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DYNAMICS SIMULATION APPROACH IN MODEL DEVELOPMENT OF UNSOLD NEW RESIDENTIAL HOUSING IN JOHOR

Lok Lee Wen[1]and Hasimah Sapiri[2]

[1] School of Quantitative Sciences, UUM College of Arts and Sciences, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia and [2]School of Quantitative Sciences, UUM College of Arts and Sciences, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia.

([1] lok_lee_wen@uumkl.edu.my and [2] hasimah@uum.edu.my)

The unsold units of residential housing in Malaysia were surged significantly in four consecutive years starting from 2015 and Johor was ranked as the highest in unsold housing over other states in Malaysia. Therefore, this study aims to identify the causal factors of unsold new residential housing and to analyse the dynamic relationship between the causal factors, unsold new housing, and the housing market in Johor. First, the model was developed to present the dynamic relationship between the factors and the unsold housing using a system dynamics approach, then the simulation results were compared with the real data, called the behavioural validity test. After that, the model was validated through the least square method. Results showed three main factors that influenced unsold new housing stocks in Johor: house prices, housing demand and housing supply. Meanwhile, those three main factors were affected by other aspects, such as household income, demand for housing loans, inflation rate and construction cost.

***Keywords*:** Unsold new residential housing, housing market, system dynamics

1. Introduction

Housing is one of the necessities for human lives and contributes to a country's economic growth (Yeap and Lean, 2020). However, when housing demand and housing supply do not match, it raises the house prices and causes the unsold new housing stocks to occur due to the unaffordability to purchase a house. Then, this problem leads to the effect of wastage of construction, affecting the construction company's financial situation and some other economic aspects (Zainal et al., 2019). Globally, some countries had experienced unsold housing in the 1990s, such as China, United Kingdom, Spain, and South Korea.

Apart from the global market, the problem of unsold new housing stocks is also becoming a common issue and a focus point in Malaysia nowadays as Ramli et al. (2019) claimed the house prices in Malaysia had increased by 7.1% from 2015 to 2016. However, it had failed to increase by only 5.6% from 2016 to 2017, compared to the unsold units had grown by 41% in 2017 and reached at 21,000 units unsold as well as it brought RM12.26 billion of loss to the country, these were the problems indicated much serious than the rising house price issue in Malaysia. Moreover, according to the Malaysian Property Market Report (2019) showed the increment of sold out volume of all properties in Malaysia, but the unsold units in residential property remained high at 30,664 units, also the unsold units had increased sharply in four consecutive years from 2015 to 2018 by 196.53%.

According to the Malaysian housing market figures released by the National Property Information Centre (NAPIC) in 2019, Johor was the top state in Malaysia with the most unsold residential property units, with 5,627 units unsold, or 18.35 percent of total unsold new housing stocks in Malaysia. Therefore, despite of the government of Malaysia and the state government of Johor had outlined many housing strategies, policies, and plans, the house prices were still increasing, and the unsold housing remained high (Osman et al., 2017). Therefore, this is important for the study aims to identify the causal factors of unsold residential housing and to analyse the dynamic relationship between the causal factors, unsold new housing, and housing market in Johor, so that to improve Malaysia's housing policies and strategies.

2. Literature Review

2.1 Unsold new housing stock issue in Malaysia and Johor

The unsold new housing stock is also known as the overhang property; this refers to the completely built housing that remains unsold for at least nine months after it is launched (The Star, 2003). In Malaysia, one-fourth of the residential property remained unsold in 2019, and this had brought a considerable loss to the country with more than RM20 billion (Kaur, 2019). This loss is most likely due to the fact that Malaysians can only afford to buy a house priced at RM250,000 or less. (Ishak et al., 2019). Besides, the unsold units were mostly ranging at a price between RM200,000 and RM700,000. Specifically, the high-rise had the most significant number of unsold units in Malaysia, approximately 4,000 units, and it mostly ranged from RM200,000 to RM300,000 (NAPIC, 2019). Also, Osman et al. (2017) stated the household income is insufficient to finance an appropriate house in Malaysia.

Apart from the case in Malaysia, the affordability index in Johor was 4.2, and this was categorised under a seriously unaffordable because it ranged in between 4.1 and 5.0 (Nadhirah, 2015; Osman et al., 2017). Additionally, the unsold units in Johor were typically occurred in Iskandar Malaysia because it is a strategic location neighbouring to Singapore and attracted many foreign buyers from China and Singapore to purchase a local house in that area (Azhar, 2019). This strategic location has driven up the house price in Iskandar Malaysia, making it more expensive than outside of Iskandar Malaysia. As a result, the house price was much over the affordability level, causing a significant unsold housing problem in Iskandar Malaysia (Osman et al., 2017).

2.2 Housing policies in Malaysia and Johor

To tackle Malaysia's housing problems, the government had created Malaysian Plans in three different phases: before 1970, 1970 to 1990, and after 1990. Other than the first and second phases, the Sixth to Eleventh Malaysian Plans were introduced in the third phase after 1990. Those plans were to sustain the housing development by concentrating on the public and private sectors of the housing developers and focusing on both urban and rural areas. The Eighth Malaysian Plan had provided the social services and the facilities to improve the life quality. At the same time, the Ninth to Eleventh Malaysian Plans were focused on providing new housing designs to improve the housing quality and the comfort of the nations. Meanwhile, the low and medium-income groups were still under concern in these plans (Soffian et al., 2018). Apart from the Malaysian Plans, there were many programs, schemes, and strategies had also been outlined by the government of Malaysia, such as *Perumahan Rakyat 1 Malaysia* (PR1MA), MyHome, *Rumah Mesra Rakyat* (RMR1M), *Program Rumah Mampu Milik* (RMM), MyDeposit Scheme, *Program Penyelenggaraan 1 Malaysia*, and My Beautiful New Home (Ishak et al., 2019).

Likewise, the state government of Johor had established a housing policy for Johor in 2014, and the policy is also known as *Dasar Perumahan Rakyat Johor* (DPRJ) to confront the housing problems in Johor. The policy was proposed in four different components that focused on the low and medium cost of housing types, namely *Perumahan Komuniti Johor A* (PKJ A), *Perumahan Komuniti Johor B* (PKJ B), *Rumah Mampu Milik Johor* (RMMJ), and medium-cost shop in both areas of within Iskandar Malaysia and outside of Iskandar Malaysia (Osman et al., 2017). Although more explicitly, it defined that there was 40% of the housing project constituted into those four components, 40% of new housing construction in the project was under affordable level. Therefore, the monthly household income and the maximum selling price for low and medium-cost houses (e.g., apartments, flats, and terraced houses) were set in the policy. Also, the percentage compositions in four components were set differently between Iskandar Malaysia and non-Iskandar Malaysia. As a result, the maximum selling prices for RMMJ and medium-cost shops in Iskandar Malaysia were slightly higher than outside of Iskandar Malaysia (Osman et al., 2017).

2.3 Factors that affecting housing demand and housing supply

Numerous factors, such as household income, mortgage loan, house price, and inflation rate, have been shown to influence the housing demand in previous studies and it is presented in Table 1.

Table 1: Factors that affecting housing demand.

Factors	Authors	Description
Household income	Caldera and Johansson (2013), Kwoun et al. (2013), and Obaid (2020).	• Household income had a positive effect on the housing demand in Organisation for Economic Co-operation and Development (OECD) countries, South Korea, and Saudi Arabia, respectively. • This was because the rising household income would affect housing demand, whereby when individuals have more ability to purchase a house, the housing demand will be increased.
Mortgage loans	Kwoun et al. (2013), and Obaid (2020).	• Mortgage loans affected housing demand positively due to the availability of housing loans. • On that account, housing demand would increase if households could receive loan approval for home purchases.
House prices	Baharuddin et al. (2019).	• House prices negatively influenced housing demand. • Since the individuals find it is more challenging to afford to buy a house when the house prices appreciated, resulting in a fall in housing demand.
Inflation rate	Bobeica et al. (2019), and Baharuddin et al. (2019).	• Inflation rate influenced housing demand through some factors, e.g., household income and house price. • The inflation rate increment would increase the household income, making it more affordable for individuals to acquire a home, resulting in a favourable impact on housing demand. • However, inflation rate also negatively affected housing demand by rising house prices because housing demand dropped when house prices soared.

However, the previous studies had also examined some factors that affected housing supply, i.e., house price, construction cost, and inflation rate as displayed in Table 2

Table 2: Factors that affecting housing supply.

Factors	Authors	Description
House prices	Kwoun et al. (2013), Caldera and Johansson (2013), and Tolles (2021).	• It positively affected since higher house prices would attract more housing investment due to a greater rate of return on investment. Therefore, the housing developer would supply more new houses to match the higher demand. In the meantime, housing developer would also expect higher revenue when house price rose.
Construction cost	Zainal et al. (2019), Caldera and Johansson (2013), and Tolles (2021).	• It would positively impact if the construction cost were measured by labour cost, which would improve the labour productivity when income increased, hence housing supply would also enhance. • Moreover, the growing material costs did not enhance labour productivity, it difficult to estimate, and would reduce developer revenue, hence resulted a negative effect on housing production.
Inflation rate	Peng (2018), and Chege (2017).	• Inflation rate affected housing supply through some factors, e.g., house price, and construction cost. • Housing supply was positively affected by inflation rate when it appreciated house price that made housing become more profitable, hence the developer would raise the supply for housing. • Inflation rate would also increase the construction cost, this reduced developer's revenue and housing would be more expensive to cover the rising cost and falling revenue. Thus, inflation rate also positively influenced housing supply via construction cost growth.

3. Methodology

3.1 System dynamics methodology

System dynamics was introduced in the 1960s by Jay Forrester from the Massachusetts Institute of Technology (MIT). It was essentially used to grasp the complex and dynamic behaviour or trend (Ahmad et al. 2019). This approach aimed to reconstruct the causalities in a specific system from the analysed results, to understand complex problems, and develop strategies to solve the problems. Developing a system dynamics model involves five stages, i.e., problem identification, dynamic hypothesis development, model formulation, model testing, and policy recommendation (Hashim et al., 2018). The process flow of the system dynamics approach is presented in Figure 1. In developing the system dynamics model, the system developer can follow the iteration, and the process will go through these steps many times to replicate the real structure and behaviour of the system (Sapiri et al., 2017).

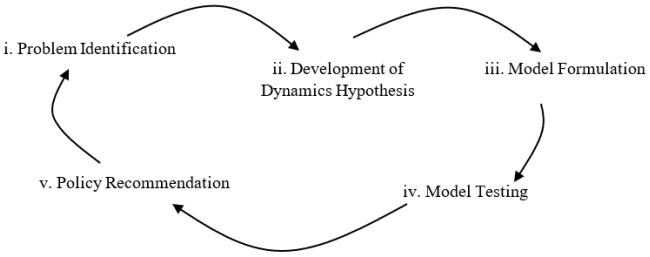

Figure 1: Process flow of system dynamics approach

3.2 Data collection

This study employed secondary data with five years of annual data from 2015 to 2019. First, the data of unit unsold, unit sold, and unit launches in Johor was taken from Real Estate and Housing Developers' Association (REHDA). Then, the mean of gross household income was obtained from the Department of Statistics Malaysia (DOSM) and the demand for housing loans sourced from Bank Negara Malaysia (BNM). Also, Johor's Housing Price Index (HPI) was taken from NAPIC, while Tender Price Index (TPI) was attained from Arcadis. Lastly, the inflation rate was based Consumer Price Index that sourced from the World Bank.

3.3 Development of dynamic hypothesis

The study comprises four subsystems: unsold new housing stocks, housing demand, housing supply, and Housing Price Index (HPI). First, those subsystems were identified to examine the factors that influenced the unsold new housing stocks in Johor, based on Kwoun et al. (2013). Then, the dynamic hypothesis was mapped to demonstrate the flow of interrelated subsystems on how it affected the unsold new housing stocks. The subsystem diagram is exhibited in Figure 2.

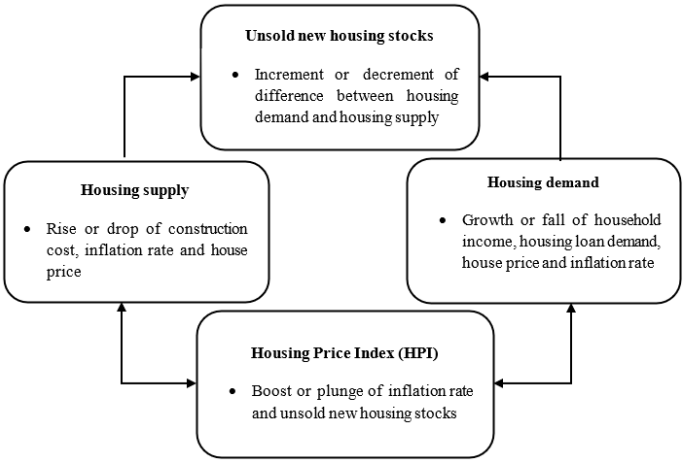

Figure 2: Subsystem diagram for unsold new housing stocks in Johor

In Figure 2, the unsold new housing stocks in Johor were affected by housing demand and housing supply. The changes were based on the difference between housing demand and housing supply. Then, housing demand and housing supply were altered by Housing Price Index (HPI); meanwhile, both housing demand and housing supply also affected HPI. Hence, there were two-way arrows between housing demand, housing supply, and HPI.

3.4 Model formulation

The subsystems in Figure 2 were transformed into stock and flow diagrams by using Vensim software. There were also four stocks, i.e., unsold new housing stocks, housing demand, housing supply, and housing price index, that involved all correlated variables, then entered them into the software to develop the model with illustrating the flows. The system dynamics model for unsold residential housing in Johor is displayed in Figure 3.

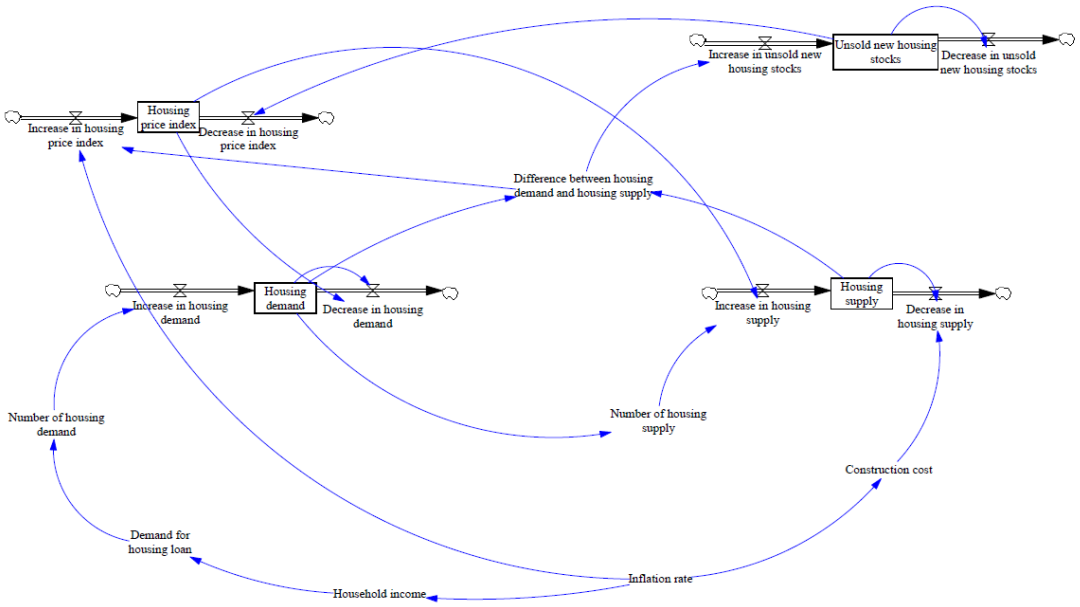

Figure 3: System dynamics model for unsold residential housing in Johor

Based on Figure 3, Johor's unsold new housing stocks were influenced by the difference between housing demand and housing supply. Several factors that affected housing demand and housing supply were classified into direct and indirect factors. The direct factors affected housing demand and housing supply directly, whereas the indirect factors indirectly influenced housing demand and housing supply.

First, there were two direct factors in housing demand, i.e., house prices and demand for housing loans, because they affected housing demand directly (Baharuddin et al., 2019; Kwoun et al., 2013; Obaid, 2020). Moreover, housing demand had two indirect factors in the model, i.e., inflation rate and household income. The reasons were the inflation rate influenced housing demand through house prices (Baharuddin et al., 2019; Bobeica et al., 2019). However, household income affected housing demand through demand for housing loans because the housing loan was determined by household income (Caldera and Johansson, 2013; Kwoun et al., 2013; Obaid, 2020).

Additionally, there were also two direct factors in housing supply, i.e., house prices and construction cost, because they influenced housing supply directly (Kwoun et al., 2013; Caldera and Johansson, 2013; Tolles, 2021; Peng, 2018; Ramli et al., 2020; Zainal et al., 2019; Chege, 2017). Besides that, housing supply had only one indirect factor, i.e., inflation rate, because it altered housing supply through house price and construction cost. Precisely, the inflation rate influenced both house prices and construction costs; then, housing supply was affected in Johor. After describing the housing demand and housing supply factors, the results were also revealed house price was affected by housing demand and housing supply. This house price movement was a symptom of

disequilibrium in the housing market that indicated the housing demand did not meet with the housing supply (Brzezicka et al., 2018).

4. Result and Discussion

In this stage of model testing, the model's structure was first tested by reviewing the previous studies, e.g., Kwoun et al. (2013). After that, the model was tested via behavioural validity test, and this was compared to the simulated data and the real data, as illustrated in Figure 4. It presented the behavioural verifications for unsold new housing stocks, housing demand, housing supply, and housing price index. Then, the model was validated through regression analysis by using the least square method that measured by the coefficient of R^2 (Kwoun et al., 2013).

Figure 4: Behavioural validations for unsold new housing stocks, housing demand, housing supply, and housing price index

In Figure 4, the red line denoted simulated data, whereas the blue line denoted real data. The results showed that only housing demand (b) and housing price index (d) were corresponded between simulated data and real data. The similarities were 88.92% and 80.17% because the coefficients of R^2 were 0.8892 and 0.8017, respectively. These figures implied the model was suitable and reliable for the simulation of housing demand and house price in Johor. However, the simulated data and the real data were not parallel for unsold new housing stocks (a) and housing supply (c), as the coefficients of R^2 were 0.1575 and 0.3026, while they were varied at 84.25% and 69.74%, respectively.

Based on the graphs, the variances were occurred from 2015 to 2018, and the state government caused these by reenacting the existing Housing Policy for Johor in 2012. The effect on housing demand was slow in the first three years, then the housing demand was started to grow since 2016 due to the construction of affordable housing had been speed up, and the government struggled to help Johor's people to own a house by 2020 (Ngadiman and Husin, 2012). Then, the housing supply was because of imposed a more rigorous housing policy to the developers in 2014 and the participation of foreign developers into the private housing sector in recent years, mainly from China

and Singapore (Lim and Ng, 2020). Also, the house price in Johor rose gradually in that period because of the Housing Policy in 2014 had enforced a maximum selling price on low and medium cost housing in Johor (Osman et al., 2017). However, the variation in unsold new housing stocks were caused by substantial ups and downs in housing demand and housing supply.

5. Conclusion

Both objectives of the study were achieved where housing demand, housing supply, and house prices were the main factors to the unsold new housing stocks in Johor. Then, its relationship had also been illustrated by the development of a system dynamics model. However, as the simulation results revealed unsold new housing stocks and housing supply were not parallel with the real data, therefore future study is suggested to use other data instead or to involve a longer time frame for simulation. Besides, the identified factors were only part of the factors that influenced the unsold new housing stocks in Johor, so the future study is also encouraged to include more factors in the model to observe and to develop a more complex and dynamic relationship of the model.

References

Ahmad, M. F., Sapiri, H., Misiran, M., Hashim, Z., & Abdul Halim, T. F. (2019). A system dynamics model of Malaysia house pricing. *International Journal of Engineering and Advanced Technology (IJEAT),* 8(6S3):57-64.

Azhar, K. (2019, September 12). Cover story: Reviewing Iskandar Malaysia. *The Edge Markets*. Retrieved February 26, 2021, from https://www.theedgemarkets.com/article/cover-story-reviewing-iskandar-malaysia

Baharuddin, N. S., Isa, I. N. M., & Zahari, A. S. M. (2019). Housing price in Malaysia: The impact of macroeconomic indicators. *Journal of Global Business and Social Entrepreneurship,* 5(16):69-80.

Bobeica, E., Ciccarelli, M., & Vansteenkiste, I. (2019). The link between labor cost and price inflation in the euro area. *ECB Working Paper*, 2235:1-66.

Brzezicka, J., Wisniewski, R., & Figurska, M. (2018). Disequilibrium in the real estate market: Evidence from Poland. *Land Use Policy*, 78:515-531.

Caldera, A., & Johansson, A. (2013). The price responsiveness of housing supply in OECD countries. *Journal of Housing Economics*, 22:231-249.

Chege, P. W. (2017). Factors affecting housing supply in Nairobi County, Kenya. *Dissertation of KCA University*:1-50.

Hashim, Z., Sapiri, H., Misiran, M., & Abdul Halim, T. F. (2018). The Utilisation of System Dynamics for House Pricing Analysis in Malaysia. *International Journal of Supply Chain Management*, 7(4):272-278.

Ishak, N. L., Yakub, A. A., & Achu, K. (2019). Buyers' perception on factors affecting affordable housing overhang in Johor, Malaysia. *International Journal of Real Estate Studies*, 13(2):48-58.

Kaur, M. (2019, December 18). Daim warns of property overhang as Bandar Malaysia resumes. *Free Malaysia Today*. Retrieved February 26, 2021, from https://www.freemalaysiatoday.com/category/nation/2019/12/18/daim-warns-of-property-overhang-as-bandar-malaysia-resumes/

iCMS2021: 4 - 5 August 2021

Kwoun, M-J., Lee, S-H., Kim, J-H., & Kim, J-J. (2013). Dynamic cycles of unsold new housing stocks, investment in housing, and housing supply–demand. *Mathematical and Computer Modelling,* 57:2094-2105.

Lim, G., & Ng, K. K. (2020). Housing policy in Johor: Trends and Prospects. *Yusof Ishak Instittute,* 424-446.

Nadhirah, A. (2015). Housing policy and housing program in Malaysia. *Universiti Sains Malaysia*, p.27. Retrieved March 8, 2021, from https://www.academia.edu/12498641/Housing_Policy_and_Housing_Program_In_Malaysia

National Property Information Centre (2019). Overhang Residential Property 2019. Retrieved February 15, 2021, from https://napic.jpph.gov.my/portal/web/guest/key-statistics

Ngadiman, N., & Husin, K. (2012). The transformation of affordable housing provision policy in Johor. *Advisory Center for Affordable Settlements and Housing,* 352-360.

Obaid, H. M. A. (2020). Factors determining housing demand in Saudi Arabia. *International Journal of Economics and Financial Issues,* 10(5):150-157.

Osman, M. M., Ramlee, M. A., Samsudin, N., Rabe, N. S., Abdullah, M. F., & Khalid, N. (2017). Housing affordability in the state of Johor. *Journal of the Malaysian Institute of Planners,* 15(1): 347-356.

Peng, Y. G. (2018). House prices in Malaysia: Demand, supply and inflation hedging ability. *Thesis of Universiti Sains Malaysia*, 1-24.

Ramli, F., Zainal, R., & Ali, M. (2020). Oversupply of the high-cost housing in Malaysia: Factors influence the developer's decision in supplying more high-cost housing. *Malaysian Journal of Sustainable Environment,* 7(2):95-110.

Ramli, F., Zainal, R., & Ali, M. (2019). Prediction supply modelling for high-cost housing in Malaysia. *International Journal of Supply Chain Management,* 8(3):2051-3771.

Real Estate and Housing Developers' Association Malaysia (2019). Property Market Report 2019. Retrieved February 15, 2021, from http://rehda.com/wp-content/uploads/2020/05/JPPH-Propert-Market-Report-2019.pdf

Sapiri, H., Zulkepli, J., Ahmad, N., Abidin, N. Z., & Hawari, N. N. (2017). *Introduction to System Dynamic Modelling and Vensim Software: UUM Press*. UUM Press.

Soffian, N. S. M., Ahmad, A., & Rahman, N. A. (2018). Housing development in Malaysia. *International Journal of Academic Research in Business and Social Sciences,* 8(2):852-860.

The Star (2003, April 8). New definition needed for property overhang. Retrieved April 4, 2021, from https://www.thestar.com.my/business/business-news/2003/04/08/new-definition-needed-for-property-overhang

Tolles, N. (2021). Determinants of housing supply expansion in the Western United States. *CMC Senior Theses,* 2550.

Yeap, G. P., & Lean, H. H. (2020). Supply elasticity of new housing supply in Malaysia: an analysis across housing submarkets. *Economics Bulletin,* 40(1):807-820.

Zainal, R., Ramli, F., Manap, N., Ali, M., Kasim, N., Noh, H. M., & Musa, S. M. S. (2019). Price prediction model of demand and supply in the housing market. *MATEC Web of Conferences,* 266.

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