

# Building Information Modelling Impact on Contracts<sup>1</sup>

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## ABSTRACT

Nowadays many Contractual Frameworks in the Construction and Building take in consideration BIM Life-Cycle within Projects; however, the problem is as there are some of the Contracts that work for BIM, there are others that complicate its use with some Regulations and Terms. That raises issues of enforceability and integration of BIM within projects. Hence, in this paper the authors will use Disjunctive Reasoning with non-compensatory methods of Multi-Attribute Decision Matrix to compare and analyze the different contracts that are favorable to the use of BIM : NEC 3 (New Engineering Contracts), JCT (Joint Contract Tribunal), PPC2000 (Project Partnering Contract) and CIOB (Chartered Institute of Building). The results of the comparisons and analysis will give insight about all the aspects considered in Contract Integration of BIM and what should Senior Managers choose in which situations.

**Key Words:** Contract – Collaboration – BIM – Modelling – Integration – Communication – ERP – Information Systems – Middleware

## INTRODUCTION

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. Since its adoption in the 70s, Building Information Modeling Sub-Contractors have been happy and satisfied by the concept. Therefore, many research studies on how to improve Contract Management to better fit and integrate BIM have been conducted, and conversely there have been research on how to better develop BIM to adapt to the Contractual Frameworks of Construction and Building industry. Therefore, nowadays many Contractual Frameworks in the Construction and Building take in consideration BIM Life-Cycle within Projects; however, the problem is as there are some of the Contracts that work for BIM, there are others that complicate its use with some Regulations and Terms. That raises issues of enforceability and integration of BIM within projects.

The author will start by first defining crystal clear the problems in BIM and Contracts relativity and impact relationships and the outcomes estimated, which will give the author the possibility to propose, assess then choose the right alternatives, the author will then review the outcomes results and assess the benefits this research will bring to the organization.

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As many agree that BIM should not be integrated in the main contract documents, what are the main issues which incurred this decision? What can be changed in contracts to integrate BIM? What can be engineered in BIM to integrate contracts? Will integrating BIM in the main contract documents improve the project processes and delivery? The author will use this article to address the questions raised and provide findings with the appropriate tools.

The problem addressed here will be then about making a decision in choosing the best fit contract to integrate BIM with the help of Multi Attribute Decision Matrix tool.

## **METHODOLOGY**

- **Feasible Alternative Solutions**

- **Alternative Solutions**

The following Contracts are the list of feasible alternative solutions for integrating BIM into contract documents:

- NEC3 (New Engineering Contracts)
- PPC2000 (Project Partnering Contracts)
- JCT (Joints Contract Tribunal)
- CIOB (Chartered Institute of Building) Contract

- **Attributes to measure, assess and evaluate each Alternative**

The following criteria will be considered while selecting the right contract that match the expectations of sub-contractors when considering BIM integration:

- Clash detection
- Collaborative working
- Early Contract Involvement
- Agreed Mutual Deadlines
- Specific Activities
- Intellectual Property

- **Development of the Feasible Alternatives**

- The author chose to illustrate the Development of the Feasible Alternatives with the help of SWOT Analysis as a tool. (*See Figure 1*).

Solution/SWOT	Strengths	Weaknesses	Opportunities	Threats
NEC3	Allows contractors early involvement.	Does not address BIM aspects in detail about collaborating information sharing failures	Facilitates using CIC protocols.	Collaboration problems
	Strongly appropriate for collaborative process.		Facilitates integrating BIM protocols.	Legal, Contractual, and insurance issues
	Appropriate for the newest engineering processes and methods.			
JCT	Allows contractors early involvement.	Does not address BIM aspects in detail about collaborating information sharing failures	Facilitates using CIC protocols.	Collaboration problems
	Strongly appropriate for collaborative.		Facilitates integrating BIM protocols.	Legal, Contractual, and insurance issues
	Strongly appropriate for public sector projects.		Governmental and public projects	
CIOB	Designed for complex projects	Requires most communication to be digital	Facilitates working in complex projects	Communication delays
	Appropriate for choosing a variety of BIM protocols			Legal, Contractual, and insurance issues
	Appropriate for using various contract documents			
PPC2000	Allows contractors early involvement.	Not update to the latest technology aspects	Speed up partnership agreements	Legal, Contractual, and insurance issues
	Wider audience of clients			

**Figure 1: SWOT Analysis for the different contracts favorable to integrating BIM**

- **Selection of the criteria**

- The chosen way of undertaking the selection of the criteria for integrating BIM into contracts is the Disjunctive Reasoning of Multi-Attribute Decision Matrix tool. (*See Figure 2*).

Evaluation Criteria	Clash Detection	Collaborative Working	Early Contract Involvement	Agreed Mutual Deadlines	Specific Activities	Intellectual Property	Overall Importance
Clash Detection	-	1	0	1	1	0	3
Collaborative Working	0	-	1	1	1	0	3
Early Contract Involvement	0	1	-	1	1	1	4
Agreed Mutual Deadlines	0	1	1	-	1	0	3
Specific Activities	1	1	1	1	-	0	4
Intellectual Property	0	0	0	0	1	-	1

**Figure 2: MADM for selecting the most important key aspect to integrating BIM in a contract**

- After undertaking the MAD Matrix in Figure 1, we clearly conclude that the most important aspects to consider when integrating BIM in contract are: Early Contract Involvement and Specific (Technical) Activities.

## FINDINGS

- **Analysis and comparison of the alternatives**

- During this analysis phase, alternatives (the different contracts listed above in part 2) are compared upon what extent they respond to the criteria listed above in part 3.

- The comparison is done by rating each one of the contracts from 1 to 5. (See *Figure 3*).

Attributes	Importance	NEC3	PPC2000	JCT	CIOB
Clash Detection	3	2	3	2	5
Collaborative Working	3	5	5	5	5
Early Contract Involvement	4	5	5	5	4
Agreed Mutual Deadlines	3	3	3	3	5
Specific Activities	4	2	4	2	4
Intellectual Property	1	2	1	2	2

**Figure 3: Criteria Versus Alternative Solutions Comparison**

- During the comparison, the importance scores obtained earlier in *Figure 1* and *Figure 3* are taken as inputs to weight the rated alternatives, and that is to obtain a clear visual about how the different contracts respond to the different criteria considering the importance rate of each. (See *Figure 4*).

Attributes	NEC3 (Weighted)	PPC2000 (Weighted)	JCT (Weighted)	CIOB (Weighted)
Clash Detection	6	9	6	15
Collaborative Working	15	15	15	15
Early Contract Involvement	20	20	20	16
Agreed Mutual Deadlines	9	9	9	15
Specific Activities	8	16	8	16
Intellectual Property	2	1	2	2
<b>Total Score</b>	<b>60</b>	<b>70</b>	<b>60</b>	<b>79</b>

**Figure 4: Criteria Versus Alternative Solutions Analysis**

- **Formulas used :**
  - *Weighted Alternative Solution per Attribute* = Importance\*Alternative Solution Per Attribute
  - *Total Score per Weighted Alternative Solution* =  $\sum$  Weighted Alternative Solution per Attribute
- **Selection of the preferred Alternative**
  - After comparing and analyzing the alternatives, the total score for each Alternative has been obtained, which gave us the insight about what is the preferred.
  - The best and preferred Alternative is then clearly CIOB with a score of 79. (See *Figure 5*).

Ranking	Contract Alternative	Score
1	CIOB	79
2	PPC2000	70
3	NEC3	60
3	JCT	60

***Figure 5: Ranking of the Contract Alternatives***

- **Performance monitoring and post-evaluation of results**

- Based on the previous results the most recommended Contract for integrating BIM is CIOB (Chartered Institute of Building Contracts).
- As CIOB contracts are mostly appropriate for complex projects, if the Senior Managers want to go for the safest contract to minimize the risk, it is recommended for them to choose PPC2000 as it is the most popular contract that integrates BIM.
- If the Senior Managers undertake projects where Early Contracting Involvement is a very important aspect, and include the newest engineering principles, it is recommended to choose NEC3 as it is the most appropriate for both.
- If the Senior Managers undertake Public projects in the UK and Early Contracting Involvement is a very important aspect, it is recommended to choose JCT as it is popular in UK for integrating BIM.

## CONCLUSIONS

As many agree that BIM should not be integrated in the main contract documents, what are the main issues which incurred this decision? What can be changed in contracts to integrate BIM? What can be engineered in BIM to integrate contracts? Will integrating BIM in the main contract documents improve the project processes and delivery?

The author used this article to address the questions raised and provided findings with appropriate tools such as SWOT Analysis and Multi-Attribute Decision Matrix.

The author started by listing the alternative solutions that are favorable to integrating BIM in a contract.

Then the author selected the list of attributes to evaluate, compare and assess each feasible Alternative Solution.

After listing the attributes, the author developed on the feasible Alternative Solutions by using SWOT Analysis.

The author proceeded then on by using Multi-Attribute Decision Matrix Disjunctive Reasoning to assess the importance of each attribute considered in integrating BIM on contracts.

The author then compared each Contract with the list of attributes and rated from 0 to 5 each contract with the information obtained in the SWOT Analysis as an input.

Then the results in the Multi-Attribute Decision Matrix were transformed into Coefficients to weight on the contract rating relatively to each attribute, which allowed a reliable calculation of the impact of each contract relatively to the list of attributes in integrating BIM into contracts.

The calculations gave the author an insight about the most appropriate contract to choose in integrating BIM, which turned out to be CIOB Contracts.

Finally, the author gave recommendations to Senior Managers on how to use each contract depending on the needs and requirements of the different projects when considering the integration of BIM into contracts.

## **FOLLOW ON RESEARCH**

As there are various contracts compatible and favorable in integrating BIM, they all without exception include and incur a great deal of risks and threats. What can be included in a contract to reduce the risks in integrating BIM in contract documents?

Integrating BIM into contracts is very practical and solves many problems, but that still raises one very important question. Is the effort to integrate BIM into contracts worth it? Is integrating BIM in contracts a Success Factor in the efficiency of Construction and Building Projects?

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