Does the analytical hierarchy process help appraisers make better decisions?: A quasi-experimental approach for property investment comparables

Abstract

Purpose: Income from investment properties can fluctuate depending on the state of the economy. The idea that there is always a potential exit (sale) value whenever the property stops performing at its optimum or deflation in the economy will always appeal to investors. To determine housing prices, investors would rely on a direct comparison approach of recent substitute sales in the open market. Appraisers use this approach to develop an opinion of value when there is a plethora of recent sales to analyze.

Design/Methodology/Approach: The study was designed to establish the use of the Analytic Hierarchy Process (AHP) approach as a support tool for deciding property appraisals. A case study of an industrial single-storey stand-alone building with grade-level parking in the South-East of Calgary, Canada, was investigated with the AHP approach. The result was cross-referenced with the direct comparison approach.

Findings: Using a consistency index of 0.077321 and a consistency ratio of 0.085912, the Matrix Multiplication (MMULT) was determined to be 0.456706. The average valuations derived from the adjusted price per square foot using the Direct Comparison Method and the unadjusted price per square foot using the AHP were deemed the best value estimate in the light of available comparables. The implications of the findings suggest that AHP, as a quantitative technique, can support and validate the use of similar non-recent sale comparables when appraising investment properties with the DCA.

Originality/Value: AHP is an alternative aid in quantitatively deciding the most significant value attribute for comparison before subjective adjustments. When intuitively applied in the direct comparison approach, these subjective adjustments almost always lead to an overvaluation of properties.

Keywords: *AHP, appraisal, comparables, decisions, direct comparison, valuation*

1. Introduction

The direct comparison approach can be applied to all property interests if sufficient sale data support current market trends. Although there are five methods of valuation techniques generally used in practice, Anuar (2002) and Fischer (2002) reckon that the direct comparison approach is the most popular because the courts tend to make their decisions based on the outcome of the approach as a last resort in valuation dispute cases especially those involving land valuation. This is not far-fetched as the approach considers the effect of the individual features (value considerations) that a property has on the overall valuation of that property (Anuar et al., 2012). The approach also seems more logical as it is believed no informed investor would pay more for a property than other investors have recently paid for comparable properties with similar characteristics, given that the general market conditions are the same (principle of substitution) (Schulz, 2003). Its application and accuracy largely depend on local circumstances and the real estate market's development level, with the appraisers' role being interpretation and application by making adjustments directly on sale prices (Munshifwa, 2021).

The appraiser would need to adjust the prices of several comparables similar in characteristics to that of the subject property based on the value indicators which convey the most weight. The adjustment of these comparables would more often than not depend on their recent sales transactions before the weight of other value indicators is compared and adjusted. Then what happens when sales of comparables are not so recent? The appraiser's experience has to be tested in making an educated guess about how the attributes in the comparable properties could be adjusted to mimic those of the subject property. Typically, the pairwise comparison method is used by appraisers to make these adjustments; a relationship is established, but an educated guess is made of the impact of the attributes and how they stack up against those of the subject property.

Rahim & Razali (2018) propose that a more objective valuation using statistical elements can be achieved since the decisions are based on quantifiable measures. To solve this problem, the Analytical Hierarchy Process (AHP) method, a hierarchical multi-criteria decision technique, is considered to ascertain if it could be an alternative solution to the direct comparison of the valuation methodology. Therefore, this investigation delved into the literature on the sales

comparison approach to appraising real estate and the AHP as a support tool in solving decision problems. To test the validity of the AHP as a support tool, a case study of tenanted industrial property would be appraised using the sales comparison and the AHP method. Then an informed choice will be made on the values obtained. Finally, the study would determine if the sales comparison approach should solely be used in investment appraisal compared to the AHP.

2. Literature review

2.1 Direct comparison approach

In the Direct Comparison Approach (DCA), an opinion of value is arrived at by analysing and comparing valid sales similar to the subject property. This approach is premised on the fact that the value of a property can be supported by studying the market's reaction to evidence from comparable and competitive properties (The Appraisal Institute of Canada, 2010). This comparable evidence could be location, physical characteristics, amenities, price per square foot, etc. Properties that can be appraised using this approach fall into the category of those transacted regularly in the open market. Some of these include residential (Rodgers, 2001; Dennis & Pinkowish, 2007), investment (Wincott, 2002), industrial (Ellsworth, 2001; 2002), vacant land (Guidry, 2003), and properties not primarily purchased for their income-producing characteristics.

According to Pagourtzi et al. (2003), the DCA should involve four main processes:

1. Identifying the most comparable sales similar to the subject property.
2. Adjusting the sales price of the comparables to complement the attributes of the subject property.
3. Using several value estimates to arrive at a market value.
4. Presenting the analysis and final value in a report format.

From the processes outlined, determining the adjustments to the comparables to bring them to par with the subject property remains the most significant step in the valuation process when applying the direct comparison approach. The adjustments are done through the "elements of comparison", which are the characteristics of properties and transactions that cause the prices paid for real estate to vary (Addae-Dapaah, 1996). These comparison units should encompass the physical, legal, and economic characteristics when defining sale transactions comparable to the subject property. The

units of comparison selected depend on the appraisal problem and the nature of the property. They include price per square foot, per acre, price per room, per bed, etc. Common attributes employed in sales comparison methods vary depending on the property market situation, location, and data availability. The type of house, size, location characteristics, and other physical characteristics are commonly used by researchers to perform sales comparison methods. Todora and Whiterall (2001) used land value/sq.ft, built-up area, quality grade of construction, and age of the property as their basis of comparison. While Krause and Kummerow (2011) adopt a different approach adopting bathrooms and accessibility as attributes for comparison, Rohana and Taher (2012) posited that the cost of a building and its locational characteristics are better attributed for comparison.

The Appraisal Institute of Canada (2010) suggested that the prices of comparable properties should be adjusted based on the differences between these units and not on Net Operating Income (NOI) as rents and sale prices tend to move in tandem. You and Chang (2009) and Brunauer et al. (2017) advanced the knowledge of hedonic models bothering on automating the sales comparison method to adjust the prices of comparables using an inverse distance-weighted mean to estimate the value of a property. To adjust for these differences, Lusht (2012), Shapiro et al. (2013), and Whipple (2013) summarize some of the techniques used by appraisers to include summative percentage, dollar percentage, add/subtract percentage, proper base adjustment, review and intuition, and paired sales regression analysis. While dollar adjustments sum up the dissimilarities of each element independently, percentage adjustments are conducted based on adjusting elements to bring them at par with dollar adjustments. (Williams, 2004). The dollar or percentage adjustment should yield the same adjusted sale price if analysed properly. The price difference between two recent transactions using ‘paired data’ is identical except for the element under consideration (Rodgers, 2001; Williams, 2004).

This paired method of weighting is based on the ‘everything is equal’ principle and enlists a database of information on similar real estate transactions for pairs of objects differing only in terms of one market feature (Dmytrów & Gnat, 2019). In a situation where there is less sales evidence, Bogin and Shui (2020) argue that heterogeneity of comparables tends for appraisals to be biased upwards, thus making accurate adjustments key in assessing the difference in properties. When adjusting for differences, it has been argued that the paired weighting method can be quite

subjective and appropriate adjustments depend greatly on the valuer's experience. Barańska (2018), Foryś-Gaca (2016) and Sawiłow (2014) suggest the use of statistical methods and regression analysis as alternative methods for adjusting comparables when using the direct comparison approach. Some of these statistical methods include *DEcision MAking Trial and Evaluation Laboratory* (DEMATEL), *ELimination Et Choix Traduisant la REalité*) (ELECTRE) and *Preference Ranking Organization METHod for Enrichment of Evaluations* (PROMETHEE) (Nermend, 2017).

Although these multiple-criteria decision-making techniques can be used to measure the weights of market characteristics, they have drawbacks in weak measurement scales and inability to determine the impact of attributes on property prices (Doszyń 2017, Foryś-Gaca, 2016). The AHP, on the other hand, has been proffered to solve the above problems by evaluating alternatives in terms of their weights to set up some decision criteria. Although studies by Kryvobokov (2005), Kozioł-Kaczorek (2012, 2014) and Karakayaci (2015) have been limited to determining weights using the AHP method and comparing them with other competitive methods, this research paper goes a step further in using the weights (from recent sales comparable) in conjunction with the direct comparison method to estimate the value of an investment property.

2.2 The analytical hierarchy process

The AHP method is a multi-criteria technique created by Thomas Saaty in the 70s to combat the issue of choice and prioritization in decision-making. (Dyer and Forman, 1992) Using a pairwise comparison that assumes that attributes are independent (Brunelli 2015), the AHP has been employed to solve complex decision-making problems. Some of these complex problems with respect to real estate include evaluating real estate for purchase purposes (Ball & Srnivasan, 1994), housing and construction (Chan et al., 2009), forecasting the value of the real estate (Yalpir, 2014), and more recently tackling sustainability issues in the area of green housing (Darko et al., 2019).

Kauko (2006) presents cross-country evidence on housing consumer preferences based on expert-elicited residential location quality profiles using the analytic hierarchy process on semi-structured interviews of real estate and planning professionals from two European housing market contexts.

The findings indicate fundamental differences between the two housing market contexts. The paper focused more on residential properties and not commercial property investment, which is the central point of this paper. Safian and Nawawi (2011) examined the evolution of the Analytical Hierarchy Process (AHP) as a decision-making tool in property sectors. It was observed that the application of AHP in the property market has taken place in the assessment of building quality and performance, tenants' perception and expectation, identification of the tenants' or occupiers' needs, investment portfolio, and grading and classification. The study, however, failed to provide a methodology for determining property values using the AHP approach. It also did not consider whether the AHP method is ideal for determining the values attributable to property investment. Balta and Ozturk (2021) identify the critical factors of residential location choice using the analytic hierarchy process as a multicriteria decision-making method. In the study, environmental quality, safety, and accessibility were determined as major factors in residential decisions. The study's results contribute to developing a model for determining residential location choices and not determining property worth which this study aims to investigate.

The pairwise comparison is the foundation on which decisions are made. To quantify them correctly, the AHP uses scales to determine the relative importance of the alternatives to each criterion. According to this scale, the available values for the pairwise comparisons are members of the set: {9, 8, 7, 6, 5, 4, 3, 2, 1} with 1 as the lower limit and a unit difference between successive scale values. (Satty, 1980). The estimation of the aij. (each entry) and Wj. (weight of criterion) values when scaling in terms of relative importance is highlighted by Saaty (1980) in Table 1.

>>>Insert Table 1<<<

This use of scales to measure the intensity of importance allows the AHP to track inconsistencies because in making judgments, people are more likely to be cardinally inconsistent than cardinally consistent as they cannot precisely estimate measurement values when dealing with tangibles or even known scales (Satty, 1980; Triantaphyllou & Mann, 1995).

3. Research methods

3.1 The working principle of AHP

The analytic hierarchy process (AHP) method is a structured technique for organizing and analyzing complex decisions based on psychology and mathematics. AHP allows researchers to determine the weights (significances) of hierarchically non-structured or hierarchical criteria. There are seven steps involved in the determination of AHP.

i. Problem identification: The scope of the research problem should be expanded as much as possible. The key factors that may affect it should be included, and the problem should be clearly defined in light of these factors.

ii. Listing the factors related to the problem using the Delphi Method (a forecasting pro- cess framework based on the results of questionnaires sent out to a panel of experts in multiple rounds, the responses to which should be kept anonymous, aggregated, and shared with the group following each round), brainstorming, literature review, etc.

iii. Establish the hierarchy: The levels of the hierarchy can be set according to the needs of the problem. The relationships between the levels should be plausible.

iv. Design the questionnaire survey: The factors at each level are compared with the factors at a higher level as a yardstick for evaluation.

v. Setting up a paired comparison matrix: The paired comparison matrix can be established by geometrically averaging the judgment values. This step enables the relative importance of the various options that need to be weighed up.

$$A = \begin{pmatrix} 1 & a_{12} & L & a_{1n} \\ a_{21} & 1 & L & a_{2n} \\ L & L & L & L \\ a_{n1} & a_{n2} & L & 1 \end{pmatrix} = \begin{pmatrix} 1 & a_{12} & L & a_{1n} \\ 1/a_{21} & 1 & L & a_{2n} \\ 1 & L & L & L \\ 1/a_{n1} & 1/a_{n2} & L & 1 \end{pmatrix}, \quad (1)$$

$$= \begin{pmatrix} W^1/W^1 & W^1/W^2 & L & W^1/W^n \\ W^2/W^1 & W^2/W^2 & L & W^2/W^n \\ L & L & L & W^3/W^n \\ W^n/W^1 & W^n/W^2 & L & W^n/W^n \end{pmatrix}. \quad (2)$$

vi. Calculating the priority vector and the maximum eigenvalue: After the paired comparison matrix is compiled, the eigenvalue solution method of numerical analysis is used to obtain the eigenvector or priority vector, and then the maximum eigenvalue is calculated based on this priority vector. Although four approximations could be used to find the dominant directions if higher accuracy was not required, Saaty (1980, 1982) believed that the standardized geometric mean of the gradient is the best method for estimating the dominant directions. This is shown in equation (3)

$$w^i = \frac{\sqrt[n]{\left(\Pi_{j=1}^{n} a_{ij}\right)}}{\sum_{i=1}^{n}\left(\Pi_{j=1}^{n} a_{ij}\right)}. \quad (3)$$

To calculate the maximum eigenvalue:

First, A × w = w' (A new vector is obtained by pairwise comparison of matrix A and product dominant vector W).

$$\begin{pmatrix} 1 & a_{12} & L & a_{1n} \\ a_{21} & 1 & L & a_{2n} \\ L & L & L & L \\ a_{n1} & a_{n2} & L & 1 \end{pmatrix} \begin{pmatrix} w_1 \\ w_2 \\ L \\ w_4 \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ L \\ w_4 \end{pmatrix}. \quad (4)$$

The maximum eigenvalue is calculated using equation (5)

$$\lambda^{max} = \frac{1}{n}\left(\frac{w_1}{w_1} + \frac{w_2}{w_2} + (\lambda^{max})\frac{w_n}{w_n}\right). \quad (5)$$

vii. Finally, the consistency index of each level is calculated. To determine the suitability of the questionnaire content, a consistency test with respect to its characteristics must be carried out to calculate the consistency ratio (CR). In determining this, equations 6 & 7 are used.

$$\text{consistency index (C.I)} = \frac{\lambda^{max} - n}{n-1}, \quad (6)$$

$$\text{consistency ratio (C.R)} = \frac{C.I}{R.I}, \quad (7)$$

According to Saaty's theory, the consistency ratio must be less than 0.1 before it can be accepted; otherwise, the consistency index is irrelevant and analysis of all factors and links must be re-conducted.

3.2 Steps involved in the direct comparison approach

The steps involved in the direct comparison approach include:

a. Research transactional data
b. Verify that the data is accurate and represents arms-length transactions
c. Select relevant units of comparison
d. Determine how the comparables selected differ from the subject and apply adjustments to reflect the differences in various elements of comparison.

3.3 Case study

Industrial real estate is the largest asset class, with some 1.5 billion square feet across the major markets. The Greater Toronto market is the third largest market in North America (behind only Chicago and Los Angeles) and holds approximately half of Canada's industrial space (Botting, 2009). Calgary, on the other hand, has the 4th largest inventory of industrial space in Canada, just behind Vancouver and is a major western administrative and corporate head office centre for the Canadian oil and gas industry. This case study has focused on one of the industrial provinces in Canada because of its mature and diverse nature. This can be attributed to the low vacancy rate, positive long-term leasing and relatively low cost of retrofitting space.

The subject property to be appraised is an industrial single-storey stand-alone concrete block building on a concrete slab with grade-level parking in the South-East of Calgary. The accommodation consists of a warehouse and an ancillary office building. The improvements are above average and fit the surrounding construction quality. The subject property was sold on 7th June 2017 for $6,200,000. After the purchase, significant renovations and lease-up of vacant space occurred. The effective date of this appraisal is 1st September 2019. The Direct Comparison method and the AHP technique would be used to appraise the subject property separately, considering selected comparables.

3.4 Steps to the valuation appraisal

The DCA can be applied to all types of properties. Still, its major drawbacks are a need for sales data and its limited application to special purpose properties, which rarely trade in the open market and whose value is mostly derived using cost to create a substitute. Where adequate sales data are available, a value indication for the subject property can be determined by identifying appropriate, relevant market-derived comparison units. The AHP technique, on the other hand, would be used to determine the relative weights of the selected units of comparison using pairwise comparison. Similar comparables in its vicinity were carefully selected and analyzed to facilitate the appraisal of the subject property. Adjustments were made for the sale dates and price per square meter of the comparables to reflect the differences in various elements of comparison. Finally, the

adjustments are reconciled, and the comparable, which provides the best indication of market value for the subject property, is selected for the appraisal process.

4. Results and discussion

4.1 Application of the sales comparison method

For this appraisal, four comparable warehouse properties were analysed. The comparable sales were obtained from RealNet (http://www.realnet.ca/), a Canadian-incorporated company that provides real estate information services. This company provides information services to Canada's commercial real estate investment and residential development sectors. They also offer a unique support platform with a comprehensive set of services, including independent online property market research and real-time interactive analytic tools designed to the specific needs of each industry professional. The initial search criteria were for buildings located in Southeast Calgary industrial areas between 50,000 sq. ft. and 100,000 sq.ft., with land size between 3-6 acres. They had sold in the last three years before the effective date. This produced several sales. Although the comparables were not replicas of the subject property, they shared some similarities regarding the date of sale, age, condition, size and location. The best four comparables were selected based on the date of sale, size, location and land use. The sales considered applicable to the valuation of the subject site are presented and analyzed in Table 2, with an adjustment chart based on comparables in Table 3.

>>>Insert Table 2<<<

>>>Insert Table 3<<<

4.2 Adjustments

4.2.1 Real property rights conveyed

All comparable sales were sold as ‘leased fee’, and no adjustment for property rights was necessary. In each case, a review of lease summaries indicated that the contract rent was similar to the current market rent. The comparable sales were specifically selected because contract rents were equivalent to current market rents. Given the state of the Calgary economy since the oil price decline in late 2014, there has been little upward or downward pressure on market rent in warehouse buildings in the subjects or comparable sales age range. The relatively active industrial

market in 2012 and late 2014 resulted in rent increases that supported new construction. Still, the market rents for older buildings have been stable for at least one full five-year renewal cycle. The comparable sales selected represent sales of leased properties at market rent.

4.2.2 Financing, conditions of sale, and expenditures made immediately after purchase

No adjustments were necessary for financing as all comparables were sold under the same market condition without financial incentives. No mortgages were assumed, and there were no vendor take-back mortgages. No expenditures were made after purchasing any comparable sales, and hence no adjustments were deemed necessary. Corporate registry information was reviewed to ensure no overlapping company directors and shareholders related to the vendors and purchasers.

4.2.3 Date of sale adjustment

The effective date of this appraisal was September 1, 2019. The comparable sales gathered provide sale dates ranging from 16 to 20 months before the effective date. Comparable 1, 2 and 3 in that order are the most recent sales, having sold within 16, 16 and 17 months of the effective date of the subject property's appraisal. Comparable 4 is the most dated sale, having occurred 20 months before the effective date of the analysis. Rahim & Razali (2018) suggest that for the best result using the sales comparison method, the transaction dates of the comparables must be as close as possible to the valuation date, preferably up to at most the past six months, depending on the number of available transactions. To estimate an appropriate time adjustment for each comparable, the following paired sales analysis has been completed using sales of comparable Industrial-General District (I-G) zoned properties located in similar light industrial areas within Calgary. There was no strong data available to complete a resale analysis. The subject property would have made for a good resale analysis as it sold sometime in 2017 (as the resale fell within the months before the effective date of its appraisal in 2019). Still, the fact that when it first sold in 2017, at least $ 1 million was used to upgrade the building and improve its 50% vacancy makes the case for a time adjustment very weak. A summary of paired sales analysis based on the sales presented in the report is provided in the appendix. Due to limitations in data availability, it was impossible to find perfectly matched pairs. In each case, one of the sales required adjustment for another factor to make the comparison valid. The subject property was selected as part of the paired sale analysis.

The examples used for the analysis represent paired sales of improved industrial properties, which are similar in most respects except the date of sale. Based on the analysis, a rate of 0.4% per month for time adjustments is deemed appropriate for this analysis.

4.4 Decisions on other forms of adjustments

No adjustments were made to the location, zoning, land size, building size, age, and site coverage, as the comparables were similar to the subject property. No Adjustment was made to any of the comparables as they all enjoyed similar exposure and building size to the subject property with respect to present use. Analysis of additional sales indicated that size adjustments would be required for very small sites or sites much larger than the subject site of 4.55 acres. Although the comparables differed in size, it would appear that they would appeal to the same market and for the same purpose hence a size adjustment was not deemed necessary. Discussion with buyers and sellers involved in sales transactions lent credence to the fact that the difference in the years between the construction of the subject property and the comparables is not enough to warrant any age adjustment as they all showed similar conditions and state of maintenance. Given the size of the subject site and adjacent developed lands, it would not likely benefit from the combination of any adjacent sites. Also, no excess land is based on typical development and site coverage ratios. Hence no adjustment was made for the site coverage ratio on the 4 comparables. The unit of comparison when analysing the market value of industrial office/warehouse properties is the price per sqft of the total building area. The comparables were analysed to provide an overall adjusted sale price range of $105 to $135 per sqft of total building area. The price per sqft has been used to estimate the subject property's market value using the direct comparison method.

4.5 Application of the AHP Method

The four selected alternative comparables were evaluated based on four decision criteria: date of sale, land size, building side, and sale price per square foot. These criteria were chosen as they showed a sufficient need for adjustments when considering the differences in the price of each comparable property. As discussed earlier, the pairwise comparisons for each comparison were determined using the Saaty Scale, which establishes 9 as the upper limit of the scale, 1 as the lower limit and a unit difference between successive scale values. Using the formula:

CI = (λ_{max} - n)/(n - 1), with λ_{max} as 4.232, the Consistency Index was calculated to be 0.0773. Using the RCI value of 0.90, which corresponds with the n number of terms 4, the Consistency ratio was determined to be 0.09. The CR value is lower than 0.10, indicating that the pairwise comparisons are relatively consistent. Table 4 shows the Lambda calculation with Lambda Max = 4.232.

>>>Insert Table 4<<<

4.6 Reconciliation into an estimate of value for the subject property

The comparables provide a narrow-adjusted sale price range. Adjustments were made mainly for the date of sale. Comparable 4 had the highest overall adjustment of 8%, which accounted for the 20-month date of sale difference between when the property was sold and the effective date of the subject property.

Comparable 1, 2, and 3 required lower adjustments of 6.4%, 6.4%, and 6.8%, respectively. These adjustments were all due to the differences in the sale dates in comparison to the effective date of the subject property.

Comparable 2 was smaller in size compared to the subject property and had a sale date 16 months before the effective date of the subject property. It was considered inferior to the subject property, with a total adjusted sale price of $127 per sqft.

Comparable 3 provided the lowest adjusted sale price among all other comparables analysed. With an overall positive adjustment of 1.8%, this comparable provides the best indication of market value for the subject property. Although it sold 18 months before the effective date of the subject property, it is similar to the subject property in age, size, and location. Therefore, the adjusted sale price of $131.00 per sqft provides the best indication of market value for the subject property.
In summary, Comparable 3 provides the best indication of market value for the subject at $131.00 per sqft. Therefore, the total value estimate is calculated as follows:

75,039 sqft @ $131 per sq.ft. = $9,830,109

Rounded to = $9,800,000

5. Implications of results for valuation

The normalized data were used to form the entries of the decision matrix for this problem. The weights initially show comparable 1 with the highest weightage at 0.53, followed by Comparable 2 with comparable 3 and 4 having the least weights, respectively. The matrix calculation also shows the building size and sale price per square foot as significant criteria in the pairwise comparison. Using the Matrix multiplication formula MMULT, the normalized data were used to multiply the averages to determine the rankings of the comparable properties. The final results show that comparable 3, with a score of 45.67%, is the most desirable of all the properties. Comparable 1 and 2 are less desirable at 26.12% and 20.47%. Comparable 4 is the least desirable of the comparables with the lowest set of criteria. Therefore the best comparable is 3, followed by 1, 2, and 4. Table 5 shows the matrix calculation and the rankings for the criteria.

>>>Insert Table 5<<<

Comparable 3, with an unadjusted sale price of $122.00 per sqft, provides the best indication of market value for the subject property.

In summary, using the AHP method, Comparable 3 provides the best indication of market value for the subject at $122.00 per sqft. Therefore, the total value estimate is calculated as follows:

75,039 sqft @ $122 per sq.ft. = $9,154,758
Rounded to = $9,155,000

After adjustments had been made using the Direct Comparison method, the property's value was estimated to be $9,800,000. The Direct Comparison Approach was based on the analysis of four similar properties sold within several months of the effective date of the appraisal. This was as a result of a very inactive industrial property market. The sales did require adjustment, and it was possible to quantify the adjustments with paired sales. The +-% and dollar adjustments were applied to determine the comparables' adjusted sale price range. The problem with this adjustment method is that it cannot be marketed and supported often. No “test” can be applied to these

adjustments to determine if these adjustments are correct. Using words such as Inferior and Superior to describe the differences between the subject property and a given comparable is also redundant hence the need for some statistical testing.

The AHP, on the other hand, was used not just to determine which comparable was similar to the subject property but to scale the actual importance (weights) of the attributes used for comparisons using a decision matrix. No adjustments were made to each comparable's initial sale price per square foot. Hence the final value of the subject property was estimated to be $9,155,000. The average of both values, rounded to **$9,500,000,** is considered the ideal estimate for the subject property. The rationale behind taking an average of both approaches is based on reducing the inconsistencies that might arise from the adjustments of the attributes of each comparable. The direct comparison approach usually would post the highest value of the three valuation methods. Consequently, appraisers find it less reliable than the income approach, as the latter was based entirely on recent leases and expenses from the property. The idea of combining the AHP method with the direct comparison method is to bring the value to par with the value obtained from the income approach, hence making it a more reliable approach that appraisers can count on when faced with rents that do not reflect the true nature of the real estate investment. Appendix A-D shows the comparison matrix for each comparable property and their respective normalized values regarding the criteria chosen.

6. Conclusion

This study sought to determine how the AHP method could complement the Direct comparison method of valuation when determining the weight of attributes used in the appraisal process. Using a Scatty Scale of importance and a 4×4 matrix, the attributes were used to determine the most ideal comparable for the appraisal. The findings revealed that the AHP could easily detect the most significant comparable when the properties are very similar. Whether the AHP is useful when there are few sale comparables with multiple dissimilar attributes is open to further research. AHP can be a useful tool in the appraisal process when faced with the problem of selecting the most appropriate comparable from a list of slightly dissimilar comparables. The results show that the AHP, rather than serving as an alternative, helps in quantitatively selecting the most significant

value attribute for the basis of comparison before subjective adjustments are made. When intuitively applied in the direct comparison approach, these subjective adjustments almost always lead to an overvaluation of properties. However, when used in tandem with the AHP, it provides a check for smoothing value estimates. The implications of this research work at a time like this are far-reaching, especially as interest rates rise and an impending recession looms. Appraisers still have to determine the value of real estate no matter the economic conditions and, with limited activity in the market, will have to justify their value estimates to their clients. This research sheds light on the usefulness of the AHP technique to appraisers and the need to validate their estimates in light of non-recent sales data with similar value attributes. Even Automated Valuation Models, which some experts have predicted might someday be the future of appraisal, require sales comparables to run their analysis, so what happens when there is a dearth of sales in the market? The process of appraising real estate is still a social science. It requires the experience of an appraiser coupled with his analytical skills to produce value estimates that can be justified. The AHP can easily help quantitatively in this regard when using the DCA. Government agencies such as the Department of Assessment can also benefit from this research as the assessment of properties based on mass appraisals employs the DCA to determine the assessed value of similar properties. Further research is encouraged into applying AHP when sale comparables are recent and value attributes are highly dissimilar.

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APPENDICES

>>>Insert Appendix A<<<

>>>Insert Appendix B<<<

>>>Insert Appendix C<<<

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Figures

Appendix D: CI and CR Calculation

Comparable showing the normalized distribution of their Decision Criteria

Preferred Over				
	Date of Sale	Land Size	Building Size	Sale Price per sqft
Date of Sale	1.00	7.00	4.00	3.00
Land Size	0.14	1.00	0.14	0.20
Building Size	0.25	7.00	1.00	2.00
Sale Price per sqft	0.33	5.00	0.50	1.00
Sum	1.73	20.00	5.64	6.20

Normalized Data					
	Date of Sale	Land Size	Building Size	Sale Price per sqft	Average
Date of Sale	0.58	0.35	0.71	0.48	0.53
Land Size	0.08	0.05	0.03	0.03	0.05
Building Size	0.14	0.35	0.18	0.32	0.25
Sale Price per sqft	0.19	0.25	0.09	0.16	0.17
Sum	1.00	1.00	1.00	1.00	1.00

Date of Sale				
	Comp 1	Comp 2	Comp 3	Comp 4
Comp 1	1.00	1.00	0.33	5.00
Comp 2	1.00	1.00	0.50	7.00
Comp 3	3.00	2.00	1.00	7.00
Comp 4	0.20	0.14	0.14	1.00
Sum	5.20	4.14	1.98	20.00

Normalized Data					
	Comp 1	Comp 2	Comp 3	Comp 4	Average
Comp 1	0.19	0.24	0.17	0.25	0.21
Comp 2	0.19	0.24	0.25	0.35	0.26
Comp 3	0.58	0.48	0.51	0.35	0.48
Comp 4	0.04	0.03	0.07	0.05	0.05
Sum	1.00	1.00	1.00	1.00	1.00

Land Size				
	Comp 1	Comp 2	Comp 3	Comp 4
Comp 1	1.00	5.00	0.33	2.00
Comp 2	0.20	1.00	0.20	0.33
Comp 3	3.03	5.00	1.00	3.00
Comp 4	0.50	3.03	0.33	1.00
Sum	4.73	14.03	1.86	6.33

Normalized Data					
	Comp 1	Comp 2	Comp 3	Comp 4	Average
Comp 1	0.21	0.36	0.18	0.32	0.27
Comp 2	0.04	0.07	0.11	0.05	0.07
Comp 3	0.64	0.36	0.54	0.47	0.50
Comp 4	0.11	0.22	0.18	0.16	0.16
Sum	1.00	1.00	1.00	1.00	1.00

Building Size				
	Comp 1	Comp 2	Comp 3	Comp 4
Comp 1	1.00	7.00	2.00	5.00
Comp 2	0.14	1.00	0.20	2.00
Comp 3	0.50	5.00	1.00	5.00
Comp 4	0.20	0.50	0.20	1.00
Sum	1.84	13.50	3.40	13.00

Normalized Data					
	Comp 1	Comp 2	Comp 3	Comp 4	Average
Comp 1	0.54	0.52	0.59	0.38	0.51
Comp 2	0.08	0.07	0.06	0.15	0.09
Comp 3	0.27	0.37	0.29	0.38	0.33
Comp 4	0.11	0.04	0.06	0.08	0.07
Sum	1.00	1.00	1.00	1.00	1.00

Sale Price per Square foot				
	Comp 1	Comp 2	Comp 3	Comp 4
Comp 1	1.00	0.11	0.20	0.17
Comp 2	9.09	1.00	0.20	2.00
Comp 3	5.00	5.00	1.00	5.00
Comp 4	5.88	0.50	0.20	1.00
Sum	20.97	6.61	1.60	8.17

Normalized Data					
	Comp 1	Comp 2	Comp 3	Comp 4	Average
Comp 1	0.05	0.02	0.13	0.02	0.05
Comp 2	0.43	0.15	0.13	0.24	0.24
Comp 3	0.24	0.76	0.63	0.61	0.56
Comp 4	0.28	0.08	0.13	0.12	0.15
Sum	1.00	1.00	1.00	1.00	1.00

Tables

Table 1. Relative Importance Index

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak Importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong Importance	Experience and judgement strongly favour one activity over another
7	Demonstrated Importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Absolute Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	When compromise is needed
Reciprocals of above non-zero	If activity 1 has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

Source: Saaty, 1980

Table 2. Sales Comparison Chart

Item	Subject Property	Comparable Property			
		1	2	3	4
Location (Address)	South East	South East	South East	South East	South East
Sale date	4/12/2019	24/04/2018	24/04/2018	15/05/2018	4/01/2018
Registration date		10/05/2018	10/05/2018	27/06/2018	24/01/2018
Sale Price		$8,180,333	$6,585,001	$9,370,000	$6,434,832
Sale Price per sq.ft of building		$99	$119	$122	$125
Rights conveyed	Leased Fee	Leased Fee	Leased Fee	Leased Fee	Leased Fee
Financing		None	None	None	None
Condition of sale		None	None	None	None
Expenses made immediately after purchase		None	None	None	None
Time difference (mos.)		16.5	16.5	18	20
Zoning	I-G Industrial	I-G Industrial	I-G Industrial	I-G Industrial	I-G Industrial
Location	Foothills	Foothills	Foothills	Foothills	Foothills
Frontage/depth	666.4 × 363.78	590.34 × 261.85	131.77 × 79.77	341.26 × 488.16	280.34× 545.34
Lot area (acres)	4.55	3.73	1.43	4.04	3.68
Building size (sq.ft)	75,039	83,044	55,180	76,770	51,544
Building height (ft)	22	21	22	22	20
Number of Bays	None-Prepaid	None-Prepaid	None-Prepaid	None-Prepaid	None-Prepaid
Year Built	1975	1980	1981	1975	1976
Condition	Good	Superior	Inferior	Similar	Inferior
Front Exposure	Interior Road way	Superior	Inferior	Similar	Inferior
Site Coverage Ratio	0.38	0.51	0.89	0.44	0.32

Table 3 Adjustment Chart

Item	Subject Property	Comparable Property			
		1	2	3	4
Location (Address)	South East	South East	South East	South East	South East
Sale Price		10/05/2018	10/05/2018	27/06/2018	24/01/2018
Sale Price per sq.ft. of building		**$99**	**$119**	**$122**	**$125**
Real property Rights Conveyed Adjustment		0%	0%	0%	0%
Adjusted Price per Sq.ft		$99	$119	$122	$125
Financing Adjustment		0%	0%	0%	0%
Conditions of Sale Adjustment		0%	0%	0%	0%
Expenses made immediately After Purchase Adjustment		0%	0%	0%	0%
Adjusted Price per Sq.ft.		**$99**	**$119**	**$122**	**$125**
Sale Date Time Differences (mos.)		16	16	17	20
Date of Sale Adjustment		6.4%	6.4%	6.8%	8%
Adjusted Price per Sq.ft.		**105**	**127**	**131**	**135**
Other Adjustments as Required					
Location Adjustment		0%	0%	0%	0%
Zoning Adjustment		0%	0%	0%	0%
Building size Adjustment		0%	0%	0%	0%
Percentage of Office Finish Adj.		0%	0%	0%	0%
Age Adjustment		0	0	0	0
Site Coverage Adjustment		0%	0%	0%	0%
Total Adjustments		0%	0%	6.8%	8%
Total Adjusted Sale Price per sq.ft.		**$105**	**$127**	**$131**	**$135**

Table 4. Lambda Calculation

Date of Sale	Size		Sale Price per sqft	Sum	Consistency Vector
	Land	Building			
0.530510518	0.333083	0.994623421	0.519751024	2.377968	4.482414353
0.075787217	0.047583	0.035522265	0.034650068	0.193543	4.067454244
0.13262763	0.333083	0.248655855	0.346500683	1.060867	4.266407332
0.176836839	0.237916	0.124327928	0.173250341	0.712332	4.111573626
Lambda Max					**4.231962389**

Table 5. Matrix Calculation

Options	Date of Sale	Size		Sale Price per sqft	Weightings	MMULT	%	Rank
		Land	Building					
Comp 1	0.213090425	0.265208	0.508501214	0.052532	0.530510518	0.261209	26.13	**2**
Comp 2	0.259174763	0.068256	0.091065784	0.238634	0.047583285	0.20473	20.47	**3**
Comp 3	0.478926448	0.501898	0.330105308	0.557956	0.248655855	0.456706	45.67	**1**
Comp 4	0.048808363	0.164638	0.070327694	0.150878	0.173250341	0.077354	7.77	**4**

Appendix A: Consistency index and ratio

N	4
Consistency Index	0.077321
Consistency Ratio	0.085912

Appendix B: Paired Sales Comparison - Date of Sale

Site Address	Sale date	Building size (sf)	Sale price ($)	Sale Price per Sq. ft.	Sale Price difference ($)	Total difference %	Months Difference	% Per Month
Comparable 2	10/05/2018	55,180	6,585,001	119	6	4.8	19	0.25
Subject Property	04/12/2019	75,039	9,200,000	125				
7303 & 7403 30th ST SE	04/04/2017	74,549	7,860,000	144	11	7.1	13	0.55
7071 11th Avenue SE	05/06/2018	71,174	11,000,000	155				

Appendix C: Comparable time adjustments

	Comparable			
	1	2	3	4
Sale price per sqft	$99	$119	$122	$125
Sale Date	24/04/2018	24/04/2018	15/05/2018	04/01/2018
Time difference in mnths	16.5	16.5	18	20
Percentage Adjustment (0.4%/mo)	6.6	6.6	7.2	8
Adjusted Price per Acre	105	127	131	135