# MODELLING SUCCESS FACTORS INFLUENCING INDUSTRIALIZED BUILDING SYSTEM PROJECT PERFORMANCE USING DEMATEL

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**SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this thesis, and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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## STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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## ABSTRAK

Sistem Pembangunan Industri (IBS) adalah terma yang digunakan bagi konsep industri pembinaan di Malaysia yang menggunakan komponen bangunan yang seragam dan dihasilkan secara besar-besaran dalam persekitaran kilang ataupun di tapak pembinaan. Adaptasi IBS di Malaysia masih berada pada tahap yang rendah di mana hanya 10 peratus daripada jumlah projek yang dianugerahkan adalah projek IBS. Secara purata, hanya 61 peratus daripada jumlah keseluruhan projek IBS yang boleh dipertimbangkan sebagai berprestasi tinggi dengan markah skor IBS melebihi 80 markah. Prestasi projek IBS diukur melalui jumlah markah yang diperolehi di dalam skor IBS. Kerajaan memperuntukkan setiap projek IBS perlu mencapai skor minimum 70 markah bagi diiktiraf sebagai projek dengan prestasi yang baik. Kajian ini dijalankan bagi mengenal pasti faktor-faktor yang mempengaruhi prestasi projek IBS dan meneliti hubungan antara faktor seterusnya mencadangkan model yang boleh digunakan sebagai alternatif dalam proses membuat keputusan. Enam faktor utama dan 17 subfaktor dikenalpasti dan digunakan sebagai kerangka teori bagi kajian ini. Responden bagi kajian ini adalah terdiri daripada individu yang mempunyai sekurang-kurangnya 16 tahun pengalaman dalam bidang IBS yang dating dari kontraktor G7 yang diiktiraf oleh kerajaan. Kajian ini menggunakan kaedah analisa DEMATEL bagi mengkaji hubungan penyebab dan akibat serta nilai kepentingan setiap faktor. Peta hubungan impak dihasilkan melalui nilai yang dianalisa menggunakan DEMATEL dan dijadikan sebagai asas kepada model yang dicadangkan. Analisa yang dijalankan menunjukkan pengetahuan dan kepakaran dalam IBS merupakan faktor paling penting diantara semua faktor lain. Diikuti dengan pengurusan, latihan, kewangan, integrasi, dan polisi IBS menjadi faktor yang paling kurang penting diantara kesemua 6 faktor. Peta hubungan impak menunjukkan polisi IBS sebagai faktor yang menyebabkan pengaruh paling besar terhadap faktor yang lain. Model yang dicadangkan dalam kajian ini memberikan pengetahuan yang lebih dalam terhadap faktor yang perlu diberikan keutamaan dan faktor yang menyebabkan impak paling tinggi terhadap faktor lain yang akan seterusnya meningkatkan pengaruh terhadap tahap prestasi projek IBS. Idea model ini boleh digunakan sebagai panduan dalam memperbaiki prestasi projek IBS ke arah yang lebih baik, terutamanya dalam mencapai skor IBS yang baik bagi meningkatkan lagi amalan IBS di dalam industri pembinaan sedia ada.

## ABSTRACT

Industrialized Building System (IBS) is the term to represent the prefabrication concept in the Malaysian construction industry that uses standardized building components mass produced in a factory or on the site. Adoption of IBS in Malaysia in still very low whereby only 10% of total awarded projects are of IBS project. On average, only 61% of total IBS is considered as highly performing IBS projects with IBS Score of more than 80. Performance of IBS can be measure in the form of IBS Score where government made it compulsory for IBS projects to achieve a minimum score of 70 to be considered as a performing IBS project. This study is directed towards identifying factors that exact influence towards project performance and examine the relationship of the factors to create models to serve as alternative in decision making process towards higher performance of IBS project. Through literature review, a total of 6 main factors and 17 subfactors were derived and served as the theoretical framework for this study. Respondents for this study were consisted of experts in IBS with minimum 16 years of experience coming from G7 contractors. This study integrated DEMATEL method of analysis to capture causal-effect relationship and prominence value to generate impact relation map as basis for the proposed models. Analysis done on the factors showed that knowledge and expertise of IBS as the most important factors followed by management, training, financial, integration, while IBS policies resulted as the least important factor among all 6 factors. Impact relation map from DEMATEL showed that IBS policies is the most influential factor. The proposed models provide intel on which factor to be given top priority and which factor can provide the biggest improvement towards the performance of IBS project when given the proper consideration. Both models proposed presents the ideal sequence of factor engagement and traces the influence-based relationship of factors that can be used as guide to improve performance of IBS particularly towards achieving higher IBS Score as well as to increase transition of contractors into IBS method of construction.

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## REFERENCES


Abas, A., Hanafi, M. H., & Ibrahim, F. A. (2014). Assessing the Malaysian architects' understanding of industrialized building system concept and implementation. *International Journal of Applied Engineering Research, 9*(1), 101-116.

Abdullah, L., Ramli, R., Bakodah, H. O., & Othman, M. (2020). Developing a causal relationship among factors of e-commerce: A. *Journal of King Saud University – , 1194-1201*

Ahmad Bari, N. A., Abdullah , N. A., Yusuff, R., Ismail, N., & Jaapar, A. (2012). Environmental Awareness and Benefits of Industrialized Building Systems (IBS). *Procedia - Social and Behavioral Sciences 50*, 392-404.

Ahmed, S. M., Zawawi W.A, N., & Ghazali, Z. (2020). *Impacts of application of IBS score regulations of CIDB on the concrete volumes required for building projects in Malaysia.* Retrieved from Akademia Baru Publishing (M) Sdn Bhd: https://www.akademiabaru.com/wvcarmea/docu/055.pdf

Akmam Syed Zakaria, S., Gajendran, T., Rose, T., & Brewer, G. (2018). Contextual, structural and behavioural factors influencing the adoption of industrialised building systems: a review. *Architectural Engineering and Design Management, 14*(1-2), 3-26. doi:10.1080/17452007.2017.1291410

Alazzaz, F., & Whyte, A. (2015). Linking employee empowerment with productivity in off-site construction. *Engineering, Construction and Architectural Management, 22*(1), 21-37. doi:10.1108/ECAM-09-2013-0083

Arashpour, M., Wakefield, R., Abbasi, B., Arashpour, M., & Hosseini, R. (2018). Optimal process integration architectures in off-site construction: Theorizing the use of multi-skilled resources. *Architectural Engineering and Design Management, 14*(1-2), 46-59. doi:10.1080/17452007.2017.1302406

Arashpour, M., Wakefield, R., Blismas, N., & Maqsood, T. (2015). Autonomous production tracking for augmenting output in off-site construction. *Automation in Construction, 53*, 13-21. doi:10.1016/j.autcon.2015.03.013

Arashpour, M., Wakefield, R., Blismas, N., & Minas, J. (2015). Optimization of process integration and multi-skilled resource utilization in off-site construction. *Automation in Construction, 50*(C), 72-80. doi:10.1016/j.autcon.2014.12.002

Arif, M., & Egbu, C. (2010). Making a case for offsite construction in China. *Engineering, Construction and Architectural Management, 17*(6), 536-548. doi:10.1108/09699981011090170

Arif, M., Goulding, J., & Rahimian, F. P. (2012). Promoting off-site construction: Future challenges and opportunities. *Journal of Architectural Engineering, 18*(2), 75-78. doi:10.1061/(ASCE)AE.1943-5568.0000081

Azman, M. N. A., Ahamad, M. S. S., Hamid, Z. A., Gomez, C. P., Kamar, K. A. M., Hilmi, N. D., . . . Ismail, Z. (2012). The selection of IBS precast manufacturing plant in Malaysia using GIS. *Malaysian Construction Research Journal, 10*(1), 77-90.

Azman, M. N., Ahamad, M. S., & Hilmi, N. D. (2012). The Perspective View of Malaysian Industrialized Building System (IBS) Under IBS Precast Manufacturing. *The 4th International Engineering Conference - Towards Engineering of 21st Century*.

Azman, M. N. A., Majid, T. A., Ahamad, M. S. S., & Hanafi, M. H. (2011). A study on the trend of the use of IBS components and the setting UP of IBS manufacturing factories in the malaysian construction industry. *Malaysian Construction Research Journal, 9*(2), 18-30.

Baharuddin, M. N., Bahardin, N. F., Zaidi, M. A., Lokman, I., & Nawi, M. N. M. (2016). A barriers and challenging criteria of IBS formwork: A current scenario amongs stakeholder. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 14-21. doi:10.21311/001.39.9.03

Balasbaneh, A. T., & Bin Marsono, A. K. (2017). Strategies for reducing greenhouse gas emissions from residential sector by proposing new building structures in hot and humid climatic conditions. *Building and Environment, 124*, 357-368. doi:10.1016/j.buildenv.2017.08.025

Becerra-Santacruz, H., & Lawrence, R. (2016). Evaluation of the thermal performance of an industrialised housing construction system in a warm-temperate climate: Morelia, Mexico. *Building and Environment, 107*, 135-153. doi:10.1016/j.buildenv.2016.07.029

CIDB IBS orange book (2018).

CIDB Malaysia Annual Report 2018. (2018)

Construction Industry Development Berhad (CIDB). (2004). Introduction to the IBS Content Scoring System (IBS SCORE) Manual. In CIDB, *IBS-CIDB Column* (pp. 18-19).

Construction Industry Development Berhad. (.2020). *Annual Report 2019.* Kuala Lumpur: Construction Industry Development Berhad (CIDB).

Dawood, N. N. (1999). Integrating design and production system for the precast industry. *Betonwerk und Fertigteil-Technik/Concrete Precasting Plant and Technology, 65*(5), 74-80.

Dzulkalnine, N., Azman, M. N. A., Bing, K. W., & Hamid, Z. A. (2017). Payment issue of industrialised building system (IBS) in Malaysian construction industry. *Malaysian Construction Research Journal, 2*(Special Issue 2), 36-47.

Falatoonitoosi, E., Leman, Z., Sorooshian, S., & Salimi, M. (2012). Decision-Making Trial and Evaluation Laboratory *Research Journal of Applied Sciences, Engineering and Technology, 5*(13), 3476-3480.

Haron, A. T., Marshall-Ponting, A. J., Zakaria, Z., Nawi, M. N. M., Hamid, Z. A., & Kamar, K. A. M. (2015). An industrial report on the Malaysian building information modelling (BIM) taskforce: Issues and recommendations. *Malaysian Construction Research Journal, 17*(1), 21-36.

Ismail, F., Yusuwan, N. M., & Baharuddin, H. E. A. (2012). Management Factors for Successful IBS Projects Implementation. *Procedia - Social and Behavioral Sciences, 68*, 99-107.

Jabar, I. L., Ismail, F., Aziz, N. M., & Janipha, N. A. I. (2013). Construction Manager's Competency in Managing the Construction Process of IBS Projects. *Procedia - Social and Behavioral Sciences 105*, 85-93.

Kamar, K. A. M., Azman, M. N. A., & Nawi, M. N. M. (2014). IBS survey 2010: Drivers, barriers and critical success factors in adopting industrialised building system (IBS) construction by G7 contractors in Malaysia. *Journal of Engineering Science and Technology, 9*(4), 490-501.

Kamar, K. A. M., Hamid, Z. A., Ghani, M. K., Rahim, A. H. A., Zain, M. Z. M., & Ambon, F. (2012). Business strategy of large contractors in adopting industrialised building system (IBS): The Malaysian case. *Journal of Engineering Science and Technology, 7*(6), 774-784.

Kassim, U., Abdullah, C. S., & Udin, Z. M. (2015). Attraction Factors in Choosing Industrialized Building System (IBS) Method over Conventional Building System. *International Journal of Science: Basic and Applied Research (IJSBAR)*, 338-347.

Kassim, U., & Walid, L. (2003). Awareness of the Industrialized Building System (IBS) Implementation In Northern Malaysia - A Case Study in Perlis. *Procedia Engineering 53*, 58-63.

Li-si, S., You, X.-Y., Liu, H.-C., & Zhang, P. (2018). DEMATEL Technique: A Systematic Review of the State-of-the-Art Literature on Methodologies and Applications. *HINDAWI, 2018*, 1-33.

Luo, L. Z., Mao, C., Shen, L. Y., & Li, Z. D. (2015). Risk factors affecting practitioners' attitudes toward the implementation of an industrialized building system a case study from China. *Engineering, Construction and Architectural Management, 22*(6), 622-643. doi:10.1108/ECAM-04-2014-0048

Mehregan, M. R., Razavi, S. M., & Anvari, M. R. A. (2012). Identification and Evaluation of Strategic Decisions in Gas Industry Using DEMATEL Method *Iranian Journal of Management Studies, 5*(2), 49-65.

Moghadasi, M., Marsono, A. K., & Mohammadyan-Yasouj, S. E. (2017). A study on rotational behaviour of a new industrialised building system connection. *Steel and Composite Structures, 25*(2), 245-255. doi:10.12989/scs.2017.25.2.245

Mohammad, F. M. (2013). Construction Environment: Adopting IBS Construction Approach Towards Achieving Sustainable Development. *Procedia - Social and Behavioral Sciences* 8-15.

Mohammad, F. M., Abd Shukor, A. S., Mahbub, R., & Halil, F. M. (2014). Challenges in Integration of Supply Chains in IBS Project Environment in Malaysia. *Procedia - Social and Behavioral Sciences 153*, 44-54.

Musa, M. F., Yusof, M. R., Mohammad, M. F., & Samsudin, N. S. (2016). Towards the adoption of modular construction and prefabrication in the construction environment: A case study in Malaysia. *ARPN Journal of Engineering and Applied Sciences, 11*(13), 8122-8131.

Naderifar, M., Goli, H., & Ghaljaei, F. (2017). Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research. *Strides in Development of Medical Education*, 1-6.

Nahmens, I., & Ikuma, L. H. (2012). Effects of lean construction on sustainability of modular homebuilding. *Journal of Architectural Engineering, 18*(2), 155-163. doi:10.1061/(ASCE)AE.1943-5568.0000054

Nasir, N. M., Nawi, M. N. M., Rahim, M. K. I. A., Bahaudin, A. Y., & Tapa, A. (2016). A review of delay factors in Malaysian industrialized Building System (IBS) construction project. *ARPN Journal of Engineering and Applied Sciences, 11*(16), 9868-9873.

Nawi, M. N. M., Azman, M. N. A., Baluch, N., Kamar, K. A. M., & Abd Hamid, D. Z. (2015). Study on the use of industrialised building system in Malaysian private construction projects. *ARPN Journal of Engineering and Applied Sciences, 10*(17), 7368-7374.

Nawi, M. N. M., Lee, A., Azman, M. N. A., & Kamar, K. A. M. (2014). Fragmentation issue in Malaysian industrialised building system (IBS) projects. *Journal of Engineering Science and Technology, 9*(1), 97-106.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2011). A critical literature review on the concept of team integration in industrialised building System (IBS) project. *Malaysian Construction Research Journal, 9*(2), 1-17.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2012). Critical success factors for improving team integration in Industrialised Building System (IBS) construction projects: The Malaysian case. *Malaysian Construction Research Journal, 10*(1), 44-62.

Nawi, M. N. M., Shaharanee, I. N. M., Hashim, K. F., Azman, M. N. A., & Ibrahim, S. H. (2015). Qualitative analysis on the barriers of industrialised building system (IBS) uptake in Malaysian construction projects. *Advanced Science Letters, 21*(6), 2134-2138. doi:10.1166/asl.2015.6233

Pozin, M. A. A., Nawi, M. N. M., Azman, M. N. A., & Lee, A. (2017). Improving communication in managing industrialised building system (IBS) projects: Virtual environment. *Malaysian Construction Research Journal, 2*(Special Issue 2), 1-13.

Rashidi, A., & Ibrahim, R. (2017). Industrialized construction chronology: The disputes and success factors for a resilient construction industry in Malaysia. *Open Construction and Building Technology Journal, 11*, 286-300. doi:10.2174/1874836801711010286

Rubio-Romero, J. C., Suárez-Cebador, M., & Abad, J. (2014). Modeling injury rates as a function of industrialized versus on-site construction techniques. *Accident Analysis and Prevention, 66*, 8-14. doi:10.1016/j.aap.2014.01.005

Salama, T., Salah, A., Moselhi, O., & Al-Hussein, M. (2017). Near optimum selection of module configuration for efficient modular construction. *Automation in Construction, 83*, 316-329. doi:10.1016/j.autcon.2017.03.008

Shamsuddin, S. M., Zakaria, R., Mohamed, S. F., Saleh, A. L., Utomo, C., Majid, M. Z. A., & Yahya, K. (2015). Developing methodology for cradle to grave cost planning for industrialised building system (IBS) In Malaysia. *Jurnal Teknologi, 77*(16), 37-42. doi:10.11113/jt.v77.6397

Tamrin, N., Nawi, M. N. M., & Nifa, F. A. A. (2016). Readiness in knowledge and ability for implementation of industrialised building system (IBS) in Malaysian construction industry. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 47-53. doi:10.21311/001.39.9.07

Tarei, P. K., Itesh, J. J., Thakkar, & Nag, B. (2018). A Hybrid Approach for Quantifying Supply Chain Risk and Prioritizing the Risk Drivers: A Case of Indian Petroleum Supply Chain. *Journal of Manufacturing Technology Management*

Taylor, M. D. (2010). A definition and valuation of the UK offsite construction sector. *Construction Management and Economics, 28*(8), 885-896. doi:10.1080/01446193.2010.480976

Vernikos, V. K., Goodier, C. I., Broyd, T. W., Robery, P. C., & Gibb, A. G. F. (2014). Building information modelling and its effect on off-site construction in UK civil engineering. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law, 167*(3), 152-159. doi:10.1680/mpal.13.00031

Xue, H., Zhang, S., Su, Y., Wu, Z., & Yang, R. J. (2018). Effect of stakeholder collaborative management on off-site construction cost performance. *Journal of Cleaner Production, 184*, 490-502. doi:10.1016/j.jclepro.2018.02.258

Yunus, R., Abdullah, A. H., Yasin, M. N., Masrom, M. A. N., & Hanipah, M. H. (2016). Examining performance of Industrialized Building System (IBS) implementation based on contractor satisfaction assessment. *ARPN Journal of Engineering and Applied Sciences, 11*(6), 3776-3782.

Yunus, R., & Yang, J. (2012). Critical sustainability factors in industrialised building systems. *Construction Innovation, 12*(4), 447-463. doi:10.1108/14714171211272216

Zakari, I., Awal, A. S. M. A., Zakaria, R., Abdullah, A. H., & Hossain, M. Z. (2017). Application of industrialized building system: A case study in Kano State, Nigeria. *International Journal of GEOMATE, 13*(39), 80-86. doi:10.21660/2017.39.19788

Zakaria, S. A. S., Majid, T. A., & Nazri, F. M. (2017). Adoption of industrialised building system (IBS): Exploring competitive advantages from a technology valuation perspective in northern Malaysia. *Malaysian Construction Research Journal, 22*(2), 1-17.