

LEAD TIME IN CONSTRUCTION PROCESS

NURUL ARAFAH BINTI ISHAK

UNIVERSITI TEKNOLOGI MALAYSIA

# **LEAD TIME IN CONSTRUCTION PROCESS**

**NURUL ARAFAH BINTI ISHAK**

**A project report submitted in partial fulfillment of the  
requirements for the award of the Degree of  
Master of Science (Construction Management)**

**Faculty of Civil Engineering  
Universiti Teknologi Malaysia**

**JULY 2012**

*Dedicated to MY BEST COUNSELLOR AND MY BEST FRIEND,*

*Abah, Ishak Bin Zakaria*

*Mak, Mariana Binti Marmun*

*“Father was Self-Made but Mother was Constructed by Others and Such Edifices are Notoriously Fragile”*

*My dearest sisters*

*Kak Ngah, Nur Syahida Binti Ishak*

*Adik, Norayshah Binti Ishak*

*Thanks for giving me infinite LOVE, care and blessing...*  
*Thank you from the bottom of my heart for being my inspiration...*

*To MY MR. DECLARED, Anas Bin Abdul Halim*

*Thanks for your support, understanding, encouraging and love...*

*Special to MY BEST EVER FRIEND, Noor Hamizah Binti Haji Baharin*

*Thanks for your support, encouraging, and care...*

*And lastly to my dear friends,*

*Thanks for your endless support to me...*

*“Friend is Hard to Find, Harder to Leave and Impossible to Forget”*

## ACKNOWLEDGEMENT

Firstly, I am forever grateful and thanks to Allah SWT whom given me the opportunity to finish my Master Project Research. I also wish to express my sincere gratitude to all who have helped me directly or indirectly in my Masters Project research work, and a big thank you especially to my project supervisor, *Associate Professor Dr. Abdul Kadir Marsono*, for his assistance, guidance, encouragement and concern. With his invaluable advice and superb guidance, I have successfully managed to complete my Masters Project. It is indeed a true honour and privilege for being able to work under the supervision of such a dedicated and enthusiastic lecturer.

I also would like to thank all parties that have been so kindly in giving me invaluable information and data. Special thanks are also to members of Building Division (Education Section) of Public Work Department (PWD) Kuala Langat and Johor Bahru for their invaluable help while I carrying out this research work. I'm very grateful for their help and forever thankful for their kindness. Also not to forget Encik Yusnizam Bin Baharuddin the owner of Teraju Precast Services Sdn Bhd who willing to assist me to get a clear view of IBS precast component of school building projects.

Last but not least, I would like to express my heartfelt gratitude to my family and my beloved friend for their utmost support and motivation throughout this research work. I may not manage to finish this project without them. My biggest thanks and love go to them all. Wasalam.

## **ABSTRACT**

This research studies on an improvement of the construction process in term of time consideration. The construction industry was considered fragmented because policy and guideline implementation and practice in the construction are inconsistent among the players involved. Commonly, town planners, architects and designers work independently with little input and communicate with each other. The construction industry is facing increased demands from society. Project are becoming more complex and customer are demanded for high quality building, lower cost and shorter lead-time of completion. Customers are requesting value of the project. Lead time minimization is importance in order to increase the quality of project. IBS is of the technology that is introduced by the government to minimize the lead time in construction process in term of time saving. Eventhough for almost 45 years, IBS were still at introduction step in Malaysian Construction Industry. The implementation of the technology are still far from achieving the 100 points of IBS Score. The main barriers that impede the implementation of IBS are the resistance of the parties involved in construction industry. This research is an effort to contribute academically for better construction management to increase the lead time of the construction process and the quality of the product. The objective of the research is to identify which activity that affecting the most of lead time in construction process and to identify and mitigate the possible cause of the delay that lead to similar completion time. Methods that are used to achieve this objective is by collection, gathering and analyze the data using the Autodesk Naviswork Manage. From the study it was conducted that the lead time can be reduced by studying the ground level of process to mitigate appropriately.

## ABSTRAK

Kajian ini dijalankan bertujuan untuk mengkaji terhadap peningkatan kualiti proses pembinaan dalam dari aspek masa pembinaan. Industri pembinaan seringkali dianggap sebagai sebuah industri yang berpecah-belah kerana pelaksanaan dasar dan garis panduan serta amalan dalam industri pembinaan adalah tidak konsisten di kalangan pihak-pihak yang terlibat. Biasanya, perancang bandar, arkitek dan pereka bekerja secara bebas dengan sedikit input dan komunikasi antara satu sama lain. Industri pembinaan merupakan sebuah industri yang sedang menghadapi peningkatan permintaan daripada golongan pengguna. Hal ini menyebabkan, peningkatan kepada pembangunan yang melibatkan projek yang lebih kompleks dilaksanakan dengan hasil kualiti yang tinggi dan kadar kos yang lebih murah disamping tempoh pembinaan yang singkat. Pelanggan pada masa kini sangat menitikberatkan perkara yang berkaitan dengan kualiti sesuatu projek. Pengurangan tempoh masa dalam sesuatu aktiviti pembinaan merupakan salah satu faktor yang menyumbang kepada peningkatan kualiti projek. IBS merupakan suatu teknologi yang diperkenalkan oleh kerajaan yang bertujuan bagi meminimumkan tempoh masa utama dalam proses pembinaan bertujuan untuk menjimatkan masa sesuatu aktiviti pembinaan. Walaupun telah hampir 45 tahun, IBS telah diperkenalkan dalam Industri Pembinaan Malaysia. Tetapi pelaksanaan teknologi masih tidak dapat mencapai 100 peratus mata Skor IBS. Kajian ini adalah satu usaha yang bertujuan untuk menyumbang idea dalam memastikan pengurusan pembinaan yang lebih baik untuk mengurangkan tempoh masa pembinaan dan sekaligus meningkatkan kualiti produk. Objektif kajian adalah untuk mengenal pasti aktiviti yang

mempunyai tempoh masa yang paling tinggi dalam melaksanakan sesuatu aktiviti dan untuk mengenal pasti dan mengurangkan kemungkinan punca kepada kelewatan yang membawa kepada suatu tempoh masa yang lebih baik. Kaedah-kaedah yang digunakan untuk mencapai matlamat ini adalah melalui pengumpulan dan menganalisis data menggunakan “*Naviswork Autodesk Manage*”. Daripada kajian yang dijalankan, dapat dirumuskan bahawa tindakan awal dalam mengawal sebarang kemungkinan memberikan banyak kelebihan dalam usaha menjimatkan masa dan meningkatkan kualiti projek pembinaan.

## TABLE OF CONTENT

CHAPTER	TITTLE	PAGES
	<b>DECLARATION</b>	ii
	<b>DEDICATION</b>	iv
	<b>ACKNOWLEDGEMENT</b>	v
	<b>ABSTRACT</b>	vi
	<b>ABSTRAK</b>	vii
	<b>TABLE OF CONTENT</b>	ix
	<b>LIST OF TABLE</b>	xiii
	<b>LIST OF FIGURE</b>	xiv
 <b>CHAPTER 1</b>	 <b>INTRODUCTION</b>	
	1.1 Introduction	1
	1.2 Problem Statement	3
	1.3 Aim of Study	4
	1.4 Objective study	5
	1.5 Scope and Limitation	5
	1.6 Expectation Result	5



## CHAPTER 2 LITERATURE REVIEW

2.1	Introduction	7
2.2	Definition of Industrial Building System (IBS)	8
2.2.1	Advantages of IBS	12
2.2.2	Disadvantages of IBS	12
2.2.3	Opportunity in IBS	13
2.3	Modular Coordination (MC)	13
2.3.1	Objectives of MC	14
2.3.2	Concept of MC	15
2.4	IBS Content Scoring System (IBS SCORE)	16
2.4.1	Objectives of IBS SCORE	16
2.4.2	Principles of IBS SCORE	16
2.5	Shortest Lead Time	17
2.6	History of Lean Production	19
2.6.1	Lean in Construction	20
2.6.2	Strategies and Techniques of Lean Construction	23
2.7	Total Quality Management	27
2.7.1	Background to Performance Measurement	29
2.8	Balance Score Card (BSC)	30
2.8.1	Performance measurement in the Construction Industry	31
2.9	Conventional Presentation Methods of Construction Schedules	34
2.9.1	Network Diagram	34
2.9.2	Gantt Chart	38
2.9.3	Calendar	39
2.10	Presentation of the 4D CAD Model	39
2.10.1	Comparison of Abilities of Presentation Methods	41
2.11	Building Information Modeling (BIM)	43
2.11.1	Advantages of BIM	44
2.11.2	Integrated practice	46
2.11.3	Collaboration	47
2.11.4	Concurrent	49
2.11.5	Life Cycle Management	50
2.12	Naviswork Manage	50
2.12.1	Naviswork Manage Background	51
2.12.2	Naviswork Manage Components	51
2.12.3	Naviswork Manage Product Family	54

2.12.4	Design Model File Format Compatibility	55
2.12.5	Naviswork File Format	55
2.12.6	Output Format	57
2.13	Closure	58

### **CHAPTER 3 RESEARCH METHODOLOG**

3.1	Introduction	59
3.2	Literature Review	61
3.3	Interview	61
3.4	Case Study	62
3.5	Conclusion	63

### **CHAPTER 4 DATA ANALYSIS AND RESULTS**

4.1	Introduction	64
4.2	Background of Analysis	64
4.3	Case Study	66
4.4	Comparative Lead Time of IBS Versus Conventional Analysis	68
4.4.1	Project Time Information	68
4.5	Lead Time Analysis	77
4.5.1	Naviswork Manage	78
4.5.2	TimeLiner Enhancements	79
4.5.3	Shortest Lead Time	80
4.6	Clash Detection	82
4.6.1	Clash Detection Result	84
4.7	Conclusion	90

### **CHAPTER 5 RECOMMENDATION AND CONCLUSION**

5.1	Introduction	91
5.2	Conclusion	92
5.2.1	Objective One	92
5.2.2	Objective Two	92
5.3	Recommendation	93
5.4	Problem of Data Collection	94
5.5	Conclusion	95

**REFERENCES**

96

**APPENDIX**

100

## LIST OF TABLE

<b>TABLE NO</b>	<b>TITTLE</b>	<b>PAGES</b>
2.1	A Comparison of Abilities of Different Presentation Methods	41
3.1	Case Study of the Research	62
4.1	Project Information Of 1 Unit 2-Storey Of Additional School Block Located at Kuala Langat, Selangor and Johor Bahru, Johor	67
4.2	Summarize of Activity from Microsoft Project (MSP) Schedule of IBS Process and Conventional Process	68
4.3	Comparison Duration of the Activity in Each Element During the Construction Process	70
4.4	Detail of the Testing Consideration	83

## LIST OF FIGURE

<b>FIGURE NO</b>	<b>TITTLE</b>	<b>PAGES</b>
2.1	IBS Staircase	9
2.2	Steel Formwork System	9
2.3	Steel Framing System for Factory Project	10
2.4	Pre-fabricated Timber Framing System for Roof Construction	11
2.5	Block Work System Usually As a Wall Retention	11
2.6	Main Point In Managing Construction Project	18
2.7	Activity on Arrow Diagram (AOA)	36
2.8	Activity on Node diagram (AON)	37
2.9	The Length of the Bar Represents the Activity Duration	38
2.10	The Organizational Structure In Design-Bid-Build Projects	48
2.11	The Organizational Structure In Design- Build Projects	48
3.1	Flow Chart of the Research Methodology	60
4.1	Distribution of The Total 333 Government IBS Project, Oct. 2008-Nov. 2010	65
4.2	School Building-Additional Block Standard Designs For 1unit-4 Storey Building	66
4.3	Comparision on Lead Time Activiy In Construction Between IBS and Conventional Process	72
4.4	Comparision Activity Time on Sub-Structure Activity	73
4.5	Comparision Activity Time on Super-Structure Activity	74
4.6	Comparision Activity Time on Finishes Activity	75

4.7	Comparision Activity Time on Mechanical and Electrical Activity	76
4.8	Work Flow on Doing the Lead Time Test	77
4.9	Workspace in Naviswork Manage Software	78
4.10	Example of CSV Report on TimeLiner	80
4.11	Eliminations on an Project Activity in Order to Minimize the Lead Time	81
4.12	The Unchange Tool Lead Time at Detection and Resolving Clash	81
4.13	Clash Test on Clash Detection Between the Structure Design and MEP Design	83
4.14	Total Clash Detection Test	84
4.15	Clash 17 of the Test, the Connector and Pipe are Not Fix with the Floor Level	85
4.16	Total Clash Detection by Level	86
4.17	Total Clash Detection For Item 1 and Item 2 During The Test	86
4.18	Clash 53 Show the Connector is Intersect With the Beam on Level 1	87
4.19	Add Text and Comment Show the Problem that Occur on that Part are Already Identify	88
4.20	Changing the Status of the Clash Detection from New to Reviewed to Shows that the Clash are Already Reviewed	89

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

The term of conventional work process can be defined as the common practice inherited from the long established custom of delivering the construction project based on fragmented work process (Tahrina Taib, 2010). Generally, this practiced has dominated the industry with the separation between design and construction process. Shortest lead time in construction can be defined as the efficiency of the process in construction project. Efficiency in construction process can be defined as the project constructed within time schedule and cost budgeted. Shortest lead time also based on the two item; time schedule and cost budget. Conventional construction process always be indicated as poor in management such as resources and material management, waste management, quality management, communication management and personnel management left unattended.

Conventional construction process always been connected with the inefficiencies in term of project time. The development of Industrialised Building System (IBS) is not new and it is a new innovative construction method in the construction industry. The history of precast in UK housing dates from the mid 1900's, when this and other forms of industrialised (prefabricated) construction were used to address the problem of widespread destruction of housing stock during the Second World War (Chong, 2006).

In United States, the use of precast in the construction industry began with the construction of General House in 1930, using of prefabricated steel house. However the early efforts of rationalising and implementation faded quickly due to price incompetitiveness, high capital and inconsistent local codes. The use of precast increased sharply after the Second World War due to the need to resolve critical shortage of houses (Chong, 2006).

The implementation of the precast concept in Malaysia began on 1966. When the government launched two precast project of housing which is located at Kuala Lumpur, Tuanku Abdul Rahman Flats and the Rifle range Road Flats in Penang. The first precast technology that implement at Malaysia are brought from Germany by Perbadanan Kemajuan Negeri Selangor (PKNS). The technology are use for the construction ranging from low cost housing until luxurious housing such as terrace house, banglows and semi detached house. Today, many private companies in Malaysia have teamed up with foreign experts to offer precast solutions to their project such as from United States, Netherlands, Japans and Australia. The precast component that used in many project in Malaysia usually are use in the construction of goverment building such as school, apartment, hospital, roads, quarters and other infrastructures.

Eventhough for almost 45 years, IBS are introduce in Malaysian Construction Industry, but the implementation of the technology are still not achieve the 100 points of IBS Score. The main barriers that impede the implementation of IBS are



the resistance of the parties involved in construction industry. For the developer, they have to plan a larger project scheme in order to reduce the costs of houses for economic viability. Beside that, contractor also will relatively play less important role because most of the responsibilities will take over by the precast manufacturer. Furthermore, the subcontractor may face of problem, out of business due to the fact that the prefabrication will reduce the number of worker and by replacing them with the machines. It is important to the Malaysian construction industry to involve and enter in the globalization industry to increase the productivity, quality and safety. The lesson from the established manufacturing industry should be learn in construction. Rather than build a greater intervention from the government linked companies (GLCs) for a mega housing projects or endless supply of building ready-made components by multiple vendors and suppliers is something shall be studied in detail.

## **1.2 Problem Statement**

Many issues were raised in traditional construction process due to its in efficiency that can causing of a delay. People are aware about the issues and problems in conventional construction process but they do could not try to find the right preventive solution beside corrective actions. The problem of delay and low project quality has been the consistent bad image to the construction industry. A process improvement need to be taken with indicator that can be used to measure the shortest lead time of construction project.

The Industrialised Building System (IBS) has been introduced in Malaysia since 1966. It was implemented for speed and accuracy for a work that involves a lot of repetition. Above all effort by the early effort by the government seems to be vain because most of the local contractor is still practising the conventional method of construction. The annotation that IBS system are more effective, can reduce the

waste, safer working environment in construction site and the construction period compared to the conventional method are already well known. According to the Construction Industry Development Board (CIDB) of Malaysia roadmap in 2011-2015, the level usage of IBS in the local construction industry is at 75%. The main barrier on the implementation of IBS is the contractor it self.

The construction industry is considered as fragmented because policy and guideline implementation and practice in the construction are inconsistent among the players involved. Commonly, town planners, architects and designers work independently with little input and less communication with each other. Their medium of communication using contract document lead to delays in revision of plans and problem of constructability. The material supplier and transporters have their own agenda causing interruptions and abandoned schedules. The consequences will affect the quality, efficiency and time in the conventional construction. The current IBS initiatives still inherit these problem due to partial implementation of IBS type of construction.

### **1.3 Aim of Study**

The main aim of this study is to model the shortest lead time in construction process that can be use in increasing the quality and completion time of project. From that aim, two objectives are studied.

## **1.4 Objective Study**

From this study, there are two objectives are created :

1. To identify which activity that affect the most of the lead time in construction process either IBS or conventional process.
2. To identify and mitigate the possible cause of the delay that will minimize the lead time through simulation.

## **1.5 Scope and Limitation**

The scope will be limited to project schedule time and cost of project. The case study implementing one a sample of IBS project. The building selected is one a school project owned by Public Work Department (PWD). School building is a repetitive project that has consistent process and that can be improved by simulation.

## **1.6 Expected Results**

The project will identify the issues in traditional construction process that causing of delay of construction. IBS is the method of construction that will help to resolve the issues. It will give a comparison of the cause of delay and to reduce a simulation modeling of both IBS and conventional projects. The detailed of the study about the conventional construction process and IBS, the others model that will

## REFERENCES

- Abdullah. MR and Egbu. C.(2009). *IBS in Malaysia: Issues For Research In A Changing Financial And Property Market*. Paper Proceedings in BuHu 9th International Postgraduate Research Conference (IPGRC). Salford, United Kingdom.
- Badir, Y.F., Kadir, M.R.A. and Hashim, A.H. (2002), “*Industrialised Building Systems Construction in Malaysia*”, Journal of Architectural Engineering, Vol. 8, No. 1
- Badir, Y.F., Abdul Kadir, M. R. and Hashim, A.H. (2002). *Industrialized Building Systems Construction in Malaysia*. Journal of Architectural Engineering (8).pp.19-23.
- Bannet, J. and Grice, A., “*Procurement Systems for Building, Quantity Surveying Techniques*”. New, Directions, United Kingdom: (ed P.S Brandon), BSD Professional Books, 1990, Oxford.
- Bou-Llusar, J.C., A.B. Escrig-Tena, V. Roca-Puig and I. Beltra' n-Martý'n, 2009. “*An Empirical Assessment Of The EFQM Excellence Model: Evaluation As A TQM Framework Relative To The MBNQA Model, J*”. Operations Management, 27: 1-22.

Bing, L., Kwong, Y.W., and Hao, K.J., (2001). *Seismic Behaviour of Connection Between Precast Concrete Beams*. CSE Research Bulletin, No. 14. Malaysia

Construction Industry Development Board (CIDB) Malaysia (2003a). *IBS Survey*. Construction Industry Development Board (CIDB), Kuala Lumpur.

Construction Industry Development Board (CIDB) Malaysia (2003b). *IBS Roadmap 2003-2010*. Construction Industry Development Board (CIDB), Kuala Lumpur.

Construction Industry Development Board (CIDB) Malaysia (20011a). *Ibs Scoring System*. Presentation by Technology And Innovation Development Sector, Construction Industry Development Board (CIDB), Kuala Lumpur (Unpublished).

Construction Industry Development Board (CIDB) Malaysia (20011b). *Transformation of Construction Industry Through Ibs Roadmap 2011-2015*. Construction Industry Development Board (CIDB), Kuala Lumpur.

Construction Industry Development Board (CIDB) Malaysia (2008). *Malaysia Construction Outlook*. Presentation by Business Development Division, Construction Industry Development Board (CIDB), Kuala Lumpur.

Construction Industry Development Board (CIDB) Malaysia (1997). *Guide to precast concrete and prefabricated reinforcement for buildings construction industry*. Development board report, Malaysia.

Construction Industry Development Board (CIDB) Singapore (1992). *Raising Singapore's construction productivity*. CIDB Construction Productivity Taskforce Report

Dale, B.G., 1999. *"Managing Quality"*. Blackwell Publishers Ltd., Third Edition. Oxford

- Dean Jr., J.W. and D.E. Bowen, 1994. *"Management Theory And Total Quality: Improving Research And Practice Through Theory Development"*. Academy of Management Review, 19(3): 392- 418.
- Eka Kusmawati Bt Suparmanto (2005), *"Penggunaan Sistem Binaan Berindustri (IBS) Dalam Industri Pembinaan Malaysia- Kajian di Sektor Swasta"*, Universiti Teknologi Malaysia: Bachelor Thesis.
- Fadhil, C.W. (2005). *Realising The Industrialisation Of Malaysian Construction Industry: Construction It Perspective*. IBS Digest (July – Sept 2005)
- Flynn, B.B., R.G. Schroeder and S. Sakakibara, 1994. *"A Framework For Quality Management Research And An Associated Measurement Instrument. J"*. Operations Management, 11(4): 339-366.
- Goodier, C.I. and Gibb, A.G.F. (2004). *Barriers and Opportunities for Offsite Production*. Loughborough University, Loughborough.
- Goodier, C.I. & Gibb, A.G.F. (2007). Future opportunities for offsite in the UK. *Construction Management and Economics* (25).pp. 585-595.
- Jeffrey K. Liker & Thomas Lamb (June, 2000). *"Lean Manufacturing Principle Guide. Version 0.5. June 26, 2000"* The University of Michingan.
- Method 123. (2003). *"project Management Guidebook : Empowering manager To Succeed"*.
- Ozsariyildiz, S. & Tolman, F. (1998). *"IT Support For The Very Early Design Of Buildings And Civil Engineering Works"*. Digital library of construction informatics and information technology in civil engineering and construction.
- Punch K. F. (2005). *"Intorduction To Social Research : Quantitative And Qualitative Approaches"*. (2<sup>nd</sup> ed.). London Sage Publications.

Rollet, M. (1986). Modular Coordination in the Building Industry. *Proceedings Towards Industrialization in the Building Industry*. France Research Centre for Concrete Industries, France.

Ross, J.E., 1993. *"Total Quality Management: Text, Cases and Readings"*. St. Lucie Press, Delray Beach, FL.

Tahrina Taib (2010). *"Effeciency In Constrcution Process"*. University Technology Malaysia, Master Thesis.

Thanoon, W. A. M., Peng, L. W., Abdul Kadir, M. R., Jaafar, M.S. and Salit, M.S. (2003). *The Experiences of Malaysia and Other Countries in Industrialised Building System in Malaysia*. Proceeding on IBS Seminar. UPM Serdang, Malaysia.

Warszawski, A., *"Industrialized and Automated Building Systems"*. E & FN Spon, 1999, London.

<http://www.pdfcarl.com/Designing-for-Lean-Construction.html#>

[http://teknologimalaysia.academia.edu/KhairulzanYahya/Papers/577989/APPLICATION\\_OF\\_CONCURRENT\\_ENGINEERING\\_CE\\_FOR\\_CONSTRUCTION\\_INDUSTRY](http://teknologimalaysia.academia.edu/KhairulzanYahya/Papers/577989/APPLICATION_OF_CONCURRENT_ENGINEERING_CE_FOR_CONSTRUCTION_INDUSTRY)