Conventional Buildings versus Green Buildings: Perception of Building Occupants

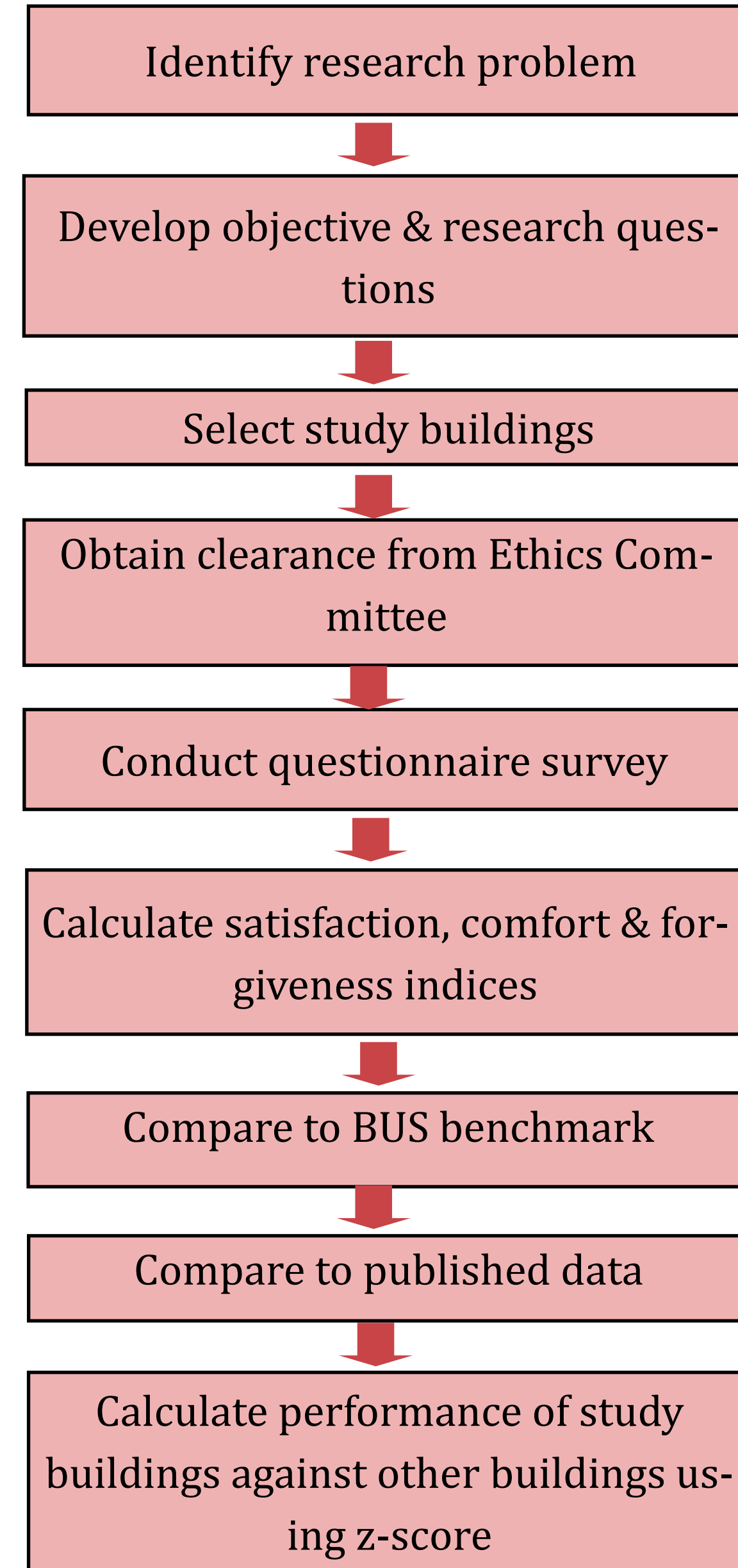Project no: PG098-2013A , FL027-2012B

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ABSTRACT:
Numerous studies have proven that green buildings can provide better overall environment for their occupants. Still, some studies have shown that green buildings were perceived to cause occupants dissatisfaction and discomfort. To prevent this, green refurbishment projects must consider current occupants' satisfaction and comfort level before charting refurbishment strategies. The present study is an initial part of a green refurbishment project, which is to investigate the performance of four conventional buildings in terms of satisfaction and comfort compared with green buildings from the current occupants' perception. The Building Use Studies (BUS) Methodology occupant survey was conducted on current randomly selected building occupants. Data collected were aggregated and the satisfaction and comfort indices were compared with the BUS benchmark and published datasets, which also adopted the BUS Methodology. The authors predicted that the conventional buildings perform less for all categories of satisfaction and comfort. However, in contrary the results showed that they perform better than green buildings in a commendable number of categories. The study also discovered that conventional buildings scored high 'forgiveness index', a measure for tolerance of the occupant for its indoor environment. This finding is essential in highlighting that green refurbishments improve its performance in providing better environment for the occupants, while improving the building physically.

Keywords: *user perception; occupant survey; user comfort*

INTRODUCTION:
Green buildings have been defined as buildings that were designed to reduce impact on natural environment and on the occupant (Zigenfus, 2008). Green buildings are achievable by building new and refurbishing conventional buildings through green refurbishments.

RESEARCH PROBLEM:
Numerous studies proved that green buildings, provide better environment for their occupants. However, a small number of studies showed that green buildings were perceived to cause occupants dissatisfaction and discomfort (Gou et al., 2013).

RESEARCH GAP:
Many studies were done to measure green building performance in isolation, or compared between two or more buildings. Only few were done on conventional buildings with the intention to measure the gap between their occupants' satisfaction and comfort and that of green buildings'. Unlike new green buildings, where all aspects of sustainability can be pre-planned, green refurbishments of existing buildings require investigations prior to the design stage where it involves the current occupants' input and participation (Umar et al., 2013).

AIM	OBJECTIVE	QUESTIONS
to examine occupants' perceived satisfaction and comfort of conventional buildings prior to the refurbishment planning stage	To compare the perceived satisfaction and comfort of occupants' from conventional buildings and green buildings	How do users perceive conventional buildings in their current condition?
		Are conventional buildings more or less satisfactory and comfortable compared with green buildings?

REFERENCES:
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Building Use Studies. (2011). The Building Use Studies (BUS) Occupant Survey: Origins and Approach Q&A. In B. U. Studies (Ed.).
Gou, Z., Prasad, D., & Siu-Yu Lau, S. (2013). Are green buildings more satisfactory and comfortable? *Habitat International, 95*(0), 156-161. doi: http://dx.doi.org/10.1016/j.habitatint.2012.12.007
Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done. *Assessment & Evaluation in Higher Education, 99*(3). doi: 10.1080/02602930701293231
Zigenfus, R. E. (2008). Element analysis of the green building process. (M.S. 1460281), Rochester Institute of Technology, United States -- New York. Retrieved from http://search.proquest.com/docview/89311507?accountid=28930 ProQuest Dissertations & Theses (PQDT) database.

METHODS:

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Identify research problem
        ↓
Develop objective & research questions
        ↓
Select study buildings
        ↓
Obtain clearance from Ethics Committee
        ↓
Conduct questionnaire survey
        ↓
Calculate satisfaction, comfort & forgiveness indices
        ↓
Compare to BUS benchmark
        ↓
Compare to published data
        ↓
Calculate performance of study buildings against other buildings using z-score
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QUESTIONNAIRE SURVEY

- Best method to investigate occupant's perception
- Easy to conduct
- Can be generalized
- Cost-efficient

Building Use Studies (BUS) Occupant Survey
- One of two large scale survey used globally for building performance
- Have developed database and benchmarks based on 50 recent buildings surveyed from 17 countries
- Provides an analysis method that is quick and thorough

Print form and self-administered
- Returns higher response rate than electronic or postal survey (Baruch, Y. ,1999)
- Captures actual occupant of buildings studied on location

Questions:
- Demographic questions
- Comfort levels:
  - Thermal, Indoor air quality, Acoustic, Visual, Overall
- Satisfaction levels:
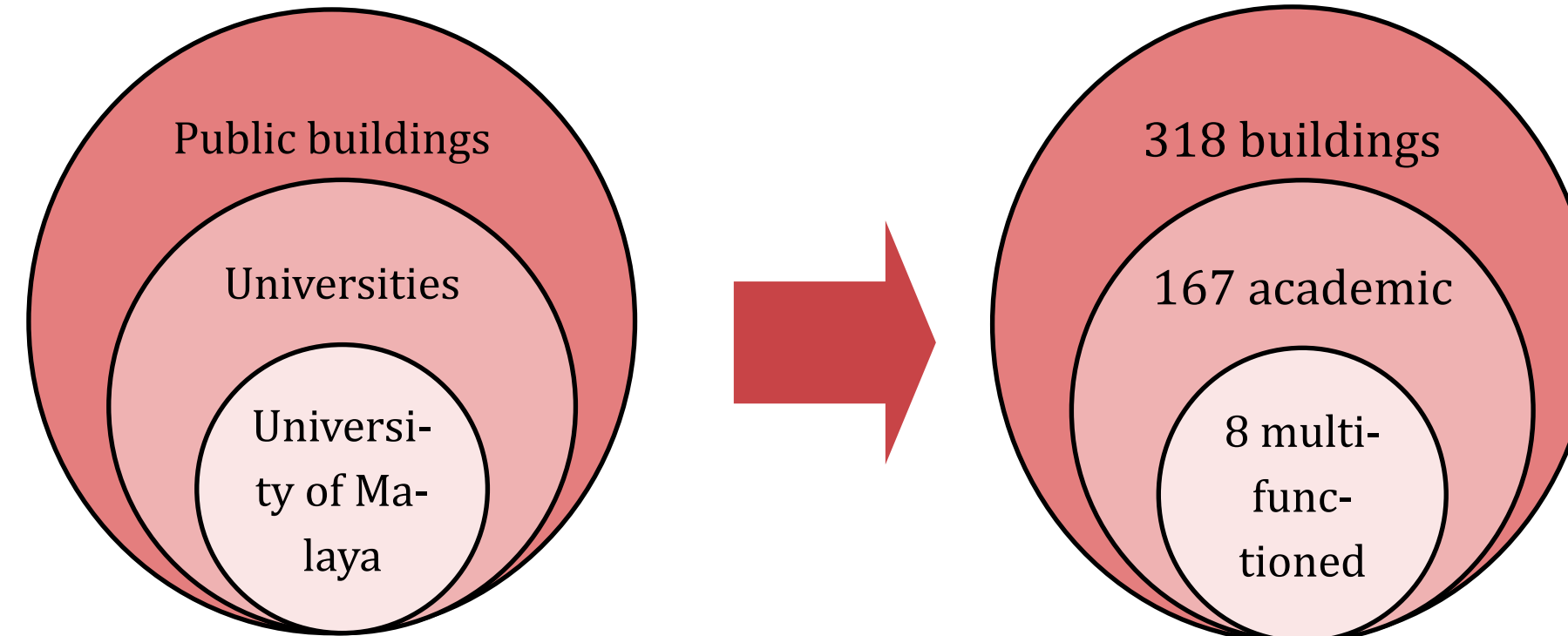 - Design, Needs, Health, Perceived productivity

SAMPLING:

Table 1: Study Buildings built-up area and response rate

Code	Built up area (m2)	Year completed	Survey response rate (%)
A1	20,611.50	2012	53.33
A2	8,314.01	1999	68.00
A3	7,875.55	1997	72.67
A4	4,945.32	1979	72.67
A5	11,480.50	1996	29.33
A6	3,953.08	1999	4.67
A7	8,913.24	2002	Barely occupied
A8	3,545.48	1971	Barely occupied

Table 2: Study Buildings Characteristics

Building	A1	A2	A3	A4
Building facade				
Building Form & Orientation				
Building height	10 storeys	3 storeys (split levels)	4 storeys	2 storeys (split levels)
Roof Properties				
Glazing Properties				
External Properties	brickwall, aluminium louvers and aluminium composite cladding	brickwall	brickwall, tempered tinted black glass, flushed façade with sun-shading louvres, aluminium composite panels	brickwall
Internal Wall Properties	plaster & paint, tempered glass and gypsum	plaster & paint, rooms too small to have internal partitions	plaster & paint, gypsum	plaster & paint, gypsum
Ventilation Type	VRF (Variable refrigerant flow) & air cooled package	Split unit	Split unit & air cooled package	Split unit & air cooled package & water cooled package

$$Z = \frac{score - benchmark\ mean}{benchmark\ standard\ deviation}$$

Z-score describe how far the study building is from the benchmark mean and thus how well it performs

$$Satisfaction\ Index = \frac{Zdesign + Zneeds + Zproductivity + Zhealth}{4}$$

$$Comfort\ Index = \frac{Ztempover + Zairover + Zlightover + Znoiseover + Zcomfover}{5}$$

$$Forgiveness\ Index = \frac{Zcomfover}{(Ztempover + Zairover + Zlightover + Znoiseover)/4}$$

'Forgiveness' : a measure for tolerance of the building occupant for its indoor environment
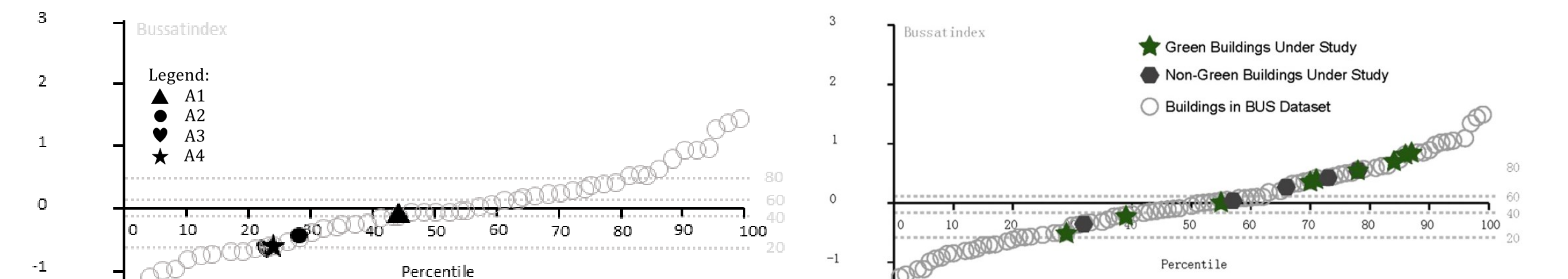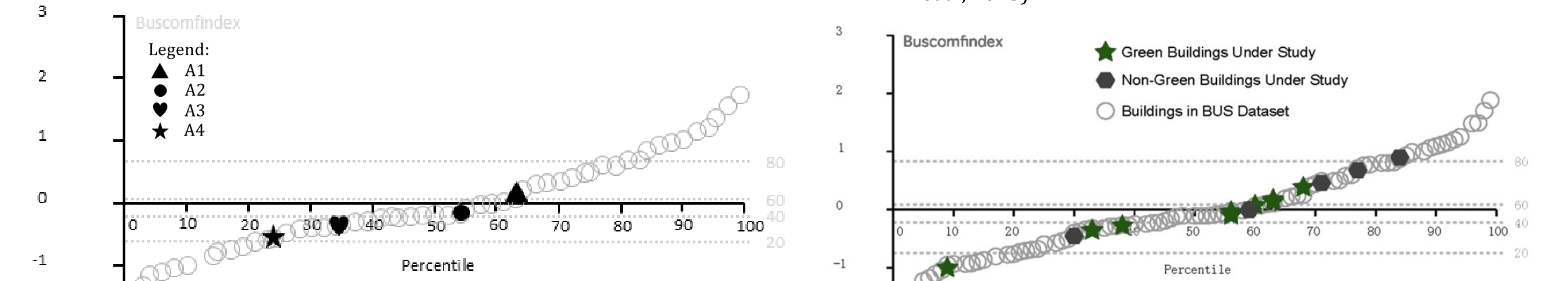

Figure 1: Satisfaction Index for Study Buildings

Figure 2: Comfort Index for Study Buildings

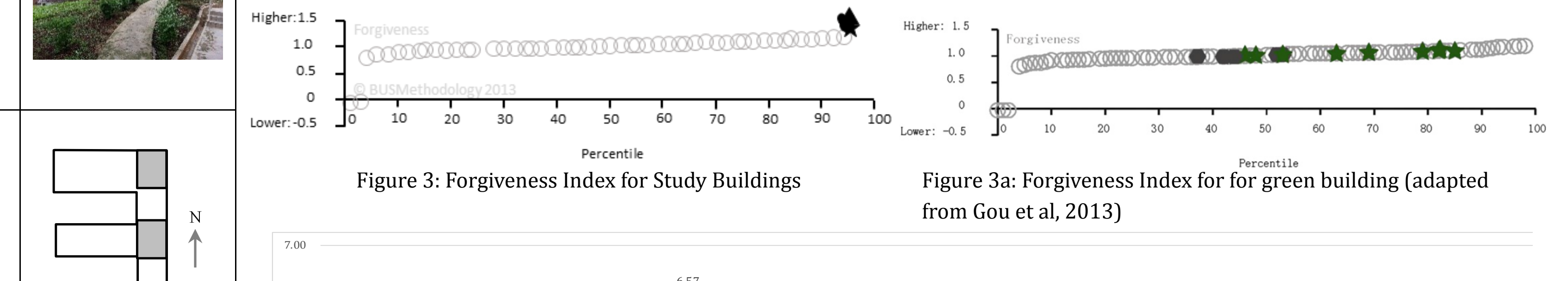Figure 1a: Satisfaction Index for green building (adapted from Gou et al, 2013)

Figure 2a: Comfort Index for green building (adapted from Gou et al, 2013)
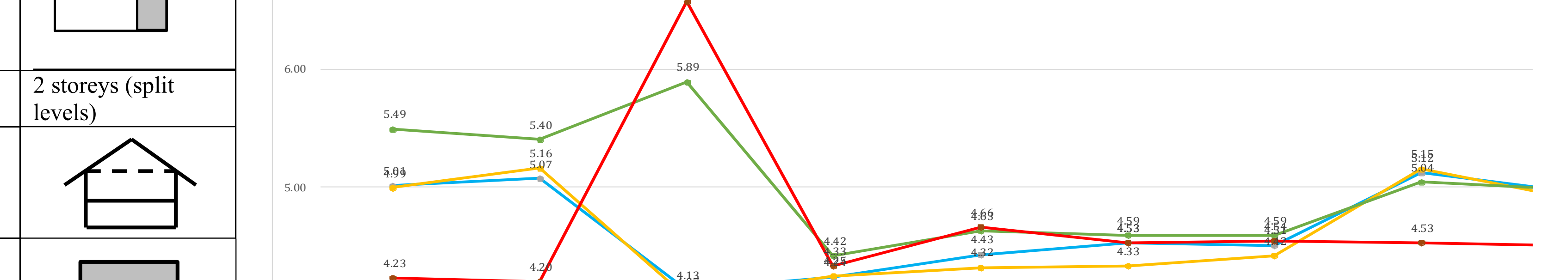

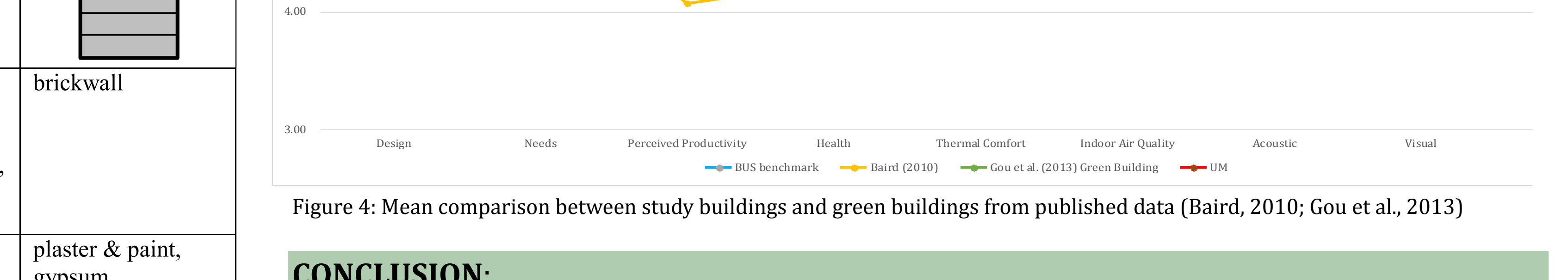Figure 3: Forgiveness Index for Study Buildings

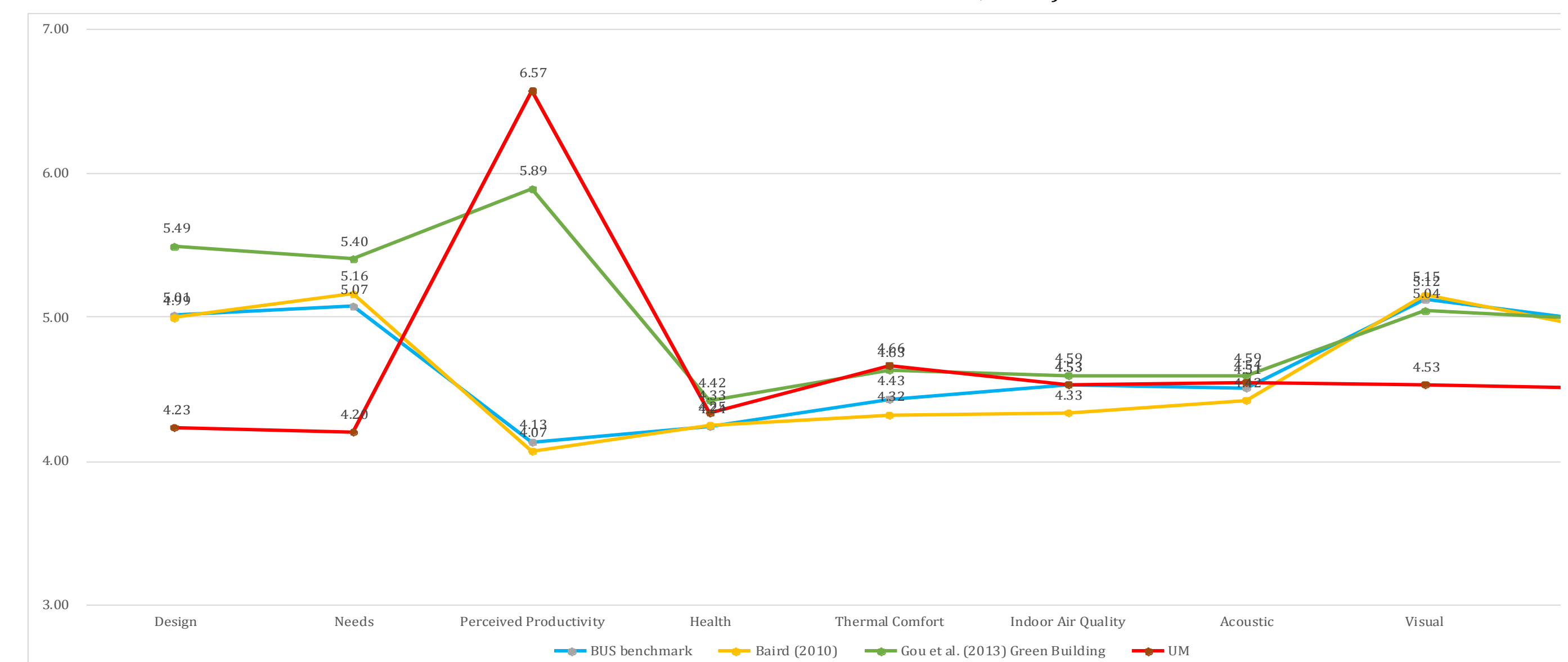Figure 3a: Forgiveness Index for for green building (adapted from Gou et al, 2013)

Figure 4: Mean comparison between study buildings and green buildings from published data (Baird, 2010; Gou et al., 2013)

CONCLUSION:

Despite earlier prediction that conventional building will perform less than green building, the study show that the study buildings scored less only for design and needs satisfaction, as well as visual and overall comfort. In addition, their occupants perceived that their productivity increased highest compared to occupants from green buildings. Figure 1-3 show that the study buildings score almost equally with green buildings from Gou et al.'s (2013) study.

In comparison with the BUS benchmark (Figure 4), the study building were below the 50th percentile for satisfaction and comfort. Building A1 often score higher while building A4 is the opposite. Building A1 is 33 years younger than building A4, therefore, it can be concluded that green buildings do not guarantee occupants' satisfaction and comfort but building's age and condition may impose a greater influence.