

Investigating the energy performance and maintenance resources of quality hotels in Hong Kong

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Outline of presentation

- Introduction
- Past relevant studies
- Approach
- Findings
- Conclusions

Introduction

- ❑ Global building sector
 - more and more buildings
 - more and more sophisticated facilities in buildings
 - more and more energy consumption
 - greenhouse gas emitted → global warming



Introduction

- ▣ Buildings in Hong Kong
 - high-rise, jam-packed



Introduction

- Hong Kong
 - a popular tourist destination

- 2012
 - over 48.6 million visitors
 - over 23.7 million were overnight visitors
 - average length of stay was 3.5 nights

- 2013
 - Over 54.3 million visitors
 - more and more hotels are needed



Introduction

- Hotels with **quality facilities**
 - engineering installations (chiller, boiler, lift, and lighting ...)
 - leisure facilities (swimming pool, sauna, gym equipment ...)

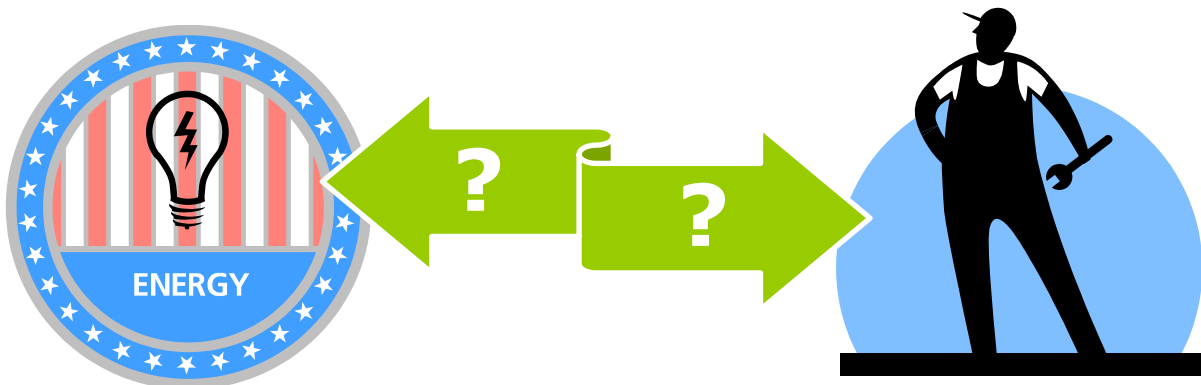
- Biggest share (**42%**) of total energy use due to the **commercial sector**

- Hotels belong to the commercial segments that used
 - 40,255 TJ in 2000
 - 63,962 TJ in 2010

(1 TJ = 10^{12} J)

Introduction

- Energy use and occupancy cost during **O&M stage** of a building life cycle prevail over other stages
- Yet little has been done to research into the **relation between energy performance and maintenance effectiveness** of hotels



- Aimed at contributing knowledge to this area, a study was carried out

Past relevant studies

- ❑ Many research studies have been carried out to study the energy use of buildings, including hotel buildings.
- ❑ Some investigated parameters such as
 - business performance (e.g. revenue, return on investment)
 - management/administrative expenses (e.g. labour cost, front-of-the-house hours)
- ❑ Some on O&M costs of hotels
 - energy cost being the greatest

Past relevant studies

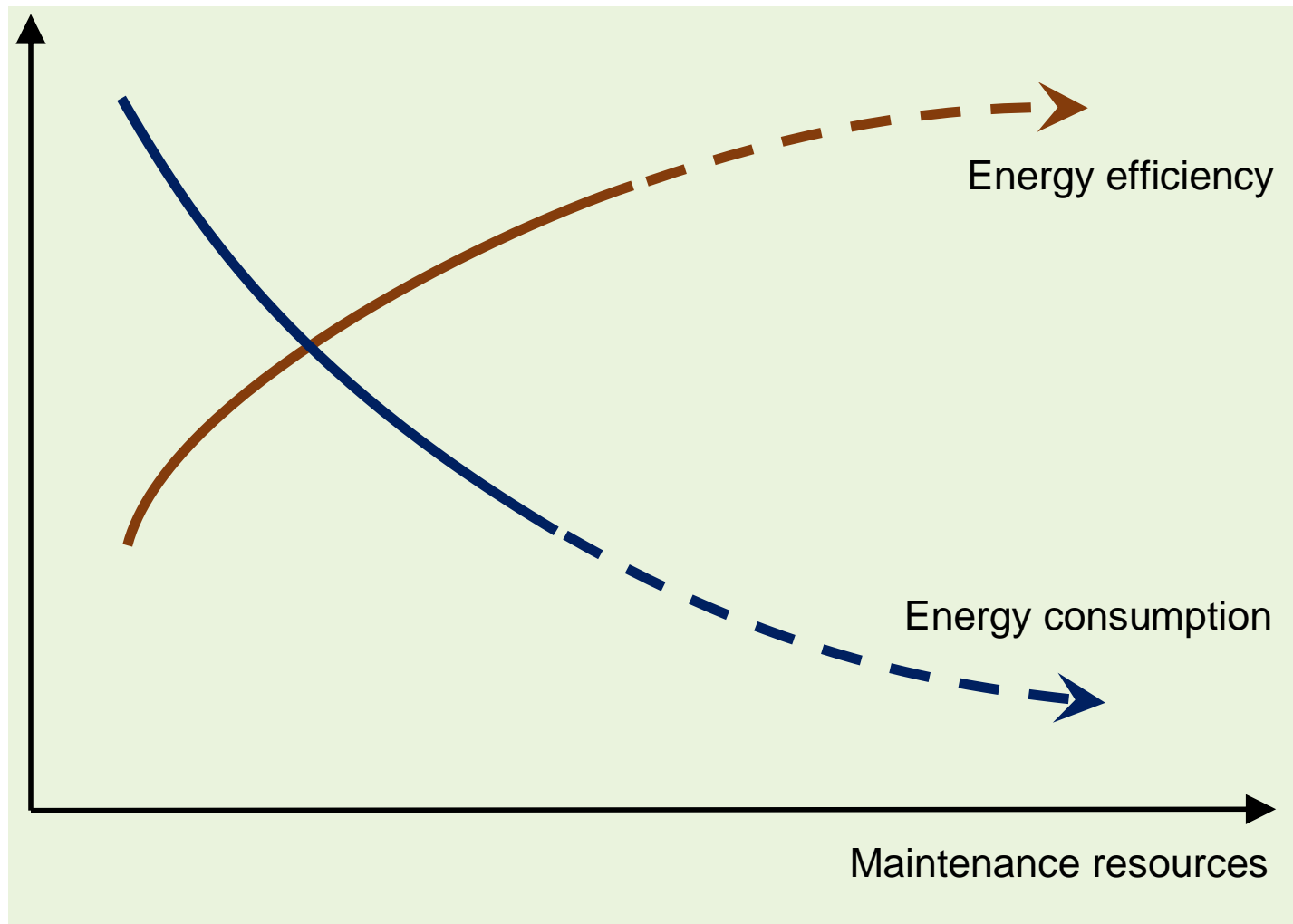
- ❑ A group of studies focuses on energy performance of hotels
- ❑ Another emerging group probed into the maintenance performance of hotels
- ❑ Limited studies on the relation between energy performance and maintenance resources

Approach

□ The premise

- energy performance is linked with level of maintenance
- higher level of maintenance resources input
 - allow more and better maintenance work to be carried out
 - enable the energy-consuming facilities to perform more efficiently
 - energy-efficient facilities use less energy

Approach



Approach

- ❑ **Energy performance** refers to the amounts of utilities the building consumed
- ❑ **Maintenance resources** include those for
 - maintenance staff
 - routine repair and maintenance work
 - some capital projects to improve existing facilities
- ❑ Such utilities and costs data are
 - **sensitive and difficult to obtain**
 - therefore collected by **face-to-face interviews**
- ❑ A **data template** was designed to facilitate collection of the utilities consumptions and maintenance resources data

Approach



- **Types of data collected:**
 - star rating of hotel
 - building age
 - gross floor area
 - number of guestrooms
 - occupancy rate
 - annual costs of maintenance staff, repair and maintenance work, and capital project
 - annual consumptions of utilities including electricity, diesel oil, town gas, and water

- **Maintenance costs include all those required for**
 - **builder's works** (e.g. façade, roof, ground)
 - **building services installations** (e.g. electrical, air-conditioning, fire, piped services)

Approach

- ❑ Analysis was started with figuring out the **descriptive statistics** of the data, including
 - those about the **characteristics of the hotels**
 - **utilities consumptions**
 - amounts of **maintenance resources** input
- ❑ Then data were processed to generate **benchmarking curves** for the various kinds of utilities consumptions and maintenance resources
- ❑ Finally **correlations between different parameters** of energy consumption and maintenance cost were **tested to identify the relation between** energy performance of the hotels and their maintenance resources.

Findings

- Data of 20 hotels
 - Collected from Director of Engineering/Chief Engineer
 - 11 nos. 5-star hotels (e.g. Marriott)
 - 9 nos. 4-star hotels (e.g. Holiday Inn)
 - total guestrooms: 10,529 nos.



Findings

□ Characteristics of the hotels

	Mean	Min.	Max.	S.D.
Star rating	-	4	5	-
Building age (year)	16.9	2	34	9.3
Floor area (m ²)	41,401	14,975	65,024	14,359
Guestroom (nos.)	526	113	884	174
Occupancy rate (%)	84.8	65.0	94.0	7.3

Findings

▣ Annual utilities consumptions of the hotels

	Mean	Min.	Max.	S.D.
Electricity (GJ)	50,197	15,259	109,101	22,605
Town gas (GJ)	11,908	500	55,317	11,984
Diesel oil (GJ)	8,892	0	40,007	13,586
Water (m ³)	162,843	43,305	297,000	61,334

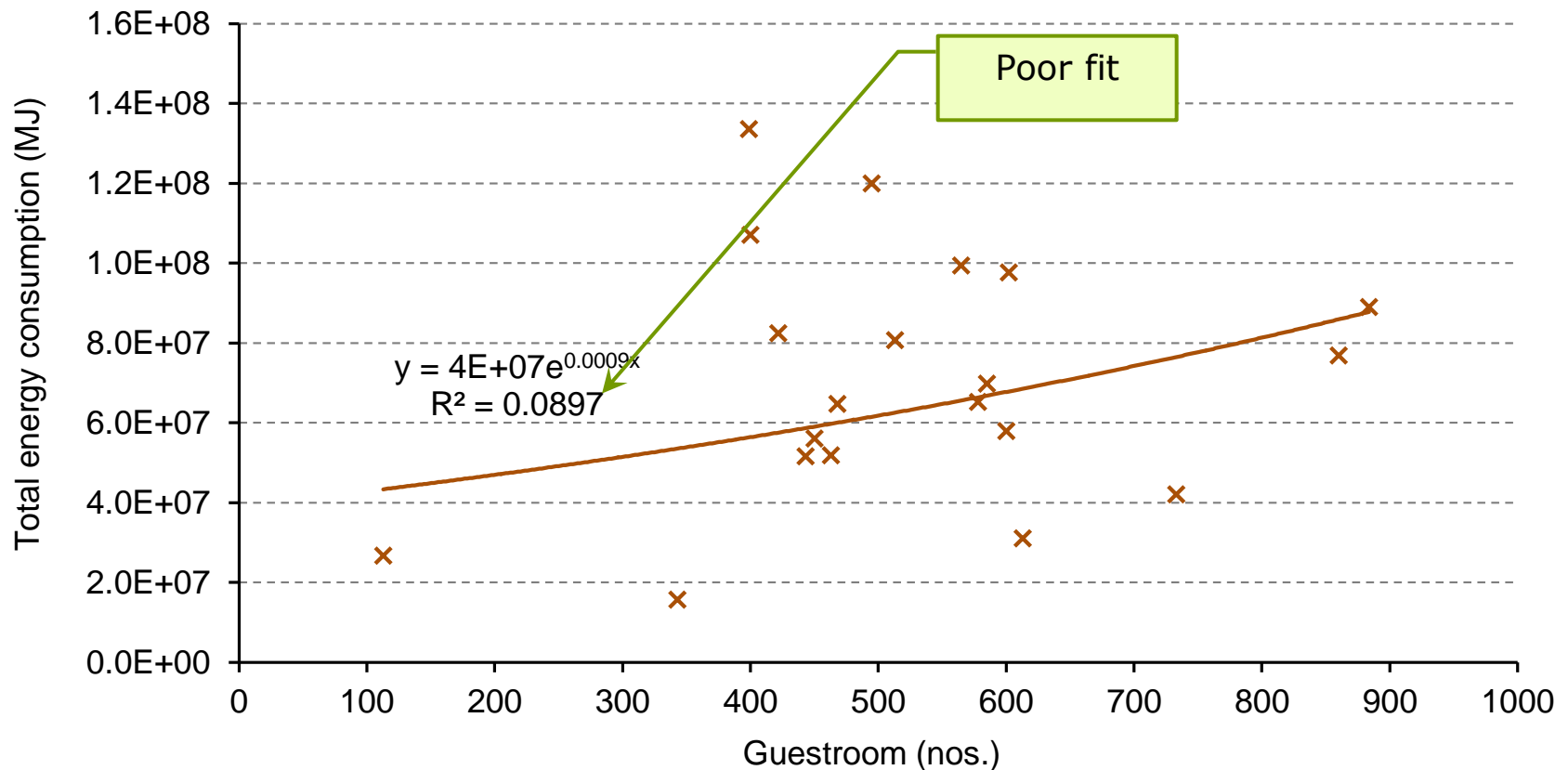
Findings

□ Annual maintenance resources of the hotels

	Mean	Min.	Max.	S.D.
Repair & maintenance (HK\$)	8,255,100	1,698,857	18,414,369	4,884,890
Capital project (HK\$)	11,126,478	1,191,000	23,000,000	7,502,980
Maintenance staff (HK\$)	5,692,214	2,469,018	8,845,669	1,917,371
Total (HK\$)	44,117,196	12,253,324	62,898,628	12,745,538

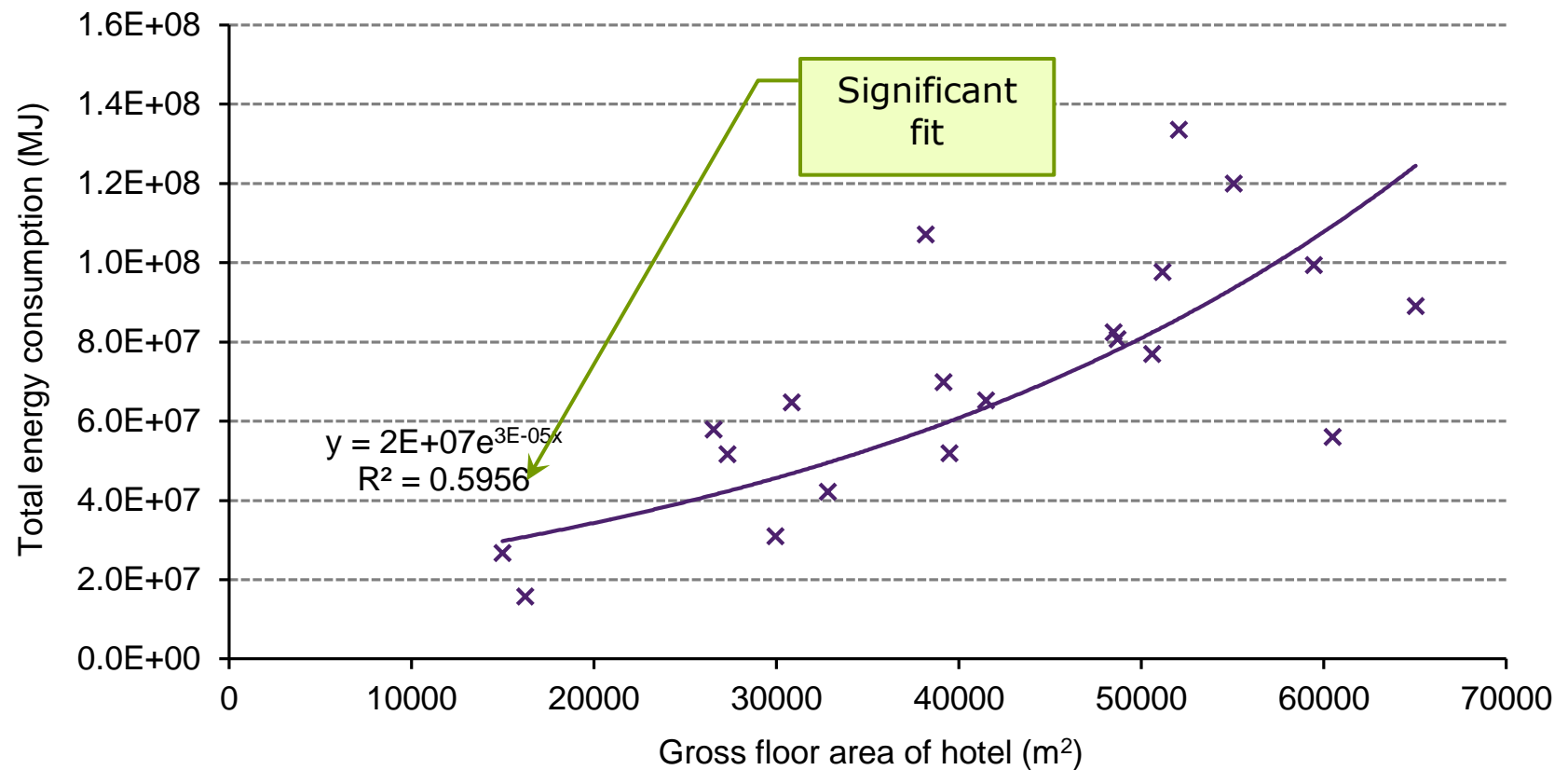
Findings

- Relation between total energy consumption and number of guestrooms



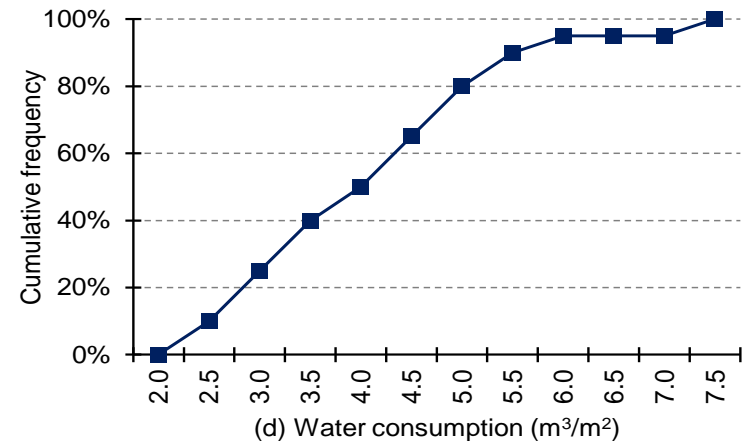
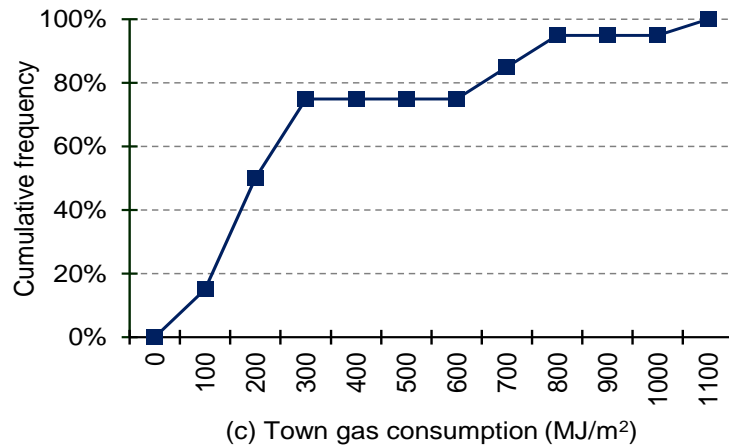
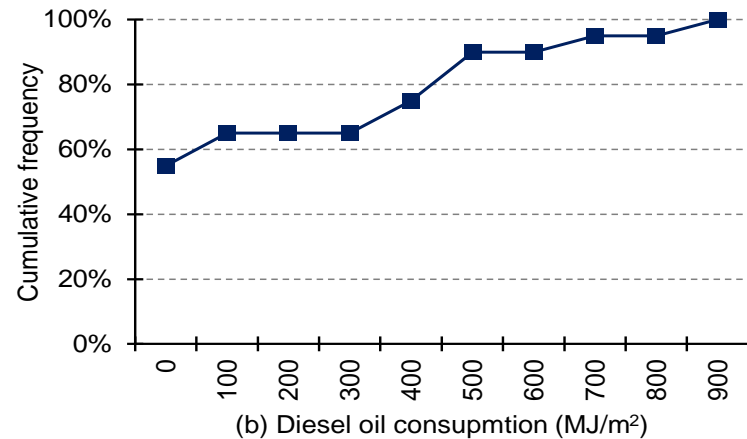
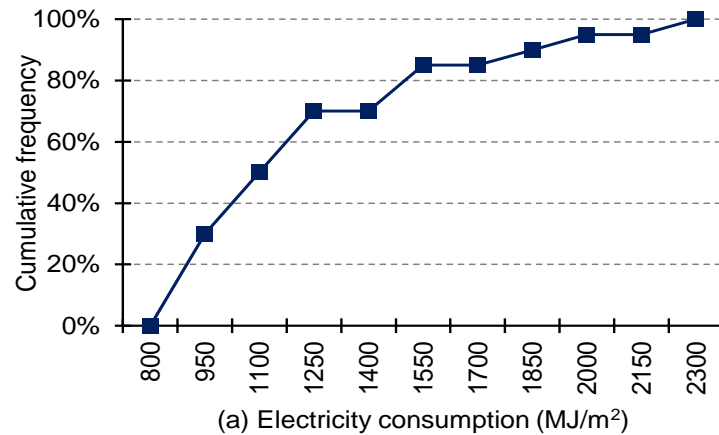
Findings

□ Relation between total energy consumption and floor area



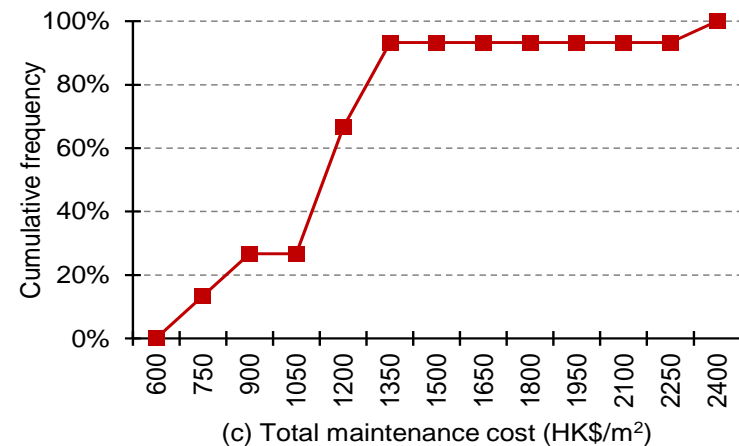
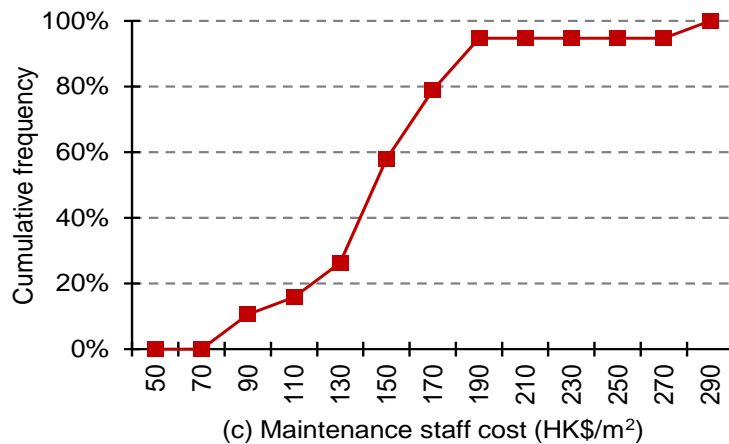
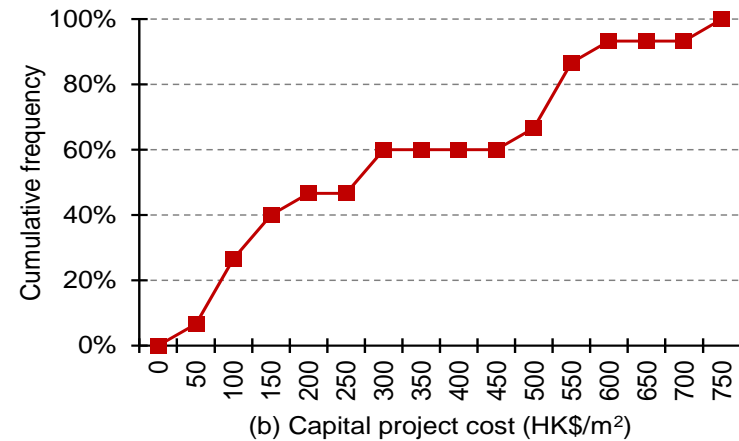
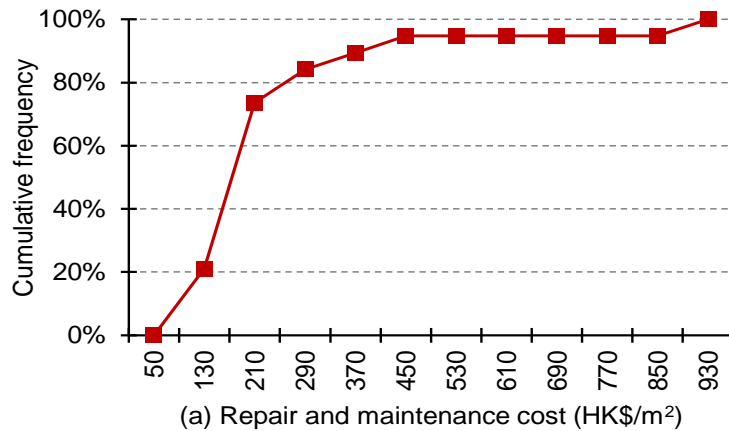
Findings

□ Benchmarking charts for utilities consumptions



Findings

□ Benchmarking charts for maintenance resources



Findings

- Correlations between total energy use and characteristics of the hotels

Parameter	n	Pearson coefficient, r	Sig.
Age (years)	20	0.0574	0.8099
GFA (m ²)	20	0.7280	0.0002**
Guestroom (nos.)	20	0.1759	0.4581
Occupancy (%)	20	-0.3846	0.0940

**correlation is significant at the 0.01 level (2-tailed)

Findings

- Correlations between total energy use and maintenance resources

Parameter	n	Pearson coefficient, r	Sig.
Repair and maintenance cost (\$)	19	0.3863	0.1023
Capital project cost (\$)	15	-0.3318	0.2269
Maintenance staff cost (\$)	19	0.6248	0.0042**
Total maintenance cost (\$)	15	0.0865	0.7592

**correlation is significant at the 0.01 level (2-tailed)

Findings

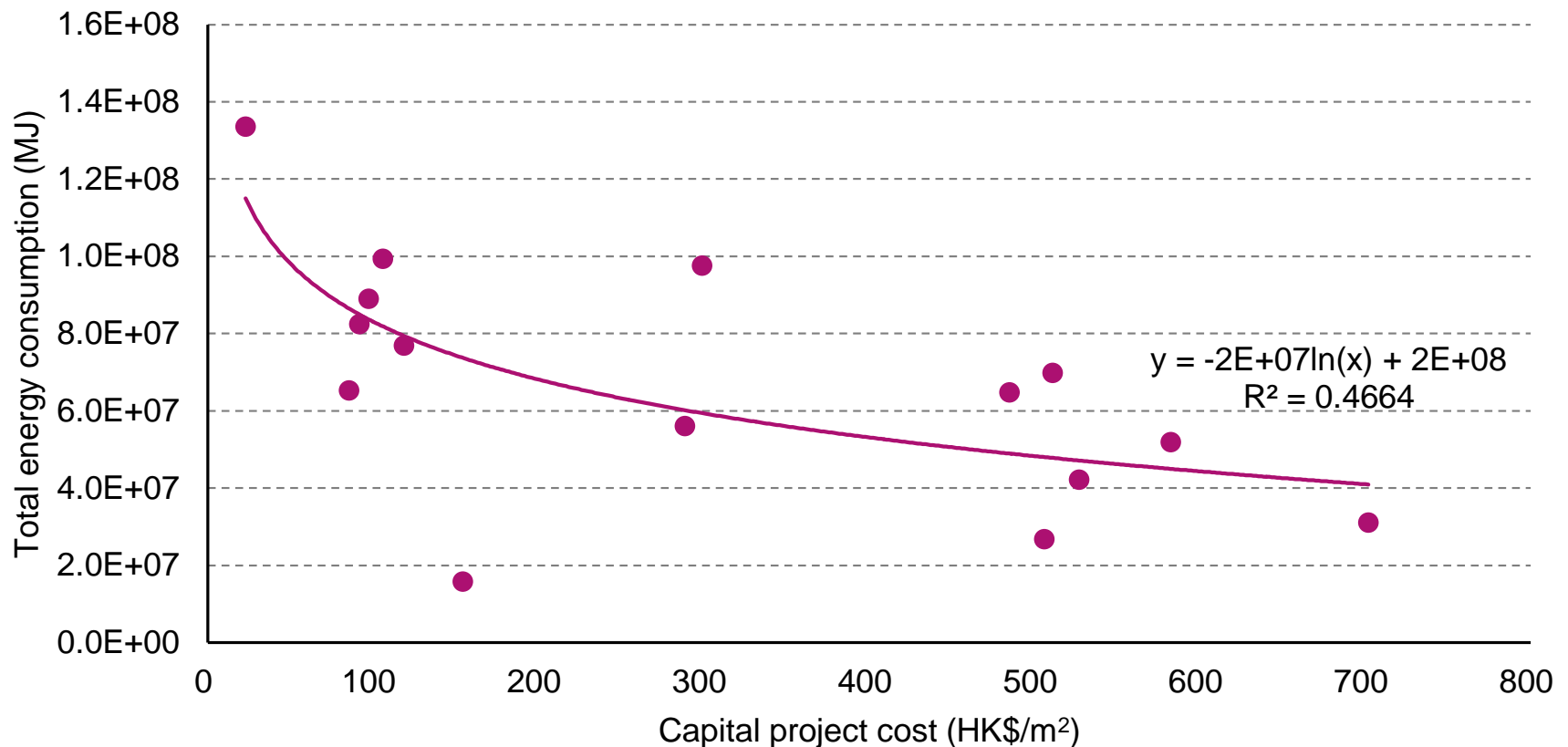
- Correlations between total energy use and normalised maintenance resources

Parameter	n	Pearson coefficient, r	Sig.
Repair and maintenance cost (\$/m ²)	19	-0.1693	0.4884
Capital project cost (\$/m ²)	15	-0.5930	0.0198*
Maintenance staff cost (\$/m ²)	19	-0.3130	0.1920
Total maintenance cost (\$/m ²)	15	-0.5550	0.0317*

*correlation is significant at the 0.05 level (2-tailed)

Findings

- Relation between total energy use and capital project cost



Conclusions

- ❑ The study is among the **limited research** that attempted to investigate the link between energy performance and resources used for maintaining hotel buildings.
- ❑ It showed that among the various energy uses, **electricity consumption dominated**.
- ❑ **Enormous amount** of maintenance resources
- ❑ **Capital projects cost generally exceeds** cost for maintenance staff or repair and maintenance works

Conclusions

- ❑ Instead of number of guestrooms, **gross floor area** was found to be a **better parameter for normalising the total energy consumptions** of the hotels.
- ❑ Cumulative distribution curves were developed based on the normalised data for
 - **benchmarking energy consumptions**
 - **benchmarking maintenance resources**
- ❑ These benchmarking tools can **facilitate comparison and evaluation** of the energy performance and maintenance effectiveness of similar types of hotels.

Conclusions

- ❑ Gross floor area, representing the scale of hotels, was the only characteristic parameter exhibiting a strong correlation with the total energy use of the hotels.
- ❑ The correlation analyses showed that hotels with greater investment in capital projects were less demanding in their total energy use.
- ❑ This highlights the link between energy performance and maintenance works for improving condition of facilities.
- ❑ Further work to examine the effects of factors such as grade, age, and occupancy rate on the maintenance resources as well as energy performance of the hotels.

End of presentation

Thank you!