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# "Applying Building Information Modeling on Steel Projects"

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**كلية الهندسة – جامعة عين شمس**
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# " تطبيق برامج نمذجة معلومات البناء على المنشآت الحديدية "

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**للحصول على ماجستير في العلوم الهندسية في الهندسة الإنشائية**

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# Abstract

*Building Information Modeling "BIM" becomes a better known established collaboration process in the construction industry. Owners are increasingly requiring BIM services from construction managers, architects and engineering firms. Many construction firms are now investing in "BIM" technologies during bidding, preconstruction, construction and post construction.*

*The use of "Building Information Modeling" programs has increased in recent years to achieve the greatest degree of coordination between Electro Mechanical works (MEP) and different design elements (Architecture & Structure) during all stages of design, manufacturing and construction for all projects in general.*

*The use of these programs in the field of steel structures is one of the first successfully use of these applications because the design, fabrication and erection of the steel structures needs a very high accuracy. Such types of steel structures are bridges, high rise buildings and factories. The use of these programs was initially conceived as an evolution of the "AutoCAD", in order to link all the details of the steel structure, making it easy to find and solve the details of connections between all elements of steel structure. One of the most important developments in this area was the "X-Steel", which links between the design and fabrication during all stages, which avoided most of the errors that existed before implementing these applications. Through these programs, "BIM" programs have recently been developed to be applied to all other projects.*

*This thesis will display different definitions for BIM concept according to varied institutions. Also, the literature review of BIM and the plans to implement it in different developing countries will be stated. The programs that can be used in BIM implementation, shop drawings used in fabrication and scheduling used for construction management will be displayed.*

*In order to study the impact of using these programs on development of steel industry; a questionnaire was designed. This questionnaire includes sets of errors that may occur during the construction of a steel structure. These errors have different probability to happen and varied impact on construction process.*

*In order to identify the "Impact of Applying Building Information Modeling on Steel Projects", the possibility of errors before applying "BIM" will be compared with their counterpart after applying "BIM". Also, the risk will be calculated using the mean impact and the probability of each error.*

*At first, the questionnaire was distributed on steel companies that work in design, fabrication and erection of steel structures around the globe by E-mail. Unfortunately, there were no responses from the several trials. That leads to minimize the respondents and make them limited to Egyptians and some Arabian Companies. The questionnaire was answered by 77 engineers who have at least 12 years of experience. The thesis will contain one of these answered questionnaires.*

*To analyze these 77 answered questionnaires, the SPSS program was used. The software name stands for Statistical Package for the Social Sciences. Brief information about SPSS program will be stated, the questionnaire's analyses using this program will be displayed in details and the results will be reviewed in the relevant chapter in this thesis. The extracted results will be used to identify the Impact of Applying BIM and the effect of BIM on risk for Steel Projects. This study will lead to clarify the impact of using BIM programs on the possibility of avoiding different construction errors.*

# Chapter I

INTRODUCTION

## 1.1 General

*The last 30 years in the twentieth century, the construction industry has suffered progressive reduction in its labor productivity. Meanwhile, non-farming industries, such as the manufacturing industry has expanded its work efficiency by increasing the labor productivity. To cover the decrease of work efficiency in the construction industry, increasing the working hours is a must. This will cause an extra cost leading to know that the construction industry is deficient with regards to the improvement for work sparing thoughts. According to a study in 2009 by the National Institute of Standards and Technology, Figure 1.1 portrays the hole between the productivity of non-farming labors and productivity of construction industry labors. There has been no efficiency pick up in the construction industry in the course of the most recent 40 years — indeed, unfortunately there is a consistent decrease, while the non-farming industries ascended more than 200% in profitability.*

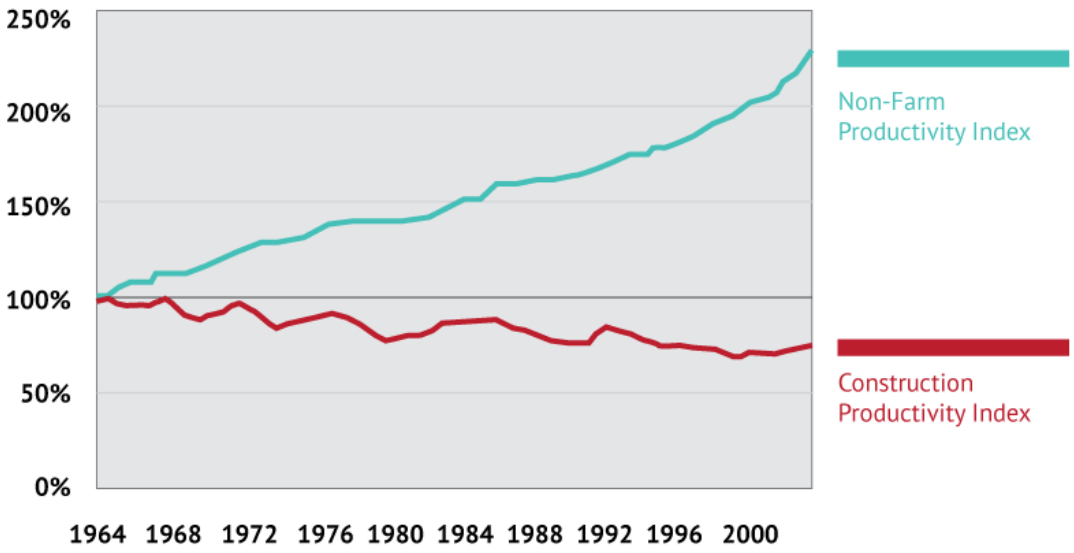


**Figure 1.1: Labor Productivity Index for the U.S. construction industry and all non-farm industries (1964-2009).**
(Advancing the Competitiveness and Efficiency of the U.S. Construction Industry, 2009)

*The traditional project delivery, the traditional use of 2D Computer Aided Drafting (CAD), the growing size of the projects and the variation of designing engineers working on the project considered to be from the main causes of the huge drop in labor productivity in construction industry.*

*Starting with the traditional project delivery, Design-Bid-Build, which hinders enrolling the participants in early stages of constructing a project. That means, the traditional project delivery prevents the collaborative coordination with the general*

*contractor or the construction manager in planning and designing stages. Also, the utilization of normal and conventional 2D CAD drawings does not advance a genuine collaborative approach. Different designing engineers (Architectural, Structural, Mechanical and plumping) deliver their own CAD drawings to carry their outlines to owners and contractors. These drawings are not incorporated and for the most part it lays clashes in information which results in a waste in labor productivity particularly that the structures have grown-up size, became more complex and they take more time to be constructed.*
*The estimators need to create their own quantities take off in light of the delivered CAD archives. In addition, the 2D CAD approach does not advance the joining of the drawings with timetable and cost.*

*One of the initial moves to utilization of 3-Dimensional innovation in the development business was started as a 3-Dimensional strong demonstrating in late 1970s. During this time, manufacturing industry carried out product design, analysis, and simulation of 3-Dimensional products. 3-Dimensional demonstrating in the development business was impeded "by the cost of registering force and later by the effective far reaching selection of CAD" (Eastman, 2008). The manufacturing industry realized, spent more assets in innovation and grabbed the "potential advantages of incorporated examination abilities, diminishment of mistakes, and the move toward plant computerization". They cooperated with displaying instrument suppliers to lessen and dispense with the innovative programming difficulties.*

*According to a study by the Construction Industry Institute In 2004, it was estimated that 57% of money spent on construction is nonvalue-added—which is WASTE. With the U.S. construction market estimated at US$1.288 trillion for 2008, at 57% waste, over $600 billion per year is being wasted, Figure 1.2.*

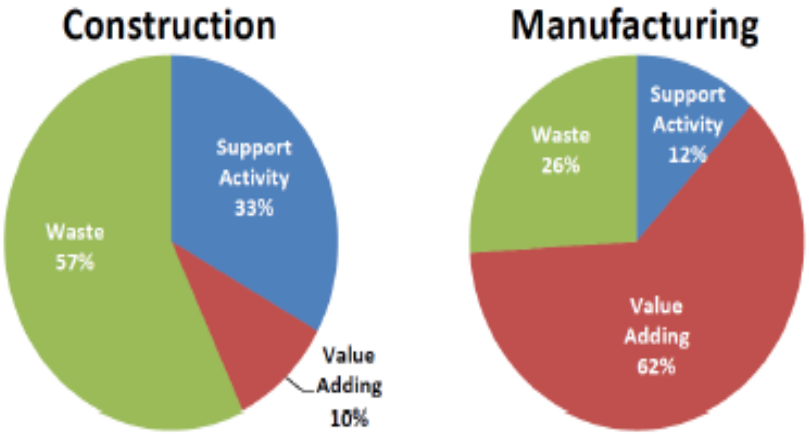


**Figure 1.2: A large portion of the money spent in the construction industry is wasted, especially when compared to the manufacturing industry.**
(BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors, By Eastman, 2008)

## 1.2 Objectives

*Steel, by some edge, is the most prominent enrolling material for multi-story structures and industrial type structures as well. It has a long reputation of conveying high quality and financially saving structures with proven sustainability benefits.*
*The steel-confined building determines a large portion of its upper hand from the advantages of pre-assembled segments that can be gathered in no time at site. Dissimilar to cementing, that is generally wet procedure led at site; steel is created and manufactured inside a controlled domain.*
*The main objectives of this research are to understand BIM by reviewing its definitions, know the historical background about BIM implementation in different leading countries, determine the percentage of elimination for errors after using BIM in implementation of steel structures and determine the reduction in risk after using it.*

## 1.3 Scope of Work

*The construction industry for steel structures improved in several countries around the globe. The usage of Building Information Modeling considered being the brilliant method for this improvement. The reasons for making this study are:*

- *Have an overview about using BIM in some leading Arabian steel firms.*
- *Explore the probability of errors that can happen during all construction processes for steel structures (before and after using BIM).*
- *Prove the importance of developing the construction industry for steel structures by utilizing Building Information Modeling (BIM). This prove will be made by comparing the percentage of each error can happen before and after using BIM.*
- *Figure the reduction in risk after using BIM.*

*To accomplish this research a questionnaire was made by surveying the researches that contain information about errors that can happen during different processes of constructing steel structures. Initially, the study intended to be a global study by distributing the questionnaire using E-mail on about 200 steel structure firms around the globe. Unfortunately, there were no response for the several trials and that caused time waste. Finally, the study made with 8 leading Arabian steel structure firms.*
*The chosen 77 respondent engineers were having at least 12 years of experience in steel structures field. This long experience allowed them to deal with steel structures before and after applying BIM. Also, they can evaluate the effect of each error on*