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AUTOMATED RULES CHECKING FOR SUSTAINABLE BUILDING PERMITS

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Abstract

Although automated rule-checking is regularly displayed within the setting of applying for licenses, to survey compliance with building codes, its most immediate application can be found in prior stages of the plan stage. The effect of design alternatives on the execution of buildings in a few spaces can be assessed automatically utilizing BIM apparatuses. In this article, we talk about the points of interest and challenges of adopting mechanized rule-checking strategy as an apparatus for plan improvement and present examples of program arrangements that can be utilized for this reason. The aim of this paper is to study the facility of sustainability compliance checking process, by focusing on inter-operability between existing methods of compliance checking and building information modeling .

This research will discuss the advantages and challenges of adopting automated rule-checking procedure as a tool for design development and present examples of software solutions that can be used for this purpose. Based on the results of this study, it can be concluded that the Egyptian market suffers from continuous losses at all levels as a result of lack of awareness of BIM in achieving comprehensive narratives in the field, which in turn led to government decisions towards E -Government. This is an important step in progress and expansion. In the field of construction, licensing and delay in such a step leads to huge economic losses compared to the experiences of the global in achieving positive results through the adoption of successful policies for expansion in this area.

Keywords

BIM, Automated, Rule, Check-ing, Industry Foundation Classes (IFC).

1. Introduction

In spite of the fact that these procedures are regularly seen as a portion of a handle to get a building permit, they ought to also be caught on as a capable apparatus which is accessible to architects, from the most punctual stages of design development.

Although there are still basic impediments to its viable usage, Automated rulechecking of plan models ought to be an progressively coordinates highlight in BIM apparatuses that are available to development experts.

Architectural data is overseen all through the life cycle of a building. BIM **B**uilding **I**nformation **M**odeling innovation has been utilized progressively in quantitative ways within the engineering, designing, and construction disciplines. In any case, owing to increasing requirements for an change in subjective factors in BIM-based plan ventures, it has gotten to be necessary to create a checking and assessment prepare for improvement of BIM-based plan quality . The delivery of the BIM information is required in advanced countries, and these nations are advancing the automated checking for BIM quality, including compliance with the building code.

2. Background

Building code checking is the foremost effectively applied quality checking inquire about. It is checked on through national laws and is based on each country's regulations. It is prepared through building code checking system developed utilizing the IFC related data.

The conveyance of BIM information is obligatory in advanced countries, and these nations advance automated building code checking. For case, Singapore has developed a BIM-based automated code checking process through the computer program FORNAX and has built a construction organization framework, CORENET [10]. The SMART codes venture within the USA has structuralized the controls of the International Code Council (ICC) and created a programmed building code checking system [11]. In specific, legality checking through an automated lawfulness checking framework can diminish errors, time, and wasteful utilize of human assets. Therefore, it is vital to create a building code checking system for plan quality change based on open BIM in Singapore, as a change over the conventional 2D drawings and records.

2.1 The Research Problems:

The problem is how to address the domain expertise assumed in the interpretation of the rules this can only be done manually today. Rule interpretation is a significant step in the process of rule checking. In CORENET, it took approximately 20 - 30% of the overall effort. This was not a small effort, but this process allowed a one-time investment for good rule checking that led to automation of the manual effort.

Complicated Permit approval system , absence of intergrated process between desgin and engineering .

Less advanced construction IT , absence of systematic code Verification system .

2.2 Research Question :

- What are the perceptions of the Egyptian AEC industry professionals for the benefits of BIM worldwide experiance ?
- What are the challenges facing the BIM users during implementation of BIM and, what are the challenges and obstacles hindering BIM non-users to adopt BIM in Egypt AEC industry?
- What are the external pressures and forces imposing the implementation of BIM in the Egypt AEC industry?

2.3Aim Of Research:

To bridge the knowledge gap in sustainability inside the condtruction industry Egypt is aimed in this investigation and this is done via criteria of sustainable conservation in relation to the model cheaker . three main issues are focussed in this investigation:

Open BIM based quality verification system development

Open BIM based construction document optimization standard and applied technogy development

Development of integrated cooperation work system during public administrative process.

2.4 Research Methodology:

Firstly, Analytical study: a general background of BIM implementation and the current development of automatic code-checking systems are presented. A survey about the BIM implementation situation in Egypt has been referenced.

Second : Manual work is still necessary to match each issue with the host model, and then modify the model one by one.

A proposal to combine both of the automated code-checking process and of model modification process is presented and after testing with different file formats, a workflow to link these two processes is developed and detailed.

Model Checker case studies involving automated code checking model (singapore).

3-BIM-based building code checking process

The Construction industry includes compiling a multitude of information from different sources working within different disciplines in a process that incorporates a variety of plan stages. This handle back collaboration between various members. Designer can BIM data checking some time recently Solibri Model Checker (SMC) (building administration permission services in Egypt) as aBIM proposal accommodation through Bim Assess-Lite.

Designer can pre-checking for BAPSE building authorization through BIM quality center confirmation prepare. Approver can Egyptian building code checking through EBim Survey in the Bapse environment [12].

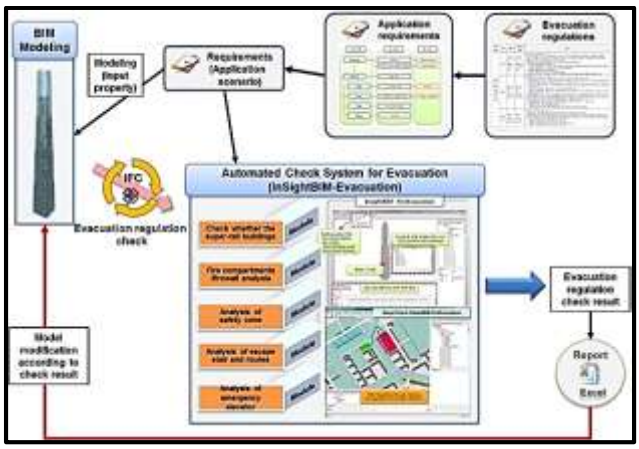

Figure 1: Automated check system for evaluation design quality checking process

Design phase

3.1.1 Design Collaboration system

Solibri Collaboration was created to assist building plan extend administration and communication in BIM and web-based environments. The reason is to encourage data exchanges and seamless communication between diverse stakeholders and to incite information sharing in an open BIM environment.

This framework flourishes on optimizing fundamental highlights for BIM-based plan collaboration by giving desirable industry highlights: [Extend Data Management], [Design Administration], [Online Assembly], and [Project File Administration].

These administration apparatus functions were determined through a comprehensive examination of the industry's needs (through a Delphi study and expert interviews) to get it and overcome the limits of existing BIM collaboration systems. In utilizing Solibri Collaboration, the project participants are free to work over different BIM applications with the backed universal open standard groups, **I**ndustry **F**oundation **C**lasses (IFC).

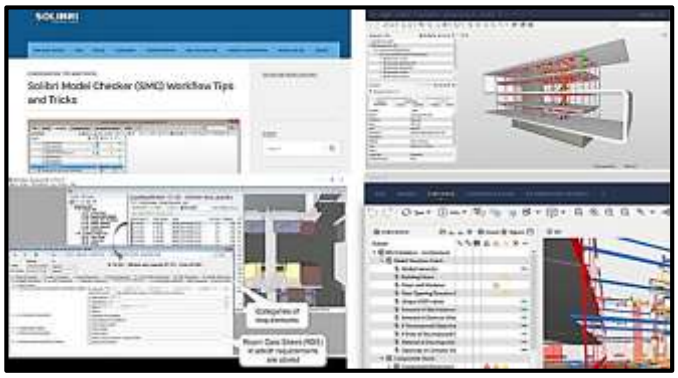

Figure 2: Solibri Model workflow Collobration and results

3.1.2 BIM quality self-assessment

Solibri Assess-Lite could be a public-access adaptation of Solibri Survey software that bolsters BIM model checking for person clients. It works as a rule-based model quality checker for IFC (**I**ndustry **F**oundation |**C**lasses) -based BIM models. Solibri Assess-Lite points to supply a helpful instrument for building extend members to survey their BIM models for building code compatibilities and common errors from the early plan stage until entries for project approvals. Key capacities include:

- IFC-based BIM show quality assessment by the rule-based checking methodology.

-Gives content depiction of relevant building clauses from the Korean Building Act, its requirement proclaim, and associated regulations.

- Execution criteria are characterized and managed with code checklists of existing Korean building controls and codes.

- Checked comes about visualized in real-time 3D graphics.

- Survey reports can be outputted as MS Excel.

- Modifiable execution criteria can be defined with user-customizable scripts.

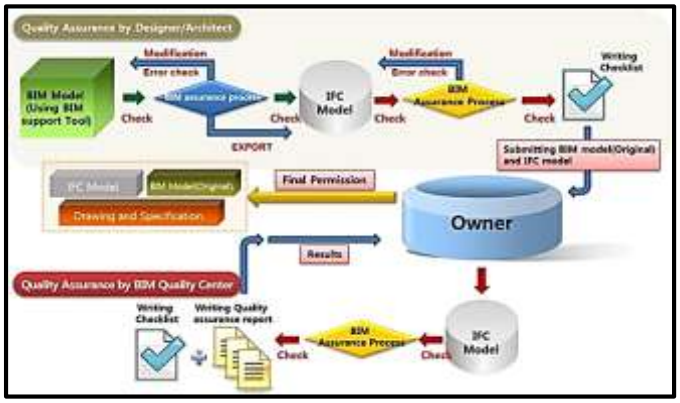

Figure 3: Solibri Assess lite

3.1.3 **Energy saving and programmed checking**

Solibri Vitality is an automation program that generates vitality execution assessments from open

BIM-based models. It is utilized in reference to energy saving standards and the vitality proficiency rating certification framework of..... for buildings with a total floor region of more than 3000 m2. The vitality ratings from the automated investigation handle are calculated according to ISO13790 to guarantee straightforwardness and reliability.

It gives a implies for the quick vitality examination of design choices; hence, it empowers clients to better determine energy requirement-compatible designs, enhances plan workflow, and successfully diminishes the amount of monotonous work. **E**nergy **P**erformance Index (EPI) yield is additionally accessible for clients from the webbased interface.

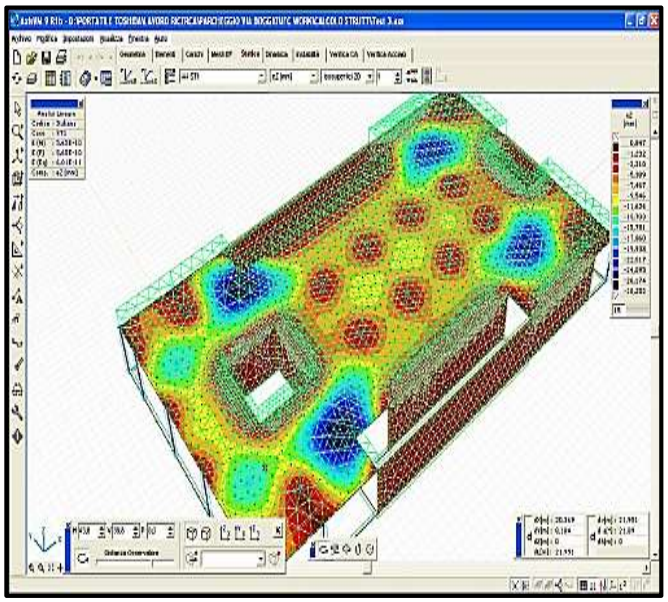

Figure 4: Energy analysis checker

3.2 Verification phase

3.2.1 BIM quality verification

Solibri Veri could be a BIM demonstrate quality assessment module for confirming Solibri Survey regulatory compliance and sometime recently submitting the BIM show data to SOLIBRI for venture approval.

Solibri Veri capacities as a part of the BIM Quality Center benefit, which may be a proposed web-based service for confirming confirmed BIM models for SOLIBRI submissions. Key capacities include:

- BIM show assessment for record mistakes, such as invalid IFC form or off-base format.
- Preparatory checking of BIM models prior to Solibri Evaluate on legitimate input of model objects and properties vital for automated code checking.
- Essential quality evaluation of demonstrate objects' dimensions, area, sort, and object relations.
- Reports era of checked comes out.

Figure 5 : SOLIBRI Model Checking Verification

3.2.2 Coherent rule for building code

The SBim Rationale application may be a logic rule-based management system that oversees the method of digitizing the National Building Controls and Codes of Singapore (common language) into Bim Code. It is comprised of 1) a rationale rule-based meta database of Korean building directions and codes; 2) the S.Bim Code creating device; 3) and the SBim Code database, a comprehensive administration device, and framework databases. The rationale rule-based meta database gives the classification of regulatory-specific objects and properties, sentence relations etc. Taking after the logic rule-based

component, the SBim Code creating tool accesses the meta database for the era and management of middle script dialect, SBim Code.

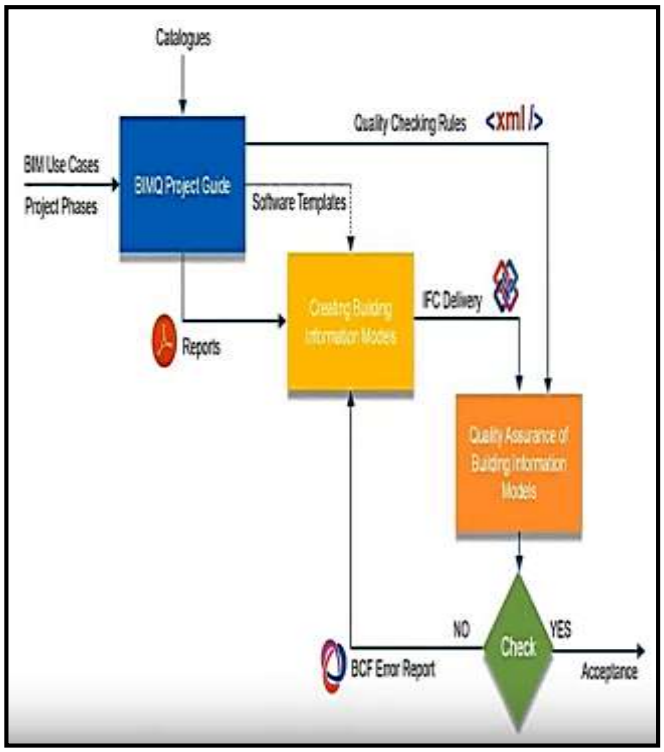

Figure 6: Logical Process check

SBim Code is the middle script language codes of Singapore Building Code sentences. It was established as a database to be reused and executed in accordance with the Building Act. solibri Code is generated and overseen by solibri Rationale, the rationale run the show-based management application. An sent-out arrangement of solibri Code can be utilized in Solibri Evaluate, an open BIMbased model checker for building grants in Singapore. Distinguishing highlights of Solibri Code incorporate the following: it may be a software-independent and standardized approach to the rule-making handle, and it is officially maintained and overseen by government authorities, guarantying unwavering quality for open utilize as well as ensuring an up-to-date database.

3.3 Submission phase

3.3.1 Automated accommodation system

The SBIM Submission program encourages the organization and administration of building grants. It enables coordinate information linkage to Solibri (a Singapore national e-submission framework), subsequently minimizing manual authoritative work on project information throughout the plan prepare. It revolutionizes the submission handle by computerizing submission data entries within the Solibri framework, giving an efficient management stage. Venturing absent from traditional processes, 280 distinctive categories of information (based on modern builds) required for building permission can presently be robotized, maintaining a strategic distance from mistake from manual input and the wastefulness of manual data collection. SBim Accommodation empowers the extraction and evaluation of the information fundamental for building permits directly from BIM models and completely bolsters open BIM. With IFC-based BIM models, clients can oversee the design-to-submission forms with ease due to the highly robotized usefulness of SBim Submission. The program too incorporates a standardized library of 399 types of materials for the precise administration of design drawings, details, and documentations applicable to building allow applications. Furthermore, the information submitted is consequently changed over and linked to the SOLIBRI inner database, disposing of the need for data re-entry.

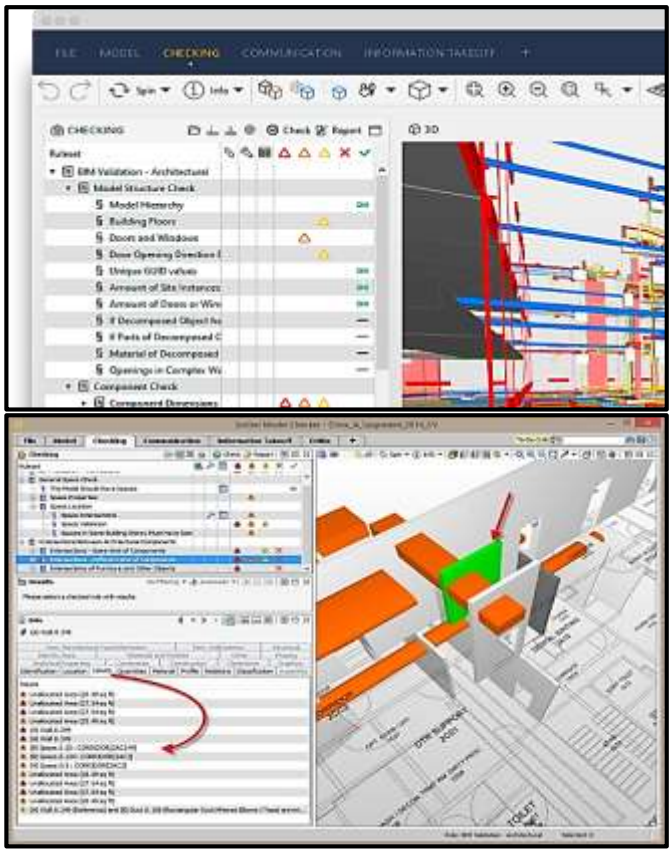

Figure 7: Solibri Model Checking and coordination between the AEC

3.4 Permission phase

Bim Evaluate could be a rule-based BIM demonstrate that checks software for screening qualified BIM-based ventures prior to venture endorsements from SOLIBRI. machine is the Singapore national development administrative online service, which incorporates e-submissions. Bim Survey rejects any defective or flawed models that contain mistakes or deficiently information for the SOLIBRI approval prepare. This pre-checking procedure spares time and manual efforts viably for governmental officers. Not at all like Bim Assess-Lite, which can be executed as a stand-alone application, Bim Assess operations depend on the SOLIBRI framework and execute checking as it were for the models given by the system. It performs checking with the most recent forms of the Korean building controls, codes a logic rulebased meta database, and conveys comes about straightforwardly back to the SOLIBRI system. Key capacities include:

*IFC-based BIM show quality assessment by a rule-based checking methodology .

*Checking comes about visualized in real-time 3D graphics .

*Interoperability with the Solibri system on BIM show downloads, results uploads to the SOLIBRI server, and project information transfer.

*Interfaces to the SINGAPORE building regulations and codes database and executes the most recent forms.

The e-Plan check is the relevant part to the review in this thesis, at the early stages of the CORENET project initiation, the electronic drawings were used for compliance checking, but, in 1998, the IFC was introduced as the data source for compliance checking. The aim of this project is to check the building plan and building services against the relevant codes. The building plan is checked against rules dealing with access, fire safety, health and safety and vehicle parking. The building service compliance check includes rules of electrical distribution, fire alarm systems, and the distribution systems such as gas, pipes, ventilation water and drainage systems; the compliance check is based on the configuration of these systems (W.Soilhin, 2004). The CORENET project developed a semantic library in FORNAX to include both rules definitions and IFC extensions, for certain entities for the compliance check. Each object in the FORNAX library has

diverse functions to retrieve the needed properties from IFC. It has been reported that the CORENET rules can be hard-coded in computer programming languages and that the FORNAX software library needs full computer programming capacity to structure a rule writing system for a requirement.

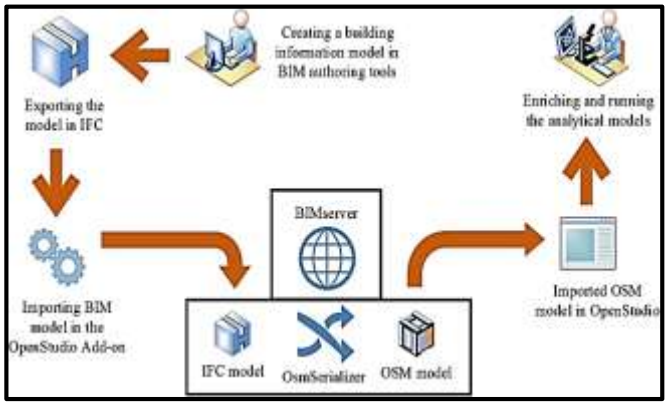

Figure 8: IFC based Files on BIM server

The aim was to provide an internet based electronic submission system for checking and approving building plans. The system utilized many of convergent technologies, such as Object Orientated software design, Standard for the Exchange of Product (STEP) Model Data (Fenves et al., 1995), and adoption of graphical project technology.

Solibri Model Checker

The most-recognized plat form of compliance checking is Solibri Model Checker (SMC), the main purpose of which is to achieve continuous quality control for the BIM model during its life cycle. It has an intuitive walk-in functionality to examine the design features and capture clashes. With SMC, the IFC files from different BIM models, such as from architects, M&E, Structures and so on, are combined and the check is then run on the combined model to assess the overall quality, and to reveal potential flaws and weaknesses. SMC is a Java-based desktop platform, with identified rule sets that are used for model checking. The functionality of SMC is based on an information take-off (ITO) capability, which allows users to collect information from the BIM, organize it, visualize it, read the IFC file. The information that can be checked with SMC includes areas and spatial calculations, the envelope of the building to be used for energy calculations, volumes, and quantities. In SMC, users can specify - for example - what requirements for the minimum thickness, length, and height of the walls, the ratio of the window area to the floor area of spaces, the maximum allowable distance of any space to the nearest exit when checking for valid escape routes, and the allowable overlaps when checking for intersections between any two types of components. The use of SMC is limited to quantitative information within the design, where a simple algorithm based on topological relationships is applied

4- RECOMMENDATION

In the previous section, the policies and strategies adopted by the Singapore and Norway show a mature and workable working framework for promotion programs of BIM, and some of them could be utilized directly while the others might need to be modified at first to fit Egypt‘s market and industry.

Building on the literature review and the interviews the study recommended some actions that should be taken by the Egyptian government, construction industry stakeholders for adopting BIM towards sustainable construction industry.

Government and public authorities	Universities and educational centers	AEC companies and manufactures
• Adopt BIM in the 2030 sustainable development strategy in the area of sustaining the built environment towards improving the construction industry practices.	• The rapid development in the construction technologies and practices towards more sustainable practices need adaptive curriculum that can follow and update the students‘ knowledge and skills.	• Set goals, form a BIM implementation plan, and inform the company‘s staff with the plan to support the implementation process.
• Set broad goals for the BIM adoption with the cooperation with the industry stockholders and set a time frame for reaching these goals.	• Use BIM applications in the environmental courses to train the students on using simulation to measure the building performance.	• Monitor the plan gradually and update it when needed.
• Release a roadmap for mandating BIM in the construction industry	• Encourage the collaboration and communication between the engineering departments through shared projects.	• Measure the implementation maturity level and evaluate the performance of the implementation process.
• Provide professional BIM education.		• Celebrate each goal achievement and support the staff by giving rewards and accepting errors at the beginning.

• Implement BIM in the building license authorities		• Inform the top management with the BIM benefits through providing training in the BIM management tools and its ability to enhance the quality and improve the productivity on the long run, in addition to showing them successful implementation and projects cases.
• Increase the awareness among the AEC stakeholders for the importance of BIM adoption		• Invest in the staff training and upgrading the firm‘s technological infrastructure
• Collaborate with the private sector to develop BIM standards and guidance based on their experience.		• Make any required change in the company‘s business or disciplines structure to support collaboration and communication between the project team.
• Form a benchmark and best practices platform in order to help more firms in the implementation		• Manufacturers and suppliers should provide the design team with BIM objects for their products to be used in the

process.		building analysis and simulation.
• Make a partnership with the international organizations that support BIM adoption through countries like the BIM task group or building SMART organizations.		
• Encourage the AEC firms to implement BIM and sustainable buildings by providing training, reducing taxes, and provide loans to update the companies' technological infrastructure.		

5- CONCLUSION

Open BIM-based automated code checking is recognized as the conspicuous future of BIM worldwide. It is anticipated to bring changes to the design and construction industry for the following 20 a long time. In Singapore, in order to progress on the structural and construction technology of the country and reinforce the competitiveness of little and medium-sized design Firms, government financed the BIM-related extend. This extend create connected innovation for building permission documentation through standardized data format, accommodation arrange, criteria and prerequisites for the advantage of BIM information trade; and to create an integrated collaborative extend authoritative framework.

Earlier to the BIM e-Submission development, building consent prepare of SOLIBRI depended greatly on 2D drawings with around 150 pieces of documents required in add up to from building, basic, MEP and etc. BIM e-Submission handle decreases 1/3 of the time required to produce required documentations for submissions by robotizing the drawing generating process, pre-checking BIM models with the latest building codes, permitting a feasible stage for collaboration, and mechanizing the code compliance assessment forms ,Along these lines, Automated checking applications ought not be viewed as just operators of a change towards advanced authoritative procedures. In fact, these applications ought to be viewed as master frameworks that can help planners, giving them a multidisciplinary, educated and point by point see on the results of their outline choices.

BIM Sustainability criterion can be used together with Code checking to avoid negative development processes and can accumulate and strengthen each other.

Need to be of global standards and the manpower needs to be equipped with the latest technologies in constructions .

Following globally recognized standards lif IFC it’s time to use it for code checking as well .

There is a need to to build such systems that can take advantage of BIM for code compliance and can help the governments as an E-governance tool .

BIM developed criteria is not always essential to scrutinize for all the suburb many times and also supplement the criteria positively; their suburbs with various features can be included.

In the end, Based on the results of this study, it can be concluded that the Egyptian market suffers from continuous losses at all levels as a result of lack of awareness of BIM in achieving comprehensive narratives in the field, which in turn led to government decisions towards E -Government.

LIST OF SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations have been used in this paper:

AEC Architecture, Engineering and Construction

BIM BIM Building Information Modeling

LEED Leadership in Energy and Environmental Design

MEP Mechanical, Electrical, and Plumbing

IFC Industry Foundation Classes

SBIM Simplified Building Information Model

ISO International Standards Organization

SMC Solibri Model Checker

ملخص

قوانين تراخيص البناء هي من الضروريات في تصميم المباني و تحتاج الى متابعة دائمة لتلك القوانين طوال عملية التصميم البناء ادوات الBIM الحالية بمصر غير قادرة على مساعدة المعماري في ترشيد عملية البناء ككل . اذا ان من الصعب لبرمجية الBIM ان نتجح في التوفيق ما بين قوانين تراخيص البناء و التعديلات التي يجريها المصمم للمشروع اثناء البناء ويتم فحص تراخيص البناء و مدى قانونيته الرسومات المقدمة من المصمم يدويا ، هذه مهمة هامة للمصممين ،اذا ان من سلبيات الفحص اليدوية القائم حاليا في مصر انه يودى الى تأخير عملية البناء ،لتأخير من قبل المسئولين بالضافة الى ما يمكن ان تخضع لة عملية الفحص الى اهواء القائمين علية ،فى حين تطور تكنولوجية الBIM في دول اخرى ان يتم فحص تلك التراخيص بالرسومات بالحاسوب في وقت وجيز تساعد على سرعة انجاز المبنى دون التدخل من ارادة القائمين علية اذا ما تم فحصة يدويا و هو ما يؤدى الى نتائج دافعة في مطابقة تلك الرسومات لوانين و اللوائح المعمول بها في تلك البلدان. ويعتبر واحدا من التكنولوجيات مع معظم الإمكانات لتوفير قيمة كبيرة لصناعة العمارة والهندسة والبناء (AEC).

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