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

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ABSTRACT

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 price, 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. Further, the study recommended the bank and the government of Malaysia to increase the overnight policy rate and to control the inflation rate in order to reduce the unsold new housing stocks in Johor.

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1. Introduction

Housing is one of the necessities for human lives and contributes to a country's economic growth (Yeap & Lean, 2020). However, when housing demand and housing supply do not match, it raises the house price and causes the unsold new housing stocks to occur due to the unaffordability to purchase a house. 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 price 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 price 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 (PR1M)*, *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 price 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 affect housing demand

Factors	Authors	Description
Household income	Caldera & Johansson (2013), Kwoun et al. (2013), and Obaid (2020).	<ul style="list-style-type: none"> 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	Kwoun et al.	<ul style="list-style-type: none"> Mortgage loans affected housing demand positively due

loans	(2013), and Obaid (2020).	<ul style="list-style-type: none"> to the availability of housing loans. On that account, housing demand would increase if households could receive loan approval for home purchases.
House price	Baharuddin et al. (2019).	<ul style="list-style-type: none"> House price negatively influenced housing demand. Since the individuals find it is more challenging to afford to buy a house when the house price appreciated, resulting in a fall in housing demand.
Inflation rate	Bobeica et al. (2019), and Baharuddin et al. (2019).	<ul style="list-style-type: none"> 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 price because housing demand dropped when house price soared.

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

Table 2
Factors that affect housing supply

Factors	Authors	Description
House price	Kwoun et al. (2013), Caldera & Johansson (2013), and Tolles (2021).	<ul style="list-style-type: none"> It positively affected since higher house price 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 & Johansson (2013), and Tolles (2021).	<ul style="list-style-type: none"> 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).	<ul style="list-style-type: none"> 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

Overnight policy rate	Tang & Tan (2015)	<ul style="list-style-type: none"> • construction cost growth. • It had a negative effect on housing supply because it helped to reduce the unit launches and the housing approvals to stimulate the housing market from supply side although it was not significant to affect the housing price.
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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).

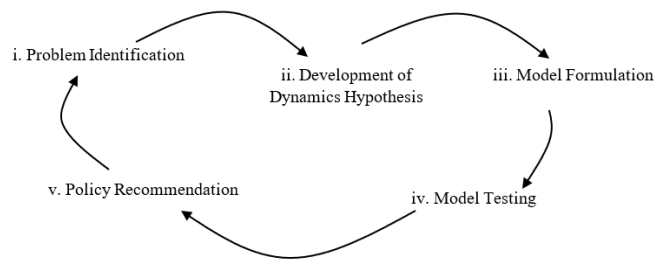


Figure 1. Process flow of system dynamics approach

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 were taken from Real Estate and Housing Developers' Association (REHDA). Furthermore, the mean of gross household income was obtained from the Department of Statistics Malaysia (DOSM), then the demand for housing loans and overnight policy rate were 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). Moreover, 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.

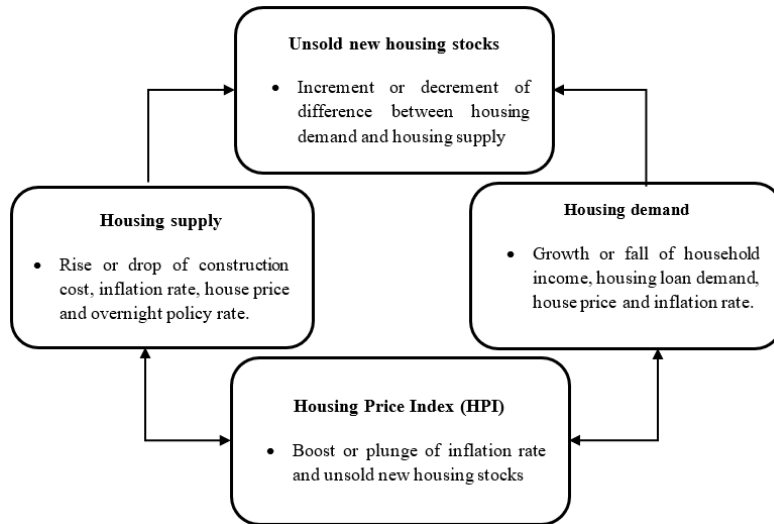


Figure 2. Subsystem diagram for unsold new housing stocks in Johor

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. On the other hand, 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.

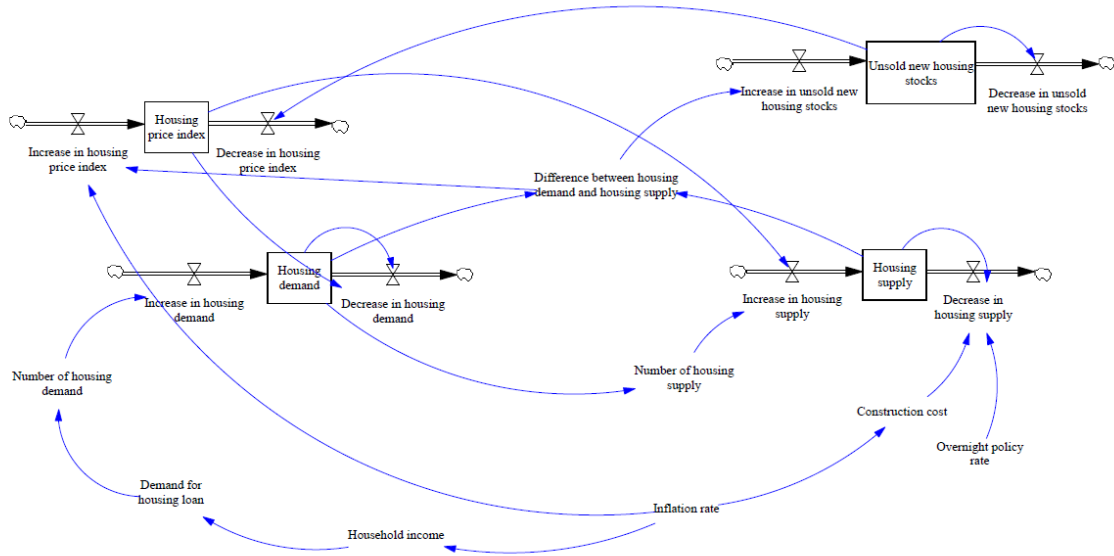


Figure 3. System dynamics model for unsold residential housing in Johor

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 price 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 price (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 & Johansson, 2013; Kwoun et al., 2013; Obaid, 2020).

Additionally, there were also three direct factors in housing supply, i.e., house price, construction cost and overnight policy rate, because they influenced housing supply directly (Kwoun et al., 2013; Caldera & Johansson, 2013; Tolles, 2021; Peng, 2018; Ramli et al., 2020; Zainal et al., 2019; Chege, 2017; Tang & Tan, 2015). 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 price 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

4.1 Model Testing

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. After that, 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 & Husin, 2012). Also, 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 & 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.

4.2 Policy Recommendations

Two scenarios were employed to decrease the unsold new housing stocks in Johor, the first was to raise the overnight policy rate and the second was to control the rising inflation rate. These scenarios were applied to combat the issues of housing surplus and increasing house price in Malaysia. The overnight policy rate was increased to 3.25% had declined the unit launches and the housing approvals in Malaysia by 74.5% and 22.5%, respectively in 2014 (Tang & Tan, 2015). However, the inflation rate in Malaysia was controlled to raise by only 1.09%, this effect on the housing price index in Malaysia to rise by only 0.76% in third quarter of 2019 (Delmendo, 2020). Thus, these two scenarios were suitable to be applied in Johor's situation.

In first scenario, overnight policy rate had an effect on housing supply to reduce the unsold new housing stocks in Johor as demonstrated in Figure 5.

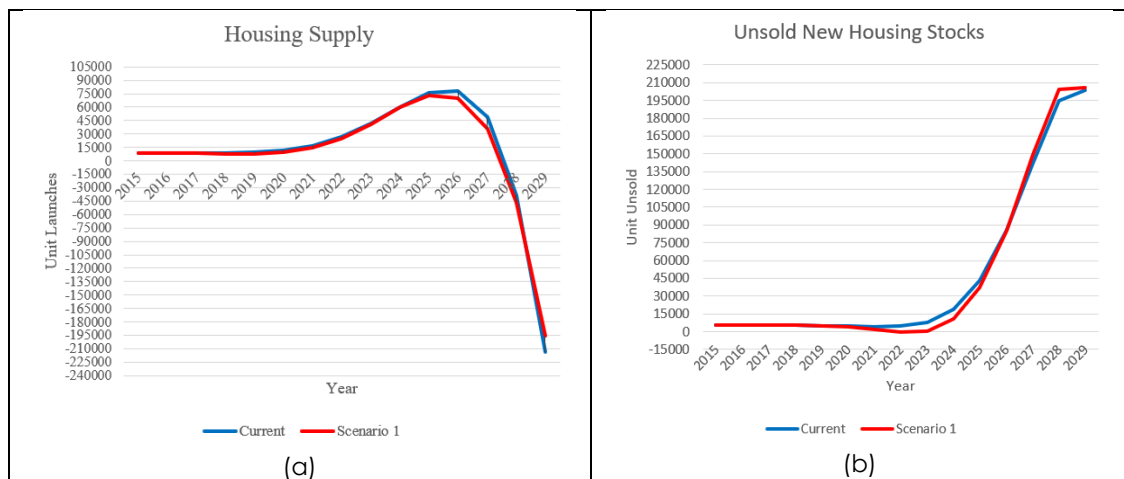


Figure 5. Result of increase overnight policy rate

Figure 5 implied the effect of increase and no increase of overnight policy rate on housing supply (a). The increase of overnight policy rate denoted in red line was effective to lower the housing supply from 2015 to 2028 by 21.75% and the housing supply was estimated to reach a deficit of 46,935 units in 2028. By comparing with no increase of overnight policy rate which showed in blue line, the housing supply was anticipated to reach a deficit of 38,549 units in 2028. Therefore, the increment of overnight policy rate displayed a good effect on housing supply.

The lower housing supply brought a lower unsold new housing stocks in Johor. (b) in Figure 5 showed the effect of increase and no increase of overnight policy rate on unsold new housing stocks. A good impact was revealed from 2015 to 2026 when raise the overnight policy rate in red line where the unsold new housing stocks were expected to reach at 85,146 units in 2026, compared to 85,464 units when no increase the overnight policy rate.

Next, the control of rising inflation rate had an impact on housing price index to decrease the unsold new housing stocks in Johor, the effect was indicated in Figure 6.

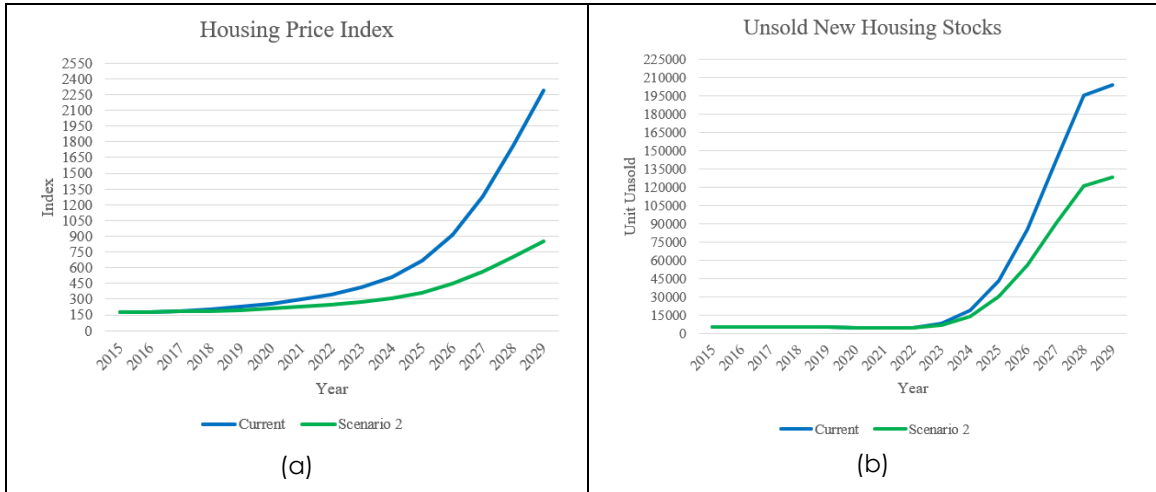


Figure 6. Result of controlling the rise of inflation rate

Figure 6 revealed the impact of control and no control of rising inflation rate on housing price index (a). The control of increasing inflation rate in green line was expected to slow down the housing price index effectively by 62.74% where the housing price index was estimated to reach at 854.3 in 2029, as compared to no control of rising inflation rate in blue line, the housing price index was expected to reach at 2295.5 in 2029.

Further, (b) also exhibited the effect of control and no control of rising inflation rate on unsold new housing stocks and a lower unsold new housing stocks in Johor was anticipated when control the increasing inflation rate as shown in green line. When the rising inflation rate was controlled, the unsold new housing stocks were expected to reach at 127,714 units in 2029, whereas the unsold new housing stocks were estimated to reach at 203,828 units in 2029 when the increase of inflation rate was not controlled.

Last but not least, both scenarios, i.e., to raise the overnight policy rate and to control the rising inflation rate were expected to be able to reduce the unsold new housing stocks in Johor. More specifically, the second scenario was more encouraged to be applied in Johor's case because the control of inflation rate could lower the unsold new housing stocks more than to raise the overnight policy rate.

5. Conclusion

Both objectives of the study were achieved where housing demand, housing supply, and house price were the main factors to the unsold new housing stocks in Johor. Next, 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. Also, the policy recommendations were contributed to help the policymakers to plan better on conquering the unsold new housing stocks issue in Johor.

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