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Adaptation of Green Building Design Concept with BIM into A New Construction Market in the AEC/FM Industry

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***Abstract*—In the world, the emergence of BIM technology with Green Building Design concept has revolutionized the Built Environment in recent times. The Green BIM concept is developing very fast and millions of Governmental institutions, Professional Bodies, Construction companies, and Research Institutions are embracing its massive impacts and contribution to construction management and projects delivery for both public and private projects. The efficiency and effectiveness of this technology is not well known in the Indian Construction industry and Asia in General. The question is "how to adapt and implement Green BIM concept into the construction market in India?" In order to improve its construction management and projects delivery system in the Architecture, Engineering, Construction, and Facility Management Industry.**

This paper has been able to ascertain some problems related to Construction management and operational process such as lack of good collaboration between project teams, Lack of analysis on energy usage on building projects, Deficiencies in project scheduling and time management, Non-function maintenance culture on constructed buildings, Ineffective mechanism for costs control, technological deficiencies, Projects delays in construction, etc. The Mixed Method Research (MMR) was used for the collecting, analyzing, evaluating and the interpretation of research data for both questionnaires and interviews.

The Green BIM concept in India was investigated and use as a model. The findings of this project research will provides the platform aimed at exploring the technological benefits, strategic advantage and operational flexibility that Green Building Design concept with BIM technology had created in these countries. The solutions and recommendation of this study will address the problems stated in the construction industry in India. This will create an enable environment which in turns will stimulate accelerated development in the construction industry and bring growth in that sector of Indian economy.

***Index Terms*—Green building design, Building information modeling.**

I. Introduction

In 21st century global construction market, there are always new requirements and regulations on building constructions. The European parliament has even given directives to all its 28 member nations on the use of BIM in 2016 on public funding projects in order to streamline the construction environment. This paper explore the Green BIM concept and the successful stories in India after it use. Moreover, highlighting the initial problem statement that ignites the desire to find appropriate solutions to improve organization and operational management system for the new construction market India. The findings of this research recommendations will be implemented in the Indian construction industry for the Architecture, Engineering, Construction, and Facility Management Industry (AEC/FM Industry).

A. Building Information Modeling (BIM)

BIM or Building Information Modelling is defined a process for manufacturing and managing information models on a construction project across the project lifecycle. One of the main outputs of this method is the Building Information Model that is the digital description of all aspects of the built model. This model relies heavily on information assembled collaboratively which is regularly updated at key stages of the project.

Construction of any scale of built environment is largely reliable upon available human resource at site and is indigenous to the development of any country across the globe. It takes certain intensive managerial and technical expertise in the organization to come up with a good quality infrastructure to serve the intended purposes throughout. Building Information Modeling (BIM) provides smart solutions to complexities arising out of problems related to management and technology.

B. Objective of the Research

The quest to comprehend the dynamics of Green Building Design with BIM Technology concept into a new construction market in Indian as follows;

1) To give clear understanding of the Green BIM concept and how this new technology can transformed the construction industry market in India when adopted.
2) To investigate the Green BIM concept development in Asian countries. What are their experiences and impacts on working with Green BIM concept in their projects delivery and construction management?
3) To explore the technological benefits, strategic advantage

and operational flexibility in Green Building Design concept with BIM technology had created in the Built Environment.

4) To give a roadmap to transfer and implement model of Green BIM concept into the new construction market.

II. Literature Review

Shaogang Zhu, Yunyu Tu et al., (2015). Under the background of sustainable development, the energy-consuming equipment and application mode of building system have changed to some degree. BIM's green building is the priority in design currently. From this study it was concluded that On account of various problems in the practice of BIM design structure, the original design process must be abandoned to reduce the impact of influencing factors and sports building design should also be comprehended in accordance with new development idea and application strategy.

Mohammed Zaid Shaikh, Dishant Shah, Kshitij Anand, Kedar Shelke, Awez Giniwale, Smit Chheda.,et al(2017). This paper reviews and reflects how key sustainability aspects are achieved through BIM in the AEC industries. Using building information modelling (BIM) data that is generated during design over the whole project lifecycle enables faster, efficient, safer, less wasteful construction and more cost-effective, better sustainable operation, maintenance and eventual decommissioning.

From this study it was concluded that Building Information Modelling (BIM) has the power to enhance the design of a building, reduce its costs and further save energy. However, very little research has been carried out on its negative impact on relevant sustainable practices.

III. Methodology

This paper is a "Desk and Field Research". The meaning of the term Desk and Field research is that some of the information can be obtained indoor via literatures (books, journal etc.) whilst the field is to go to companies for interviews in order to have the needed information or data. The methodology for this dissertation would be Mixed Methods Research (MMR), where Qualitative and Quantitative means of collecting data would be deployed to gather, evaluate and analysis data by the researcher on the need for the adaptation of Green Building design concept with Building Information Modeling (BIM) into the new construction market. Furthermore, the findings of the collected data will addressed the research questions posed in this research work.

A. Mixed Methods Research (MMR)

According to Creswell, (2014) Mixed Methods Research it is the methods which qualitative and quantitative research is used to collect data by way of integrating the two data gathered. This design structure provides a better understanding of the research problem by comparing, relating and interpreting the data gathered for comprehensive results outcomes. Again, it can be either theoretical frameworks or philosophical assumptions. In the account of the research questions in mind, the research motive and choice of consideration for Mixed Methods Research is able used this method to have full knowledge and understanding on how Green BIM is implemented in the Danish Construction industry and also, test the perception level on Green Building with Building Information Modeling in the new construction market.

This in a long run, will provide the researcher the best framework to recommend practical solutions in respect to the research questions for this thesis report. The figure shows the characteristics of Mixed Methods Research.

Quantitative Methods	Mixed Methods	Qualitative Methods
Pre-determined	Both predetermined and emerging methods	Emerging methods
Instrument based questions	Both open- and Closed-ended questions	Open-ended questions
Performance data, attitude data, observational data, and census data	Multiple forms of data drawing on all possibilities	Interviews data, observation, document data, and audiovisual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases interpretation	Themes patterns interpretation

Fig. 1. Mixed methods research

IV. Green Building Design

A. Sustainability Development in India

In India, Sustainability development is transforming and growing very fast in the construction industry. In light of this thesis report, the researcher was granted an opportunity for an interviewed. The DGBC also organize sustainable courses for companies which wish to have DGNB certification system on new constructed buildings and more so, support the growth of sustainable buildings among stakeholders and ensuring for its stable development by achieving sustainable goals.

This search of knowledge is for the inspiration for the Indian construction market players and to increase the level of ambition for sustainable construction in the Indian construction market. However, the researcher aimed to implement the adaptation of Green BIM concept will tap into this innovation at DGBC as they adopted this system from Germany. The statistics obtained from the Green Building Council shows the growth sustainable development as be illustrated in the DGNB pre-certified buildings per year from 2012 to 2016.

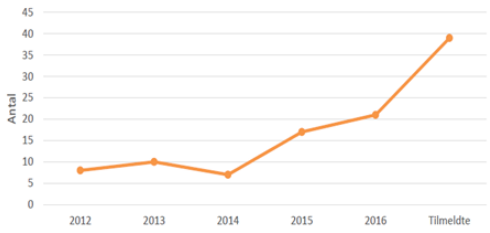

Fig. 2. Illustrated in the DGNB pre-certified buildings

B. DGNB Certification

DGNB certification system is similar to that of Leadership in Energy and Environment Design (LEED) system (US) and the Building Research Establishment Environmental Assessment Methods (BREEAM) system (UK). In 2012, the Green Building Council introduced this form of green certification system award to the Danish construction companies. DGBC adopted this DGNB system from Germany, which started using this award of certification system in their construction sector in 2008. The Green Building Council tailored this certification concept to suit the Danish construction environment and its legislation. The indicators on the graphic shows potentials and interest that this system is gaining in the Danish construction industry. The Fig. 2, shows the DGNB building certifications in Denmark from 2012 - 2016.

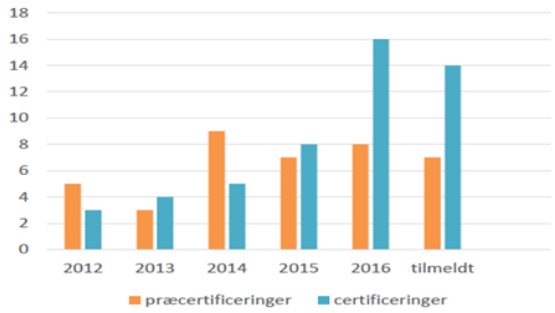

Fig. 2. DGNB building certifications

Fig. 3. DGNB measuring tool for sustainability

V. Building Information Modeling

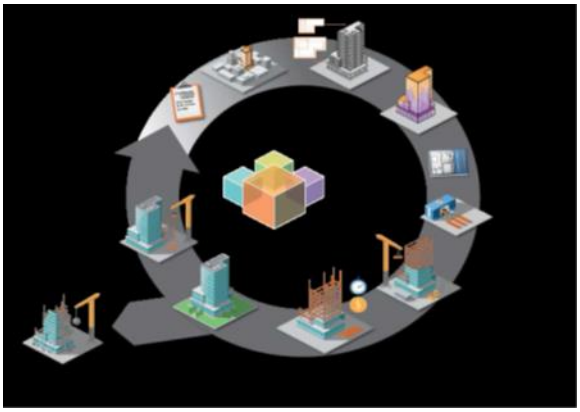

Fig. 4. BIM functions

A. Origin of Building Information Modeling (BIM)

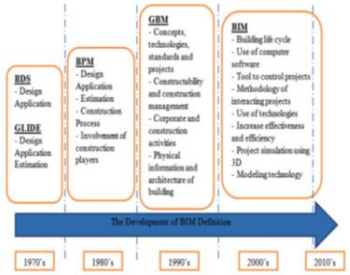

Fig. 5. Development of BIM definition

B. BIM Integrated Information Model

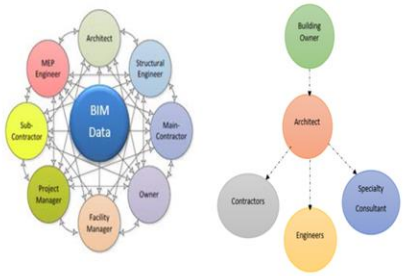

Fig. 6. BIM information model vs. traditional

C. Building Information Modeling (BIM) Stages

Fig. 7. Illustrate linear view of BIM maturity

VI. Analysis and Data Discussion

A. Background of Respondents

Variable	Categories	Frequency	Percentage
Professional Background			
	Architect	10	42%
	Engineer	4	17%
	Contractor	5	21%
	Facility Manager	1	4%
	Project Manager	2	8%
	Others	3	13%
Total		25	100%
Years of working Experience (Years)	0-5	12	52%
	6-10	7	30%
	11-15	3	13%
	16-20	0	0%
	Over 20	1	4%
Total		23	100%
Working Place			
	Architectural Firm	7	30%
	Real Estate Developer	3	13%
	General Contractors	8	35%
	Owner-Builders	3	13%
	Engineering Firm	2	9%
	Others	1	4%
Total		24	100%
Educational level			
	Post Graduate	11	48%
	First Degree	8	35%
	Higher National Diploma (HND)	2	9%
	Construction Technician Certificate	2	9%
	Others	0	0%
Total		23	100%

Fig. 8. Stakeholder's attitude and perception on Green BIM

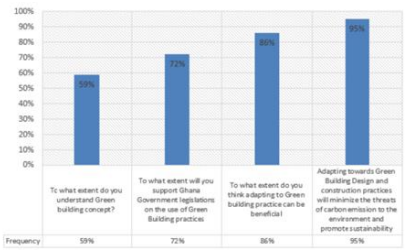

Fig. 9. Illustrate Green Building perceptions of stakeholders

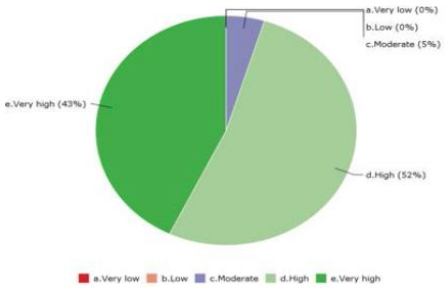

Fig. 10. Interest of BIM implementation by stakeholders

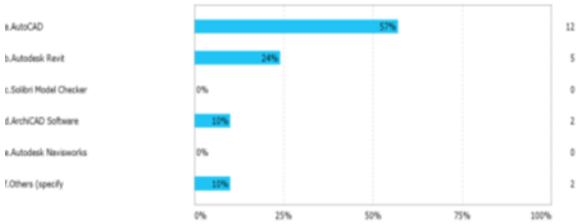

Fig. 11. BIM software use in the construction

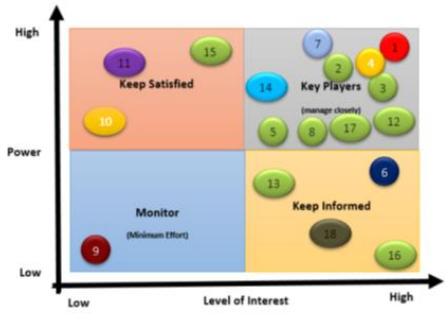

Fig. 12. Stakeholders Power/interest matrix

B. *Construction Style Analysis*

Fig. 13. Illustration of the Macleamy curve, BIM process vs. Traditional design

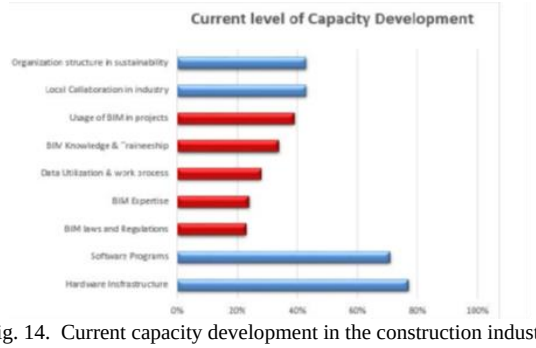

Fig. 14. Current capacity development in the construction industry

C. *Solutions and Recommendation*

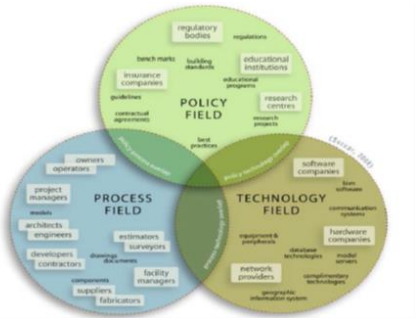

Fig. 15. Three interlocking field of BIM

VII. IMPLEMENTATION

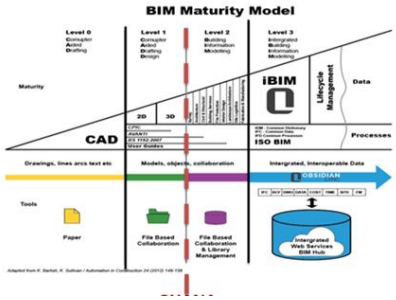

Fig. 16. Level of BIM maturity model

Fig. 17. Focus areas for BIM at Company Ltd.

Fig. 18. Kotter's Change Model

VIII. CONCLUSION

1. Government have to establish an independent BIM Development Task Force who will work under the Ministry of Works and Housing. Government has to review all University and Polytechnic studies curriculum in order to propagate Green BIM concept in large segments of the population.
2. Construction Stakeholders should form partnerships with

Financial Institution to grant them loans to uplift their businesses through acquisition on advance technologies

3. Government have to take initiative by investing into Hardware acquisition and software programs for the industry.
4. Inviting foreigner with BIM specialist from Europe to develop the human resource capital on BIM.
5. Government should give incentives like tax reductions to companies who's invest IT software
6. Laws and policies on sustainability practices must be reviewed and enforced in the industry.
7. Moving the construction industry towards Sustainable construction requires laws and legislation which requires stakeholders to adhere to, so there must be dialogue between Government and all stakeholders in the construction sector. E.g. all public funding projects must have a contractual agreement on the use of Green BIM concept as requirement for qualification.
8. Government and India. AEC/FM industry must invest in training more workers on BIM specialist in the next 3 years.
9. Research Centers and Professional bodies have to assist Government in policy design, most especially the drafting of standard requirement of Green.

The researcher have the convictions that if all these points are execute to it perfection it will answers all the research questions. Again, the Kotter's 8 steps action plan, will come handy when implementing this concept into the new construction market -Indian for AEC/FM industry.

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