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STRUCTURING KNOWLEDGE ON HOUSE PRICE VOLATILITY THROUGH A METAMODEL

Aishah Abdullah[1], Siti Hajar Othman[1] and Muhammad Najib Razali[2]
[1]Faculty of Computing, Universiti Teknologi Malaysia, Johor Bharu, Malaysia
[2]Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia, Johor Bharu, Malaysia
E-Mail: hajar[2], mnajibmr[3]@utm.my

ABSTRACT

House Price (HP) valuation involves highly complex decision making. This requires collaborating with other parties to plan and organize activities and gathering knowledge from various sources that are distributed across time, space and people. In other words, not all situational knowledge is immediately available and no one person is positioned to make all the decisions. To gather the knowledge of HP systematically, observations were made, but we found that the utilization of the information system model for house price volatility domain is still limited. This paper suggests a unified way to gather the knowledge of House Price Volatility (HPV) in the form of a metamodel. Through the metamodelling technique, an artifact called a 'metamodel' is produced; it is capable of gathering and generalizing all house price determinant concepts and their relationships. Particularly for this House Price Volatility domain, the House Price Volatility Metamodel (HPVM) is developed by using a Design Science Research methodology. By combining the qualitative and quantitative method, the 8-Step of Metamodelling Creation Process and content analysis method was adopted in this research. In this paper, we are presenting the HPVM as a way to gather the information of HPV. The metamodel developed in this paper is validated by using in a case study: House Price in Penang State. The validation found that the HPVM can be applied in the Penang's current house price determinant. It is believed that the HPVM would benefit many housing authorities such as government, investors, economists, buyers and practitioners. HPMV can widen the views of housing authorities regarding their investment activities and enhance their vision when making decisions on policies involving house price volatility. Representing HPVM in the Unified Modeling Language (UML)-based diagram and transferring the domain information is easier nowadays, as many practitioners are familiar with the language.

Keywords: metamodel, metamodeling, house price, house price volatility.

INTRODUCTION

The growth in the housing or property market has a significant influence on the stability of the financial system. Changes in demography, market force and the rise of speculation will eventually lead to house price volatility. Change in house prices can directly and indirectly impact the demand for household credits, particularly in an environment where the rise in house prices are not accompanied by changes in income associated with the rise in house prices; there is a fear that this trend will result in an excessive debt accumulation for households and developers. If house prices falls sharply, the impact on the banking economic institutions can become so bad that it will pose a major risk to financial firmness [12]. From the macroeconomic view, the housing market has become an essential sector and is also a backbone of the property market for many developing countries. A house can become 'the' major investment compared to other needs. The volatility of house prices always attracts attention and large responses from country residents. [4] in his research stated that the large movement of house price will likely affect the economic growth of a country. With the rapid increase in demand for properties, house prices have continued to change and this have largely impacted other goods and services, making it a highly volatile investment when compared to other investments.

On the other hand, information regarding house price volatility is scattered and un-organized clearly which make it harder to grab the information about HPV. Therefore, in this research, we have introduced the use of a software engineering approach called the metamodelling technique to manage knowledge of the house price volatility determinant factors and all concepts related to these factors. This research creates a unified view of house price volatility (HPV) in the form of a metamodel that can be seen as a language for this domain. A metamodelling process is applied to ensure that the outcome metamodel is complete and consistent. The metamodel is validated and refined to serve as a representative layer to assist and expedite the access of HPV by the experts. We aim to facilitate knowledge sharing by combining and matching different HPV activities when different situations arise, similar to [18], but in HPV. This is demonstrated by applying the metamodel as a semantic modeling standard of HPV to describe data models independently from the language of the domain itself.

In this paper we show our approach finding by presenting the resultant and validation of the metamodel by generalizing HPV determinants factors found. The rest of this paper is organized as follows: In Section 2, we present some related works to this research. Section 3 provides the methodology used in this study. In Section 4, we present the development process of HPVM based on *8-*

step metamodelling creation process approach. Section 5 shows the resultant of HPVM while section 6 present validation of HPVM using a case study on Penang state. Finally, Section 7 concludes this paper with a discussion of possible future work related to this research and section 8 shows an acknowledgement to those involve in this study.

RELATED WORK

House price volatility determinants

House price volatility has drawn the attention of policymakers and investors in the recent market. Volatility is significantly related to lagged information or "news". Excess volatility may have consequences of housing price risk. The house price will be volatile whenever there is any new information in the market.

[11] discussed in their study that income, population and mortgage rates are among the house price predictability factor. [15] also agreed that mortgage rates are also one of the determinants of house price changes. [8] suggests that macro economy is one of the determinants. [8] has also determined that other 'economic variables' like unemployment rate, income, and inflation rates and are crucial factors in house price determination. [23] used a method which estimates the probability of house price changes in a market using their sale price and have concluded that population growth, employment rates and changes in income have an effect on house price. [6] also mentioned that income, population, interest rates and house price changes have affected house price in the United States.

In addition, the increase in construction cost and land price for housing development had also affected house price. High demands on a limited supply of suitable land for housing and the rising price of construction materials gave reasons as to why house price increased [19]. [2] and [8] also mentioned construction cost as one of the factors causing a change to house prices. According to [1], the buyer and seller who waits for more information on house price in the market before making any decision, exercises the approach of wait and see; they play an important role in price growth.

[1] also agrees that macro economy; herding and social influence brings about the increase in house price. Furthermore, any misinterpretation of housing market information by investors and buyers can lead to speculation. The fact is that an escalating house price makes many buyers anxious that the escalation will continue. This added fuel to speculations resulting in some investors purchasing more homes than intended so as to gain more profit in the future by selling or renting their properties at higher prices [10]. [22] had also found in their research that cities with higher rents contribute to the escalation of house price because the owners who would have been influenced by speculations will advertise their homes at higher prices when reselling. House price volatility is caused by the investor who makes a calling without sufficient information and often reacts to speculative information [20].

Metamodelling

Metamodelling is an approach use in this study to represent the HPV in deep and broader way to understanding the reality of HPV. Based on its ability to show domain policy and their record, these theories motivate the research on the implementation of metamodelling in managing the house price domain. Metamodelling, a technique that is taken to visualize HPV concepts, allows the user to specify modeling languages and domain abstractions in a declarative manner and generate tools for their support, and thus solves the customization problem.

It is designed to generate a reusable, transferable software process and mechanism [16]. It is an activity to generalize about HPV domain through gathering all field concepts and dividing the domain issues into sub domain issues. There are involving a model creation in both methods. Models are abstract representations of real-world systems or processes. When the process being modeled is the process of creating other models, this modeling activity is correctly termed metamodelling. Hence, concepts that apply to modeling also apply to metamodelling. To running a framework, a metamodelling process is required. This typically contains the degree of the application and the representation of the metamodel.

METHODOLOGY

This paper will follow three phase of creation wherein the first phase, the literature review on the current trend of house price and the review on house price volatility and its determinant in order to build the reliable metamodel framework specially for HPV. The second phase will start using 8-step of metamodelling creation process adopted from [17] to develop a metamodel. The reason of this development step is adopted into this study is because the step involved in this creation process can be illustrated with more clear view and it can make more easy to generalize the concept found in the study. In this phase, the content analysis will be conducted to the literature review found in the previous phase in order to extract the determinant of HPV. The rest of the step will be explained in the next section. After the development of metamodel is done, the validation of HPVM was conducted by using a case study: House Price in Penang

HPVM knowledge structure

A domain model is usually developed to lay the ground for a problem-solving effort. It is a conceptual model describing various topics and aspects related to a specific problem. It describes the various entities, their attributes, roles, and relationships, plus the constraints that govern the problem domain. For example, in UML (Meta Object Facility (MOF) -based metamodel) class diagram is

used to represent the domain, model. The metamodel-based system is defined by a package which consists of metamodel and other components such as knowledge repository, classes, relationships, syntax and semantic rules. Table-1 shows the representation of HPVM in 4-layer MOF.

Table-1. Representation of HPVM concept in 4-layer MOF modeling paradigm (Instantiated from [16]**.**

Level	Level Name	Description
M3	Meta-metamodel	**MOF Level** Infrastructure for a metamodelling architecture Defines the language for specifying metamodel **Meta-Metamodel Elements** MetaClass, MetaAttribute, MetaOperation MOF::Class, MOF::Attribute, MOF::Operation
M2	HPVM Metamodel	**Instance of MOF Meta-metamodel** Defines the language for specifying a HPV model Consists of MetaClasses, MetaAttributes, MetaOperations, MetaRelationships of HPVM concepts **M2-Fragment** (Metamodel fragments) contains HPVMClass (e.g.: Concept: "Population")
M1	HPV Model	**Instance of HPV Metamodel** Models a specific information of HPVM problems Model - all the required components for this model are defined in HPVM) **M1-Fragment** (Data Model Fragments) - Contains HPVMObject
M0	HPV User Model	**Instance of HPVM Model** Models user's real world data HPVM Model represents a real HPV problem. **M0-Fragment** (User Model Fragments) Contains HPVMInstance of Real World Data (e.g.:PenangHousePrice, KualaLumpurHousePrice)

Notes: MOF - Meta Object Facility

In Table-1, the M3 level shows the Meta-metamodel which shows the structure include in the architecture. It defines the language for specifying the metamodel. The M2 level defines the domain model, in this case, is HPV. In this level, every HPVM concept is represented as Class; HPV Concept is equal to HPVMClass. Each HPVMClass has the following fields: name, ID, type, definition, attribute, operations, and relationships. Each HPVM concept is represented as HPVMClass which has its own M2-Fragment, a unit fragment. Table 2 shows an example of HPVM concept used in this study.

Table-2. Example of HPVM concept.

HPVMClassID	HPVMClassName
DF01	Micro-Economy
DF02	Loan rates
DF03	Inflation Rates
DF04	Producer Price Index
DF05	Taxes
DF06	Mortgage Rates
DF07	Construction Cost

Notes: DF - Determinant factor

Representations used in this study are: HPVMClass = <HPVMClassName, HPVMClassID, HPVMClassDefinition,HPVMClassAttribute, HPVMClassOperation, HPVMClassRelationship> where:

- HPVMClassName represents a HPV concept name
- HPVMClassDefiniton represents a HPV concept definition

- HPVMClassAttribute represent a HPV requirement
- HPVMClassOperation represent a HPV task
- HPVMClassRelationship represents the relationship with other concept/s
- HPVMClassID is a unique identifier for the concept

In M1 level, the architecture will capture in model with more specific of HPVM concepts and problem. Each concept will have its own task, requirement, plan, responsible user etc. These are refined down the MOF hierarchy through the corresponding unit fragments. Table-3 shows HPVMClass of LoanRates concept.

Table-3. The HPVMClass of LoanRates concept**.**

HPVMClassName	**LoanRates**	
HPVMClassId	DF02	
HPVMClassDefinition	The interest rate applied to a loan depending on the type of the loan.	
HPVMClassRelationship	Land Rates <influence by>	
HPVMClassAttribute	**Attribute_Id**	**HPVMClassAttribute Name**
	DF021 DF022 DF023 DF024 DF025 DF026 DF027 DF028	loanID loanType loanAmount loanTimeInYears processingFee loanTerm interestRate interestPayment
HPVMClassOperation	**OperationID**	**OperationClassName**
	a DF021 aDF022 aDF023	loadLoanAmount() calculateProcessinngFee() calculateMountlyPayment()

A HPVMClass (M2-Fragment in HPVM) equivalent as in UML Class. Attributes of a UML Class is used to represent HPVM concept's requirements as shown in the example in Table 3, HPVMClass's LoanRates can include: LoanType and LoanAmount to define loan rates. UML-based operations are used to represent tasks and processes of HPVMClass (e.g.: loadLoanAmount(), calculateProcessinngFee(). The () symbol is used to signify the operation process. M0 level model represents a real HPV problem and using real world data.

FINDINGS AND RESULT

This section present the development step involved in the creation of HPVM.

HPVM step-by-step development

To construct our House Price Volatility Metamodel (HPVM), a set of common and frequently used HPV factors is first determined. Our identified HPV factors and their definitions are rooted in the existing HP literature. A study of the HP domain is first performed by investigating a large collection of existing HP models. All the HPVM creation step using the 8-Step of Metamodeling Creation Process which was the creation of Othman and Beydoun [17] are described below.

Development step

Step 1- Content Analysis and Existing House Price Model Investigation

Prior to the development stage of the metamodel HPV system, the process of data gathering for HPV was carried out. This was done by analyzing the previous study of the HPV factors and conducting the investigation on the current factors that affect the HPV. The first step is conducting the analysis to discover the models by using Model Importance Factor (MIF) formulated by [17] to find the best collection of house price models. The first ten sets of house price models out of 20 models of the MIF calculation is shown in Table-4. The ten sets of models selected will be used in the development of metamodel with a further ten sets of models used for the validation. The MIF will be written as below

$$\mathrm{MIF} = \frac{(\mathrm{T_C} \times (\mathrm{E_L} \times \mathrm{P}) \times \mathrm{R_{cover}})}{((\mathrm{Y_{now}} + 1) - \mathrm{Y_p})}$$

Where the representation is defined as

T_c	:	Total number of Times the model was cited.
E_l	:	Effort is represented using a level of model creator with the definition as follows: 0.1 - Individual 0.2 - National Organization 0.3 – International Organization
P	:	Total Participants involved in model development
R_{cover}	:	Relevancy will cover how useable the model is to the HPVM development requirement
Y_{now}	:	The current Year of MIF calculation
Y_p	:	The Year House Price model was published

Table-4. MIF calculations of ten selected house price models.

HPV model	T_c	E_l	R_{cover}	Y_{now}	Y_p	MIF
Capozza *et al*. [5]	196	0.1	0.3	2015	2002	1.68
McQuinn and O'Reilly [13]	77	0.1	0.3	2015	2008	0.867
Gelain, *et al*. [8]	38	0.1	0.3	2015	2012	0.855
Miller and Pandher [14]	41	0.1	0.3	2015	2008	0.65
Dolde and Tirtiroglu [7]	54	0.1	0.3	2015	2002	0.23
Banks *et al*. [3]	11	0.1	0.3	2015	2010	0.22
Zhou and Haurin [23]	13	0.1	0.3	2015	2010	0.13
Lee [11]	19	0.1	0.3	2015	2009	0.08
Hott [10]	44	0.1	0.3	2015	2012	0.03
San Ong [21]	11	0.1	0.3	2015	2013	0.02

Step 2: Drawing out the general concepts definition

Out of the 10 selected house price models that were investigated, the concept that determines the volatility of the house price in the models were then extracted from the house price models gathered before the development. Table-5 shows an example of the concepts extracted from the ten models selected.

Table-5. Concepts extracted from house price models selected.

Researchers	Determinant Factors						
	Population	Income	Mortgage Rates	Inflations Rates	Speculation	Construction Cost	Employment rates
McQuinn and O'Reilly [43]		√		√			
Hott[31]	√	√	√		√		
Lee [48]	√	√		√			√
Capozza, *et al*. [5]	√	√		√		√	
Gelain, *et al*. [8]		√	√	√			
Banks, *et al*. [3]	√	√					√
Zhou and Haurin [23]		√	√			√	

Step 3: Short listing of candidate

By analyzing 10 house price models, 36 general concepts of HPV were found in the selected models. After comparing and analyzing the concepts definitions and

characteristics, only 24 out of 36 concepts were shortlisted for the metamodel development.

Table-6 shows an example of the HPV determinant concepts that were shortlisted from the models selected.

Table-6. Concepts and definition derived from selected model.

Concepts	Concepts definition
Population	A group of people that were linked by concepts such as, ethnicity, demography and location.
Income	The total amount of money received by individuals after providing services or work, or profits from investments.
Employment rates	The number of people getting hired in one place or population. Can be used to indicate the state of economy of the country.
Mortgage Rates	The rate of interest charged by a mortgage lender for a property
Construction Cost	The expenses incurred on material, etc., needed for construction work
Loan rates	The interest rate applied to a loan depending on the type of the loan.
Taxes	Compulsory contribution to countries' profit; imposed by the authorities on employees' salary and profits made from business or proportion from the "*cost of some goods, services, and transactions*".
Real GDP	Real Gross Domestic Product (GDP) is a movement in the price and cost level, and offer a more precise number for a product produced in a certain year

Step 4: Reconciliation of candidate definitions

After the concept of HPV determinants were extracted from the materials gathered, the definition of each of the concept will identify its common feature or attribute to group the concepts into its own unique group that will be used by HPV. For example, population and employment rates can be described as having a common meaning or group due to its direct involvement by human factors. By using this common 'meaning' or 'grouping', the two concepts can be grouped together by 'demography factors' that can affect the house price. The process to maintain the common definitions identified earlier in order to create the metamodel will be done after the determinant factors of HPV are determined.

Step 5: Designation of concepts

After engaging in a various short listing of the concepts in step 4, the groupings of the concept for HPV is divided into two sets of views: Economy Factors and Demography factor. Among the concepts of HPV, these two groups of a concept have a common meaning that groups together most of the other concepts in the same metamodel. Even though the concepts are separated into two different groups, some of the concepts do actually have a correlation with each other. The interaction between those concepts will be shown in the HPV metamodel. Table-7 shows the concepts in their respective groups.

Table-7. Reconciled concepts are grouped into two different views: economy factors and demographic factors

Economy factors	Demography factors
Micro-Economy	Location
Loan rates	House type
Inflation Rates	Population
Producer Price Index	Consumer Sentiment
Taxes	Demand
Mortgage Rates	Income
Construction Cost	Employment rates
Land Price/Market	Herding Behavior
Good and Service Tax (GST)	Supply
Real GDP	
Speculations	

Step 6: Relationship identification

When the concept of HPV has been determined, the relationship between the concept and the relationship between the sub-concepts will be investigated and validated to create the link or connection between the concepts. Some of the symbols of relationship used in this

Metamodel are as follows: Association, ———— , which is to show the influence of a concept over another concept. For example, employment or job opportunity has a significant relationship with population; where there are more people residing in one location, there is a "need" for more jobs to survive. The use of Generalization ——▷ is to show the relationship between the general concepts with more specific concepts. This combination can be seen through the relationship between incomes which is a "typeOf" demography factor. Other than that, the symbol Aggregation ◇———— s also used to define the concept that depends on another concept such as demand will "dependsOn" vacancy of the supply. The Dependency, ---------- symbol is used to show the concept that may or may not have an influence on another concept. After the relationship is recognized, the process to develop a metamodel will begin.

Step 7: HPVM development

In this step, the HPVM will be drawn using UML representations to shows the interaction between the concept derived from the selected metamodel.

HPVM RESULTANT

This step presents the HPV metamodel initial results. Figure-1 and Figure-2 shows the view of HPV metamodel which was designed based on two separate general concepts: Demography Factors and Economy Factors of the HPV determinants and its relationship with house price and other concept that triggers volatility of house price. We can see in Figure 1 how population relates to employment rates in a country. A growth in the population increases the demand for employment. Employment brings income for the population. A further growth in population and income will increase consumer confidence and sentiment. This concept will create a demand for housing. House type and a hot location is one type of consumer demand that exists. When consumer demand increases and exceeds the vacant supply of housing, house price will eventually increase and priority will be given to those who can afford to buy the property. Table-8 shows the definition of the concept mentioned in Figure-1.

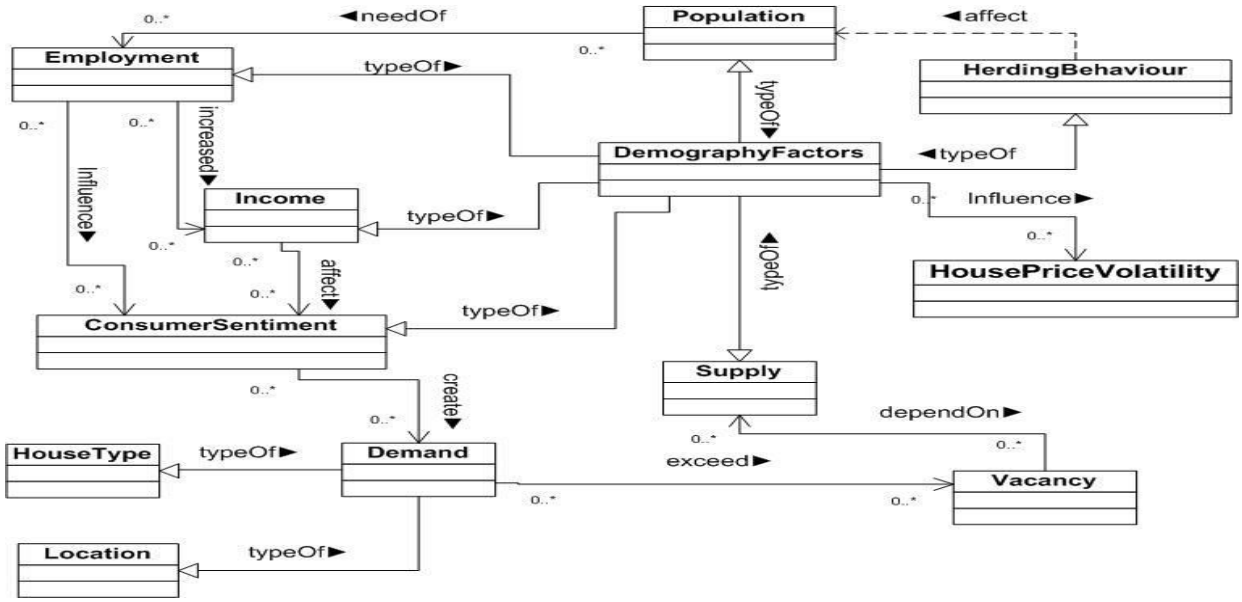

Figure-1. Demography-view of HPVM.

Table-8. Demography-view of HPVM concepts and definition.

Concepts	Concepts definition
Population	A group of people that are linked by concepts such as ethnicity, demography and location. Increases by birth rate and migration.
Income	The total amount of money received by an individual on the provision of services or work, or profits from sale and investments.
Employment rates	The number of people getting hired in one place or population. Can be used to indicate the state of economy of the country.
Demographic	Related to population
Consumer Sentiment	Person's confidence on his or her current economic state, their own style or liking in determining and using their financial worth.
Herding Behavior	An occurrence in which a person leans towards purchasing an identical or same investment just because many other people invest in it.
Supply/Vacancy	The number of vacant house that available for purchased.

In Figure-2, we discovered the relationship between the concept and the determinants of HPV that contributes towards the volatility of house price. There are some determinants that do not actually have a direct relationship with HPV, such as, GST. This concept has a relationship with only one of the HPV determinant, such as, construction cost. The introduction of GST by the government affects the cost of material used in construction which eventually led to some speculation among investors, realtors and developers and as a result, used this as an excuse to increase house price.

On the other hand, there are some determinants that actually have a correlation with each other even when the concepts are in different groups; although, it cannot be seen or proven in both metamodels that employment rates and micro-economy are related. A low rate of unemployment and depending on the sentiments of those employed in the country may mean the state of the country's economy is on the rise. Table-9 shows the definition of the concept mentioned in Figure-2.

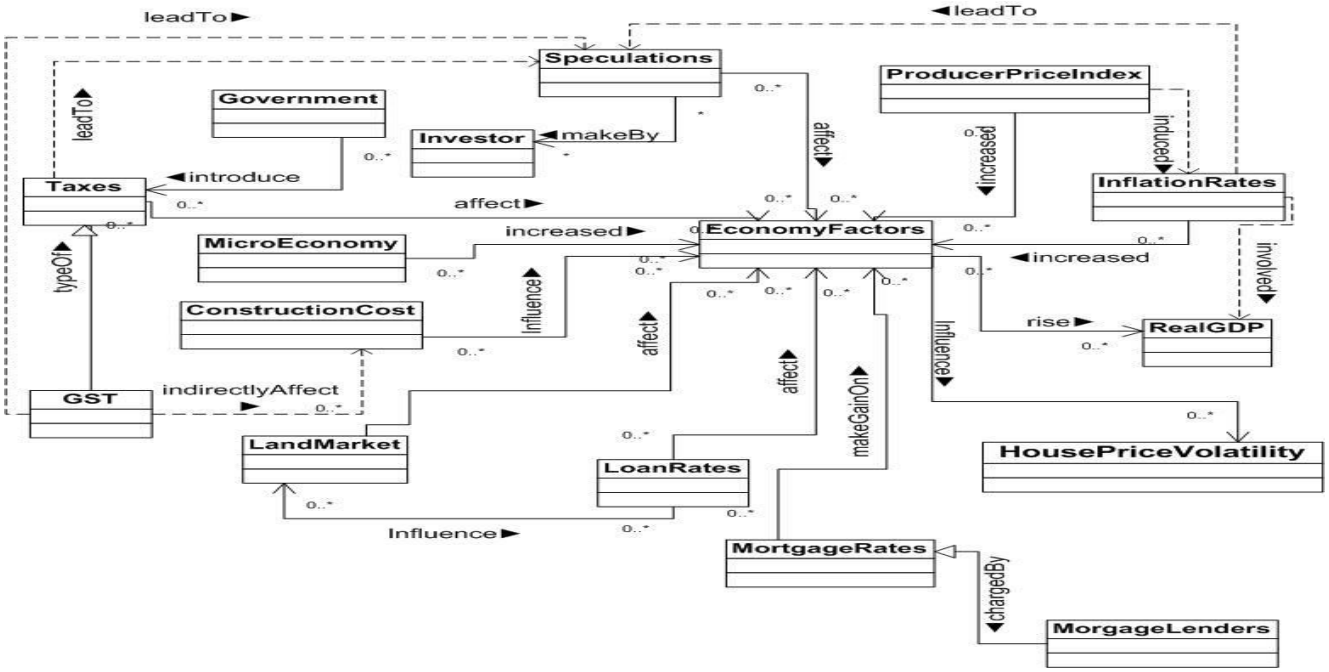

Figure-2. Economic view of HPVM.

Table-9. Economic-view of HPVM concepts and definition.

Concepts	Concepts definition
Mortgage Rates	The rate of interest charged by a mortgage lender for a property
Micro-economy	Human, households and organization performance in decision making and distribution of resources.
Speculations	Speculative theories on housing may be influenced by the involvement of the taxation system, which makes investing in housing more interesting than other investments.
Land Price	The amount of rates charged by a seller for a property.
Inflation Rates	The percentage rates or changes of the value in the Wholesale Price Index (WPI) per year.
Taxes	Compulsory contribution to country profit; imposed by the authorities on employee's salaries and profit of business or proportion from the "cost of some goods, services, and transactions".
Construction Cost	The price charge on materials needed for construction.
Loan rates	The interest rate applied to a loan depending on the type of the loan.
GST	Good and Service Taxes, a type of taxes introduced by government.
Real GDP	Real Gross Domestic Product (GDP) is a movement in the price and cost level, and offer a more precise number for a product produced in a certain year.
Government	The officials or authorities who govern the country or state.

data analysis and VALIDATION result

Validation of HPVM by using a case study: Penang state

In this validation, we use the correlation between HP in Penang, Malaysia with the determinants found in the study. The relationship between house prices and the determinants were analyzed using Pearson Correlation Analysis. The independent variables are the determinants while the dependent variables are the sale prices of residential properties. The level of significance between two variables is determined by consulting the two-tail significance. Specifically, these analysis shows that there are three common determinants which have a significant relationship with the house prices in Penang, Malaysia. The determinants are Real GDP, population growth, housing demand and supply. The relationship between the determinants and house prices are strong. From the r value, Real GDP has a positive correlation with the house prices while housing supply and population growth have a negative correlation with the house prices. Table 10 shows the correlation between house prices in Penang and the determinants.

Table-10. Correlation between house prices in Penang and the determinants**.**

		LGDP	LHSD	POP
LPST1	PC	.917**	-.777**	-.927**
	Sig. 2T	0.000	0.000	0.000
LPST2	PC	.910**	-.797**	-.950**
	Sig. 2T	0.000	0.000	0.000
LPSD1	PC	.690**	-.614**	-.762**
	Sig. 2T	0.000	0.000	0.000
LPSD2	PC	.845**	-.732**	-.907**
	Sig. 2T	0.000	0.000	0.000
LPD	PC	.674**	-.621**	-.713**
	Sig. 2T	0.000	0.000	0.000

Notes: LPST1, LPST2, LPSD1, LPSD2, LPD is house type. PC-Pearson Correlation, Sig. 2T – Significant at 2-Tailed

Based on the result in Table 10, house price will increase when Real GDP increases or vice versa. This is supported by [9]; income is the driving force in house price fluctuations. As income increases, the consumer's purchasing power increases. The demand for housing increases broadly in line with an increase in income.

House price changes are also driven by the supply of housing. The result shows that there is a negative relationship between house price and housing supply. This is in line with the theory of supply and demand. When supply is limited, and demand increases, house prices are forced to increase. The behavior of the housing market depends on the buyer and the seller. This study shows that population growth has a negative relationship with house price. An increase in population growth will result in a decrease of house prices and vice versa. This phenomenon may be caused by an overestimated or oversupply of housing in the market during population growth. The rate of demand for housing is hard to estimate and it's the same problem when the population growth slows down. The Demography View (instantiated from HPVM) can be seen in Figure-3.

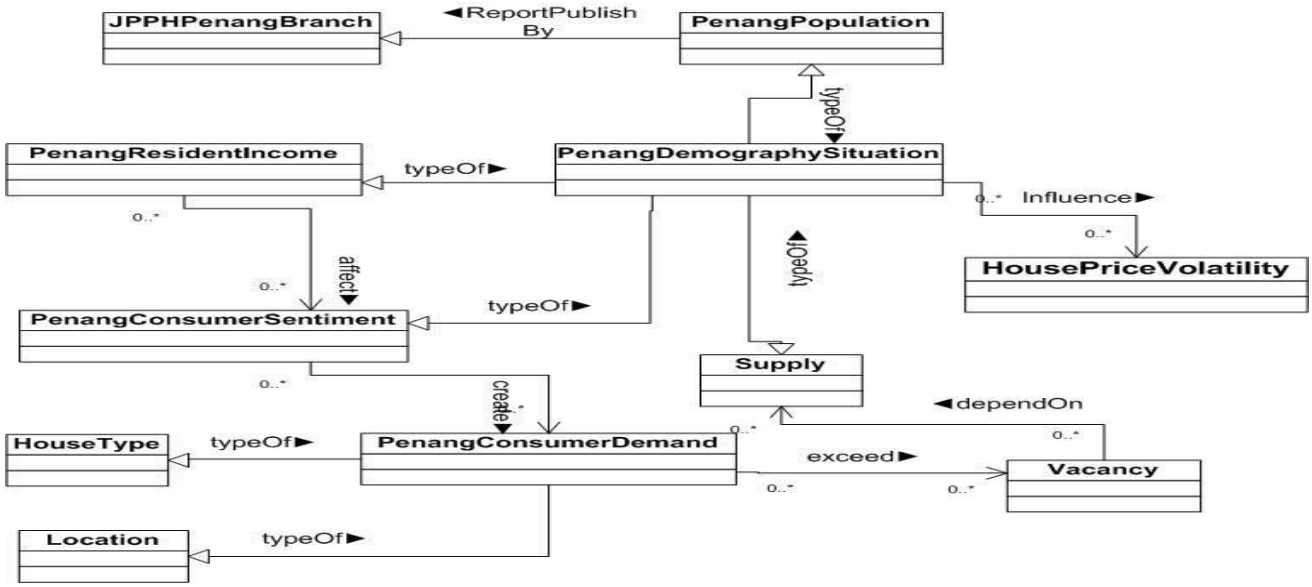

Figure-3. Penang demography-view (instantiated from HPVM) Based on the figure shown, the adaption of HPVM is believed suitable for Penang state house price. With the increasing demand of housing in Penang, the housing vacancy becomes limited as it only depends on the supply provided by the developer in Penang. In Penang demography-view which instantiated from HPVM, the relationship between the incomes, consumer sentiment in Penang is clearly shown in the Figure-3.

CONCLUSION AND FUTURE WORKS

This paper has presented the capabilities and performance in managing the knowledge of HPV using metamodel. The metamodel is validated and refined to serve as a representational layer to unify, facilitate and expedite knowledge access for many domain stakeholders. The aim is to facilitate knowledge sharing by combining and matching different HPV determinant factors as different situations arise. Due to the familiarity with Unified Modeling Language (UML) by the community, the use of UML increases the targeted client's understanding of metamodel. This paper also only focuses on unifying the determinant factor of HPV in the development of metamodel and validation using case study, Penang state's house price. As an improvement to HPVM, our future aim is to focus on producing a repository based on HPVM to gather house price volatility knowledge and to allow an approachable and adaptable HPVM approach based on the integration of house price determinant factors in economic changes.

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