CHAPTER 4

PREFABRICATION AND PREFABRICATED STRUCTURES IN SCIENTIFIC LITERATURE: SCIENTOMETRIC INVESTIGATION WITH VOSVIEWER

İlhami AY[1]
Sema BEKLER[2]
Murat DAL[3]
Barış BEKLER[4]

INTRODUCTION

Prefabrication can be defined as "facilitating construction, providing economic gain, saving time and providing the required comfort by quickly combining prefabricated elements prepared in advance" (Aydemir, 2005). In other words, it is to ensure a certain level of quality in working conditions and to increase standardisation by controlling the quality and capacity of labour in the factory so as to leave the least number of work areas on the construction site (Gümüsburun Ayalp and Ay, 2021). Prefabrication is increasingly being adopted worldwide with the aim to improve construction efficiency and reduce the negative environmental and social impacts that can occur in traditional construction activities. In prefabrication, the production process takes place on a factory site or outdoors. Prefabricated construction is made possible by advances in specially adapted equipment for transport and assembly (Ay, 2019).

[1] Lecturer, Hakkari University, Çölemerik Vocational School, ilhamiay@hakkari.edu.tr, ORCID iD: 0000-0002-3506-3234
[2] Scientist, Munzur University, Department of Culture and Arts Management, ksy.semabekler@gmail.com, ORCID iD: 0009-0002-2152-2767
[3] Prof. Dr., Munzur University, Faculty of Fine Arts, Design, and Architecture, prof.dr.dal@gmail.com, ORCID iD: 0000-0001-5330-1868
[4] Scientist, Munzur University, Department of Culture and Arts Management, ksy.barisbekler@gmail.com, ORCID iD: 0009-0002-5908-6390

DOI: 10.37609/akya.3856.c1262

derstanding of global best practices. Such research can identify context-specific barriers and opportunities, thereby helping to develop tailored strategies for increased adoption and effectiveness in different regions.

- ***Promoting Interdisciplinary Collaboration:*** Prefabrication should be addressed through a multidisciplinary lens that includes not only engineering and architecture, but also environmental science, materials technology, logistics, and labor management. Interdisciplinary collaboration can lead to more innovative and holistic solutions. Moreover, partnerships between academia and industry should be encouraged to bridge the gap between theory and practice through applied research and pilot projects.
- ***Policy Development and Incentive Mechanisms:*** Government policies and incentive programs play a critical role in mainstreaming prefabricated construction. Future studies should focus on analyzing the impact of supportive regulations, tax incentives, streamlined permitting processes, and capacity-building initiatives. Policy-focused research can guide decision-makers in designing frameworks that accelerate the adoption of prefabricated systems and enhance their contribution to sustainable construction goals.

REFERENCES

Ajayi, S. O., Oyedele, L. O., Bilal, M., Akinade, O. O., Alaka, H. A., Owolabi, H. A., & Kadiri, K. O. (2015). Waste effectiveness of the construction industry: Understanding the impediments and requisites for improvements. *Resources Conservation And Recycling*, *102*, 101–112. https://doi.org/10.1016/j.resconrec.2015.06.001

Akanbi, L. A., Oyedele, L. O., Akinade, O. O., Ajayi, A. O., Delgado, M. D., Bilal, M., & Bello, S. A. (2018). Salvaging building materials in a circular economy: A BIM-based whole-life performance estimator. *Resources Conservation And Recycling*, *129*, 175–186. https://doi.org/10.1016/j.resconrec.2017.10.026

Aksoylu, C., Özkılıç, Y. O., Yazman, Ş., Gemi, L., & Arslan, M. (2021). İnceltilmiş Uçlu Önüretimli Aşık Kirişlerinin Yük Taşıma Kapasitelerinin Deneysel ve Numerik Olarak İrdelenmesi ve Çözüm Önerileri. *Teknik Dergi*, *32*(3), 10823–10858. https://doi.org/10.18400/tekderg.667066

Arditi, D., Ergin, U., & Günhan, S. (2000). Factors Affecting the Use of Precast Concrete Systems. *Journal of Architectural Engineering*, *6*(3). https://doi.org/https://doi.org/10.1061/(ASCE)1076-0431(2000)6:3(79)

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

Ay, İ. (2019). *Türk İnşaat Sektöründe Prefabrike Yapıların Tasarım, Üretim Ve Yapım Süreçlerini Etkileyen Kriterlerin Belirlenmesi*. Hasan Kalyoncu University.

Ay, İ., Bekler, S., Bekler, B., & Dal, M. (2025). Sustainability and Ecology Focused Tourism Research: A Bibliometric Evaluation With VOSviewer. *Yakın Mimarlık Dergisi*, *9*(1), 1–22. https://doi.org/10.32955/neujna202591909

Ay, İ., & Dal, M. (2025a). Bibliometric Analysis of Life Cycle Assessment and Sustainable Design Literature Using Vosviewer. In M. Geçimli (Ed.), *Sustainable Approaches in Spatial Design* (pp. 387–416). IGI Global. https://doi.org/10.4018/979-8-3373-0174-7.ch013

Ay, İ., & Dal, M. (2025b). Scientific Production in Waste Management and Ecological Sustainability From a Bibliometric Approach. In M. Geçimli (Ed.), *Sustainable Approaches in Spatial Design*

(pp. 159–192). IGI Global. https://doi.org/10.4018/979-8-3373-0174-7.ch005

Ay, İ., & Gümüşburun Ayalp, G. (2021). Prefabrike Yapıların Tasarım, Üretim, Depolama, Nakliye ve Yapım Süreçlerini Etkileyen Faktörler. *Teknik Dergi*, *32*(3), 10907–10917. https://doi.org/10.18400/tekderg.647272

Aydemir, B. (2005). *Prefabrike Betonarme İskelet Sistemlerle İnşa Edilen Endüstri Yapılarında Prefabrike Döşeme Bileşenlerinin Yük ve Açıklık Kriterleri Açısından İrdelenmesi*. İzmir Dokuz Eylul University.

Aye, L., Ngo, T., Crawford, R. H., Gammampila, R., & Mendis, P. (2012). Life cycle greenhouse gas emissions and energy analysis of prefabricated reusable building modules. *Energy and Buildings*, *47*, 159–168. https://doi.org/10.1016/j.enbuild.2011.11.049

Biondo, G., & Rognoni, E. (1976). Prefab In Italy - Industrialized Prefabrication In Concrete. *Domus*, (557), 1–12.

Bobovec, B., Korlaet, L., & Virag, N. (2015). Architect Ivo Bartolic Prolegomena to His Work. *Prostor*, *23*(1), 161–173.

Burkut, E. B., & Dal, M. (2023). Systematic Literature Review and Scientific Maps on Ecological Architecture and Eco-Architecture. *International Journal of Pure and Applied Sciences*, *9*(2), 369–380. https://doi.org/10.29132/ijpas.1365407

Burkut, E. B., & Dal, M. (2024). Analysis of Articles on Occupational Health and Safety with Scientific Mapping Techniques in WoS & Scopus Database (2000-2023). *Digital International Journal of Architecture Art Heritage*, *3*(1), 1–13.

Cao, L., Cong, W., Su, Y., & Zheng, Z. (2024). Research on the Production Capacity Evaluation of Prefabricated Component Manufacturing Enterprises. *Buildings*, *14*(6). https://doi.org/10.3390/buildings14061816

Cao, X., Li, X., Zhu, Y., & Zhang, Z. (2015). A comparative study of environmental performance between prefabricated and traditional residential buildings in China. *Journal of Cleaner Production*, *109*(SI), 131–143. https://doi.org/10.1016/j.jclepro.2015.04.120

Chen, C. (2017). Science Mapping: A Systematic Review of the Literature. *Journal of Data and Information Science*, *2*(2), 1–40. https://doi.org/10.1515/jdis-2017-0006

Chen, C. M. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of The American Society For Information Science and Technology*, *57*(3), 359–377. https://doi.org/10.1002/asi.20317

Chen, Y., Okudan, G. E., & Riley, D. R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation In Consturction*, *19*(2), 235–244. https://doi.org/10.1016/j.autcon.2009.10.004

Chiang, Y.-H., Chan, E. H.-W., & Lok, L. K.-L. (2006). Prefabrication and barriers to entry - a case study of public housing and institutional buildings in Hong Kong. *Habitat International*, *30*(3), 482–499. https://doi.org/10.1016/j.habitatint.2004.12.004

Dal, M., Burkut, E. B., & Karataş, L. (2023). Analysis of Publications on Earthquake Research in Architecture Category and Analysis with R Studio-Biblioshiny Software. *Journal of Architectural Sciences and Applications*, *8*(Special Issue), 183–197. https://doi.org/10.30785/mbud.1333876

Debska, B., Wojtaszek, K., Caetano, M. A., & Silva, G. J. B. (2024). Sustainable Polyester Composites Containing Waste Glass for Building Applications. *Sustainability*, *16*(2). https://doi.org/10.3390/su16020719

Dong, Y. H., Jaillon, L., Chu, P., & Poon, C. S. (2015). Comparing carbon emissions of precast and cast-in-situ construction methods - A case study of high-rise private building. *Construction and Building Materials*, *99*, 39–53. https://doi.org/10.1016/j.conbuildmat.2015.08.145

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Entezari, A., Aslani, A., Zahedi, R., & Noorollahi, Y. (2023). Artificial intelligence and machine learning in energy systems: A bibliographic perspective. *Energy Strategy Reviews*, *45*. https://doi.org/10.1016/j.esr.2022.101017

Gan, X., Chang, R., Zuo, J., Wen, T., & Zillante, G. (2018). Barriers to the transition towards off-site construction in China: An Interpretive structural modeling approach. *Journal of Cleaner Production*, *197*(1), 8–18. https://doi.org/10.1016/j.jclepro.2018.06.184

Gibb, A. G. F., & Isack, F. (2003). Re-engineering through pre-assembly: client expectations and drivers. *Building Research and Information*, *31*(2), 146–160. https://doi.org/10.1080/09613210302000

Giuffrida, G., Dipasquale, L., Pulselli, R. M., & Caponetto, R. (2024). Compared Environmental Lifecycle Performances of Earth-Based Walls to Drive Building Envelope Design. *Sustainability*, *16*(4). https://doi.org/10.3390/su16041367

Gökçe, H. S., & Şimşek, O. (2011). Prefabrik Taşıyıcı Hafif Beton Elemanlarda Bazaltik Pomza Agregasının Kullanılabilirliğinin Araştırılması. *Politeknik Dergisi*, *14*(1), 25–29.

Goodier, C., & Gibb, A. (2007). Future opportunities for offsite in the UK. *Construction Management and Economics*, *25*(6), 585–595. https://doi.org/10.1080/01446190601071821

Gümüsburun Ayalp, G., & Ay, I. (2019). Identifying the Factors Affecting the Use of Prefabricated Construction Systems in Turkey. *International Journal of Technology and Engineering Studies*, *5*(1), 1–8. https://doi.org/https://dx.doi.org/10.20469/ijtes.5.10001-1

Gümüsburun Ayalp, G., & Ay, İ. (2021). Model validation of factors limiting the use of prefabricated construction systems in Turkey. *Engineering, Construction and Architectural Management*, *28*(9). https://doi.org/10.1108/ECAM-04-2020-0248

Han, Z., & Wang, Y. (2017). The Applied Exploration of Big Data Technology in Prefabricated Construction Project Management. In Y. Wang, Y. Pang, G. Q. P. Shen, & Y. Zhu (Eds.), *ICCREM 2017: Prefabricated Buildings, Industrialized Construction and Public-Private Partnerships* (pp. 71–78).

Hao, J. L., Cheng, B., Lu, W., Xu, J., Wang, J., Bu, W., & Guo, Z. (2020). Carbon emission reduction in prefabrication construction during materialization stage: A BIM-based life-cycle assessment approach. *Science of the Total Environment*, *723*. https://doi.org/10.1016/j.scitotenv.2020.137870

Hong, J., Shen, G. Q., Li, Z., Zhang, B., & Zhang, W. (2018). Barriers to promoting prefabricated construction in China: A cost-benefit analysis. *Journal of Cleaner Production*, *172*, 649–660. https://doi.org/10.1016/j.jclepro.2017.10.171

Hong, J., Shen, G. Q., Mao, C., Li, Z., & Li, K. (2016). Life-cycle energy analysis of prefabricated building components: an input-output-based hybrid model. *Journal of Cleaner Production*, *112*(4), 2198–2207. https://doi.org/10.1016/j.jclepro.2015.10.030

Jaillon, L., & Poon, C. S. (2008). Sustainable construction aspects of using prefabrication in dense urban environment: a Hong Kong case study. *Construction Management and Economics*, *26*(9), 953–966. https://doi.org/10.1080/01446190802259043

Jaillon, L., & Poon, C. S. (2009). The evolution of prefabricated residential building systems in Hong Kong: A review of the public and the private sector. *Automation In Consturction*, *18*(3), 239–248. https://doi.org/10.1016/j.autcon.2008.09.002

Jaillon, L., & Poon, C. S. (2010). Design issues of using prefabrication in Hong Kong building construction. *Construction Management and Economics*, *28*(10), 1025–1042. https://doi.org/10.1080/01446193.2010.498481

Jaillon, L., Poon, C. S., & Chiang, Y. H. (2009). Quantifying the waste reduction potential of using prefabrication in building construction in Hong Kong. *Waste Management*, *29*(1), 309–320. https://doi.org/10.1016/j.wasman.2008.02.015

Kale, S., & Arditi, D. (2006). Diffusion of ISO 9000 certification in the precast concrete industry. *Construction Management and Economic*, *24*(5), 485–495. https://doi.org/10.1080/01446190600601594

Kamali, M., & Hewage, K. (2016). Life cycle performance of modular buildings: A critical review. *Renewable & Sustainable Energy Reviews*, *62*, 1171–1183. https://doi.org/10.1016/j.rser.2016.05.031

Klarin, T. B. (2012). International Competition For The Foundation Hospital and The Clinics of The School of Medicine in Zagreb, 1930-1931. *Prostor*, *20*(2), 282–295.

Klarin, T. B., & Kranjcevic, J. (2023). Tourist Camps and Prefabricated Structures Produced by Zagreb's Jugomont for Istria and Kvarner during the 1950s and 1960s. *Ars Adriatica*, *13*, 275–290.

https://doi.org/10.15291/ars.4349

Kolchunov, V. I., Fedorova, N. V, Savin, S. Y., & Kaydas, P. A. (2024). Progressive Collapse Behavior of a Precast Reinforced Concrete Frame System with Layered Beams. *Buildings*, *14*(6). https://doi.org/10.3390/buildings14061776

Komurlu, R., & Onel, H. (2007). Usage of Aerated Concrete Construction Elements in Houses. *Megaron*, *2*(3), 145–158.

Li, C. Z., Hong, J., Xue, F., Shen, G. Q., Xu, X., & Luo, L. (2016). SWOT analysis and Internet of Things-enabled platform for prefabrication housing production in Hong Kong. *Habitat International*, *57*, 74–87. https://doi.org/10.1016/j.habitatint.2016.07.002

Li, C. Z., Xu, X., Shen, G. Q., Fan, C., Li, X., & Hong, J. (2018). A model for simulating schedule risks in prefabrication housing production: A case study of six-day cycle assembly activities in Hong Kong. *Journal of Cleaner Production*, *185*, 366–381. https://doi.org/10.1016/j.jclepro.2018.02.308

Li, C. Z., Zhong, R. Y., Xue, F., Xu, G., Chen, K., Huang, G. G., & Shen, G. Q. (2017). Integrating RFID and BIM technologies for mitigating risks and improving schedule performance of prefabricated house construction. *Journal of Cleaner Production*, *165*, 1048–1062. https://doi.org/10.1016/j.jclepro.2017.07.156

Li, X., Shen, G. Q., Wu, P., & Yue, T. (2019). Integrating Building Information Modeling and Prefabrication Housing Production. *Automation In Consturction*, *100*, 46–60. https://doi.org/10.1016/j.autcon.2018.12.024

Li, Z., Shen, G. Q., & Xue, X. (2014). Critical review of the research on the management of prefabricated construction. *Habitat International*, *43*, 240–249. https://doi.org/10.1016/j.habitatint.2014.04.001

Liu, W., Fan, G., & Liu, Z. (2024). Driving Factors in Carbon Emission Reduction in Prefabricated Building Supply Chains Based on Structural Equation Modelling. *Sustainability*, *16*(8). https://doi.org/10.3390/su16083150

Lu, W., & Yuan, H. (2010). Exploring critical success factors for waste management in construction projects of China. *Resources Conservation And Recycling*, *55*(2), 201–208. https://doi.org/10.1016/j.resconrec.2010.09.010

Ma, S., Li, Z., & Fu, R. (2024). A Fully Prefabricated Pile-Wall Composite Scheme of Open-Cut Tunnel and the Mechanical Behavior of the Composite Structure during Construction. *Buildings*, *14*(6). https://doi.org/10.3390/buildings14061693

Manrique, J. D., Al-Hussein, M., Telyas, A., & Funston, G. (2007). Case study-based challenges of quality concrete finishing for architecturally complex structures. *Journal Of Construction Engineering and Management*, *133*(3), 208–216. https://doi.org/10.1061/(ASCE)0733-9364(2007)133:3(208)

Mao, C., Shen, Q., Pan, W., & Ye, K. (2015). Major Barriers to Off-Site Construction: The Developer's Perspective in China. *Journal of Management In Engineerıng*, *31*(3). https://doi.org/10.1061/(ASCE)ME.1943-5479.0000246

Mao, C., Shen, Q., Shen, L., & Tang, L. (2013). Comparative study of greenhouse gas emissions between off-site prefabrication and conventional construction methods: Two case studies of residential projects. *Energy and Buildings*, *66*, 165–176. https://doi.org/10.1016/j.enbuild.2013.07.033

Mao, C., Xie, F., Hou, L., Wu, P., Wang, J., & Wang, X. (2016). Cost analysis for sustainable off-site construction based on a multiple-case study in China. *Habitat International*, *57*, 215–222. https://doi.org/10.1016/j.habitatint.2016.08.002

Mayr, P., & Scharnhorst, A. (2015). Scientometrics and information retrieval: weak-links revitalized. *Scientometrics*, *102*(3), 2193–2199. https://doi.org/10.1007/s11192-014-1484-3

Mecanov, D. (2015). Prefabricated Construction System Jugomont From Zagreb `Horseshoe' Building in Block 28 in New Belgrade. *Prostor*, *23*(1), 175–185.

Memis, S., Sahin, S., & Sirin, U. (2017). Some properties of prefabricated building materials produced from ground diatomite and hydrophone clay. *Pamukkale University Journal of Enginee-*

ring Sciences, *23*(3), 245–249. https://doi.org/10.5505/pajes.2016.34467

Molavi, J., & Barral, D. L. (2016). A Construction Procurement Method To Achieve Sustinability In Modular Construction. In O. Chong, K. Parrish, P. Tang, D. Grau, & J. Chang (Eds.), *ICSDEC 2016 - Integrating Data Science, Construction and Sustainability* (pp. 1362–1369). https://doi.org/10.1016/j.proeng.2016.04.201

Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2007). Perspectives of UK housebuilders on the use of offsite modern methods of construction. *Construction Management and Economics*, *25*(2), 183–194. https://doi.org/10.1080/01446190600827058

Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2012). Strategies for Integrating the Use of Off-Site Production Technologies in House Building. *Journal of Construction Engineering and Management*, *138*(11), 1331–1340. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000544

Pavlovic, M., Markovic, Z., Veljkovic, M., & Budevac, D. (2013). Bolted shear connectors vs. headed studs behaviour in push-out tests. *Journal of Constructional Steel Research*, *88*, 134–149. https://doi.org/10.1016/j.jcsr.2013.05.003

Piccardo, C., Steinik, C., Caffe, S., Argentoni, A., & Calderini, C. (2024). Primary Energy and Carbon Impacts of Structural Frames with Equivalent Design Criteria: Influence of Different Materials and Levels of Prefabrication. *Sustainability*, *16*(10). https://doi.org/10.3390/su16104209

Polat, G. (2008). Factors affecting the use of precast concrete systems in the United States. *Journal of Construction Engineering and Management*, *134*(3), 169–178. https://doi.org/10.1061/(ASCE)0733-9364(2008)134:3(169)

Rahman, M. M. (2014). Barriers of Implementing Modern Methods of Construction. *Journal of Management In Engineering*, *30*(1), 69–77. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000173

Rausch, C., Nahangi, M., Haas, C., & Liang, W. (2019). Monte Carlo simulation for tolerance analysis in prefabrication and offsite construction. *Automation In Consturction*, *103*, 300–314. https://doi.org/10.1016/j.autcon.2019.03.026

Strmo, N. V., Delic, A., & Kincl, B. (2013). Causes of Housing Stock Problems in Croatia. *Prostor*, *21*(2), 341–350.

Tam, V. W. Y. (2008). On the effectiveness in implementing a waste-management-plan method in construction. *Waste Management*, *28*(6), 1072–1080. https://doi.org/10.1016/j.wasman.2007.04.007

Tam, V. W. Y., Tam, C. M., Zeng, S. X., & Ng, W. C. Y. (2007). Towards adoption of prefabrication in construction. *Building and Environment*, *42*(10), 3642–3654. https://doi.org/10.1016/j.buildenv.2006.10.003

Tan, T., Chen, K., Xue, F., & Lu, W. (2019). Barriers to Building Information Modeling (BIM) implementation in China's prefabricated construction: An interpretive structural modeling (ISM) approach. *Journal of Cleaner Production*, *219*, 949–959. https://doi.org/10.1016/j.jclepro.2019.02.141

Tekin, S., Burkut, E. B., & Dal, M. (2024). Culture and Arts Management: A Bibliometric Analysis Using Software. *Cultural Heritage and Science*, *5*(1), 62–74. https://doi.org/10.58598/cuhes.1471765

Ullah, H., Zhang, H., Huang, B., & Gong, Y. (2024). BIM-Based Digital Construction Strategies to Evaluate Carbon Emissions in Green Prefabricated Buildings. *Buildings*, *14*(6). https://doi.org/10.3390/buildings14061689

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

VanGeem, M. (2006). Achieving sustainability with precast concrete. *PCI Journal*, *51*(1), 42+. https://doi.org/10.15554/pcij.01012006.42.61

Wang, He, Zhang, Y., Gao, W., & Kuroki, S. (2020). Life Cycle Environmental and Cost Performance of Prefabricated Buildings. *Sustainability*, *12*(7). https://doi.org/10.3390/su12072609

Wang, Hong, Liu, F., Fu, W., Fang, Z., Zhou, W., & Liu, Z. (2014). Two-dimensional heterostructures: fabrication, characterization, and application. *Nanoscale*, *6*(21), 12250–12272. https://doi.org/10.1039/c4nr03435j

Zhang, X., Skitmore, M., & Peng, Y. (2014). Exploring the challenges to industrialized residential building in China. *Habitat International*, *41*, 176–184. https://doi.org/10.1016/j.habitatint.2013.08.005

Zhong, R. Y., Peng, Y., Xue, F., Fang, J., Zou, W., Luo, H., … Huang, G. Q. (2017). Prefabricated construction enabled by the Internet-of-Things. *Automation In Consturction*, *76*, 59–70. https://doi.org/10.1016/j.autcon.2017.01.006