شبكة المعلومات الجامعية

بسم اللّه الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم باللّه العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

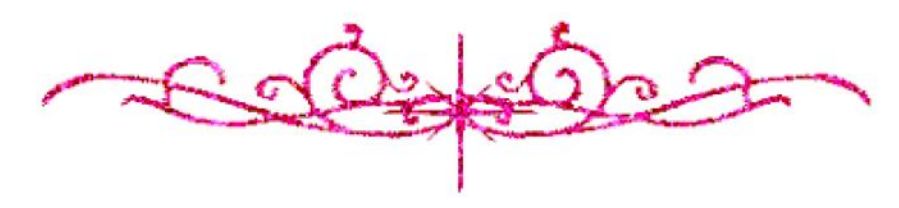
تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصل



Content Analysis for BIM Adoption in Construction Contracts

By

Mohamed Ahmed Mahmoud Ragab

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfilment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Integrated Engineering Design in Construction Projects

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

Content Analysis for BIM Adoption in Construction Contracts

By

Mohamed Ahmed Mahmoud Ragab

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfilment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Integrated Engineering Design in Construction Projects

Under the supervision of

Prof. Mohamed Mahdy Marzouk

Professor of Construction Engineering and Management
Structural Engineering Department
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

Acknowledgment

Since day one from the work on this research I intended and actually vowed to myself that I would try as much as possible to gain true knowledge and experience from the journey that I was about to begin. This could have not been possible without the people who supported me throughout this journey. I am grateful to my supervisor **Professor Mohamed Mahdy Marzouk** for his guidance and valuable ideas. I truly appreciate his trust in me, which provided me with motivation and sense of responsibility.

I am sincerely thankful to my family for their support and efforts through my life-time journey. I would specially like to show my gratitude to my father and role model. Last but not least, a special thanks to my mother who gave me the persistence to move forward in my research. The completion of this research could not have been possible without your continuous encouragement.

Mohamed A. Ragab

30 December 2019

Table of Contents

Acknowledgment ..... **i**
Table of Contents……..……..**ii**
List of Tables ..... **v**
List of Figures ..... **vi**
Abstract ..... **viii**
Chapter 1 Introduction **2**
1.1 General 2
1.2 Problem Statement 2
1.3 Research Objectives 3
1.4 Research Scope and Limitations 3
1.5 Research Methodology 3
1.6 Thesis Organization 4
Chapter 2 Literature Review **5**
2.1 General 5
2.2 Potential Contractual Issues 5
2.2.1 Standard of Care 5
2.2.2 Risk Allocation 6
2.2.3 Interoperability Issues 7
2.2.4 Model Ownership and Intellectual Property 8
2.2.5 BIM and Collaboration 10
2.2.6 Project Information Requirements 11
2.2.7 Limited Liability of Software providers 13
2.3 The treatment of BIM in Standard form of contracts 14
2.4 An overview on BIM Protocols 17
2.4.1 Integration of the CIC Protocol in contract documents 19
2.4.2 BIM Protocols and Model Ownership 20
2.4.3 BIM Protocols and Integrity of Data 21
2.4.4 BIM Protocols and Standard of care 22
2.4.5 Summary and Research Gaps 22
Chapter 3 Proposed Framework **24**

3.1 General 24
3.2 Content Analysis: An Overview 24
3.2.1 Data Collection and Selecting the Unit of Analysis 25
3.2.2 Developing the Category System 26
3.2.3 Assessing Validity 26
3.3 Types of Content Analysis Approaches 26
3.4 Implementing Directed Content Analysis approach 27
3.4.1 Validating the Identified Contractual Categories 29
3.4.2 Selecting the unit of analysis 33
3.4.3 In detail Analysis 34
3.5 Summary 34
Chapter 4 Content Analysis 35
4.1 General 35
4.2 Project Partnering Contract (PPC 2000): An Overview 35
4.3 Analyzing PPC2000 35
4.3.1 Core Group 36
4.3.2 Collaboration in PPC2000 39
4.3.3 Common Data Environment 44
4.3.4 Model Ownership and Intellectual property in PPC2000 45
4.3.5 Project Operation (Post Construction) in PPC2000 47
4.3.6 Standard of Care in PPC2000 47
4.3.7 Summary of PPC2000 BIM Supporting Features 48
4.4 Nec4 Engineering and Construction Contract (NEC4 ECC): An Overview 50
4.5 Analysis of the NEC4 ECC amended January 2019 50
4.5.1 Early Warning in NEC4 ECC 51
4.5.2 Project Operation in NEC4 ECC 53
4.5.3 Collaboration in NEC4 ECC 54
4.5.4 Common Data Environment in NEC4 ECC 54
4.5.5 Interoperability in NEC4 ECC 55
4.5.6 Standard of Care 55
4.5.7 Summary of NEC4 ECC BIM Supporting Features 56
Defines liability to handle Interoperability issues 56

4.6 JCT – Construction Excellence Contract (JCT – CE 2016): An Overview 57
4.7 Analysis of the JCT – CE 2016 57
4.7.1 Collaboration in the JCT 58
4.7.2 Standard of Care in the JCT 59
4.7.3 Priority of Documents in the JCT 60
4.7.4 Project Operation (Post Construction) in the JCT 61
4.7.5 Summary of JCT CE BIM Supporting Features 61
4.8 Summary 62
Chapter 5 Results and Discussion 63
5.1 General ..... …63
5.2 Adopted approaches for Risk allocation aspects 65
5.3 Adopted approaches for Model Ownership aspects 66
5.4 Adopted approaches for Information loss aspects 68
5.5 Adopted approaches for Collaboration aspects 69
5.6 Adopted approaches for Professional legal duty aspects 70
5.7 Result Discussion 71
5.8 Summary 72
Chapter 6 Conclusion and Recommendations 73
6.1 Conclusion 73
6.2 Research Contribution 74
6.3 Research Limitation 75
6.4 Recommendations for future work 75
References 76

List of Tables

Table 2.1: The Treatment of BIM in Standard Form of Contracts 18
Table 3.1: Identified Legal Categories 29
Table 3.2: Selection Criteria of Standard form of contracts 33
Table 4.1: Core Group Responsibility Check list in PPC2000 38
Table 4.2: BIM supporting Features in PPC2000 49
Table 4.3: NEC4 ECC Components 51
Table 4.4: Core Group Responsibility Check list in NEC4 54
Table 4.5: BIM supporting Features in NEC4 ECC 56
Table 4.6: BIM supporting Features in JCT – CE2016 61
Table 5.1: BIM supporting features in the studied contracts 71

List of Figures

Figure 2.1: Sharing of the Digital Model using IFC 8
Figure 2.2: BIM Maturity Levels 10
Figure 2. 3: Information management interactions between parties 11
Figure 2. 4: Relationship between the contractual documents 12
Figure 2.5: CDE in BIM projects 13
Figure 2.6: The relationships between the contract and the associated documents 16
Figure 2.7: The key contents of a BIM Protocol 17
Figure 2.8: The association of the CIC BIM protocol within the Project Contracts 19
Figure 3.1: Content Analysis Process developed 28
Figure 3.2: Flow of information through the different phases of a systematic review 30
Figure 3.3: Definition of BIM in FIDIC 31
Figure 3.4: Legal aspects associated to BIM 32
Figure 4.1: Core Group responsibilities in PPC2000 37
Figure 4.2: Governing principle of the Partnering Team in PPC2000 39
Figure 4.3: Design development Process in the PPC2000 41
Figure 4.4: Shared incentives in PPC2000 43
Figure 4.5: Early Warning system and CDM in PPC2000 44
Figure 4.6: Intellectual Property in PPC2000 45
Figure 4.7: Appendix 10 in PPC2000 46
Figure 4.8: Standard of Care in PPC2000 48
Figure 4.9: No. of legal issues addressed in PPC2000 50
Figure 4.10: Early Warning System in NEC4 52
Figure 4.11: Model Ownership according to Option X10.6 53
Figure 4.12: Option X10:Information Modeling 55
Figure 4.13: No. of legal issues discussed in the NEC4 ECC 57
Figure 4.14: Overriding principle in JCT CE 58
Figure 4.15: The standard of care required according to JCT 59

Figure 4.16: The overriding principle of JCT 60
Figure 4.17: Model Ownership in JCT..... 61
Figure 4.18: No. of legal issues discussed in the JCT CE..... 62
Figure 5.1: Summative comparison between PPC2000, NEC4 ECC and JCT CE..... 63
Figure 5.2: Formulated map for the contractual categories and sub-categories in PPC2000, NEC4 ECC and JCT CE..... 64
Figure 5.3: Provisions and Clauses in the studied contracts that approach Risk Allocation aspects 65
Figure 5.4: Provisions and Clauses in the studied contracts that approach Model Ownership aspects 67
Figure 5.5: Provisions and Clauses in the studied contracts that approach Information loss ..... .68
Figure 5.6: Provisions and Clauses in the studied contracts that approach Collaboration aspects 70
Figure 5.7: Provisions and Clauses in the studied contracts that approach Professional legal duty aspects 71

Abstract

Building Information Modeling (BIM) is rapidly restructuring the construction industry offering major enhancements in project outcomes. Although the emerging demands for BIM adoption is developing to become an industry norm, yet there are uncertainties concerning the ability of the existing legal paradigm to fully incubate and promote BIM. The basis of construction contracts which rely on definite and single point responsibilities, did not cope with the collaborative approach of BIM causing potential contractual aspects to arise. These contractual aspects may become obstacles in the sufficient implementation of BIM and achieving anticipated productivity gains. This research aims to identify the core provisions in the contract that should be addressed when BIM is utilized in the project. The research highlights the main contractual issues associated with BIM and explains the current treatment of BIM in contractual documents from standard form of contracts and BIM Protocols. Content analysis method is used to analyze three main standard forms of contracts that adopts BIM and are of different approach of drafting, covering multiparty agreement, partnering agreement and standard bi-party agreement. A comparative study is held between the contracts under investigation, which are PPC2000: Project Partnering Contract, NEC4 ECC: Engineering and Construction Contract and JCT CE: Constructing Excellence Contract. The research presents and assesses the extent to which these standard forms of contracts deal with the contractual issues identified and accordingly the research proposes a drafting structure and framework for core provisions that should be included in a BIM based contract.