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THE UNIVERSITY OF HONG KONG

EFFECTS OF BUILDING ORIENTATION ON THE RESIDENTIAL PROPERTY PRICE: AN EMPIRICAL STUDY IN TELFORD GARDEN

A DISSERTATION SUBMITTED TO
THE FACULTY OF ARCHITECTURE
IN CANDIDACY FOR THE DEGREE OF
BACHELOR OF SCIENCE IN SURVEYING

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION

BY

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HONG KONG

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Declaration

I declare that this dissertation represents my own work, except where due acknowledgment is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed: _____

Name: _____

Date: _____

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Abstract

To face the southeast has long been said to be the best one for building orientation in Hong Kong. However, there is no research about the impact of facing southeast on property price. Therefore, this dissertation aims to bridge the gap by studying the climatic advantages of facing southeast and their impact on property price.

Two hypotheses are set in this dissertation. The first hypothesis is that facing southeast has a positive effect on the property prices. The second hypothesis is to face southeast has a positive effect, no matter for higher or lower floor levels. The data set that contains 1939 sales transactions in Telford Garden during the period from January 1993 to December 2009 was used.

Our results show that facing southeast has a positive and significant effect on the property price in Telford Garden. On average, people are willing to pay up to 2% more for the southeast facing properties.

However, when we distinguish the buildings into two sections, lower floor level and higher floor level. There is no statistical evidence to prove that facing southeast is a valuable attribute on lower floor levels. This indicates that the building orientation on lower floors might not be taken into consideration for valuation.

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Chapter 1. Introduction

1.1 Background

Hong Kong has long been well known for its soaring residential housing prices. According to the Global Property Guide, Hong Kong is ranked No.5 in the list of World's Most Expensive Residential Real Estate Markets 2009. For most of Hong Kong's residents, buying a property is the single largest investment in their life as they are most probably only able to buy one property in their lifetime, owing to high property prices. As a result, they will try their best to find a flat or house that suits them the best through balancing different factors like price and view.

Building orientation is one of the most important factors that affect consumers' property purchasing decision. In Hong Kong, Estate Agents usually regard southeast facing as a selling point of a property. In the Centaline Property Website in March 2010, the words 'south facing' in Chinese had 118 search records and 'southeast facing' in Chinese got 448 records, while only 10 searches were recorded for 'north facing' in Chinese. This indicates that the southeast facing properties contain some

favorable attributes that attract consumers. As there are many advisements using southeast facing as a selling point, consumers belief towards southeast facing may be equal to a brand name effect. People may treat southeast facing as always superior to other directions.

Nowadays, with a booming economy and various infrastructural constructions, Hong Kong's building density has kept on rising. The alignments of buildings might have blocked some of the southeast facing properties, especially for the properties on the lower floor, leading to a loss of advantageous features like breeze during summer and sunlight. Despite the advantageous features of those southeast-facing properties to have been ceased, people may be still willing to pay a high price for them by virtue of clinging to the idea that southeast facing properties are superior.

To identify the importance and the value of the building orientation would lead to three major benefits. The first being a more accurate valuation of property prices in the field of surveying. As the author will proceed to show, the orientation of the property is a determinant in the value of the property. To achieve a more

comprehensive and precise valuation, the orientation of the building has to be taken into consideration and this can be done through computations with pricing models. The transaction cost between buyers and sellers can be reduced if the value of the orientation of the building is recognized. Buyers would be more willing to pay a higher price if they know the reasons for the superiority of southeast facing properties and sellers would be better able to come up with a selling price. Lastly, the design of the building can also be improved if the reasons of the superiority of southeast facing buildings are identified. Designs of building can be adjusted to further capture the benefits of a desirable orientation.

1.2 Objectives of study

The main objectives of this paper are:

- To study the advantages of facing southeast Hong Kong

- To investigate the effects of facing southeast on property prices

- To analyze whether the value of the southeast properties on the lower floor would still be higher, even though the climatic advantages are limited.

1.3 Organization of study

The dissertation would be categorized into 8 chapters. The first chapter introduces the background, objectives and the organization of this paper. In Chapter 2, the past literatures related to the natural sunlight and ventilation will be reviewed. Besides, the research gap would be pointed out as well. The reasons of having climatic advantages for southeast facing properties would be explained in Chapter 3. In Chapter 4, the hypotheses for this study would be illustrated and explained. The methodology and model employed in this study would be discussed in Chapter 5. For the selection and source of data used, it would be introduced in Chapter 6. In Chapter 7,the results of the empirical study would be presented and interpreted. Last but not least, Chapter 8 would summarize the findings and limitations of the study. In addition, the areas suggested for further studies would also be introduced.

Chapter 2. Literature Review

2.1 Introduction

The building orientation determines three factors, which are the view, natural sunlight and natural ventilation for the flats in the buildings. Given a similar view, the advantages of a particular building orientation is the intake of natural sunlight and natural ventilation determined by that orientation. In this chapter, the studies about the natural ventilation and natural sunlight in the indoor environment would be reviewed.

2.2 Natural ventilation

Ventilation can occur naturally or mechanically. It is considered as ‘natural’ when it does not involve any energy consumption for breezes (Gratia, Bruyère, De Herde, 2004). A natural ventilation system is very important for quality building design as it brings benefits to an indoor environment in the following areas: air quality, energy use, and electric costs. Hence, a good natural ventilation system is an encouraging factor for people to purchase a flat.

2.2.1 Bring thermal comfort

Natural ventilation can be considered as an effective passive cooling system. Given that the building faces prevailing wind directions and the surrounding temperature is lower than that of indoor, natural ventilation is able cool the indoor temperature even without mechanical ventilation. Ayata and Yıldız (2006) mentioned that thermal comfort is attained since human generate heat and will radiate or give out heat. Strong air movement can affect an individual's thermal comfort by increasing the convective and evaporative heat loss rate from a human body to the environment, implying that one will feel cooler and more comfortable in an environment with a higher air velocity (Lovins, 1992). Besides, in the context of Europe, natural ventilation can cool loads in the range 10 – 35 W/m^2 (Dickson, 1998). Therefore, with natural ventilation, it is enough to cool flats and bring thermal comfort to occupants.

2.2.2 Reduce energy consumption and minimize costs

Since natural ventilation system can be utilized as a passive cooling system, it is able to reduce the electricity used by Heating Ventilation and Air-Conditioning (HVAC) system within a building. There are studies showing that buildings consume less energy when resorting to natural ventilation. According to the British Research Establishment Conservation Support Unit (2000), at least two-thirds of the total energy consumption for cooling purposes is accounted for by the use of fans in office buildings in U.K. Yet, natural ventilation can offset fan energy consumption of buildings in the U.K. from 20 kWh/m^2 to 60 kWh/m^2 per annum, for good standard office buildings to typical reputed office buildings respectively (Emmerich, Dols, and Axley, 2001). Such a drop in energy consumption can consequently/ as a result save electric costs ranging from 1.0£/m^2 to 3.0£/m^2 annually. For a resident living in a naturally ventilated flat, he/she would bear a significant smaller financial burden as the electric costs for cooling purposes would be reduced.

2.2.3 Create a healthy and comfortable environment

Natural ventilation is also an effective way to create a healthy and comfortable indoor environment for occupants. The existing literature on the issue points out that ventilation in the building has a significant effect on the health of the resident. Escombe et al. (2007) studied eight hospitals in Lima, Peru. They found that the possibility of airborne contagion is lower in the clinical rooms with natural ventilation, compared with the clinical rooms with mechanical ventilation. Vincent et al. (1997) compared the existence of short term and usual prodromes in office buildings with different kind of ventilation systems, showing that the workers in the mechanical ventilated offices have a higher chance of health problems compared with natural ventilated offices. Several literature (Seppanen et al. , 2004; Wong and Huang 2004; Hedge et al., 1989) also pointed out that the use of mechanical ventilation such as air-conditioning system will cause more symptoms of Sick Building Syndrome (SBS) in buildings. This phenomenon might be explained by the potential indoor air pollutants caused by the HVAC system (Leyten and Kurvers, 2006).

2.3 Natural sunlight

The difference in property prices between the preferred direction and other directions mainly lies in sunlight exposure. With a higher level of sunlight exposure, a southeast-facing flat can provide a more stable and comfortable living environment for individuals as it leads to/induces benefits to human physical health and psychological states. Meanwhile, beneficial effects are also shown through working productivity and electric costs.

2.3.1 Physical health

Sunlight exposure can exert significant influences on human health and performance. Through exposure to sunlight, individuals' vitamin D productions are boosted to support most metabolic functions, neuromuscular transmission and bone mineralization (Mead, 2008). A prolonged lack of the light vitamin, according to Begemann, Van Den Beld and Tenner (1997), can lead to a number of health problems, such like sleep disorders, performance difficulties and even depression. Though people can meet the vitamin D requirement by conducting outdoor activities, in view of

nowadays lifestyle, in which people usually stay indoors and wear sunscreens during outdoor activities, the risk of vitamin D deficiency has increased (Tangpricha et al., 2001). A flat with higher sunlight availability helps ensure the vitamin D production of an individual.

Exposure to light can help promote sleep and ease the problem of sleep disorders. It is found that people suffering from insomnia sleep longer and better if they have exposed to light in the evening (Lack and Schumacher, 1993). Campbell et al. (1993) indicated that sleep quality of elderly patients with sleep disorder was improved after having light exposure in the evening. These studies have shown us that light exposure can be considered as a treatment of sleep disorders. Sunlight is also effective in alleviating sleep problems (Terman et al., 1995). Living in a flat with greater sunlight exposure can help improve a sleep disorder patient's sleep quality.

2.3.2 Psychological states

Lighting condition can affect people's satisfaction in an indoor environment and their moods, according to Boyce, Hunter and Howlett (2003). They mentioned that a lot of studies have already shown people's mood is altered temporarily when there are changes in color and intensity of lights. Statistics pointed out that sunlight exposure can contribute to a small but significant reduction in negative mood of a person who has worked for 20 minutes (Dasgupta, 2003). More importantly, studies have shown that people prefer daylight compared to electric lighting in an indoor environment (Table 1).

Factor	Daylight Better	Electric Lighting better	No difference	No opinion
For psychological comfort	88	3	3	6
For office appearance and pleasantness	79	0	18	3
For general health	73	3	15	8
For visual health	73	9	9	9
For color appearance of people and furnishing	70	9	9	12
For work performance	49	21	27	3
For jobs requiring fine observation	46	30	18	6

Table 2.1: Percentage of occupants preferring daylight or electric light for different factors

It is because natural light can provide information about the time and weather conditions, relieve one from monotony and acts as an channel of interaction with the outside world (Kim and Kim, 2010). It is clear that people prefere to live in rooms receiving abundant sunlight more than rooms with dim sunlight.

2.3.3 Minimize the use of electric lighting

Daylight can replace the requirement of electric lighting, reducing a flat's electric cost as well as individuals' financial burden. Vartiainen (2001) has conducted an experiment showing how electricity saving is enhanced by increasing the window area of a building. It is found that daylight can replace 44% of the annual electric lighting requirements of the building during the office hours in Northern Europe (60°N) and 58% in Southern Europe (38°N), indicating that a higher daylight availability means a greater reduction in the use of electric lighting. Therefore, a flat exposed to more to sunlight means less electric lighting and lower electric cost is needed

2.4 Research gap

After reviewing the literature about the importance of natural sunlight and natural ventilation, a research gap can be found.

Although there are a number of researches related to the natural sunlight and natural ventilation, no researcher studied the relationship between the property price and the desired building orientation, from which one can enjoy natural sunlight and natural ventilation at the same time. By studying the effect of a desirable building orientation on the property price, the effect of natural sunlight and natural ventilation on the property price can also be indirectly reflected.

Chapter 3. The advantages of Southeast facing flats in Hong Kong

3.1 Introduction

In Hong Kong, among different building orientation, southeast facing is known to be “ Warm in winter, Cool in summer “. As mentioned above, estate agents have been treating southeast facing as one of a significant selling points and some people say that southeast facing has a better ventilation and receive more sunlight. In fact, the reasons for having the feature of “ Warm in winter, Cool in summer “ and the superior status compared to other building orientations, are not because of something supernatural. It is probably solely due to climatic reasons , those reasons will be introduced in this chapter.

Before introducing the reasons of having “ Warm in winter , Cool in summer “ , better ventilation and preferable sunlight in the southeast facing, the major factor that affecting the thermal comfort should be discussed first, as those features are related to

the thermal comfort closely. According to the United States Environmental Protection Agency, there are a number of variables determining whether the users in the building are comfortable with the indoor temperature. Among the variables, the indoor temperature is of the most important one and closely related to building orientation.

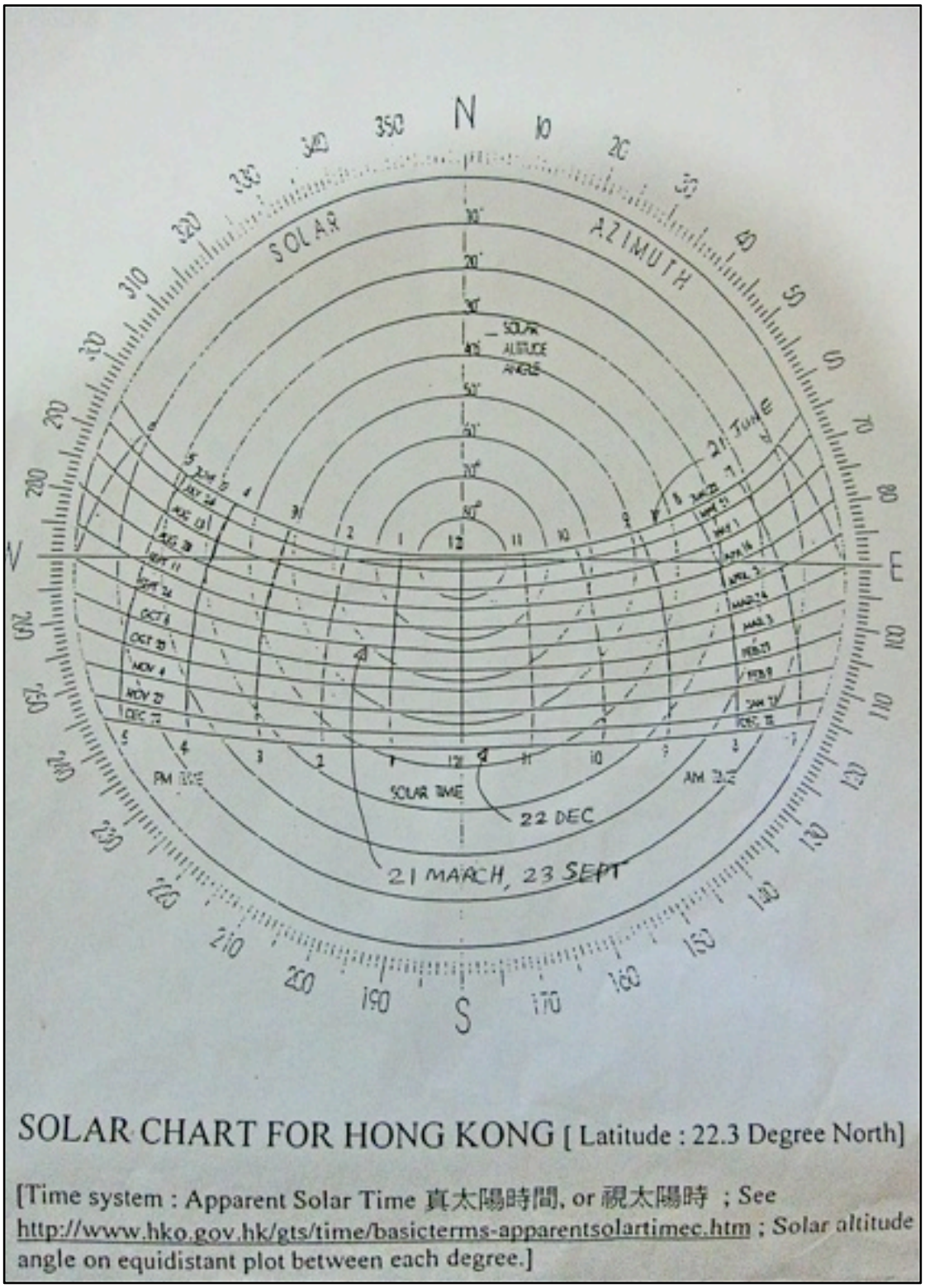
It is a well known fact that people dislike environments too hot and too cold, so living in a mild environment that suits us is always desirable . (Santamouris, 1998) mentioned that the indoor temperature is determined by internal factors and climatic factors. For internal factors, it includes the indoor human activities, the heat generated by artificial lighting and equipments and etc. For climatic factor, it includes the outdoor air temperature , wind effect , sunlight and etc. As our study is focused on how building orientation affects property price, so we will consider the factors that are related to building orientation only , which are wind effect and sunlight.

3.2 Sunlight

Apart from the advantages of sunlight found by scholars, which are mentioned in chapter 2 , sunlight can also provide heat for the earth. Incoming sunlight from the sun will be absorbed by the surface of an object and converted into measurable heat. Within a flat, the objects such as floor and furniture will be heated up by the absorption of sunlight through the windows. In addition, the external wall of the flat will also contribute to heating up the indoor. As a result The flat is warmer if it receives more sunlight. However, more sunlight is not always preferable, as it may cause over-heating, especially in the Summer. Therefore, how to maximize (or minimize) the heat caused by sunlight during cold climate (or hot climate) is a critical issue in building design.

If the maximization of sunlight is needed, the windows should be located oriented to face the sun for the longest duration possible. Regarding the position of the sun, as the motion of the sun follows an accurate pattern from time to time, so the radiation intensity

striking a given area of the buildings at different hours and seasons can be predicted. (Givoni, 1997)



SOLAR CHART FOR HONG KONG [Latitude : 22.3 Degree North]

[Time system : Apparent Solar Time 真太陽時間, or 視太陽時 ; See http://www.hko.gov.hk/gts/time/basicterms-apparentsolartimec.htm ; Solar altitude angle on equidistant plot between each degree.]

Figure 3.1: Solar Chart for Hong Kong

The Solar Chart for Hong Kong (Latitude : 22.3 Degrees North), generated by computer software - ECOTECT, shows a view of the sky of Hong Kong from a horizontal plane. The degrees around the chart show the direction of the sun, the solar azimuth circles (concentric circles) show the solar altitude angle, the lines with the dates across from the east to west indicate the time and date. The time system used in the chart is apparent solar time, according to the Hong Kong Observatory, which is the time derived from the sun's apparent position. For example, on the 22rd December (Winter Solstice), the solar altitude angle is about 44 degrees and the sun is from the south (180 degrees north). The graph obtained from the website of the Hong Kong Observatory is attached for better understanding.

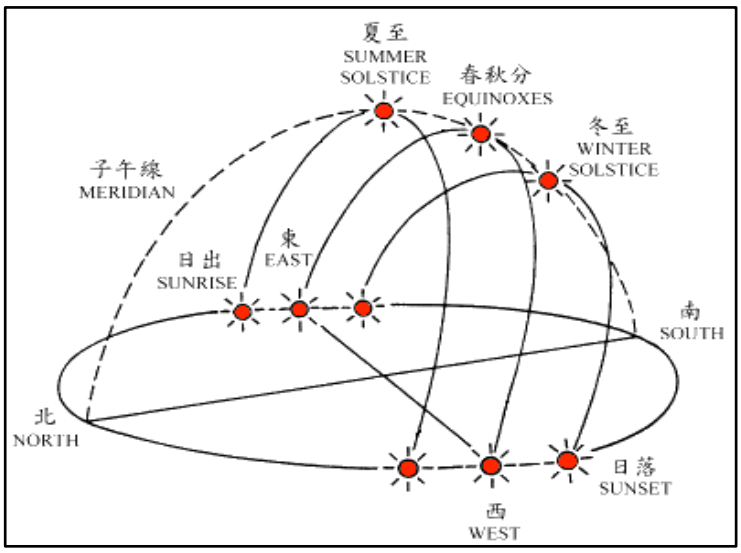


Figure 3.2: Paths of the Sun throughout the Year 2009

In Hong Kong, according to Hong Kong Observatory, the average temperature is around 28 degrees celsius in summer and around 17.6 degrees celsius in winter. Therefore, more sunlight is needed for heating in winter, and less sunlight is needed in summer.

In summer, the west is the worst orientation compared with other directions . It is because a west facing flat would face the sun for the whole of the afternoon according to the solar chart. During that period the highest air temperature in a day is recorded. In addition, the cooling time for the flat is also shorter compared with the flats facing to other directions, as the flats facing to other directions would not face to the sun directly in the afternoon, so they have more time to cool down, resulting in a lower temperature at night. Therefore, a west facing flat will be very hot in summer comparatively.

On the contrary, facing to north or south would be cooler as they receive less sunlight. However, for the typical south facing windows, as it has 180 degree view, it may receive some sunlight from the western side. Therefore, it is not as preferable as north facing. It is also desirable to face the east in the summer, although

it receives same amount of sunlight as west facing flats. It is because it receives the sunlight when the building is not yet heated and has a longer cooling period to ensure better comfort at night. Moreover, sunlight is usually welcomed in the morning. (Givoni, 1997)

In winter, according to solar chart, the sun is located on the southern side for most of the day. A south facing flat can enjoy the sunlight for the whole day, so the flat would be warmer. For the flat that is facing the north, as it cannot receive the sunlight directly in the whole day, it would be colder.

Direction	**Winter** ✔ if warmer; ✖ if otherwise	**Summer** ✔ if cooler; ✖ if otherwise
North	✖	✔
Northeast	✖	✔
East	✖	✔
Southeast	✔	✔
South	✔	✖
Southwest	✔	✖
West	✖	✖
Northwest	✖	✖

Table 2.2 : The comparison of different building orientations in Winter and Summer due to the sunlight

The above table shows the advantages of different building orientations in Winter and Summer due to the sunlight. It is shown that Southeast facing in Hong Kong can enjoy a warmer environment in winter and a cooler environment in summer.

3.3 Wind effect

Wind can cause the surface pressures to vary around the building, As natural ventilation rely on pressure differences to move air through the building, the varying pressure will affect the natural ventilation of the building Apart from the advantages of natural ventilation found by scholars, which are mentioned in chapter 2 , a good ventilation can also help to cool down a building because of cross ventilation, which relies on wind to force cool outdoor air into the building and to force warm indoor air out of the building.

The orientation of window to the direction of wind is vital to the volume of inflow air. For the sake of better cross ventilation, the wind flow direction should be in the range of + 45 to - 45 degrees to the window. (Santamouris,1998.) Therefore, If the wind is

coming from the south (180 degrees north), the window for inflowing air should be placed facing to between 135 to 225 degrees north.

In Hong Kong , the climate is dominated by the two monsoons, the warm south-easterly in summer, and the cool north-easterly in winter (Brian et. al. 1983). In summer, the climate is hot and humid, more ventilation is preferable as it is important for cooling down the building and helping to reduce the humidity level. In winter, the climate is cold and dry, more ventilation is not preferable as it reduce the heat and causes excess dryness that is uncomfortable.

(Holmes, 1994) studied the traditional buildings of the pearl river delta in the chi'ng dynasty, he found that the sitting of the buildings is always associated to the climate , the windows and doors were placed according to the cool winds which come with southeast monsoon during summer, and turn their backs to the cold winds from the northern side during winter.

Southeast facing is said to be more desirable compared to other directions because it can enjoy more wind during summer for better ventilation, and block out the cold wind during winter.

Chapter 4. Hypotheses

In this paper, there will be two hypotheses, and they will be tested by an empirical model.

The aim of this dissertation is to study the impact of the preferred building orientation on the property price and to find out whether the preferred orientation would be higher in value for whole building. In the pervious chapters, it is confirmed that the southeast facing in Hong Kong is the preferred orientation because it is able to enjoy the climatic advantages. In order to find out the impact of the southeast facing on the property price and whether southeast facing directions would be higher in value for the whole building, two hypotheses are given in the dissertation.

4.1 First hypothesis:

“The value of southeast facing properties is higher, other things being constant” i.e. if there are flats that have no difference except the orientation, the price of the flats which are southeast facing would be higher comparatively.

If the first hypothesis is not rejected in the following empirical study, the second hypothesis can be tested in order to find out whether the southeast would be higher in value in the whole building.

4.2 Second hypothesis:

“The value of southeast facing properties is higher, no matter if it is on higher or lower floor levels, other things being constant” i.e. if there are flats that have no difference except the orientation, the price of the flats that are southeast facing would be higher comparatively, no matter if it is on the higher floor level or the lower floor level.

Chapter 5. Methodology

5.1 Introduction

The objective of this study is to study the impact of the preferred building orientation on the property price and find out whether the preferred orientation would be higher in value in the whole building. In reaching the objective, a proper method is adopted. Therefore, the methodology adopted in this research would be discussed in this chapter.

5.2 Methodology

In order to test the hypotheses mentioned above, qualitative and quantitative methods could be used. For qualitative method, interviews and questionnaires can be used so as to test the hypothesis. However, it is easy to use quantitative method to show the percentage change on the property price caused by the preferred building direction. Therefore, quantitative method would be used for testing the result.

For the quantitative method, the hedonic price function will be used. the hedonic price function was developed by Rosen (1974). It is a good tool for examining the impact of different attributes to the price. Therefore, it is commonly applied to the study of the property price as property is heterogeneous in nature, which is contains a number of attributes. In the Hedonic Price Function, each attribute carries some values, which are determined by the valuation of sellers and buyers.

In order to find out whether facing southeast has a positive effect on the property price, the coefficients of the attributes in the hedonic price function will be estimated by a regression analysis. Regression analysis is a statistical method that models and studies the variables, and find out the relationship between the dependent and independent variables. By so doing, we can understand how the property price changes if the property is southeast facing, while the other independent variables are kept constant. For estimating the parameter of the regression analysis, Ordinary Least Squares (OLS) will be applied in this paper.

In this chapter, the structure of the hedonic price function in this paper will be introduced in the first place. After than the regression analysis applied will be discussed.

5.2.1 Structure of Hedonic Price Function

For the hedonic price function, in general, there are three categories of attributes that have an impact on the property price. They are structural, location and neighborhood attributes. As the objective of this study is to study the impact of nominal southeast facing on the property price, so the nominal southeast facing will be one of the attributes in the equation.

The hedonic price function applied in this paper can be expressed in the following equations:

$$P = f(S,L,N,NSE)$$

Where,

P = Property Price

S = Structural Attributes

L = Location Attributes

N = Neighborhood Attributes

NSE = Nominal Southeast Facing

5.2.2 Regression Analysis

In order to find out the relationship between different variables and the property price, multiple regression analysis is applied, as it is used for testing hypotheses about the relationship between a dependent variable and two or more independent variable (Salvatore, 2002).

In the equation, the Ordinary Least Squares (OLS) technique will be used so as to minimize the residual sum of squares. By so doing, the true but unobservable function can be estimated.

For the functional form of the model, as there is no prior knowledge about the functional form, the function is assumed to be a linear one. The property price model can therefore be represented by the following equation:

$$Y = a_0 + a_1X_1+a_2X_2+.....+a_nX_n+\varepsilon$$

Where,

Y = Dependent variable

$X_1, X_2, \ldots, X_n$ = Independent variables

$a_1, a_2, \ldots, a_n$ = The parameters that are going to be estimated

ε = The error term

5.2.3 Separate Subgroup Regressions

For testing the second hypothesis, separate subgroup regressions will be applied. By estimating separate regressions within the subgroups (e.g. one regression for lower floor level and a second regression for higher floor level), we can estimate the group-specific effect. By doing so, whether the southeast facing has a significant effect or not for lower and higher floor level can be known. (Hardy, 1993)

For finding out whether a particular independent variable has a significant effect on the dependent variable, using separate subgroup regressions is better, compared with the full-sample model with interaction terms. It is because this can obviate the need for constructing a t test for the sum of two coefficients.

5.2.4 Test Statistics

In this paper, some test statistics will be applied in the model so as to test the hypotheses. By studying those test statistics, we can know whether the empirical results are significant or not.

5.2.4.1 t-statistic

t-statistic tests the significance of the effect of an independent variable on the dependent variable, other things being constant. It is the coefficient of an independent variable divided by the standard error. A large t-statistic means that the coefficient can be estimated with accuracy.

In addition, we can look at the p-value, which is associated with the t-statistic. A smaller p-value of an independent variable means more significant of the independent variable. For example, if the p-value of a variable is 0.05, we can say that the coefficient of the variable is significant at ((1-0.05) x100%) 95% level, the probability of having the coefficient equals to zero is 5%

5.2.4.2 Coefficient of Determination (R^2)

The coefficient of determination (R^2) measures the goodness of fit of the model, indicating the proportion of variation in the dependent variable explained by the variation in the independent variables. The range of R^2 is between 0 to 1. However, the value of R^2 will increase if there are more independent variables added in the model. Therefore, adjusted $R^{2,}$ which can adjust for the increase in the independent variables will be applied instead of R^2.

5.3 Our model

5.3.1 Test 1

Testing the impact of southeast facing on the property price

In this study, the multiple regression model is using 1939 transaction records in block A , B , C , D , E , F , G , H , I , J , L , M , P and Q with the similar view of the Telford Garden from January 1991 to December 2009.the equation is shown as follows:

$$\ln P = a_0 + a_1 FLOOR + a_2 FLOOR^2 + a_3 GFA + a_4 GFA^2 + a_5 AGE + a_6 AGE^2 + a_7 SE + a_8 INDEX + \varepsilon$$

Where,

P = The transaction price of the unit

FLOOR = The floor level of the unit

GFA = The gross floor area of the unit

AGE = The age of the building

INDEX = The price index of the residential property

SE = SE equals to 1 if the property is Southeast facing;
0 if otherwise

ε = Error term

5.3.2 Test 2

Testing the impact of southeast facing on the property price (Higher floor level)

In this study, the multiple regression model is using 851 transaction records of the flats from 7/f to 12/f in the block A , B , C , D , E , F , G , H , I , J , L , M , P and Q with the similar view of the Telford Garden from January 1991 to December 2009.the equation is shown as follows:

$$\ln P = a_0 + a_1 FLOOR + a_2 FLOOR^2 + a_3 GFA + a_4 GFA^2 + a_5 AGE + a_6 AGE^2 + a_7 SE + a_8 INDEX + \varepsilon$$

Where,

Price = The transaction price of the unit

Floor = The floor level of the unit

GFA = The gross floor area of the unit

AGE = The age of the building

INDEX = The price index of the residential property

SE = SE equals to 1 if the property is southeast facing; 0 if otherwise

ε = Error term

5.3.3 Test 3

Testing the impact of southeast facing on the property price (Lower floor level)

In this study, the multiple regression model is using 1088 transaction records of the flats from 1/f to 6/f in the block A , B , C , D , E , F , G , H , I , J , L , M , P and Q with the similar view of the Telford Garden from January 1991 to December 2009.the equation is shown as follows:

$$\ln P = a_0 + a_1 FLOOR + a_2 FLOOR^2 + a_3 GFA + a_4 GFA^2 + a_5 AGE + a_6 AGE^2 + a_7 SE + a_8 INDEX + \varepsilon$$

Where,

Price = The transaction price of the unit

Floor = The floor level of the unit

GFA = The gross floor area of the unit

AGE = The age of the building

INDEX = The price index of the residential property

SE = SE equals to 1 if the property is southeast facing; 0 if otherwise

ε = Error term

5.4 Explanation of variables

5.4.1 Dependent Variable

ln(Price)

ln(Price) refers to the natural logarithm of nominal transaction price of each transaction.

5.4.2 Independent Variables

FLOOR

FLOOR refers to the floor level of the property. For a property on a higher floor level, in general, it can enjoy a better view and less polluted environment because is likely of being blocked by other buildings and being affected by the transportations and activities on the ground. On the other hand, there is also a disadvantage of a higher floor level property, which is an increase in the time for

vertical transportation. However it is believed that the advantages outweigh the disadvantage of higher floor level. Therefore, it is predicted that buyers are willing to pay a higher price and sellers are expected to ask for a higher price for the property on a higher floor level. For that reason, the coefficient of Floor is expected to be positive in the equation.

FLOOR^2

FLOOR^2 equals to the square term of FLOOR. It is added for capturing any non-linear effects that increase at an increasing or decreasing rate.

GFA

GFA refers to gross floor area in square feet (ft^2). For the size of a property, in general, a property with a larger size is preferable because of the larger space. Therefore, it is expected that buyers are willing to pay a higher price and sellers are expected to ask for a higher price for a property with larger size. For that reason, the coefficient of GFA is expected to be positive in the equation.

GFA^2

GFA^2 equals to the square term of GFA. It is added for capturing any non-linear effects that increase at an increasing or decreasing rate.

AGE

AGE refers to how old the property is at the time of transaction. It is the difference between the issue date of the occupation permit of the building and the transaction date. The age of the property is measured in years for the sake of easier calculation, if the age of a property is 15 months, it will be rounded to 1 year. As the function and appearance of the building deteriorate with time, the maintenance cost will increase if the building is getting older and older. Therefore, it is expected that buyers are only willing to pay a lower price and sellers are willing to ask for a lower price for the older property. For that reason, the coefficient of AGE is expected to be negative in the equation.

Age^2

AGE^2 equals to the square term of AGE. It is added for capturing any non-linear effects that increase at an increasing or decreasing rate.

INDEX

INDEX equals to the index for residential price index. It is used because the transaction records are across a number of years, the time effect may be very significant due to the different economical situation in different years. In order to reduce the time effect, the corresponding price index for private domestic obtained by Rating and Valuation Department will be used. As the price index reflects the economical situation, a higher price index implies higher demand for housing. Therefore, the coefficient of INDEX is expected to be negative in the equation.

SE

SE refers to southeast facing. In the regression model, SE is one of the dummy variables. SE is equal to one if the property is southeast facing; otherwise it is equal to zero. In this study, a property is defined as southeast facing if it has at least one window that is facing to south and at least one window that is facing to east. For example, Flat 5 and Flat 6 in the Block A in Telford Garden are defined as southeast facing. If the first hypothesis and the second are accepted, the coefficient of SE is expected to be positive in the three tests.

Variable	Expected sign
Floor	+
$Floor^2$	?
GFA	+
GFA^2	?
AGE	-
AGE^2	?
INDEX	+
SE	+

Table 5.1 : Expected sign for independent variables – Test 1

Variable	Expected sign
Floor	+
$Floor^2$	?
GFA	+
GFA^2	?
AGE	-
AGE^2	?
INDEX	+
SE	+

Table 5.2 : Expected sign for independent variables – Test 2

Variable	Expected sign
Floor	+
$Floor^2$	?
GFA	+
GFA^2	?
AGE	-
AGE^2	?
INDEX	+
SE	+

Table 5.3 : Expected sign for independent variables – Test 3

Chapter 6. Selection and Source of data

6.1 Introduction

The transaction data of the units with a similar view in fourteen blocks of Telford garden from year 1993 to 2009 will be used for the three tests.

Telford garden is selected because Telford garden has 4991 units, the transaction volume is one of the largest properties in Hong Kong. Moreover, the design of all the units in Telford garden are almost identical. Also, they are constructed on the same podium and the building ages are quite similar (28-30 years). It is good for controlling the design feature of the flats.

In addition, Block A, B, C, D, E, F, G, H, I, J ,L , M , P and Q are not tall compared to the surrounding buildings, they are only eleven or twelve stories, and their views are usually blocked by other buildings. Therefore, the view of each unit can be controlled more easily. In addition, the direction of the prevailing wind in Telford Garden is southeast.

6.2 Views of Telford Garden

The view is closely related to the orientation of the windows, so only the flats with the same view will be used in the model so as to minimize the bias. The views of different directions in Telford are as the following.

For the southern views, the views are mainly blocked by the buildings such as the Kowloon East Police Operational Base, Hang Seng Tower , MTR Tower and etc. However, there are some units can enjoy an obstructed scenery.

For the western views, the views are blocked by the industrial and commercial buildings such as Metro Centre II, HKU SAPCE, Yeung Yiu Chung (No.8) Industrial Building, Chevalier Engineering Service Centre and etc.

For the northern views, the field of view enjoyed from the flats are quite wide. However Block N , K , U are not included in the study. Therefore, most of the units in the other blocks, which are facing to north, are facing to the Block N, K and U. In addition, there are

only some units that can enjoy an obstructed wide view.

For the eastern view, the residential buildings nearby such as Amoy Gardens and Lower Ngau tau Kok Estate block the views.

For the units that are facing the internal side of Telford Gardens, there are two views, which are facing to other flats within Telford Gardens and the garden on the podium of Telford Gardens

According to the sceneries mentioned above, there are five categories of views possible for Telford Garden. The most common view, which is facing to other flats within the Telford Garden, will be used in the model. As a result, all of the data collected are the flats that facing to other flats within the Telford Garden.

6.3 The prevailing wind in Telford Garden

More importantly, according to the Summary of Meteorological Observations in Hong Kong produced by the Hong Kong Observatory from 1999 to 2008, the annual prevailing wind, as measured at the nearest weather station (Kai Tak), was from the southeast (around 110^{o} and 120^{o}). In summer, the wind was also from southeast (around 120^{o} to 140^{o}). As our study is focusing on the impact of price for flats facing southeast, Telford Garden is a suitable place for the study because southeast facing units can enjoy the southeast wind in the summer.

6.4 First Test

For the first test, There are 1939 transaction records of the units which are facing other flats within Telford Garden, in block A, B, C, D, E, F, G, H, I, J, L, M, P and Q of Telford garden from January 1993 to December 2009 will be used. The following Table shows the summary statistics of the data.

	Mean	Maximum	Minimum	Standard Deviation
ln(Price)	14.57	15.24	13.50	0.28
AGE	19.51	29.00	11.00	5.16
FLOOR	5.94	12.00	1.00	3.42
GFA	598.46	661.00	418.00	24.95
INDEX	109.59	182.10	57.60	26.11
SE	0.23	1.00	0.00	0.42
Note: The square terms of AGE, FLOOR and GFA are not included				

Table 6.1 : Summary Statistics of the data used in Test 1

6.5 Second Test

For the second test, There are 851 transaction records of the units on 7/f to 12/f which are facing other flats within Telford Garden, in block A, B, C, D, E, F, G, H, I, J, L, M, P and Q of Telford garden from January 1993 to December 2009 will be used. Table shows the summary statistics of the data.

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	Mean	Maximum	Minimum	Standard Deviation
ln(Price)	14.59	15.23	13.60	0.28
AGE	19.25	29.00	11.00	5.08
FLOOR	9.30	12.00	7.00	1.56
GFA	597.96	630.00	418.00	20.51
INDEX	108.55	182.10	57.60	25.87
SE	0.23	1.00	0.00	0.42
Note: The square terms of AGE, FLOOR and GFA are not included				

Table 6.2 : Summary Statistics of the data used in Test 2

6.6 Third Test

For the third test, There are 1087 transaction records of the units on 1/f to 6/f which are facing other flats within Telford Garden, in block A, B, C, D, E, F, G, H, I, J, L, M, P and Q of Telford garden from January 1993 to December 2009 will be used. Table shows the summary statistics of the data.

	Mean	Maximum	Minimum	Standard Deviation
ln(Price)	14.55	15.24	13.50	0.28
AGE	19.72	29.00	11.00	5.22
FLOOR	3.31	6.00	1.00	1.76
GFA	598.88	661.00	515.00	27.95
INDEX	110.37	182.10	57.60	26.30
SE	0.23	1.00	0.00	0.42

Note: The square terms of AGE, FLOOR and GFA are not included

Table 6.3 : Summary Statistics of the data used in Test 3

6.7 Source of the data

All of the transaction records in this research are extracted from the database system Economic Property Research Center (EPRC) on the Internet. The EPRC, provides all the sales and purchases records of all individual property since 1991. Important data for the empirical model such as transaction date, gross floor area, floor level, age, transaction price and etc. can be extracted from the transaction record.

In addition, for the view and the orientation of properties, they are achieved from the www.centamap.com and site visits. Because of the security issue, the buildings cannot be accessed by non-resident, therefore the view of each unit could only be estimated from the Telford podium, so there is a chance that the views are not absolutely accurate, but every effort is made to ensure the data does not deviate too far from the fact.

Chapter 7. Empirical Results and Interpretation

7.1 Introduction

In this chapter, the empirical results for the three tests will be presented one by one. For generating the regression results, EViews, which is computer software for econometric analysis, is adopted.

7.2 First test

Dependent Variable: ln (Price)
Method: Least Squares
Included observations: 1939

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant*	8.638648	0.733064	11.78431	0.0000
AGE*	-0.071231	0.004964	-14.34973	0.0000
AGE^2*	0.001692	0.000122	13.90479	0.0000
FLOOR*	0.065599	0.003490	18.79567	0.0000
$FLOOR^2$*	-0.004608	0.000273	-16.87319	0.0000
GFA*	0.016924	0.002484	6.814716	0.0000
GFA^2*	-1.30E-05	2.10E-06	-6.198988	0.0000
INDEX*	0.009032	0.000103	87.72708	0.0000
SE*	0.020487	0.006136	3.338501	0.0009

R-squared	0.836463
Adjusted R-squared	0.835785
F-statistic	1233.949

* Significant at the 1%level
** Significant at the 5%level
*** Significant at the 10%level

Table 7.1 : Results of regression model for the first test

The table above shows the results of regression model for the first test. All of the coefficients are complied with the expected signs. The coefficient of SE is positive and significant at 1% level. It shows that people are willing to pay a premium for southeast

facing units. On average, people are willing to pay 2% more for the southeast facing properties. For the square terms of Floor ad GFA, the coefficient signs are negative and significant at 1% level, which are opposite to the corresponding un-squared terms (Floor and GFA). It implies that there is a non-linearity effect, suggesting the effects of the floor level and the size increase at a decreasing rate. For the square term of AGE the coefficient sign is positive and significant at 1% level, which is opposite to the corresponding un-squared term (AGE). It implies that there is a non-linearity effect, suggesting the effects of the age of the building decrease at a decreasing rate. For the model, the coefficient of determination (Adjusted R-squared) is 83.6%, which is quite satisfactory.

7.3 Second test

Dependent Variable: ln(Price)

Method: Least Squares

Included observations: 851

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant*	10.93161	0.913797	11.96284	0.0000
AGE*	-0.070618	0.007333	-9.629790	0.0000
AGE^2*	0.001674	0.000182	9.224556	0.0000
FLOOR*	0.179134	0.032092	5.581870	0.0000
$FLOOR^2$*	-0.010505	0.001713	-6.132964	0.0000
GFA**	0.006977	0.003064	2.276832	0.0230
GFA^2***	-4.36E-06	2.62E-06	-1.659768	0.0973
INDEX*	0.009175	0.000153	59.93253	0.0000
SE*	0.038187	0.009197	4.151994	0.0000

R-squared	0.839309
Adjusted R-squared	0.837782
F-statistic	549.7342

* Significant at the 1%level
** Significant at the 5%level
*** Significant at the 10%level

Table 7.2 : Results of regression model for the second test

The table above shows the results of regression model for the second test. As in the first test, all of the coefficients are complied

with the expected signs. The coefficient of SE is positive and significant at 1% level. It shows that people are still willing to pay a premium for southeast facing on the higher floor level. For the signs of the square terms of FLOOR, AGE and GFA, they are the same as the first test. For the model, the coefficient of determination (Adjusted R-squared) is 83.7%, which is quite satisfactory.

7.4 Third test

Dependent Variable: ln(Price)

Method: Least Squares

Included observations: 1088

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant*	5.771577	1.426955	4.044680	0.0001
AGE*	-0.072171	0.006566	-10.99165	0.0000
AGE^2*	0.001722	0.000160	10.77198	0.0000
FLOOR*	0.108235	0.011882	9.108890	0.0000
$FLOOR^2$*	-0.011506	0.001582	-7.272601	0.0000
GFA*	0.026613	0.004842	5.495842	0.0000
GFA^2*	-2.13E-05	4.07E-06	-5.225840	0.0000
INDEX*	0.008988	0.000135	66.41578	0.0000
SE	0.005822	0.008044	0.723762	0.4694

R-squared	0.845095
Adjusted R-squared	0.843946
F-statistic	735.1394

* Significant at the 1%level
** Significant at the 5%level
*** Significant at the 10%level

Table 7.3 : Results of regression model for the third test

The table above shows the results of regression model for the third test. Unlike the pervious tests, most of the coefficients are

complied with the expected signs, except the SE. The coefficient of SE is not significant. It implies that people are not willing to pay a premium for southeast facing flats on lower floor level levels. As mentioned in Chapter one, the positive effect of the preferred orientation on the property price may be due to two reasons, which are the climatic advantages and the psychological effect.

The impact of climatic advantages of facing southeast on the property price, for the lower floor level, is expected to be smaller because less sunlight can be received due to the surrounding buildings. According to the solar chart discussed in Chapter 3, the solar altitude angle is less than 50 degrees in the winter. In the selected data, some of the flats on the lower floor level may not be able to enjoy it because other blocks are in front of them.

For the brand name southeast effect or the existence of the psychological effect of southeast facing can be as to have been rejected on the lower floor level. As there is no evidence to prove that the facing southeast on lower floors is superior to other directions.

Compared to the test two, the only difference for data selection is the floor level. It is expected that the difference in floor level will be captured by the constant term in the equation.

For the model, the coefficient of determination (Adjusted R-squared) is 84.4%, which is quite satisfactory.

Chapter 8. Conclusion

It is common notion that a flat facing southeast is more preferred than the other directions. People commonly believe a southeast facing flat to be superior and has a so called brand name effect.

There are scientific reasons behind this preference for southeast facing flats. A southeast facing flat is able to benefit from climatic advantages such as natural ventilation and sunlight. Natural ventilation has the advantage of reduced electricity cost and healthier residents. To attain an optimum amount of sunlight has the benefits of receiving more heat from the sunlight in winter and bring greater indoor comfort.

There is however currently no research on the whether a southeast facing flat would be able to charge for more on the market. Throughout this dissertation, I have shown through data compiled from actual transaction of Telford Garden that the orientation of a flat does affect its value.

From the regression model, it can be concluded that flats facing southeast on higher floors are able to be sold at a higher price compared to similar flats with a different orientation. However there is no statistical evidence to show that southeast facing flats on lower floors are of higher value.

This dissertation has the effect of filling the current research gap in showing that the orientation of a flat does indeed affect its value. This would aid surveyors in valuation, reduce information cost of transaction between buyers and sellers and work towards to improve building design.

There are still further areas of possible research. Much more research could still be done in regards to determining the extent of the benefits of south facing flats. There is a lack of precise data on the actual increase in ventilation of flats facing southeast. More data could also be computed to determine how much sunlight can heat up flats in the winter. From these sets of data, more ecological friendly buildings can be designed as to maximize the positive effects of a south facing flat that many prefer.

Appendix

Appendix 1 The layout of Telford Garden

(From http://www.centamap.com)

Appendix 2 The layout of Telford Garden (Aerial View)

(From http://www.centamap.com)

Appendix 3 Some examples of views in Telford Garden

(From the Podium)

Residential Buildings

Industrial and Commercial Buildings

Buildings of Telford Garden

Block U and K in the northern side

Garden of Telford Garden

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