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Potential of Incorporating NRM on the Incompatibility between BIM Software Applications and NRM

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Abstract.

The quantity surveying profession on the international platform has adopted automated quantities technology through the Building Information Modelling (BIM) to provide up-to date sophisticated cost management services to take care of the implementation of time management and cost display and subsequently share the cost data with various stakeholders. This strategy aims to promote the integrated delivery approach which BIM is providing. It is fundamentally important to have a BIM model incorporated with the method of measurement to enable shifting from the traditional approach to a fully integrated platform whereby sharing and working on the same information is paramount. The difficulties encountered during the process of shifting from the traditional method to an automated system was the lack of standard between BIM and the New rule of Measurement (NRM1). This research is aimed to study the incompatibility between the software application and (NRM1) which was and is still the biggest issue to implement BIM in the construction industry. In order to bring an interface between the software application and the NRM1, the author has investigated a coding system. This coding system is made compatible with the interfaces of the software and the NRM1 so as to enable interoperability of all team parties to understand the entire principles of BIM. A BIM Model designed, incorporated the calculated coding data of elements established from NRM1 was initially tested. The results obtained, showed that the approximate Bill of Quantities derived from the model linked the standard specification of NRM1 with the BIM software interface.

Keywords: Building Information Modelling; Coding; Incompatibility; New Rules of Measurement1 (NRM1); Quantity Surveying.

1. Introduction

The construction industry is seen for many decades as an investment-led sector contributing to the economic advancement of various governments. The contribution of this industry, in developing various infrastructures for the prosperity of any nation, is quintessential. The importance attached to cost estimation nowadays has made the profession to develop accurate standard measurement principle to enhance the services provided to clients during the three stages of construction development. Construction industry still found to be underperformance due to many issues associated with uncertainties (Durdyev & Ismail, 2012; Alhasan et al., 2019). Poor planning of the project, fragmented nature of the construction firms, poor communications and inaccuracy of estimation which Leeds to the cost overrun are parts of the main problems facing the construction industry (Babatunde et al, 2020). Incorporating information technology may have brought the project to its final destination by providing an appropriate solution to the existing problems and improve the adopted method of problem-solving compared to the conventional methods (Skibniewski & Zavadskas, 2013).

1.1 Building Information Modelling

BIM is a modeling technology and associated set of processes to produce, communicate, and analyze building model (Eastman, 2012). BIM as a digital technology has a vast capabilities opportunity to improve the overall performance of the construction project in terms of accuracy, speed and quality (Smith, 2016). Likewise, acceleration of the automated extraction and measurements of the building quantities from the b Contrary, it is found that BIM still lack of standardization, the inflexibility of workflow, and the complexity of information due to huge numbers of elements in the digital model (Mayouf, 2019).

1.2 Barriers of Building Information Modelling

Numerous research studies have been carried out to explore the main reasons behind the hindrance of adopting BIM despite its various benefits. Most of the researchers concluded that the barriers are encountered with Lack of skills, high cost of training, reluctance to change the culture and stick to the conventional method, shortage of sharing pieces of information (Siddiqui et al. ,2019). Similarly, it is found that incompatibility of BIM with takeoff/ estimating software tools, a high level of design detail at the early stage of construction leads to confusion in making a decision and last but not least lack of industry-standard and protocols and inaccurate bill of quantities found to be the most challenges faced by the construction industry in general and quantity surveyors in particular. (Eadie etal.,2014; Bečvarovská & Matějka, 2017; Phillip &, Jon ,2004; Stanley & Thurnell, 2014; Gerges et al., 2017; Alhasan et al., 2017). Other problems associated behind the ineffective adoption of BIM in different countries are addressed by (Farooq et al., 2020). Complexity of BIM authoring tools of cost estimating, interoperability issues which leads to the poor information exchange and missing data during data transferring between BIM applications. Lack of awareness, government support, and other issues related to economics, technology, management, and communication. Lack of standard is the main issues toward the poor utilizing of BIM estimation tool by the quantity surveyors.

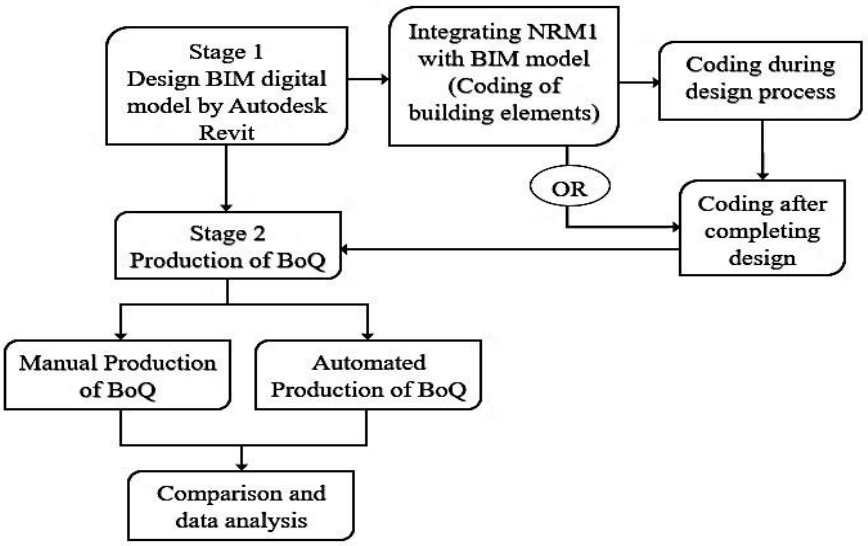
1.3 Lack of Standard

In the construction and building industry compliance and clarity of building codes and measurement standards minimize the lack of consistency and enhance the process of quantity take off to produce an accurate and reliable BoQ (Barison & Santos, 2010; Abanda, 2017). Royal Institute of Chartered Surveyors RICS, quantity Surveying and construction professional group set an understandable standard documents of measurements rules of New Rules of Measurement1 (NRM1) for the detailed measurements of a building in new rules of measurement which can be accessible to any participant in the construction project team (RICS, 2013). It is also has been investigated by (Wu et al, 2014) how BIM could support the new rules of measurement by (The current research proposed method which may support to overcome these issues. Results of incorporating NRM to BIM digital model is investigated in the current research, subsequently set of recommendations will be set.

2. Methodology

Research methods is designed in accordance to the research criteria adopted from (Saunders et al., 201) to investigate the answer of the research problem associated to the lack of standards in BIM. The adopted research methodology is a quantitative approach adopted for this exploratory research. This enables to finding out some conclusive evidence with assumptions conforming to the nature of the research for better understanding of the research problem. The current research method is designed to proposed a solution that might overcome the issue of lack of standards associated with applying BIM technology by the quantity surveyors. Research methodology is divided into two stages as represented in Figure 1. It is to note that all the figures are developed by the author, unless otherwise specified.

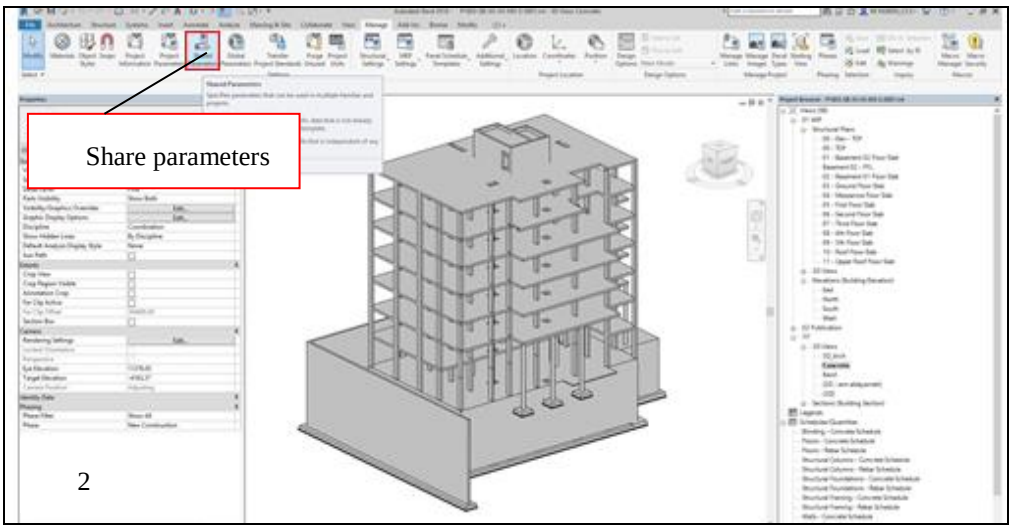
Fig 1: Research Methodology



Stage 1:
Developing a digital model conforming to the design criteria utilizing BIM design tool of Autodesk Revit. The model consists of multistorey which is designed for dual purposes of residential and commercial. Details related to the four disciples of Architectural, structural, electrical and mechanical are incorporated with same model. The coding process has been done for two building element of wall and column as sample for the purpose of the research.

Step 1: Integrating NRM1 (RICS,2013) standard with digital models and define the building elements with reference to NRM1 levels and categories by creating shared parameters and share parameter file. New groups are defined followed by naming and selecting types of the parameter and categories under the parameter data for a certain project. Some of the steps are shown in the given figure below 2, 3 & 4. At this stage all the building elements are added in the shared parameters to be used for the second stage of coding process. It is important to point that he coding of building elements could be completed during the process designing of the digital models or after completing the design process depends on the decision taken by the design team.

Figures 2,3 & 4 Integrating NRM to BIM digital model illustrating the process of Coding elements in the digital model



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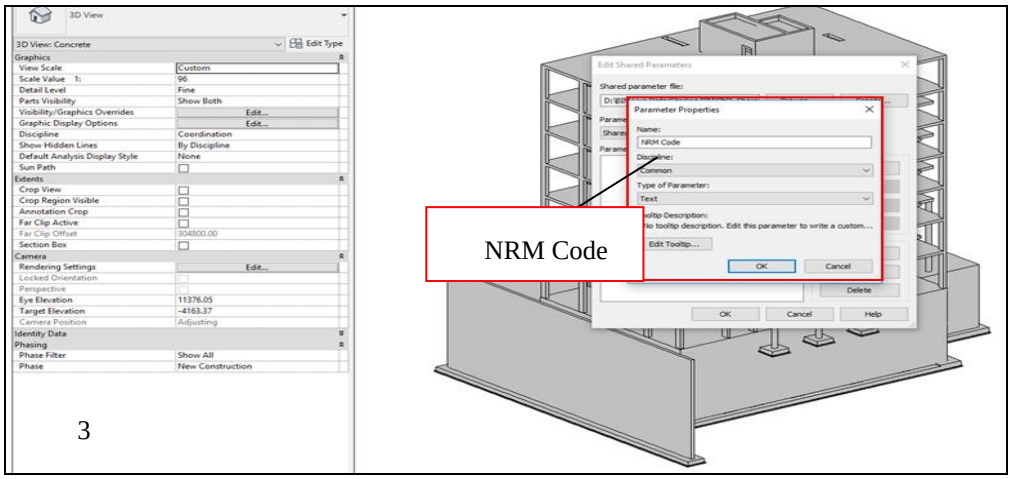

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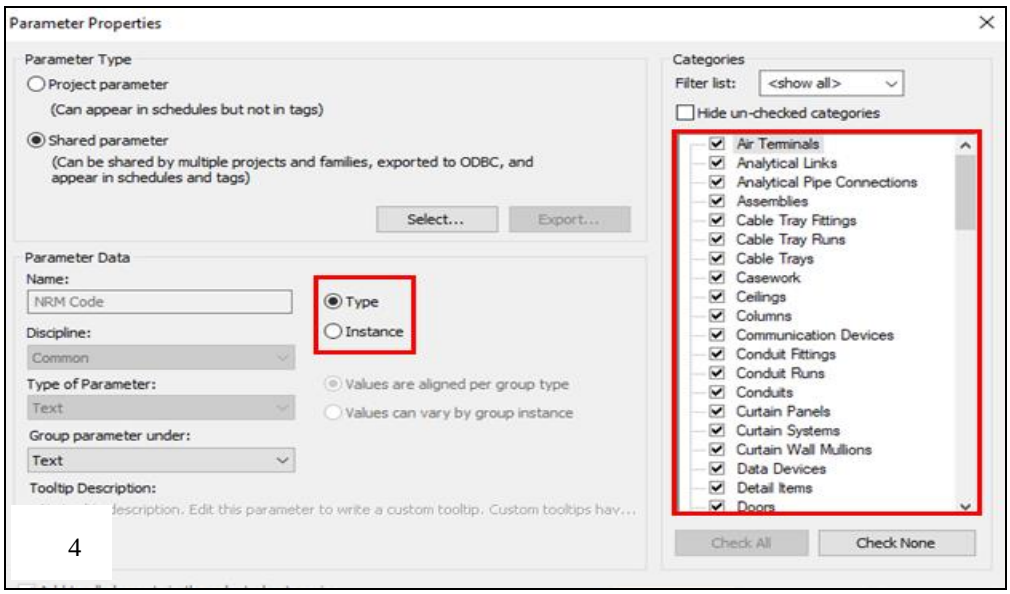

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Step 2: illustrates how to define the NRM code to each and every Revit type on the project. The direct way is to create a schedule contains all Revit type and then to assign the code directly to each type starting from the materials take off schedule adding the materls parameter to create the schedule as shown in Figure 5. At the coming steps, the schedule ofdifferent buiding elemnts along with its specifications and types should appear including a column of NRM Code, where each element in the digital model can be identified with according to NRM code and its respective levels and groups Figure 6. start the coding process of the building elements. Referring to the structure of NRM standard, code should be a combination of 5 levels separated by dots, the first 3 levels (Group element number, Element number, Sub-element number) are defined by the NRM Code and the other two (Component, Sub-component) are usually user-defined as shown in Figure 7 and Figure 8, for column and wall finishes as examples of the coding system. Eventually, NRM1 was integrated with the digital model and automated BoQ was generated from the same model with list of the building element defined with reference to NRM1.

Fig. 5 Creating a schedule of Materials Take- off

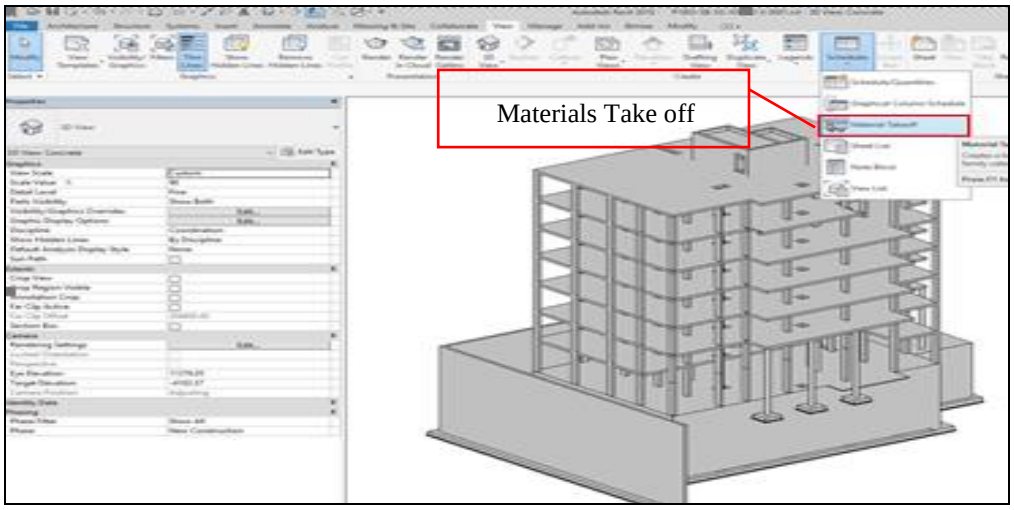


Fig. 6 Addition of RM code to the Take-off schedule

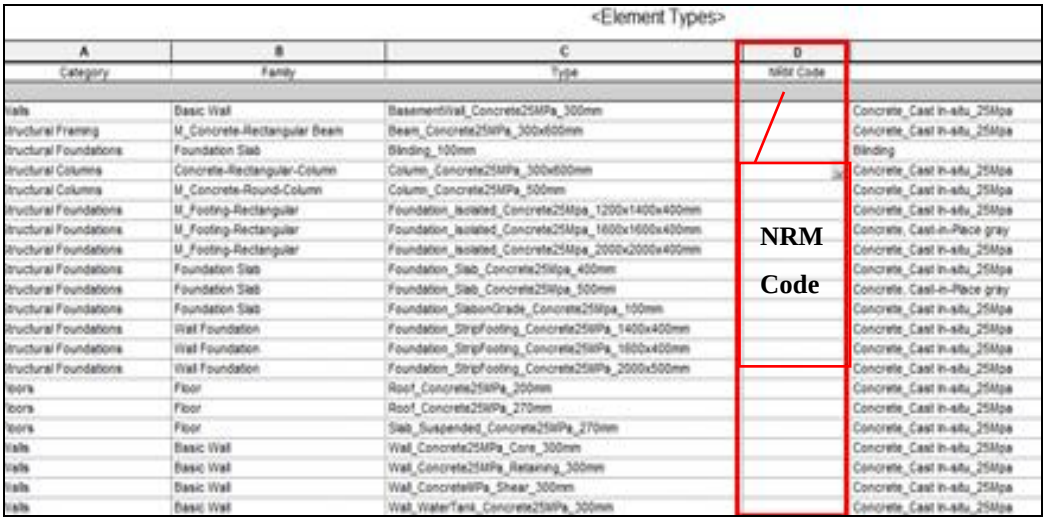
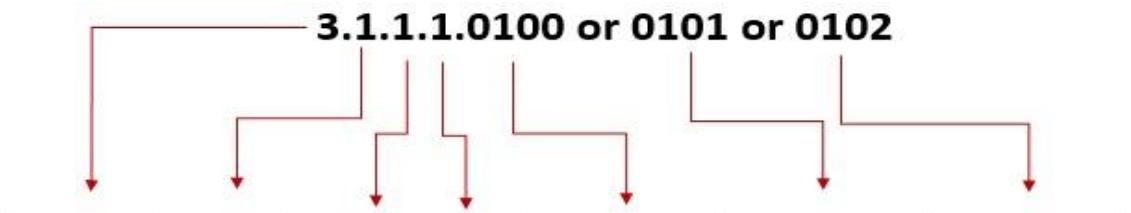
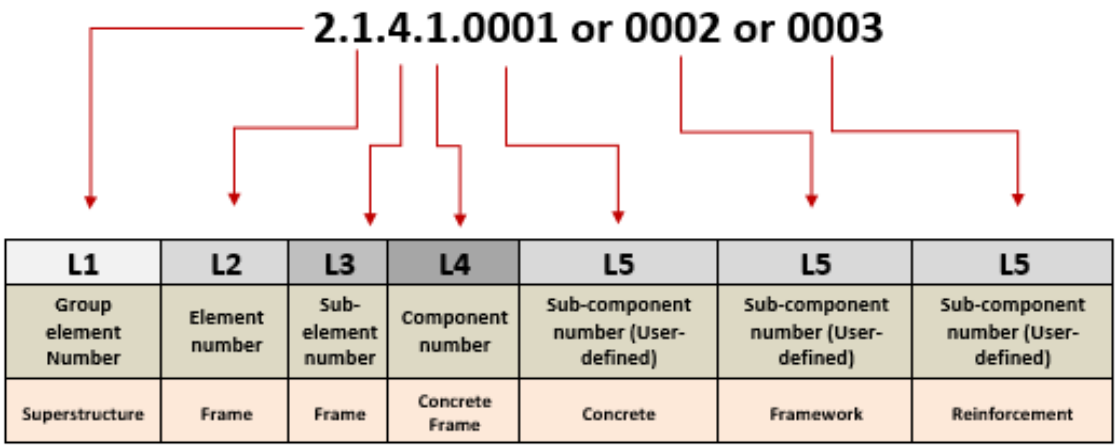


Fig. 7 Combination of 5 levels of NRM1 in digital model- wall finishes



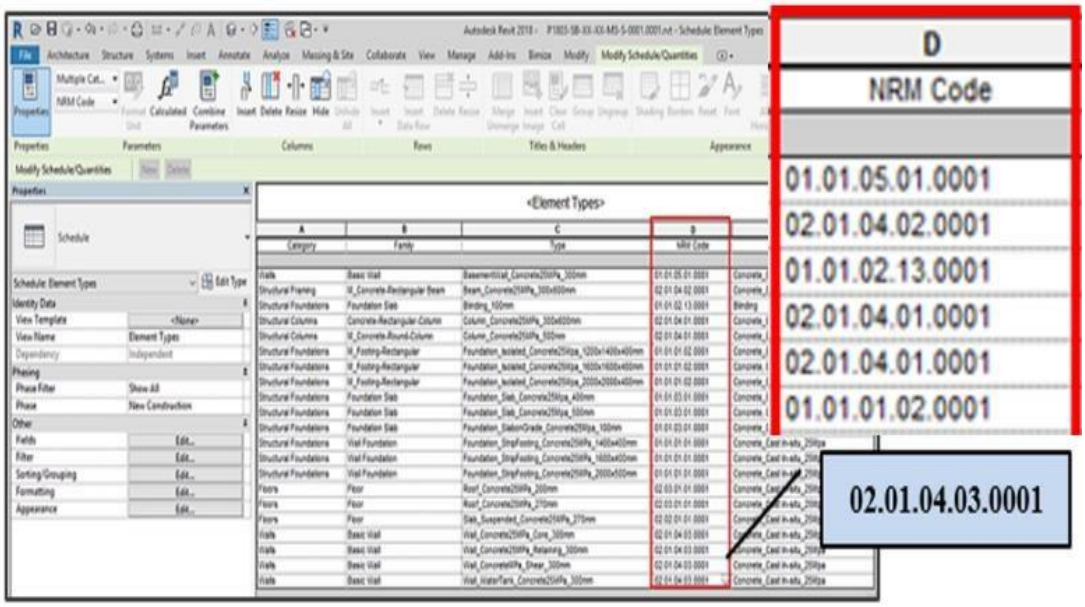
L1	L2	L3	L4	L5	L5	L5
Group element Number	Element number	Sub-element number	Component number	Sub-component number (User-defined)	Sub-component number (User-defined)	Sub-component number (User-defined)
Internal finishes	Wall Finishes	Wall Finishes	Finishes to walls and Columns	Porcelain Tiles	Paint	Plaster

Fig. 8 Combination of 5 levels in NRM1- Column



L1	L2	L3	L4	L5	L5	L5
Group element Number	Element number	Sub-element number	Component number	Sub-component number (User-defined)	Sub-component number (User-defined)	Sub-component number (User-defined)
Superstructure	Frame	Frame	Concrete Frame	Concrete	Framework	Reinforcement

Fig. 9 Incorporated NRM 1 to the BoQ



Stage 2: To investigate the applicability of integrating NRM to the BIM model, and produce a bill of quantity with the new defined elements based on NRM1. Developing of BoQ is carried out through two different methods considering the accuracy and time consuming when utilizing the both methods. Both methods of data extraction and measurements could be completed at the same time.

***Step 1*:** Quantifying the building components of the digital model which is composed of multistory building and produce automated copy of BoQ. Sample of the

Step 2: Quantifying the building components of the digital model by adopting the conventional method and produce the conventional copy of BoQ. Two examples of concrete work have been selected where the large volume is expected. These examples are Blinding and retaining wall may have notable effect on the total quantities and total cost accordingly. On the other hand, the limitation of the paper size provides a small area for data representation and analysis. Further details on the same research area may be recommended in the future for more reliable data.

Step 3: Comparing the results obtained from the both measurement method; automated and conventional methods in term of the total quantities.
The next section of data collection and result analysis provide a clear explanation on the results obtained from the applied method.

3. Data Analysis and Results Discussion

Data analysis is carried out based on the data collected from the proposed methodology. Stage1: The results obtained from stage1 highlighted on the one of the main barriers behind the reluctance by the QSs to start utilizing BIM tools on their professions. It is showed that the developed BoQ from the Revit platform is consistent with NRM 1 code in term of materials specifications and categories considering the five levels of each group as shown in the methodology section. The final format of BoQ which produced from Revit complies to NRM1 may change the quantity surveyors thought and motivate them to start thinking of adopting BIM measurement tools on their profession, as demonstrated in Figure 10.

Fig. 9 Generated BoQ by Autodesk Revit incprorated with NRM1

<Revit Types>

A	B	C	D	E
Category	Family	Type	NRM Code	Material: Vol
Walls	Basic Wall	BasementWall_Concrete25MPa_300mm	01.01.05.01.0001	153.58 m³
Structural Framing	M_Concrete-Rectangular Beam	Beam_Concrete25MPa_300x600mm	02.01.04.02.0001	0.77 m³
Structural Foundations	Foundation Slab	Blinding_100mm	01.01.02.13.0001	50.48 m³
Structural Columns	Concrete-Rectangular-Column	Column_Concrete25MPa_300x600mm	02.01.04.01.0001	158.63 m³
Structural Columns	M_Concrete-Round-Column	Column_Concrete25MPa_500mm	02.01.04.01.0001	10.14 m³
Structural Foundations	M_Footing-Rectangular	Foundation_Isolated_Concrete25Mpa_1200x1400x400mm	01.01.01.02.0001	3.36 m³
Structural Foundations	M_Footing-Rectangular	Foundation_Isolated_Concrete25Mpa_1600x1600x400mm	01.01.01.02.0001	3.07 m³
Structural Foundations	M_Footing-Rectangular	Foundation_Isolated_Concrete25Mpa_2000x2000x400mm	01.01.01.02.0001	14.40 m³
Structural Foundations	Foundation Slab	Foundation_Slab_Concrete25Mpa_400mm	01.01.03.01.0001	13.59 m³
Structural Foundations	Foundation Slab	Foundation_Slab_Concrete25Mpa_500mm	01.01.03.01.0001	46.10 m³
Structural Foundations	Foundation Slab	Foundation_SlabonGrade_Concrete25Mpa_100mm	01.01.03.01.0001	46.34 m³
Structural Foundations	Wall Foundation	Foundation_StripFooting_Concrete25MPa_1400x400mm	01.01.01.01.0001	13.51 m³
Structural Foundations	Wall Foundation	Foundation_StripFooting_Concrete25MPa_1600x400mm	01.01.01.01.0001	86.11 m³
Structural Foundations	Wall Foundation	Foundation_StripFooting_Concrete25MPa_2000x500mm	01.01.01.01.0001	12.97 m³
Floors	Floor	Roof_Concrete25MPa_200mm	02.03.01.01.0001	5.54 m³
Floors	Floor	Roof_Concrete25MPa_270mm	02.03.01.01.0001	120.18 m³
Floors	Floor	Slab_Suspended_Concrete25MPa_270mm	02.02.01.01.0001	1007.93 m³
Walls	Basic Wall	Wall_Concrete25MPa_Core_300mm	02.01.04.03.0001	319.28 m³
Walls	Basic Wall	Wall_Concrete25MPa_Retaining_300mm	02.01.04.03.0001	221.19 m³
Walls	Basic Wall	Wall_ConcreteMPa_Shear_300mm	02.01.04.03.0001	12.86 m³
Walls	Basic Wall	Wall_WaterTank_Concrete25MPa_300mm	02.01.04.03.0001	59.86 m³

Stage 2: of the research methodology investigated the issues of producing inaccurate BoQ from the Revit model. The total volume of the concrete work of retaining wall and blinding concrete was calculated manually and digitally. The results obtained from the both methods showed consistency between the results as explained below.

i. Applying the conventional method of quantity take off, the retaining walls have a thickness of 300mm, with dimension of 30.58m and height of 10.5m, so the volume will be 96.327 m^3 which is the same value obtained on the BoQ from Revit as shown in Figure 11.
ii. Similarly, for blinding the thickness is 100mm as figured out from the digital model, of width and length of 10.23m, 9.39 respectively, the volume will be 9.606 m^3 which is the same value obtained from automated BoQ, as shown in Figure 12.

Figure 11. Total Quantity of Retaining Wall

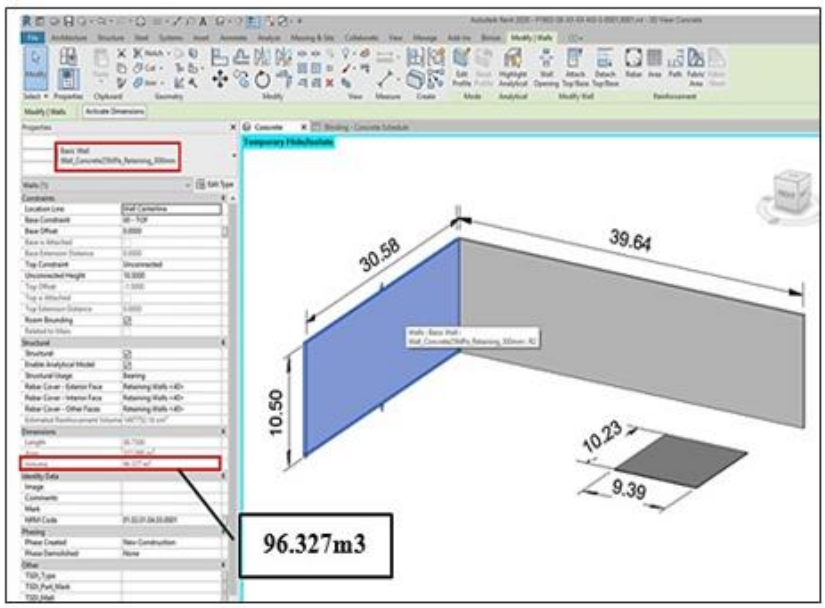
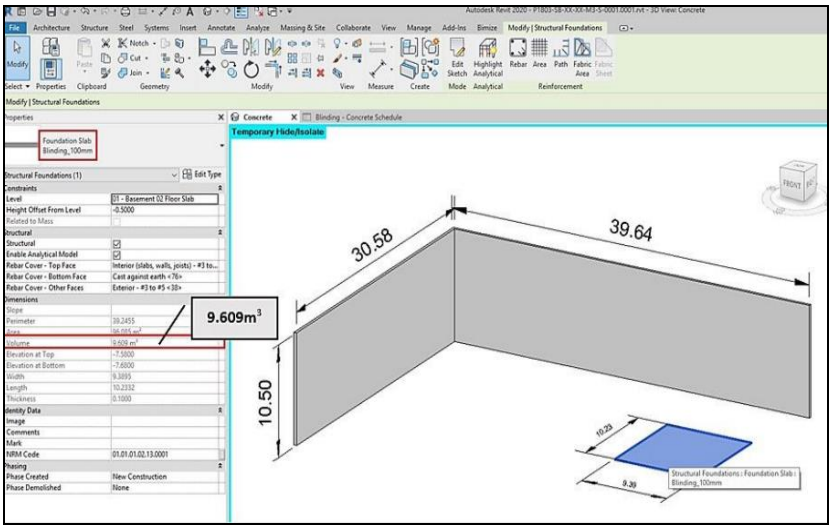


Figure 12. Total Quantity of Blinding Foundation



To sum-up, thinking the utmost benefits of producing standardized an accurate BoQ, free from errors and minimizing the time of completing the all related tasks may stop the quantity surveyors to refraining from adopting BIM tools from one side and eliminate the conflict raise due to nonstandard BoQ and avoid the data missing and the consequent inaccuracy of the building cost.

4. Conclusion

Many research studies are carried out investigation the potential of incorporating BIM technology in the construction industry in general and by quantity surveyors in particular as one of the key professions in the building industry. Most of the construction companies lack of BIM standards which is counted as one of the major obstructions behind the shortage of utilizing BIM tools. Hence it is required to increase the awareness of adopting BIM measuring tools and to diminish the attitude of reluctance in adopting methods such BIM based Technology. Through proper research methods, this research paper aimed to prove the production of reliable and accurate BoQ from digital model compared with conventional methods. The accuracy is demonstrated on the total quantity of concrete work; retaining wall and blinding foundation as research sample of estimation process. On the other hand, to investigate the problem with the lack of standards, it was decided to incorporate the specifications of building elements as shown in NRM1 to the digital model. The building elements appeared in the evolved BoQ was in synchrony with NRM standard. For further investigation and more reliable results, more elements should be quantified and compared form manual and automated BoQ. Exploration studies are recommended to test the validation of the suggested coding system for the global implementation by the quantity surveying professions.

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