

# Article Title Page

## [Measuring Instrument Constructs for Green Office Building Investments Variables Using Rasch Measurement Model]

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## Structured Abstract:

The aim of this paper is attempt to introduce the application of Rasch measurement model analysis to determine the validity and reliability of each construct in the questionnaire. In achieving this objective, a questionnaire survey was developed consists of 6 sections and a total of 106 responses were received from various investors who owned and rent office buildings in Kuala Lumpur. The Rasch Measurement analysis is used to measure the quality control of item constructs in the instrument by measuring the specific objectivity within the same dimension, to reduce ambiguous measures, and a realistic estimation of precision and implicit quality. The Rasch analysis consists of the summary statistics, item unidimensionality and item measures. A result shows the items and respondent (person) reliability is at 0.91 and 0.95 respectively.

**Keywords:** Green office building investment, Rasch measurement model, instrument constructs, validity and reliability.

## Article Classification:

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## Running Heads:

### 1.0 The Rasch Measurement Model

Rasch model analysis is the only tool available in social science research to determine whether the construct of the instrument is measuring the specific objectivity within the same dimension, minimising ambiguous measures, and that it is a realistic estimate of precision and implicit quality (Azrilah Abdul Aziz, 2011). This model introduced a logarithm for the odds, or probabilistic value, to produce a measurement method with a logit function, dependant on the nature of the research. The logit is on a scale with an equal interval separation, and measurement starts at 0, like other tools that establish a model to fit the research data. In this case, it establishes the hierarchical relationship between a person's response to an item and his or her level of construct measured by the scale (Edelen & Reeve, 2007).

Each item has its logit measure, which determines the level of difficulty of a question. Therefore, this study used the Rasch measurement model theorem to determine the credibility of the data and to further elaborate the Cronbach's alpha for data reliability and validity. This method has been more successful in envisioning and identifying investors that are highly interested in green office building investment, and the responses that were perceived as easy items, where respondents had opinions in common, if they invested in green office buildings. The Rasch model is a well-known method to convert ordinal data to interval data, to determine whether the latent traits or constructs are within the same dimension, and to provide data quality control before further analysis takes place (T. G. Bond & Fox, 2007). Thus, the purpose of the Rasch measurement model is to produce a linear measure, to overcome missing data, to give an estimate of the precision and quality of the construct of the instrument, and to detect misfits or outliers. This is achieved by considering three parameters: point measure correlation  $0.32 < x < 0.8$ , outfit mean squared  $0.5 < y < 1.5$ , and outfit z-standard  $-2 < z < 2$ . It also provides a separable or independent measurement instrument for the parameters of the research object.

For the purposes of this study, the Winstep 15 Rasch programme was used for the data screening analysis. It produced tables and graphical outputs that enabled the fit of the data measurement to be checked. The summary statistics were derived based on the values of important indicators (Cronbach's alpha, item reliability, person reliability, person measure, and standard error), to determine whether the data were suitable for further analysis. The process of analysis involved three stages of data screening, consisting of summary statistics, unidimensionality, and item measures.

### 2.0 Instrument Development

The development of specific research procedures that will result in empirical observations relies on the operationalization of variables. This research was developed based on variables derived from a conceptual framework that integrates all information to form several hypotheses to be tested, and to determine if the data supports them. The concepts were then operationally defined so that they could be measured, or operationalized, in order to be able to examine the behavioural dimensions, facets, or properties, denoted by the concept (Sekaran & Bougie, 2010). These were then translated into observable and measureable elements, to develop an index of measurement of the concept. Operationalization is the "process of precisely delineating how a construct is to be measured; that is, the variables which have to be specified in such manner as to be potentially observable or manipulated" (Joseph F. Hair, Black, Babin, & Anderson, 2010) Therefore, to assess the research hypotheses, all of the constructs in the questionnaire were defined operationally in the ways described below.

The survey questionnaire consisted of six sections, and each section was created with the purpose of finding answers to a different part of the research. Section A consisted of the demographic profile, which was further divided into the respondent's background and the organisation's background. The respondent's background included details about their gender, age, qualifications, position, and experience; while the organisation's background included the category of the company, company establishment, green ownership, total number of buildings owned, and level of participation in green office buildings.

Section B was designed to obtain respondents' opinion on green office buildings, and whether they disagreed (1) or strongly agreed (5), using a Likert scale rating system. The items were designed based on the return on investment of green office buildings that relate to financial return, and social and environmental benefits. The purpose of this section was to identify the general opinion on green office building investment in Malaysia. Appendix 1 shows 13 questions that were designed to seek the general opinion of respondents on green office building investment. This was to investigate the general knowledge of the respondents on the research matter.

Section C was the core area of the research and consisted of ROI factors and attributes, for example, financial return, cost savings, financial incentives, social benefits, and environmental benefits. This section attempted to obtain the opinions of the respondents on the perceived importance of return factors when investing in green office buildings. Each factor was broken down into few attributes, and this section contained 17 items. Appendix 2, lists the items, consisting of financial return, cost saving, financial incentives, and social and environmental benefits, which form the ROI from green office buildings investment. The explanation of each item is defined clearly to ensure the respondents understood the research matter.

The second part of Section C consisted of the risks and building factors, which aimed to obtain the opinion of the respondents on the factors they perceived to be important in influencing returns (See appendix 3).

In section D, the respondents were asked about the green office attributes that they perceived to be important in influencing the return of green office building investment. This section focused on the attributes that form a green office building as shown in Appendix 4.

Section E was intended to obtain the respondents' opinion on green office investment barriers, using a five-scale Likert rating system. The items consisted of 13 questions as shown in Appendix 5.

Section F investigated the willingness of respondents to participate in green office building investment. This section consisted of 6 items that rated the organisation's willingness to participate in green office building investment as shown in Appendix 6.

Much consideration was given to the development of all the items in the questionnaire. Too many items could have increased the amount of invalid data, while too few items may have affected the reliability and validity of the findings. The items in the questionnaire were selected to support the respective research constructs and research objectives. All of the items in this study questionnaire were adapted based on the combination of the literature review and previous studies. Based on work of current research interests, the appropriate items were selected from the previous researchers. A pilot test was undertaken, before the large-scale study was conducted. The format of the questionnaire and structure of each question was carefully designed with the objective with the objective of reducing, as much as possible, any biased answers from respondents. All of the questions were designed to be short, precise, and understandable. The format of the instrument was made simple, short, and comprehensible, and adaptable to statistical analysis (Bryman & Bell, 2011; Collis & Hussey, 2009).

### 3.0 Methodology

To assess the status of green office building investments in Malaysia, feedback was obtained from office investors that own and rent office buildings in the Federal Territory of Kuala Lumpur using a questionnaire survey. Prospective respondents are stakeholders of the office building, or a representative of the owner, and they should hold at least a managerial position in the organisation. The profile of the respondents includes gender, age, highest tertiary qualification, positions held in the organisation, and years of experience. As all respondents hold high managerial positions within their respective organisations, their opinions can be considered strong enough and noteworthy for this study to determine the expected ROIs of organisation and the various factors influencing such returns.

This study employed the questionnaire method which is an inexpensive and efficient way to collect data that cover a wide geographical area (Neuman, 2011). The questionnaire consisted of 44 items that represented the various factors related to green office building investments. The ratings of these items by the respondents were in terms of their 'degrees of importance'. The questionnaire comprised two parts. The first part evaluated the factors considered important by investors when investing in green office buildings. The questionnaire survey is similar to those carried out in Singapore (Addae-Dapaah, Hiang, & Sharon, 2009), Italy (Morri & Soffiatti, 2013), the United Kingdom (Sayce, Ellison, & Parnell, 2007), and New Zealand (S. Bond & Perrett, 2012). The length of the questionnaire and the questionnaire items were redesigned to suit local conditions and the assessment of green office buildings in Malaysia. A five-point Likert scale was employed for the questionnaire.

#### 3.1 Response Rate

All the data were collected from office building investors in Kuala Lumpur, who acted as respondents in the questionnaire survey. A breakdown of the questionnaire metrics is presented in Table 1 below.

**Table 1 Breakdown of the questionnaires received**

| Data collection                                    | Number of questionnaires |
|--|--------------------------|
| Questionnaires distributed (including pilot study) | 394                      |
| Effective number of questionnaires distributed     | 394                      |
| Questionnaire received – main study                | 106 (8 rejected)         |
| Questionnaire received – pilot study               | 16 (4 rejected)          |
| <b>Total questionnaires received</b>               | <b>130 (33%)</b>         |

In the two phases of the study, a total of 394 questionnaires were distributed, of which 130 were returned, but 12 could not be used. The total of 130 questionnaires received, represents a 33% response rate. However, only 106 questionnaires are used for the main analysis. In conducting a questionnaire survey, a response rate from the population size is acceptable at 10% or less (Collis & Hussey, 2009). The requirement in achieving the minimum sample size for a population of 400 as suggested by Bartlett et al (2001) for categorical data is 196.

However, this study managed to achieve only 106 responses. A few strategies were used to encourage responses from the top management including initiatives such as telephone call reminders, emails reminders and re-sending questionnaires to no-response locations by postage.

The main reasons for not responding to the questionnaires is were time-related, such as the respondents were very busy with meetings and appointments, and were unable to fix appointments due to unexpected reasons. To justify further, the sample size very much depends on the type of respondents, and the more senior the position of the respondent in an organisation's hierarchy, the harder it is to persuade them to respond to a survey. Anseel, Choragwicka, Lievens, and Schollaert (2010) identified the lowest response rate trend across respondent types ranked from executive positions and above. The distribution of responses from investors who own and rent office buildings in the Kuala Lumpur area is shown in Table 2.

**Table 2 Distribution of office building locations and respondents' responses**

| Location                  | No. of buildings | Frequency | Percent | Valid percent | Cumulative percent |
|---------------------------|------------------|-----------|---------|---------------|--------------------|
| Golden Triangle           | 89               | 43        | 40.6    | 40.6          | 40.6               |
| Central Business District | 95               | 14        | 13.2    | 13.2          | 53.8               |
| Within City Centre        | 132              | 25        | 23.6    | 23.6          | 77.4               |
| Suburban KL               | 78               | 24        | 22.6    | 22.6          | 100.0              |
| Total                     | 394              | 106       | 100.0   | 100.0         |                    |

Table 2 shows that Golden Triangle recorded the highest percentages of responses from the respondents at 41 percent, followed by the City Centre (25 percent), Sub-urban areas in KL (24 percent) while the lowest response rate was in the Central Business District (14 percent). These frequencies show that the total number of the buildings within the location in the study area does not relate to the number of responses received from the respondents.

#### 4.0 Results and Discussion

The first step in this research was to test whether the data obtained from the survey was statistically acceptable in terms of reliability and validity, and suitable for further analysis. At the same time, it was crucial to determine whether or not the constructs in the instrument were measuring the specific objectivity within the same dimension. To determine the requirement for data reliability and validity, Rasch measurement model analysis was conducted and the results of the survey were analysed in three ways to confirm data reliability and quality control, unidimensionality, and item measures and respondent-item fits. For the purposes of this research, the Rasch model is a suitable tool to achieve the above-mentioned requirements.

The summary statistics for respondents (persons) and items (questions) are depicted in Tables 3 and 4. The analysis was generated from 106 respondents, and consists of institutional investors, property developers, and private individuals, who own and rent office buildings within Kuala Lumpur. The study data would predictably fit the model, if all the indicators were in an accepted range. In summary, the statistics shown in Tables 3 and 4 contain a total of 8,479 data points, arising from 106 respondents on 80 items that were analysed. The generated response from the Winstep Rasch software showed the programme could obtain a statistical person measure and stable item calibrations. It yielded a chi-square value of 15,690.43 with an 8,291 degree of freedom at  $p = 0.0000$ . This indicated there was an association between the items.

**Table 3 Summary of 106 measured respondents (persons)**

|                            | TOTAL SCORE |         | MEASURE | MODEL ERROR | INFIT |                    | OUTFIT |      |
|----------------------------|-------------|---------|---------|-------------|-------|--------------------|--------|------|
|                            | SCORE       | COUNT   |         |             | MNSQ  | ZSTD               | MNSQ   | ZSTD |
| MEAN                       | 296.1       | 80.0    | 1.11    | .18         | 1.04  | -.3                | 1.02   | -.4  |
| S.D.                       | 19.7        | .1      | .67     | .02         | .61   | 3.2                | .61    | 3.2  |
| MAX.                       | 366.0       | 80.0    | 3.95    | .23         | 2.92  | 6.8                | 2.87   | 6.5  |
| MIN.                       | 247.0       | 79.0    | -.17    | .14         | .29   | -6.2               | .25    | -6.0 |
| REAL RMSE                  | .20         | TRUE SD | .64     | SEPARATION  | 3.18  | PERSON RELIABILITY | .91    |      |
| MODEL RMSE                 | .18         | TRUE SD | .65     | SEPARATION  | 3.66  | PERSON RELIABILITY | .93    |      |
| S.E. OF PERSON MEAN = 0.07 |             |         |         |             |       |                    |        |      |

PERSON RAW SCORE-TO-MEASURE CORRELATION = .99  
 CRONBACH'S ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .91

**Table 4 Summary of 80 measured items**

|                         | TOTAL SCORE | COUNT   | MEASURE | MODEL ERROR | INFIT |      | OUTFIT      |      |
|-------------------------|-------------|---------|---------|-------------|-------|------|-------------|------|
|                         |             |         |         |             | MNSQ  | ZSTD | MNSQ        | ZSTD |
| MEAN                    | 392.3       | 106.0   | .00     | .15         | .99   | -.1  | 1.02        | .1   |
| S.D.                    | 30.6        | .1      | .67     | .02         | .22   | 1.5  | .25         | 1.6  |
| MAX.                    | 439.0       | 106.0   | 2.16    | .18         | 1.64  | 4.5  | 1.67        | 4.6  |
| MIN.                    | 268.0       | 105.0   | -1.25   | .12         | .49   | -3.6 | .50         | -3.5 |
| REAL RMSE               | .16         | TRUE SD | .65     | SEPARATION  | 4.03  | ITEM | RELIABILITY | .94  |
| MODEL RMSE              | .16         | TRUE SD | .65     | SEPARATION  | 4.18  | ITEM | RELIABILITY | .95  |
| S.E. OF ITEM MEAN = .07 |             |         |         |             |       |      |             |      |

UMEAN=.0000 USCALE=1.0000

ITEM RAW SCORE-TO-MEASURE CORRELATION = -.98

8479 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 15690.43 with 8291 d.f. p=.0000, Global Root-Mean-Square Residual (excluding extreme scores): .6442

The spread of person responses is from 3.95 to (-0.17) = 4.12 logit. According to Fisher (2007), person and item separated criterion for critical measures that are between 3 to 5 logit are considered good to excellent. A reliability of 0.91 and a Cronbach's alpha of 0.91 indicated highly reliable data, hence the data could be used for further analysis. For the questionnaire items, the summary of 80 measured items confirms a data spread from 2.16 to (-1.25) = 3.41 logit, and a reliability of 0.94, which are both good. The acceptable limits are 0.4 <Acceptable Point Measure Correlation<0.8 and 0.5< Outfit Mean Square <1.5 and Outfit z-standardisation value <2.0.

The maximum item and respondent (person) measures are +2.16 logit and +3.95 logit respectively. Despite good reliability, a few difficult items (items that test the most capable persons or receive the least responses) need to be introduced where the gap is 1.79 (2.16 logit to 3.95 logit). The gap reflects the lack of items on difficult tasks constructed for the most capable investors in green office buildings investment. However, there are sufficient easy items, where the minimum item measure was -1.25 logit, in contrast to the least number of investors in agreement at -0.17 logit. The summary statistics describe the general overview of the complete data processed on items and persons' responses. Based on the literature, this data would require a second step, to determine whether or not the item measuring is within the same specific objectivity of the dimension, using unidimensionality analysis. This test identifies the contrasts and variances of the data, by checking groups of items sharing the same patterns of unexpectedness.

#### 4.1 Unidimensionality

The assessment of unidimensionality is crucial to ensure the items in the instrument are measuring the specific objectivity within the same dimension. Rasch model analysis applies principal component analysis to the residuals, to determine whether the variance is measuring what is intended. For this research, the unidimensionality test is conducted to further investigate whether or not the items in the constructs are being measured consistently within the dimensions. This is the second step after examining the summary statistics. According to Linacre's recommendations for unidimensionality, the variance explained by measures must be above 40%, with unexplained variance less than 15% in the first contrast, on the strength of at least 3 items. Conrad, Dennis, Riley, and Funk (2011) also stated the unidimensionality requirement to be 40%, which is consistent with Linacre, with above 30% is considered a moderate measurement dimension.

**Table 5 Overall standardised residual variance (in eigenvalue units)**

| Description                                      | Eigenvalue units | Empirical (%) | Modelled |
|--|------------------|---------------|----------|
| Raw variance explained by measures               | 27.2             | 25.3%         | 26.2%    |
| Raw unexplained variance (total)                 | 80.0             | 74.7%         | 73.8%    |
| Unexplained variance in 1 <sup>st</sup> contrast | 6.0              | 5.6%          |          |
| Unexplained variance in 2 <sup>nd</sup> contrast | 5.5%             | 5.2%          |          |
| Unexplained variance in 3 <sup>rd</sup> contrast | 5.1              | 4.7%          |          |
| Unexplained variance in 4 <sup>th</sup> contrast | 4.4              | 4.1%          |          |
| Unexplained variance in 5 <sup>th</sup> contrast | 4.0              | 3.7%          |          |

From the overall analysis of the items in Table 5, the raw variance explained by measures is 26.2%, with unexplained variance in the first contrast of 6.0 and 5.6%. This confirms that the raw variance explained by measures is below 40%, with a high eigenvalue of 6.0, indicating the items in the questionnaire are multi-dimensional constructs. The Winstep software is programmed to only measure a one dimension direction, therefore rectifying the issue of low percentages in modelled measures is achieved by analysing each construct separately.

Several tests had to be done to ensure that items belong to each construct. To address this issue, the unidimensionality analysis is carried out on each section in the questionnaire, which was divided into six sub-sections, as described in Table 6 overleaf.

Table 6: Standardised residual variance for each construct in the questionnaire

| Description   | Eigenvalue units | Empirical | Modelled |
|---|------------------|-----------|----------|
| <b>Section B: General opinion on green office building investment</b>             |                  |           |          |
| Raw variance explained by measures  | 21.1             | 42.9%     | 44%      |
| Raw unexplained variance (total)  | 28.0             | 57.1%     | 56%      |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 2.6              | 11.6%     | 20.3%    |
| <b>Section C: ROI in green office building investment</b>                         |                  |           |          |
| Raw variance explained by measures  | 21.1             | 42%       | 44%      |
| Raw unexplained variance (total)  | 28%              | 57%       | 56%      |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 3.0              | 6.2%      |          |
| <b>Section C: Factors influencing investment return</b>                           |                  |           |          |
| Raw variance explained by measures  | 7.1              | 39.4%     | 38.8%    |
| Raw unexplained variance (total)  | 11.0             | 60.6%     | 61.2%    |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 2.6              | 14.4%     | 23.8%    |
| <b>Section D: Factors influencing investment return (green office attributes)</b> |                  |           |          |
| Raw variance explained by measures  | 13.3             | 40.0%     | 40.4%    |
| Raw unexplained variance (total)  | 20.0             | 60%       | 59.6%    |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 2.9              | 8.7%      | 14.4%    |
| <b>Section E: Barriers in green office building investment</b>                    |                  |           |          |
| Raw variance explained by measures  | 11.3             | 46.5%     | 45.3%    |
| Raw unexplained variance (total)  | 13.0             | 53.5%     | 54.7%    |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 2.6              | 10.5%     | 19.6%    |
| <b>Section F: Willingness to invest in green office building investment</b>       |                  |           |          |
| Raw variance explained by measures  | 8.7              | 59.1%     | 57.6%    |
| Raw unexplained variance (total)  | 6.0              | 40.9%     | 42.4%    |
| Unexplained variance in 1 <sup>st</sup> contrast                                  | 1.9              | 13.0%     | 31.8%    |

From Table 6, the variance in data explained by measures is within the modelled fit, ranging from 39% to 59%. For questionnaire items, summaries of the 80 measured items, according to the order of measure, are shown in Appendices A1, A2, A3, A4, A5 and A6.

#### 4.2 Item measures

The Rasch measurement model was used to check the precise position of each item. From item measures, we can identify the infit and outfit of each item by examining the mean square (MNSQ), z-standard (ZSTD), and point-measure correlation. From generated findings using the Winstep programme, each item position was ranked according to the level of response in the survey.

The items were ranked based on the highest and lowest number of persons selecting a particular response. The most important rating with the highest selection rate is ranked lowest, while items with the lowest number of selections and difficult to endorse are ranked highest. Therefore, the item ranked first is shown as the most difficult item to endorse. However, if the interpretation was made using SPSS by generating the mean score, the ranking would be in reverse order.

Based on the above item measures, in Appendix A1 item B1 failed Fisher's critical measures on ZSTD (infit and outfit) and point-measure correlation. However, the MNSQ value was good. Although items B7 and B8 failed to fit the ZSTD and B6 was on the point-measure correlation, these items still remained in the analysis. Item B1 showed an unpredictable answer, while items B7, B8, and B6, were still relevant because the value only affected one criterion. The items were retained in the analysis because of the need to provide a descriptive analysis to support the rationalisation of green office building investment in Malaysia. In Appendix A2, all items in Section C met the 3 indicator requirements in Fisher's critical measures. This was shown earlier in the summary statistics of the items in Table 4 – Summary of 80 measured items. Item C23 in Appendix A3 showed the item response was unpredictable with high outfit ZSTD, but the item was still relevant for further analysis. All other items were accommodated by the Rasch measurement model. All items are fits, except item D6, which has a high infit ZSTD for green office attributes, as shown in Appendix A4. However, the item was relevant for further analysis.

It can be seen from Appendix A5, that all items fit the model dimension. Based on the above, the items were revised for more precise constructs before further analysis using SPSS took place. The number of removed items was minimal, and this was already expected because the findings from the summary statistics showed very good reliability of the items at 0.94, as shown in Table 4.

#### 5.0 Conclusions

The Rasch model analysis confirmed that all the items in the questionnaire constructs were statistically reliable and valid for further analysis, and each item was measuring the specific objectivity within the same dimension. The results were also supported by Cronbach's alpha test at 0.91, which showed excellent reliability for persons-items data. The application of the Rasch measurement model aims to provide a new dimension and technique, to examine the data reliability and validity of the instrument used for this research.

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## Appendix 1

Table 1: Operationalization of variables: Section B

| Constructs  | Item | Operationalization of variables   | Measurement scales   |
|---|------|---|--|
| General opinion on green office building investment<br><br>(IV) | B1   | My organisation invest/will invest in green because our organisation's policy is towards green              | Five-point scale with anchors from Strongly disagree to Strongly agree |
|   | B2   | Green office buildings generate better yield than non-green office buildings                                |  |
|   | B3   | Green office buildings produce relatively better rental incomes   |  |
|   | B4   | Attract prestigious tenants   |  |
|   | B5   | Green office buildings reflect a better image for an organisation   |  |
|   | B6   | The green office building achieves a relatively higher occupancy rate compared to non-green buildings       |  |
|   | B7   | Green office buildings are energy saving buildings  |  |
|   | B8   | Generally, green office buildings have better access to public transportation and are more user friendly    |  |
|   | B9   | A green building is an environmentally friendly building  |  |
|   | B10  | Green office buildings provide better working environments to their tenants and occupiers                   |  |
|   | B11  | Green office buildings reduce energy costs, and water and waste expenses; thus, lowering operating expenses |  |
|   | B12  | A green office building is a low maintenance building   |  |
|   | B13  | A green office building has better marketability  |  |

Note: IV = Independent variable



## Appendix 2

Table 2: Operationalization of variables: section C

| Construct                          | Item                                   | Operationalization of variables   | Measurement scales  |  |
|------------------------------------|--|---|---|--|
| <b>Financial return (DV)</b>       |  |   |   |  |
| Financial return                   | FR_1:Capital appreciation              | Higher capital appreciation   | Five-point scale with anchors from Not very important to Very important |  |
|                                    | FR_2:Rental income                     | Higher rental, regularity of income, high potential in rental growth  |   |  |
|                                    | FR_3:Occupancy rate                    | High occupancy rate, due to being green,  |   |  |
|                                    | FR_4:Yield                             | Lower yield - as a reflection of high market value (higher in value)  |   |  |
| Cost Saving                        | CS_1:Energy efficiency                 | Reduce energy usage of the building, due to applications, such as renewable energy, sub-metering, efficient energy performance, and natural lighting  |   |  |
|                                    | CS_2:Water and waste efficiency        | Application of appliances & fittings that reduce water usage, and rainwater harvesting for landscape and cleaning usage   |   |  |
|                                    | CS_3:Operations and maintenance        | Reduce costs in outgoings and repairs, low maintenance costs, due to the application of re-usable and recyclable materials, green products, less obsolescence and longer life building facilities |   |  |
| Financial incentives               | FI_1:Insurance premiums                | Low insurance premiums, due to low environmental risk   |   |  |
|                                    | FI_2:Green tax and assessment benefits | Reductions in assessment rate and on income tax for rental income imposed by LHDN   |   |  |
|                                    | FI_3:Green incentives                  | Green incentives, such as green grants and lower interest rates awarded to green projects registered under KeTTHA   |   |  |
| <b>Social benefits (DV)</b>        |  |   |   |  |
| Social benefits                    | SB_1: Corporate social responsibility  | CSR of investors or organisations towards sustainability and the environment  |   |  |
|                                    | SB_2:Image                             | Better image or reputation for being green  |   |  |
|                                    | SB_3: Branding                         | Green certification, such as platinum, gold, or silver ratings for marketability  |   |  |
|                                    | SB_4:Satisfaction from occupation      | Satisfaction from tenants and occupiers, due to better working environments, improved air quality, natural lighting, and designs that are adjustable to the user's needs                          |   |  |
|                                    | SB_5:Productivity                      | High productivity, due to better indoor air quality, natural lighting, and user friendly layouts and designs  |   |  |
| <b>Environmental benefits (DV)</b> |  |   |   |  |
| Environmental benefits (EB)        | EB_1:To sustain the environment        | Buildings emit less CO <sub>2</sub> into the environment  |   |  |
|                                    | EB_2: Minimise pollution               | Reduce waste pollution, such as solid and liquid wastes   |   |  |

Notes: DV = Dependent variable

## Appendix 3

Table 3: Operationalization of variables: section C (continued)

| Construct             | Item   | Operationalization of variables   | Measurement scales  |
|-----------------------|--|---|---|
| Risk (IV)             | RS_1:Economic and political risk                 | Risks, such as Gross Domestic Product (GDP), inflation rate, and political stability  | Five-point scale with anchors from Very not important to Very important |
|                       | RS_2:Government policies                         | Government interventions, such as fiscal and financial policies towards green developments  |   |
|                       | RS_3:Surrounding competitors                     | Similar office buildings located within the vicinity  |   |
|                       | RS_4:Physical risk                               | Natural disasters, such as floods, tsunamis, and landslides   |   |
| Building factors (IV) | BF_1:Location                                    | Selection of site; whether located within the Central Business District (CBD), Golden Triangle area, or within the city or suburban areas |   |
|                       | BF_2:Building grade                              | Grade of office building, such as Grade A or B office buildings   |   |
|                       | BF_3:Building materials and cost of construction | The green material's usage and the costs of construction  |   |
|                       | BF_4:Type of tenants                             | Tenant's portfolio (i.e., single or multiple tenants)   |   |
|                       | BF_5:Property management team                    | Whether in-house or outsourced management team managing the building  |   |
|                       | BF_6:Building design and architecture            | Design, in terms of layout, accessibility, interior, and exterior of the building   |   |
|                       | BF_7:Building facilities and services            | The functionality of facilities and building services   |   |

Note: IV = Independent variable

## Appendix 4

Table 4: Operationalization of variables : section D

| Construct                                    | Item                                   | Operationalization of variables   | Measurement scales  |
|--|--|---|---|
| <b>Green office building attributes (IV)</b> |  |   |   |
| Energy efficiency                            | EE_1:Renewable energy                  | The use of renewable energy to reduce energy consumption  | Five-point scale with anchors from Very not important to Very important |
|  | EE_2:Electrical sub-metering           | The application of electrical sub-metering to reduce energy use   |   |
|  | EE_3:Lighting                          | Day lighting (natural or artificial lighting) to reduce energy use  |   |
|  | EE_4:Efficient cooling system          | Air-conditioning consumption reduction, due to better design, natural air circulation by having a good layout, space within the building  |   |
| Water efficiency                             | WE_1:Rain conservation                 | Application of rain-water harvesting in the building  |   |
|  | WE_2:High tech appliances and fittings | Appliances and fittings for the reduction of water usage in toilets, urinals, waste fittings and cleaning   |   |
| Indoor environmental quality                 | IEQ_1:Air quality                      | Indoor air quality within the building  |   |
|  | IEQ_2:Thermal comfort                  | User comfort to humidity and temperature control  |   |
|  | IEQ_3: Lighting, visuals and acoustics | Visual comfort, and lighting and noise controls   |   |
|  | IEQ_4:Health and safety                | Better air quality and ventilation that contributes to high productivity and a healthier environment  |   |
| Sustainable site planning & management       | SPM_1:Site planning                    | Low impact site construction, infrastructure to minimize environmental pollutions   |   |
|  | SPM_2:Construction management          | Health and safety of the site, construction area, workers and infrastructure efficiency   |   |
|  | SPM_3:Accessibility                    | The building's accessibility to public transportation and amenities for users' convenient   |   |
|  | SPM_4:Building design                  | Allocation of space, layout, and exterior and interior design that reflects the building functionality  |   |
| Materials & resources                        | MR_1:Reused and recycled materials     | The application of the recycled materials in construction and building materials  |   |
|  | MR_2:Waste management                  | Waste management strategies   |   |
|  | MR_3:Green products                    | The use of green products in building materials and construction  |   |
| Innovation                                   | IN_1:Innovation                        | Green design that maximises the environment and natural resources; in order to achieve better performance in energy efficiency, water efficiency and functionality of the technology employed within the building |   |
|  | IN_2:Green accreditation               | Green accreditation, such as Platinum, Gold, or Silver, Certified for better building value   |   |

## Appendix 5

Table 5 Operationalization of variables: section E

| Constructs  | Item | Operationalization of variables                                   | Measurement scales   |
|---|------|---|--|
| Barriers in green office building investment (IV) | E1   | Higher capital required to invest in green office buildings       | Five-point scale with anchors from Strongly disagree to Strongly agree |
|   | E2   | Do not see the necessity to invest in green office buildings      |  |
|   | E3   | No faith in green   |  |
|   | E4   | Onerous procedure to comply with green certification requirements |  |
|   | E5   | Unsure of benefits and return from the investment                 |  |
|   | E6   | Not enough public sector encouragement                            |  |
|   | E7   | Lack of best practices among property investors                   |  |
|   | E8   | Lack of knowledge/expertise on GB investment                      |  |
|   | E9   | Absence of clear financial benefits                               |  |
|   | E10  | No legal requirement to invest in green office buildings          |  |
|   | E11  | Insufficient green building to invest in                          |  |
|   | E12  | Insufficient tenant demand  |  |
|   | E13  | Lack of property performance data on green buildings              |  |

Note: IV = Independent variable

Table 6 Operationalization of variables: Section F

| Constructs       | Item | Operationalization of variables  | Measurement scales   |
|------------------|------|--|--|
| Willingness (IV) | F1   | Rate your organisation's willingness to participate in green office buildings.   | Five-point scale with anchors from Strongly disagree to Strongly agree |
|                  | F2   | Willingness to purchase a green office building  |  |
|                  | F3   | Willingness to occupy a green office building  |  |
|                  | F4   | Willingness to participate in the dissemination of green office building literature (such as green promotions, seminars, workshops and road shows by green agencies)   |  |
|                  | F5   | Willingness to take the opportunity from government financial incentives (i.e., tax exemptions, green grants, lower interest rate for green projects and reduction in tax assessment) by investing in green office buildings |  |
|                  | F6   | Willingness to exercise the implementation of green office features in your office building  |  |

Note: IV = Independent variable

## APPENDIX A1

## Item Measures of Section B

| No Item  | Entry No | Item                      | Raw Score | Count | Measure | Model S.E | Infit |      | Outfit |      | PT Mea Corr |
|--|----------|---------------------------|-----------|-------|---------|-----------|-------|------|--------|------|-------------|
|  |          |                           |           |       |         |           | MNSQ  | ZSTD | MNSQ   | ZSTD |             |
| Section B: General Opinion on Green Office Building Investment |          |                           |           |       |         |           |       |      |        |      |             |
| B1   | 1        | Willingness               | 347       | 106   | 1.29    | 0.14      | 1.35  | 2.3  | 1.43   | 2.7  | 0.38        |
| B2   | 7        | Yield                     | 394       | 106   | 0.18    | 0.17      | 0.84  | -1.0 | 0.85   | -.9  | 0.35        |
| B3   | 8        | Rental                    | 396       | 106   | 0.12    | 0.17      | 0.83  | -1.0 | 0.87   | 0.42 | 0.42        |
| B4   | 5        | Tenant                    | 386       | 106   | 0.40    | 0.16      | 0.91  | -.50 | .99    | .0   | 0.47        |
| B5   | 9        | Image                     | 410       | 106   | -.32    | .18       | 1.19  | 1.1  | 1.16   | .9   | 0.53        |
| B6   | 4        | Occupancy                 | 376       | 106   | 0.66    | 0.16      | 0.98  | -.10 | 1.25   | 1.5  | 0.23        |
| B7   | 12       | Energy                    | 434       | 106   | -1.23   | .20       | .78   | -1.3 | .77    | -1.3 | 0.48        |
| B8   | 3        | Accessibility             | 371       | 106   | 0.77    | 0.15      | 1.21  | 1.4  | 1.40   | 2.4  | 0.55        |
| B9   | 13       | Environmentally friendly  | 439       | 106   | -1.44   | 0.20      | 0.63  | -2.5 | 0.62   | -2.5 | 0.57        |
| B10  | 10       | Better working enviroment | 419       | 106   | -.64    | .19       | .92   | -.4  | .91    | -.5  | 0.55        |
| B11  | 11       | Cost                      | 423       | 106   | -.79    | 0.20      | 1.16  | .9   | 1.03   | .30  | 0.51        |
| B12  | 2        | Low mainatenance          | 370       | 106   | 0.80    | 0.15      | 1.16  | 1.1  | 1.25   | 1.6  | 0.44        |
| B13  | 6        | Marketability             | 393       | 106   | .21     | .17       | .66   | -2.3 | .67    | -2.2 | 0.63        |

## APPENDIX A2

## Item Measures Of Section C

| No Item  | Entry No | Item               | Raw Score | Count | Measure | Model SE | Infit |      | Outfit |      | PT Mea Corr |
|--|----------|--------------------|-----------|-------|---------|----------|-------|------|--------|------|-------------|
|  |          |                    |           |       |         |          | MNSQ  | ZSTD | MNSQ   | ZSTD |             |
| Section C: Returns Factors of Green Office Building Investment |          |                    |           |       |         |          |       |      |        |      |             |
| C1   | 14       | Capital            | 415       | 106   | -0.55   | 0.18     | 1.08  | 0.5  | 1.13   | .8   | .40         |
| C2   | 10       | Rental             | 398       | 106   | -.05    | .16      | 1.31  | 1.9  | 1.35   | 2.1  | .41         |
| C3   | 9        | Occupancy          | 396       | 106   | .00     | .16      | 1.17  | 1.1  | 1.17   | 1.1  | .46         |
| C4   | 7        | Yield              | 383       | 106   | .33     | .15      | .75   | -1.8 | .8     | -1.4 | .52         |
| C5   | 17       | Energy             | 438       | 106   | -1.36   | .20      | .85   | -0.9 | .86    | -.8  | .50         |
| C6   | 16       | Water              | 428       | 106   | -.99    | .19      | 1.06  | .4   | 1.12   | .7   | .42         |
| C7   | 15       | Operational        | 423       | 106   | -.81    | .19      | 1.20  | 1.1  | 1.22   | 1.3  | .43         |
| C8   | 2        | Insuran            | 367       | 106   | .69     | .15      | 1.02  | .2   | 1.14   | 1.0  | .50         |
| C9   | 8        | Green tax          | 395       | 106   | .03     | .16      | .96   | -.2  | 1.05   | .4   | .48         |
| C10  | 12       | Green incentives   | 403       | 106   | -.19    | .17      | .84   | -1.0 | .80    | -1.3 | .57         |
| C11  | 1        | CSR                | 349       | 106   | 1.06    | .14      | .72   | -2.3 | .76    | -1.9 | .68         |
| C12  | 4        | Image              | 373       | 106   | .56     | .15      | .94   | -.4  | .94    | -.4  | .63         |
| C13  | 6        | Branding           | 377       | 106   | .47     | .15      | 1.10  | .8   | 1.23   | 1.5  | .49         |
| C14  | 11       | Satisfaction       | 399       | 106   | -.08    | .17      | .74   | -1.9 | .70    | -2.1 | .70         |
| C15  | 13       | Productivity       | 404       | 106   | -.22    | .17      | .82   | -1.2 | .80    | -1.3 | .61         |
| C16  | 3        | Sustainability     | 371       | 106   | .60     | .15      | 1.27  | 1.9  | 1.31   | 2.1  | .56         |
| C17  | 5        | Minimise pollution | 376       | 106   | 0.49    | .15      | 1.04  | .4   | 1.04   | .4   | .54         |

## APPENDIX A3

## Item Measures Of Section C

| No Item  | Entry No | Item         | Raw Score | Count | Measure | Model S.E | Infit |      | Outfit |      | PT Mea Corr |
|--|----------|--------------|-----------|-------|---------|-----------|-------|------|--------|------|-------------|
|  |          |              |           |       |         |           | MNSQ  | ZSTD | MNSQ   | ZSTD |             |
| Section C: Factors Affecting Returns in Green Office Building Investment |          |              |           |       |         |           |       |      |        |      |             |
| C18  | 2        | Economic     | 367       | 106   | .66     | .16       | .96   | -.3  | .93    | -.4  | .60         |
| C19  | 5        | Govern       | 383       | 106   | .28     | .16       | .83   | -1.2 | .76    | -1.6 | .69         |
| C20  | 1        | Surrounding  | 367       | 106   | .68     | .16       | .77   | -1.8 | .91    | -.6  | .64         |
| C21  | 3        | Physical     | 374       | 106   | .51     | .16       | 1.01  | .1   | 1.01   | .1   | .61         |
| C22  | 10       | Location     | 416       | 106   | -.78    | .20       | 1.34  | 1.8  | 1.29   | 1.5  | .48         |
| C23  | 6        | Building     | 396       | 106   | -.09    | .17       | 1.22  | 1.4  | 1.40   | 2.2  | .48         |
| C24  | 7        | Building     | 396       | 106   | -.09    | .17       | .93   | -.4  | .87    | -.7  | .61         |
| C25  | 4        | Type         | 374       | 106   | .51     | .16       | 1.15  | 1.1  | 1.18   | 1.2  | .57         |
| C26  | 8        | Property Mgt | 397       | 106   | -.13    | .18       | 1.06  | .5   | 1.05   | .3   | .58         |
| C27  | 9        | Building     | 415       | 106   | -.74    | .19       | 1.00  | .1   | .97    | -.1  | .50         |
| C28  | 11       | Facility     | 415       | 106   | -.81    | .20       | .68   | -.20 | .66    | -2.0 | .56         |

## APPENDIX A4

## Item Measures Of Section D: Green Office Building Attributes

| No Item   | Entry No | Item              | Raw Score | Count | Measure | Model SE | Infit |      | Outfit |      | PT Mea Corr |
|---|----------|-------------------|-----------|-------|---------|----------|-------|------|--------|------|-------------|
|   |          |                   |           |       |         |          | MNSQ  | ZSTD | MNSQ   | ZSTD |             |
| Section D: Green Attributes of Green Office Building Investment |          |                   |           |       |         |          |       |      |        |      |             |
| D1  | 18       | Renewa            | 435       | 106   | -1.02   | .22      | 1.35  | 1.8  | 1.16   | .8   | .43         |
| D2  | 11       | Electricity       | 418       | 106   | -.26    | .20      | 1.35  | 1.8  | 1.19   | 1.0  | .53         |
| D3  | 17       | Light             | 431       | 106   | -.84    | .22      | .62   | -2.3 | .78    | -1.1 | .57         |
| D4  | 19       | Cooling           | 438       | 106   | -1.17   | .22      | .73   | -1.6 | .66    | -1.8 | .57         |
| D5  | 20       | Effect            | 439       | 106   | -1.22   | 0.22     | 0.97  | -.1  | .97    | -.1  | .54         |
| D6  | 5        | Rain Conservation | 389       | 106   | .75     | .17      | 1.39  | 2.3  | 1.55   | 2.7  | .66         |
| D7  | 8        | High              | 399       | 106   | .44     | .18      | .84   | -1.0 | .84    | -.9  | .65         |
| D8  | 14       | Air Quality       | 423       | 106   | -.47    | .21      | 1.03  | .2   | .83    | -.8  | .62         |
| D9  | 12       | Thermal           | 418       | 106   | -.26    | .20      | .76   | -1.4 | .58    | -2.4 | .66         |
| D10   | 15       | Lighting          | 423       | 106   | -.47    | .21      | 1.00  | .1   | .78    | -1.1 | .62         |
| D11   | 16       | Heal              | 430       | 106   | -.79    | .22      | .58   | -2.6 | .45    | -3.3 | .68         |
| D12   | 2        | Site              | 377       | 106   | 1.09    | .16      | .97   | -.2  | 1.19   | 1.1  | .61         |
| D13   | 4        | Construction      | 385       | 106   | .87     | .17      | .94   | -.3  | 1.1    | .6   | .6          |
| D14   | 7        | Accessibility     | 398       | 106   | .47     | .18      | 1.27  | 1.6  | 1.36   | 1.8  | .49         |
| D15   | 13       | Building          | 418       | 106   | -.26    | .20      | .89   | -.5  | .82    | -.9  | .59         |
| D16   | 1        | Recycling         | 364       | 106   | 1.41    | .16      | 1.03  | .3   | 1.32   | 1.9  | .51         |
| D17   | 9        | Waste             | 402       | 106   | .34     | .18      | .90   | -.6  | .88    | -.6  | .56         |
| D18   | 6        | Green             | 393       | 106   | .63     | .18      | .90   | -.6  | .99    | .0   | .55         |
| D19   | 10       | Innovation        | 417       | 106   | -.22    | .20      | 1.33  | 1.7  | 1.27   | 1.3  | .53         |
| D20   | 3        | Green             | 380       | 106   | 1.00    | .16      | 1.03  | .2   | 1.18   | 1.1  | .52         |



## APPENDIX A5

## Item Measures Of Section E

| No Item   | Entry No | Item                       | Raw Score | Count | Measure | Model S.E | Infit |            | Outfit |            | PT Mea Corr |
|---|----------|----------------------------|-----------|-------|---------|-----------|-------|------------|--------|------------|-------------|
|   |          |                            |           |       |         |           | MNSQ  | ZSTD       | MNSQ   | ZSTD       |             |
| Section D: Green Attributes of Green Office Building Investment |          |                            |           |       |         |           |       |            |        |            |             |
| E1  | 1        | Higher capital             | 268       | 106   | 1.87    | .14       | 1.02  | .2         | .99    | .0         | .56         |
| E2  | 2        | No necessity               | 292       | 106   | 1.43    | .13       | 1.21  | 1.6        | 1.23   | 1.7        | .57         |
| E3  | 13       | No faith                   | 422       | 106   | -1.29   | .18       | 1.57  | <b>2.9</b> | 1.57   | <b>2.8</b> | .31         |
| E4  | 4        | Onerous procedure          | 346       | 106   | .49     | .13       | .67   | -3.1       | .76    | -2.0       | .57         |
| E5  | 3        | Unsure benefits            | 315       | 106   | 1.03    | .13       | 1.02  | .2         | .98    | -.1        | .64         |
| E6  | 9        | Public encouragement       | 395       | 106   | -.53    | .16       | .89   | -.7        | .89    | -.7        | .56         |
| E7  | 12       | Lack best practices        | 406       | 106   | -.81    | .17       | .85   | -.9        | .85    | -.9        | .45         |
| E8  | 6        | Lack knowledge             | 381       | 106   | -.20    | .15       | .94   | -.3        | 1.10   | .7         | .56         |
| E9  | 5        | Absence                    | 376       | 106   | -.09    | .15       | .89   | -.8        | 1.01   | .1         | .58         |
| E10   | 10       | No legal requirement       | 397       | 106   | -.58    | .16       | 1.05  | .4         | 1.03   | .2         | .46         |
| E11   | 7        | Insufficient               | 384       | 106   | -.27    | .15       | .90   | -.6        | 1.00   | .1         | .44         |
| E12   | 8        | Insufficient tenant demand | 390       | 106   | -.41    | .15       | 1.03  | .3         | 1.13   | .9         | .35         |
| E13   | 11       | Lack property performance  | 400       | 106   | -.65    | .16       | .76   | -1.6       | .76    | -1.6       | .60         |

## APPENDIX A6

## Item Measures Of Section F

| No Item   | Entry No | Item             | Raw Score | Count | Measure | Model S.E | Infit |      | Outfit |      | PT Mea Corr |
|---|----------|------------------|-----------|-------|---------|-----------|-------|------|--------|------|-------------|
|   |          |                  |           |       |         |           | MNSQ  | ZSTD | MNSQ   | ZSTD |             |
| Section F: Willingness To Invest In Green Office Building |          |                  |           |       |         |           |       |      |        |      |             |
| F1  | 2        | Participate      | 379       | 106   | .12     | .23       | 1.27  | 1.7  | 1.33   | 1.6  | .65         |
| F2  | 1        | Purchase         | 346       | 106   | 1.66    | .21       | 1.04  | .3   | 1.23   | 1.4  | .74         |
| F3  | 3        | Occupy           | 376       | 106   | .11     | .23       | 1.08  | .5   | .96    | -.1  | .73         |
| F4  | 4        | Dissemination    | 382       | 106   | -.04    | .23       | 1.08  | .5   | .96    | -.1  | .77         |
| F5  | 6        | Take opportunity | 399       | 106   | -.95    | .23       | .71   | -2.0 | .64    | -2.1 | .73         |
| F6  | 5        | Implementation   | 398       | 106   | -.89    | .23       | .76   | -1.6 | .67    | -1.9 | .76         |