is not necessarily always discussed and clarified between the stakeholders, as LF-2 mentioned: “Things like intellectual property, etc. that are kind of core issues that oftentimes get debated when BIM is used”. Moreover, LF-4 emphasized that the scope of model usage also requires clarification:

> So there are the drawings, but then there's the copyright in the drawings. A lot of times, agreements don't make that distinction, and then, again, in terms of the scope of uses that you can do, like, can you photocopy the drawing? Who can you give the photocopy to? Can you only use it to create this building? Can you use it to create other buildings? Can you sublicense it to the subcontractor? So there's a whole scope of rights, and that you should be as specific as if you're the owner of the IP, right? You want to make it as narrow as possible because it's an asset.

LF-1 mentioned that although there are some pre-defined rules for ownership of IP, it mostly depends on the negotiation between the parties: *“*So it depends on the bargaining power, like whoever has the most power is probably going to own it. To be honest with you, there are certain default positions at law as to who owns the IP. But you can change that through contracts”. LF-1 added that designers also are willing to maintain the IP of their model even if they grant other parties licenses: “If you're the creator, you want to be able to really leverage it if you can still license it to other people, and if you're the one who is having someone to create these models or drawings for you, you're going to want to own it to ensure that you can then, in turn, sue people who come up with similar designs”. While in cases, in which the design process is outsourcing, the designers will have this ownership:

> There's a default position at law, that if the person who's creating the work is an independent contractor, as opposed to an employee, which is like 99.9% of the case, in the construction world, it's independent contractors, the default position outlaw is that the copyright in the drawings and models, etc, is owned by the designer, who are the architects. And so unless the person who's hired, the architect gets an explicit assignment (LF-4).

While all the BIM contracts (IBC, Consensus Docs 301, AIA, CIC) recognize each contributor of the model as the IP ownership of their contribution, CCDCs do not clarify this matter. Reviewing CCDC contracts indicted that the IP issues are not considered in CCDC 2 and 5 whatsoever. Although CCDC 14 discusses copyrights, it does not include digital models.

CCDC 30 refers stakeholders to the IBC contract whenever BIM is being applied in the project. Since BIM models are created collaboratively, the IP issues related to its elements and the whole model should be clarified within the contractual provisions.

3.1.2.3 Model ownership (code)

According to Sacks et al. (2018), legal issues related to design, engineering, and construction are not new in construction projects; however, in BIM projects, the ownership and rights to information are considered the key elements due to the digital and collaborative nature of BIM. Sacks et al. (2018) put forward questions such as who owns the information? who owns the copyright of a BIM model? who has the right to use a model? who has the right to change a model? and adds that these issues are different in legal terms. A party can be the model's owner, but concerning the copyright issues, they cannot freely change the model. BIM guides published by various countries (United States, Finland, South Korea, and Singapore) recognize the client as the owner of the model and other deliverables (Sacks et al., 2018). Fountain and Langar (2018) discuss that one challenge in BIM projects is the ownership of the model after completing it. The owner might believe being entitled to have the model as they paid for that, while the responsible party who created the model claims the ownership. Thus, some support the idea that the creator of the model has ownership (Arensman & Ozbek, 2012).

Meanwhile, some others, such as AIA 2007, highlighted the fact that the BIM model is a production of multidisciplinary parties; thus, the ownership belongs to the client. AIA 2007 Standard Form of Agreement Between Owner and Architect, also stated that model authors must grant a nonexclusive license to the owner (Alwash et al., 2017). One concern that various contributors to a model might have, is the repurposing of the model by the owner, which includes using the data in the model for other projects or in ways other than the licensed ones. However, Consensus DOCs 301 addresses this problem by granting each party a limited, non-exclusive right to use the models for that project only; however, this notion is not understood by the industry (Arensman & Ozbek, 2012).

Interviewees unanimously emphasized that the ownership issue should be clarified. For instance, LF-4 stated: “And the issue called ownerships is a disaster. You want to avoid that at

all costs, because it gets extremely complicated in terms of when you need consent from the other party to license it or to sell it, etc". They also mentioned the licensing approach as a solution to the ownership as LF-4 stated: "So generally speaking, what you can do in some cases is to have one party own it, but then the other party gets a super broad license to do whatever they need to do so that way the ownership is clear".

Moreover, the owner receives a license for using the model during the project lifecycle according to the IBC contract and Consensus Docs 301. Regarding AIA's E203, the transmitting party has the ownership of the model or the right to transmit it, while the receiving party is not considered the model's owner, and they only have the right to modify and use the model according to the license they are given. This limitation could include the operation phase as well (Alwash et al., 2017). On the other hand, CIC recognizes the owner, as the possessor of the digital models, illustrating that the current ownership approach is still subjective. On the other hand, CCDCs do not address digital models' ownership. Besides, the owner's right to retain the models after ending the project should be considered.

As discussed so far, primarily designers have the intellectual property rights (specifically, copyrights) of their drawings, which permits them to modify and use their model elements in any project. While the ownership of BIM models is still controversial. The model owner can not necessarily modify or use the model for other projects unless they have the model copyright. In order to address the ownership issue, licenses are issued and granted to owners by the model authors (or by the owner to the team members).

3.1.2.4 Liability (code)

Another potential issue that occurs in BIM projects is pertinent to design liabilities. Fountain and Langar (2018), and Eadie et al. (2015) argue that identifying the responsible party for an error and its reparation might be a challenge when errors happen, given that multiple parties contributed to the model. Although, when collaborators in BIM, co-create models, they often add disclaimers to their contracts to avoid liabilities for their product. They try to shift the blame to the other party but not to a specific actor (Alwash et al., 2017). In this regard, Kuiper and Holzer (2013) suggest that to avoid this kind of dispute arising from incorrect assumptions

of responsibilities of the designers and contractors, their roles should be appropriately defined and controlled during the collaborative processes. Moreover, disclaimers and warranties might be required to consider in the agreements. For instance, this could be useful where a designer's warranties are affected by the contribution of the subcontractor to the model (Kuiper & Holzer, 2013). Jamil and Fathi (2019) also recommend applying an integrated contracting methodology to avoid disputes between the actors involved.

In the interviews, when participants were asked about the liability issue, they highlighted the fact that until 3D models are not among the contractual documents, the liable party cannot be tracked, as CC-8 stated: “It depends on the contract. Unfortunately, in some contracts, it's still the 2d form that would be considered priority but the first thing that we have to look at the model can be just information and we have to double-check that this is real in some contracts”. CC-9 mentioned using disclaimers by the designers: “Designers on many projects issue disclaimers, saying that they are not responsible for anything in the model”. They also emphasized that liability should be addressed in the contracts to clarify who put the information to the model, who uses it, and who can modify it.

According to the IBC contract, the liability of parties is limited to direct damages. Consensus Docs recognizes each model contributor as liable for their contribution. CIC pointed out that liability only includes the project team members and employers who are granted licenses. However, the liability issue is not mentioned in the AIA document. Furthermore, the liability of design in CCDC 2, 5, and 30 must be clarified. According to CCDC 14, Design-Builder has the sole responsibility of the design services; however, software liability is not covered. Thus, the CCDC contracts need to specify liabilities regarding the collaborative nature of BIM projects.

3.1.2.5 Model insurance (code)

While BIM provides a collaborative framework, it also creates possible insurance issues. Ashcraft (2008) asserts that many professional liability policies consider exclusions for means and methods to avoid coverage for construction activities. Moreover, in cases of a joint venture, insurers mostly deny or limit liability. Ashcraft (2008) adds that contractors also

deal with insurance issues. Most of the insurers exclude professional services and do not cover the pure economic loss. However, there is much debate over the insurance of design liabilities, and modification of the identified clashes (Oraee et al., 2019). Fan et al. (2019) argue that indemnity should be considered for the client in the agreement to protect the owner's interests in the BIM model.

In practice, LF-1 argued that in some cases, the insurers are unwilling to cover the BIM model: "Their insurers are a bit wary of them. Because they are concerned that there is perhaps an expansion of liability that parties are going beyond what they would normally do in terms of providing services. And so, if it opens up the insurer to new claims for that". CC-11 added that instead of 3D models, insurance firms only cover 2D drawings: "There are a lot of firms that we deal with where their insurance companies are just like, no, don't ever give models out. Only the PDF drawings".

Meanwhile, the insurance of the model is not mentioned in any of the CCDCs and the BIM appendixes.

3.1.2.6 Model security (code)

ISO standard 19650-part 5 defines security as "the state of relative freedom from threat or harm caused by deliberate, unwanted, hostile or malicious acts" (International Organization for Standardization, 2019). Like other forms of digital data, BIM models are prone to data loss; thus, the responsible party should take steps to preserve the data (Ashcraft, 2008). Chong et al. (2017) state that security and privacy issues are among the BIM adoption barriers. The information can be easily extracted from a BIM model. Using a standard Quick -Response Code (QR-Code) has been applied with BIM to protect the model, preventing infringements of copyright issues (Fan et al., 2019).

Moreover, ISO standard 19650-5 specifies the principles and requirements for information security in BIM projects. This standard provides a framework for organizations to help them understand the key vulnerability issues and the controls required for managing the security risks. ISO 19650-5 is appropriate to be used by organizations who are involved in the use of

digital engineering to assist them in protecting their personal information and intellectual property (International Organization for Standardization, 2019).

Interviewees also mentioned the model security as an issue to be considered in the projects. One simple way is to have revisions of the model after implementing changes in each step, which also assists in identifying the responsible party, CC-12 stated. LF-2 was concerned about confidentiality: “Confidentiality provisions are not properly fleshed out, not as fleshed out as we would want them to be”.

Security of data is not pointed out in IBC, Consensus Docs, and CIC; however, AIA highlighted that model security requirements should be defined by the model manager and other model users. Furthermore, none of the CCDC 2, 5, 14, and 30 considers data security as a contract provision.

3.1.2.7 Standard of care (code)

The importance of considering the standard of care was mentioned by CC-1: “I would always have the standard of care clearly set out in the agreement because you avoid the potential argument later. If all parties can point to a clear standard of care, no one can argue about what the standard is later on (they can, of course, argue about whether or not someone met the standard of care, but that is another issue altogether)”. In defining this issue, CC-1 also added:

> To define the standard of care, I see two options. The first would be to draft one from scratch and have everyone agree. Something as simple as "The Consultant shall exercise the degree of care, skill, and diligence normally provided by a qualified professional consultant in the performance of services of a similar nature to the Services required under this Agreement." may be suitable. Alternatively, parties can turn to industry-standard documents (CC-1).

Ashcraft (2008) states that as BIM is becoming a standard in construction projects, the design process, specifically in complex projects will change. If the physical conflicts can be avoided by providing a detailed model, then the stakeholders are supposed to apply that, as resolving the conflicts in the field or through post-design coordination is unacceptable (Ashcraft, 2008).

Defining the standard of care in the IBC, Consensus Docs, and CIC document is based on the party's agreement, while AIA does not address this issue. Moreover, CCDCs (2, 5, 14, 30) lack addressing this concern.

3.2 Dimension 2: Trust Development

This dimension was devised to answer the second research question as to how trust among the BIM project stakeholders can be developed through contractual functions. Therefore, the most significant trust-building elements were identified (see Table 2.5 Trust development codes) and described in the next points.

3.2.1 Contractual flexibility (code)

Zhang (2016) states that in some cases, parties intentionally decide to craft an incomplete contract to provide room for flexibility and maximize their benefits. However, Das and Teng (1998) argue that such flexibility and the willingness of the stakeholders to include deviations from the contract in some instances are the key factors in adopting cooperation and gradually trust. Moreover, Jiang et al. (2016) support this notion and add that there is no true complete contract that can address all the uncertainties in the projects. They also recognize this lack of completeness as an opportunity for mutual trust, which can positively or negatively affect both parties.

Furthermore, when we asked the interviewees whether designing a too detailed contract can improve trust or not, CC-13 mentioned the value of flexibility with a practical example: “We have contracts that go on for five years, for example, if my contractor says we're working only in this software of this version, say Revit, 2016. Well, five years later, it's very difficult to keep working in that format. It's very difficult to invite new parties, if it's a multi-phase project, and expect that they will work on the same protocol. So there have to be certain rules for building flexibility”.

3.2.2 Clear requirements (code)

This code specifically originated from the interviews. The participants highlighted that clear expectation from other players has a significant role in building trust. CC-13 stated that: “When there is a clear understanding of responsibility for certain means and scope, there is way more trust”. CC-13 also added that considering flexibility in the contracts to some extent depends on the knowledge and understanding of the client: “You have to leave room for negotiation and modifying certain requirements when the owner is knowledgeable or has some understanding of what they want in the end”.

LF-2 acknowledged the influence of having a proper contract as a basis of trust: “Certainly our contract by its very nature is there to build trust amongst parties, right, trust that you will follow your contract. It's kind of a basic premise of contractual contract law, and so having a contract from my perspective, at a basic level ensures that there's at least some level of trust amongst the parties that they reach, abide by their obligations, and that’s already a big step”.

3.2.3 Fair risk allocation (code)

Allocation of fair risks between the parties has been mentioned as a trust-building element by previous studies. In this regard, Alves and Shah (2018) state that fair risk allocation could be achieved through using the IPD contract. Moreover, Wong et al. (2008) point out that fair risk allocation would improve trust. CC-12 also mentioned this element: “To build trust, fair risk allocation will be a keystone”.

3.2.4 Good Faith (code)

Good faith can be defined as not having the intention to harm the other party. When the stakeholders act reasonably during the contract and project and comply with their duty to inform, they are in good faith. CC-6 explained good faith as follows: “And that you believe that if there's a need for anything to be communicated, you'll know when you need to know, and if there's something that will work in your disfavor, or cause you damage, they will let you know, so, it brings the implication of good faith”.

Many studies have introduced good faith as an element of trust (e.g., Rahman et al., 2020; Järvinen & Branders, 2020). Rezvani et al. (2018) also state that when the trust level is high, and the actors realize that the others are in good faith, they are more likely to collaborate effectively.

3.2.5 Honesty (code)

Honesty implies being truthful, and not misrepresenting, lying to, or misleading other parties. Various scholars identify honesty as a fundamental element in trust promotion, including Rahman et al. (2020); Rezvani et al. (2018); Uusitalo, Seppänen, Peltokorpi, and Olivieri (2019). Pishdad-Bozorgi and Beliveau (2016) highlight that trust could be built over time if the parties display attitudes such as honesty.

CC-6 stated that: "So by creating trust, you're presuming that the parties are of good faith. The parties are honest, then they are transparent, so you cannot create trust unless all the other parameters are met around them".

3.2.6 Information exchange (code)

Information exchange is considered a fundamental criterion when creating a practical contractual framework based on good faith (Dagenais, 2007). Dagenais (2007) mentions that this exchange of information should be accomplished honestly to build trust among the stakeholders. However, Di Giuda et al. (2020) point out that the maintenance of trust between the parties in the construction industry is difficult due to the complexity of the links between the actors, which hinders information sharing. Moreover, information sharing, including exchanging organizational strategies or confidential information, is a critical factor of trust-building (Wong et al., 2008). Wong et al. (2008) add that information sharing also optimizes the level of understanding and expectations of the parties. On the other hand, Pishdad-Bozorgi and Beliveau (2016) state that holding the information breeds distrust, defensive behaviors, and ultimately a dysfunctional team.

Interviewees believed that regular meetings are one way to keep the flow of information. Moreover, sharing correct information was emphasized by CC-9 as an element of trust: “If you produce information that is not complete, and you send that to the construction site, and you say that it is complete, and then structures realize that this is not coordinated and is not complete, they're going to have problems with their job. So, they stop and ask for better information the first time. The second time, it's a mistake, different behaviors to say, I know I don't trust this guy. Send me information, send me complete information”.

3.2.7 Communication (code)

Xu (2019) argues that as a channel of communication, project meetings provide members with the opportunity to openly express their opinions as well as listening to other’s ideas instead of conveying one-way information. Uusitalo et al. (2019) add that information communications between the team players improve their understanding of each other, which can develop trust.

CC-11 explained this aspect of trust with an example: “It's that conversation because a lot of times we noticed our trades were like, well, that's where the engineer told me to put it. So, that's where I'm putting it, and then it causes a ton of problems, and then there's always that early on, and every project, just that general conversation has to happen. Okay, we're going to use and what are we going to use them for? what are the expectations?”

3.2.8 Transparency (code)

Transparency is defined as sharing what the actors know and not hiding or partially give information. In this regard, Das and Teng (1998) mention that communication and proactive information exchange are the trust-building elements. Rahman et al. (2020) highlight that truthful information is amongst the factors that emerged as crucial in boosting trust. Moreover, good communication delivers accurate and on-time information; thus, stakeholders can realize the requirements of one another (Jiang et al., 2016). Jiang et al. (2016) add that if one of the players lies, trust quickly disappears and cannot be recovered easily. On the other hand, trust in return can strengthen openness and transparency between the parties in a project, leading to better flow of information and gradually fueling trust-building (Uusitalo et al., 2019).

LF-1 emphasized the importance of transparency: “So I don't necessarily know that a more detailed contract builds trust, but there may be important provisions in a contract that could help to build trust. So, when you're talking about making decisions by consensus, having transparency, an early collaboration of team members, and regular meetings are important”. CC-6 stated: “Trust is based on the premise that you believe that the other person is going to be transparent with you. And that you believe that if there's a need for anything to be communicated, you'll know when you need to know”.

CC-13 interpreted this element: “When we say trust, I don't mean that I expect that other party will guess what I want. By trust, I mean that there is a trust that if my partner sees that I'm doing something wrong, they will alert me before it becomes a problem. So, that is more of a trust in my understanding that we have on projects. So, I don't expect anybody to guess what I need. I just expect that they do as we agreed, or they will alert if something doesn't look right”.

3.2.9 Competence (code)

This element of trust is based on one party’s abilities and resources to fulfill its obligations and meet the requirements (Zhang, 2016). Competence can be defined as technical expertise and production methods, knowledge of the market and competitors, and industry (Rahman et al., 2020). Moreover, according to Xu (2019), the competence of individuals would lead to shared understanding. Both parties are expected to have the knowledge and experience that can support the project's accomplishment (Xu, 2019). Several scholars have emphasized this factor as a significant trust builder (e.g., Jiang et al., 2016; Malhotra & Murnighan, 2002; Pishdad-Bozorgi & Beliveau, 2016; Uusitalo et al., 2019). However, this element was not mentioned by the interviewees.

3.2.10 Past common experience (code)

Given the high level of uncertainties in construction projects, owners are willing to sign contracts with those contractors who had accomplished their projects before since repeated transactions will improve trust (Shi et al., 2018). Shen et al. (2020) mention that the need for safeguarding provisions in the contracts will diminish over time in the party's perspectives due

to the acquired familiarity and mutual understanding between them. Das and Teng (1998) also emphasize that trust can be considered as the accumulation of prior satisfactory experience.

Many interviewees also pointed out past common experiences as a trust builder. CC-13 mentioned that: “There are still issues with new partners who we work with, but if it's an established company that's been around for five years, they typically know what they're providing. And we just specify a very brief thing in the execution plan, because they know what needs to be done”. CC-12 mentioned: “The more you work with a company, the more you build the trust, more and more contracts become simple, and we work together”.

3.2.11 Reputation (code)

Das and Teng (1998) argue that the first step in awarding contracts is to find a company with a good reputation. A partner with a reputation of honesty, trustworthiness, and fairness can encourage the other party to take some initial risks (Das & Teng, 1998). The reputation of an organization and past experiences assist in evaluating that party in terms of being reliable for fulfilling the project (Wong et al., 2008). Wong et al. (2008) add that the company’s financial status is also essential as it reflects its capability to facilitate the processes and manage risks. However, only one interviewee mentioned this element.

3.2.12 Integrity (code)

Integrity has been identified as a crucial factor in establishing trust among parties (Jiang et al., 2016). Jiang et al. (2016) refer to integrity as keeping one’s promise and being consistent between words and actions. Various studies mentioned integrity as a trust booster e.g., Wong et al. (2008); Järvinen and Branders (2020); Xu (2019). This factor was not mentioned by the interviewees.

3.2.13 Reciprocity (code)

Wong et al. (2008) argue that enhancing the level of trust among the stakeholders is achievable when treating acts are reciprocated by the parties. Harper and Molenaar (2014) claim that

reciprocity, is the belief that the success of one organization depends on another party's success, and they cannot become successful without each other. Therefore, reciprocity occurs when the organizations continuously respect each other, which will lead the project to be a success (Harper & Molenaar, 2014). Moreover, Das and Teng (1998) believe that trust and risk-taking are associated with each other, and they can be considered mirror images. Thus, trust and risk-taking can form a reciprocal relationship (Das & Teng, 1998).

CC-13 also stated: "Construction is a team sport, and sometimes you do a favor, sometimes the other party does a favor, and that's, what builds trust".

3.3 Results from the interviews' analysis

After defining codes extracted from the literature and interviews, they were categorized into two dimensions (contractual language and trust development). The following parts will indicate the results of analyzing the codes by representing code frequency tables and analysis charts.

3.3.1 Dimension 1: Contractual language

In this dimension, the findings for both groups, including contractual success hampering issues and BIM-related legal issues will be analyzed using code frequency tables and analytical charts. In the code frequency charts, the number of times that each code was mentioned in the references are shown, while in the code percentage charts, the number of files/interviews that contains each code was applied to draw the chart. In these cases, the number of Literature review files was considered 100% and then the number of files for that code was converted to percentage. The same process applied for interviews (industry professionals) as well as comparison between lawyers and BIM professionals.

3.3.1.1 Contractual elements of project success

As this category was created to recognize the elements of project success, we first detected the success factors, and then the contractual success hampering issues (caused by the lack of such

elements) were used as codes. The codes are extracted from the literature review as well as interviews. Table 3.1 shows the frequency of each code according to the type of references.

Table 3.1 Code frequency for success hampering issues based on the type of references

Codes	**Type of references**	
	Literature review	**Interviews**
Unclear roles & responsibilities	5	0
Unclear BIM requirements	0	27
Incomplete contractual documents	2	14
Incomplete contractual provisions	11	2
Inconsistent definitions	0	6
Contractual complexity	9	0
Too much emphasis on controlling clauses	13	0
Lack of standard BIM-based contracts	7	9
Total	47	58

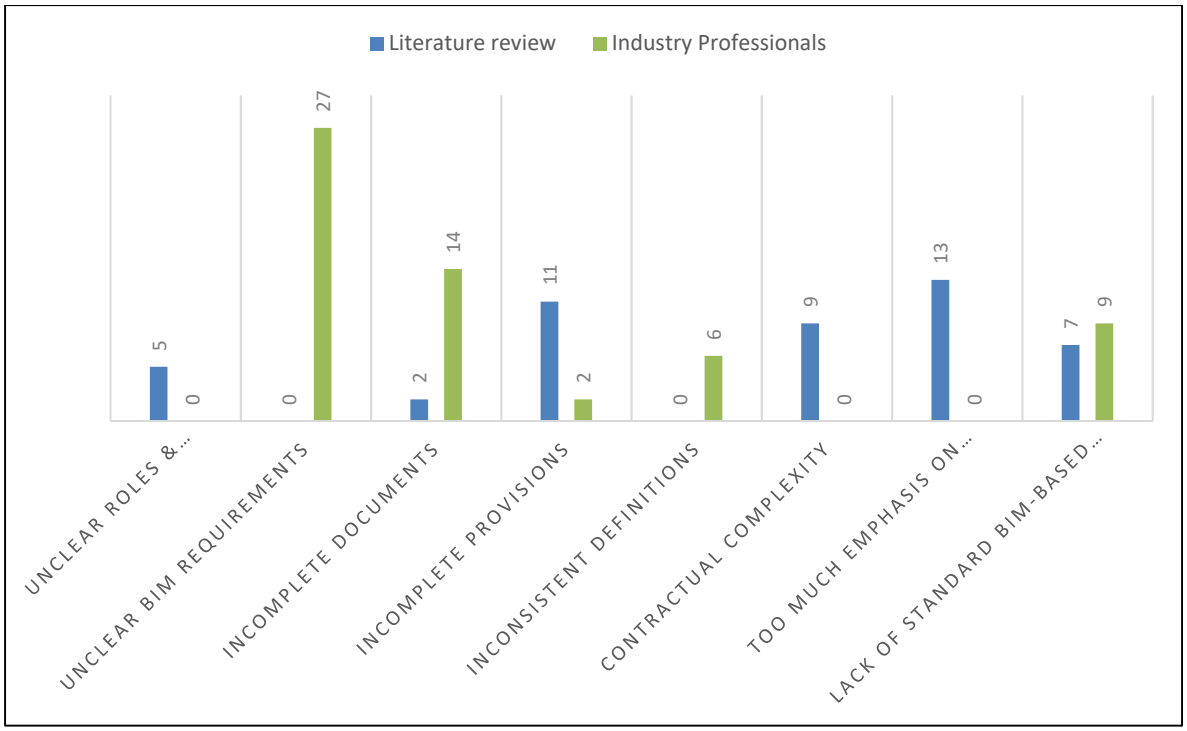


Figure 3.1 Analysis of success hampering issues based on the type of references

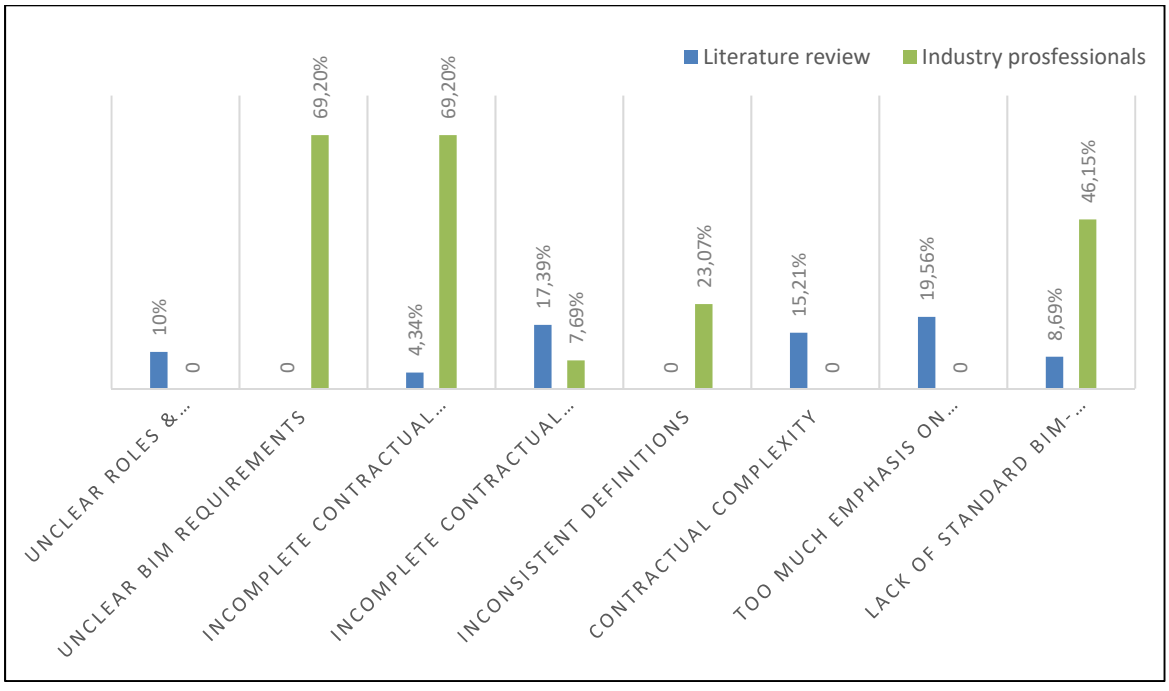


Figure 3.2 Code percentage for success issues based on the type of references

As shown in Figure 3.1, and **Erreur ! Source du renvoi introuvable.**, the industry is more concerned about issues such as unclear BIM requirements (highest references number by far), and incomplete contractual documents, while literature mainly focused on too much emphasis on the controlling provisions, incomplete contractual provisions, and contractual complexity. However, there is a gap in the literature regarding issues namely unclear BIM requirements and inconsistent definitions. Meanwhile, the lack of standard BIM-based contracts was identified in both categories. Therefore, the identified gaps in the current studies can be further investigated, while the issues put forward by the construction professionals can be taken into consideration in designing contracts. Moreover, Table 3.2. **Erreur ! Source du renvoi introuvable.** and Figure 3.4 present the findings based on the interviewees' occupations distinguishing between lawyers and BIM professionals.

Table 3.2 Code frequency for success hampering issues based on occupation

Codes	**Interviewees' occupation**	
	Lawyer	**BIM professional**
Unclear roles & responsibilities	0	0
Unclear BIM requirements	3	24
Incomplete contractual documents	2	12
Incomplete contractual provisions	2	0
Inconsistent definitions	1	5
Contractual complexity	0	0
Too much emphasis on controlling clauses	0	0
Lack of standard BIM-based contracts	3	6
Total	11	47

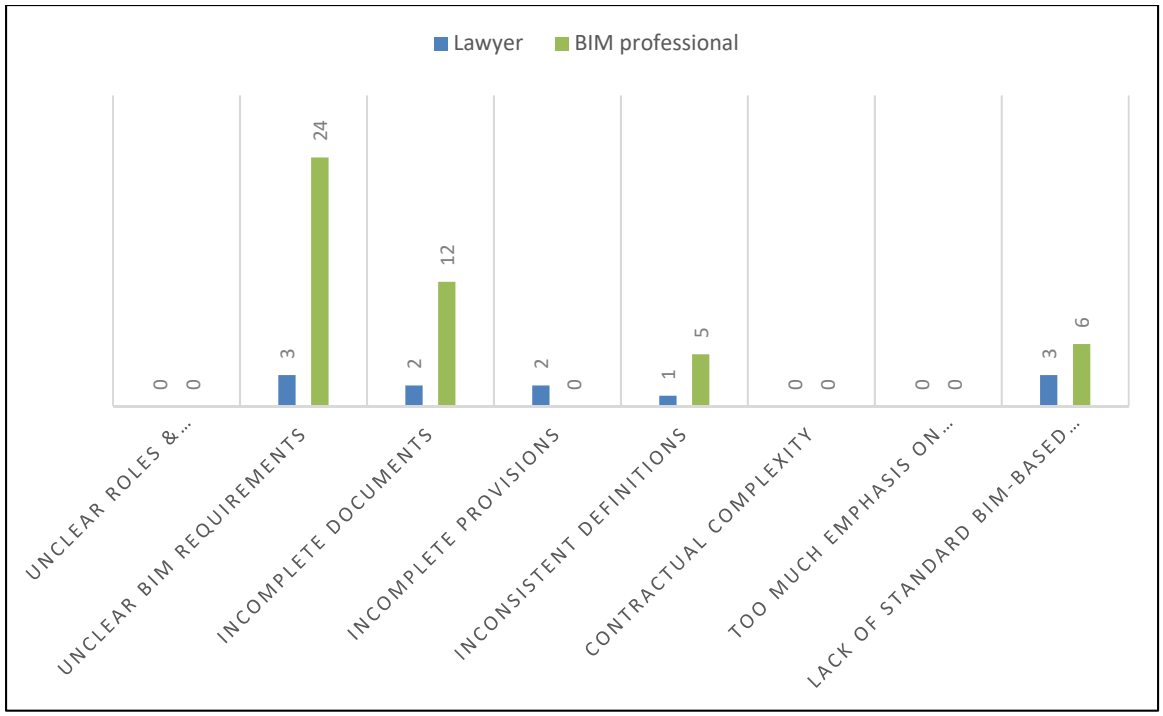


Figure 3.3 Analysis of success hampering issues based on occupation

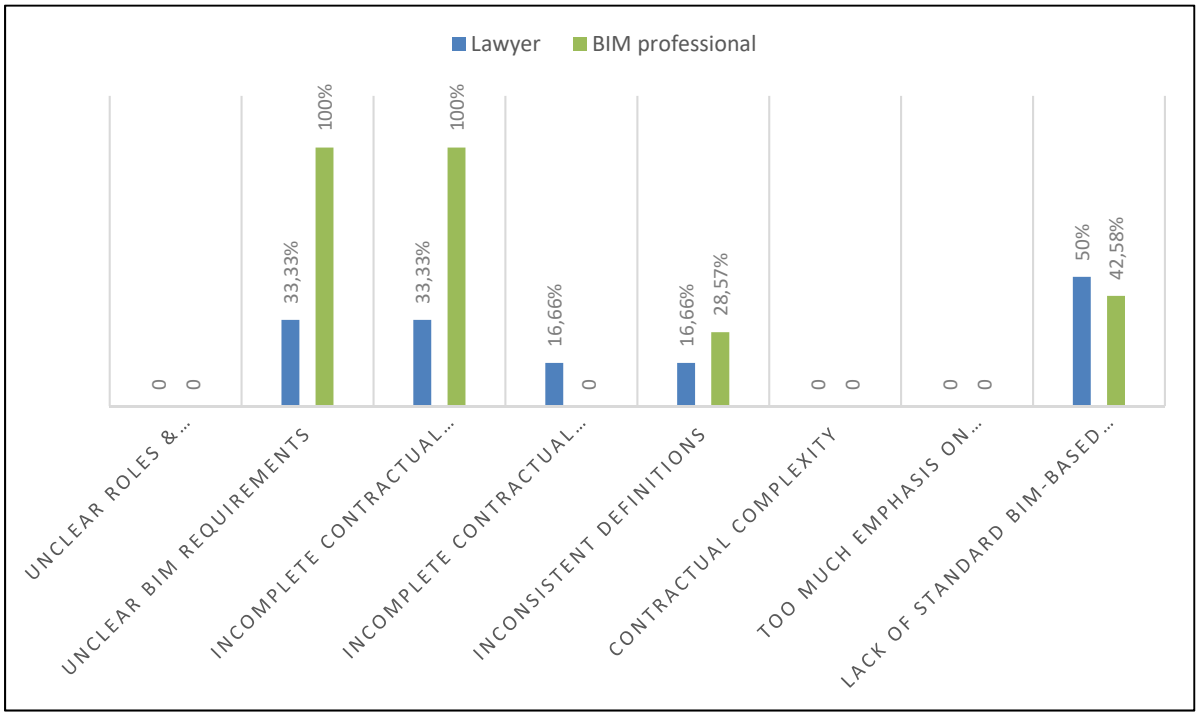


Figure 3.4 Code percentage for success issues based on occupation

As shown in the chart, unclear BIM requirements, incomplete contractual documents, inconsistent definitions are the issues that BIM professionals commonly experience in their projects. At the same time, these aspects do not seem important to the lawyers responsible for designing the contracts. Lack of standard BIM-based contracts was mentioned by two groups.

3.3.1.2 BIM-related legal issues

The second category was developed regarding the themes pertinent to BIM legal issues. Eight codes are included in Table 3.3, which were identified as crucial in BIM agreements.

Table 3.3 Code frequency for BIM-related legal issues based on the type of references

Codes	**Type of references**	
	Literature review	**Industry professionals**
Clear BIM roles & responsibilities	8	12
Intellectual property	10	17
Liability	11	9
Model insurance	5	2
Model ownership	11	15
Model security	7	3
Standard of care	7	1
Total	59	59

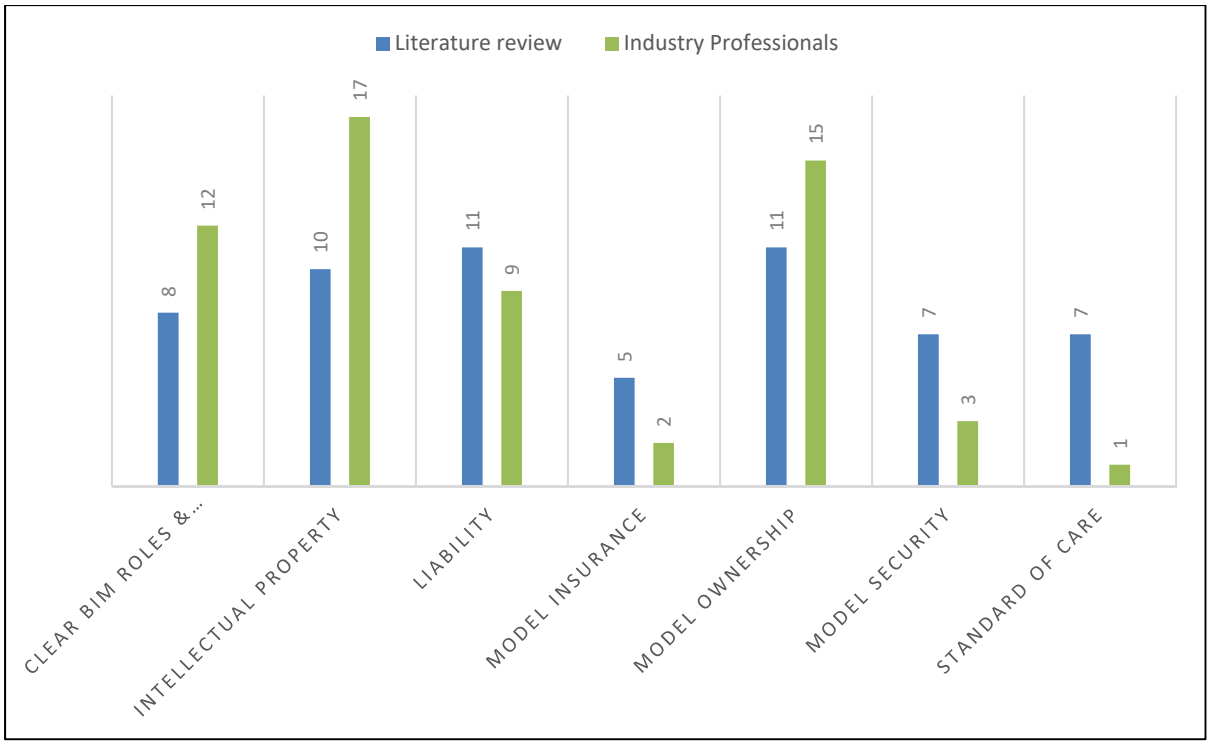


Figure 3.5 Analysis of BIM-related legal issues based on the type of references

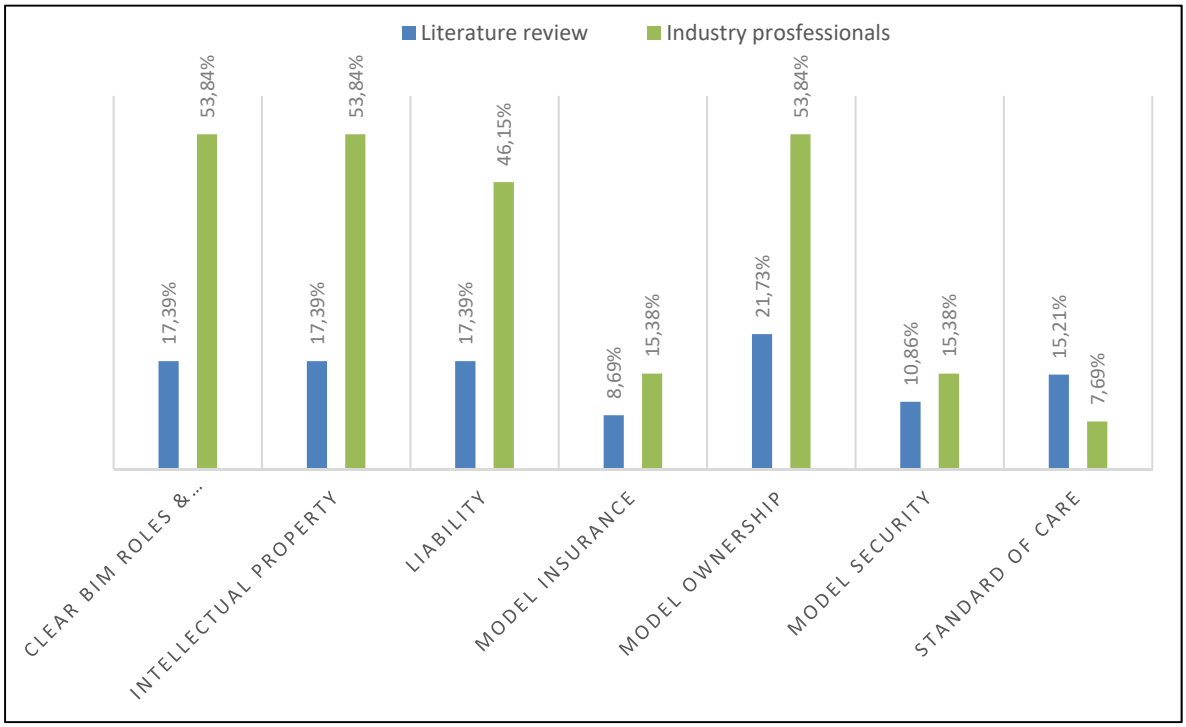


Figure 3.6 Code percentage for BIM legal issues based on the type of references

According to **Erreur ! Source du renvoi introuvable.** and Figure 3.6, the scholars and industry professionals mutually mentioned all the elements as significant contractual aspects. There is a difference in opinions for the standard of care, model security, and model insurance, which all were recognized mainly by the studies. However, in practice, intellectual property, model ownership, clear BIM roles, and responsibilities are considered vital. Furthermore, Table 3.4 and **Erreur ! Source du renvoi introuvable.** and Figure 3.8, illustrate the comparison between lawyers and BIM professionals regarding the BIM-related legal barriers.

Table 3.4 Code frequency for BIM-related legal issues based on occupation

Codes	**Interviewees' occupation**	
	Lawyer	**BIM professional**
Clear BIM roles & responsibilities	8	4
Intellectual property	15	2
Liability	4	5
Model insurance	1	1
Model ownership	8	7
Model security	2	1
Standard of care	1	0
Total	39	20

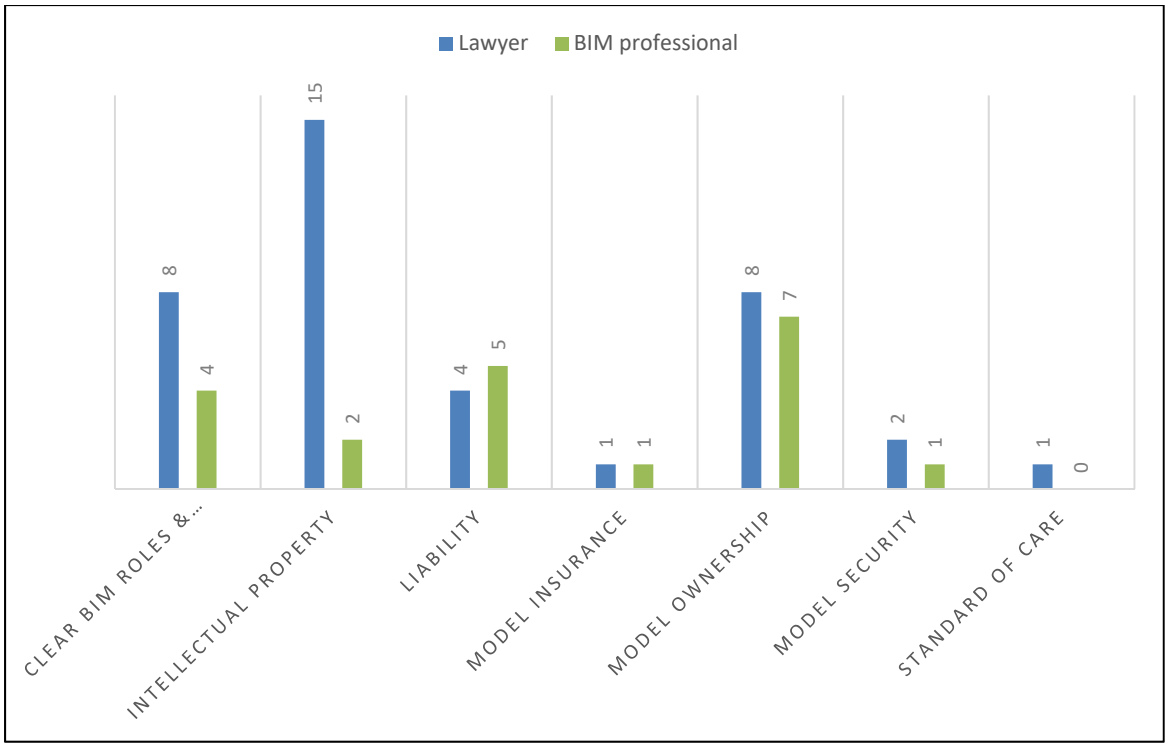


Figure 3.7 Analysis of BIM-related legal issues based on occupation

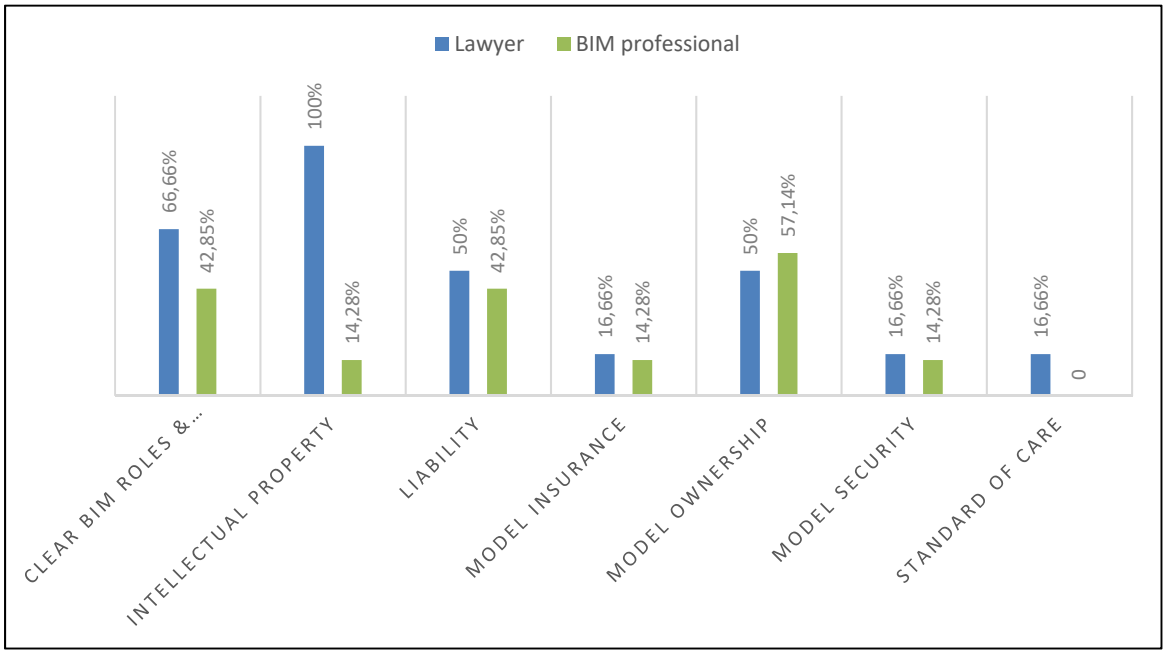


Figure 3.8 Code percentage for BIM legal issues based on occupation

The results from **Erreur ! Source du renvoi introuvable.** and Figure 3.8 demonstrate that legal aspects such as intellectual property, ownership, and clear BIM roles and responsibilities are identified as most important from the lawyers' side, while most of the other elements, were equally discussed by the interviewees. The standard of care was just mentioned by the lawyers. Moreover, model security and model insurance draw the least attention from the two groups.

3.3.2 Dimension2: Trust development

This dimension explores various elements potentially contributing to trust improvement. Fifteen trust-building factors were extracted and compared in the following tables and charts. First, the results of literature and industry are shown in Table 3.5 and **Erreur ! Source du renvoi introuvable.** and Figure 3.10.

Table 3.5 Code frequency for trust elements based on the type of references

Codes	**Type of references**	
	Literature review	**Industry professionals**
Competence	15	0
Past common experience	14	6
Reputation	7	1
Fair risk allocation	2	1
Clear requirements	0	10
Contractual flexibility	3	4
Communication	5	5
Good faith	7	3
Honesty	4	2
Information exchange	12	5
Transparency	9	5
Integrity	13	0
Reciprocity	11	1
Total	102	43

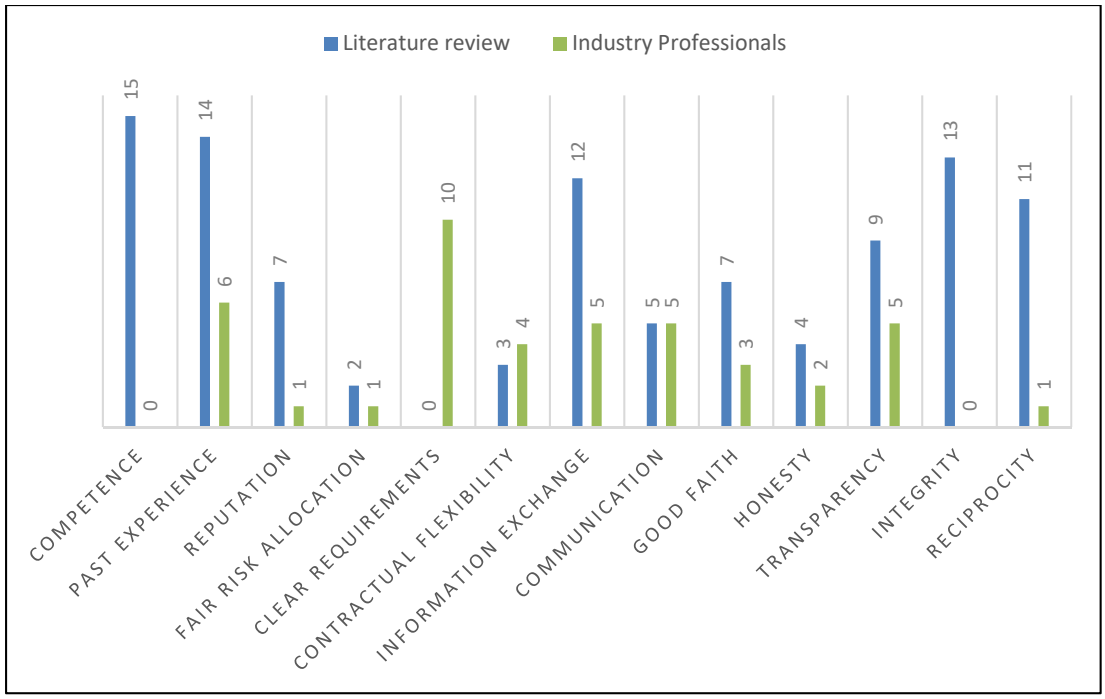


Figure 3.9 Analysis of trust elements based on the type of references

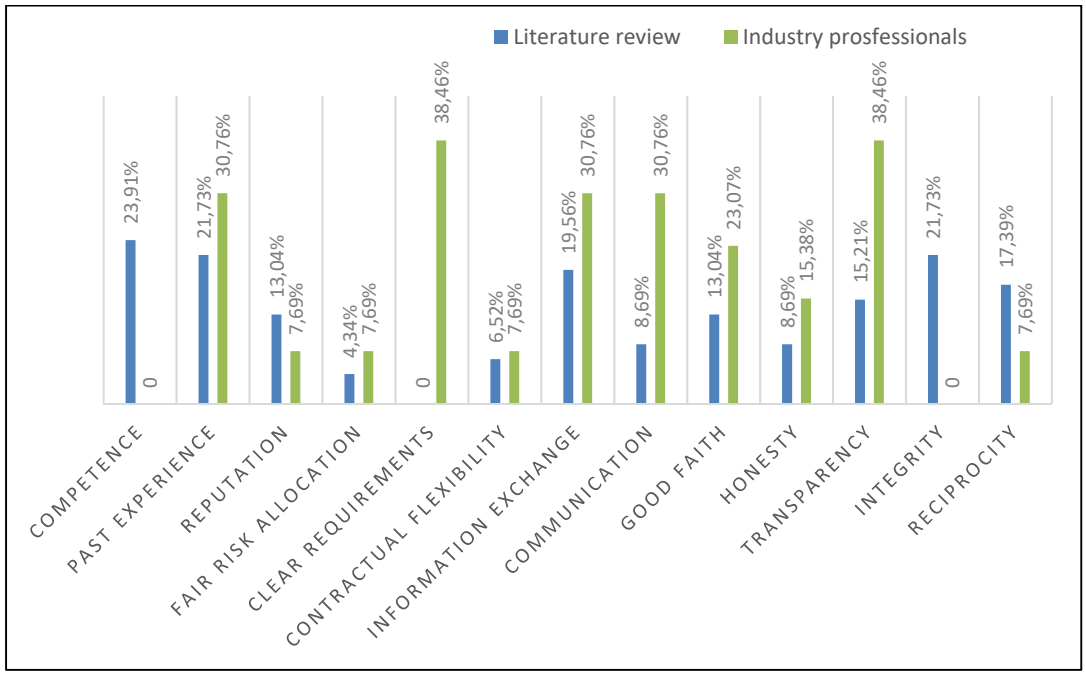


Figure 3.10 Code percentage for trust elements based on the type of references

The outcomes illustrate that clear requirement is the only item ignored in the literature, while all other elements have been covered. On the other hand, elements such as integrity and competence were not mentioned by the interviewees. The most critical trust-building factors pointed out in the literature were competence, past common experience, information exchange, reciprocity, and transparency. There is a wide gap regarding some elements, including reputation, reciprocity, and competence. However, some items like contractual flexibility, open conversation, and honesty are identified as pivotal in trust-building by literature and industry alike. Moreover, the findings from analyzing the lawyers' and BIM professionals' opinions are presented in Table 3.6, Figure 3.11, and Figure 3.12 in follow.

Table 3.6 Code frequency for trust elements based on occupation

Codes	**Interviewees' occupation**	
	Lawyer	**BIM professional**
Competence	0	0
Past common experience	1	5
Reputation	1	0
Fair Risk allocation	0	1
Clear requirements	5	5
Contractual flexibility	0	4
Communication	1	4
Good faith	2	1
Honesty	1	1
Information exchange	2	3
Transparency	2	3
Integrity	0	0
Reciprocity	0	1
Total	15	28

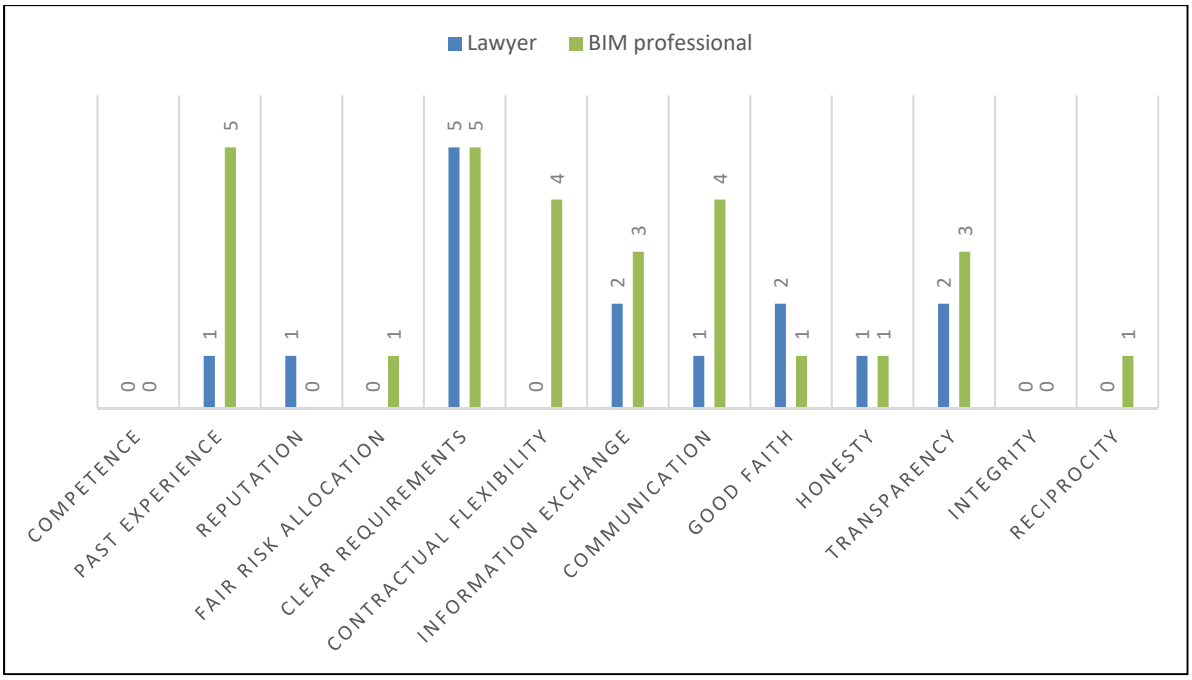


Figure 3.11 Analysis of trust-building elements based on occupation

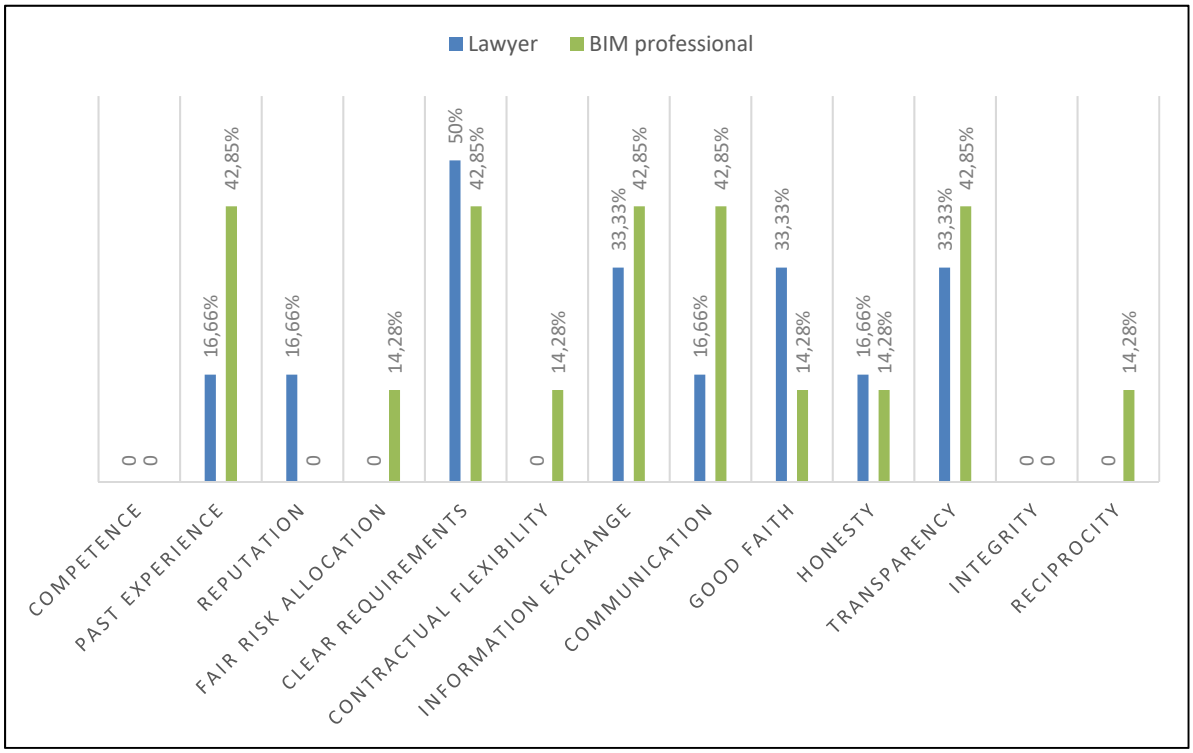


Figure 3.12 Code percentage for trust-building elements based on occupation

As the findings show, in order to develop trust, the BIM professionals identified more practical elements, namely past common experience and communication as trust-building factors, while reputation, was only mentioned by the lawyers. Moreover, the industry believed that contracts should be more flexible to make room for trust. BIM professionals also added that fair risk allocation is another contractual factor in boosting trust. Items, including honesty, good faith, and clear requirements were pointed out by the two groups, alike.

3.4 Proposed Trust Framework

As reported previously, various significant elements in promoting trust were identified during the literature review and the interviews. On the other hand, different types of trust were discussed in the literature review chapter. In addressing the third research objective, which aims at proposing a contractual framework contributing to developing trust, the identified trust-building element through literature review and interviews were divided into four categories to develop a trust framework.

This research proposes a conceptual trust framework based on the trust developing elements identified in the data analysis. This framework includes four types of trust, among which the "Contractual-based trust" is the focus of this study. Since the proposed framework is theoretical, further research on validation of that, through the lens of experts is needed for future studies. The developed trust framework is presented in **Erreur ! Source du renvoi introuvable.**, and has the following parts:

1. **Contractual-based trust** arises from the explicit written or oral agreements that a party will stick to the contracts or initial understanding (Sako, 1992). Therefore, the identified elements pertinent to contracts were classified in this category.

2. **Relational trust** derives from repeated interaction over time between the parties (Rousseau et al., 1998). Thus, elements such as good faith, honesty, communication, and transparency were put in this group.

3. **Calculative trust** is based on rational choice, emerges when the trustor perceives that the trustee intends to perform a beneficial action (Rousseau et al., 1998). Therefore, the features, which can be advantageous to the stakeholders in making rational decisions are considered in this group, including past common experience, competence, and reputation.

4. **Risk-taking trust** is the one suggested by this research inspired by the study of Das and Teng (1998). Since trust and risk-taking are associated with one another, they can be considered as "mirror images" of each other (Das & Teng, 1998). Therefore, it is stated that trust and risk-taking are reciprocal. Trust leads to risk-taking and risk-taking increases trust. Thus, risk-taking might be considered as a type of trust with elements, including reciprocity and integrity.

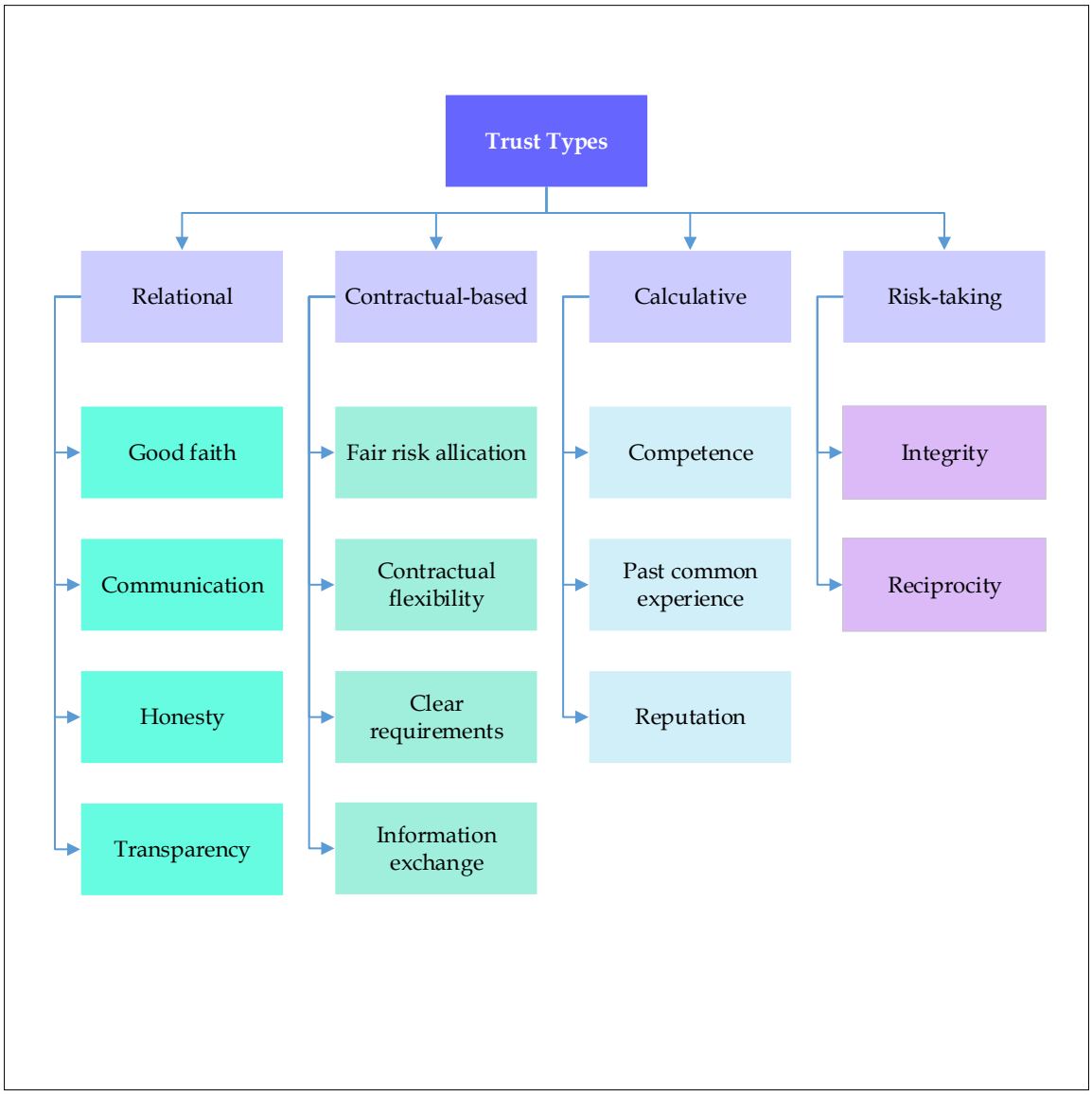


Figure 3.13 Proposed Trust framework

All these types of trust and their elements are influential in gaining a project's success. They could be developed in different phases of a project based on their type. For instance, calculative trust is more significant in the early stage of project when stakeholders are choosing the other party. Relational and risk-taking trust impact projects during the whole construction course. However, this study investigates only the trust elements pertinent to contracts, thus we focused on the contractual-based trust and analyzed it in more detail. Exploring the impact of other types of trust (from the proposed trust framework) on the success of projects, is beyond the scope of this research. The results based on the literature review and the interviews are shown in Table 3.7, **Erreur ! Source du renvoi introuvable.** and Figure 3.15.

Table 3.7 Code frequency for contractual-based trust based on the type of references

Codes	**Type of references**	
	Literature review	**Industry professionals**
Fair Risk allocation	2	1
Clear requirements	0	10
Contractual flexibility	3	4
Information exchange	12	5
Total	17	20

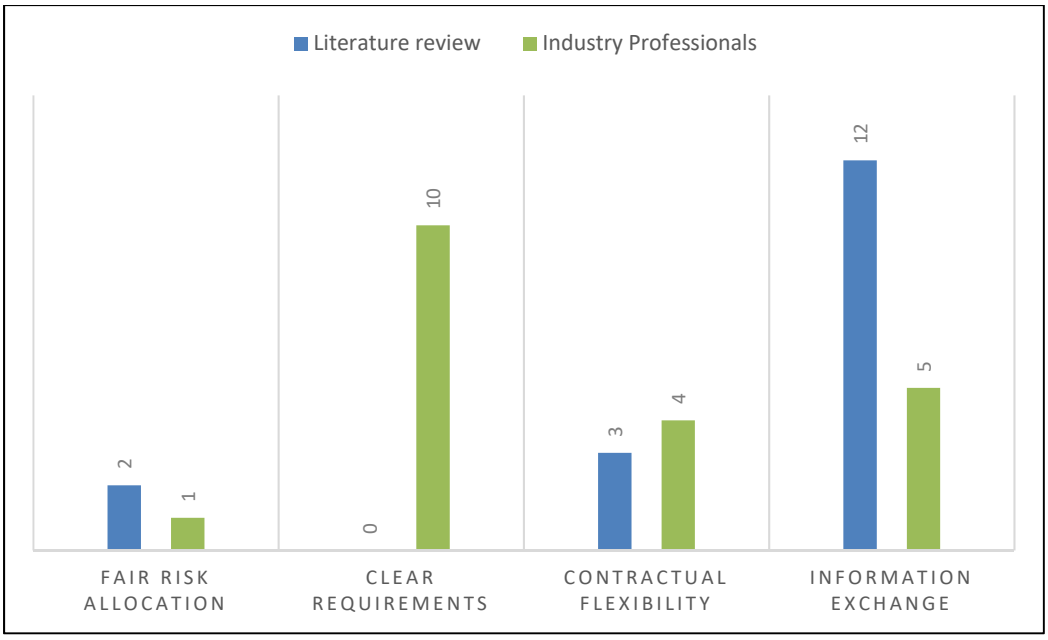


Figure 3.14 Analysis of contractual-based trust based on the type of references

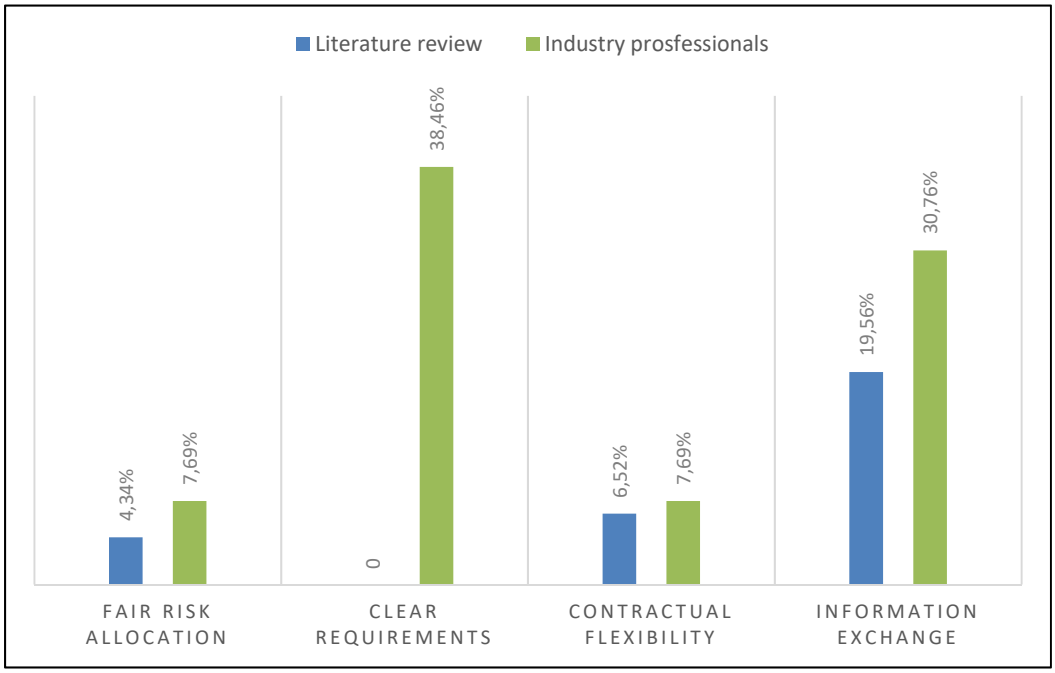


Figure 3.15 Code percentage for contractual-based trust based on the type of references

According to the chart above, industry professionals mainly mentioned clear requirements as an important trust factor, while previous studies have almost overlooked this item. On the other hand, both the literature and professionals pointed out contractual flexibility and fair risk allocation, indicating the significance of such items. Moreover, information exchange as the core of BIM projects was emphasized by both references. The following data will present the comparisons between the lawyers and BIM professionals in Table 3.8, **Erreur ! Source du renvoi introuvable.** and Figure 3.17.

Table 3.8 Code frequency for contractual-based trust based on occupation

Codes	**Interviewees' occupation**	
	Lawyer	**BIM professional**
Fair Risk allocation	0	1
Clear requirements	5	5
Contractual flexibility	0	4
Information exchange	2	3
Total	7	13

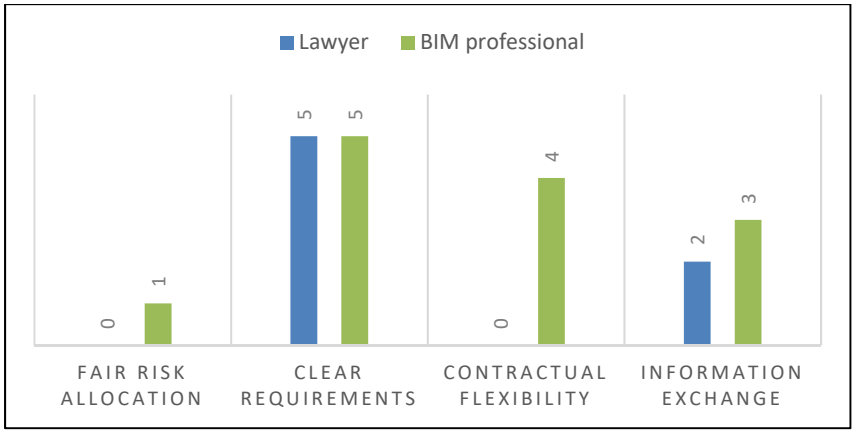


Figure 3.16 Analysis of contractual-based trust based on occupation

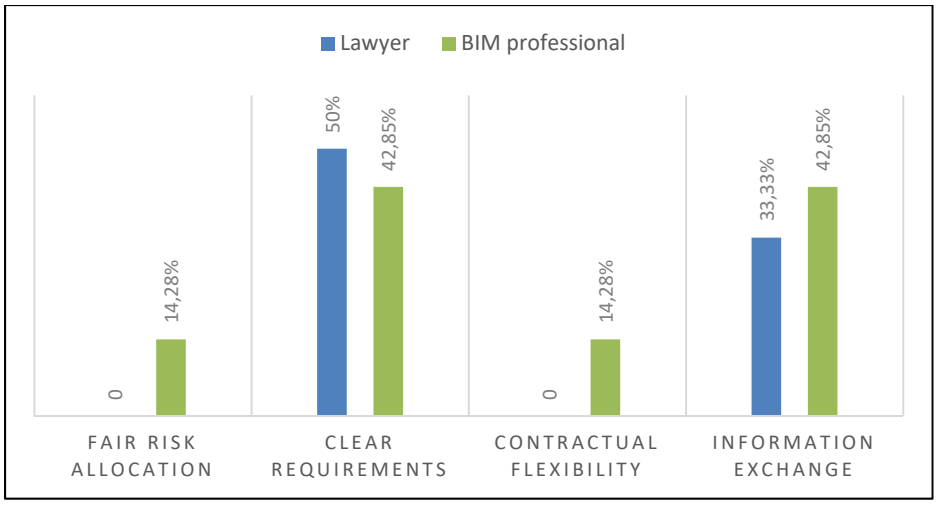
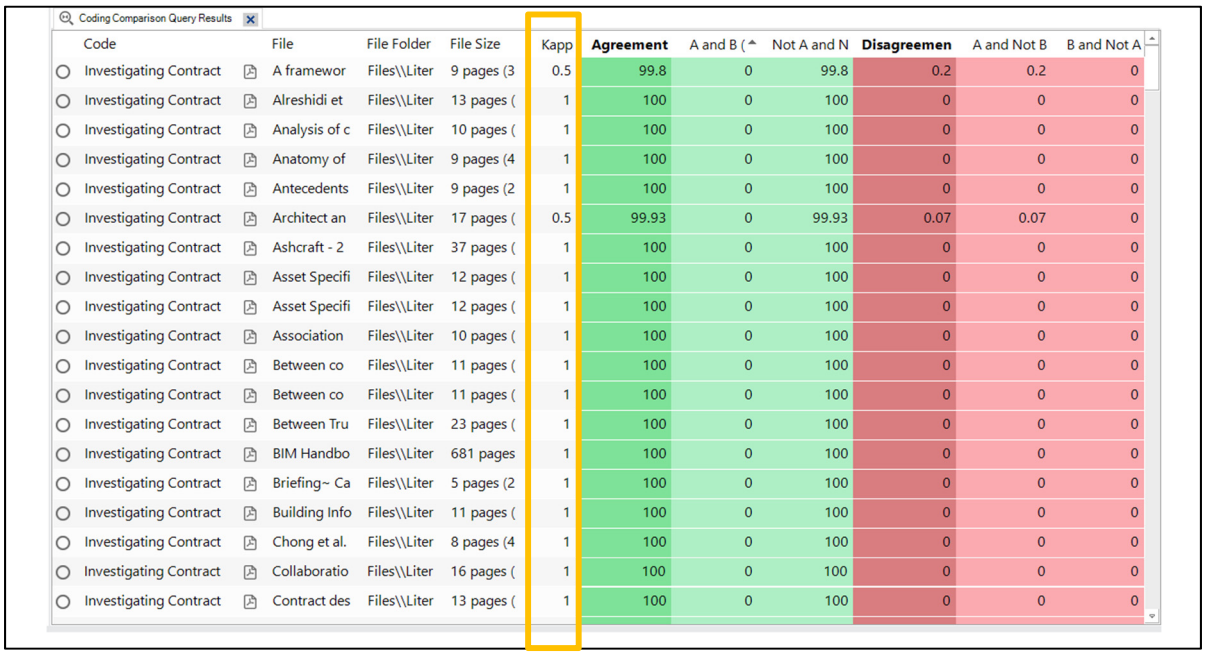


Figure 3.17 Code percentage for contractual-based trust based on occupation

As illustrated in the chart, clear requirements and information exchange, are considered necessary by both the lawyers and BIM professionals. Moreover, contractual flexibility, and fair risk allocation, are only stated by the BIM users, showing that the construction agreements require modifications on these items.

3.5 Coding system reliability test

After identifying the codes, they were reviewed by a validator in order to check the reliability of the system. Then, by using a coding comparison query, the results of the two coders were compared. The query results provide a “Kappa score”, as well as an agreement score for each file and node (Jackson & Bazeley, 2019), which illustrates the extent to which two coders agree on certain codes. Total agreements on a code are shown by a “kappa score=1”. Disagreements on the codes were discussed and resolved before producing the final results, and analyzing them. A sample of this test is represented in Figure 3.18.



Coding Comparison Query Results

Code	File	File Folder	File Size	Kapp	Agreement	A and B (	Not A and N	Disagreemen	A and Not B	B and Not A
Investigating Contract	A framewor	Files\\Liter	9 pages (3	0.5	99.8	0	99.8	0.2	0.2	0
Investigating Contract	Alreshidi et	Files\\Liter	13 pages (	1	100	0	100	0	0	0
Investigating Contract	Analysis of c	Files\\Liter	10 pages (	1	100	0	100	0	0	0
Investigating Contract	Anatomy of	Files\\Liter	9 pages (4	1	100	0	100	0	0	0
Investigating Contract	Antecedents	Files\\Liter	9 pages (2	1	100	0	100	0	0	0
Investigating Contract	Architect an	Files\\Liter	17 pages (	0.5	99.93	0	99.93	0.07	0.07	0
Investigating Contract	Ashcraft - 2	Files\\Liter	37 pages (	1	100	0	100	0	0	0
Investigating Contract	Asset Specifi	Files\\Liter	12 pages (	1	100	0	100	0	0	0
Investigating Contract	Asset Specifi	Files\\Liter	12 pages (	1	100	0	100	0	0	0
Investigating Contract	Association	Files\\Liter	10 pages (	1	100	0	100	0	0	0
Investigating Contract	Between co	Files\\Liter	11 pages (	1	100	0	100	0	0	0
Investigating Contract	Between co	Files\\Liter	11 pages (	1	100	0	100	0	0	0
Investigating Contract	Between Tru	Files\\Liter	23 pages (	1	100	0	100	0	0	0
Investigating Contract	BIM Handbo	Files\\Liter	681 pages	1	100	0	100	0	0	0
Investigating Contract	Briefing~ Ca	Files\\Liter	5 pages (2	1	100	0	100	0	0	0
Investigating Contract	Building Info	Files\\Liter	11 pages (	1	100	0	100	0	0	0
Investigating Contract	Chong et al.	Files\\Liter	8 pages (4	1	100	0	100	0	0	0
Investigating Contract	Collaboratio	Files\\Liter	16 pages (	1	100	0	100	0	0	0
Investigating Contract	Contract des	Files\\Liter	13 pages (	1	100	0	100	0	0	0

Figure 3.18 Reliability Test

3.6 Proposed Contractual Framework

The third objective of this research was to propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes.

Therefore, Figure 3.19 presents the conceptual contracting framework suggested by this study. It is in tune with objectives 1 and 2, which investigate:

- Contractual functions, their instantiation within BIM contractual language and their potential impact on BIM projects' success;
- How trust among BIM-enabled project's stakeholders can be developed through contractual functions.

According to the literature, it was illustrated that an adequate level of different contractual functions (controlling, coordinating, and contingency) is required to improve the positive

outcomes of trust and decrease the negative outcomes of distrust (Lumineau, 2017). Moreover, regarding the trust framework proposed in this study, the contractual trust could be enhanced through its elements, as identified in section 3.2.

On the other hand, contractual functions impact the contractual language of agreements by considering the success elements and covering BIM-related legal aspects in devising contracts. Delivering all those factors may lead to the successful conduct of BIM projects based on the contractual factors.

It is necessary to be noted that this framework includes only those elements related to contracts, therefore, contractual based trust cloud be enhanced by implementing this framework, while other types of trust are not directly related to contracts. However, another framework can be designed in future studies to tie the proposed trust framework and contractual framework to achieve BIM projects' success regarding the elements influential during the whole project processes. Devising such a framework is out of this study's scope.

Since this framework is conceptual, it requires to be validated by experts.

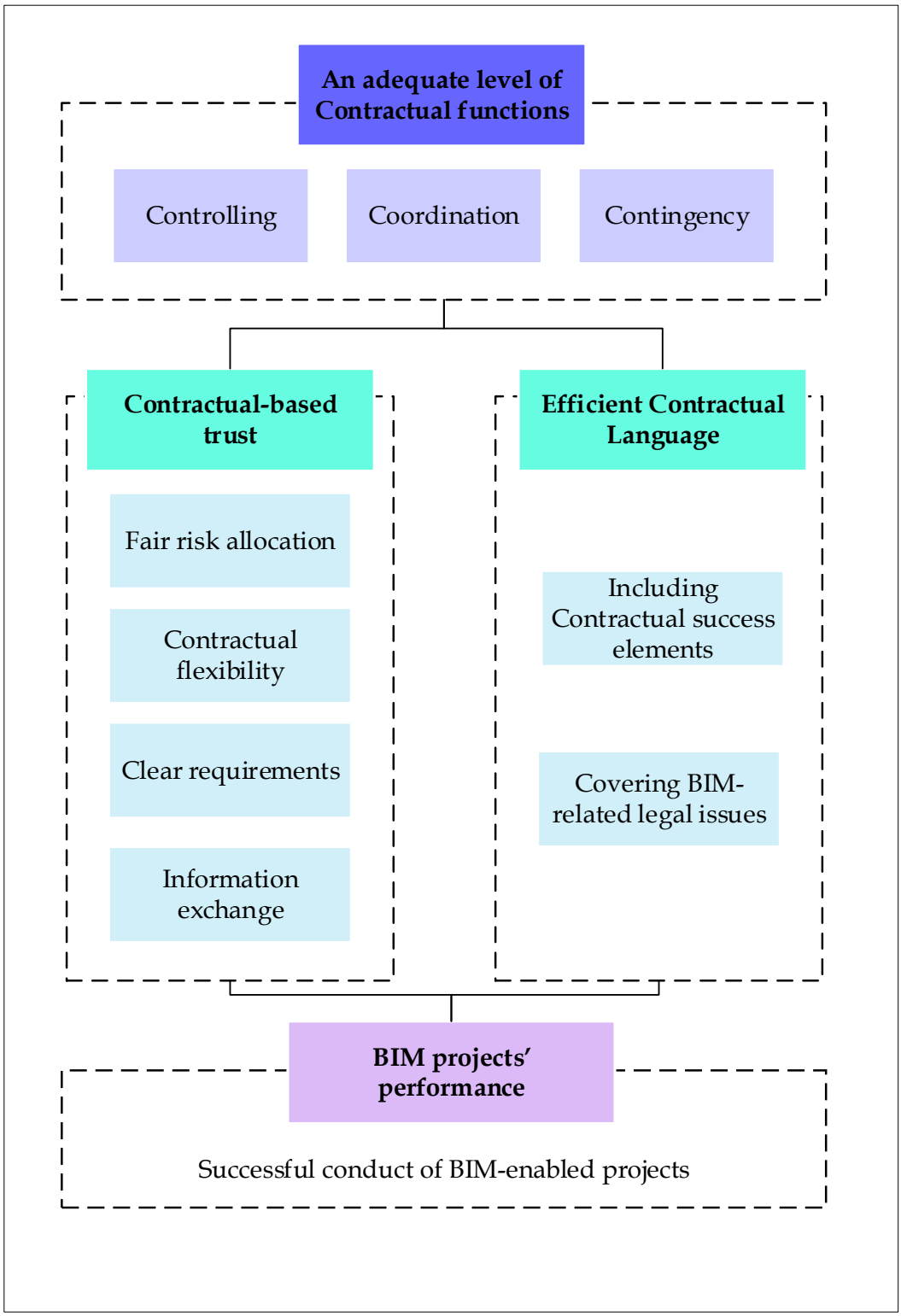


Figure 3.19 Proposed Contractual Framework

3.7 Results from the contracts analysis

In order to address the forth objective of this study: “To investigate current contractual mechanisms and their limitations in Canada”, this section provides a gap analysis of those agreements. CCDCs and BIM appendixes were analyzed based on the proposed contractual framework. The results are as follows.

3.7.1 CCDCs gap analysis

As discussed before, the legal issues of BIM-enabled projects were determined and introduced in depth. In this section, these elements are justified in the content of the contracts, including CCDC 2, 5, 14, 30, and BIM appendixes (CIC, AIA, Consensus, and IBC). Table 3.9 summarizes the level of coverage for each legal issue in the CCDC contracts.

Analysis of CCDCs based on the contractual framework indicates that the contractual language of these agreements is problematic for BIM-enabled projects. Contractual success elements are not considered in CCDCs, for instance, contractual documents are incomplete (BIM models are not included). Moreover, these agreements are incomplete regarding the provisions related to BIM. The legal issues of BIM projects (e.g., intellectual property and ownership of the BIM model) are not mentioned.

Therefore, that these agreements are not suitable to be applied alone in the BIM project. Some recommendations for introducing BIM in these contracts will be provided later (see chapter 4, Discussion).

Table 3.9 Gap analysis of CCDCs

	CCDC 2	**CCDC 5**	**CCDC 14**	**CCDC 30**
Intellectual Property	Not addressed	Not addressed	Copyright of digital models are not included	If using BIM, copyright is based on IBC
Ownership	1-Absence of digital models 2- Absence of the owner's right to keep the models for the project's lifecycle	1-Absence of digital models 2- Absence of the owner's right to keep the models for the project's lifecycle	1- Absence of digital models 2-Owner can just keep models he paid for	1- Absence of digital models 2-Owner can just keep models he paid for
Roles & Responsibilities	BIM roles are not defined	BIM roles are not defined	BIM roles are not defined	BIM roles are not defined
Liability	The liability of design is not clarified	The liability of design is not clarified	limited to liability of design services	Not clarified
Standard of Care	Not addressed	Not addressed	Not addressed	Not addressed
Model Security	Absence of model security	Absence of model security	Absence of model security	Absence of model security
Model Insurance	Not addressed	Not addressed	Not addressed	Not addressed

3.7.2 BIM appendixes gap analysis

BIM appendixes also require modifications to cover the legal issues. A summary of how such legal aspects are treated in the BIM appendixes is shown in Table 3.10.

Table 3.10 Gap analysis of BIM Protocols

	IBC	Consensus Docs	AIA	CIC
Intellectual Property	Copyright is for model element author	Each model contributor has the IP of their contribution	Transmitting party has the copyright ownership or the right to transmit it	All rights (including copyright) belong t o team members
Ownership	Each model author grants the owner license for project lifecycle	Each model contributor has the ownership of their contribution	Transmitting party has the ownership or the right to transmit it	The owner has the model ownership
Roles & Responsibilities	The role of the model manager is not defined in detail, and it will be determined based on the party's agreement	BIM manager's role and responsibilities a re defined	Model manager's role and responsibilities ar e defined	Information manager responsibilities are defined
Liability	Liability of parties is limited to direct damages	Each model contributor has the liability of their contribution	Not addressed	Excluded to those who have a license
Standard of Care	Defined based on agreement or law	Defined based on agreement or law	Not addressed	Defined based on agreement or law
Model Security	Absence of model security	Absence of model security	Defined by the model manager and users of the model	Not addressed
Model Insurance	Not addressed	Not addressed	Not addressed	Not addressed

The outcomes of analysis considering the contractual framework show that BIM appendixes lack including contractual success elements. Incompleteness of documents and provisions was identified in these agreements. BIM models are not among the contractual documents. Moreover, inconsistency of definitions was recognized. BIM roles and responsibilities are not clearly defined in some cases (IBC dose not provide model manager's responsibilities).

In addition, BIM-related legal issues require modifications. Intellectual property and ownership are not clearly defined. For instance, CIC applies a different approach regarding the model ownership and states that the owner possesses the model. Some differences regarding other legal aspects were identified in these BIM appendixes as well. For example, liability issues are not appropriately covered, and AIA does not explicitly address this aspect. It also applies to the standard of care, which is not mentioned in AIA. However, AIA is the only addendum that deals with model security. Model insurance and interoperability issues are not referred to in these agreements.

3.8 Summary

This section provided some results extracted from the coding system. The findings include the contractual elements of project success, BIM-related legal issues, and trust-building elements. By analyzing the collected data, some gaps between the studies and the interviewed BIM industry professionals were identified. Moreover, the differences between the opinions of the lawyers and the BIM experts were illustrated. A conceptual trust framework was presented as well. CCDCs and BIM appendixes were also analyzed to find the gaps regarding their contractual language. Finally, a contractual framework was proposed.

CHAPTER 4

DISCUSSION

This chapter will bridge the knowledge from previous studies and the practical experience of industry professionals. Through this section, the findings of each dimension of the research will be discussed in detail. In addressing the research objectives, suggestions for modifications in the construction contracts will be provided. Some recommendations for introducing BIM into Standard construction contracts (CCDCs), and updating the IBC contract will be presented as well.

4.1 Dimension 1: Contractual Language

Since the first dimension was developed to study contractual functions, their instantiation within BIM contractual language, and their potential impact on BIM projects' success, this section will explain how the outcomes of this research can address that objective.

4.1.1 Contractual elements of project success

In this cluster, seven important contractual factors, which may lead to accomplishing a BIM project successfully, were identified in the literature and from the interviews, and then the issues that arise from the lack of each element (success hampering issues) were used as codes, including:

- Unclear BIM requirements,
- Lack of standard BIM-based contracts,
- Incomplete contractual documents,
- Incomplete contractual provisions,
- Too much emphasis on controlling clauses,
- Contractual complexity,
- Inconsistent definitions,
- Unclear roles & responsibilities.

To analyze the codes, we compared the codes first between current literature and construction professionals to bridge the theory and the practice, then between the legal advisors and BIM professionals. The goal was to create a deep understanding of the contractual needs of the construction industry, which the contracts designers should consider. Moreover, we found out that some significant aspects require more consideration by the industry.

The results of the analysis indicate that there is a gap between the literature and industry regarding the contractual elements. While the scholars are more concerned about the completeness and complexity of the contracts, the industry identified some other factors as problematic in the projects. One item mentioned by the industry was "unclear BIM requirements". The reasons for not having clear requirements in BIM projects are varied. Sometimes the differences exist between what is written in the contract and what the stakeholders expect, which will lead to disputes and distrust. Moreover, some owners are not entirely familiar with BIM; thus, they are unaware of its capabilities and deliverables. In such cases, many specifications might be asked after signing the contract, thus leading to disputes. Furthermore, an unclear level of detail (LOD) could also be problematic in the project if, for instance, the contractor and designers have not come into an explicit agreement about that aspect. Therefore, a full clarification on such issues is required among all the stakeholders. As such, all the desired elements of the model should be specified with the required level of detail depending on the phases of the project, and with the respective responsible party (Model Element Author).

The interviewees also pointed out incomplete contractual documents as an obstacle in BIM projects. 3D models as the fundamental tools of BIM projects are not often included in the contractual documents. As a result, 3D models are merely used as references and not the main instrument to be collaboratively used by all the stakeholders. Designers are not considered liable for any errors and deficiencies, and thus, 3D models are not reliable. This causes a waste of time and resources for any party involved in the project using the models. They might have to recreate the whole or at least part of the model to serve their purposes in the project.

Lack of standard BIM-based contracts was discussed by both the studies and industry as a significant barrier in BIM projects, requiring more recognition. Interviewees also suggested

that all required guidelines and appendixes be introduced and referred to in the standard forms of contracts such as CCDCs.

Moreover, the three factors, including unclear BIM requirements, incomplete contractual documents, and lack of standard BIM-based contracts, are emphasized by the BIM professionals more than the lawyers. This indicates a lack of connection between the lawyers as designers of the agreements and the industry professionals as the end-users of such contracts. Thus, these elements require urgent attention by the contract designers to alleviate the negative outcomes of such inefficiencies.

4.1.2 BIM-related legal issues

In this part, the legal issues of BIM-enabled projects were explored. Eight elements were identified to be used as codes. They are as follows:

- Model ownership,
- Intellectual property,
- Clear BIM roles & responsibilities,
- Liability,
- Standard of care,
- Model security,
- Model insurance.

The outcomes of the comparison between the studies and industry illustrate that issues such as model ownership, intellectual property, clear BIM roles and responsibilities, and liability are of great importance in both literature and industry viewpoints. Whereas, model security, model insurance, and standard of care have drawn the scholar's attention primarily. While these aspects are not considered necessary in practice, they may lead to negative consequences like disputes and claims. Thus, construction stakeholders may need to take these issues into account when preparing and signing a contract.

On the other hand, the comparison between lawyers' and BIM professionals' perspectives on the BIM legal issues indicates that legal advisors emphasized the inclusion of clear BIM roles and responsibilities, intellectual property, and standard of care. While among the industry professionals, there is much debate on model ownership and liability. It is evident that current contracts lack covering these issues. Thus, the contract designers have the responsibility to revise the agreements. Moreover, the standard of care, model security, and model insurance are the elements that require a higher level of attention by both the legal advisors and the BIM users.

Moreover, regarding the contractual functions presented in the literature review section, the provisions of the agreements serve different purposes. These functions include controlling, coordinating, and contingency adaptability. Therefore, among the BIM issues investigated in this research, model ownership, intellectual property, liability, standard of care, model insurance, and model security are safeguarding clauses. While, clear BIM roles & responsibilities, acts as the coordinating function.

4.2 Dimension 2: Trust development

The second category aimed at answering how trust among the BIM project stakeholders can be developed through contractual functions. Thus, in this dimension, the most significant factors in developing trust within projects were identified and named as codes, including:

- Past common experience,
- Information exchange,
- Competence,
- Transparency,
- Integrity,
- Reciprocity,
- Communication,
- Good faith,
- Clear requirements,

- Reputation,
- Contractual flexibility,
- Honesty.

The results indicate the literature's emphasis on the elements such as competence, past common experience, integrity, and reciprocity. While, in practice, clear requirements, was mentioned for improving trust more than other factors. This research focused on the contractual trust developing items, which are:

- Fair risk allocation,
- Contractual flexibility,
- Clear requirements,
- Information exchange.

Considering these four items in the studies and the industry showed that literature has paid less attention to the clear requirements as a trust factor. Moreover, both the scholars and the construction professionals took fair risk allocation, contractual flexibility and information exchange into account.

On the other hand, when comparing the lawyers and BIM professional perspectives pertinent to contractual-based trust elements, it was realized that fair risk allocation and contractual flexibility were introduced only by the construction practitioners. It shows that lawyers may not be fully aware of such issues being influential in building trust. The legal advisors seem to be more willing to include items such as intellectual property, to avoid the legal consequences, while in practice, users expect to also have room for flexibility. This approach may provide them with the opportunity to share risks fairly among themselves.

4.3 Suggestions to improve contractual language and trust in BIM projects

In the previous sections, BIM contractual language, contractual functions and trust were discussed, and a contractual framework was proposed. Therefore, in addressing the research objectives, the proposed contractual framework, which was designed based on the collected data from the literature review, interviews, and the analysis results could be applied. These recommendations provided in what follows, could be validated in the future with help of experts through a survey study. The objectives of this study and their respective responses are:

- To study contractual functions, their instantiation within BIM contractual language, and their potential impact on BIM projects' success:

According to the results, it is not recommended to have a too detailed contract. Involving too many provisions with a high level of elaborateness may lead to complexity of the agreement (Mellewigt et al., 2012), and misunderstanding by the stakeholders, and opportunism (Lumineau, 2017). Moreover, lower trust and higher cost (Shi et al., 2018) would be the possible negative consequences of this issue.

On the other hand, stakeholders are advised to avoid the incompleteness of specific documents and provisions. According to the interviews, for BIM-enabled projects, necessary elements such as 3D models, appendixes, and standards should be included in the contractual documents.

Meanwhile, risk allocation, dispute resolution, and allocation of roles and responsibilities can be achieved through a concrete agreement. Therefore, devising a standard BIM-based contract is drastically required (Abd Jamil & Fathi, 2020), which also decreases the adoption of costly bespoke contracts (Kuiper & Holzer, 2013).

According to the interviewees, common definitions are required as well, for different BIM appendixes and guidelines to avoid misinterpretations and potential disputes. It is also recommended that stakeholders avoid too much emphasis on the controlling clauses, which may negatively influence trust (Lumineau, 2017).

For the coordination provisions, it is advised to clarify the contractual relationships specifically for the key parties. The flow of information would be more efficient when each actor knows their connections with other members. Furthermore, stakeholders should avoid any ambiguity in defining the responsibilities of the members. Such clarity assists in identifying the liable members, lower disputes, and increase trust

- To determine how trust among BIM-enabled project's stakeholders can be developed through contractual functions:

It was illustrated that an optimal level of trust is required in the projects (Lee et al., 2018). While the low level of trust will lead to devising a complex contract, too much trust also brings about adverse outcomes, including blind faith (Lee et al., 2018). In addition, parties may consider some room for flexibility in their agreements. Such flexibility might be pertinent to risk and reward provisions, which may also improve trust (Das & Teng, 1998).

Previous studies point out fair risk allocation as an influential factor in project success. Hsu et al. (2015) declare that specific performance that is expected from stakeholders arises from the contractual terms. Thus, designing contractual provisions regarding the potential damage might be considered a process of allocation and management of risk. With this approach, parties jointly negotiate certain limitations imposed on their liabilities (Ashcraft, 2008). Such risk allocation decreases the liability fears and increases the information flow. Moreover, fair risk allocation between the parties may lead to an adequate level of each contractual function (controlling, coordinating, contingency) that would positively affect trust and increase project performance (Lee et al., 2018).

Moreover, coordination provisions, which are related to roles and responsibilities, reporting, project schedule, and team design (Mellewigt et al., 2012) should be carefully drafted since excessive coordination function with too much information sharing and confidence may increase adverse outcomes of trust (Lumineau, 2017). Furthermore, identifying the project's requirements and the stakeholders' expectation is a key element in increasing trust and project success. Moreover, in order to promote the collaborative environment, the communication

channels, including meetings and platforms for sharing information, should be precisely defined, as emphasized by the interviewees. These two goals could be achieved by applying ISO 19650 as an international standard for managing information over the whole life cycle of a built asset using Building Information Modeling.

On the other hand, integrating IPD with BIM-enabled projects will lead to higher collaboration, boosting trust, and better performance. IPD, as an integrated delivery system has received a positive reputation in improving trust among stakeholders. Pishdad-Bozorgi and Beliveau (2016) state that IPD aims to address mistrust by creating an environment of mutual trust and respect. It offers a new contractual, behavioral, and organizational context for delivering construction projects in such a collaborative manner (Pishdad-Bozorgi & Beliveau, 2016). It includes many trust-building attributes, such as an effective communication system, a relational form of contract, fair/equitable agreements, balanced risk/reward sharing, information sharing, open dialogue/honest communication/transparency, and collaborative and cooperative culture (Alves & Shah, 2018).

- To propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes:

According to the results of this study, a contractual framework was proposed in chapter 3 (Results). This framework aims to clarify the connection between various elements of this research, including contractual functions, trust, and contractual language, in providing a suitable platform for contracting. It illustrates that contractual functions (controlling, coordinating, and contingency) impact both the contractual language of agreements and contractual trust development among stakeholders. Meanwhile, efficient contractual language requires contractual success elements (such as completeness of contractual documents, completeness of contractual provisions, consistency of definitions, an optimal level of detail, allocation of roles and responsibilities, clarity of requirements, and standardization) to be considered when designing a contract. Moreover, BIM-related legal issues (such as intellectual property rights, model ownership, model security, model insurance, liability issues, clear BIM roles and responsibilities, and standard of care), should be covered in the agreements.

Furthermore, an optimal level of trust in the projects can be achieved through factors such as fair risk allocation between the parties, contractual flexibility, defining clear requirements, and clarifying the information exchange in the contracts. Should all these requirements be met, the BIM project's performance will be higher, leading to the successful conduct of such projects.

The proposed framework could be applied in different delivery systems discussed in Chapter 1: Literature Review. While the contractual language in CCDC 2, 5, 14, 30 can be developed by considering the success elements and covering BIM-related legal issues, optimal trust is more achievable in IPD contracts (CCDC 30). For DBB projects (CCDC 2), items such as fair risk allocation and contractual flexibility may not be attainable as contractors normally shoulder projects' risks. DB (CCDC 14) and Construction management (CCDC 5) are more flexible in terms of improving trust comparing to CCDC 2. However, as the projects' risks are mutually shared between stakeholders in CCDC 30, the contractual elements of trust are more likely to be justified in these contracts to elevate trust.

Since this study focuses on the project's elements related to contracts, trust part in this framework only includes contractual-based trust. Although, improving trust among the stakeholders is not limited to the contractual factors, investigating three other types of trust in this study (relational, calculative, risk-taking) and their elements requires further studies.

Since this framework is theoretical, it requires to be validated. Such a process was not defined within the scope of this study; however, further research can be carried out for validation of the framework. Applying a survey approach, including interviews with experts and designing a questionnaire is recommended.

- To investigate current contractual mechanisms and their limitations in Canada:

In the previous chapter, a gap analysis of the CCDCs was presented. It was illustrated that these agreements are not appropriate for use in BIM-enabled projects, and an adequate BIM environment could be introduced to them. To do so, according to the interviews, the BIM models are required to be added to the contractual documents. Moreover, BIM appendixes and

standards might be referred to in the CCDCs to encourage stakeholders to become familiar with them and choose the most appropriate contract.

Since this study focused on the IBC as a Canadian BIM appendix, this agreement will be discussed further. According to the previous studies, interviews, and contracts investigation, some amendments to the IBC appendix in terms of its contractual language can be proposed, which are related to BIM-related legal aspects as follows:

As mentioned previously, intellectual property and model ownership are identified as significant issues mentioned in the contracts. Interviewees emphasized that these aspects require more detail in the agreement. Such amendments should be accomplished by the legal advisors. Moreover, section 5.8 in IBC contains a blank box to define the BIM manager role by the stakeholders. Model manager's responsibilities are not pre-defined in the IBC appendix. However, a lack of standard responsibilities will lead users to customize the contract. Aside from the higher cost of such effort, there might be disagreements and claims over the duties of the model manager. Thus, clarification of this role and its responsibilities seems necessary.

In addition, required arrangements for model security and model insurance should be pointed out in the BIM contract. Furthermore, the standard of care is expected to be defined by the stakeholders; otherwise, the law of the place of the work will be applied. In this regard, an interviewee (CC-1) recommended:

> To define the standard of care, I see two options. The first would be to draft one from scratch and have everyone agree. Something as simple as “The Consultant shall exercise the degree of care, skill, and diligence normally provided by a qualified professional consultant in the performance of services of a similar nature to the Services required under this Agreement.” may be suitable. Alternatively, parties can turn to industry standard documents. See for example ACEC 31 GC 5.2/ OAA 600 GC 1.1 / RAIC Document Six GC 1.1 as examples.” In either case, it can be referred to in the contract provisions.

4.4 Summary

The goal of this chapter was to describe how the findings of the study address the research objectives. It was realized that in each dimension, some factors were mutually mentioned by the previous studies, and the industry professionals, while for other codes, there were some discrepancies. These identified gaps require further research to help improve the contractual language and trust in the BIM-enabled projects. Moreover, the recommendations provided on contractual language, trust, and modifications for the IBC contract might be beneficial for the successful conduct of BIM-enabled projects.

CONCLUSIONS

Despite all the benefits of BIM in the construction industry, contractual issues are among the barriers to successful BIM implementation. Various BIM appendixes have been introduced to deal with such problematic factors, while proper application of these documents remains low. Moreover, unless such obstacles are eliminated, BIM cannot fully accomplish its core purposes and contribute to projects' success.

On the other hand, contracts are not the only mechanism for gaining the project's goals. Trust is identified as another element that can influence construction processes, improving the flow of information, by enhancing team performance, promoting collaboration, and decreasing opportunism. Therefore, the collaborative nature of BIM projects requires trust, and in turn, trust can enhance the project's performance.

However, when investigating the impact of contractual language and trust, different contractual functions, including controlling, collaborating, and contingency adaptability, should be considered as well.

Therefore, the objectives of this research were defined as:

- To study contractual functions, their instantiation within BIM contractual language and their potential impact on BIM projects' success;
- To determine how trust among BIM-enabled project's stakeholders can be developed through contractual functions;
- To propose a framework that considers trust between parties in BIM projects from a contractual perspective to improve project outcomes;
- To investigate current contractual mechanisms and their limitations in Canada.

To address these research objectives, a content analysis approach was applied. First, data collection was carried out through an in-depth literature review on contractual language, BIM-related legal issues, and trust development. Then a coding system was developed in Nvivo 12 containing the identified codes from the literature.

Semi-structured interviews were fulfilled in the next step. A panel of BIM experts, including legal advisors and BIM practitioners, were invited, and thirteen interviews were accomplished online. Next, the data gathered from the interviews were transcribed in Nvivo, and a round of coding action was conducted. The coding process was repeated several times to increase the level of accuracy. Two dimensions were defined for the codes: contractual language and trust development. Moreover, the comparisons for analysis were performed in two different clusters, once between the literature and construction professionals, and then between the lawyers and BIM users.

The analysis of the first dimension (Contractual language), indicated a gap between the studies and the industry. Scholars have not identified elements such as allocations of roles and responsibilities and completeness of contracts. On the other hand, the importance of standardization was emphasized by both studies and professionals.

In the second part of the analysis of dimension 1(Contractual language), the legal issues of BIM projects were identified. The outcomes illustrated that issues such as model ownership, intellectual property, clear BIM roles and responsibilities, and liability were considered significant to be clarified in the contracts. On the other hand, model security, model insurance, and standard of care, were not often mentioned by the BIM professionals. These issues have also been overlooked in the BIM appendixes. Thus, there is a need to investigate and include them in the agreements.

The analysis of the second dimension (Trust development), yielded the essential elements of improving trust. By proposing a conceptual trust framework, these elements pertinent to contracts were explored in more detail. The results represented that, the importance of clear requirements, as a trust-building element introduced by the industry, has not been adequately studied by the researchers. However, literature and industry stated fair risk allocation and contractual flexibility, emphasizing its importance in designing contracts. Additionally, these elements were cited mostly by the BIM users, showing that the legal advisors should pay more attention to such factors in devising the agreements. Some recommendations were proposed

as to how contractual language and trust can be elevated for the successful implementation of BIM-enabled projects.

Furthermore, to address the last third objective, a contractual framework was proposed. It considers the dimensions explored in this study, including contractual language and trust development as well as contractual functions, and depicts the relationships between them.

Moreover, CCDCs (2, 5, 14, 30) were investigated to realize whether they cover the BIM-related issues. The results indicate that introducing BIM into those standard contracts might be practically accomplished by pointing out the BIM appendixes and standards and encourage stakeholders to apply them in BIM projects.

Furthermore, the deficiencies of the BIM appendixes (AIA, CIC, Consensus Docs, IBC) were explored, with more focusing on the IBC. It was realized that the IBC appendix requires to be updated. Some modifications pertinent to the legal issues were presented as well.

Research Limitations

Since part of data collection in this study was carried out by conducting interviews, one possible limitation might come from the relatively small number of participants. Although 25 experts in the construction field and BIM processes were invited to the interviews, only a panel of 13 professionals accepted to take part in the meetings. Thus, as a result of a small sample group, the results of this research may not be generalized. Increasing the number of interviewees may enhance the reliability of the research.

Moreover, the data collection in this study was accomplished through literature review and interviews, which then were coded within a qualitative system. As one researcher performed the whole process of data gathering and data analysis, some biases may exist. In order to alleviate such drawbacks, the accuracy of the findings might be examined by validators.

In studying trust, this research focused on the trust elements, while investigating distrust factors was beyond the scope of this study.

Furthermore, the conceptual trust framework and contractual framework proposed in the result chapter remained theoretical. They could be validated by experts through a survey study.

In addition, reflection of the improved contractual language and contractual-based trust on the project's outcome is not considered in this research, thus this limitation may require further investigation.

RECOMMENDATIONS

Given the bounded scope of this research and its limitations, there is still room for the study of the subject further. In this regard, some suggestions for future research will be proposed as follows:

1. Two dimensions were investigated in this research namely contractual language and trust. The first dimension included the success elements of projects and BIM-related legal barriers, and the second dimension involved trust-building elements. However, this data can be further explored to discover other potential dimensions (and elements).
2. Moreover, with a larger sample group, the comparisons between the literature and industry would be more accurate. The outcomes of more thorough and detailed research in this area would collect the industry requirements regarding the agreements and then assist the designers in amending the contractual language to be more effective and practical. The application of a questionnaire can enhance the accuracy of the outcomes.
3. Along with trust, previous studies examined distrust as well. Since exploring distrust elements was mentioned previously as a limitation to this research, investigating the impact of distrust factors is recommended for future studies.
4. As this research presented a conceptual trust framework, it requires further investigation and validation by the experts.
5. Lastly, the contractual framework proposed by this research is conceptual. Validating that framework would be accomplished through future research.

APPENDIX I

TRUST FRAMEWORKS TABLE

Table-A I-1 Trust Frameworks

Researcher	Type of trust	Trust Elements
Wong et al. (2008)	System-based trust	Organizational policy Communication system Contracts/agreements
	Cognition-based trust	Communication/interaction Knowledge
	Affect-based trust	Being thoughtful Emotional investments
Laan et al. (2012)	Trust propensity	Past experiences Cultural backgrounds Social settings
	Cognition- or knowledge-based trust	Competences Capabilities Tendency to abstain from opportunistic behavior
	Affect-based trust	Care, Concern, Honesty, Understanding
	Habituation or routine-based trust	Actors are so used to each other's working procedures

Table-A I-1 Trust Frameworks (Continued)

Researcher	Type of trust	Trust Elements
Pishdad-Bozorgi and Beliveau (2016)	System-based trust	Team building Create a sense of belonging Set mutually shared goals Effective communication system Clearly defined contract A fair and equitable agreement Alternative dispute resolution Balanced risks sharing
	Cognition-based trust	Increased work interaction Information sharing Reciprocity Open dialogue Transparency Reputation and experience
	Affect-based trust	Mutual understanding Developing a personal relationship Establishing a long-term relationship

Table-A I-1 Trust Frameworks (Continued)

Researcher	Type of trust	Trust Elements
Järvinen and Branders (2020)	System-level features	Established structures Roles and responsibilities Regulations, culture, processes Forums of communication
	Individual- and organizational level features	Interests and revenue Generation models Personal relations Situational awareness
	Rules of interaction	Rules of behavior Rules of communication & matters to be communicated

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