DEVELOPMENT OF AN ENVIRONMENTAL ASSESSMENT METHOD FOR WATER MANAGEMENT IN CHINESE RESTAURANTS

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CERTIFICATE OF ORIGINALITY

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_____________________ (Signed)

Lo Yuk, Jennifer

ABSTRACT

In Hong Kong, Chinese restaurant sector makes up nearly half of the restaurant industry in 2007. However, it is evident that they produce more pollution than other types of restaurants. Therefore an environmental assessment method (EAM) was proposed to monitor and control pollutions stemmed from Chinese restaurant operations. This was an exploratory attempt to investigate water management issues in Chinese restaurants. The objectives of this study were to (1) investigate the current state of water consumption and sewage generation in Chinese restaurants; (2) identify potential areas for operational improvement in conserving water and controlling sewage; and (3) develop an EAM for water management in Chinese restaurants. The research was divided into three phases, and the target population is the five thousand Chinese restaurants in Hong Kong.

In the first phase, case studies were carried out in three local Chinese restaurants. Data were collected by in-depth interviews, observations, field measurements and archival records. Major water-consuming procedures in Chinese restaurants were identified, such as dishwashing, cold-water thawing and hot water supply near frying wok station. It was further discovered that the dish washing section and the cold-water thawing station were the two most water-consuming functional zones in a typical Chinese restaurant, accounting for 40% and 30% of total water consumption respectively. The performances of various cold-water thawing methods were also compared by a series of field tests. It was found that the application of thawing machine and microbubble-generating machine could save 20% and 13% of water respectively, comparing with traditional thawing

method. The projected payback periods were around 16 months and 10 months respectively.

In the second phase, a water consumption survey was conducted by collecting water consumption information from 52 local Chinese restaurants. It was discovered that the water consumption mean score is 2,840 cubic meters per month. Chinese restaurants that provided banquet services had a statistically higher water consumption mean score than those did not. Moreover, the water use index for local Chinese restaurants (WUI_{CR}) was established. For restaurants providing banquet services, WUI_{CR-B} was $0.9633m^3/m^2$ of kitchen's floor area; while for those not providing banquet services, the $WUI_{CR-W/OB}$ was $0.8012m^3/m^2$ of kitchen's floor area.

Findings from case studies and survey were finally used to develop the *EAM for Water Management in Chinese Restaurants* in the last phase. The EAM covered three areas – overall water use policy and training, water consumption, and water quality. It aimed to provide a comprehensive evaluation for local Chinese restaurants' performance on water management. The drafted document was then revised after review by various stakeholders. Finally, potential incentives and barriers of EAM implementation were also discussed.

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List of Abbreviations

AH&MA	American Hotel & Motel Association
BEAM	Building Environmental Assessment Method
BEPAC	Building Environmental Performance Assessment Criteria
BRE	Building Research Establishment
BREEAM	Building Research Establishment's Environmental Assessment Method
BOD	Biochemical Oxygen Demand
CCTV	Closed-Circuit Television
CET	Centre of Environmental Technology
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CSD	Census and Statistics Department
DAF	Dissolved Air Flotation
DEFRA	Department of Environment, Food and Rural Affairs, U.S.
DSD	Drainage Services Department
EAM	Environmental Assessment Method
EF	Electroflotation
EIA	Environmental Impact Assessment
ELP	Environmental Load Profile
EMS	Environmental Management System
EMSD	Environmental and Mechanical Services Department
EPA	Environmental Protection Agency of U.S.
EPD	Environmental Protection Department
ES	Electrostatic Spraying
EU	European Union
FEHD	Food and Environmental Hygiene Department
FGD	Flue Gas Desulphurizer
FOG	Fat, Oil and Grease
FOH	Front-of-the-house
GFA	Gross Floor Area
GFA_{FOH}	Gross Floor Area of Front-of-the-house Area

$GFA_{Kitchen}$	Gross Floor Area of Kitchen
GFA_{Total}	Total Gross Floor Area
GG21	Green Globe 21 Certification
GH	Green Hotel Certification
GN	Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places
HBEAS	Hotel Building Environmental Assessment Scheme
HK-BEAM	Hong Kong Building Environmental Assessment Method
HKHA	Hong Kong Hotel Association
HKSAR	Hong Kong Special Administrative Region
HKTB	Hong Kong Tourism Board
IAQ	Indoor Air Quality
IHEI	International Hotels Environment Initiative
IH&RA	International Hotel and Restaurant Association
ISO	International Organization of Standardization
LEED	Leadership in Energy and Environmental Design
LCA	Life-Cycle Assessment
LNG	Liquefied Natural Gas
MM	Microbubble Machine
MR	Microbubble Machine with Recycled Water
NBSC	National Bureau of Statistics of China
NIMBY	Not In My Back Yard
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxide
O_2	Oxygen
O_3	Ozone
P	Number of Patrons
PCC	Pollution control cost
PM	Particulate
PRC	People's Republic of China
R^2	Coefficient of Determination
SARS	Self-Propelled Semi-Submersible
SBS	Sick Building Syndrome
SC	Sewage Charge
SETAC	Society of Environmental Toxicology and Chemistry

SO_2	Sulphur Dioxide
SPSS	Self-Propelled Semi-Submersible
SS	Settleable Solid
SSDS	Strategic Sewage Disposal Scheme
TES	Trade Effluent Surcharge
TM	Thawing Machine
TR	Traditional Cold-water Thawing Method
UN	United Nations
UNEP	United Nations Environmental Program
UNEP IEO	United Nations Environmental Program Industry and Environment Office
VOC	Volatile Organic Compound
WSD	Water Supplies Department
WTO	World Trade Organization
WTTC	World Travel and Tourism Council
WUI	Water Use Index
WUI_{CR}	Water Use Index of Chinese Restaurants
$WUI_{CR\text{-}B}$	Water Use Index of Chinese Restaurants Providing Banquet Services
$WUI_{CR\text{-}W/OB}$	Water Use Index of Chinese Restaurants Not Providing Banquet Services

1. INTRODUCTION

1.1 Background of Study

1.1.1 The Restaurant Industry in Hong Kong and the Mainland

As the Chinese saying goes, "food is people's paramount concern". Hong Kong, as a popular Asian tourist city, has earned its well-known reputation as one of the most notable "*gourmet paradise in the world*", proffering a local cuisine which is famous for its exotic blend of Eastern and Western flavours (HKTB, 2007). In the past three decades, we witnessed that the local restaurant sector has been expanding, making it one of the largest industries in the territory. In 2007, the numbers of restaurants and persons employed have reached 11,116 and 217,985 respectively, with the total restaurant receipt of over HK$87.4 billion (Census and Statistics Department (CSD), 2008a). Considering all restaurant-types available in the territory, Chinese restaurants have the largest numerical count in Hong Kong, making up around 47% of the local restaurant industry in 2007 (CSD, 2008a).

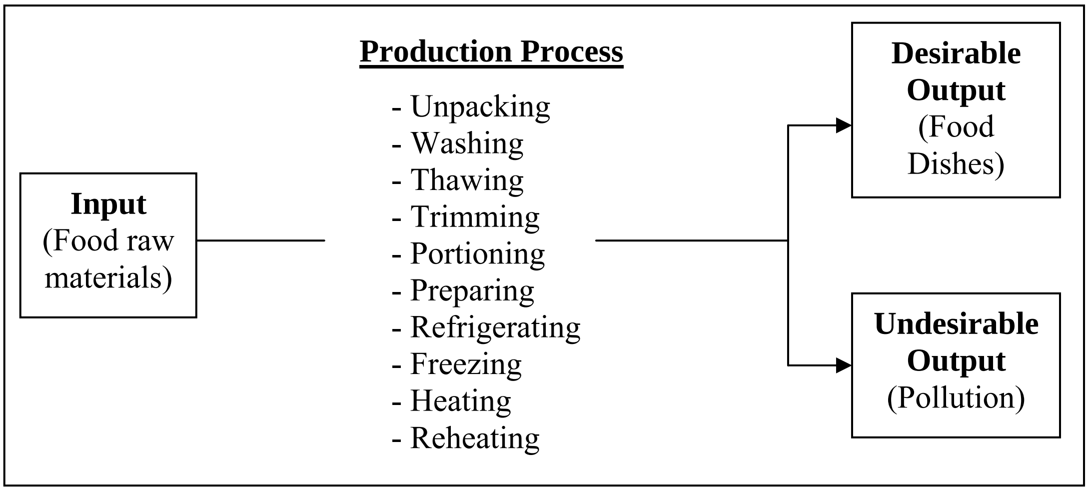
Over the past few years, the restaurant industry in Mainland China has been growing rapidly too. It is estimated that Mainland's restaurant industry consists of tens of thousands of establishments, from small-scale eatery to large-scale chain restaurants. Figures published by the National Bureau of Statistics of China (NBSC) (2007) showed that the number of restaurants above designated size[1] increased from 6,127 units in 2003 to 11,822 in 2007, nearly doubled in the past five years. Up to 557,000 persons were employed in this premium restaurant sector in 2006. This persistent increment is mainly the result of wealth increase of the Mainland Chinese. With the continuous growth of tourist arrivals to the region, the demand for catering service in Hong Kong and the Mainland is expected to continue to rise in the coming decades. More restaurants will be opened and more people will be engaged in order to cater the dining needs of local residents and international visitors.

1.1.2 Environmental Problems Created by the Restaurant Industry

This rapidly expanding catering industry, however, has imposed some negative impacts to the environment. Figure 1.1 simplifies the production process in a restaurant. The food raw materials (input) are converted into dishes for patrons (desirable output). However, some undesirable outputs may also be produced in the process, such as pollution. It refers to the "*direct effect of socio-economic activities on the components of the environment*" according to the United Nations (UN) (1997, p.29).

[1] including premium restaurants, snack counters, cafes and other establishments with more than 40 employees and more than 200,000 RMB annual sales.

Figure 1.1: Simplified Production Process in Restaurants



While the local Tourism Board continues to promote Hong Kong as a destination for gastronomy tourism, the environmental performance of our catering industry should not be overlooked. The Environmental Protection Department (EPD) categories 5 types of pollution problems generated by restaurants, namely, sewage, solid waste, air pollution, noise and energy-induced emissions. According to EPD (2004), complaints about restaurants in 2001 amounted to 2,220, with which 58% about polluted air, 30% about noise nuisance, and 12% about sewage and solid waste. Also, activities in the restaurant business consume huge amount of energy, which may be in the form of electricity and gas. The generation of electricity and gas at power plants causes emissions of greenhouse gases, such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2) and particulates. The environmental problems generated by the restaurant industry are summarized in Table 1.1. More details will be discussed in *Literature Review* (Section 2.1).

Table 1.1: Environmental Problems Generated by Local Restaurant Industry and Corresponding Local Control Ordinances

Pollutant	Present Situation	Corresponding Control Ordinance(s)
Solid Waste	Daily food waste up to 2,800 tones, i.e. 30% of total solid waste produced daily in Hong Kong (EPD, 2004).	🕮 Waste Disposal Ordinance
Sewage	Daily consumption of water up to 200,000m^3, and about 80% of which is discharged everyday (EPD, 2004).	🕮 Water Pollution Control Ordinance
Noise	Over 600 complaints were received by EPD in 2001 (EPD, 2004).	🕮 Noise Control Ordinance
Air Pollutants	Over 1,000 complaints were received by EPD each year from 1999 to 2001 (EPD, 2004).	🕮 Air Pollution Control Ordinance 🕮 Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alternation) Regulations 🕮 Air Pollution Control (Smoke) Regulations 🕮 Air Pollution Control (Fuel Restrictions) Regulations
Energy Consumption & Associated CO_2 & SO_2	Account for around 9% of the total energy consumption in Hong Kong. 50% of the energy is used for cooking, 30% for ventilation and air conditioning, and 6% for lighting (EPD, 2004).	

In particular, it is evident that Chinese restaurants produce more pollutions than restaurants serving other cuisines. Chinese restaurants consume more water in the preparation process (Chan and Au, 1998; Deng and Burnett, 2002b); they use more energy for lighting, air conditioning (Electrical and Mechanical Services Department (EMSD), 2006) and cooking (Chan and Au, 1998); they produce stinky and dark smoke (EPD, 2004); and they have poor indoor air quality (Benfenati, Pierucci and Niego, 1998; Lee, Li and Chan, 2001; Zhang and Kirk, 1999).

Kirk (1996) pointed out that the hospitality industry might not be "*in the front line of environmental concern*". It is because most of the hospitality firms are small-to-medium in size that do not cause gross environmental pollution nor consume vast amounts of non-renewable resources. However, if the adverse impacts of all these small individual operations are combined together, the industry does have a significant effect on global environment.

1.1.3 Directive and Voluntary Environmental Measures in Hong Kong

Being positioned as Asia's world city, Hong Kong should set the example by curbing its pollution problems and reduce emissions of pollutants which cause environmental problems on global scale, like atmospheric warming, acid rain and ozone depletion. The local policies on dealing with environmental pollution were set out in the White Paper "Pollution, A Time to Act" in 1989. Since then, the HKSAR Government has already shown increasing efforts in response to this growing environmental concern. For instance, an Energy Efficiency Advisory Committee has been set up; a Strategic Sewage Disposal Scheme has been implemented; and the Clean Air Charter has been recently launched. In 2006, the Chief Executive re-voiced the importance of environmental harmony in the society, and placed more emphasis on environmental work in the Policy Address (HKSAR Government, 2006b). In this message, the Government would continue to apply the "user/polluter pays" principle. Efforts would be stepped up in raising public awareness of environmental protection, and making Hong Kong a green city. Cooperation with Guangdong Province would also be strengthened particularly in the area of implementation of various emission reduction schemes and pollution control measures.

To cope with the environmental problems stemmed from restaurants, the government has applied both "push" and "pull" strategies. Currently, there are several directive ordinances controlling the pollution problems generated by local restaurants as listed in Table 1.1. These regulatory measures can be viewed as "push forces", as the restaurant operators must fulfill all the legal requirements when applying for a new license or renewing an existing one. In addition, the Environmental Protection Department has specifically launched a series of seminars and printed some booklets about the green practices of restaurants and the allied benefits (EPD, 2004), which are the "pull forces" to motivate restaurant operators to become eco-friendly.

Apart from the control ordinances executed by the Government, a firm can be motivated by voluntary certifications that distinguish outstanding environmental performance. The ISO 14001 certification is an example. Advocates of this standard suggested that it could provide a comprehensive "plan-do-check" framework for significantly improving the environmental performance of organizations, and even substantial operational and competitive benefits (Eroth and Zackrisson, 2000). Nevertheless, it was criticized being too generic that it does not specify performance criteria (Burnett and Chan, 2002).

An environmental assessment method (EAM) is another complementary measure to control pollution and encourage green practices in a more specific way. An EAM, in brief, is a point scoring system which provides information on environmental issues likely to be encountered, and awards green operations with an eco-label. Unlike the regulatory ordinances, an EAM is voluntary in nature. In other words, the operators can decide whether to take part in the assessment or not.

At present, there are several EAMs related to existing buildings / premises in Hong Kong, and some examples are listed in Table 1.2 below.

Table 1.2: Examples of Environmental Assessment Methods in Hong Kong

Type of building/premise	Corresponding Assessment Methods
Air conditioned office	[1] An Environmental Assessment for Existing Air Conditioned Office Premises, HK-BEAM Version 2/96
	[2] An Environmental Assessment for Existing Office Buildings, HK-BEAM Version 2/96R
New buildings	[3] An Environmental Assessment for New Building Developments, HK-BEAM Version 4/03
Hotels	[4] Hotel Building Environmental Assessment Scheme – An Environmental Assessment for Existing Hotels, Version 1/00 (HBEAS)

Source: [1] CET (1996); [2] CET (1999); [3] HK-BEAM Society (2004); [4] HKHA (2000)

Although a hotel and a restaurant share some similar features, the assessment scheme for local hotels mentioned in Table 1.2 is not applicable to restaurants because of three reasons. First, the pollutants produced by a restaurant are characterized with a huge volume of FOGs (fats, oils and greases), organic waste, and smoke during the cooking process. This is different from the case of a hotel. Second, most restaurants are small-to-medium enterprises. They are not comparable to hotels in terms of resources, especially capital and labour. Third, it is discovered that the current assessment method for existing hotel buildings only covers energy and water usage in general kitchens (Hong Kong Hotel Association, 2000). The ways to evaluate gas consumption, noise level, odour, indoor air quality, solid waste and sewage generation in various types of kitchen have not been addressed. Particularly, solid waste and sewage have exerted the most traumatic impact, in terms of their remediation costs, on the environment (Chan, 2005). Thus there is a need to reconstruct a separate EAM tailor-made for restaurant establishments.

Additionally, during the life of a commercial restaurant, alternations and refurbishments are likely to be occurred, with extensive changes to the restaurant's layout and building materials. The way the restaurant is managed and maintained may be changed as well. These come to the opportunity for improving the environmental performances of the premise. An environmental assessment can identify those improvements and provide recognitions.

1.2 Problem Statement, Research Scope and Objectives

1.2.1 Problem Statement

The local restaurant industry is one of the largest business sectors in the territory in terms of revenue and number of person engaged. Considering its rapid growth in the past few decades, the pollution problems associated with the restaurant businesses are becoming more serious. And among all types of restaurants, Chinese restaurants dominate in terms of number, gross floor area and the amount of pollution produced.

Unlike the hotel industry, there is a lack of understanding of environmental problems created by the restaurant industry. In particular, very few past studies in this area deal with the environmental issues of Chinese restaurants. There appears a gap of knowledge which needs to be filled by providing a better understanding of the adverse environmental impacts created by Chinese restaurants.

Hong Kong provides an excellent context for this study, because the local catering industry is well-developed. The Chinese restaurant sector represents the most significant part of the local restaurant industry. In addition, the recent announcement of the green focus in the government's business plan, public concern for the environment now runs deeper than at any time in Hong Kong's history. Companies are now being appraised not merely on their financial performance, but also their ethical performance and social responsibility. The prospect that the restaurant industry will be receptive to a campaign on environmental protection looks promising.

Furthermore, the fast development of China's restaurant industry has generated a need for better environmental practice. An eco-friendly restaurant industry in Hong Kong would have far-reaching implications for the environment in the region.

1.2.2 Research Scope

In light of the above conditions, a study was carried out to develop an EAM for restaurants in Hong Kong. Since the local restaurant industry comprises a large number of relatively heterogeneous entities, it was unsuitable to develop a generic EAM applicable to the entire restaurant industry. Therefore, the Chinese restaurant sector was chosen, due to its dominance and significance in the local restaurant industry.

Originally, it was planned to develop the entire EAM, evaluating all the pollution categories stemmed from local Chinese restaurants. However, it was later found it was not possible to construct the entire EAM. It was because the development of an EAM would require immense time, resources and manpower, as revealed by one of the members of the HBEAS and HK-BEAM development team. He manifested that setting the assessment criteria was the most time-consuming procedure in developing the two EAMs. Therefore, the current investigation focused on only one of the pollution categories – sewage. This category was selected because the pollution-control cost for sewage treatment in Hong Kong is the highest among all pollution problems (Chan, Wong and Lo, 2008). The cost for controlling sewage accounted for over 70% of the total pollution-control cost in Hong Kong in 2005. A summary of regulatory requirements about water supply and sewage discharge for local restaurant premises is attached in Appendix 1.1.

1.2.3 Research Objectives

This was the first large-scale study about water-related environmental issues of Chinese restaurants. The objectives were to:

1. investigate the current state of water consumption and sewage generation in local Chinese restaurants;
2. identify potential areas for improvement in conserving water and controlling sewage in Chinese restaurant operations; and
3. develop an environmental assessment method for water management in Chinese restaurants.

Overall, this study was aimed at raising the awareness of the Chinese restaurant sector with regards to the support for green operation. In particularly, the reduction in water use and sewage generation could help reduce the operation expenses of the concerning establishments. Also, it was hoped that the long-term adverse environmental impacts that Chinese restaurants impose on the environment would be reduced.

1.3 Structure of Thesis

Chapter 1 explains the research background, problem statement, objectives and scope of study. After this introductory chapter, the previous literature are examined and discussed in Chapter 2. Then in Chapter 3, the methodology of this study is explained. This study constituted three phases – case studies, water consumption survey and development of EAM. The findings and discussions of the three phases are detailed in Chapter 4, 5 and 6 respectively. Finally in Chapter 7, the major findings of this study are reviewed, and significances are presented. In addition, some recommendations for Chinese restaurant operators, decision makers, trade associations, as well as further studies, are made.

2. LITERATURE REVIEW

This chapter presents a self-study context review. Existing literature relevant to the research area were examined and discussed. The purposes were to identify if there was any trend or gap in the literature, and to determine how and where the current study could fit into the literature. Previous researches could also shed a light on designing the methodology of the current study. Before conducting the literature review, it would be useful to revisit the research objectives. The objectives of this study were to examine the current state of water consumption and sewage generation in local Chinese restaurants, identify the potential areas for operational improvement, in order to develop an EAM for water management for these establishments.

The pollution problems created by restaurants are discussed first in Section 2.1. Since this study focused on scrutinizing water consumption and sewage generation problems, these issues are examined in detail in Section 2.2. Next, literatures about Chinese restaurants' history, development, as well as the detrimental environmental impacts stemmed from their business activities, are presented in Section 2.3. These pollution problems have led to the discussion on how businesses react to the greening urge from customers in Section 2.4. Review of published works about greening of business can help identify any gap in the literature. Following that, literature about EAM is reviewed in Section 2.5. Various hospitality EAMs worldwide are compared and contrasted, so as to provide some insights to the EAM development process of this study. Finally, this chapter ends with a summary presented in Section 2.6.

2.1 Pollution Problems Created by Restaurants

Environmental impact of local activities would have global effects on the planet (Jacobson and Price, 1990; Kruse, 1994; Malone and Roederer, 1985; Stern, Young and Druckman, 1992). The U.S. Green Building Council (1996) alerted that the "side-effects" of human activities are straining the limits of the Earth's "carrying capacity". This referred to the Earth's ability to provide the necessary resources to sustain life while retaining the ability to regenerate and remain viable. In order to cease the rate of natural degradation and sustain our resources, it is necessary to determine the potential pollution problems produced by different human activities, as well as the use of appropriate treatments or pollution abatement technologies.

2.1.1 Definition of Environment, Pollution and Pollutant

Before examining the pollution problems produced by restaurants, it is essential to define the terms "environment", "pollution" and "pollutant". From an ecological perspective, the "environment" refers to a totality of existence, conditions and things that affect an organism (Bhardwaj and Rao, 1998). The environment forms an inevitable component of tourism, sharing a complex relationship (Pigram, 2000).

According to the Department for Economic and Social Information and Policy Analysis of the United Nations, "pollution" is the:

> "**1**. *Presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects;* **2**. *activity that generates pollutants*".
>
> (UN, 1997, p.58)

And Holdgate (1979) defined pollution as,

> "*The introduction into the environment of substances or energy liable to cause hazards to human health, harm to living resources and ecological damage, or interference with legitimate uses of the environment.*"

Pollution is caused by pollutant which is defined as:

> "*Substances that is present in concentrations that may harm organisms (human, plants and animals) or exceed an environmental quality standard.*"
>
> (UN, 1997, p. 58)

Many of the human activities are producing various kinds of pollution, which have caused some global and regional environmental problems, such as global warming (Hong Kong Observatory, 2006; U.S. Environmental Protection Agency (EPA), 2006a), ozone depletion (U.S. EPA, 2006a; 2006b), abiotic resources depletion (BP Global, 2004), air pollution (Chang and Koo, 1986; Cheng, Chan and Chan, 1997; "Chief Executive", 2006; "Dongguang factories", 2006; Information Services Department, 2006; Tao, 2003; Wong, 2000), and water pollution (EPD, 2004; "Sea water", 2004).

2.1.2 Pollutions Created by Restaurant Operations

As visualized in Figure 1.1 in Section 1.1.2 (see page 2), pollution is generated as an undesirable output during the production process of a restaurant. The term "primary pollution" applies to the production of any pollutant at a premise or directly associated with its operations. According to EPD (2004), the key primary pollutants stemmed from foodservice operations include 1) solid waste, 2) FOG-containing sewage, 3) noise, 4) air pollutants, and 5) greenhouse gases emitted from power plant due to the use of electricity or gas.

An extensive literature review regarding these five pollutant categories was conducted at the initial stage of this study. For each kind of the pollutants, respective applicable abatement methods were also studied. The United Nations (1997) defined pollution abatement method as the "*technology applied or measure taken to reduce pollution and/or its impacts on the environment*", such as scrubbers, noise mufflers, filters, incinerators, waste-water treatment facilities, and so forth. The importance of understanding technological advance in pollution control has been recognized for more than twenty years, when marketing expert Philip Kotler suggested that companies should respond effectively to such a marketing opportunity as environmental concern in early 1980s (Kotler, 1984). While specific environmental abatement methods are employed for each type of primary pollutant generated directly from restaurants, the current treatments also produce some derivative environmental problems which are very often neglected by the general public. These derivative environmental problems are also examined.

It has been decided that the scope of this study should be placed on water consumption and sewage generation problems. Therefore, the reviewed contents about other pollution categories are attached in Appendix 2.1, while the contents about water and sewage is presented in Section 2.2 below.

2.2 Water as Important Natural Resources

2.2.1 Worldwide and Local Water Resources

Water is an important and irreplaceable resource of our society. There is no doubt that consumption and disposal of water are important global issues. Rapid economic development and droughts have caused shortages of water in numerous locations. The shortage in water supply has led to increases in the purchase and disposal prices of water. According to the National Restaurant Association (2008a), the cost of a gallon of water is rising faster than the inflation rate. By 2025, 4 billion people, which is about half of the world's population, will live in "severe water stress" condition.

2.2.2 Local Water Supply

According to a recent survey concerning the perceptions of different building professionals on the environment, water was perceived as the most important resources for the sustainability of our society (Lo, Zhao and Cheng, 2006). Table 2.1 presents the fresh water resources and consumption data in Hong Kong in the past 11 years (Water Supplies Department (WSD), 2008b). The average fresh water resources from 1997 to 2007 were 963.47 million cubic meter. Only one-fourth of the water resources were from local yield. Local water supplies rely mainly on water from Dongjiang, Guangdong Province. Under the existing deal, the local government has to pay around HK$2.5 billion each year for buying the water resources from Dongjiang, though not all are consumed.

Table 2.1: Water Resources and Consumption in Hong Kong

Calendar Year	Water Resources: Yearly Local Yield (Mm^3)	Yearly Water Supply from Dongjiang, Guangdong (Mm^3)	Total (Mm^3)	Yearly Consumption (Mm^3)
1997	224.24	679.62	903.86	913.37
1998	237.93	760.02	997.95	915.60
1999	106.37	737.95	844.32	910.72
2000	260.76	706.36	967.12	924.13
2001	301.46	728.63	1030.09	939.55
2002	252.40	743.84	996.24	948.65
2003	252.67	760.58	1013.25	973.75
2004	111.00	808.43	919.43	955.33
2005	298.16	770.60	1068.76	967.71
2006	319.95	617.27	937.22	963.42
2007	186.65	715.35	902.00	950.89
Average	231.96 (24.1%)	731.51 (75.9%)	963.47	942.10

Sources: WSD (2008a, 2008b)

WSD is in charge of providing potable water for household and commercial premises. Over 99.8% of the local population is served with fresh water supplies in 2006 (WSD, 2008a). The average fresh water consumption from 1997 to 2007 was 942.1 million cubic meter. The daily average was 2.58 million cubic meter (WSD, 2008b). Domestic fresh water consumption per capita was 127.6 litres per day. Most domestic water treatment works and pumping stations are powered by electricity. On average, 0.591 kWh of electricity is required per cubic meter of fresh water supply (WSD, 2008a). Currently, the local water charge is HK$4.58 per cubic water consumed. Around 16% of the total potable water supply is consumed by the local restaurant industry, i.e. more than 80 million cubic meter every year (Drainage Services Department (DSD), 2008).

2.2.3 Water Consumption in Restaurants and Hotels

Water use in hotels and restaurants is very much diversified. Major water users are the in-house laundry, guest rooms, kitchen and swimming pool. Several studies had been carried out to investigate water consumption and sewage discharge in hospitality settings as summarized in Table 2.2. Although this does not represent an exhaustive list of relevant previous researches, the summary of previous published articles can reflect the seriousness of restaurants' water consumption and sewage generation problems.

Industry norms of water consumption by hotels have been established in existing literature. In Chan and Lam's (2001c) study, the average water consumption was 1.145m^3 per occupied room per day, based on the figures recorded in 1994-1996. On the other hand, Deng and Burnett (2002b) found that average water use, which was termed "Water Use Index (WUI)" in their study, was 4.5m^3 /m^2. In addition, some large hotel chains had separately recorded the water consumption in cubic meters. These water consumption data are useful in evaluating trends in water consumption, allowing projections of future water demands, assessing water use performance, and ascertaining the impact of water-saving measures (Deng and Burnett, 2002b).

Besides, water consumption in hotels and restaurants is affected by several factors. Many previous studies have investigated and identified the underlying reasons. For instance, the American Hotel & Motel Association (AH&MA) (1995) suggested that the variation in water consumption could be explained by fluctuations in business volume and weather conditions. Also, large hotels tended to offer services and amenities associated with high volume of water consumption, such as fine-dining restaurants, swimming pools, extensive landscaping and central chilled water plant. A similar result was reported in another study carried out by Waggett and Arotsky (2006). They found a major correlation between the “star” rating of the hotel and the water consumption. The higher is the star rating, the more is the water consumption. Another study done by Deng and Burnett (2002b) found that the laundry load, the number of guests and the number of food covers would collectively influence the total water consumption in a hotel. In-house laundry consumes nearly half of the total water used by a hotel. The average WUI for hotels with an in-house laundry was significantly higher than those without an in-house laundry. Water consumed by laundry can be up to 30% of the total water consumption of a hotel. For those without an in-house laundry, more than 50% of the water consumption goes to the kitchen.

Table 2.2: Summary of Literature about Water Consumption and Sewage Generation in Hotels and Restaurants

Author(s) (Years)	Place of Study	Aim(s) of Study	Sample Size	Instrument	Major finding(s)
Kumar, *et al*. (1987)	Southeast Asia				- Daily total hot water consumption in entire hotel was not related to the no. of occupants nor the no. occupied room.
AH&MA (1995)	U.S.	To develop models which permit estimation of water consumption for hotels with various sizes, market segments and property components.	148	Survey	- Large hotels tended to offer services and facilities associated with high volumes of water consumption. - Water consumption per occupied room per night was 114 gallons.
Chu and Hsu (1999)	Hong Kong	To identify the major pollutant sources in all types of food preparation in typical fast food restaurants of different sizes.	3 30	Case study Survey	- 43% of the process water is used for meat defrosting. - Pre-boiled broth releases the highest concentration of oil/grease and chemical oxygen demand (COD) of all the processes. - More than 60% of the COD and oil/grease comes from the washing of pots, pans, and dishes.
Thames Water's unpublished report (as cited in Waggett & Arotsky,2006)	U.S.	To investigate water use in hotels and proposed benchmarks for a number of hotel types.	597	Desk research of secondary data	- Water consumption per occupied room per night was 30-40m^3 for B&Bs, 40-60m^3 for 2to3-star hotels, and 80-100m^3 for 4to5-star hotels.

(Table 2.2 Cont)

Author(s) (Years)	Place of Study	Aim(s) of Study	Sample Size	Instrument	Major finding(s)
Chan and Lam (2001c)	Hong Kong	To estimate the environmental costs of the hotel industry's water consumption and major water uses in hotel operation.	20	Survey	- Water consumption per occupied room per night was $1.145m^3$. - Green cost attributable to water consumption per occupied hotel room ranged from HK$3.657 to HK$7.641.
Deng and Burnett (2002b)	Hong Kong	To report a study of water use in a number of leading hotels in Hong Kong.	17 1	Survey Case Study	- Avg. Water Use Index (WUI) was $4.5m^3/m^2$. - Laundry load, no. of guests and no. of food covers would collectively affect the water use in a hotel.
Alonso (2008)	Australia	To explore the views of hospitality operators on water consumption and water conservation.	158	Survey	- Most hospitality operators were aware of the importance of water for their businesses, but it is not among their main current concerns.
Chan, Wong and Lo (2009)	Hong Kong	To estimate the average water consumption and the environmental costs attributed to water consumption in local hotels; To examine various water-saving technologies and measures adopted by local hotels.	28	Survey	- Avg. water consumption decreased from 1.145m3 in 1994-1996 to 0.904m3 in 2001-2002. - Flow regulator is the most common water saving device used in local hotels.

2.2.4 Generation of Sewage from Restaurants

Restaurants consume water for washing food ingredients, cooking, washing dishes and cleaning. After the consumption of water, sewerage is produced. The term "sewerage" refers to the "*organic waste and waste water produced by residential and commercial establishments*" (UN, 1997, p.66. The effluent from restaurants may contain heavy metals, pathogens, preservations, pesticide, detergent and other chemicals (EPD, 2004). When the effluent is discharged into the river system, it may cause poisoning in aquatic organisms and human beings.

Sewerage generated by restaurant kitchens also contains FOGs. These are basically triglycerides consisting of straight-chain fatty acids attached, as esters, to glycerol. The fatty acids may differ in chain length, may be saturated or unsaturated, and may contain an odd or even number of carbon atoms (Wakelin and Forster, 1997). According to EPD (1996), restaurants and food processing factories are the main sources of wastewater with FOGs. In 2000, local restaurants produced 55 million tones of liquid effluent, in which FOGs accounted for over 10% of the effluent content. The fatty acid concentration of the effluent grease depends on the menu, and the types of cooking fats and oils used in the kitchen. When these greasy substances accumulate in the drainage pipe, the drainage system may be blocked. Overflows, offensive odour and an unhealthy environment are the possible consequences.

In fact, the local government has determined the permission standards, in terms of physical, chemical and microbial quality, that make effluents acceptable to public sewers. The Water Policy Group of EPD had published a technical memorandum regarding the standards for effluent discharged into local drainage and sewerage systems (1991). Major indicators of sewage quality include pH value, chemical oxygen demand (COD), biochemical oxygen demand (BOD), oil and grease and settleable solid (SS). Table 2.3 below shows the permission standards of these indicators in Hong Kong, as well as the estimated quantities in sewage from several types of restaurant.

Table 2.3: Permission Standards of Various Indicators for Sewage Quality
(to the nearest 0.1)

Indicator	Permission Standard in HK [a]	Type of Restaurant [b]		
		Chinese Restaurants	Western Restaurants	Fast Food Restaurants
pH	6.0 –10.0	6.2 – 8.0	6.3 – 7.2	6.3 – 7.2
COD (mg/l)	3,000.0	292.0 – 3,390.0	912.0 – 3,500.0	980.0 – 4,240.0
BOD (mg/l)	1,200.0	58.0 – 1,430.0	489.0 – 1,410.0	405.0 – 2,240.0
Oil & grease	100.0	120.0 – 172.0	53.0 – 2,100.0	158.0 – 799.0
SS (mg/l)	1,200.0	13.2 – 246.0	152.0 – 545.0	68.0 – 345.0

Sources:
[a] Water Policy Group of EPD (1991) [b] Chen, Chen and Po (2000)

It was observed from Table 2.3 that Chinese restaurants may not be the worst pollutant generator, but the estimated levels of most pollution indicators (e.g. FOG, BOD, COD, pH) in Chinese restaurant effluent had exceeded the local permission standard. Nowadays, Chinese restaurants dominate the local restaurant industry. Altogether, the adverse impacts of sewage generating from these establishments would significantly deteriorate the environment. Therefore it would be worthwhile to investigate their water use and sewage problem.

2.2.5 Sewage Treatment in Hong Kong

Sewerage treatment refers to "the process to render waste water fit to meet environmental standards or other quality norms" (UN, 1997, p.77), and it can be divided into two levels – on-site sewage treatment and public sewage treatment.

In Hong Kong, it is illegal to dump untreated wastewater into public sewer (EPD, 1996), thus sewage from restaurants must go through the on-site treatment first. Basically, on-site sewage treatment facilities must be highly efficient in removing FOGs, cause no food contamination, compact in size and easily operated by restaurant staff, with low capital and operating costs (Chen, *et al.*, 2000).

Currently, all local restaurants and food processing factories are required to install grease traps, which are used for separating FOGs from wastewater before passing into communal sewers (EPD, 1996). A typical grease trap is a two-chambered tank positioned along the wastewater drain pipe. When the wastewater passes through the trap, it slows down, thus allowing time for less dense greasy materials to rise to the liquid surface. Greasy stuffs accumulated in the grease trap must be removed regularly. Restaurant managers should decide the frequency of grease trap cleaning depending on the type of food served.

Apart from grease trap, the method of "electrocoagulation" is another option for restaurant operators to remove FOGs in kitchen effluent. Electrocoagulation has been tested to be a simple yet efficient method for treatment of potable water and wastewaters. It is particularly effective in treating wastewaters containing small and light suspended particles, such as swage from restaurants (Chen, *et al*., 2000).

After the sewerage is discharged, it is transferred to the second level – public sewage treatment facilities via the drainage system. The local Drainage Services Department is responsible for treating municipal sewerage in Hong Kong. Currently, there are four types of sewage treatment facilities according to DSD (2008). The first type is the preliminary screening plants, which screen and remove solids larger than 6mm in diameter from the sewerage. The second type is the primary treatment plants, where a primary sedimentation process is carried out. Solid waste and settleable suspended solids are removed. The third type is the chemically-enhanced primary treatment plants. Chemical are added during the treatment process to facilitate the removal of suspended solids and the biochemical oxygen demand. The last type is the secondary treatment plants, where sewerage is purified by means of a biological treatment process. The invention of microbial cultures for use in a bioreactor provides effective treatment of grease-containing restaurant wastewater (Wakelin and Forster, 1997). Grease removal by microbial cultures involves complicated chemical and biological reactions. The principle mechanism is by removing the fatty acids from the glycerol molecules of the triglycerides with the aid of microorganisms. Yet expensive, this method is by far the most effective in FOG removal.

The sewage treatment service provided by the government can be divided into two categories – 1) construction of sewerage and sewage treatment and disposal facilities; and 2) operation and maintenance of such facilities (EPD, 2003). The government bears all the construction costs for capital projects, while the users of sewage treatment services contribute by paying for the operation and maintenance costs under the "user/polluter pays principle". Prior to the introduction of this principle to the sewage charge scheme, the cost of sewage collection and treatment came entirely from the public revenue (DSD, 2008). As the public was unaware of the cost of the sewage services, they had no incentive to reduce water pollution. Since 1995, sewage dischargers have been required to pay the cost for sewage services according to the quality and quantity of their discharge. Therefore apart from water charge, the Sewage Charge (SC) and Trade Effluent Surcharge (TES) have also been imposed on around 30 industries since April 1995. SC aims at recovering the cost of collecting and treating wastewater at or below domestic strength. TES aims at recovering the additional cost of treating trade effluent with pollution strength exceeding the domestic sewage.

Since the wastewater from restaurants has a high FOG concentration, these establishments have to pay both SC and TES. Starting from April 2009, SC for local foodservice establishments is HK$1.43 per cubic metre of water consumed with a discount factor of 70%, while TES is HK$3.05 per cubic metre with a discount factor of 80%. The sewage disposal fee will soon be increased to HK$2.4 per cubic meter, but the rate would still be among the lowest in the world (Cheung, 2005; "Polluter pays principle", 2007).

The local Government's determination to clean up water can be traced back to the formulation of Strategic Sewage Disposal Scheme (SSDS) in early 1990s. The scheme consists of enhancement of primary treatment of sewage and building outfall beyond Lamma Island. More recently, a stepped up proposal, worth HK$19.5 billion to clean up the Victoria Harbour has been released. Under the plan, all sewage will be treated before being discharged into the harbour (Tang and Wallis, 2004). In 2005, the Government eventually formulated a "Total Water Management Policy" to achieve higher efficiency in water usage (HKSAR Government. 2006a). During the same year, a pilot project reusing domestic effluent for non-drinking purposes has also been started in Ngong Ping, Lantau Island (Cheung and Chan, 2004). According to Dr. Liao Sau-tung, the former Secretary for the Environment, Transport and Works, the cost of turning sewerage into reusable water was comparatively low. Therefore the use of recycled water for non-drinking purposes should be expanded. Reduction in water consumption will not only reduce water charge and sewage charge, but also the emissions of greenhouse gases from the energy-intensive process of heating, transporting and treating water.

2.2.6 Water Conservation in the Hospitality and Restaurant Industry

According to Mr Ng Tak-Leung, Chairperson of Hong Kong Federation of Restaurants and Related Trades, the monthly water bill for an individual Chinese restaurant ranges from HK$7,000 to HK$15,000. Altogether, the restaurant industry pays HK$2 billion every year for SC and TES ("SC", 2004).

This charging principle is generally accepted by the local restaurant industry practitioners, but it still accounts for a significant proportion of the operating expenses. Thus restaurant operators have to cut water expenses, otherwise they may have to shift the burden to the patrons by raising the food price ("Increasing pressure", 2007).

In the early 1990s, AH&MA had already recognized the importance of water on the future of the hotel industry. Shanklin (1993) pointed out that the availability of potable water to meet competing demands will significantly affect the hospitality and tourism industry. Water conservation efforts must be implemented in all areas of the hotel and restaurant operations. In this regard, Brodsky (2005) suggested that the first step is to understand how much water is consumed by a premise, where the major uses occur and which of these occurrences can be improved upon with the best return. Submetering is the most effective way to do so. It is the second-most popular water saving measure in Hong Kong hotels (Chan, Wong and Lo, In print). Submeters are installed in different functional zones in a hotel, including kitchens (65%), laundry (50%) and guest rooms (42%). While a submeter itself cannot reduce water usage, it can assist managerial staff in measuring and monitoring water consumption in different functional zones. In practice, it is difficult to measure the water consumption of each guest room because it is infeasible to install a submeter for every room. However, installation of floor meter can effectively reveal significant water loss attributed to leakage flappers.

Apart from sub-metering, a number of water conservation initiatives in the hospitality industry have been developed and implemented in recent years. A desk research on existing water conservation initiatives in hotels and restaurants was, thus, conducted. This would aid the development process of assessment criteria in the *EAM for Water Management in Chinese Restaurants* in Chapter 6.

The findings were organized and summarized in Appendix 2.2. 18 green initiatives related to water conservation were identified from around the world. The water-related environmental guidelines in existing EAMs were also included. It should be noted that this might not be an exhaustive list, and the desk research was only limited to water conservation programmes written in English and/or Chinese. From Appendix 2.2, it was discovered that all the 18 water conservation initiatives were targeting general restaurants or hotel restaurants. There was no specific initiative for Chinese restaurants. Thus, there is a strong need for developing a tailor-made environmental assessment for Chinese restaurant operations on water consumption and sewage generation, given that the Chinese restaurant sector occupies nearly 63% of the total gross floor area of restaurants within the territory.

2.3 Chinese Restaurants and Their Pollution Problems

2.3.1 Development of Chinese Restaurant Industry

Broadly speaking, Chinese restaurants are those restaurants that offer Chinese cuisine to customers. However, in Hong Kong, restaurants owners have to indicate the type of business as “Chinese style restaurants” on the application form for new restaurant, if they are going to open a restaurant (FEHD, 2006). Therefore, the current study will only focus on those officially registered Chinese restaurants.

According to Yau and Lee (1996), Chinese restaurants make up the largest segment of the local restaurant industry, in terms of number of establishment, number of persons engaged, sales and market share. In 2007, there are 5,264 Chinese restaurants in Hong Kong, accounting for around 47% of the number of restaurants in the territory (CSD, 2008a). They offer a wide range of food choices from Cantonese cuisine, Shanghainese cuisine, Chaozhou cuisine, Chinese barbeque meats, vegetarian foods, noodles and congee, and other Chinese foods. Information from CSD (2008b) shows that in 2007, the annual receipt of local Chinese restaurants was HK$36,785 million. This represents 53% of the total restaurant receipt in Hong Kong.

Yau and Lee (1996) constructed a conceptual model for local restaurants. In their paper, they narrated the historical development of Chinese restaurants in Hong Kong. It was the late 1970s when the local economy began to recover, the restaurant business started to move into diversification. In addition to conventional Chinese restaurants, seafood restaurants gained greater popularity among diners. In the early 1980s, Chinese restaurant chains were established. Jade Gardens were the forerunner in the race, offering Cantonese cuisines. Later, more Chinese restaurant chains were formed. Some member restaurants in the same chain might operate under separate names. At the same time, independent restaurants also continued to flourish. Competition became intensive in this fast growing sector.

Chinese restaurants also outperform their counterparts in terms of market share in Mainland China. Zhao and Li (2001) examined the current status and future opportunities of the Chinese restaurant industry. They stated that traditional full-service Chinese restaurants are the backbone of the restaurant industry in Mainland China currently. Most of them feature one of the four major geographic cuisines – Shandong, Huaiyan, Sichuan and Guangdong. Zhao and Li (2001) predicted that the restaurant industry in the Mainland would continue to expand because of the fast-growing economy and an increasing domestic consumer demand.

Chinese cuisine is also very popular worldwide. According to Chen and Bowen (2001) and Qu (1997), Chinese restaurants performed well in the ethnic restaurant market segment in the United States, with more than 80% of the respondents selected it as a popular ethnic cuisine. In addition, the U.S. National Restaurant Association (1989) found that 78% of adults had tried Chinese food in the past, which was a higher percentage of people that had tried any other types of ethnic food.

Nevertheless, Chinese restaurants were the worst affected during the SARS outbreak in 2003. As much as 90% of their business was lost during the period (Tse, So and Sin, 2006). The service style of local Chinese restaurants might facilitate spread of virus, where patrons usually shared platters of food in a crowed environment. In response to the drop in Chinese restaurant business, the former Chief Executive, Mr Tung Chee-hwa, announced a HK$11.8 billion package including tax rebates, lower rent for shops in public estate shopping malls, reduced water and sewage charges for local restaurants.

2.3.2 Sewage Problem Created by Chinese Restaurants

Despite their dominance, Chinese restaurants produce apparently more pollutants than other types of restaurants in terms of sewage generation, energy consumption and air-pollution emissions. In particular, Chinese restaurants usually consume more water than other types of restaurant. It is because a large volume of water is used for "cold-water thawing" (啤水) (Chan and Au, 1998) (see Appendix 2.3), which is a unique process in Chinese cooking. Most food ingredients in Chinese restaurants are frozen to -18^{o}C for preservation. Therefore defrosting is necessary before any subsequent food processing in commercial kitchens. In Chinese kitchens, defrosting is usually done by cold-water thawing, in which frozen foods are placed under running tap water. Heat from water is transferred to the food surface, and then to the body. In addition, this process can expel unwanted taste and remove impurities of food ingredients.

According to an experienced Chinese chef, food stuffs need to be thawed include dried shark fins, frozen meat, ribs, shrimps, squids (土魷), chicken feet (鳳爪), jellyfishes (海蜇), and dried vegetables (梅菜). The thawing time must be well-controlled. Table 2.4 compares the time and amount of water required for thawing various food stuffs. The data can be treated as a reference, even though it was obtained from a local contractor of commercial thawing machines. If the thawing time is too short, the inner part of the food will remain frozen. On the other hand, if the thawing time is too long, it may cause chemical and biological deterioration of the food (Leung, Ching, Leung and Lam, 2005). This may be one of the reasons why Chinese kitchens usually use more water than Western kitchens (Deng and Burnett, 2002b).

Table 2.4: Cold-water Thawing of Various Food Stuffs

Food stuffs	Ribs	Shrimps	Chicken feet	Chicken steaks	Jellyfishes	Squids
Time needed (min per kg)	16.67	6	4.8	3.6	60	16
Amount of water needed (m^3 per kg)	1.10	0.39	0.32	0.24	3.95	1.05
Estimated water charge per kg* (HK$ per kg)	5.02	1.80	1.45	1.08	18.08	4.82

* HK$4.58 per m^3 for non-domestic water supplies   Source: Totaru Plan (H.K.) Ltd.

In Chu and Hsu's (1999) study, it was estimated that more than 40% of water is used for thawing meat by traditional thawing method. Although their study was carried out in a local Chinese fast food restaurant, this estimation gave a good reference to the situation.

A more eco-friendly option is the application of microbubble in cold-water thawing. Microbubbles are very small gas bubbles produced by a microbubble generating machine. These tiny gas bubbles are extensively used in many environmental and industrial processes, such as treatment of potable water and wastewaters, remediation of volatile contaminants in aqueous phase, and separation of particulate materials from the aqueous phase (Burns, Yiacoumi and Tsouris, 1997). For industrial and environmental treatments, smaller bubbles are preferred due to the higher surface area-to-volume ratio and the higher bubble density (Burns, *et al*., 1997). A comparison between different microbubble generating methods are presented in Appendix 2.4.

The application of microbubbles in foodservice industry is still in infancy. It has been introduced to the foodservice industry for a couple of years, mainly for keeping aquatic species alive in fish tanks. A microbubble generating machine (161cm x 218cm x 116cm) is put into the fish tanks to produce tiny gas bubbles with a diameter of 50 μm. The gas bubbles are so small that cannot be seen by naked eyes, but the water will gradually turn milky. These bubbles increase the oxygen concentration of water, thus help keeping the aquatic species for a longer period of time.

It is believed that microbubbles can also be used in cold-water thawing to save water and time. It is because the tiny gas bubbles can greatly increase the surface area for heat exchange during the defrosting process. Yet, its effectiveness and efficiency have not been proved. Therefore a field test would be carried out in this research to determine the performance of using microbubbles in cold-water thawing.

2.4 Greening of Hospitality and Catering Businesses

As the human beings produce more pollution, the natural environment is deteriorated at an alarming rate. The global environmental problems mentioned in the previous section are the signs of "environmental overdraft". Ecologists urged that if we continued our way of living as in the past, the Earth's non-renewable resources would soon be used up, and our successors would not have the right to access the resources. This gave rise to the concept of sustainable development and green movements. Corrective measures should be adopted in order to cease the rate of natural deterioration, and eco-responsibility should become an aspect of the search for total quality (Cairncross, 1992).

In this section, literatures about how businesses, particularly hotels and restaurants, react to the greening advocacy are examined. This could aid revealing major trends in business environmental issues over the decades, and identifying any gap that the current study could fit in.

2.4.1 Concept of Sustainability

One of the most fundamental principles of environmental management relates to the concept of sustainability. It is a very broad and complex issue, comprising the social, economic and environmental dimensions. The concept refers to the "*use of the biosphere by present generations while maintaining its potential yield (benefit) for future generations*". It can also be defined as the "*non-*

declining trends of economic growth and development that might be impaired by natural resource depletion and environmental degradation" (UN, 1997, p.71).

There are various definitions of the term "sustainable development". The most extensively adopted one was from the Brundtland Report (1987). It defined sustainable development as the form of development that "*meets the needs of the present generation without compromising the ability of future generations to meet their own needs*". Other international organizations portrayed sustainable development as the way to "*improve the quality of human life without exceeding the carrying capacity of the ecosystems that sustain it*" (International Union for Conservation of Nature, United Nations Environmental Program and World Watch Foundation, 1991). Moreover, Pol (1998) pointed out that sustainability development implied both *intragenerational* and *intergenerational* solidarity. The former aimed to meet the needs of the present generation, while the later protected the resources of future generations. Although the definitions slightly varied with each other, they all expressed the same theme – our successors should have continued access to the natural resources.

It is impossible to extend the Western model of development to the rest of the world, as many non-renewable natural resources have to be consumed (Brown, Flavin and Kane, 1992; Brown, Flavin and Postel, 1991; McKenzie-Mohr, Nemiroff, Beers and Desmarais, 1995; Meadows, Medows and Randers, 1992; Milbrath, 1989). The most vital problem of such environmental irresponsible manner would be the off-site consequences, such as global warming and ozone depletion. These consequences may be more expensive to our society as they might not be immediate and would well remain hidden for some times (Dzinkowski, 1998). They would usually keep undiscovered until it was too late to prevent significant damage. Therefore, we ought to be more efficient in the use to natural resources, and at the same time reduce the environmental impacts resulting from our activities. Efforts from the business sector would definitely assert the success of sustainable development.

2.4.2 Corporate Environmental Responsibilities

The environmental responsibilities of private companies have been discussed extensively in existing literature. Worcester (1994) reported that environmental management in the private sector had been emerged in the 1980s. It was a new and vital aspect of management that was expected to be adopted by an increasing number of firms. The Business Council for Sustainable Development, which is an organization consisting of 50 world's leading corporate executives, stated that environmental issue might well be the most important issue in the next century (Schmidheiny, 1992). Some large-scale companies had shown their responsibilities to the environment. DuPont, for instance, had made an investment equivalent to 35% of its share price in technologies to protect the environment (Walley and Whitehead, 1994).

The increasing public awareness about green issues in the past two decades was the major driving force for the adoption of green strategies in companies. It was revealed that companies were being evaluated not only on their financial performance, but also on their ethical or environmental performance (Chau, Burnett, and Lee, 1999; Engel, Blackwell and Miniard, 1990; Greeno and Robinson, 1992; Kirk, 1996; Tyteca, 1996). Ecological sensitivity had become not only a social responsibility, but an important marketing focus. Poor environmental decision making of a firm could affect its long term viability through its impact on investors, consumer perceptions, stock prices, access, cost of capital and insurance (Dzinkowski, 1998).

Benefits for integrating environmental practices with business activities had probably been among the mostly discussed topics across different industries and disciplines. Improved company efficiency and financial savings are believed to be the two key benefits. Al Gore, the former Vice President of the United States, advocated that making environmental improvements was the best way to increase a company's efficiency and profitability (Gore, 1993). He believed being green was no longer a cost of doing business; it could be a catalyst for constant innovation, new market opportunity and wealth creation. This view was theoretically supported by other scholars such as Cairncross (1992) and Porter (1991). Bohdanowicz (2006) also agreed and pointed out that the cost of running inefficient apparatus would frequently be much higher than the initial cost of installing more efficient equipment in the entire lifecycle.

However, some scholars had an opposite opinion. They believed the perceived benefits were too rosy. The goals of businessmen and environmentalists seemed irreconcilable. Walley and Whitehead (1994) argued that firms would only invest in specific environmental strategies that would have paybacks within an economic timeframe. Responding to environmental challenges had always been a costly and complicated process. To most companies, the green costs were “skyrocketing”, and the investment would never generate a positive financial return. There must be a trade-off between business and environmental concerns. Palmer, Oates and Portney (1995) said that expenditures on environmental protection might crowd out other more productive investments. Moreover, Hillary (1999) criticized that most firms perceived themselves causing no major pollution, and customers were indifferent to environmental performance. Therefore environmental measures should not be of the top priority of a company.

The argument between the two schools of thought can be justified through scientific investigations. A study in the United States found that poor environmental performance has a significant negative effect on the intangible-asset value of large listed firms due to lower operation efficiency (Konar and Cohen, 2001). Another pilot project carried out in a tourist attraction at Hainan, China, demonstrated the viability of economic and environmental symbiosis (Hu and Wall, 2005). The green practices had brought about higher financial return, as well as higher quality environment. Some large-scale international hotel chains, such as the Mandarin Oriental Hotel Group and the Shangri-La Hotels and Resorts, also demonstrated improvement in efficiency and reduction in operating expenses, while implementing the green practices (Mackie, 1994). These proved that the benefits associated with eco-friendly operations were not merely optimism.

Benefits from being green are not only limited to a particular company, but can be extended to the society. The reason is that evolving local, regional and global environmental regulations require firms to make new investments in abatement technologies (Dzinkowski, 1998). These green innovations could offer new opportunities for economic growth (Miller, 1997). Reduction in cost, market demand for greener production, reduced liability, and recognition of the link between quality and stewardship would drive the application of green technologies in the future.

Most of the previous studies on corporate environmental management were done on large firms as it was assumed that there existed a direct relationship between size and environmental performance (Aragón Correa, 1998; Fineman and Clarke, 1996; Konar and Cohen, 2001). Alvarez Gil and Cespedes Lorente (2001) were of the view that large firms were exposed to considerably more environmental pressure from stakeholders than dispersed units because of three reasons. First, their environmental impacts were more visible to stakeholders. Second, it should be easier for them to control centralized sources of pollution. Third, these industry leaders should act as a role model for other companies to imitate. Andersen (1997) added that large firms possessed economies of scale in controlling pollution problems.

Notwithstanding, the environmental impacts created by small businesses should not be overlooked, as these small operations may not have proper environmental management systems (EMS). In the restaurant industry, large chains such as the McDonald's, KFC and Starbucks do have a formal training system and operation guidelines for the staff. Their environmental problems can be easily spotted and controlled by stakeholders. On the other hand, most small restaurants lack a formal management structure, standardized procedures and documentation system. Their environmental performance can hardly be traced and evaluated. For that reason, the current study will not only investigate chained Chinese restaurants. The investigator will also try to include those individual, small-scale ones in the sample, in order to project a more holistic picture of the current situation.

2.4.3 Environmental Initiatives in the Hospitality and Catering Industries

Foster, Sampson and Dunn (2000) suggested that service firms did not have a readily apparent “smokestack”, thus they did not receive as much attention on environmental issues as traditional manufacturing firms. Notwithstanding, being an important part of the business sector, many hospitality firms have also participated in the green movement. Various environmental initiatives have been introduced as a consequence.

The importance of maintaining the quality of our environment in tourism development was first acknowledged by WTO in the late 1970s with the establishment of the Environmental Committee. Then environmental management in the hospitality and catering industries gained momentum and recognition by various associations and activities in the early 1990s. It begun when the world leaders attended the United Nations Conference on

Environment and Development in Rio de Janeiro, Brazil in June 1992 adopted the Agenda 21. It was a plan of action to achieve sustainable development. A number of developed countries agreed that by 2001, the level of carbon dioxide emissions in their countries would be reduced to the levels of 1990 (UN, 1993). It also identified tourism as one of the priority areas for sustainable development. In the following year, the Prince of Wales launched the International Hotels Environment Initiative (IHEI) (1993). In 1994, 16 hotel groups in the Asia Pacific Rim formed the first Regional Chapter – the Asia Pacific Hotels Environment Initiative (Mackie, 1994). In the same year, the Hotel and Catering Institute Management Association also participated in Green Globe, an environmental management awareness program initiated by the World Travel and Tourism Council (WTTC) (Mensah, 2006).

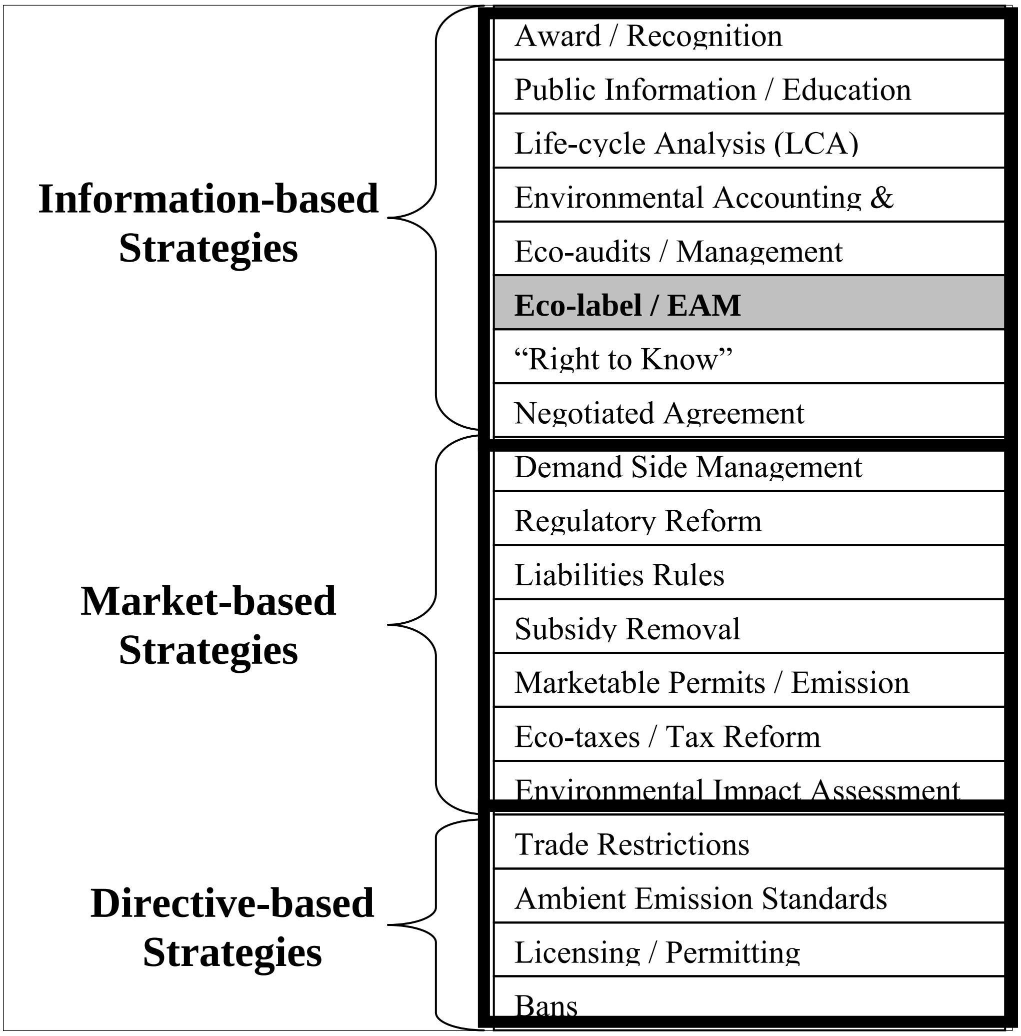
Now pro-ecological initiatives are becoming increasingly popular among hoteliers worldwide (Bohdanowicz, 2006). Numerous hospitality and tourism organizations have actively promoted sustainable concept in their websites (Burnett and Chan, 2002). They also developed environmental guidelines, best practice case studies and training programmes for industry workers (Accor Group, 1998; Bergkvist, 2004; Bohdanowicz, Simanic and Martinac, 2005; Department of Building Services Engineering, 1998; EPD, 2004; Environmental Assistance Division, 1999; Genot, Pogson, Francois and Carbone, 2001; International Hotel and Restaurant Association (IH&RA), IHEI and United Nations Environment Programme (UNEP), 1995; Sveriges Hotel loch Restaurangföretagare (SHR), 1999; UNEP and IH&RA, 1997). Some hotels and restaurants were using different quantitative methods to measure and monitor the company's environmental performance in energy and water consumption, waste generation and disposal, etc (Vögl, 1998). Chained hospitality firms took advantage of successful practices of individual unites and distributed it among members of the chain (Alvarez and Lorente, 2001; Darr, Argotte and Epple, 1995). These showed the industry practitioners' recognition on environmental responsibility as a core business concern.

In Hong Kong alone, a survey conducted in 1992 found that about 30% of hotels have launched environmental programs with varying degrees of success (Barlett, 1992). Environmental management issues that have been of concern to the hotel industry have been recycling of waste, waste management, energy savings, water conservation, compliance with legislation, purchasing policy and environmental education (Forte, 1994; Kotler, Bowen and Makens, 2006; Middleton and Hawkins, 1998). The former General Manager of Hotel Nikko Hongkong, one of the pioneering local green hotels, said that being green did not affect the service standards of the hotel. Rather, it did save money and contribute to profitability. He revealed that the key to success was to reduce energy consumption without reducing guest comfort ("Focus on the Green Hotelier", 1996).

2.4.4 Environmental Policy Instruments

To propel green movement in the business sector, various environmental policy instruments can be utilized. Jiménez-Beltrán (2000) listed a range of these instruments, and they were grouped into three categories – directive-based, market-based, and information-based approaches, as shown in Figure 2.1.

Figure 2.1: Range of Instruments for Environmental Policy



Adapted and Modified from Jiménez-Beltrán (2000)

i. Directive-based Approaches

Directive-based approaches, also called command-and-control strategies, are mandatory requirements prescribing how to comply with specific standards defining acceptable levels of pollution. Prohibitive penalties are used to force polluters to make specific technology or behaviour choices or to produce certain products. Bans, licensing/permitting, ambient emission standards and trade restrictions are bounded in this category. In Hong Kong, there are several control ordinances regulating restaurants' operation, and they are presented in Table 1.1. Enforcements are conducted in a fair, consistent and transparent manner (HKSAR Government, 2006b).

The main advantage of directive-based approaches is that they provide a clear outcome. All parties concern would be aware of the requirements and have to comply. It is simple to monitor compliance since regulators only have to ensure the minimum standard of performance has been met across the territory. They can also help spreading the awareness of environmental issues among industries and communities during its earlier time of implementation.

However, such an interventional approach can only lead to moderate results. The first reason is that regulators need to gather necessary information from the polluter that they are regulating, therefore creating the possibility for inaccurate or dishonest reporting, i.e. information uncertainty. Second, the compliance requirement would be set at a level that they would be relatively easy to achieve, otherwise, the private companies would object to the enactment (Lee and Yik, 2004). Third, the command-and-control regulations allow corporate decision makers very little freedom. There is no incentive for the polluters to research new and creative ways to further reduce their own pollution emission.

Forth, extra costs are needed for litigation in case of any violations. Finally, they usually focus on a narrow scope of environmental aspects. Thus they have given way to voluntary measures, including market-based and information-based approaches as discussed below.

ii. Market-based approaches

In the previous two to three decades, most of the eco-friendly practices of the industry were mainly dictated by impositions originating from governmental decisions (Tyteca, 1996). However, some companies had realized the huge potential benefits they could obtain by implementing more conscious and pro-active environmental strategies, such as the market-based approaches.

These approaches aim at making pollution an expensive activity to companies, and encourage polluters to find innovative and low-cost way to reduce the impact of their behaviour to the environment. They rely on market mechanism to achieve environmental protection, which is a more flexible and cost effective way. Environmental impact assessment (EIA), eco-taxes, marketable permits, subsidy removal, liabilities rules, regulatory reform, and demand side management fall within this category.

These new incentives provide a clear set of financial incentives that are designed to influence behaviour positively. It can also promote dialogues between policy makers and the private sector, and raise public awareness of environmental issues.

Market-based approaches are also popular in Hong Kong. Emission trading, which falls within this category, is a recently hot topic. The local Government and the Guangdong Government are jointly studying the details of setting up an emission trading pilot scheme covering the power plants in the two places (Information Services Department, 2006). Another example of market-based approach is the subsidies provided by the government for retrofitting pre-Euro diesel vehicles with emission reduction devices (HKSAR Government, 2006b). Even so, the market-based approaches are not as flexible and cost-effective as the information-based approaches as discussed below.

iii. Information-based approaches

Over the past decade, the information-based approaches, which educate the general public and encourage firms to report environmental information voluntarily, have proliferated rapidly (Portney and Stavins, 2000). These approaches are believed to be the most cost-effective and flexible measures to achieve sustainability goals (Achanta, Mittal and Mathur, 1999; Cowan, 1998; Heyes, 1998), and have been receiving more attention over the years.

The local government has also realized the importance of information-based approaches. An Environmental Campaign Committee was set up in 1990, aiming at raising the environmental awareness of the community. The Environmental and Conservation Fund, which provides financial support for non-profit making organizations to organize green education and research projects, was established in 1994. In addition, three Environmental Resource Centres, and an Environmental Education and Information Counter were opened in 2001 (HKSAR Government, 2006b). Presently, all bureaus and departments are required to report their environmental performance annually. Such information reporting can increase public awareness of the government's actions; in turn, this can encourage the government departments to keep aware of their eco-behaviour. And several environmental initiatives, such as "Switch off Idling Engines", "Keep Room Temperature at 25.5^{o}C", "Source Separation of Domestic Waste", and "Recovery of Rechargeable Batteries" have been launched recently.

The EAM developed in this study was voluntary in nature, aiming at providing guiding information to Chinese restaurant operators in regard to water management. This EAM contained neither mandatory requirements nor market incentives, thus it did not belong to the directive-based and market-based approaches. Instead, it fell into the category of information-based approach, as highlighted in Figure 2.1.

2.5 Environmental Assessments

Today's managers lack a framework that would allow them to turn their good intentions into reality (Walley and Whitehead, 1994). The need to account for the potential environmental impacts of different investments and for monitoring the environmental impacts of ongoing activities gives rise to the use of environmental assessments tools. These assessment tools would allow proper and objective measurement of a firm's performance with respect to the environment (Tyteca, 1996).

2.5.1 Definition and Background of Environmental Assessments

The term "assessment" is defined as a process of measurement in education, and different assessment methods composite the assessment of a course, on which the decision concerning the certificate or other award is based (Ward, 1980). Environmental assessments have the same notion as educational assessments.

According to Lee, Chau, Yik, Burnett and Tse (2002), an environmental assessment method (EAM) is a voluntary initiative that may take the form of informative environmental guidelines, which provide information on environmental issues likely to be encountered. These EAMs are not laws, but rather accreditations that encourage good environmental practices through awarding credits or performance points for various addressed criteria. The assessment process is usually conducted by benchmarking a product against a set of prescribed quantitative and qualitative performance indicators of diverse objectives. It can be done by self-declaration, certification by independent agents or by the government (Lee, Chau, Yik, Burnett and Tse, 2002). Examples include Blue Angel in Germany (Blauer-Engel, 2006), Energy Star in the United States (Energy Star, 2006), EU Eco-label in Europe (Philip, 1998) and ISO 14000 certification (ISO, 2002) which is used globally.

The total score awarded is the aggregation of the total number of credits obtained, and this will be categorized into one of the pre-set performance grades. An eco-label is the outcome of an environmental assessment. It is also voluntary in nature that the producers are not obliged to apply for it. Based on reinforcement psychology, eco-labels reward those who achieve better results than the minimum environmental performances required by law and those who open themselves to voluntary review to verify this improvement (Pol, 2002).

Green labeling or eco-labeling schemes for manufactured products were first introduced in the late 1980s as a result of the increasing public awareness of environmental issues. These schemes rapidly became an established part of the marketplace for products since then (Chau, Burnett and Lee, 2000; Lathrop and Centner, 1998). They have placed emphasis on consumer demand to transform markets, and actively encouraged manufacturers to design products with less environmental impacts.

Eco-labels offer benefits to both consumers and manufacturers according to Crawley and Aho (1999). To consumers, it recognizes environmental friendly products, and provides better information on the environmental impacts of the products. To manufacturers, it offers a way of differentiation and enhancing their products, thereby gaining advantages in the market by meeting certain environmental standards as required in the scheme.

A good assessment method should be valid, reliable and efficient (Ward, 1980). "Validity" refers to the appropriateness of the assessment. In other words, it is the extent to which the assessment measures what it is supposed to measure or what it ought to measure. However, it may be difficult to make any objective measurement of validity of a particular assessment method. In this regard, Ward (1980) suggested that estimating validity would therefore depend largely on the considered judgment of a number of experts. "Reliability" is the second criterion for a good assessment method, and it refers to the consistency of the measurement. If an assessment is not reliable, its result cannot be used with confidence. Therefore, Ward (1980) recommended that two or more assessors can be invited to assess the same object in order to ensure reliability. "Efficiency" is the last criterion pointed out by Ward (1980). An efficient assessment method should make the best use of time, effort and resources devoted to it, without making any unnecessary demands on the stakeholders. Nevertheless, efficiency is a less significant consideration than validity and reliability. Reijnders and van Roekel (1999) categorized all present assessment methods into two classes – qualitative and quantitative.

- **Qualitative Environmental Assessment**

Definition

Qualitative environmental assessment tools are often based on auditing of products and awarding credits or performance points for various addressed criteria / parameter (Forsberg and von Malmborg, 2004). The total score awarded is the aggregation of the total number of credits obtained, and this will be categorized into one of the pre-set performance grades. The assessment process is usually conducted by benchmarking a product against a set of prescribed quantitative (e.g. energy use) and qualitative (e.g. building material) performance indicators of diverse objectives (Lee, *et al*., 2002).

Approaches to Qualitative EAM Development

One of the critical issues of developing a Qualitative EAM is the justification of what environmental aspects should be included, and how their relative significance can be reflected. The criteria in an EAM may not carry equal weighting as they may possess different importance to the global, regional and local environment. Thus, the way the weights are designated becomes an important consideration in EAM development. A systematic way to establish the relative importance (weightings) of different criteria will determine the success of an EAM (Zhao, Lo, Lu and Fang, 2004). Currently, there are several approaches to decide the weightings of each criterion in an EAM, and they are compared and contrasted below:

i. Endpoint Approach

By applying the endpoint approach, weights are allocated based on the relative importance of the potential impacts that each criterion might have on the global and regional environment, human health and well-being (Chau, *et al*., 2000; Todd and Geissler, 1999). The environmental impacts are converted into "impact equivalent factors" (Todd, 1999), or "potentially affected fractions" of lower organisms (Klepper and van de Meent, 1997) as proxy for ecosystem health in ecosystem. While this approach represents the most conceptually appropriate direction for deriving a credible weighting system, the lack of consensus in establishing the relative importance of the criteria may obstruct its extensive application (Levin and Associates, 1997). In addition, this approach only considers the impact weights within the same issue (Chau, *et al*., 2000). It does not reflect the socio-economic factors shat should be included in determining the weighting (Todd and Geissler, 1999). For this reason, this approach will not be applied in the development of EAM in the current study.

ii. Monetary Approach

This is a variance of the endpoint approach. It can also be viewed as the environmental cost approach that allots weights according to the relative economic importance by converting different environmental impacts into commensurate monetary terms (Trinius, 1998). The externalities can be valued by the damage costs, pollution-control costs, or the extent to which the society is willing to pay for a certain improvement in life quality

(Trinius, 1998). This approach seems to be more suitable for the present study, as it can mirror the important social and economic factors.

iii. Effort-proportional Approach

The underlying rationale of the effort-proportional approach is to reward investors in proportion to the effort they made in achieving a higher level of environmental performance (Chau, Burnett, and Lee, 2000; Chau, Lee, Yik and Burnett, 2000). A criterion based on this approach is called a "quantitative criterion". It has been incorporated into certain environmental assessment methods by giving more credits or points for a given increment in environmental performance (Cole, Rousseau and Theaker, 1993). For example, in the HK-BEAM 4/03 (New Buildings) section 4.3.2, a reduction in the maximum electricity demand in hotel buildings by 15% would be given 1 credit; a reduction by 23% would be given 2 credits; and a reduction by 30% would be given 3 credits. As this approach can encourage the investors to input more effort in attaining better environmental performance, it would be used, when appropriate, in developing certain criteria in the EAM of this study.

iv. Subjective Judgment Approach

The absence of conclusive scientific evidence in determining the ultimate impact lead to the use of people's subjective judgment in setting the weighting values (Chau, *et al*., 2000). By employing this approach, either the experts (Finch, 1992) or public opinion (der Butter and van der Eyden, 1998; Hope, Parker and Peake, 1992) are solicited to determine the relative importance (weightings) among various environmental issues. Burnett (2001) pointed out that there must be general agreement by stakeholders on which environmental aspects are considered more significant. However, the foremost problem is that the opinion from different group of people may vary. In other words, the allocation of weights may differ among groups of people with unlike, or even polar, concerns and apprehensions. However, this is the only approach that can reflect the true feeling of various stakeholders. Therefore it will also be employed complementarily with other approaches in the development of EAM in this study. To justify the objectivity of this study, the opinion from Chinese restaurant owners, managers, frontline staff and customers would be considered or employed in the data analysis process.

To summarize, the four approaches mentioned above employ different principles in assigning weights. The monetary approach would form the basis in developing weight assignment in the Chinese restaurant EAM, with the aid of the effort-proportional method and subjective judgment method. Due to its inappropriateness, the endpoint approach would not be used. Detail steps of how to combine the three approaches in setting up the EAM are presented in Chapter 6. Notwithstanding, the assessment must be able to establish definitive criteria that are reliable and consistent (Burnett, 2001). The ultimate aim of any assessment methods must fulfil the sustainability goal and minimize the overall environmental impact, no matter how the weights are designated (Chau, Lee, Yik and Burnett, 2000).

In addition, Cascio (1996) and Cole (1998) had enumerated some essential elements of a successful assessment scheme from the investors and facility managers' perspective. Listed in Table 2.5, these elements served as guidelines for the development of EAM for Chinese restaurants in the Chapter 6.

Table 2.5: Essential Elements of a Successful Assessment Scheme

- The subjectivity of assessment should be reduced to a minimum.
- The assessment should provide a consistently reliable result when used on similar premises.
- The result should offer a meaningful indication of the premise's total performance.
- Environmental attributes must be available to the purchasers.
- Labels and declarations must be based on thorough scientific methodology.
- Criteria for label/declaration must be available to all interested parties.
- Label and declarations developments must take into account the life-cycle of the relevant product.
- Labels and declarations standards and criteria must be developed by consensus.
- The administrative work must be limited to establishing conformance with criteria.
- The administrative cost for apply for the assessment should not be overly expensive.
- The label scheme should be able to offer tangible benefit for the investors.
- The cost of compliance with the prescribed criteria within the scheme should be reasonable.

Adopted and modified from Cascio (1996) and Cole (1998)

- **Quantitative Environmental Assessment**

Another category of environmental assessment tool is based on quantitative data extracting from life-cycle assessment or production data of material or energy flows. These can easily be measured and compared (Font and Bendell, 2002).

The concept of lifecycle had been raised in the late 1970s when the awareness and concern over environmental impacts associated with the provision of goods and services increased. A comprehensive evaluation of all "upstream" and "downstream" effects of the activity or product was demanded by the public. At that time, lifecycle related studies focused on the quantification of energy and materials used and wastes released into the environment along the entire lifecycle of a product or activity (SETAC, 1993b).

Later, the Society of Environmental Toxicology and Chemistry (SETAC) initiated the Life-cycle Assessment (LCA) method in 1990 (SETAC, 1993b). This is an internationally recognized methodology to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment, and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life-cycle of the produce, process, or activity, including processing, manufacturing, transportation, distribution, use, re-use, maintenance, recycling and final disposal (SETAC, 1991; Department of Industrial and Systems Engineering, 2006).

Normally, LCA composed of four interrelated components, namely definition of goal and scope, life-cycle inventory analysis, impact assessment, and improvement assessment (SETAC, 1991; 1992; 1993a & b). However, conducting a full LCA is very complicated, thus some simplified or streamlined LCA methods have been developed. These streamlined methods involve the process identification, limited inventory analysis, impact assessment matrix and strategies development (Department of Industrial and Systems Engineering, 2006). Lundie and Peters (2005) pointed out that LCA was developed to take into account issues that are not addressed by other environmental management tools such as statutory environmental impact assessment. It has proved itself particularly useful as a technique for comparing two or more alternative options in terms of their combined potential environmental impacts and ecological sustainability.

Forsberg and von Malmborg (2004) made a comparison between five quantitative assessment tools in regards to their context and methodology. It was found that all analyzed tools have a "technoshpere" focus rather than "ecosphere", implying a focus on technological systems rather than ecological systems. The overall purposes of the tools are for strategic decision support and communication with third parties. Finally, the scholars concluded that all analyzed tools have a common ambition to increase the knowledge about the built environment by giving quantitative information.

Since these quantitative tools have only existed on the market for less than a decade, they are not used as extensively as the qualitative ones currently.

However, Forsberg and von Malmborg (2004) predicted that quantitative assessment tools are expected to be more common due to "*an increasing understanding of cities and the built environment as systems metabolizing matter and energy*". Simultaneously, they pointed out that more works are still needed on the development of this kind of assessment tool, especially in the economical and social aspects, as well as the inclusion of cumulative environmental effects of buildings.

Even though LCA is more objective than the qualitative approaches in evaluating the environmental impact, it may not be appropriate to analyze the environmental performance of the service-based hotel and restaurant industries, as LCA was originally used for appraising manufactured products. This method can hardly evaluate the greenness of services provided by a restaurant. Due to this defect, the LCA method will not be employed in the development of Chinese Restaurant EAM in this study.

Overall, qualitative approaches rather than quantitative approaches were dictated by the nature of environmental awards in Tourism (Font and Tribe, 2001). No matter it is a quantitative or qualitative assessment method, the assessment criteria and credit weightings must be updated regularly, as local regulations, standards and performance benchmarks may change over time (Burnett, 2001). Continuous updating and refining can also help in establishing credibility (Chau, Lee, Yik and Burnett, 2000). The baseline standard should be raised over time, because the levels of performance would be expected to improve. However the upward movement of standards should only be incrementally and over a time frame, so that the industry can be allowed to assimilate the new demands as pointed out by Burnett, Chau and Lee (2005). A massive and ongoing marketing effort is also necessary to convince the industry of the long-term benefits of green practices.

2.5.2 Environmental Assessments for Different Types of Buildings

In the early 1990s, the eco-labeling trends had also spread to building assets. The assessments for buildings are generally regarded as BEAMs (building environmental assessment methods). BEAMs generally cover the most significant environmental aspects (Burnett, *et al.*, 2005), including global impacts (such as global warming, ozone depletion, deforestation and acid rain), regional impacts (such as NOx, SO_2 emissions, ambience particulate level and river pollution), local impacts (such as solid waste and sewage) and indoor impacts (such as indoor air pollutants and micro-organisms). Some BEAMs are relatively simple, while others incorporate complex calculation and weighting factors.

The first voluntary environmental assessment scheme, BREEAM, was launched by the Building Research Establishment (BRE) in 1990 (BRE, 1993), aiming at reducing the impact of buildings on the environment through good design, operation and maintenance. It provided guidance on ways to "minimize the adverse effects of buildings on the global and local environments, while promoting a healthy and comfortable indoor environment". Despite having a high international profile, the market penetration rate of BREEAM was slow (Cooper, 1999).

Later, other voluntary environmental assessment schemes for different types of premise/building had also emerged around the world. A great number of environmental assessment tools, focusing on energy use, the sick building syndrome, indoor climate, building materials, of the built environment is found due to the increasing interest in assessing the built environment (Forsberg and von Malmborg, 2004). Examples of well-known assessment tools include BEPAC (Building Environmental Performance Assessment Criteria), LEED (Leadership in Energy and Environmental Design), Eco-Quantum, ELP (Environmental Load Profile), and EcoEffect. A list of environmental assessment schemes for buildings worldwide is attached in Appendix 2.5. The attributes identified may be different across assessments, due to the variation in the form of buildings, the maintenance levels and culture of building users (Zhao, *et al*., 2004). However, it was revealed that application of these voluntary assessments in buildings had met with moderate success only (Cooper, 1999).

The HK-BEAM is the assessment tailor-made for local buildings. In the scheme, green buildings are defined as those having measurably less impact on the environment than the norm (Burnett, *et al*., 2005). There is a baseline for assessment, i.e. zero credit, which is the general or average performance. However, such benchmark could be difficult to define and quantify across all assessment criteria (Burnett, 2001). Therefore in some aspects, the zero credit level may be set by prevailing legal requirements, while in other aspects it defines the minimum level of performance. Apart from the baseline, it is necessary to establish an expectation of the best environmental performance, and to quantify the maximum attainable score for each criterion (Burnett, 2001). “Points” or “credits” were awarded to the buildings that satisfied those criteria for a range of issues, including greenhouse gas emission, recycling, ozone depletion and indoor air quality. However, there would not be any penalty for being below the baseline.

2.5.3 Environmental Assessments for Hotels

A BEAM can also take account of the current circumstances within a particular sector (Burnett, 2001; Burnett, *et al*., 2005). Various assessment methods have been introduced to evaluate and benchmark the environmental performance of tourism and hospitality entities. However, none of them direct against restaurant establishments. Therefore a review on hotel EAMs was carried out. The hotel sector was chosen because of its closest relevance to the restaurant sector. Some of these hotel EAMs include criteria for assessing the eco-performance of hotel restaurants and kitchens. It shed a light on criteria development and weight assignment in the current study.

There are over 100 ecolabels or EAMs for tourism, hospitality and eco-tourism entities, with many of them overlapping in sector or geographical coverage. They have different meanings, criteria, messages, and systems (Font, 2002).

EAMs commonly used in Asian hotel sectors include the *Green Globe 21* (GG21), *Hotel Building Environmental Assessment Scheme* (HBEAS) and the *Green Hotel Certification* (GH). They share the same core notion – providing operational guidelines and assessment criteria for hotel managers in respect to environmental issues. Once a hotel succeeds in an assessment, an eco-label will be awarded to the hotel. This can be a useful marketing tool to the certified hotel.

Table 2.6: General Features of *Green Globe 21 Certification*, *Hotel Building Environmental Assessment Scheme* and *Green Hotel Certification*

	GG21 [1]	HBEAS [2]	GH [3]
Development			
Initiation Year	1994	2000	2002
Initiator	World Travel and Tourism Council (WTTC)	Hong Kong Hotel Association (HKHA)	People's Republic of China Government (PRC)
Target Group	Tourism sector (including accommodation, tour operators, destinations, etc)	Accommodation sector	Accommodation sector
Originality of Target Group	Global	Hong Kong	Mainland China
Objective / Aim	1. To raise environmental awareness and promote good practice in the global hospitality industry. 2. To promote the business benefits of sound environmental and socially responsible business practices. 3. To develop hotel-specific self-help guidance, enabling properties of all sizes to implement environmental programmes.	To reduce a building's environmental impact using the best available techniques and within manageable cost and available human resources.	To provide practical suggestions in developing green hotel, implementing and enhancing EMSs in a hotel.

(Table 2.6 Cont)

	GG21 [1]	HBEAS [2]	GH [3]
Latest Version	Version 602 (Sector Benchmarking Indicators for Accommodation)	Version 1/00	--
Assessment			
Assessment Framework	1. Operation performance 2. Operation activities	1. Environmental management, operations and maintenance practices 2. Facilities and building performance	1. Green design 2. Safety management 3. Utilities conservation management 4. Environmental protection 5. Health management 6. Green promotion
Quantitative / Qualitative Criteria	Both	Both	Both
Regular Update of Criteria	Yes	Yes	Yes
Procedure			
Assessment Procedure	Independent assessment by Green Globe	1. Self-assessment 2. Independent certification by certified agency	Independent assessment by designated local agent
Regularity of Audit	1 year	Not mentioned	2 year
No. of Grading Level	Three: 1. "A – Affiliates" 2. "B – Benchmarking" 3. "C – Certification"	Four: 1. Fair 2. Good 3. Very Good 4. Excellent Under "Management" and "Performance" categories	Five: 1. One Leaf 2. Two Leaves 3. Three Leaves 4. Four Leaves 5. Five Leaves
Length of Validity	Not mentioned	Not mentioned	4 years
Penalty for Non-compliance	No	No	No

Sources: [1] Green Globe (2006), [2] Hong Kong Hotel Association (HKHA) (2000)
[3] Standardization Administration, PRC (2001)

i. General features

With the diversity of the background of the certification bodies, however, the emphasis of these assessment methods may vary. The general features of three EAMs for Asian hotels are presented in Table 2.6 below.

Green Globe 21

Green Globe 21Certification (GG21) is claimed to be the only global benchmarking program for travel and tourism organizations with varying types and sizes (Green Globe, 2006), which is different from the other two EAMs. The certification is based mainly on commitment rather than performance. Established in 1994 by the World Tourism and Travel Council (WTTC), the scheme aims at turning the principles of Agenda 21 into practical actions for tourism-related organizations around the world. The core indicators were developed by the Sustainable Tourism Cooperative Research Centre. The assessment process is uniquely facilitated by a computer program called "Earthcheck™". After inputting relevant operation activity measures by the applicant (such as number of occupied room night of a hotel, or use of environmental friendly detergent in laundry, etc), the program will automatically produce a rating report on all "Earthcheck™" indicators. Up to 2007, there are around 230 hotels possessing GG21 certification according to the Green Globe's official website.

Hotel Building Environmental Assessment Scheme

Initiated by the Hong Kong Hotel Association, the *Hotel Building Environmental Assessment Scheme* (HBEAS) aims at promoting eco-friendly management and operation practices for hotels (HKHA, 2000). More specifically, it encourages reduction of natural resources consumption, reduction of waste and effluents, whilst maintaining a comfortable, healthy and productive indoor environment. The assessment framework is clearly divided into two sections – 1. environmental management, operations and maintenance practices (32 criteria), and 2. facilities and building performance (50 criteria). The former considers the actions by a hotel in endeavouring to reduce environmental impacts through effective operating practices, i.e. the software. The latter, on the other hand, looks at the hardware of a hotel, such as the building services systems, energy input and output, etc. The scores of the two sections are rated separately, which is different from other EAMs in the study.

<u>Green Hotel Certification</u>

The *Green Hotel Certification* (GH) was developed by the Central Government of the People's Republic of China (PRC) in 2001. It was initiated by the state's Ministry of Commerce, National Development and Reform Commission, State-owned Assets Supervision and Administration Commission of State Council, State Environmental Protection Administration, National Tourism Administration, and Standardization Administration. This national standard has incorporated several commercial and provincial standards, such as the "Green Hotel" standard in Zhejiang Province. Five grading levels are set up, represented by the same number of gingko leaf logo. The better the performance of a hotel, the more number of leaves it can obtain.

ii. Criteria Covered

Different numbers of criteria or indicators are used in the three EAMs, and their scoring structures are also different. For GG21, there are only 8 indicators with same weightings. The indicators are simple without much explanation. In HBEAS, there are 25 unevenly-weighted criteria, which add up to a maximum of 82 scores. For GH, there are 45 key criteria. The indicators are also unevenly-weighted, and the score is capped at 300. In addition, there are 12 prerequisite criteria in GH under general issues. These prerequisite criteria must be accomplished before proceeding to the assessment of other criteria. Unlike GH, HBEAS and GG21 do not include any prerequisite criteria.

The key criteria / indicator, with their correspondent scores, covered in each EAM are summarized in Appendix 2.6. The three EAMs generally cover similar issues, such as energy-, water- and waste-related issues, green purchasing and pollution control. However, a very dissimilar distribution of scores over various key environmental issues is shown. The assessment methodologies are inconsistent, depending on the type of tourism companies targeted (Font, 2004).

From Appendix 2.6, it is observed that HBEAS put a heavy weighting on energy-related issues. A maximum score of 28 can be attained in this part, which accounts for around 34% of the total score in the scheme. For GH, 51 points (i.e. 17%) are allocated for energy-related issues. Emphasis has been put on air-conditioning installations. Only 1 indicator is used to evaluate energy consumption by hotels in GG21.

Due to the fact that HBEAS was developed and prepared by the Department of Building Services Engineering of the Hong Kong Polytechnic University, a large proportion of points (15 points; 18%) are put under the category of building and building services systems. However, only 1.3% (4 points) of the total score is related to building and building services systems in GH. There is even no indicator in this category in GG21. A similar situation is observed from the category of indoor environmental quality. 13 points (16%) are allocated for this category in HBEAS, while only 5 points (1.7%) and even 0 point in GH and GG21 respectively.

Safety and health management is the most heavily weighted category in GH. The maximum attainable score is 132, which represents 44% of the total score. In particular, green guest room (53 points) and green restaurant (56 points) carry most of the points. On the other hand, very different score allocation is observed in HBEAS and GG21 for safety and health management criteria. Only 3 points are assigned under this category in HBEAS, and even no score in GG21.

Hotel design is also significant in the score component of GH. This category is about the design of hotel's total environment, including the building and garden, as well as the workflow. A maximum of 47 points (16%) can be obtained. Yet, it is interesting to discover that GG21 and HBEAS do not touch this category.

For GG21, 3 out of the 8 indicators are put under the category of green purchasing. The concerning materials include pesticides, paper and cleaning products. This shows that green purchasing is important in obtaining GG21 certification.

Finally, it is important to note GH's emphasis on social indicators in addition to environmental indicators. Some innovative social indicators are used, such as staffs' involvement in social welfare activities, and special offer or discount to green consumers. GG21 also contains an indicator reflecting the hotel's community commitment. In contrast, no social indicators are included in HBEAS's assessment. This is probably due to the fact that HBEAS was developed by mainly engineers. Their prime concern was put on building performance and maintenance, rather than social indicators.

Although a hotel and a restaurant share some similar features, the assessment methods for hotels are not entirely applicable to restaurants. It is because the pollutants produced by a restaurant are characterized with a huge volume of FOGs (fats, oils and greases), organic waste, and smoke during the cooking process, which is different from the case of hotels. Moreover, most restaurants are small-to-medium enterprises. They are not comparable to hotels in terms of resources, especially capital. Thus, it provided strong justification on the development of a separate EAM for tailor-made for restaurants.

Moreover, these three EAMs have very little coverage on water-related issues as summarized in Table 2.7. Percentage of scores allocated to water-related issues in GG21 and HBEAS are only 12.5% and 11.0% respectively. It is even worse in GH that only 1.3% of the maximum attainable scores are assigned to water-related issues. An EAM was therefore proposed in this study to pinpoint the water consumption and sewage generation problems in Chinese restaurants.

Table 2.7: Scores Allocated to Water-related Issues in Various Hotel EAMs

	GG21	HBEAS	GH
Maximum Attainable Scores	8	82	300
Scores Allocated to Water-related Issues	1	9	4
Percentage of Scores Allocated to Water-related Issues	12.5%	11.0%	1.3%

2.6 Summary of Literature Review

There were only a few of published works about restaurant environmental issues in the existing literature, from which it was indicated that Chinese restaurants were generally producing more pollutions than other types of restaurants. However, there were insufficient in-depth studies on Chinese restaurants' environmental issues, despite their dominance in market share. There appeared a gap in the literature, which made the environmental problems of Chinese restaurants being veiled. In order to fill the literature gap, this study will focus on Chinese restaurants' environmental issues. More specifically, this study focused on water consumption and sewage generation problems in Chinese restaurant premises.

Greater environmental consciousness of customers has made greening of businesses more promising. Various voluntary initiatives have been implemented across industries. EAM is one of these initiatives, which can assist evaluation of a firm's environmental performance, and provide green operational guidelines. In light of these developments, an EAM would be set up in this study, targeting the local Chinese restaurants business activities. Given the limited resources of this study, expert of HBEAS development team commented it would not be possible to set up an entire EAM, covering all aspects of environmental pollutants for Chinese restaurants. Thus, the scope of planned EAM was trimmed to specifically examine the water consumption and sewage problem of local Chinese restaurants, due to the fact that the pollution control cost (PCC) for sewage is the highest when compared with air pollutants and solid waste as shown in Chan, Wong and Lo (2008).

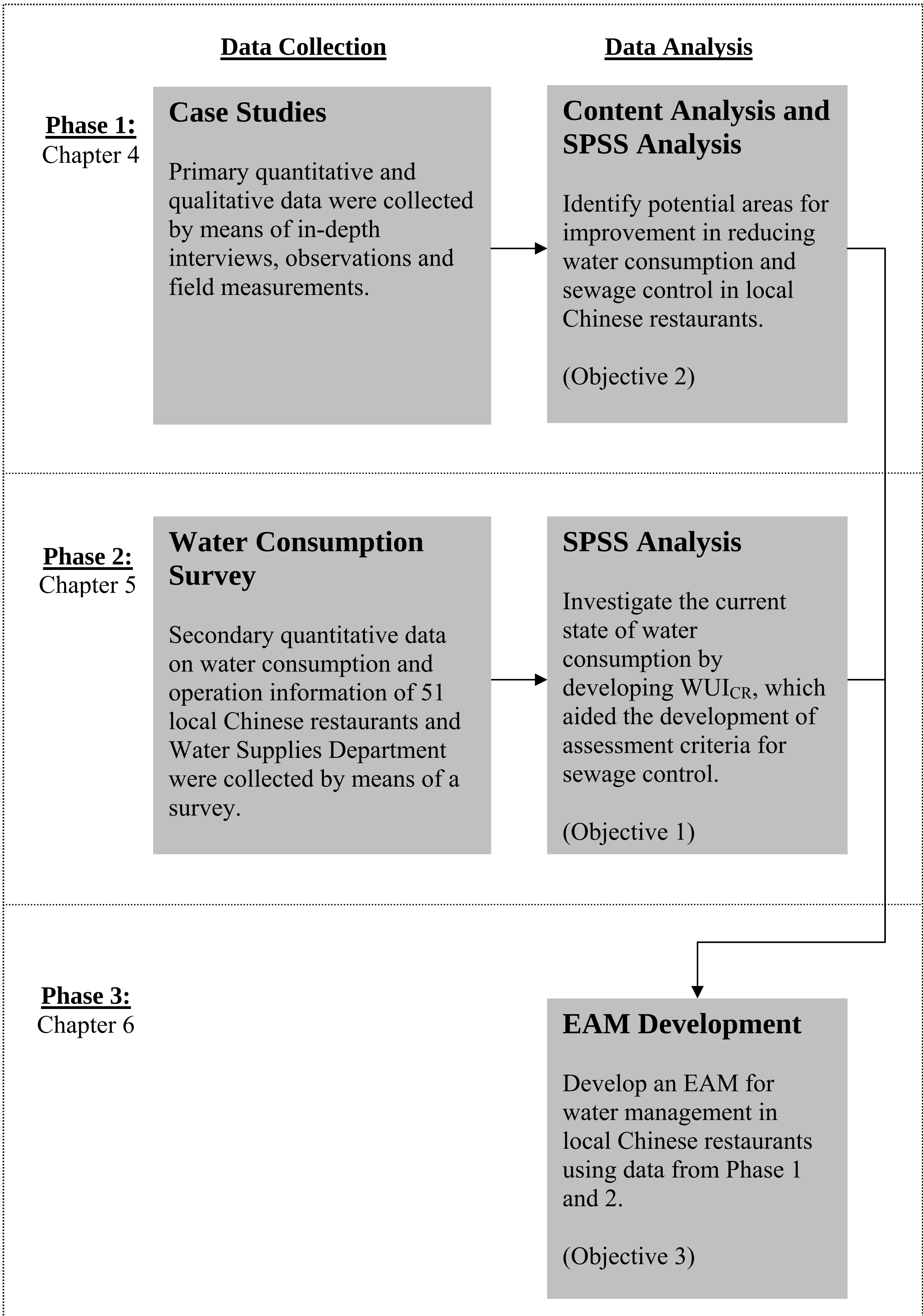
Four EAM development approaches were identified in existing literature. Except the end-point approach, the other three approaches would be appropriate to this study. The monetary approach would be used primarily in assigning weights, while the effort-proportional approach and subjective judgment approach would be applied in developing and fine-tuning assessment criteria.

3. METHODOLOGY

The purpose of this chapter is to present the methodology utilized to accomplish the objectives of this research. The target population was the five thousand Chinese restaurants in Hong Kong, excluding those in hotels and clubs. The principles of methodological triangulation and data triangulation were adopted.

The overall methodological framework is presented in Figure 3.1 below. The research was divided into three phases. In the first phase, three case studies were carried out. Then in the second phase, a water consumption survey was conducted. Finally, findings from both case studies and survey were used in the development of the EAM for water management in Chinese restaurants. The data collection and analysis methods of these three phases are detailed in Section 3.1, 3.2 and 3.3 respectively.

Figure 3.1: Methodological Framework



3.1 Phase 1 – Case Studies

As pointed out by Burnett and Yik (2001), it is imperative to include characteristics of local design, operation and maintenance practices in EAMs, some insightful inputs should be sought in the data collection process. Thus in the first phase, case studies would be the most pertinent approach to the phenomenon of the present study. According to Yin (2003), case studies would be the preferred strategy when the focus is on a contemporary phenomenon within some real-life context. In other words, this strategy would be the most suitable for examining contemporary events with non-manipulated behaviours as in this study. Case studies' unique strength, according to Yin (2003), is its ability to deal with a full variety of evidence – documents, artifacts, interviews and observations. These evidences, complementing with survey data collected in the second phase, would aid the assignment of weights in EAM for Chinese restaurant water consumption.

3.1.1 Sampling and Data Collection

A multiple-case design was adopted to make the evidences more compelling, and the overall study more robust (Herriott and Firestone, 1983). Three Chinese restaurants were selected by convenience sampling. The reason for adopting convenience sampling was that difficulties were faced in inviting restaurants to participate in the investigation. Some water meters had to be installed in various parts of the studied restaurants, and the installation process might affect the restaurants' normal operation. Therefore, simple random sampling methods might appear not appropriate in this case. Instead, a few Chinese restaurants were invited directly by connections, and three of them agreed to participated finally. These three restaurants were sampled because of their readily availability. Anyhow, the use of convenience sampling appeared to be acceptable in this case, due to the homogeneity of local Chinese restaurants, in terms of their sizes, menu items, and operation styles.

Information about the three studied restaurants is presented in Table 3.1 below. They varied in operational scale and style, thus they could represent the majority of the target population.

Table 3.1: Operational Information of Studied Restaurants

	Case 1 **Restaurant A**	**Case 2** **Restaurant B**	**Case 3** **Restaurant C**
Location of restaurant	Kowloon Bay, Kowloon	Wan Chai, Hong Kong Island	Wong Tai Sin, Kowloon
Operating hours	7:00am to 5:00pm (Dim sum section) 10:00am to 12:00 midnight (Front-of-the-house) 10:00am to 11:00pm (Barbeque Section and Main Kitchen)	4:00am to 5:00pm (Dim Sum Section) 7:00am to 1:00am (Front-of-the-house, Barbeque Section and Main Kitchen)	3:00am to 4:30pm (Dim Sum Section) 6:00am to 12:00 midnight (Front-of-the-house, Barbeque Section and Main Kitchen)
Max. capacity	600 persons	365 persons	712 persons
Peak hours	Lunch: 12:30pm to 1:30pm Dinner: 7:30pm to 9:30pm	Lunch: 11:00am to 2:00pm Dinner: 7:00pm to 11:00pm	Breakfast: 7:30am to 9:00am Lunch: 11:00am to 2:00pm Dinner: 7:00pm to 9:30pm

(Table 3.1 Cont)

	Case 1 Restaurant A	Case 2 Restaurant B	Case 3 Restaurant C
Cuisine	Cantonese dim sum; Chinese banquet	Cantonese dim sum; Chinese hot pot	Cantonese dim sum, Chinese banquet
Chain / Independent	Independent (during the period of study)	Chain	Chain
Central food processing factory	No	Yes	No
No. of Employees (including both back- and front-of-the-house)	78	47	90

Data triangulation was employed through three collection paths, including in-depth interviews, direct observations and field measurements. Data from field measurements were quantitative in nature, while those from in-depth interviews and direct observations were qualitative. A protocol was developed to guide the data collection tasks in fields (Appendix 3.1).

In-depth Interviews

Yin (2003) identified in-depth interviews as the most important source of case study information. A total of 14 interviews were carried out. The interviewees were recommended by the Restaurant Manager of the respective premise. They must be full-time working at the current position for more than 1 year. Although these selection criteria would limit the number of eligible interviewees, this could ensure that the interviewees were familiar with the company's policy and operation, as well as their own role.

The interviewees comprised personnel from different hierarchy level, including restaurant managers, head chefs, front-of-the-house and kitchen staffs. This allowed the researcher to find out if there was any discrepancy between the responses about the restaurants' water saving issues. Also, all interviewees must be full-time working at the current position for more than 1 year. Although this selection criteria might limit

The interviews were carried out in a semi-structured manner. The researcher prepared a set of interview questions, but flexibility was allowed for the researcher to ask probing questions. This could provide an opportunity for the interviewees to elaborate on what they had answered. The interviews started with throw out questions in order to make the interviewees feel relaxed, as well as to set the context for the interview (Spradley and McCurdy, 1972, p.63). Then the following core questions were asked for all interviewees:

1. Are there any environmental measures implemented in your restaurant?
2. Who is responsible for controlling water consumption in your restaurant?
3. What are the most water consuming procedures in your restaurant?
4. Are there any instructions for staff regarding water use in your restaurant?
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?
6. Do you have any water saving suggestions to your restaurant?

Additional questions for Restaurant Manager respondents about the restaurants' operation included:

1. Location of restaurant	5. Cuisine
2. Operating hours	6. Chain / Independent operation
3. Maximum capacity	7. Central food processing factory
4. Peak periods	8. No. of employees

Finally, for kitchen staff, one additional question was also asked:

- Can you describe your usual practice for cold-water thawing?

It took around 20 minutes for each interview with non-managerial staff, and around 30 minutes with Restaurant Managers and Head Chefs. Originally the researcher planned to record the interviews by a digital recorder, but it was refused by most of the interviewees, thus the researcher took notes instead.

Direct Observations

The researcher also took the role of a complete observer, meaning that he/she did not take part in the activities being studied, but his/her identity was unveiled. In Tashakkori and Teddlie's (1998) words, the researcher was not an "active" part of the setting. The researcher scrutinized the staffs' behaviour in kitchen and floor area during operation. Field notes were jotted and photos taken, which meant to trigger the researcher's memory at a later time. After leaving the restaurants, detail observation reports were written within 24 hours with the aid of the field notes and photos. By conducting direct observations, it was believed that the possibility of controlled responses can be reduced, though the problem of reactivity might not be eliminated completely (Tashakkori and Teddlie, 1998).

It should be aware that data collected by direct observation could be situational dependent. Therefore, this study employed a multiple-case approach instead of single-case approach. One of the advantages of multiple-case approach was that the researcher could conduct cross-case analysis by comparing and contrasting different situations. For example, the researcher could observe the kitchen staff's usual practice in their normal working environment, and then compare with that in other studies cases. Moreover, multiple evidences were sought from interviews, observations and field measurements. This could check the consistency of observation findings from different situations.

Field Measurements

Field measurements formed an important part in the case studies, as this could trace the amount of water used by various functional zones within the cases. The process consisted of two parts – measurements by fixed water meters and portable water meters.

- Fixed Water Meters

  Normally there is only one fresh water flow meter which measures the total amount of fresh water consumption in a restaurant premise. The meter is usually located in the main water supply pipe to a restaurant from city main. However, the breakdown of water use by various functional zones cannot be tracked. That is what Redlin and de Roos (1990) pointed out that knowledge on the magnitude of water use was limited due to a lack of submeter data. They highly recommended the use of submeters to measure water use within individual properties. Therefore, as a supplement to the data collected from interviews and field observations, several sub-meters were installed in Restaurant A and Restaurant B to track the water consumption pattern within the kitchen and floor areas.

Although this kind of field measurement by sub-meter has long been considered reliable and accurate in previous studies (Redline and de Roos, 1990), a pilot test had been conducted in Restaurant A for 3 months. This was to ensure that the water meters functioned normally and the taps were not blocked.

With the help of the Chef Engineer of Restaurant A, 9 major water end-users in a Chinese restaurant were identified. Suitable sub-meters with diameters ranged from 20mm to 32mm were installed, except for the guest toilets due to technical constraints. The locations of sub-meter installation are listed in Table 3.2 and shown on the kitchen floor plans in Appendix 3.2 (Restaurant A) and Appendix 3.3 (Restaurant B). All meters were marked with a number for recognition. A staff from each restaurant helped to record the readings on the water meters daily for four months. A sample of the recording sheet is attached in Appendix 3.4. In order to ensure reliability and consistency, the researcher checked the figures recorded by the two helpers on the first seven days. This made sure they had recorded the correct figure on the meter. Then, the researcher checked weekly with the helpers.

Table 3.2: Locations of Water Meters Installed in Restaurant A and Restaurant B

Section	Working Station
Dim Sum Section	1. Steamer 2. Cold-water thawing station
Barbeque Section	3. Sinks
Main Kitchen Section	4. Cold-water thawing station 5. Hot running water near frying wok stoves 6. Soup and sauce making station
Dish Washing Section	7. Dish washing section
Front-of-the-house	8. Hot drinking water machine 1 9. Hot drinking water machine 2

- Portable Electronic Water Meter

  Due to budget constrain, no fixed sub-meter was installed in Restaurant C. Instead, a portable electronic meter [Model No.: LXS15E, Gamma Metering System] was used to measure the amount of water consumed during the cold-water thawing process. The specification of the portable electronic water meter is detailed in Appendix 3.5. Four field tests were carried out in July 2008 with the help of two technicians and two experienced chefs. The prime objective was to compare the thawing performance among 1. traditional cold-water thawing method (TR), 2.

thawing machine (TM), 3. microbubble machine (MM), and 4. microbubble machine with recycled water (MR), in terms of:

- volume of water used
- thawing time needed
- quality of thawed food

By doing so, relevant and practical suggestions could be made to reduce water consumption by cold-water thawing. The equipment setup for field measurement in Restaurant C is attached in Appendix 3.6.

Traditional thawing method

Thawing machine

Microbubble machine

3.1.2 Data Analysis

The main purpose of conducting case studies was to identify characteristics of local design, operation and practices in Chinese restaurants in regard to water consumption. Therefore the data analysis process mainly focused on comparing and contrasting the data collected from different cases. Some potential areas for improvement about water consumption in Chinese restaurants would be identified, achieving Objective 2 of this study.

Qualitative Data

For qualitative data analysis, the technique of content analysis was employed. The process was done manually, and to a large extent followed Berg's (2001) suggestions. Data from direct observations and in-depth interviews were collected at fields in forms of jotted notes and photos. Then the data were made into text and transcripts (Appendix 3.7), and coded within twenty-four hours. They were then transformed into categories, labels or themes. Similar phrases, patterns, relationships and commonalities or disparities were spotted. Finally, meaningful patterns were identified. These patterns are compared and contrasted across cases (Appendix 3.8), in order to find out the characteristics of local design, operation and practices in Chinese restaurants in regard to water consumption.

Quantitative Data

Quantitative data were collected from field measurements by water meters. Before analyzing the water meter records, it was necessary to note that each water meter had a "roll over" figure, which was the number at which the meter rolled back to zero. In this study, all water meters installed had a roll-over figure of "0000". Therefore, special attention regarding roll-over were paid when calculating the water consumption recorded by each meter. Then these water consumption data were input into the computer, and analyzed with the aid of SPSS. The aim was to find out the water consumption pattern among the two studied restaurants, as well as among various functional zones within the restaurants.

3.2 Phase 2 – Water Consumption Survey

After an exploratory examination of water usage in local Chinese restaurants in the first phase, a survey was carried out in the second phase to gather quantitative data regarding water consumption in local Chinese restaurants. This mode of data collection is regarded as the most frequently used one and most common in social science research (Barbie, 2007). Its versatility, efficiency and generalizability can enhance our understanding of a particular social issue (Wysocki, 2008).

The main purposes of this water consumption survey were to document the current state of water usage by local Chinese restaurants, and to identify the most dominant factor in predicting water consumption in these operations.

3.2.1 Sampling and Data Collection

By non-random convenience sampling method, a total of 52 restaurants were invited to participate in this survey. Self-administered data collection forms were used as the survey instrument (Appendix 3.9). The forms, together with invitation letters explaining the research objectives, were sent to the head offices of the 6 participating restaurant groups. Since almost all of the industry practitioners in the Chinese restaurant sector were local Chinese, the data collection forms and invitation letters were printed in Chinese.

Design of the data collection form was guided by the hypothetic independent and dependent variables. These variables were identified based on findings from case studies, interviewees' experiences, professor's opinion, as well as extensive literature review. The data collection form included three sections, with both open-ended and close-ended questions. In the first section, the restaurants were asked to provide some operational information which might affect water consumption level in their premises, including:

- Availability of off-premise central food processing factory (close-ended)
- Provision of banquet services (close-ended)
- Provision of hot pot (close-ended)
- Total gross floor area (GFA) (open-ended)
- GFA of kitchen (open-ended)
- GFA of front-of-the-house area (open-ended)
- Operating hours (open-ended)

As a remark, the GFA-related information was determined based on the responding restaurants' layout plan when the restaurant owner / operator submitted application for a general restaurant license or renovation. According to the licensing section of FEHD, GFA of a restaurant premise should be measured to inside of boundary walls including columns (FEHD, 2006). In this study, only the area for preparing and cooking food was considered as "kitchen". Other back-of-the-house areas (such as storerooms, cold storage chambers, staff changing rooms, offices, air-conditioning plant rooms, etc) were excluded in kitchen GFA calculation.

The second section requested archival records about the number of patrons in a 12-month period from July 2007 to June 2008. These were secondary data provided by the participated restaurants. It was counted by the restaurant staff by adding up the number of cover in all bills, plus the estimated number of attendees of banquets in the respective month.

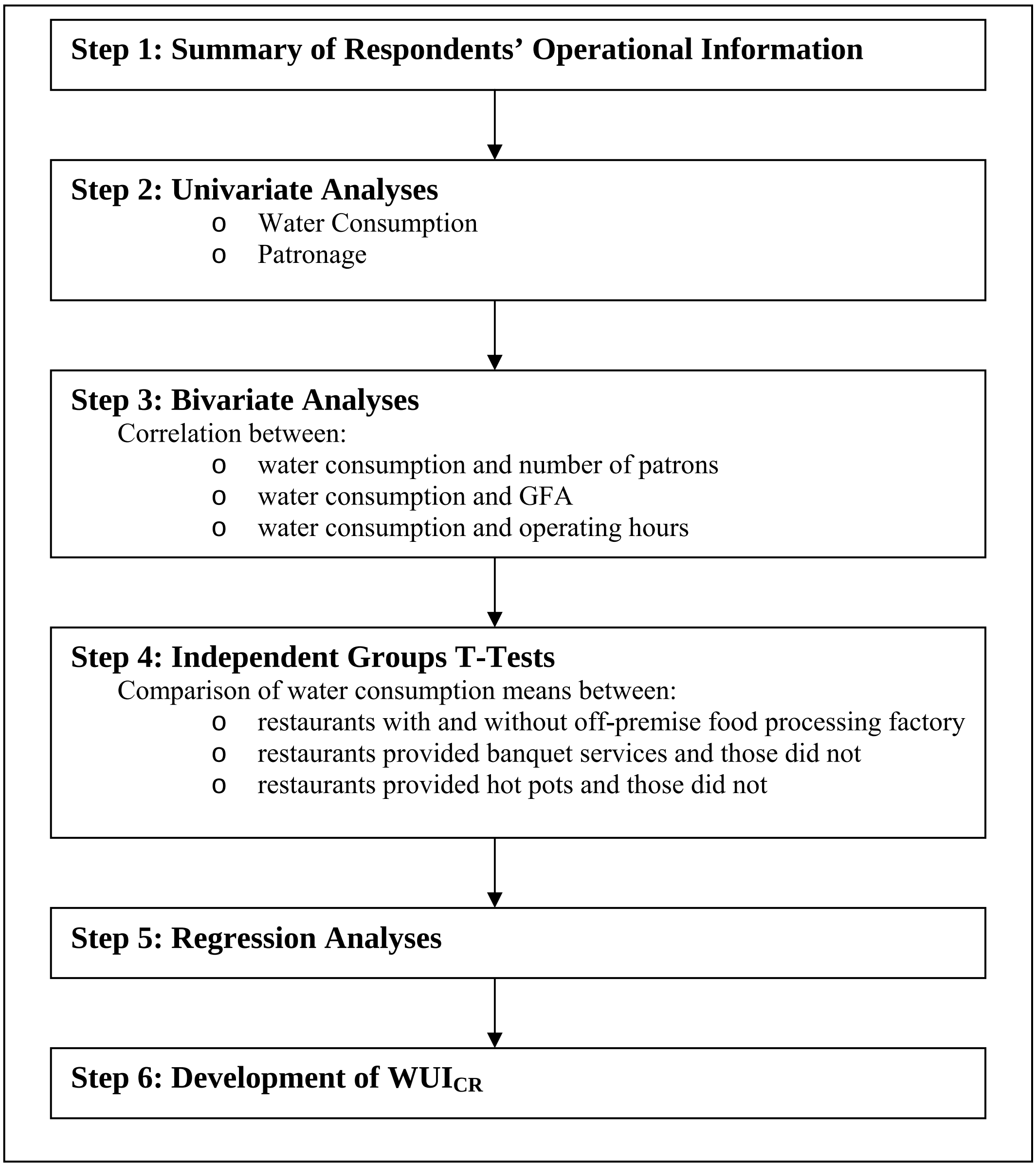
The last section asked the restaurants' water billing account numbers and current meter numbers, which were used to request water bill copies from WSD. The water consumption figures on the water bill copies obtained from WSD were important for the data analysis.

A total of 52 sets of data collection form were collected. The response rate was 100%. However, it was noted that some of the participated restaurants shared the same water meter with another sister restaurant in the same building. Thus data from those restaurants were combined as one single set. The final number of subject for this survey was reduced to 46. In addition, adjustments on water consumption figures were made, where necessary, to match time periods used for data analysis. These involved calculating daily averages for water consumption, and then adding or subtracting values for the number of days missing or in excess.

3.2.2 Data Analysis

The data analysis procedures were shown in Figure 3.2. The quantitative data collected were organized and input manually into the computer. The analysis procedures were guided by the two aims of this survey. The first aim was to document the current state of water usage in local Chinese restaurants. Therefore, descriptive analyses of the respondents' operational information were summarized and presented at the outset (see Section 5.1). Then, univariate analyses of the water consumption data and patronage data were performed, and the results were plotted into separate graphs for comparison (see Section 5.2).

Figure 3.2: Data Analysis Procedures for Water Consumption Survey



The second aim was to identify the most important factor in predicting water consumption in Chinese restaurant operations. This was achieved by a series of statistical analyses using SPSS. First, several bivariate analyses were conducted to find out if water consumption in Chinese restaurant would be affected by various factors, such as number of patrons, operating hours and GFA (see Section 5.3). Of these, GFA is usually used in analysing utility consumption in the lodging industry, for example in Deng and Burnett (2002b). They calculated the average energy consumption level per unit of floor area of hotels in Hong Kong. Besides, Warnken, Bradley and Guilding (2004) suggested that the main advantage of GFA approach was that this information is standardized, objective and readily obtainable.

Next, three independent groups t-tests were carried out to compare the mean scores of water consumption between respondents of unlike operational modes (see Section 5.4). Third, regression analyses were performed to generate a regression model for prediction of water consumption in local Chinese restaurants (see Section 5.5). The results from the descriptive and statistical analyses were used as references in the development of WUI_{CR} finally (see Section 5.6).

3.3 Phase 3 – Development of EAM

The last phase of this study was to development the *EAM for Water Management in Chinese Restaurants*, which would focus on water consumption and water quality control in local Chinese restaurants. This was done by compiling findings from both case studies and survey, as well as references from a number of water conservation programmes in the hospitality industry (Appendix 2.2).

An integrated approach, combining the monetary approach, effort-proportional approach and subjective judgment approach, was employed. The features, advantages and appropriateness of applying these three approaches have already been discussed in Section 2.3. An integrated approach would be the most appropriate method in this study, as the three approaches could complement with each other in assigning weights and setting up assessment criteria.

Application of the integrated approach in the EAM development process is illustrated in detail in Section 6.1 to 6.3. The monetary approach was used in the first step to develop the weighting framework of the EAM (see Section 6.1). Next, the effort-proportional approach and subjective judgment approach aided the development of some of the assessment criteria (see Section 6.2 and Section 6.3). The drafted document was then sent to various stakeholders for review. Some amendments were made after receiving the reviewers' comments (see Section 6.4). The potential incentives, as well as the barriers, are also discussed.

4. CASE STUDIES

Three case studies were carried out in the first phase of this study. Therefore, in this chapter, results of the case studies are presented. Section 4.1 details the findings from various data collection methods, including in-depth interviews, direct observations, field measurements by fixed water meters and portable electronic water meters. Then, Section 4.2 presents the validity, reliability and limitations in carrying out the studies, while Section 4.3 summarizes this chapter.

4.1 Case Studies Findings

4.1.1 In-depth Interviews

Table 4.1 shows the demographic data of the interviewees. They comprised personnel from different hierarchy levels. The majority of them were male aged between 40 and 49. Other findings from the interviews are presented afterwards.

Table 4.1: Demographic Data of Interviewees

		No. of Interviewee	Percentage
Position	Restaurant Manager	2	(14.3%)
	Head Chef	3	(21.4%)
	Section Head / Supervisor	1	(7.1%)
	Chef	3	(21.4%)
	Junior Chef	1	(7.1%)
	Dish-washing Staff	2	(14.3%)
	Senior Captain	1	(7.1%)
	Engineer	1	(7.1%)
Gender	Male	11	(78.6%)
	Female	3	(21.4%)
Age	20-29	3	(21.4%)
	30-39	1	(7.1%)
	40-49	8	(57.1%)
	50 or above	2	(14.3%)

i. Water Saving Measures Implemented

Table 4.2 below compares and contrasts the water saving measures adopted in the three restaurants. All of the restaurants had installed a dish-washing machine. This could save water for washing and sterilizing cookware and dishes. In Restaurant A and B, water for washing vegetables was reused for washing the floor. One of the interviewee from Restaurant B told that only the water for the third rinse of vegetables could be reused for washing floor. It was because water from the first two rinses was quite dirty and might contain chemicals. Therefore water from the first two rinses was not suitable for cleaning purpose. Other water saving measures mentioned by the interviewees include installing thawing machine, turning off unused water taps, and avoiding cold-water thawing if not necessary.

Table 4.2: Water Saving Measures Implemented in Studied Restaurants

Water Saving Measures Implemented	Restaurant A	Restaurant B	Restaurant C
Install dish-washing machine	√	√	√
Water for washing vegetables is reused for washing floor	√	√	
Turn off water taps that are not in use	√		
Use water to thaw food ingredients only when necessary		√	
Install thawing machine			√

Interview with the Head Chef of Restaurant B revealed that water conservation in the kitchen was mainly driven by cost minimization, rather than a concern for environmental issues. This might explain the limited adoption of innovative water saving measures in these three restaurants as summarized in Table 4.2.

ii. Other Eco-friendly Measures Implemented

Apart from water saving measures, the interviewees were also asked to identify any eco-friendly measures implemented in their restaurants. Two of the restaurants recycled aluminium cans. These aluminium cans were separated manually from other garbage for recycling. In addition, some of the lights were switched off during rest hours (3:00 pm to 6:00pm everyday). In Restaurant B, the staff would suggest the customers to turn off the hot pot stove when they nearly finished their meals. In Restaurant C, utilities bills of different outlets were kept at head office for comparison periodically.

iii. Responsibility of Water Saving in Premise

Most of the interviewees thought that the Head Chef, the Restaurant Manager and Section Heads/Supervisors, were responsible for water saving issues in the premise. They were mentioned by the interviewees for 12 times, 7 times and 6 times respectively. Besides, some of the interviewees thought that the Engineer and Head Office should also be responsible for on-site water saving. However, it was observed that none of the operational interviewees mentioned their responsibilities or involvements in water saving at their workplace. To extend in meaning, this could be a sign of the low awareness of water conservation among operational staff.

iv. Water-consuming Procedures

"Washing vegetables and other food ingredients" was regarded as the most water-consuming procedures in a Chinese restaurant. It had been mentioned by the interviewees for 11 times. "Washing dishes" came second, being mentioned by 9 times in the interviews. Other water-consuming procedures brought up by the interviewees included "cold-water thawing", "cooking" and "hot running water near stove at frying wok station".

v. Water-saving Instructions for Staff

There were several water-saving instructions for kitchen staff in Restaurant A and B. Both of the restaurants required staff to turn off unattended water taps and sprays, and avoid cold-water thawing unless necessary. Also, water for washing vegetables was reused for other purposes, such as washing the floor. In Restaurant B, there were additional water-saving instructions that the hot running water taps near frying wok stoves must be turned off when not in use, and the standardized production procedures must be followed by kitchen staff. However, the interviewees from Restaurant C could not mention any water-saving instructions at their workplaces.

It was also revealed that there was no water-saving instruction for front-of-the-house staff in all three studied restaurants. This was explained by one of the interviewees that only very little amount of water was consumed by the front-of-the-house section.

vi. Factors Affecting Water Consumption

"Number of patrons" and "weekends" had been mentioned 7 times and 4 times respectively as the two most determining factors of water consumption in Chinese restaurants. One of the interviewee revealed that there was usually a "baseload" of water consumption in every restaurant. This referred to the basic water consumption when there were zero patrons. Above the baseload, water consumption would increase as the number of patrons increased. "Choice of menu item" was brought up as a determinant of water consumption too. The interviewee gave an example that vegetables for hot pot might required much water for washing, while dim sum items might require less water in the preparation and cooking process.

It was also worth-noting that 5 out of the 14 interviewees could not associate water consumption with any factor. This could be explained that their awareness in water conservation was still low.

vii. Water-saving Suggestions

Among the 14 interviewees, only 5 of them could give suggestions on water-saving in their workplaces. Their suggestions include, putting up posters to remind staff on water conservation; reusing water for other purposes; employing more eco-friendly methods to defrost and thaw foods; stopping refill of hot water to the pot when the patrons nearly finish their hop pot dinner; and inviting staff to give suggestions on water conservation.

From the above interview findings, it was discovered that there were some discrepancies between the answers from managerial and operational staffs in all three cases. The Restaurant Managers and Head Chefs though that there were enough guidelines for the staff in environmental aspects. They expected the operational staff to carry out green practices in their own roles. However, the operational staffs said that they did not receive any eco-guidelines from their supervisors. They admitted that they knew neither their roles nor responsibilities in water conservation in their workplaces. This indicated a gap in-between – the green messages or commitments were not effectively communicated from the managerial level to the operational level.

Conveying the green messages effectively to the frontline staff should be of prime importance. It does not merely mean to state the environmental motto, but to let the employees know where, when and how they can conserve. Particularly, frontline employees' commitment and participation in environmental protection should be highly appraised. Getting their involvement can be a way to increase their general environmental awareness. For this reason, one of the criteria in the *EAM for Chinese restaurants water management* in Chapter 6 requires the certified restaurant to ensure that the frontline employees understand their own roles and responsibilities in the restaurant's water conservation programme (A 1 xiv). Restaurant Managers, Head Chefs, Training Personnel and Engineers should together work out a complete flow chart, incorporating green suggestions in every procedure and position. This document should be available to staff from all levels, so that they can carry out green practice in their roles.

4.1.2 Observations

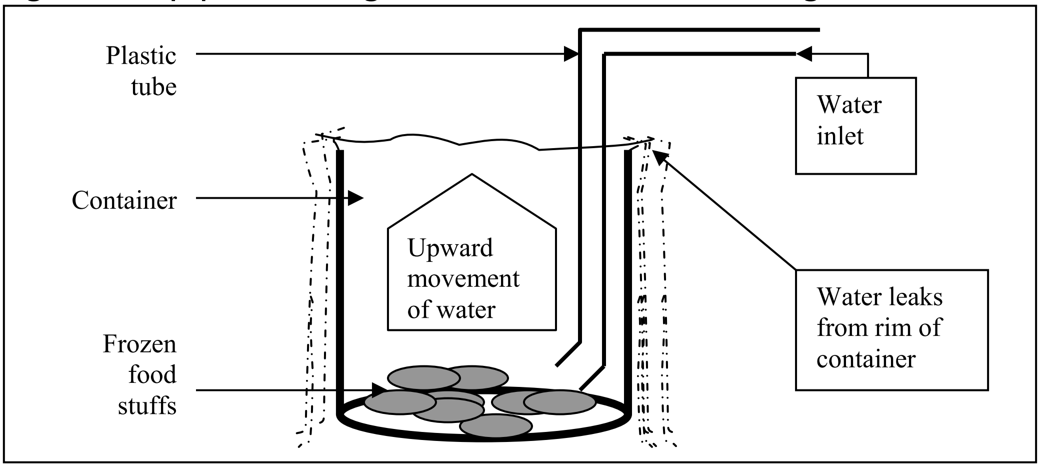
During the observations, some unique features in commercial Chinese cooking and serving were scrutinized and revealed. These features regarding water consumption are explained one by one below.

i. Cold-water Thawing

"Cold-water thawing" is a unique preparation procedures in commercial Chinese cooking. This is different from normal washing procedure that certain kinds of food stuff, such as frozen meat, chicken feet and seafood, are placed under running tap water, and thawed until they become defrosted and tender. By doing so, unwanted tastes of these food stuffs are expelled and impurities are removed (Chan and Au, 1998). It can also improve the texture of the foods. The three studied restaurants took different approaches to cold-water thawing.

In Restaurant A, traditional cold-water thawing method was employed (Figure 4.1). This was done by putting the food at the bottom of a container. The size of the container varied, depending on the quantity of food stuffs to be thawed. A plastic tube connecting to the water tap was also placed at the bottom of the container. Water was injected from the bottom, as a result an upward water flow was created, and excessive water leaked from the rim of the container. The water tap was kept opened until the food stuffs were fully thawed. After the process, the water was discharged into the sewer.

Figure 4.1: Equipment Settings of Traditional Cold-water Thawing Method



In Restaurant B, on the other hand, most of the cold-water thawing treatments were done in the off-premise central processing factory. Only a small quantity of frozen scallops, frozen prawns and frozen shrimps were thawed within the premise due to hygiene reason. Similar to the previous case, traditional cold-water thawing method was used. The Chefs of Restaurant B stirred regularly to ensure the food stuffs were thawed evenly. The water was also discharged into the sewer after the process.

In Restaurant C, three thawing machines were installed, one for each section in the kitchen. These machines were used when a large quantity of food stuffs were needed to be thawed. According to an experienced chef, the thawing machine was particularly suitable for thawing chicken feet, ribs and chicken wings. At least half of the water and time could be saved by using the thawing machine. Other food stuffs, such as crab's meat, shrimps and scallops, were thawed by traditional method instead.

One of the deficiencies of traditional cold-water thawing method was that the water tap had to be kept opened during the process. If the thawing time was not well-controlled, it tended to cause wastage in water. In addition, water for cold-water thawing was not suitable for reuse, as it might contain grease or impurities. Therefore the water would be discharged immediately after the process. Installation of thawing machine could be an alternative, as it could save water and thawing time. However, the initial investments and maintenance costs would be quite high that might not fall into the affordable range of many restaurant owners. In regard to these problems, a new method of cold-water thawing by microbubbles was proposed. The efficiency and effectiveness were tested by field experiments.

ii. Washing Vegetables and Other Food Ingredients

This process was different from "cold-water thawing" as food ingredients were washed and immersed in a tank of still water. It was observed in Restaurant B that 4 containers with a capacity of about 79 litres each were used for washing vegetables and other food ingredients (Appendix 4.1). The staff revealed that at least 12 rinses were needed everyday. This meant that nearly 5 cubic meter of water was consumed every day only for this purpose.

Besides, many expensive food ingredients in Chinese cooking were dehydrated. Examples included dried abalone, dried sea cucumber, dried shark's fin, dried fish maw, dried Chinese white cabbage and conpoy. These items needed to be washed and immersed in water overnight before further processing.

iii. Hot Water Supply at Frying Wok Station

Another unique feature of commercial Chinese cooking was found at the frying wok station. Hot water from a running tap was collected in a small pot which was placed next to the frying wok stove (Appendix 4.2). The hot water in the pot was used for cooking, as well as quick cleaning of woks. During peak hours, the chefs often kept turning the tap on, so that hot water could be supplied continuously. Although the Head Chef reminded the staff in the morning briefing that unattended water taps must be turned off, it was observed that the chefs in Restaurant A sometimes forgot to turn the taps off after peak hours, resulting in water wastage.

iv. Steamer

Steamed fish, steamed dim sum and stewed soup are very common in Cantonese cuisine. Like other Chinese foodservice establishments, the three studied restaurants used a commercial steamer to prepare steamed items and stewed soups (Appendix 4.3). The Head Chef of Restaurant B explained the mechanism of a steamer. Water was injected into a small compartment at the bottom of the steamer, and then heated by a pair of heat generation coils. At the boiling point, steam was formed and used to cook the foods. This was the cleanest and healthiest way of cooking. During peak hours, the steamers were kept switched on, so that dim sum and other steamed dishes could be offered continuously. This implied that non-stop water supply to the steamer was necessary.

v. Dishwashing

Dishwashing was regarded as the most water consuming activity in a Chinese restaurant. In the dish washing section, it was observed that treatment of used tableware and cookware was divided into several steps. First, the leftovers were removed manually by the dishwashing ladies. The majority of the solid wastes were removed and discarded separately in this first step. Second, the tableware and cookware were treated by high pressure water spray heads. This process removed all of the leftovers and solid wastes, but this was also the most water consuming step. Third, the tableware and cookware were immersed in water with detergent for around 10 minuets in order to remove the grease (Appendix 4.4). Fourth, the dishes were spongy-mopped and washed under running water as the final rinse. Finally the tableware and cookware were sterilized in the dish washing machine.

All three restaurants had installed a moving dishwasher (also called conveyor dishwasher), inside which dishes move through a cycle on conveyor belts. Flexible strip curtains made of plastic hang at both ends of the dishwashing chamber. This allows easy access to its interior. Washing is done by two fixed spray assemblies located at the top and bottom of the machine respectively.

According to the dishwashing ladies in the kitchen, they have to take care of the dishwasher. On a daily basis, they have to drain, clean and flush the water tanks in the machine; remove and clean the spray assemblies; refill the detergents; check water temperature and pressure. If there is any problem with the machine, they have to report immediately to the restaurant manager, so that the restaurant manager can seek help from the engineering department.

Restaurant C had installed a recyclable dishwasher, in which water from the last rinse was collected to do the initial rinse of used tableware of the next round. Even though this could save much water, the Engineer disclosed that the recycle function was no longer in use. It was because space was required to store the water, and electrical power was needed to pump the water from the storage tank up to the initial rinse spray heads. After conducting a cost-and-benefit analysis, the company decided not to use the recycle function.

vi. Serving Style

It was noticed that many utensils and tableware were provided to the patrons on a Chinese dinning table. According to one of the Restaurant Managers, a standard table setting for a patron included a pair of chopsticks, a chopstick holder, a spoon, a small bowl with a plate, a tea cup with an underplate, and a tiny dipping bowl (Appendix 4.5). For some high standard Chinese restaurants, the bowls and plates would be changed after each course. Besides, Chinese dim sum items were served in small portions, i.e. three to four pieces per dish usually. More plates and containers were thus needed. This might increase the workload of the dish washing section.

Last but not least, hot water and tea, accompanying the food dishes, were served to patrons in Chinese restaurants. Continuous serving of hot water and tea was regarded as enthusiastic and good service. Therefore, the front-of-the-house staff would keep filling hot water in the tea pots without the patrons' request.

4.1.3 Field Measurements

Findings from field measurements are summarized in Table 4.3 below. Only complete data sets, which included water consumption data recorded from all 9 fixed water meters, were used in statistical analysis. After eliminating the incomplete data, there were 72 and 79 sets of complete data for analysis from Restaurant A and Restaurant B respectively. Analysis results from these 151 (=72 + 79) sets of data were quite consistent.

Table 4.3: Summary of Water Consumption Findings from Field Measurements

Functional Zone	Restaurant A (N = 72)	Restaurant A Confidence Limits 95%	Restaurant B (N = 79)	Restaurant B Confidence Limits 95%	Average (N = 151)	Average Confidence Limits 95%
	Daily Water Consumption (m^3)					
Dim Sum Section						
Steamer	6.4028	± .1878	5.1944	± .2722	5.7986	± .1914
Cold-water Thawing Station	11.4583	± .2814	9.1944	± .2722	10.3264	± .2691
Subtotal:	**17.8611** (19.3%)	± .3422	**11.8897** (18.2%)	± .5444	**16.1250** (18.8%)	± .4281
Barbeque Section						
Sinks	9.0694	± .2023	6.2778	± .2710	7.6736	± .2849
Subtotal:	**9.0694** (9.8%)	± .2023	**6.2778** (8.0%)	± .2710	**7.6736** (8.9%)	± .2849
Main Kitchen Section						
Cold-water Thawing Station	17.2500	± .3939	13.0972	± .2902	15.1736	± .4198
Hot Running Water near Frying Wok Stoves	4.2222	± .1773	2.6111	± .2180	3.4167	± .1924
Soup and Sauce Making Station	0.2222	± .0984	1.3889	± .1154	0.8056	± .1221
Subtotal:	**21.6944** (23.4%)	± .4222	**17.0972** (21.7%)	± .3682	**19.3958** (22.6%)	± .4701

(Table 4.3 Cont)

Dishwashing Section	42.8889	± .8390	40.0972	± 2.0535	41.4931	± 1.1198
Subtotal:	**42.8889** (46.3%)	± .8390	**40.0972** (50.8%)	± 2.0535	**41.4931** (48.4%)	± 1.1198
Front-of-the-house						
Hot Drinking Water Machines	1.1389	± .1066	1.0972	± .1257	1.1181	± .0814
Subtotal:	**1.1389** (1.2%)	± .1066	**1.0972** (1.4%)	± .1257	**1.1181** (1.3%)	± .0814
Total Water Consumption	**92.6528**	±1.0141	**78.9583**	± 2.0185	**85.8056**	± 1.5894

i. Overall Water Consumption

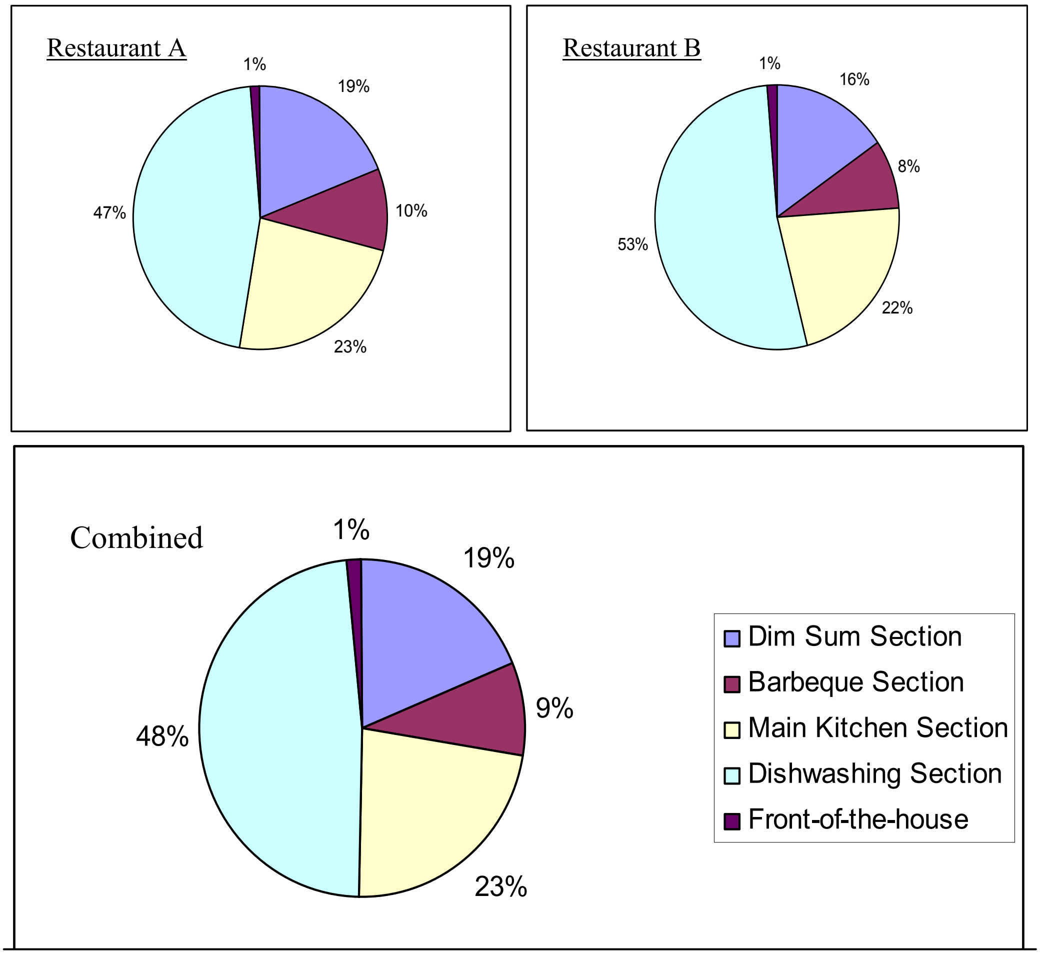
On average, the two studied restaurants consumed about 85.8 cubic meters of water every day in the kitchen and front-of-the-house area. For Restaurant A, the daily average water consumption was 92.7 cubic meter, and there was a 95% confidence that the mean score lied between 91.6 and 93.7 cubic meter. For Restaurant B, the daily average water consumption was 79.0 cubic meter, and there was a 95% confidence that the mean score lied between 76.9 and 81.0 cubic meter.

It was noted from the results that Restaurant A consumed more water on average than Restaurant B. A possible reason could be that Restaurant B was operated under a chain. Some of the food-processing tasks, such as cold-water thawing and washing ingredients, were carried out in the central food processing factory outside the premise. In contrast, Restaurant A was individually-operated at the time when the research was conducted. Therefore most of the food-processing tasks were carried out inside the premise, leading to a greater water consumption figure.

ii. Water Consumption in Different Sections

The sectional breakdown information in Table 4.3 is shown graphically in Figure 4.2 below. Combining the data from both Restaurant A and Restaurant B, the dishwashing section accounted for a noteworthy percentage of 48% (41.4931 cubic meter) of the total water consumption in a Chinese restaurant, followed by the main kitchen section (19.3958 cubic meter, 23%), the dim sum section (16.1250 cubic meter, 19%), and the barbeque section (7.6736 cubic meter, 9%). Water consumption in the front-of-the-house area (1.1181cubic meter, 1%) was comparatively insignificant in both restaurants.

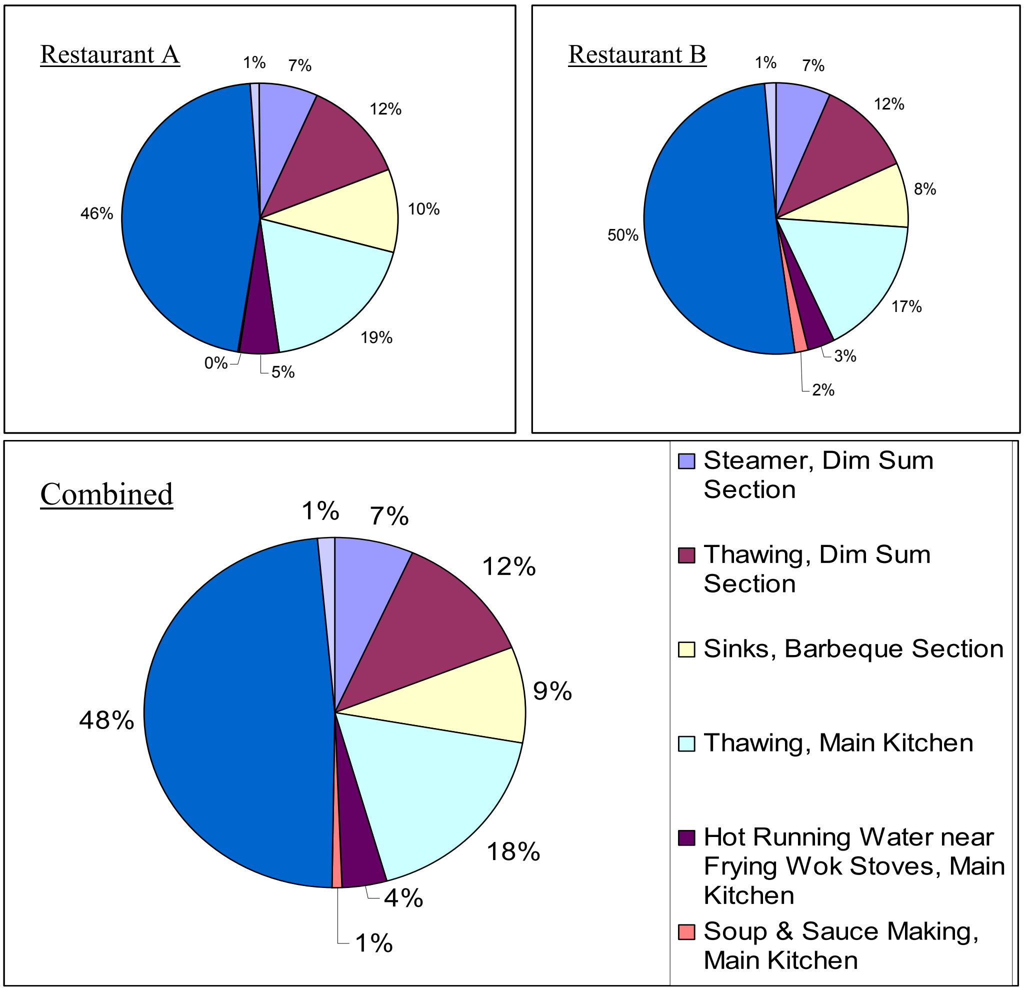
Figure 4.2: Water Consumption in Different Sections



iii. Water Consumption in Different Functional Zones

Figure 4.3 below shows the breakdown of water consumed by different functional zones. It was obvious that the dish washing section ($41.4931m^3$, 48%) was the number one water end-user in a Chinese restaurant. The cold-water thawing station in the main kitchen ($15.1736m^3$, 18%) came second, while the cold-water thawing station in the dim sum section ($10.3264m^3$, 12%) came third. The two cold-water thawing stations together made up nearly 30% of the total water consumption. This proportion was quite significant. On the other hand, the proportions of water for soup and sauce making in the main kitchen ($0.8056m^3$, 1%), hot drinking water for guests ($1.1181m^3$, 1%) and hot water supply at frying wok station ($3.4167m^3$, 4%) were not very significant.

Figure 4.3: Water Consumption in Different Functional Zones



4.1.4 Portable Electronic Water Meter

Based on the findings above, cold-water thawing was identified as the second most water consuming procedure in a Chinese restaurant. This practice is done everyday, and is one of the unique preparation procedures in Chinese commercial cooking. Therefore, a series of field tests were carried out to examine various cold-water thawing methods by a set of portable water meter, aiming at comparing the effectiveness and efficiency of different thawing options.

i. Comparison of Thawing Performance

Test 1, Test 2 and Test 3 examined the time and volume of water needed to defrost the same quantity of frozen food by traditional cold-water thawing method, thawing machine and microbubble machine respectively. Chicken feet (1 pack weighed 4.77kg) were selected as the food stuff for the field test because this is one of the most common food commodity used in local Chinese restaurants. Test 4, on the other hand, aimed to find out if further water saving could be made by using the microbubble machine with recycled water. The key results are summarized in Table 4.4 below.

Table 4.4: Comparison of Performances of Different Cold-water Thawing Methods

	Test 1 Traditional Cold-water Thawing Method (TT)	**Test 2** Thawing Machine (TM)	**Test 3** Microbubble Machine (MM)	**Test 4** Microbubble Machine with Recycled Water (MR)
Thawing Time Needed	Longest (15 minutes)	**Shortest** (12 minutes)	**Shortest** (12 minutes)	Medium (14 minutes)
Volume of Water Used	Most ($0.3037m^3$)	**Least** ($0.2443m^3$)	Medium ($0.2636m^3$)	**Least** ($0.2440m^3$)
Quality of Thawed Food*	Good	**Very Good** (Suitable for small pieces of frozen foods, such as chicken feet and ribs)	**Very Good** (Suitable for large pieces of frozen foods, such as frozen whole chicken)	Good

* The quality of thawed food was determined by an experienced chef.

In terms of length of thawing time, it was not surprising that traditional cold-water thawing was the most time-consuming method, which took 15 minutes to completely thaw the chicken feet. Oppositely, the application of thawing machine and microbubble machine showed satisfactory results. Only 12 minutes were needed for both methods.

In terms of quantity of water consumed, traditional cold-water thawing method (TT) was found to be the most water-consuming, which required 0.3037 cubic meter of water. On the other hand, least water was required by the thawing machine (TM) and the microbubble machine with recycled water (MR), which needed 0.2443 cubic meter and 0.2440 cubic meter of water respectively.

Comparing with traditional cold-water thawing method (TT), around 20% less water was required for the thawing machine (TM) and the microbubble machine with recycle water (MR). Around 13% less water, i.e. 0.2636 cubic meter, was required by the microbubble machine (MM) alone.

Finally, the quality of thawed food was determined by two experienced chefs in the field. The two major criteria were the tenderness of defrosted food and the degree of impurities removal. Traditional thawing method was rated "good" by the chefs in this test. The frozen food items became defrosted and tender, and the impurities were removed. The performances of thawing machine and microbubble machine were even better, and they were rated "very good" by the chef. The impurities were removed more quickly and the foods were defrosted more evenly. The chefs agreed that the thawing machine would be the most efficient in treating a large quantity of frozen food stuffs. At least half of the water and time could be saved by using the thawing machine. However, the thawing machine would generate vigorous circular motion of water, making it unsuitable for thawing frail food stuffs such as crab's meat, shrimps and scallops. Therefore, the chefs suggested the use of microbubble machine in thawing frail food stuffs. Besides, the microbubble machine showed better performance in thawing food stuffs of larger piece, such as whole chicken and whole conch. This was opposite to the thawing machine, which performed better in thawing food stuffs of small piece, such as chicken feet, chicken wings and ribs.

ii. Comparison of Temperature Change

From the above four tests, it was found that both the thawing machine and the microbubble machine showed better overall thawing performance. Therefore, Test 5 was carried out in order to compare the temperature change of the food stuffs thawed by the two machines. The purpose was to trace the change in mid-layer and inner temperature of the food stuffs.

The temperature change of the food defrosted was detected by a pin-like thermometer [Model: PDT300 Digital Thermometer, Comark Instruments Inc], which was specially designed for measuring food temperature. In this test, conches were used as the testing food material instead of chicken feet, since it was technically impossible to measure the inner temperature of chicken feet by the thermometer.

Figure 4.4 and Figure 4.5 visualized the temperature change of food thawed by the thawing machine and microbubble machine respectively. At the beginning of the test (time = 0), the inner and mid-layer temperatures of the frozen conches was -8.5^{o}C and -8 ^{o}C respectively. As the cold-water thawing process started, the mid-layer temperature raised more quickly than the inner part in both cases. This was expected as heat was transferred by conduction from water to the outer-layer, to the mid-layer, and finally to the inner part.

Figure 4.4: Temperature Change of Food Thawed by Thawing Machine (TM)

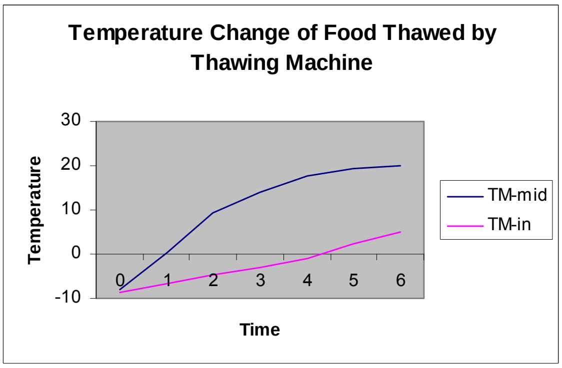
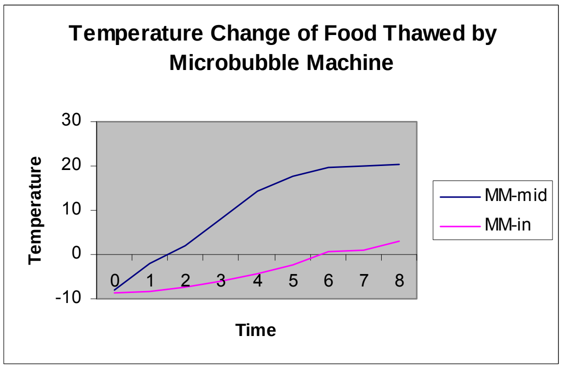


Figure 4.5: Temperature Change of Food Thawed by Microbubble Machine (MM)



TM-mid: Mid-layer temperature of food stuffs thawed by thawing machine

TM-in: Inner temperature of food stuffs thawed by thawing machine

MM-mid: Mid-layer temperature of food stuffs thawed by microbubble machine

MM-in: Inner temperature of food stuffs thawed by microbubble machine

From both graphs, it could be observed that the rate of temperature increment at the mid-layer was faster at the beginning of the thawing process, and then slow down gradually. On the other hand, the inner temperature increased steadily throughout the test in both cases.

The test was ended when the experienced chef agreed that the food stuffs were completely thawed. Usually it referred to the state that the food was defrosted and the inner temperature was above 0 ^{o}C. By using the thawing machine (Figure 4.4), it took 6 minutes to completely thaw the conch. The final mid-layer temperature was 20.1 ^{o}C, while the final inner temperature was 5 ^{o}C. By using the microbubble machine (Figure 4.5), it took 8 minute to complete the thawing process. The final mid-layer temperature was 20.3 ^{o}C, while the final inner temperature was 3 ^{o}C.

Using the same temperature data, Figure 4.6 and Figure 4.7 were plotted to compare the mid-layer temperature and inner temperature of the conches by the two methods respectively. Both graphs showed that the rate of temperature increase was faster by using the thawing machine. In addition, the thawing machine took less time to complete the process. This signified that the thawing machine was more efficient in accelerating the heat transfer process between water and the frozen food stuffs.

Figure 4.6: Comparison of Mid-layer Temperature between Thawing Machine (TM) and Microbubble Machine (MM)

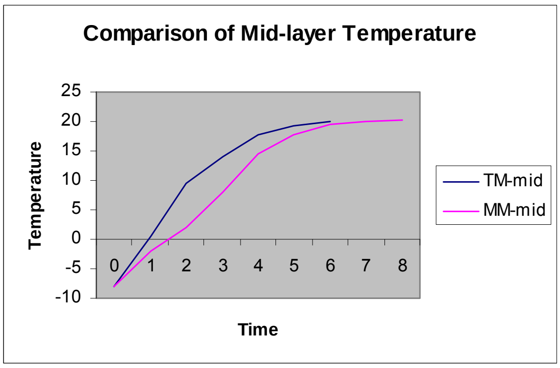
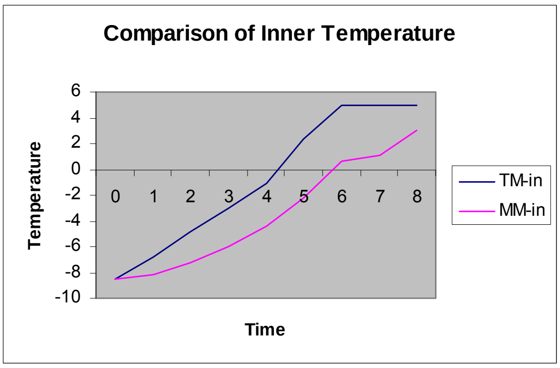


Figure 4.7: Comparison of Inner Temperature between Thawing Machine (TM) and Microbubble Machine (MM)



iii. Cost-benefit Analysis

In the first phase of this study, it was found that the studied restaurants on average spent 25.5 cubic meter of water for cold-water thawing. Then in the second phase, it was found that the application of thawing machine and microbubble machine could save 20% and 13% of water respectively, comparing with traditional thawing method. Therefore in the third phase, a cost-benefit analysis was performed to determine the pay-back period of the machines and potential savings for restaurant operators as shown in Table 4.5

below. The payback period and potential savings was estimated based on the local water cost for non-residential premises.

Table 4.5: Payback Period of Thawing Machine and Microbubble Machine

	Traditional Cold-water Thawing Method	Thawing Machine	Microbubble Machine
Initial Cost	HK$0	HK$20,000	HK$8,000
Daily water consumption for cold-water thawing (m^3)	25.50	25.50 x (1-20%) = 20.40	25.50 x (1-13%) = 22.20
[a] Daily Water Charge for cold-water thawing	HK$116.79	HK$93.43	HK$101.67
[b] Daily Sewage Charge for cold-water thawing	HK$25.52	HK$20.42	HK$22.22
[c] Daily Trade Effluent Surcharge for cold-water thawing	HK$62.22	HK$49.78	HK$54.17
Total Daily Cost for Water Consumption for cold-water thawing	HK$204.53	HK$163.63	HK$178.06
Daily Saving	--	HK$40.90	HK$26.47
Pay Back Period	--	**489days**	**302days**

a - HK$4.58 per cubic meter
b - HK$1.43 per cubic meter with a discount factor of 0.7
c – HK$3.05 per cubic meter with a discount factor of 0.8

If a restaurant adopted the traditional cold-water thawing method, it was predicted that the daily water cost would be HK$204.53. Installation of thawing machine could make a 20% discount on water consumption, resulting in a saving of HK$40.90 daily. Thus the payback period should be 489 days, i.e. around 16.3 months. The microbubble machine, on the other hand, could save 13% of water consumption, i.e. HK$26.47 per day. Although the daily saving seemed less than that of the thawing machine, the payback period would be shorter due to the lower initial cost. The microbubble machine could be paid off in 302 days, i.e. around 10 months. Attention should be paid that the estimation of payback period was based on water cost only. Other potential costs, such as electricity cost and maintenance cost, were not included. It was because accurate data of other potential costs were not acquirable.

4.2 Validity, Reliability and Limitations

This study mainly followed Yin's (2003) suggestions on building research validity and reliability. Details are discussed below.

4.2.1 Validity

Validity refers to the degree to which a measure accurately represents what it is supposed to (Hair, Anderson, Tatham and Black, 2006). During the data collection stage, multiple sources of evidence, including documentations, interviews and observations, were obtained in each case for literal replication logic, i.e. data triangulation. Then corroboration and pattern-matching were done in the data analysis process, so that the more occurrence reported, the greater the confidence in the final conclusion. These steps were expected to ensure internal and construct validity of the study.

In addition, it is important that the findings from a valid study can be generalized to some extent beyond the immediate situation (Gibson, 1998). Thus replication logic was followed in the research design; the multiple cases would be considered as a series of experiments to explore the environmental problems created by Chinese restaurants' operation. It was anticipated that the findings could be generalized and transferred to other Chinese restaurants in Hong Kong.

4.2.2 Reliability

Reliability refers to the consistency of measurement (Wysocki, 2008). To ensure reliability, it was necessary to minimize the potential errors and biases in this study. Yin (2003) recommended that having a case study protocol would be desirable especially for multiple-case studies. Therefore a protocol containing the procedures for interviews and observations were produced before data collection. The protocol guided the researcher in carrying out the case studies in fields. Particularly, the interview questions were stated in the protocol to ensure consistency in all interviews. In addition, the 24-hour rule was conformed in writing the interview transcripts and observation records after the field visits.

For field measurements, pilot tests were carried out to ensure the equipments functioned normally. Standardized data collection forms were used in different restaurants, and the researcher frequently checked the recorded figures with the helpers. In case a recorded figure was found abnormal (too high or too low), the data would be eliminated in the analysis. This could further ensure the reliability of the computed results.

4.2.3 Limitations

While conducting the case studies, there existed some limitations in executing the research methodologies. The problems were mainly due to budget and technical constraints of the current study.

Firstly, there were only a limited number of in-depth interviews conducted. It was because the long working hours and heavy workload reduced the staff's willingness to participate. Nonetheless, there is no standard number of interviews to be conducted in case studies as suggested by Kvale and Brinkmann (2009). A total of 10-15 interviews would be common in social science researches.

Secondly, there was only one observer in the field studies, and the observer's identity was unveiled. This might create a problem of reactivity of the objects being observed (Tashakkori and Toddlie, 2003).

Thirdly, the budget only allowed installation of fixed water meters in two Chinese restaurants. The data might be more reliable and comprehensive if there were additional participating restaurants.

Lastly, convenience sampling was adopted, which was not a random sampling method. In fact, the operating modes of most local Chinese restaurants are homogeneous, in terms of their business hours, division of labour, menu items, service style and staff-to-customer ratio. This ensured that the selected cases could represent the target population. Besides, existing literature suggested that the purpose of conducting case studies is not to generalize truth. According to Yin (1993), an assumption of case studies is that there is no generalization to a population beyond cases similar to those studied. The emphasis of case studies should be placed on exploration and description.

4.3 Summary of Case Studies

This chapter reported the findings of three case studies. Major water consuming units/procedures in Chinese restaurants, including dishwashing, cold-water thawing, hot water supply near frying wok station, etc, were identified through interviews and observations. Then a series of field measurements were carried out, and it was discovered that the dish washing section was the most water consuming procedure in a Chinese restaurant, which accounted for over 40% of total water consumption. The cold-water thawing procedure, which accounted for around 30% of water consumption, came second.

This chapter also presented the field tests carried out to examine the performance of different cold-water thawing methods. The overall performance of thawing machine was the best. Although the thawing performance of microbubble machine was behind that of the thawing machine, the microbubble machine would still be potentially applied in local commercial kitchens. The major advantage of microbubble machine is its size. It is a tiny, portable device that can be put into any water tanks for thawing. Oppositely, a thawing machine has to be installed in a fixed place. It requires much space, thus it may not be suitable for small-scale foodservice establishments. In addition, the initial cost of a microbubble machine was only 40% of that of a thawing machine, and it has an average lifespan of around 5 to 10 years. Therefore it appears to be an attractive alternative for small-to-medium scale foodservice establishments.
The case studies identified some important features and characteristics of local Chinese restaurant operation. The studied restaurants varied in operational scale

and style, so they could represent the majority of the target population. The findings would provide insightful inputs for constructing the *EAM for Chinese restaurants water management*, and setting the relevant assessment criteria in Chapter 6.

5. WATER CONSUMPTION SURVEY

This Chapter presents the findings from the water consumption survey, so as to document the current state of water usage by local Chinese restaurants, and identify the most dominant factor in predicting water consumption in these operations. The factor would then be used to develop WUI_{CR} – the first water use index for the Chinese restaurant industry. This would be a gauge for the development of assessment criteria of the EAM regarding water management in local Chinese restaurants in Chapter 6.

This chapter is structured as followed. Descriptive findings about the respondents' operational information are presented in Section 5.1, and their water consumption and patronage patterns in Section 5.2. These are followed by discussions of the statistical analyses using SPSS. Findings from bivariate analyses, independent groups t-tests, and multiple regression analyses are discussed in Section 5.3, 5.4 and 5.5 respectively. These findings are then used to establish WUI_{CR} as detailed in Section 5.6. Finally the limitations of this survey are acknowledged in Section 5.7, and a summary is presented in Section 5.8.

5.1 General Operational Information of Respondents

The 46 participated restaurants were operated under 6 restaurant groups, 15 brands. Their operational features are summarized below:

- 45.7% (21 restaurants) were located in Kowloon, 39.1% (18 restaurants) in the New Territories, and 15.2% (7 restaurants) on Hong Kong Island.

- Almost all (45 restaurants) were operated under a chain company. Only 1 restaurant was operated independently at the time when the survey was conducted.

- 52.2% (24 restaurants) offered banquet service, while the remaining 47.8% (22 restaurants) did not.

- 73.9% (34 restaurants) possessed an off-premise central food processing factory, while the remaining 26.1% (12 restaurants) did not.

- 41.3% (19 restaurants) offered hot pots, while the remaining 58.7% (27 restaurants) did not.

- The total gross floor area of the respondents ranged from 4,500 to 46,422 square meters. The mean was 15,834 square meters, with a 95% confidence that the mean lied between 13,115 square meters and 18,554 square meters.

5.2 Univariate Analyses

Univariate analyses of local Chinese restaurants' water demand and patronage were conducted at the first place. The monthly water consumption figures and patronage figures were used to plot separate graphs. These two graphs could visualize and compare the overall variation of water consumption and patronage in local Chinese restaurants within a year. Excluding the missing values[2], there were 31 sets of 12-month data for analyzing the yearly water consumption and patronage patterns.

5.2.1 Monthly Water Consumption

Monthly water demand fluctuated within a year as shown in Table 5.1 and Figure 5.1 below. Results from SPSS showed that the overall mean score of monthly water consumption was 2,840.84 cubic meters, with a 95% confidence that the mean lied between 2,393.33 and 3,288.54 cubic meters. According to Hair, *et al*. (2006), prediction by this mean score could be used as a baseline for comparison, as it could represent the best possible prediction without using any independent variables.

The high water usage months clustered in the second half of a year. The mean score of water consumption in July (3,528.21 cubic meters) was the highest. This was followed by August and December, with mean scores of 3,369.29 and

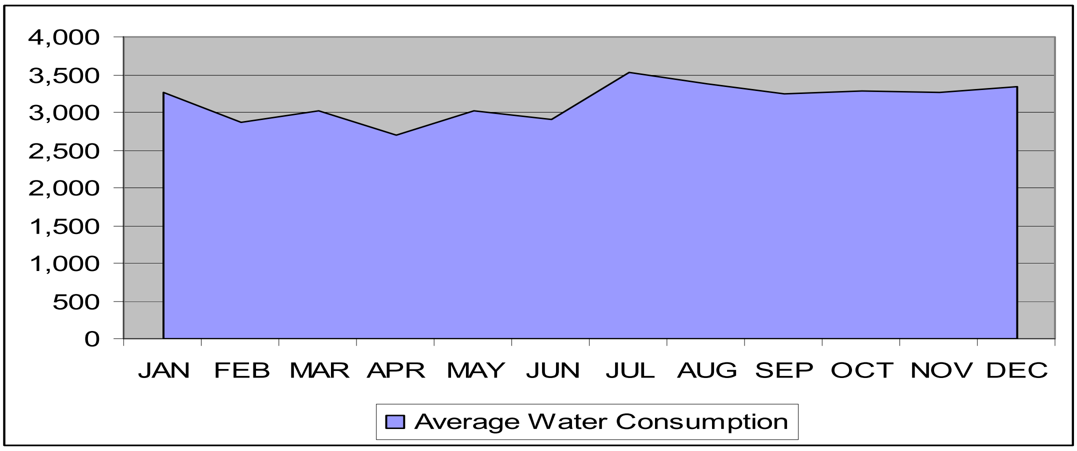
[2] Missing values might due to restaurant operators' reluctance to disclose sensitive operational information, shared water meter data, incomplete water billing information, etc.

3,338.14 cubic meters respectively. In contrast, water consumption was relatively low in April (2,696.64 cubic meters), February (2,876.86 cubic meters) and June (2,913.86 cubic meters). The difference between the highest and lowest months was 831.57 cubic meters.

Table 5.1: Monthly Water Consumption of Responded Restaurants (N=31)

Month	Average Water Consumption (m^3)	95% Confidence Interval
January	3,269.36	± 901.56
February	2,876.86	± 843.07
March	3,012.43	± 810.58
April	2,696.64	± 826.41
May	3,023.57	± 872.23
June	2,913.86	± 856.47
July	3,528.21	± 1,117.30
August	3,369.29	± 980.57
September	3,240.29	± 992.97
October	3,278.00	± 1,023.11
November	3,255.64	± 986.72
December	3,338.14	± 966.58
Overall	**2,840.84**	**± 447.61**

Figure 5.1: Monthly Water Consumption of Responded Restaurants (N=31)



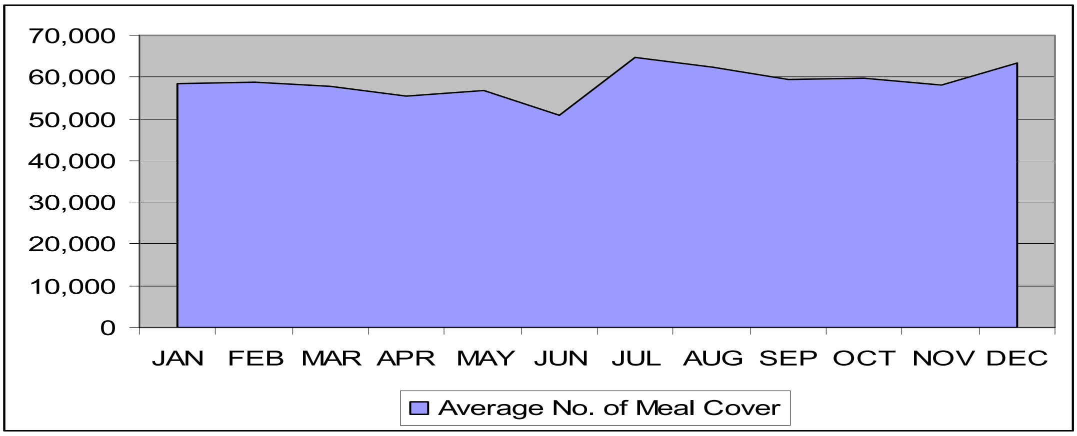
5.2.2 Monthly Patronage

The variation of monthly patronage is presented in Table 5.2 and Figure 5.2 below. The overall mean score was 57,893 meal covers, with a 95% confidence that the mean lied between 44,663 and 71,123 meal covers. The peak months identified were July, December and August, with means scores of 64,584, 63,440 and 62,354 meal covers respectively. On the other hand, patronage in June and April were the lowest, with a mean score of 50,801 and 55,343 meal covers respectively.

Table 5.2: Monthly Patronage of Responded Restaurants (N=31)

Month	Average No. of Patrons	95% Confidence Interval
January	58,335	± 15,792
February	58,914	± 16,208
March	57,660	± 15,912
April	55,343	± 15,317
May	56,685	± 14,999
June	50,801	± 13,066
July	64,584	± 18,311
August	62,354	± 17,659
September	59,439	± 16,852
October	59,767	± 16,912
November	58,119	± 16,183
December	63,440	± 17,730
Overall	**57,893**	**± 13,230**

Figure 5.2: Monthly Patronage of Responded Restaurants (N=31)



5.2.3 Summary of Univariate Analyses

In the local Chinese restaurant sector, both water consumption and patronage fluctuated across the year. Average water consumption of the respondents was over 2,800 cubic meters per month, and average number of patrons was over 13,200 per month.

The above yearly water consumption average can serve as an industry norm, but it is suggested that Chinese restaurant operators should not use this figure as the only reference. The reason is that the state of water consumption varies across the year. More water is consumed during peak months. For benchmarking purpose, therefore, Chinese restaurant operators are suggested to refer to the average water consumption in the corresponding month. This can effectively help detection of any abnormal water consumption arisen from leakage, water abuse, or other problems.

Moreover, it was interesting to note similar patterns in Figure 5.1 and Figure 5.2. Peak months of Chinese restaurant business (July, August and December) were associated with higher water consumption. Oppositely, low seasons (April to June) were associated with lower water consumption. This might, to a certain extent, cue a relationship between patronage and water consumption in Chinese restaurants. In order to prove this, a series of bivariate analyses were conducted in the next section.

5.3 Bivariate Analyses

In the previous section, it was envisaged that water consumption in Chinese restaurants might be related to level of patronage. In addition, it was generally agreed that water consumption in restaurants would be affected by other explanatory variables, namely gross floor area (GFA) and operating hours. Thus, a series of bivariate analyses were preformed to determine how strong the correlations were.

5.3.1 Pre-analysis Assumptions

Prior to performing the correlational analyses, the following underlying assumptions should be noted (Coakes and Steed, 1999):

i. Related Pairs

The data must be collected from related pairs. In these analyses, the volume of water consumed and the explanatory variables were collected and analyzed in pairs. In the terminology of statistical analysis, water consumption was the dependent variables, while the number of patrons, GFA and operating hours were the independent variables.

ii. Scale of Measurement

The scale of measurement of the data for correlational bivariate analysis should be ratio or interval in nature. In the current study, the scale of measurement of both the dependent and independent variables were ratio.

iii. Normality

The scores within each variable should be normally distributed. Thus, the normality of each variable would be screened before conducting the analyses.

iv. Linearity

Linearity refers to the linear relationship between the two variables. This would be tested by examining the scatterplots of the variables in the following sections.

v. Homoscedasticity

This concerns with how the scores cluster uniformly about the regression line. Again, this would be tested by examining the scatterplots of the variables in the following sections.

5.3.2 Correlation between Monthly Water Consumption and Monthly Patronage

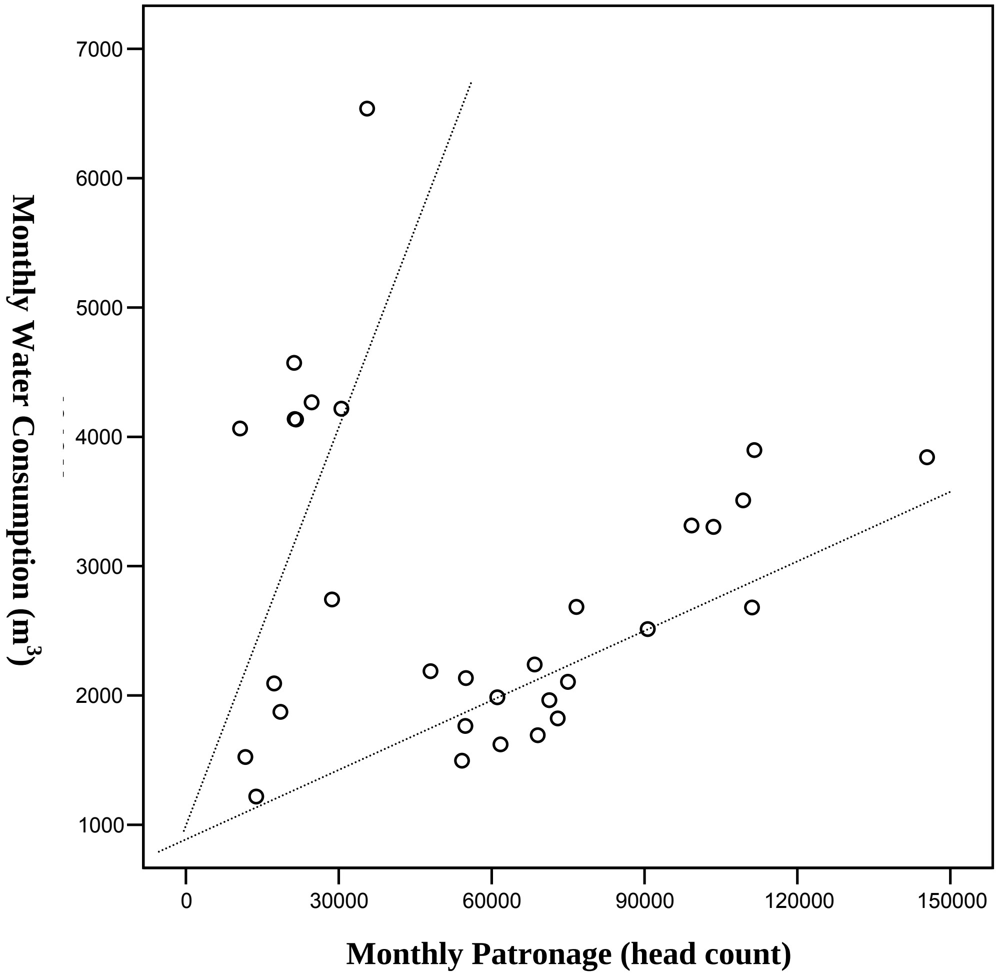
As suggested by previous researches (Redline and de Roos, 1990), as well as some of the interviewees, that water consumption in catering premises would be affected mainly by the number of patrons or meal covers. Therefore in the first bivariate analysis, the strength of correlation between monthly patronage and monthly water consumption was determined. The independent variable (X) was the number of patron in a period, while the dependent variable (Y) was the volume of water consumed in the same period. After trimming all missing values[2], there were totally 31 pairs of complete data for this analysis.

Table 5.3 below shows the results from SPSS bivariate analysis for the correlation between monthly water consumption and monthly patronage. There was only a very weak correlation ($r = 0.240$, $p > 0.05$). This result was very surprising, as it was generally agreed that water consumption in restaurants would be chiefly affected by the number of meal covers. The scatterplot in Figure 5.3 indicates that the assumptions of linearity and homoscedasticity were violated. However, it should be noted that the scatterplot formed a v-shape, which meant there might be two "categories" among the respondents that possessed dissimilar water consumption patterns. This was an interesting result, and the "categories" would be identified by a series of independent groups t-tests in Section 5.6.

Table 5.3: Correlation between Monthly Water Consumption and Patronage (N=31)

		Monthly Water Consumption
Patronage	Pearson Correlation	.240
	Sig. (1-tailed)	.449

Figure 5.3: Scatterplot of Correlation between Monthly Water Consumption and Patronage (N=31)



5.3.3 Correlation between Monthly Water Consumption and Gross Floor Area (GFA)

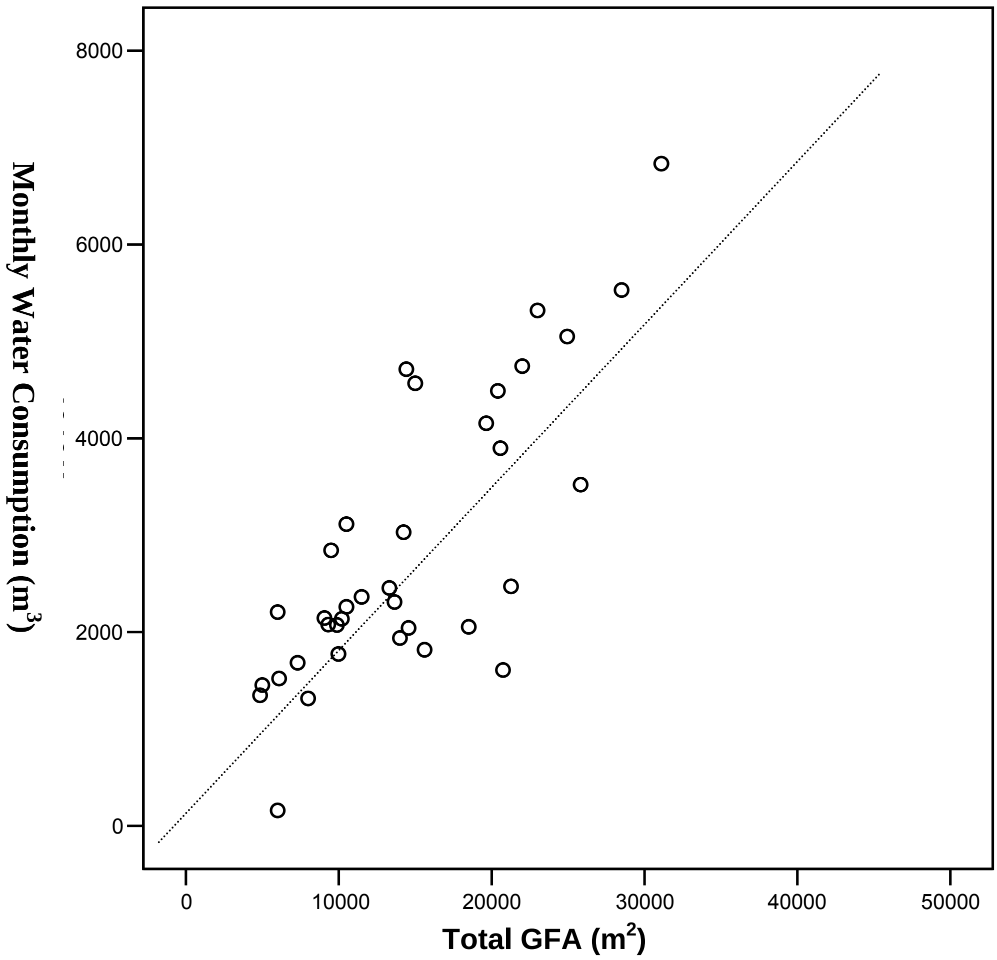
The second bivariate analysis aimed to determine the strength of correlation between GFA and monthly water consumption. The rationale for choosing this factor was that water consumption was found to be strongly correlated to GFA in the hotel industry (Deng and Burnett, 2002b). Conducting this bivariate analysis could find out if the same phenomenon happened in the Chinese restaurant industry. The independent variable (X) was the total GFA of the respondents, while the dependent variable (Y) was the volume of water consumed by the respondents in a month. In this analysis, there were totally 43 pairs of complete data for analysis after trimming all missing values[2].

Unlike the scatterplot in the previous section, there were no obvious outliers in the scatterplot for water consumption and total GFA (Figure 5.4). The assumptions of linearity and homoscedasticity were not violated. This cued a linear relationship between the two variables. The output from SPSS is shown in Table 5.4, which confirmed the results of the scatterplot that there was a positive relationship between the variables ($r = 0.519$, $p < 0.05$). Although the correlation was not particularly strong, it could be concluded that larger GFA might be associated with more water consumption in Chinese restaurants.

Table 5.4: Correlation between Monthly Water Consumption and Total Gross Floor Area (N=43)

		Monthly Water Consumption
Total GFA	Pearson Correlation	.519
	Sig. (1-tailed)	.000

Figure 5.4: Scatterplot of Correlation between Monthly Water Consumption and Total Gross Floor Area (N=43)



In order to increase the accuracy of analysis, two additional bivariate analyses were preformed. The first one examined the correlation between the monthly water consumption and GFA of kitchen, while the second one examined the correlation between monthly water consumption and GFA of front-of-the-house (FOH) area. The scatterplots are shown in Figure 5.5 and Figure 5.6 respectively. The SPSS outputs are presented in Table 5.5 below.

Table 5.5: Correlation between Monthly Water Consumption and Gross Floor Area of Kitchen and Front-of-the-house Area (N=43)

		Monthly Water Consumption
GFA of Kitchen	Pearson Correlation	.807
	Sig. (1-tailed)	.000
GFA of FOH area	Pearson Correlation	.578
	Sig. (1-tailed)	.000

Figure 5.5: Scatterplot of Correlation between Monthly Water Consumption and Gross Floor Area of Kitchen (N=43)

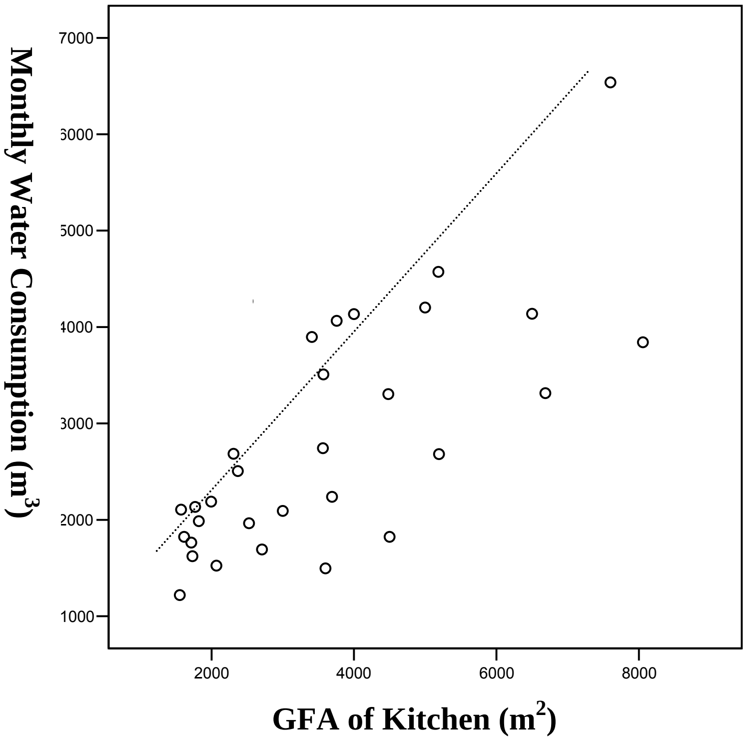
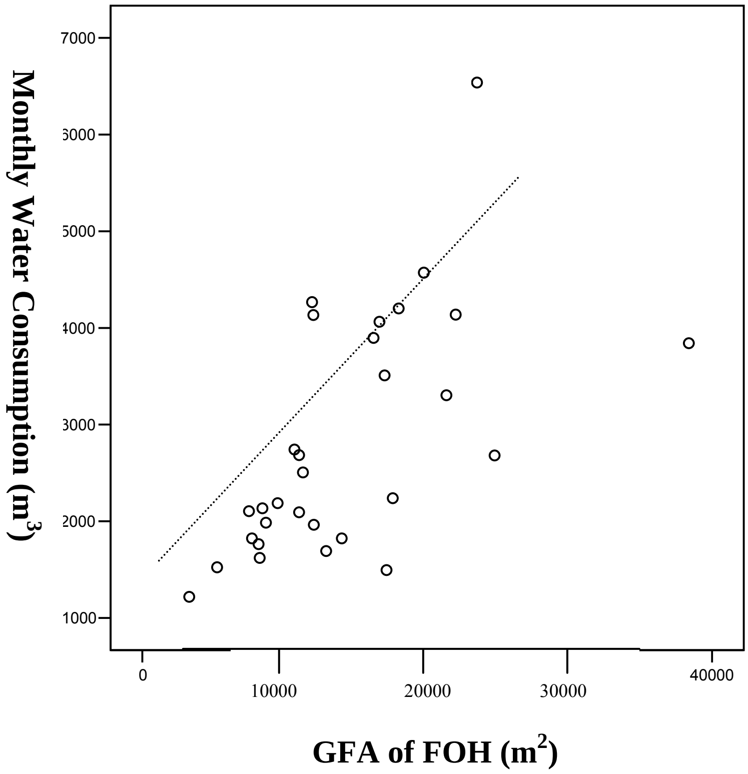


Figure 5.6: Scatterplot of Correlation between Monthly Water Consumption and Gross Floor Area of Front-of-the-house Area (N=43)



Again, the two graphs outlined similar patterns as in Figure 5.4 that the points clustered around a positively-sloped line. A positive relationship was revealed in each of the cases. Specifically, the correlation between monthly water consumption and GFA of kitchen ($r = 0.807$, $p < 0.05$) was stronger than that between monthly water consumption and GFA of FOH area ($r = 0.578$, $p < 0.05$).

5.3.4 Correlation between Monthly Water Consumption and Operating Hours

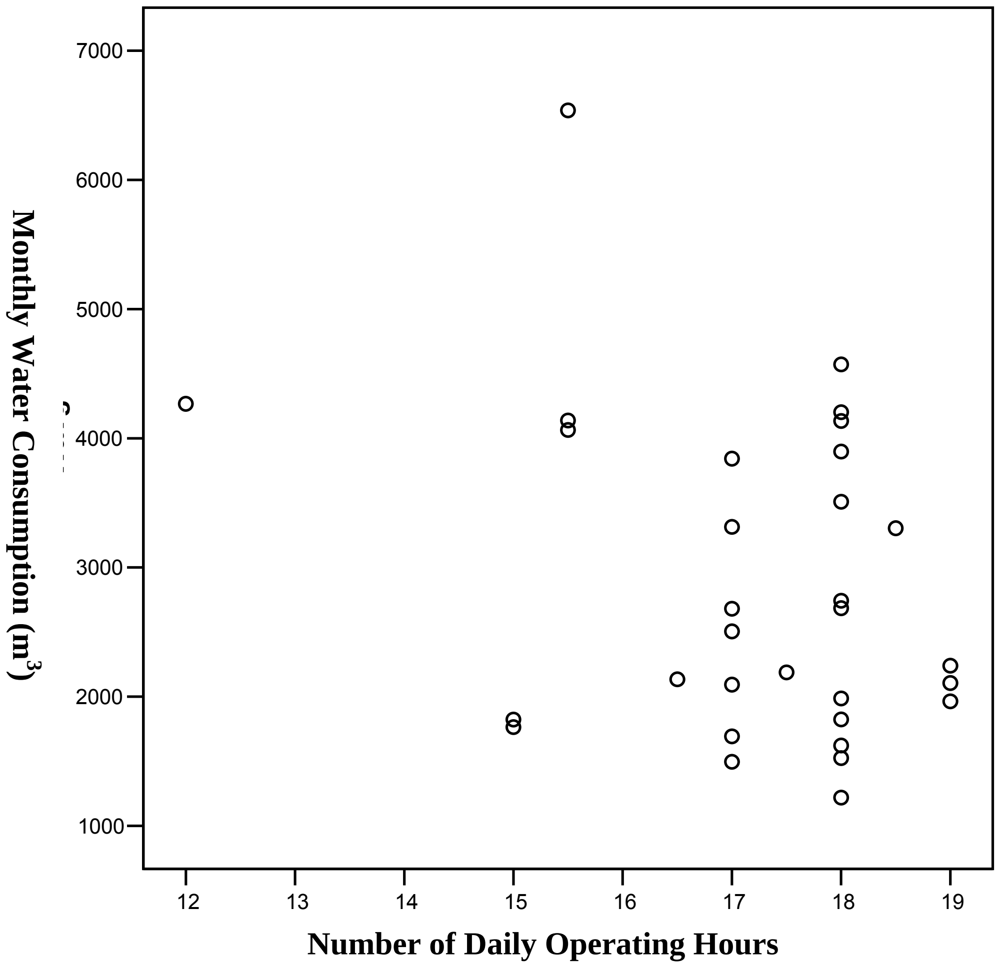
The third bivariate analysis aimed to determine the strength of correlation between number of operating hours and monthly water consumption. The independent variable (X) was the respondents' number of operating hours per day, while the dependent variable (Y) was the volume of water consumed by the respondents in a month. In this analysis, there were totally 31 pairs of complete data for analysis after trimming all missing values[2].

Figure 5.7 shows the scatterplot of monthly water consumption against daily operating hours of the respondents. There was no specific pattern identified. The assumption of linearity and homoscedasticity were violated. From Table 5.6 below, the output from SPSS confirmed that there was no relationship between the two variables at all ($r = -0.029$, $p > 0.05$).

Table 5.6: Correlation between Water Consumption and Operating Hours (N=31)

		Water Consumption
Operating Hours	Pearson Correlation	-.029
	Sig. (1-tailed)	.051

Figure 5.7: Scatterplot of Correlation between Monthly Water Consumption and Operating Hours (N=31)



5.3.5 Summary of Bivariate Analyses

A total of five bivariate analyses were carried out to explore if correlations existed between water consumption in Chinese restaurants and various independent variables. It was discovered that GFA had a positive correlation with water consumption. In particular, GFA of kitchen had the strongest determining effect on water consumption (r = 0.807). Surprisingly, number of patrons was found to be very weakly correlated with water consumption (r = 0.24). This finding showed disagreement on our general agreement reality. However, the v-shape scatterplot hinted that there might be two categories of respondents with dissimilar operational modes that led to diverse water demands. This would be verified by several independent groups t-tests in the next section. Finally, operating hours did not affect water consumption in Chinese restaurants at all.

5.4 Independent Groups T-Tests

Apart from GFA and number of patrons, it was generally assumed that several operational factors (also called "property specific effects") would affect water consumption level in Chinese restaurants. Suggested by the interviewees in the case studies, these factors might include the availability of central food processing factories, provision of banquet service, and provision of hot pots. These operational factors were paired, and mutually exclusive in nature. To determine if significant difference existed between water consumption mean scores of pair groups, three independent groups t-tests were carried out as followed:

- The first t-test compared the water consumption means between restaurants with and without off-premise food processing factories.

- The second t-test compared the water consumption means between restaurants that provided banquet services and those did not.

- The third t-test compared the water consumption means between restaurants that provided hot pots and those did not.

5.4.1 Pre-test Data Arrangement and Assumptions

Before conducting the independent groups t-tests, the data set were reduced to ensure that it contained the necessary information to estimate the effects of variations in water consumption. Finally, there were 44 sets of 12-month water consumption data for these analyses[2]. In addition, there were certain assumptions that must be met prior to performing t-tests (Coakes and Steed, 1990), including:

i. Scale of Measurement

The scale of measurement of the data for t-tests should be interval or ratio. In this case, the scale of measurement for water consumption was ratio.

ii. Independence of Groups

The independence of groups refers to the condition that subjects should appear in only one group, and the groups are unrelated. All of the three pairs of data could fulfil this condition.

iii. Normality

Water consumption scores should be normally distributed in the population. Therefore each of the data set would be screened for normality before computing the statistics.

iv. Homogeneity of variance

The homogeneity of variance, which refers to the equal variance of groups, was examined by the Levene's test using SPSS. If $p > 0.05$, there would be no significant differences between the variance of the groups. The equal variance estimate from the independent groups t-test would be consulted. On the other hand, if $p < 0.05$, there would be significant differences between the variance of the groups. Then, the unequal variance estimate would be consulted.

5.4.2 Availability of Off-premise Food Processing Factories

The first t-test compared the water consumption means between restaurants with and without off-premise food processing factories. The null hypothesis and alternative hypothesis were:

Ho: There would be no significant difference between the water consumption means of restaurants with and without a central food processing factory.

H_1: There would be a significant difference between the water consumption means of restaurants with and without a central food processing factory.

Table 5.7: Independent Groups T-Test Results for Availability of Off-premise Food Processing Factories (N=44, Confidence Level 95%)

Group Statistics		
Off-premise Food Processing Factory	**N**	**Water Consumption Mean (m^3)**
No	11	2,900.45
Yes	33	2,826.15

Levene's Test for Equality of Variances	
F	**Sig.**
.075	.785

Independent Groups T-Test			
	T-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	.153	42	.879
Equal variance not assumed	.157	18.044	.877

The results from SPSS are shown in Table 5.7 above. The Levene's test had a probability greater than 0.05, which meant the population variances were equal. In this instance, the equal variance estimate was consulted. The two-tailed sig. value was 0.879 (greater than 0.05), thus the null hypothesis was accepted. There was no significance difference between the water consumption means of restaurants with and without off-premise food processing factories.

5.4.3 Provision of Banquet Services

The second t-test compared the water consumption means between restaurants provided banquet services and those did not. The null hypothesis and alternative hypothesis were:

Ho: There would be no significance difference between the water consumption means of restaurants provided banquet services and those did not.

H_1: There would be significance difference between the water consumption means of restaurants provided banquet services and those did not.

The results from SPSS are shown in Table 5.8 below. The Levene's test had a probability greater than 0.05, which meant the population variances were equal. In this instance, the equal variance estimate was consulted. The two-tailed sig. value was 0.002 (less than 0.05), thus the null hypothesis was rejected. There was significance difference between the water consumption means of restaurants that provided banquet services and those did not. For restaurants provided banquet services, the mean score of water consumption was 3,433.87 cubic meters. On the other hand, for those did not provide banquet services, the mean score of water consumption was 2,199.48 cubic meters. The difference was 1,234.39 cubic meters.

Table 5.8: Independent Groups T-Test Results for Provision of Banquet Services (N=44, Confidence Level 95%)

Group Statistics			
Provided Banquet Services	**N**	**Water Consumption Mean (m^3)**	
No	21	2,199.48	
Yes	23	3,433.87	
Levene's Test for Equality of Variances			
F		**Sig.**	
3.406		.072	
Independent Groups T-Test			
	T-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	-3.288	42	.002
Equal variance not assumed	-3.334	40.302	.002

5.4.4 Provision of Hot Pots

The third t-test compared the water consumption means between restaurants provided hot pots and those did not. The null hypothesis and alternative hypothesis were:

Ho: There would be no significance difference between the water consumption means of restaurants provided hot pots and those did not.

H_1: There would be significance difference between the water consumption means of restaurants provided hot pots and those did not.

Table 5.9: Independent Groups T-Test Results for Provision of Hot Pots (N=44, Confidence Level 95%)

Group Statistics				
Provided Hot Pots	**N**	**Water Consumption Mean (m^3)**		
No	25	3,066.16		
Yes	19	2,553.37		
Levene's Test for Equality of Variances				
F		**Sig.**		
11.016		.002		
Independent Groups T-Test				
	T-test for Equality of Means			
	t	df	Sig. (2-tailed)	
Equal variances assumed	1.23	42	.226	
Equal variance not assumed	1.33	38.027	.191	

The results from SPSS are shown in Table 5.9 above. The Levene's test had a probability smaller than 0.05, which meant the population variances were unequal. In this instance, the unequal variance estimate was consulted. The two-tailed sig. value was 0.226 (greater than 0.05), thus the null hypothesis was accepted. There was no significance difference between the water consumption means of restaurants that provided hot pots and those did not.

5.4.5 Summary of Independent Groups T-Tests

To conclude the independent groups t-tests above, provision of banquet service was the only factor that would affect water consumption statistically in local Chinese restaurants. Those restaurants offering banquet services had significantly higher water consumption means than those did not. It was deduced that the number of eating utensil for each banquet attendee (about 20 items) doubles that of a normal patron (10 items) on average. And half of a Chinese restaurant's total water consumption is for dish washing. Therefore, it should be the number of eating utensil that matters, but not the number of patron. This is different from the case in other types of restaurants, where large-scale banquet is not common.

The other two factors (provision of hot pot and availability of off-premise food processing factory) did not statistically affect water consumption. These findings would be very important in developing WUI_{CR} in Section 5.8. Two separate indexes would be established for restaurants providing banquet services and those not providing banquet services.

5.5 Regression Analyses

In Section 5.3, it was found that water consumption in Chinese restaurants might be correlated with GFA and number of patrons. In this step, thus, regression analyses were conducted. Multiple regression method would be appropriate for research problems involving a single metric dependent variable presumed to be related to two or more metric independent variables (Hair, *et al*. 2006). It could predict the changes in the dependent variable (Y) in response to changes in the independent variables (X). The purpose of these regression analyses was to find out the magnitude change in the dependent variable (water consumption) when the independent variable(s) changed by one unit.

The general multiple regression model is shown below:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \ldots.. \qquad \text{[Equation 1]}$$

Where

$\hat{Y}$ = Predicted volume of water consumed

b_0 = Constant water consumption (or called the base load)

b_1, b_2, b_3, b_4 = Change in water consumption associated with unit change in independent variables

X_1, X_2, X_3, X_4 = Magnitude of independent variables

In the current analyses, the dependent variable is water consumption in Chinese restaurants, while the independent variables are:

- P – Number of patrons
- GFA – Gross Floor Area

In order to determine more precisely the effect of GFA on water consumption in Chinese restaurants, it is further divided into three sub-categories, namely:

- $GFA_{Kitchen}$ – GFA of kitchen
- GFA_{FOH} – GFA of front-of-the-house area
- GFA_{Total} – Total GFA (= $GFA_{Kitchen}$ + GFA_{FOH})

A total of seven regression analyses were conducted as presented in Table 5.10, including four single-parameter analyses and three two-parameter analyses. The method of "enter" was used. Excluding the missing values[3], there were 31 observations for analysis. The equation from regression analysis should represent the best prediction of a dependent variable from several independent variables. It could also compare two or more sets of independent variables to ascertain the predictive power of each variable.

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[3] Missing values might due to restaurant operators' reluctance to disclose sensitive operational information, shared water meter data, incomplete water billing information, etc.

Table 5.10: Regression Analyses Conducted

Single-parameter Analyses			
	Independent Variable	Symbol	Equation
1	Number of patrons	P	Water Consumption $= b_0 + b_1P$
2	Total gross floor area	GFA_{Total}	Water Consumption $= b_0 + b_1\ GFA_{Total}$
3	Gross floor area of kitchen	$GFA_{Kitchen}$	Water Consumption $= b_0 + b_1\ GFA_{Kitchen}$
4	Gross floor area of front-of-the-house	GFA_{FOH}	Water Consumption $= b_0 + b_1\ GFA_{FOH}$
Two-parameter Analyses			
	Independent Variable	Symbol	Equation
5	Number of patrons; Total gross floor area	P GFA_{Total}	Water Consumption $= b_0 + b_1P + b_2GFA_{Total}$
6	Number of patrons; Gross floor area of kitchen	P $GFA_{Kitchen}$	Water Consumption $= b_0 + b_1P + b_2GFA_{Kitchen}$
7	Number of patrons; Gross floor area of front-of-the-house	P GFA_{FOH}	Water Consumption $= b_0 + b_1P + b_2GFA_{FOH}$

Table 5.11: Regression Analyses for Chinese Restaurants in General (N=31)

Single-parameter Analyses							
Independent Variable	R^2	SEE	b_0	b_1	b_2	t_1	t_2
1. P	.059	1475.106	3272.865	-.017	--	1.35	--
2. GFA_{Total}	.220	1161.405	1922.099	-.105	--	2.85	--
3. $GFA_{Kitchen}$	.508	1041.621	1116.425	.625	--	5.47	--
4. GFA_{FOH}	.233	1151.436	1738.782	-.065	--	2.96	--
Two-parameter Analyses							
Independent Variables	R^2	SEE	b_0	b_1	b_2	t_1	t_2
5. P, GFA_{Total}	.248	986.561	-560.341	.061	-0.02	1.03	1.10
6. P, $GFA_{Kitchen}$	.509	940.235	-240.864	-.0335	.432	1.12	2.02
7. P, GFA_{FOH}	.235	1003.251	-364.850	.007	.249	0.94	0.96

Table 5.11 shows the results from SPSS. First of all, single-parameter analyses (number 1 to 4) were carried out to assess the correlation between water consumption in Chinese restaurants and each of the independent variables. The partial t values were examined first. The critical value for the one-sided test on the regression coefficient was 1.86 at a significance level of $\alpha = 0.05$. All the partial t values of the three GFA-related variables (GFA_{Total}, GFA_{FOH} and $GFA_{Kitchen}$) exceeded 1.86, which meant that the null hypothesis of $b_1 = 0$ could be rejected. In other words, there was 95% confidence that these three GFA-related variables would have a significant influence on water consumption in Chinese restaurants. On the other hand, the partial t value of number of patrons (P) was 1.35, which was less than 1.86. The null hypothesis of $b_1 = 0$ could not be rejected at a 0.05 significance level. Thus the number of patrons did not appear to be an appropriate predictor for water consumption in Chinese restaurants.

Then, the coefficients of determination (R^2) of the independent variables were examined. It was observed that P, GFA_{Total} and GFA_{FOH} had very low R^2, ranging from 0.059 to 0.233. That meant these three variables had very low explanatory power on the regression equations. $GFA_{Kitchen}$, on the other hand, had comparatively the highest explanatory power (50.8%), and the smallest standard error (1041.621). This implied more reliable prediction of the dependent variable. Although the coefficient of determination was not very high, $GFA_{Kitchen}$ seemed to be the best single predictor.

Two-parameter analyses (number 5 to 7) were conducted in the next step. The number of patrons and one of the GFA-related parameters were paired and tested in each analysis. Comparing to the results from single-parameter analyses, addition of one more parameter did not show much improvement in the predictive power of the regression equations. The R^2 ranged from 0.235 to 0.509. However, almost all of the t-values were smaller than the critical value of 1.86. The null hypotheses of their corresponding regression coefficient b = 0 could not be rejected at a 95% confidence level. Thus, the estimated equation for predicting water consumption in Chinese restaurants would be:

<u>Estimated equation:</u>

$$\textbf{Water consumption} = \mathbf{1116.425} + \underset{(5.47)}{\mathbf{0.625}}\textbf{(GFA of Kitchen Area)}$$

[Equation 2]

The Y-intercept or constant was 1,116.425, while the regression coefficient for GFA of kitchen area was 0.625. That meant the base load of water consumption was 1,116.425 cubic meters. And above the base load, the magnitude of water consumption would be increased by 0.625 times of the unit change in GFA of kitchen area. However, it should be noted that the R^2 was only 0.508, which represented that the strength of correlation between kitchen GFA and water consumption was fair only.

5.6 Development of Water Use Index for Chinese Restaurants (WUI_{CR})

In the bivariate analyses in Section 5.3 and regression analyses in Section 5.5, it was discovered that GFA of kitchen was the most significant determinant for water consumption in local Chinese restaurants. Thus, this factor was used to establish WUI_{CR} – the first Water Use Index for Chinese restaurants. The index could serve as a useful benchmark for restaurant managers in controlling water consumption, reducing water costs, and minimizing sewage-induced environmental impacts.

5.6.1 Water Use Index for General Chinese Restaurants

Similar to WUI for local hotels (Deng and Burnett, 2002), WUI_{CR} could be achieved by dividing the water consumption by the determining factor. In this case, WUI_{CR} would be expressed as average water consumption per square meter (m^3/m^2) of kitchen GFA. The general equation is as follow:

$$WUI_{CR}\,(m^3/m^2) = \frac{\text{Water Consumption}}{\text{Kitchen GFA}} \qquad \textbf{[Equation 3]}$$

Table 5.12: Water Use Index for General Chinese Restaurants

Mean Score	**0.8796**
95% Confidence Interval for Mean	
- Lower Bound	0.7714
- Upper Bound	0.9878
Minimum	0.4200
Maximum	1.7000
Range	1.2800
Percentiles	
25	0.4500
50	0.8800
75	1.3100

Table 5.12 above shows the descriptive results of the calculation of WUI_{CR}. The mean score was 0.8796 m^3/m^2, with 95% confidence that the mean lied between 0.7714 and 0.9878. This meant that on average around 0.9 cubic meter of water was consumed per square meter of kitchen GFA. Based on the local water cost, local Chinese restaurants were paying around $6.98 per square meter for water consumption. Respondents from the upper quartile used less than 0.45 cubic meter of water per square meter. The minimum score was 0.42. On the other hand, respondents from the lower quartile used more than 1.31 cubic meters of water per square meter. The maximum score was 1.7. Based on the local water cost again, the maximum-scored respondent was paying an addition of $10.16 per square meter for water consumption comparing with the minimum-scored respondent. This result denoted that water cost could be greatly reduced if appropriate water conservation measures were undertaken.

5.6.2 Water Use Indexes for Restaurants Providing and Not Providing Banquet Services

Since significant difference was detected between mean scores of restaurants that provide banquet services and those did not, two separate WUIs were established. Descriptive results in calculating the two indexes are presented in Table 5.13.

Table 5.13: Water Use Index for Chinese Restaurants Providing and Not Providing Banquet Services

	Providing Banquet Services	Not Providing Banquet Services
Mean Score	**0.9633**	**0.8012**
95% Confidence Interval for		
Mean	0.8253	0.6306
Lower Bound	1.1013	0.9718
Upper Bound		
Minimum	0.4200	0.4100
Maximum	1.3400	1.7000
Range	0.9200	1.2900
Percentiles		
25	0.5800	0.3400
50	0.9500	0.8000
75	1.3200	1.2600

For restaurants provide banquet services, the index would be:

$$WUI_{CR\text{-}B} = \frac{\text{Water Consumption}}{\text{Kitchen GFA}}$$

$$= \mathbf{0.9633}\ m^3/m^2 \qquad \textbf{[Equation 4]}$$

Then, for restaurants do not provide banquet services, the index would be:

$$WUI_{CR\text{-}W/OB} = \frac{\text{Water Consumption}}{\text{Kitchen GFA}}$$

$$= \mathbf{0.8012}\ m^3/m^2 \qquad \textbf{[Equation 5]}$$

The water use index for restaurants providing banquet services (WUI_{CR-B}) was 0.9633 m^3/m^2, while the water use index for restaurants not providing banquet services ($WUI_{CR-W/OB}$) was 0.8012 m^3/m^2. Converting to monetary terms, those restaurants providing banquet services were paying $7.65 per square meter of kitchen GFA, while those did not provide banquet services were paying $6.36 per square meter. These two indexes could serve as the industry norms or benchmarks of water consumption in local Chinese restaurants. Moreover, these figures would be used as reference for constructing the assessment criteria for the water management EAM in Chapter 6.

5.7 Limitations

While carrying out the water consumption survey, there were several limitations that the author would like to acknowledge. First of all, the selection of survey sample was not a random process. The respondents were biased towards chain restaurants, which might have more resources in undertaking green operations. Also, these Chinese restaurants might have better internal training systems than individually operated ones. This selection bias might result in a lower water consumption mean score than the actual mean score of the industry. Nevertheless, small-scale or independent restaurants were not ignored in this study. This limitation had been complemented by inclusion of an independent restaurant in the case studies in Phase 2. The in-depth investigation of this case did give insightful inputs in this thesis.

Second, although most respondents were willing to provide complete data for this research, they could only give a rough number on patronages. They admitted that it was not feasible to give a very accurate data on number of patrons. Some of the data on number of patrons provided by the respondents were rounded up to 100. This might affect the accuracy of the quantitative analyses.

Third, the sample size of survey was only 52, i.e. less than 2% of the population size. In addition, a small proportion of the respondents did not provide complete data. One of the reasons was that the majority of local Chinese restaurant operators were quite conservative. They were reluctant to disclose sensitive information about their businesses, such as number of patrons and water bills, to the researcher. The limited number of respondent might affect the representativeness of the survey findings. In this regards, it is suggested to leave for further investigation when more accurate data on water consumption and patronage are available. As such, the samples can either be split into two groups for analysis, or use some randomization techniques to over the problems with independence of paired monthly water consumption and patronage data.

Last, it might be argued that the problem of multicollinearity might arise in the two-parameter analyses, because the number of patrons might depend on the size of the restaurants. Theoretically a large restaurant might tend to have more patrons. However, in reality, the level of patronage can be affected by a number of factors, such as patron turnover rate, average check, density of tables and location. It cannot be concluded that there is an exact linear relationship between the number of patrons and GFA of the restaurants. In addition, the final equation from multiple regression analyses contained only one variable – Kitchen GFA (please refer to P.157 Equation 2). In other words, the problem of multicollinearity did not exist. Nevertheless, multicollinearity would neither reduce the predictive power, nor bias the results of the regression equation. It would not affect the reliability of the model as a whole.

5.8 Summary of Water Consumption Survey

This chapter detailed the water consumption survey of 52 local Chinese restaurants conducted in this study. After collecting the data, they were analyzed descriptively and statistically. The correlations between water consumption and several independent variables were examined, and the major findings are summarized in Table 5.14 below.

Table 5.14: Factors Affecting Water Consumption in Chinese Restaurants

Factor	Tested by			
	Univariate Analyses	Bivariate Analyses	Independent Groups T-Tests	Multiple Regressions
Total GFA		√		
GFA of Kitchen		√		√
GFA of FOH area		√		
Provision of Banquet Services			√	
Number of Patrons	√			√

More important, several industrial benchmarks were developed in the analysis of the water consumption survey data. The first benchmark was the water consumption mean score (2,840.84 cubic meters) identified in Section 5.2.1. This mean score could serve as a baseline for comparison in the absence of any independent variables (Hair, *et al*, 2006). Moreover, it was statistically proved that restaurants that provided banquet services had a higher water consumption mean score than those did not.

The second benchmark was an estimated equation developed in Section 5.5 for predicting water consumption in Chinese restaurants. According to the equation, the base load of water consumption of local Chinese restaurant is around 1,100 cubic meters. And above the base load, the magnitude of water consumption will be increased by 0.625 times of the unit change of GFA of kitchen area.

The third benchmark was the water use index for local Chinese restaurants (WUI_{CR}) in Section 5.6. Two separate water use indexes were constructed. For restaurants providing banquet services, the water use index (WUI_{CR-B}) was 0.9633 cubic meter per square meter of kitchen gross floor area. For those not providing banquet services, the water use index ($WUI_{CR-W/OB}$) was 0.8012 cubic meter per square meter of kitchen gross floor area. These two established indexes would be substantial in developing the *EAM for Water Management in Chinese Restaurants* in Chapter 6.

6. DEVELOPMENT OF *ENVIRONMENTAL ASSESSMENT METHOD FOR WATER MANAGEMENT IN CHINESE RESTAURANTS*

This chapter details the last phase of this study – development of the *EAM for Water Management in Chinese Restaurants*. By compiling the findings from both case studies and survey, as well as references from a number of water conservation programs in the hospitality industry, an initial set of assessment criteria for water management in Chinese restaurants was produced. According to Schwandt (2001), criteria are standards, benchmarks and norms that guide judgments about the goodness, quality, validity, truthfulness of the unit being assessed.

An integrated approach was employed in developing the assessment criteria and their corresponding weightings. This approach was similar to the "multicrtieria decision making process" used in the development of a fire safety assessment system for local existing buildings (Lo, 1999; Lo, Lam and Yuen, 2000). Numerous methods were used simultaneously. First of all, the monetary approach was used to set up the weighting framework of the EAM (Section 6.1). Next, the effort-proportional approach (Section 6.2) and subjective judgment approach (Section 6.3) aided the development of some of the assessment criteria. The drafted document was then revised after review by various stakeholders (Section 6.4). After detailing the development process, the *EAM for Water Management in Chinese Restaurants* is presented in Section 6.5. In addition, the potential incentives and barriers of EAM implementation in local Chinese restaurants are also discussed in Section 6.6 and 6.7 respectively, and then followed by a summary in Section 6.8.

6.1 Monetary Approach

The monetary approach, which means assigning weights according to the relative economic importance, first formed the weighting framework for evaluating a Chinese restaurant's performance in water conservation. As illustrated in Table 6.1 below, weights were allotted to various functional zones according to the percentage of water consumed.

Table 6.1: Illustration of Weight Assignment of *EAM for Water Management in Chinese Restaurants*

Functional Zone	Water Consumption (%)	Weighting (%)
Kitchen	51	51
Front-of-the-house area	1	1
Dishwashing Section	48	48
Total	**100**	**100**

In Chapter 4 Case Studies, the breakdown of water consumption in typical Chinese restaurants was discovered (See Table 4.3 for derivation of water consumption percentages for various functional zones). The kitchen and the dishwashing section were the two major water end-users, which consumed 51% and 48% of water respectively. The front-of-the-house area was relatively insignificant, accounting for only 1% of the restaurants' total water consumption. Therefore weights were assigned to these functional zones according to their relative significance as shown in Table 6.1.

6.2 Effort-proportional Approach

The effort-proportional approach was used in developing some of the assessment criteria of EAM, so that restaurant operators could be rewarded in proportion to the effort they made in achieving a higher level of eco-protection. In other words, the investors would be encouraged to input more effort in attaining better environmental performance under this approach.

The assessment criteria developed by the effort-proportional approach must be quantitative in nature. Additional scores would be given for quantifiable incremental achievements. References had been made to existing EAMs, such as *HBEAS*, in drafting the following effort-proportional assessment criteria below (Table 6.2).

Table 6.2: Assessment Criteria Developed by Effort-proportional Approach

Assessment Criteria	Attainable Score
Water Use Index	
1. For Chinese restaurants providing banquet services:	
- WUI_{CR} between 0.96 and 1.32 (1st to 2nd quartile)	1
- WUI_{CR} below 0.96 (1st quartile)	2
2. For Chinese restaurants not providing banquet services:	1
- WUI_{CR} between 0.80 and 1.26 (1st to 2nd quartile)	2
- WUI_{CR} below 0.80 (1st quartile)	

(Table 6.2 Cont)

<u>Water Flow Control Devices and Technologies</u>	
1. Using water flow control devices (such as flow regulator, aerator, automatic shut-off spray nozzles and pedal-activated hand sinks) at the water taps in the kitchen and bar areas.	Maximum score: 2 (1 score for each kind of device installed)
2. Using water flow control devices in faucets (such as aerators, electronic sensors and automatic shut-off spray nozzles) in guests' toilet.	Maximum score: 2 (1 score for each kind of device installed)
3. Adopting new technology, or reuse water, to reduce overall water consumption.	Maximum score: 3 (1 score for each kind of new technology or water reuse)

6.3 Subjective Judgment Approach

In the previous two steps, the weighting framework for water consumption and some effort-proportional assessment criteria had been developed. Yet, some important water-related issues, such as the overall water use policy and staff training had not been included. Therefore the subjective judgment approach was employed in this final step to incorporate the missing important issues.

6.3.1 Overall Water Use Policy and Staff Training

Making reference to the case studies' findings, as well as previous studies and existing hospitality EAMs, the assessment criteria for overall water use policy and staff training were developed. They are listed in Table 6.3 below. To avoid complexity in implementing the EAM, all the assessment criteria in Table 6.3 were assigned with equal weights.

Table 6.3: Assessment Criteria Developed by Subjective Judgment Approach

Assessment Criteria	Attainable Score
Overall Water Use Policy and Training	
1. Possessing an overall water conservation policy and an action plan for the restaurant.	1
2. Assigning a managerial staff to monitor water use, and evaluate water conservation opportunities and effectiveness.	1
3. Determining water requirements (quantity and purpose of water being used) for each functional zone.	1
4. Undertaking an ongoing water audit of the restaurant, or carried out a water audit within the previous 12 months.	1

(Table 6.3 Cont)

5. Installing adequate meters allowing measurement of water used by major functional zones in the restaurant.	1
6. Reducing water pressure to the minimum practical level.	1
7. Carrying out regular leakage test on concealed piping, and recording maintenance activities in a log book.	1
8. Turning off all water systems at night.	1
9. Providing suitable trainings to staff to make sure they know about the importance of water conservation, and how to practice water conservation in the workplace.	1
10. Using innovative methods to raise staff awareness in water conservation.	1
11. Seeking suggestions from employees and customers on water conservation.	1
12. Setting up a mechanism for reporting leaking tap/pipe to the restaurant's Engineering Department or Chief Engineer.	1

6.3.2 Water Quality

In addition, water quality also constitutes an essential component of water management in restaurants. Therefore, another section about water quality control was added, containing the assessment criteria listed in Table 6.4. Again, these criteria contained equal weights.

Table 6.4: Assessment Criteria Regarding Water Quality Control

Assessment Criteria	Attainable Score
<u>Fish Tanks</u>	
1. Participating in the "Quality Seawater Assurance Scheme" and is accredited as a "Quality Seawater Logo" holder by the Hong Kong Productivity Council.	1
2. Adjusting the temperature and pH value of water for different aquatic species in fish tanks.	1
3. Applying new technologies or innovative methods (e.g. ozone filter) to sanitize water in fish tanks more effectively.	1
<u>Kitchen</u>	
1. Using kitchen paper, instead of hot water, to clean woks at frying wok station.	1
<u>Dishwashing and Cleaning</u>	
1. Removing all food residues on used utensils and cookware manually and dispose of as solid waste before washing.	1
2. Handling the grease from pots, pans, grills and deep-fryers separately and keep out of the drains.	1
3. Installing sieves on floor drains to prevent the release of food residuals to the sewer.	1
4. Developing a cleaning schedule for grease trap and removing the residual from grease trap regularly.	1
5. Using efficient detergent which contains at least 15% of surface active agent and low phosphorus concentration.	1
6. Providing guidelines to cleaning staff about the appropriate procedures of using bleach.	1

6.4 Review by Stakeholders

Employing the monetary approach, effort-proportional approach and subjective judgment approach, a draft of the *EAM for Water Management in Chinese Restaurants* had been generated (Appendix 6.1). As discussed earlier in Section 2.5.1, the validity of an assessment can be enhanced by review of experts. Therefore, this draft document was sent to some stakeholders for review. All of the reviewers were experienced in Chinese restaurant operation and management.

Reviewer 1: **Deputy Director** of a local restaurant chain, managing 30 outlets in Hong Kong and 4 outlets in Shenzhen

Reviewer 2: **Training Officer** of a local large-scale catering establishment, who is responsible for providing trainings to staff in 52 Chinese restaurants, 63 non-Chinese restaurants, 73 fast food restaurants, as well as 160 cake shops and 100 coffee shops

Reviewer 3: **Chief Chef** of the Chinese restaurant in a local prestigious club in Causeway Bay, with more than 15 years of experience

Reviewer 4: **Assistant Executive Chef** of a local mid-priced Chinese restaurant chain with more than 20 years of experience, overseeing the kitchen operation of 20 outlets now

Some amendments of the credit requirements were made after the review process (Table 6.5). Besides, the reviewers also raised an important issue that almost all Chinese restaurant practitioners and frontline employees are ethnic Chinese. Therefore a bilingual version of the assessment method should be produced, so as to increase the readability and usability of the EAM.

Table 6.5: Amendments of Credit Requirements Made after Review

Section	Original Assessment Criteria	Amended Assessment Criteria	Reason for Amendment
A ii	**Assigning a managerial staff** to monitor water use, and evaluate water conservation opportunities and effectiveness.	**All Section Heads are responsible** for monitoring water use, evaluating water conservation opportunities and effectiveness **in their section in-charge**.	It would be more feasible if the monitoring tasks are done by section heads, as they should know better on water conservation possibilities in their sections' operation. [Reviewer 1, 3 and 4]
B1.1 i	Using water flow control devices (such as flow regulator, aerator, automatic shut-off spray nozzles and pedal-activated hand sinks) at **all of the water taps** in the kitchen and bar areas.	Using water flow control devices (such as flow regulator, aerator, automatic shut-off spray nozzles and pedal-activated hand sinks) at **50% of the water taps** in the kitchen and bar areas.	From the reviewers' experience, the use of water flow control devices in kitchen was not supported, particularly in the cold-water thawing section. This was because the chef needed a much longer period to collect the same amount of water for thawing the food ingredients. However, water flow control devices would be useful in dishwashing section and guest toilets. [Reviewer 3 and 4]

(Table 6.5 Cont)

B1.2 i	Adopting the environmental-friendly cold-water thawing method.	Adopting the environmental-friendly cold-water thawing method, **<u>or using a thawing machine / microbubble machine</u>**.	Apart from environmental-friendly cold-water thawing method, this EAM should offer other options, such as the use of thawing machine and other technologies, in the thawing process. [Reviewer 1]
B1.4 ii	Serving beverage in ready-to-use forms (e.g. boxed tea, canned soft drink, etc).	**<u>Deleted</u>**	The cost for boxed tea is too high. Almost all of the local Chinese restaurants are serving hot tea by adding hot water and tea leaves in pots. Thus this criterion seems to be inappropriate in local Chinese restaurant operations. [Reviewer 3 and 4]

6.5 *Environmental Assessment Method for Water Management in Chinese Restaurants*

After making the above amendments, the assessment method was finalized. The purpose of this assessment scheme is to assist local Chinese restaurant operators in:

1. developing an effective water management program regarding water consumption and water quality management; and
2. improving the effectiveness and efficiency of existing water management programs.

Totally there are three sections. The sectional maximum attainable scores, weight distribution and passing scores are listed in Table 6.6. The complete assessment scheme is presented in Table 6.7, while the Chinese version is attached in Appendix 6.2. In order to obtain the Eco-label of this EAM, a Chinese restaurant must achieve the passing score in all three sections. The weights had not been normalized because the EAM development process did not employ a normalized approach. Instead, a participative approach was utilized. The weights were allotted based on field measurement results from case studies.

Criteria in Section A and Section C were equally-weighed. The sectional score of these two sections were simply the aggregation of the attained scores. The justifications for equal weighting were twofold. First, criteria in these two sections did not have conclusive scientific evidence in determining their respective ultimate impact. Thus, neither the monetary approach nor the effort-proportional approach was appropriate to assign weights. Second, from a practical perspective, the use of equal weighting could reduce complicity in EAM adoption and assessment. This could make the proposed EAM more use-friendly.

In Section B, however, scores were unequally-weighed. The three sub-sections, namely "Kitchen and Bar", "Front-of-the-house Area" and "Dishwashing and Cleaning", were weighed 0.51, 0.01 and 0.48 respectively. The weighed sub-sectional score would be derived by:

$$\text{Weighed Sub-sectional Score} = \frac{\text{Attained score}}{\text{Max. Attainable Score of Sub-section}} \times \text{Sub-sectional Weight}$$

[Equation 6]

Table 6.6: Sectional Maximum Attainable Scores, Weight Distribution and Passing Scores

Section	Maximum Attainable Score	Weighed Maximum Attainable Score	Sectional Passing Score
Section A – Overall Water Use Policy and Training	**18**	**18**	**9**
Section B – Water Consumption		**10**	**5**
1. Kitchen and Bar	13	5.1	
2. Front-of-the-House Area	4	0.1	
3. Dishwashing and Cleaning	8	4.8	
Section C – Water Quality Management		**10**	**5**
1. Fish Tanks	3	3	
2. Kitchen and Bar	1	1	
3. Dishwashing and Cleaning	6	6	

Table 6.7: Final Set of Assessment Criteria for Water Management in Chinese Restaurants

Section		Assessment Criteria	Credits Attainable
A.		**<u>Overall Water Use Policy and Staff Training.</u>**	**18**
	i	Possess a water conservation policy and an action plan for the restaurant.	1
	ii	All Section Heads are responsible for monitoring water use, evaluating water conservation opportunities and effectiveness in their section in-charge.	1
	iii	Determine water requirements (quantity and purpose of water being used) for each functional zone.	1
	iv	Undertake an ongoing water audit of the restaurant, or conduct a water audit within the previous 12 months.	1
	v	Install adequate sub-meters allowing measurement of water use by major functional zones in the restaurant.	1
	vi	Adopt new technology, or reuse water, to reduce overall water consumption.	3
	vii	For water consumption based on Chinese restaurant water use index (WUI_{CR}): - between 0.96 and 1.32 for restaurants providing banquet services. - between 0.80 and 1.26 for restaurants not providing banquet services.	1
		For water consumption based on Chinese restaurant water use index (WUI_{CR}): - below 0.96 for restaurants providing banquet services. - below 0.80 for restaurants not providing banquet services.	2
	viii	Reduce water pressure to the minimum practical level.	1
	ix	Carry out regular leakage test on concealed piping, and record maintenance activities in a log book	1
	x	Turn off all water systems at night.	1

(Table 6.7 Cont)

	xi	Provide suitable trainings to staff to make sure they know about the importance of water conservation, and how to practice water conservation in the workplace.	1
	xii	Use innovative methods to raise staff awareness in water conservation.	1
	xiii	Seek suggestions from employees and customers on water conservation.	1
	xiv	Set up a mechanism for reporting leakage to the Engineering Department.	1
	xv	Facilitate academic researches in restaurant water management by offering financial support, or allowing equipment set up for field measurement, or by other means.	1
B.		**<u>Water Consumption</u>**	**10**
1		**Kitchen and Bar**	**5.1**
1.1		General	
	i	Install water flow control devices (such as flow regulator, aerator, automatic shut-off spray nozzles and pedal-activated hand sinks) at half of the water taps in the kitchen and bar areas.	2
1.2		Cold-water thawing and washing vegetables	
	i	Adopt the environmental-friendly cold-water thawing method, install a thawing machine or a microbubble machine.	1
	ii	Wash vegetables in basins of water, not under running water.	1
	iii	Defrost frozen foods in refrigerator instead of cold-water.	1
	iv	Reuse water from washing vegetables for other purposes.	1
1.3		Cooking	
	i	Use a connectionless steamer instead of a traditional boiler-based steamer.	1
	ii	Prevent occurrence of spillage from overfilling.	1
	iii	Use an automatic rice washer.	1

(Table 6.7 Cont)

1.4		Bar Area and Ice-making	
	i	Place unused ice in the sink at the end of the day so it melts on its own overnight.	1
	ii	Adjust the ice-making machine to ensure no excessive ice is dispensed and wasted.	1
	iii.	Use a presser or tea strainer to squeeze steeped tea bags.	1
2		**Front-of-the-house Area**	**0.1**
2.1		Restaurant	
	i	Display information on tables to encourage water conservation.	1
	ii	Serve water only upon customers' request.	1
2.2		Toilet	
	i	Install water flow control devices in faucets (such as aerators, electronic sensors and automatic shut-off spray nozzles) in toilet.	2
3		**Dishwashing and Cleaning**	**4.8**
	i	Presoak the utensils and cookware in basins of standing warm water before washing.	1
	ii	Collect water from the last rinse for use as a pre-wash of the next cleaning cycle or for other purposes.	1
	iii	Install water flow control devices in faucets (such as low flow spray valves) or use high-pressure spray washes in the dishwashing section.	1
	iv	Run dishwashers in full load.	1
	v	Use counter current washing and rinsing method.	1
	vi	Turn dishwashers off when dishes are not being processed.	1
	vii	Reuse the warm water from steaming machine and other constant-temperature equipments for cleaning purpose after business hours.	1
	viii	Use dry cleanup procedures (e.g. brooms, squeegees or sponges) prior to the use of water for cleanup.	1

(Table 6.7 Cont)

C.		**Water Quality**	**10**
1		**Fish Tanks**	**3**
	i	Participate in the "Quality Seawater Assurance Scheme", and is accredited as a "Quality Seawater Logo" holder by the Hong Kong Productivity Council.	1
	ii	Adjust the temperature and pH value of water for different aquatic species in fish tanks.	1
	iii	Apply new technologies or innovative methods (e.g. ozone filter and microbubble generator) to sanitize water in fish tanks.	1
2		**Kitchen and Bar**	**1**
	i	Use kitchen paper, instead of hot water, to clean woks at frying wok station.	1
3		**Dishwashing and Cleaning**	**6**
	i	Remove all food residues on utensils and cookware manually and dispose of as solid waste before washing.	1
	ii	Handle the greases from pots, pans, grills and deep fryers separately and keep out of the drains.	1
	iii	Install strainers on floor drains to prevent the release of food residuals to the sewer.	1
	vi	Develop a cleaning schedule for grease trap and remove the residual from grease trap regularly.	1
	v	Use efficient detergent which contains at least 15% of surface active agent and low phosphorus concentration.	1
	vi	Provide guidelines to cleaning staff about the appropriate procedures of using bleach.	1

6.6 Potential Incentives of EAM Implementation in Chinese Restaurants

The experiences of implementing EAMs or other voluntary initiatives suggested that their success depended on whether they could offer certain kind of self-interest or incentives to the investors (UNEP Industry and Environment Office (IEO), 1994). In other words, business will be motivated if they are offered convincing incentives. Understanding the opinions and expectations of Chinese restaurant operators and owners towards environmental issues, and making the incentives foreseeable to them, will help formulating an EAM which is likely to win their acceptance and support. The discussion below is divided into two parts – direct financial incentives and marketing advantages.

6.6.1 Direct Financial Incentives

From experiences of UNEP IEO (1994), direct financial incentive was one of the major driving forces for firms to adopt voluntary green initiatives. Significant savings in operating expenses could be made by implementing effective utilities conservation programmes. According to the experience of a local 5-star hotel, water consumption had been reduced by 19% after implementing a water conservation programme for 5 years (Department of Building Services Engineering, 2000c). Moreover, the pay-back analysis in Section 4.3.4iii showed that adoption of a thawing machine or microbubble machine in restaurants could save HK$28.0 to HK$43.1 per day, i.e. an annual saving of up to HK$15,000.

Cutting down restaurant operating expenses has become more important recently, as many local restaurants closed down in the global economic recession ("Barbeque pork", 2008; "Booking", 2008; "Closure", 2008; "Fast food restaurant", 2008; "Local restaurants", 2008; "Restaurant closed", 2008; "Retail receipts", 2008; Sun, 2008; "Two restaurants", 2008; "Unemployment rate", 2008; "150 unemployed", 2008). Careful control of the operating expenses would be a strategy to survive.

The guidelines and criteria in *EAM for Water Management in Chinese Restaurants* can effectively aid Chinese restaurant operators to cut water consumption and sewage generation. From the management perspective, this can mean reduced water charge, sewage charge and trade effluent surcharge. In other words, this EAM provides reasonable financial incentives to Chinese restaurant operators, so as to confront the adverse business environment.

6.6.2 Marketing Advantages

Apart from direct financial incentives, another major driving force for adoption of EAMs would be the marketing advantages. Being certified by an EAM or awarded by an eco-label would increase marketing and promotion, as well as improve public relationship (UNEPIEO, 1994). A positive image can be built, showing the certified firms' efforts in natural resources conservation and adverse eco-impacts reduction. This kind of positive image is becoming more important, as the public's demand for corporate social responsibilities has increased over the past decade.

For those awarded firms, they may enjoy preferred status for use of certain resources. They can also obtain technical or financial assistance more easily (Rome, 2005). These may all because of the awarded firms' improved public image and assurance on green operation.

In discussion of incentives offered to businesses by EAMs, Room (2005) also suggested that EAMs and eco-labels could help the awarded firm increase its market share and find new customers. Nevertheless, this point was rather controversial. Some scholars pointed out that certification by an EAM or an eco-label did not imply sales increase. According to Grankvist and Biel (2001), purchasing eco-labeled alternatives often require a change of consumer habit. Even though the customers know that the eco-labeled alternatives would produce less detrimental effects on the environment, such knowledge might not be "activated" in the purchases situation and influence choice behavior. Another research conducted by the London National Consumer Council (1996) suggested that environmental concern is growing, but it had not yet reached the point where consumers want to shoulder environmental costs. This meant that an eco-label or an EAM award might only serve as a reminder in customers' decision-making process. For that reason, the marketing incentives may not be as attractive as the direct financial incentives to Chinese restaurant operators, such as eco-savings and recycling revenue (Font and Tribe, 2001).

6.7 Barriers of EAM Implementation in Chinese Restaurants

Implementation of EAMs and other green initiatives can be a difficult task, especially in the traditional Chinese restaurant industry. It is because there exist many barriers hindering the greening process. Major barriers were identified during the research, and elaborated separately in this section.

6.7.1 Financial Barrier

Financial investment is regarded as the prime barrier to implement EAMs and other green practices. Restaurant owners have to overcome the financial hurdles – the initial costs of installing less environmental-harmful equipments and starting green operation procedures.

Although environmental advocates suggested that the projected monetary savings of green operation can be attractive to firms, these savings usually appear in the medium-to-long term. Considering the local practice, the leasing terms for restaurant premises usually last for three years, according to one of the interviewees. The medium-to-long term financial returns of green operation may not be foreseeable to most local restaurant operators.

Worse still, local restaurants are facing financial difficulties under the current economy recession. Some establishments have already gone into bankruptcy recently. Economists projected that recovery may come after three years at least.

It will be even more difficult to instigate green operations in both new and existing restaurants.

6.7.2 Conservative Attitude and Low Environmental Awareness

Probably due to the long history of traditional Chinese restaurant business, most of the owners and operators are quite conservative in regard to change. They prefer following the traditional practices in their operations, even though these traditional practices are water-consuming. Also, their environmental awareness is generally low, comparing with other sectors of the hospitality and tourism industry. Previous studies suggested that low awareness of the overall environmental impact of small firms had been a major hindrance to change (Hillary, 1995; Holland and Gibbon, 1997; Rutherfoord, Blackburn and Spence, 2000). The environment appears to be a low priority for them, as they cannot recognize the business benefits of improving their firm's environmental performance.

6.7.3 Lack of Human Resources

Lack of properly-trained staff also hinders the implementation of EAM in local Chinese restaurants. The majority of the industry practitioners are less-educated, so they may not understand the importance of environmental protection. In addition, many Chinese restaurant managers have insufficient knowledge in environmental management. Using the term from Hillary (2000), they exhibit low levels of “eco-literacy”. They may neither be able to train their subordinates in eco-conservation, nor assist execution of the green guidelines in EAMs.

6.7.4 Lack of Pressure from Customers, Suppliers and Government

It is witnessed that the importance of corporate social responsibilities has increased in many hospitality and tourism sectors over the decades, probably due to the green pressure from customers, suppliers and regulations. For instance, in the airline industry, release of greenhouse gases is now under strict international regulations. In eco-tourism sites and resorts, negative eco-impacts are monitored carefully. In the accommodation sector, the green demand from guests has become stronger than ever before.

Unlike those above-mentioned hospitality and tourism sectors, restaurants are generally facing less pressure in regard to their environmental responsibilities. Only the large-scale multi-national restaurant chains are forced to exhibit environmental concerns. For local small-to-medium-sized Chinese restaurants, however, the only green pressure is the up-going sewage charge imposed by the Government. There is very little, or even no, pressure from customers and suppliers. This is mainly because the adverse impacts stemmed from the small-to-medium-sized operations are often ignored by the general public.

6.8 Essential Elements of Successful Environmental Assessments

In Section 2.5 of the Literature Review, the essential elements of a successful assessment scheme suggested by Cascio (1996) and Cole (1998) have been discussed. The elements, which are listed in Table 2.4, had provided very useful guidance on the development of EAM in this study.

During the research process of this study, three additional elements of successful assessment schemes were identified. Thus a modified list is suggested and presented in Table 6.8 below. It is hoped that this modification could shed a light on future researches about environmental assessment development.

Table 6.8: Essential Elements of Successful Environmental Assessments

Suggested by Cascio (1996) and Cole (1998)

- The subjectivity of assessment should be reduced to a minimum.
- The assessment should provide a consistently reliable result when used on similar premises.
- The result should offer a meaningful indication of the premise's total performance.
- Environmental attributes must be available to the purchasers.
- Labels and declarations must be based on thorough scientific methodology.
- Criteria for label/declaration must be available to all interested parties.
- Label and declarations developments must take into account the life-cycle of the relevant product.
- Labels and declarations standards and criteria must be developed by consensus.

(Table 6.8 Cont)

- The administrative work must be limited to establishing conformance with criteria.

- The administrative cost for apply for the assessment should not be overly expensive.

- The label scheme should be able to offer tangible benefit for the investors.

- The cost of compliance with the prescribed criteria within the scheme should be reasonable.

Suggested by the Current Study

- The assessment criteria and weight assignment should be updated according to change in local regulation requirements.

- The assessment should be able to serve as an industry benchmark, which can offer a fair comparison for similar operations.

- Support and advocacy from industry practitioners, trade associations and government can aid the development and implementation of environmental assessments.

6.9 Summary of EAM Development

An EAM in regards to water management in local Chinese restaurants was developed by an integrated approach, and the development process was detailed in this Chapter. The assessment criteria covered three areas – 1) overall water use policy and training, 2) water consumption, and 3) water quality. It aimed to provide a comprehensive evaluation for local Chinese restaurants' performance in water management. There should be two or more assessors to assess the same object in order to ensure the EAM's reliability. In addition, the potential incentives and barriers in implementing the *EAM for Water Management in Chinese Restaurants* were also discussed. Key incentives identified were direct financial incentives and marketing advantages. Key barriers included financial barrier, conservative attitude and low environmental awareness, lack of human resources, and lack of pressure from customers, suppliers and government.

No water conservation program will succeed without the effort of the hotel staff. Commitment and support from top management is essential. Thus there is a need to provide suitable trainings to staff in order to convey the green message, and incorporate water conservation measures in the daily operations. In addition, water audits should be carried out on a regular basis, preferably once a year.

It is hoped that local Chinese restaurants can achieve greater efficiency, lower operating cost and enhanced public image by adopting the guidelines and suggestions in the above EAM. In addition, attentions should be paid that development of assessment criteria is not a one-off process. The assessment criteria and credit weightings must be updated regularly, as local regulations, standards and performance benchmarks may change over time (Burnett, 2001). Continuous updating and refining can also help in establishing credibility (Chau, Lee, Yik and Burnett, 2000). The baseline standard should be raised over time, because the levels of performance would be expected to improve. However the tightening of standards should only be incrementally and over a time frame, so that the industry can be allowed to assimilate the new demands as pointed out by Burnett, *et al*. (2005). A massive and ongoing marketing effort is also necessary to convince the industry of the long-term benefits of green practices.

7. CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

This action research was an exploratory attempt to investigate water consumption in Chinese restaurants. It was conducted because of an identified real-life problem – the huge amount of sewage stemmed from Chinese restaurant operations. In addition, a gap was identified in the existing literature that only very few previous researches covered the environmental issues of Chinese restaurants. Thus, the prime objectives of this study were to establish a framework to assess the environmental performance of Chinese restaurants in regard to water use, as well as identifying potential areas for operational improvement in controlling sewage from these premises. It is the intention of this study to raise the level of green awareness among industry practitioners, and lessen the adverse environmental impacts arising from the business activities in Chinese restaurants.

Major findings of the case studies, water consumption survey and EAM development are summarized and reviewed in Section 7.1. The significances are discussed in Section 7.2. Subsequently, some recommendations are made in Section 7.3 in regard to individual Chinese restaurant operation, policy makers, trade associations and future researches.

7.1 Review of Major Findings

Table 7.1 below summarizes factors affecting water consumption in Chinese restaurants as discovered in case studies (Chapter 4) and water consumption survey (Chapter 5). The magnitudes of the respective determining power are also presented.

Table 7.1 Summary of Factors Affecting Water Consumption in Chinese Restaurants (with magnitude if appropriate)

Factor	Tested by				
	Case Studies	Univariate Analyses	Bivariate Analyses	Independent Groups T-Tests	Multiple Regressions
Provision of Banquet Services	√			Strong (2-tailed sig. = 0.0002)	
GFA of Kitchen			Strong (r = 0.807)		Moderate (R^2 = 0.508)
GFA of FOH area			Moderate (r = 0.578)		Weak (R^2 = 0.233)
Total GFA	√		Moderate (r = 0.519)		Weak (R^2 = 0.220)
Number of Patrons	√	√	Weak (r = 0.240)		Very weak (R^2 = 0.059)
Provision of Hot Pot Item	√			Very Weak (2-tailed sig. = 0.226)	

7.1.1 Case Studies

In Chinese restaurant operations, the dish washing section and cold-water thawing sections were found to be the two highest water-consuming units. Approximately, they accounted for 40% and 30% of a restaurant's total water consumption respectively. The performance of various cold-water thawing options was also compared by a series of field tests. It was found that the thawing machine performed the best, followed by the microbubble machine. A cost-and-benefit analysis indicated that the pay-back periods of these machines would be around 10 to 16 months.

7.1.2 Water Consumption Survey

Two water consumption benchmarks for local Chinese restaurants were established. The first benchmark was the water consumption mean. On average, a local Chinese restaurant was consuming around 2,840 cubic meters of water per month. The second benchmark was the water use index WUI_{CR}. For those banquet-providing Chinese restaurants, $WUI_{CR\text{-}B}$ was 0.9633 cubic meter per square meter of kitchen gross floor area. And for those not providing banquet services, $WUI_{CR\text{-}W/OB}$ was 0.8012 cubic meter per square meter of kitchen gross floor area. These benchmarks can serve as a reference for local Chinese restaurant operators.

7.1.3 Development of EAM for Water Management in Chinese Restaurants

The *Environmental Assessment Method for Water Management in Chinese Restaurants* is one of the most important outcomes of this research. It was developed by an integrated approach, aiming at providing an objective evaluation on local Chinese restaurants' overall performance in water management. Major incentives and barriers of EAM implementation in Chinese restaurants were also identified and discussed in Chapter 6.

In this EAM, improvement works related to water management in Chinese restaurants were categorized into three areas, namely "overall water use policy and staff training", "water consumption" and "water quality". The ultimate aim of the green guidelines in this EAM is to help reducing water consumption in local Chinese restaurants. It is hoped that this EAM can effectively reduce sewage stemmed from these operations, and simultaneously contribute to their profitability.

7.1.4 Applicability of Findings

It should be acknowledged that major findings discussed above can only be generalized to the target population, i.e. the five thousand general Chinese restaurants in Hong Kong. It is sector-specific and geographic-specific in nature. Beyond the border, the extent of applicability of these findings is limited.

The water consumption benchmark, WUI_{CR}, was derived based on local Chinese restaurants' data. It can hardly pertain to other types of restaurants, because of dissimilar water consumption demands and patterns.

This benchmark is not recommended to evaluate businesses outside the territory too. It is because water use habit may be different between local Chinese restaurants and their counterparts in other parts of the world, resulting from a combination of factors, such as water tariff, local regulatory requirement, menu item and scale of operation.

Same as water use indexes, EAMs are usually very localized and specialized. Beyond the target population, applicability of an EAM is not encouraged, unless adjustments are made to incorporate operation and maintenance practices of different situations. Therefore, it should be noted that the *EAM for Water Management in Chinese Restaurants* can neither be directly employed to other restaurant sectors, nor Chinese restaurants outside Hong Kong.

Nevertheless, the green guidelines for water conservation are universal. It can provide a practical reference for all types of restaurants within and outside Hong Kong.

7.2 Significance of Study

An in-depth examination of water consumption situation in local Chinese restaurants had been carried out in this study, which could be seen within the framework of action research. It primarily grounded on a problem-solving approach, with the intention to improve some aspects of current operation and practice. The author hoped that findings from this study could contribute to the hospitality industry and the academia by identifying and prioritizing improvement works.

7.2.1 Contributions to the Hospitality Industry

Chan (2005) pointed out that further investment in large environmental projects would not be easy after the Asian financial crisis in the late 1990s and early 2000s. The situation is expected to be worse recently under the global financial tsunami. Chan advocated that future studies about environmental improvements should be conducted at the "individual level", i.e., within particular premises. Therefore the present study developed several water consumption benchmarks and an EAM, targeting improvement in individual operation.

i. Water Consumption Benchmarks

This study was the first attempt to comprehensively examine water consumption situation in Chinese restaurants. Industry norms of water consumption and WUI_{CR} for local Chinese restaurants were developed, so as to provide benchmarking information for simple comparison of water usage among counterparts. As such, these benchmarks can make the water consumption level more visible to Chinese restaurant operators, thus raising their perceived importance of operating in an eco-friendly manner.

ii. Assessment Framework for Water Management

More importantly, the first environmental assessment method directed against water consumption in the Chinese restaurants was also developed. The assessment aims to provide guidance on conserving water, reducing sewage, and improving water quality in Chinese restaurant operations. This can enable managers to set practical objectives and achievable targets for their water conservation programme. The head office of Chinese restaurant groups can evaluate individual branch's environmental effort in a more objective way. Since points will be given to individual restaurant according to its environmental performance, the total score can be compared with other outlets/restaurants. In other words, benchmarking on overall water conservation performance will become possible under this assessment framework.

Operators of new restaurants, or potential operators, can make use of this EAM as a reference for their restaurant design. The scheme can also be used by government departments, such as EPD and FEHD, as one of the criteria for assessing existing restaurants, or issuing license for new comers. With some adjustments and modifications in the content, the assessment framework can be applied to other types of restaurants, or in other places.

7.2.2 Contributions to Academia

Apart from the contributions to hospitality industry, this study has also filled research gap in existing literatures, and employed an integrated approach in developing the *EAM for Water Management in Chinese Restaurants*.

i. Fill Literature Gap

During the literature review stage, a gap was identified that there were very limited books and published papers about environmental issues of Chinese restaurants. Therefore this study aimed at filling the gap by conducting an in-depth investigation into this topic. Broadly, this research can be seen under the broad topic of sustainability, with a prime concern of the social responsibility of Chinese restaurant businesses. More specifically, this study focused on investigating water consumption and sewage generation in local Chinese restaurant operations.

Although hospitality and tourism firms do not have a readily apparent “smokestack” (Foster, Sampson and Dunn, 2000), and they may not be “in the frontline of environmental concern” (Kirk, 1996), the importance of these firms in maintaining environmental quality had already been acknowledged by the World Tourism Organization in 1970s. In this regard, Budowski's (1976) identified three relationships between tourism and the environment – conflict, coexistence and symbiosis. Jennings (2001:10) echoed and suggested future tourism research should facilitate the movement towards and the establishment of a symbiotic relationship, which was the core notion of the current study. Theories about sustainable development in the environmental context formed the foundation of this study. The characteristics of service firms and uniqueness of Chinese restaurant operation then constituted the cornerstones and building blocks of the research.

The present study also covered several areas suggested by Jennings (2001:10) for future tourism environmental research. First, the development of water consumption regression models and WUI_{CR} help monitoring the environmental impacts stemmed from local Chinese restaurants. Second, the identification of potential areas for improvement aids the development of amelioration strategies, as well as subsequent legislative requirements and policies. Finally, this study made the first attempt to develop a framework in assessing the environmental impacts by restaurants, and scrutinizing the attitude of industry practitioners. An interdisciplinary triangulation approach was applied, consulting other disciplines such as environmental engineering, building services engineering, accounting, and public policies.

ii. Integrated Approach to EAM Development

An integrated approach was used in the development of *EAM for Water Management in Chinese Restaurants* in this study, because there exists no universally agreed method to construct EAMs at present. The monetary approach was employed in assigning weights to different water-consuming procedures, while the effort-proportional approach and the subjective judgment approach were used in setting and adjusting the assessment criteria and scale. The three approaches complemented with each other, thus the shortcomings of each approach could be overcome. This approach can be used to develop EAMs for other catering sectors and other hospitality sectors

7.3 Recommendations

In recent years, we witnessed the deterioration of quality of the environment. Many of the human activities are actually imposing various kind of ecological impacts, and cause some global environmental problems, such as global warming, ozone depletion, acid rain and abiotic resource exhaustion. Apart from these global environmental pressing issues, we also face some regional environmental problems, including serious air pollution, degradation of water quality and shortage of landfill space. This is the time that we should react immediately to the ecological alarm.

Our city is renowned as a gourmet paradise in the world, and has great potential to develop gastronomy tourism. Nevertheless, the environmental problems of the local restaurant industry are always overlooked. Therefore, this section provides practical recommendations to Chinese restaurant operators, policy makers and trade associations in order to reduce negative environmental impacts. It also suggests directions for further investigation on this topic. By cooperation of the operators, policy makers, trade associations and the academia, the restaurant industry can contribute in the sustainable development of our city.

7.3.1 Recommendations to Chinese Restaurant Operations

The local water cost has been increased gradually, and is still going up. Particularly, the sewage charge will be increased by more than 220% in the next ten years according to Drainage Services Department. Although water rates differ immensely across the world, the rates are increasing in nearly all locations. Reduction in excessive water consumption can be a solution to lower water cost. Therefore, the following suggestions directed against Chinese restaurant operations are made.

i. Cold-water Thawing

In order to cut down the volume of water for cold-water thawing, it is suggested that Chinese restaurants can install a thawing machine or a microbubble machine. Some of the suppliers of these machines offer a kind of "performance contract" partnership to their clients. The supplier would first analyze the current state of water consumption in the client's premise, and simulate the potential savings after installation of the machine. Then the suppler would provide the machine to the client restaurant. There are various models of thawing machine and microbubble machine available, with varying size and capacity, in order to cater the needs of a particular restaurant premise. Finally, the supplier would share an agreed percentage of the money saving arose from reduction in water consumption. Under the performance contract, Chinese restaurant investors need not to spare a huge sum of money for installation of eco-friendly equipments. Also, the supplier would take care of the machines' maintenance and warranty. Therefore, this kind of partnership should be highly promoted, especially for those less-resourced small-to-medium Chinese restaurants.

Apart from thawing machine and microbubble machine, an "environmental-friendly cold-water thawing method" (Leung, *et al*, 2005) should also be advocated. This can be done by placing a stainless steel rack at the upper part of a large container. Frozen food stuffs are spread evenly on the rack and immersed in water. Unlike traditional cold-water thawing, water is injected from the bottom of the container. The upward movement of water can increase the efficiency of heat transfer between water and the frozen food stuffs. Previous laboratory experiments showed that up to 90% of water could be saved by employing this method. More importantly, this method is cheap and easy to operate in most commercial kitchens.

ii. Dish Washing Section

In many traditional Chinese restaurants, removal of leftovers on used plates is done by high pressure water sprays, which is a very water-wasting procedure. In fact, the leftovers can be removed manually. To ensure hygiene standard, gloves must be provided to the dish-washing staff. After manual removal of leftovers, the used plates are treated by three cycles of rinsing. WSD highly recommends recycling the cleaner water from the final rinse to use in the first rinse. Yet, much space is required for storage of recycled water. Thus this recycling method may only be feasible in large-scale operations.

iii. Water Taps

While the use of aerator or low flow water taps has been proven to achieve significant water reduction, some of the interviewees of this study expressed negative comments towards the use of these devices in kitchen. They though it was not practical to install these devices in all water taps in kitchen. Especially, the use of these devices was unwelcome at the soup and sauce making station, and the cold-water thawing station. The chef would need a much longer time to collect the same quantity of water from water taps after installation of these devices. Therefore, it is suggested that at these two stations, posting up water conservation reminders would be more effective than installation of aerators or low flow water taps. On the other hand, the devices can efficiently reduce water consumption in the dish-washing section and guests' toilets. The increased air pressure in water spout can aid the cleaning purpose.

iv. Front-of-the-house Area

In order to reduce the load of the dish washing section, it is suggested only necessary tableware should be provided to patrons. In fact, all patrons interviewed agreed that provision of underplates and chopstick holders might not be essential. The service quality would not be affected if the Chinese restaurant did not provide such tableware. Besides, it is not necessary to change the underplates for guests after each course. The waiting staff can replace a clean underplate only upon guests' request.

Apart from the above recommendations, there are many new technologies available in the market for water conservation in restaurant premises. A list of these water-saving technologies is provided in Appendix 7.1. Although it is not an exhaustive list, it can serve as a reference for restaurant operators. In addition, Chinese restaurant operators can seek information and assistance from local government departments, such as WSD, DSD and FEHD. By reducing water consumption and sewage generation, the water charge, sewage charge and trade effluent surcharge of a restaurant can be cut down. Chinese restaurant operators can therefore be benefited from reduced operating expenses.

7.3.2 Recommendations to Decision Makers and Trade Associations

In this study, some potential areas for improvement in Chinese restaurant operations were identified. This can aid the development of target-based management approaches, amelioration strategies, as well as subsequent legislative requirements and policies.

i. Review Practicability of Existing Environmental Manuals

The research findings revealed that one of the major barriers in promoting green practice was the low eco-awareness among Chinese restaurant operators and employees. Although FEHD and some restaurant associations had issued conservation manuals for local restaurants, the operational guidelines inside were not widely practiced. One possible reason could be the non-practicability of the guidelines.

Therefore, it is recommended that FEHD and the associations should check the practicability of the guidelines, and amend the content if appropriate.

ii. Seminars for Introducing Green Technologies

It is suggested that the local Productivity Council can arrange series of seminars for industry practitioners, and invite the suppliers / manufacturers to introduce the advance water-saving technologies. The local government can also consider providing subsidies or low-interest loans to restaurant operators for purchasing and installing efficient water-saving technologies.

iii. Promotion of "Performance Contract" Partnership

The "performance contract" should be highly promoted (see Section 7.3.1) by restaurant associations. It is because restaurant operators need not to spare a huge sum of money for installation of water-saving equipments of uncertain efficiency. The cost will be redeemed gradually when the equipments starts saving water.

iv. Inclusion of Eco-performance Indicators in Trade Reports

Currently, environmental performance indicators are rarely included in tourism-related statistical reports and trade reports. The majority of these reports emphasize financial and marketing indicators. It is, therefore, suggested that some green indicators or indexes should be contained in these reports, such as the *Quarterly Restaurant Revenue Receipt*, the

Survey of Wholesale, Retail & Import / Export Trade, *Restaurants & Hotels*, and the *Statistical Review of Tourism in Hong Kong*. The government can consider requiring commercial water consumption and wastewater production data to be made accessible to the public.

v. Provision of Financial Support for Greener Operation

Acquirement of eco-friendly technologies often means large capital investment. Although most eco-friendly technologies possess attractive financial savings in the long-term, the initial investment may make businesses hesitate. Especially, the local restaurant sector is predominantly made up of small-to-medium enterprises, which may not be able to afford the initial investment. Therefore, it is recommended that the local government should take a more pro-active role in providing financial support to local restaurants. This kind of financial support can take forms of direct money subsidy or tax reduction. It is believed that financial support from the government would definitely aid overcoming the hurdle of adopting greener restaurant operation.

7.3.3 Recommendations for Future Studies

Given the limited availability of research about environmental issues of Chinese restaurants, the findings generated from this study can guide future researches and provide insights into an area that is worthy of getting more academic attention.

i. Enhanced Data for Regression Models Development

The regression models for predicting water consumption in Chinese restaurants can be further developed with enhanced data collection, especially the inclusion of non-chain Chinese restaurants in the sample. This can explain more of the variance in the models, and reduce the standard error in the models.

ii. Time Series Study on Water Consumption in Chinese Restaurants

A time series or longitudinal study can be conducted to examine water consumption status in local Chinese restaurants before and after implementation of the guidelines in the voluntary EAM developed in this study. Collection of water consumption data over several years can provide the basis for calculating relatively accurate models and capture the factors driving water consumption. A further cost-and-benefit analysis can be performed by comparing the implementation costs and the monetary savings arose from compliance of the EAM criteria.

iii. Inclusion of Criteria for Sewage Quality in EAM

Due to technical and budget constrains, the current study did not include any criteria for assessing the quality of sewage generated from Chinese restaurants. This is one of the limitations of this study that should be acknowledged. Thus, future investigations on the efficacy of various on-site sewage treatment facilities (such as grease trap and electrocoagulation) are recommended.

iv. Extension of EAM Applicability

The EAM produced in this study only focuses on assessing water management systems in Chinese restaurants within the territory. The applicability is in fact quite limited. It was due to the fact that consumption rates would be influenced by a multitude of site specific characteristics (Warnken, Bradley and Guilding, 2005), such as restaurant type, layout, age of premise, and so on. By adjusting or fine-tuning the assessment weighs and criteria, it is suggested that this kind of environmental assessment can be extended to:

- other types of restaurants (e.g. fast food restaurants and buffet restaurants);
- other aspects of environmental problems (e.g. solid waste generation, electricity and gas consumption);
- other geographic locations (e.g. Guangdong Province and Pearl River Delta Region).

APPENDIX

Appendix 1.1
Summary of Regulatory Requirements about Water Supply and Sewage Discharge for Local Restaurant Premises

Chapter 132X Food Business Regulation		
Section 10A	**Control of water quality**	L.N. 320 of 1999
	No person shall in the course of any food business keep any live fish or shell fish intended for human consumption in water of a quality below the standard specified by the Director by notice published in the Gazette. In this section, "food business" includes any trades or business for the purpose of which live fish or shell fish is sold or is intended to be sold for human consumption.	
Section 28	**Prohibition against the collection of shell fish in certain areas**	L.N. 320 of 1999
	No person shall collect for sale for human consumption any shell fish in- (a) the harbour; or (b) the harbour in Aberdeen, being all those waters and foreshores bounded by a line drawn north from the westernmost extremity of the Island of Ap Lei Chau and a line drawn east from the southernmost extremity of that island.	
Section 32	**Application for license**	L.N. 320 of 1999
	(1) Every application for a licence under section 31 shall be made in writing addressed to the Director and accompanied by 3 copies of a plan, as nearly as may be to scale, of the whole of the food premises (excluding a stall) to which such licence will relate, and, so far as may be applicable having regard to the nature of business, including the following particulars: (e) sanitary fitments and drainage works (i) the sitting of all furniture of a substantial and permanent nature, including food manufacturing or preparation plant, cooking ranges, refrigeration or cooling equipment, fixed sideboards, washbasins or sinks, drying racks, water tanks and other like equipment	
Section 33	**Conditions for issue of license**	L.N. 320 of 1999
	(1) No full licence shall be granted under section 31 unless the Director is satisfied, in relation to the premises in respect of which the application for such	

	licence was made, that- (L.N. 493 of 1995) (c) sanitary fitments are provided to a standard not less than that required by the Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations (Cap 123 sub. leg. I): Provided that in the case of any premises to which such regulations do not apply, the Director may approve such lesser standard as, having regard to considerations of public health and the circumstances of the case, he may consider adequate; *Cap 132X - FOOD BUSINESS REGULATION* 16 (d) public mains water is laid on to the premises and that adequate tank storage suitably protected against access of dust and mosquitoes is provided: Provided that where the Director is satisfied that public mains water cannot reasonably be laid on, for all or any purpose, the Director may in his discretion approve such other water supply as, having regard to consideration of public health, he considers adequate;	
Chapter 358 Water Pollution Control Ordinance		
Section 9	**Prohibited discharges into communal sewers and communal drains**	L.N. 320 of 1999
	"Domestic sewage" means waste of a kind an quantity that is generated by the domestic use of a toilet, water closet, bath, shower, sink, basin or other sanitary fitment by a person residing in a household or while at a place of work but does not include: (c) waste that is generated by a food business that is subject to the Food Business Regulation (Cap 132 sub. Leg.); (Replaced 83 of 1993 s.6. Amended 78 of 1999 s.7)	

Sources:

Department of Justice (2009). *Bilingual Laws Information System*. Retrieved from http://www.legislation.gov.hk

Environmental Protection Department (1997). *A Guide to the Water Pollution Control Ordinance*. Retrieved from http://www.epd.gov.hk/epd/english/environmentinhk/water/guide_ref/files/guide.pdf

Food and Environmental Hygiene Department (2000). *A Guide to Application for Restaurant Licenses*. Retrieved from http://www.fehd.gov.hk/english/howtoseries/forms/new/A_Guide_to_Restaurant.PDF

Appendix 2.1
Literatures about Solid Waste, Air Pollution, Noise Pollution and Energy-induced Emissions from Hotels and Restaurants

i. Solid Waste Generation

Author(s) (Years)	Place of Study	Aim(s) of Study	Sample Size	Instrument	Major finding(s)
DeGeare and Ongerth (1971)	Not mentioned	To identify the variables for predicting solid waste generation in different commercial establishments.	32 (incl. 4 restaurants)	Field measurement	The number of employees and number of opening hours were the two most significant independent variables to predict solid waste generation.
Cummings (1997)	Las Vegas	To document major solid waste minimization practices, challenges and recommendations in the studied hotel.	1	Case study	A five-tier hospitality solid waste minimization model was developed. 1) Commit to waste minimization 2) Purchase with eco-intelligence 3) Use efficiently to generate less waste 4) Procure reusables 5) Procure recyclables
Chan and Lam (2001a)	Hong Kong	To estimate the amount of solid waste generated in hotel guestrooms and restaurants; To estimate the cost of external effect exerted by solid waste in the	20 hotels	Field measurement	Over 53,000 tons of solid wastes were produced by the Hong Kong hotel industry in 1996. The environmental cost was over HK$3 million. Plastic toiletries and newspapers ranked top two in terms of weight.

		hotel industry.			
Heck and Major (2002)	Not mentioned	To determine an accurate and practical method to predict solid waste generation rate.	21 (incl. 10 were fast food restaurants, 7 larger restaurants)	Field measurement	A multiple regression model was developed to predict solid waste generation in restaurants using variables including average number of waste collections per week, container size, square footage, weekly storage capacity, number of employees, and weekly opening hours.
Chan and Wong (2006)	Hong Kong	To investigate the number and total weight of newspapers distributed in hotels in Hong Kong.	52 hotels	Semi-structured questionnaire	18 million copies of newspapers were distributed a year in Hong Kong hotels, which weighted around 5.6 million kilograms. Four-star hotels carried the largest number and the highest weight of newspapers.

Solid wastes are those useless, and sometimes hazardous, materials with low liquid content, including municipal garbage, industrial and commercial waste, sewage sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, etc (UN, 1997, p.69). The solid waste produced in a restaurant can be divided into two categories, namely organic and inorganic.

Organic wastes are those degradable by micro-organisms, include the inedible parts of food raw materials (e.g. skin of fruits), expired, deteriorated or mistreated food commodities, leftovers and garnishes. In Hong Kong, daily food waste is about 3,200 tons including domestic and commercial sources in 2005 (Green Student Council, 2007). Discarded daily by the hospitality industry alone, the amount of food waste has been increased from 282 tonnes in 2000 to 701 tonnes in 2005 (Wong, 2007), constituting mainly leftovers on dining tables. The spokesman of the Hong Kong Federation of Restaurants and Related Trades said that customers are wasteful. He pointed out that people enjoy hotpots and buffets, but they seldom eat all the foods that have been brought to their tables. Customers always have a temptation to order more than they can finish to get value for money (Siu, 2007). This causes much food waste. As a result, some restaurants have already formulated policies to fine greedy and wasteful customers.

Inorganic wastes, on the other hand, cannot be broken down naturally, such as packaging materials, disposable dinning utensils, metal/glass containers, etc. Extensive use of disposable items in the foodservice industry is a consequence of our convenience-oriented, single-use, throwaway lifestyle. An investigation carried out by a local environmental protection group found that the three most popular fast-food restaurant chains produce more than 10 million disposable items a month ("Fast-food chains", 2007).

The steadily rising disposal cost of solid waste constitutes an increasingly high contribution to overheads. Thus there appears a clear incentive for all businesses to identify potentially cost-cutting approaches to waste management. In the foodservice industry, some international foodservice providers have demonstrated good examples in solid waste minimization. McDonald's Corporation was the pioneer who formed a joint task force with a leading U.S. environmental group – the Environmental Defense Fund – to combat the garbage generation problem in early 1990s (Quinton, 1990). Over 20 million pounds of packaging materials have been trimmed in five years (McDonald's Corporation, 1996). In 2004, McDonald's and Burger King participated in another voluntary litter reduction program, and the result showed that up to 65% of solid waste was reduced (Kettle, 2004). Other restaurant chains, such as the Hard Rock Café and the Subway Sandwich Restaurant, have also shown their commitment to waste minimization by redesigning the packaging materials for food items (Martin, 1990; National Restaurant Association, 2008b & c).

Solid Waste Treatment Methods

The Rio Earth Summit in 1992 had advocated some waste handling strategies – minimizing production of waste, maximizing reuse of waste by recycling, promoting environmentally sound waste disposal practices and extending waste services (Uberoi, 2003). In Hong Kong, the waste disposal strategy comprises three similar key elements. The first element involves waste avoidance and reduction. Second, the waste materials are being reused or recycled. Finally, the non-recyclable wastes are treated and disposed of (HKSAR Government, 2006b).

Landfill is the main treatment for solid wastes generated by local residents. It is the "*final placement of waste in or on the land in a controlled or uncontrolled way according to different sanitary, environmental protection and other safety requirements*" (UN, 1997, p.45). According to FEHD (2006), currently there are three landfills, which are located in the western, north-eastern and south-eastern parts of the New Territories, occupying a total of 270 hectares of land. Waste collectors transport municipal solid waste to seven refuse transfer stations, which serve as intermediary reception facilities where waste is compacted for bulk delivery to landfills. These stations are located in West Kowloon, Hong Kong Island East and West, Shatin, North West New Territories, North Lantau and Outlying Islands.

Nevertheless, disposal of solid wastes to landfills may not be the best final treatment as it may generate some derivative problems. Firstly, landfill gas will be produced by the decomposition of waste within the landfill (Lamborn, 1999). It produces unpleasant odour, and is potentially explosive. More importantly, the landfill gas is mainly composed of methane (CH_4), which is a greenhouse gas more potent than carbon dioxide by over 20 times (Earnshaw, 2007). Secondly, landfill leaches contain concentrated dissolved toxins from landfill contents such as inks, paints, cleaning agents, pharmaceuticals, and other chemicals (Cummings, 1994). The leaches may contaminate groundwater, threatening the safety of public water supplies. Thirdly, building landfills is expensive, especially in Hong Kong where land is an extremely scared resource. As the existing landfills in the territory will soon be exhausted in 6 to 10 years, the Government has proposed other ways to treat the solid wastes.

Composting is one of the proposed treatment methods. It is the "*process of reducing vegetable and animal refuse, either by natural biological decomposition of organic material in the presence of air or by controlled mechanical methods, for the purpose of increasing and maintaining soil fertility*" (UN, 1997, p.17). EPD is planning to launch a recycling scheme for leftovers generated from local restaurants, catering companies, breweries and food manufacturers. Two composting units, which will cost HK$5 million in total, will be built to tackle 4 tonnes of food waste per day. The food waste will be decomposed into organic fertilizer and oil conditioner. An odour-removal system will be installed in the composting units to minimize the smell (Wong, 2007).

In fact, some small scale compost machines have been installed in, for example, the airport and shopping centres in Hong Kong. According to the Building Manager of a large shopping mall in Kowloon Tong, the annual leasing cost of the compost machine was around HK$96,000, with daily organic wastes absorption of 100kg. The organic wastes were generated from the food court in the shopping mall. The volume of the final residue was about 20% of the original volume. The Director of Engineering and Facilities of a local hotel explained that the shrink in waste volume had sharply cut down the disposal costs, as fewer waste-collecting trucks were needed. However, he also revealed that it would be impractical for hotels or restaurants to recycle their own food waste because there was no room for the machine (Wong, 2007).

Another treatment method on plan is incineration. It refers to the controlled burning of waste materials at high temperature (UN, 1997, p.42). Same as composting, incineration can greatly reduce the volume of solid waste. The ash produced is then landfilled. The evolving thermal energy can be used for the production of steam, hot water or electric energy. However, this combustion method is controversial, because the incineration exhaust and ash may threaten air safety (Cummings, 1994). Altercation between green bodies and the Government has led to the postponement of building incinerators in Hong Kong. In addition, leftovers from restaurants are not suitable for incineration, as they contain high water content.

Feeding livestock with food waste is another option. It is not a recent innovation. In fact, it has been practiced throughout the world for decades (Westendorf, Dong and Schoknecht, 1998). For health and safety reasons, many countries have banned this practice. However, as the waste disposal options are becoming more expensive, feeding food wastes to livestock seems to be an attractive waste disposal alternative (Westendorf, *et al.*, 1998). Technology is now available to convert food wastes into dry and stable products that can be incorporated into many modern pig feeding programs (Myer, Brendemuhl and Johnson, 1999). In spite of this, more ongoing researches are needed to examine the nutritive value of food waste as feeding stuffs.

If the solid wastes cannot be treated locally, they may be transported to other places. This method is called "waste flight". Strictly speaking, it is not a final treatment of solid waste. It is an expensive yet controversial way to deal with solid waste by paying other countries or states to haul away and dispose of local garbage. Cummings (1994) deduced that waste flight is the result of an interesting social phenomenon known as the NIMBY syndrome: "not in my back yard" (Beck, 1989). This phenomenon arises as the citizens no longer tolerate solid waste disposal facilities, such as landfills, incinerators and large-scale compost machines, in their communities. The reasons behind NIMBY may include possible public safety dangers, related odours and hazardous gas emission, and the potential depression of property values. The NIMBY phenomenon also happened in Hong Kong where the residents of Sai Kung opposed the expansion of existing landfill sites nearby ("Sai Kung District Council", 2006).

ii. Air Pollutants

Air pollutants emitted from a restaurant include oily fume, odour, smoke, particulates, volatile organic compounds (VOCs), steam and vapour, which are mainly produced during the cooking process. Among all types of air pollutants, odour is the only one that cannot be measured by an objective method. It is perceived by our brains in response to a mixture of chemicals in the air we breathe in. Human beings can detect odour even when the chemical concentration is very low.

The U.K. Department of Environment, Food and Rural Affairs (DEFRA) (2005) summarized the odour and grease characteristics arising from a range of commercial kitchens. Air exhaust from tea shops were ranked "low" in both odour concentration and grease content, while that from fast food restaurants and pubs ranked "very high" in both categories. Air effluent from Chinese restaurants was characterized with moderate odour concentration but high grease content.

In 2001, nearly 60% of the complaints received by EPD were about polluted air from restaurants' exhaust vent (EPD, 2004). A similar situation had been reported in Taiwan too (Su, 2005). In particular, some restaurants in Hong Kong still use charcoal or diesel oil as the fuel for cooking (EPD, 2004), and dark smoke are produced and emitted from the exhaust duct. Although air movement gives good dispersal and dilution of gaseous emissions, heavy particulates tend to fall out near the source. This may cause irritation to the respiratory system, coughing and even lung cancer to the employees and nearby residents.

Air Pollution Control Methods

Common air pollution abatement equipments include exhaust hood and electrostatic precipitator (EPD, 2004). An exhaust hood is a basic equipment for controlling cooking smoke. It can filter large oily fume particles. Usually an exhaust hood must be complemented with other types of abatement equipments in order to achieve satisfactory results. An electrostatic precipitator is much more efficient in removing oily vapour than an exhaust hood. Traditional electrostatic precipitators use plate-and-wire high voltage electric field design to collect oil mist. When the oil mist accumulates on the collection plates, it quickly causes electric discharge and the performance of the electrostatic precipitator would drop by 60% ("Restaurant electrostatic precipitators", 2007). Therefore frequent and proper cleaning is required. Other air pollution abatement technologies utilize water or activated carbon to remove oil vapour. Again, equipments of this category must be used with the aid of other exhaust treatment facilities in order to improve the efficiency.

Indoor Air Pollutants

Air pollutants also exist inside the premise – both front-of-the-house and back-of-the-house areas. Indoor air pollutants include carbon dioxide (CO_2), carbon monoxide (CO), particulates (PM_{10}), nitrogen dioxide (NO_2), VOCs, tobacco smoke, formaldehyde, radon, asbestos, ozone (O_3), bacteria, and water vapour (EPD, 2004). The only practical way of limiting the concentration of indoor air pollutants is by dilution with fresh air from outside the premise.

The study of indoor air quality (IAQ) is a relatively new endeavor (Melink, 2003), but it has become a matter of public concern recently (Lee, Li and Chan, 2001). Earlier studies in western countries discovered that restaurant chefs had an increased risk of lung cancer as they were constantly exposed to cooking stove smoke in kitchens (Coggon, Pannet, and Osmond, 1986; Dubrow and Wegman, 1984). A recent investigation revealed that average CO_2, PM_{10}, and formaldehyde level, as well as bacteria counts of restaurants were relatively higher than other indoor premises such as classrooms, shopping malls and offices (Li, 2001). Therefore the IAQ problem of restaurants should not be overlooked.

Some other studies compared the amount of indoor air pollutants generated by different types of restaurants. The general conclusion was that Chinese cooking would produce more contaminants. More carcinogenic air pollutants could be released from a Chinese wok than other types of cooking utensils, which could explain the higher rate of lung cancer in Chinese women (Benfenati, Pierucci and Niego, 1998; DEFRA, 2005; Shields, Xu, Blot, Fraumeni, Trivers, Peizzari, Qu, Gao and Harris, 1995; Zhang, Goldberg, Parent and Hanley, 1999). And among various types of restaurants, Korean barbeque restaurants had the worst IAQ, followed by Chinese hot pot restaurants (Lee, *et al*., 2001). This was because the cooking process took place in the front-of-the-house area, and various indoor air pollutants would be emitted.

Poor indoor air quality may reduce the productivity of employees, threaten their health, and affect the restaurants' image. It may even lead to Sick Building Syndrome (SBS), Humidifier fever, Pontiac fever and Legionnaire's disease (EPD, 2004). Li (2001) estimated that the lifetime risk of food service workers were higher, due to the poor IAQ in restaurants.

Second-hand smoke was once a major source of indoor air pollutant in local restaurants. Exposure to second-hand smoke may heighten the chance of stroke by 50 percent (Benitez, 2005). James Repace, an ventilation system expert, predicted that there were 150 food service workers died every year in Hong Kong, due to second-hand smoke ("150 workers", 2005). Fortunately, a smoking ban has been enacted in 2007. Since the enforcement of the ban, all restaurants in Hong Kong have become smoke-free, and the indoor air quality has been improved.

In fact, the government understands the importance of indoor environment, and has shown its effort in improving IAQ. The "*Guidance Notes (GN) for the Management of Indoor Air Quality in Offices and Public Places*" has been enacted. This voluntary GN applies to buildings or totally enclosed areas served with mechanical ventilation and air conditioning (MVAC) system for human comfort, except domestic, medical and industrial buildings (Indoor Air Quality Management Group, 2003). Apart from the GN, the IAQ Management Group has launched a voluntary IAQ Certificate Scheme. A 2-level IAQ objective (Excellent Class and Good Class) is used as the benchmark to assess IAQ of buildings. Both the GN and the Certificate are applicable to local restaurants.

iii. Fuel / Energy Consumption and Associated Emissions

Author(s) (Years)	Place of Study	Aim(s) of Study	Sample Size	Instrument	Major finding(s)
Chow and Chan (1993)	Hong Kong		20		- Average electrical energy consumption per unit gross floor area was 928MJ/m^2.
Zmeureanu (1994)	Ottawa, Canada		19	Survey	- Total annual energy use per unit of gross floor area was 2,479 MJ/m2. - Electricity was accounted for around 29% of the total energy consumption.
Deng, Burnett and Yik (1999)	Hong Kong	To carry out an audit of electricity use in major hotels.	13	Data form, survey and field measurement in hotels	- Avg. EUI : 1,287 MJ/m^2; Max. EUI: 1,579 MJ/m^2; Min. EUI: 900 MJ/m^2 - Over 50% of total electricity consumed was for HVAC, 17% for lighting, 8% for lifts and escalators.

					- Electricity use was related to outdoor air temperature variation, but not occupancy rate.
Chan (2000)	Hong Kong	To investigate the environmental cost attributable to gas consumption in the local lodging industry.	20	Survey	- Green cost attributable to gas consumption was HK$0.04 per MJ. - Green cost relating to gas consumption for hot water supply to each occupied room was HK$0.123 per day.
Deng and Burnett (2000b)	Hong Kong	To examine the energy use in quality hotels.	16	Survey, field measurement and hotel operational records	- Total energy use was dominated by electricity. - HVAC dominated the total electricity use. - Other factors, such as hotel class, total GFA and occupancy rate did not correlate with energy consumption.
Lee, Chan and Burnett (2000)	Hong Kong	To establish daily load profiles and examine the energy performance of hotels.	1	Case study	- Occupancy rate and volume of meals served would affect the amount of towngas and diesel oil used, but not electricity. - HVAC system, plumbing and electrical systems and appliances accounted for 55.5%, 3.4% and 41.1% of the total electricity consumption respectively. - The peak of electricity consumption occurred between 23:00 and 01:00, while the trough between 14:00 and 17:00. - Parameters correlated to energy demand included outdoor air temperature, occupancy rate and no. of food covers.
Chan and Lam (2001b)	Hong Kong	To investigate the environmental cost attributable to	20 3	Survey Case studies	- The green costs attributable to electricity consumption in hotel ranged from HK$4.52 to HK$9.05 per occupied room.

		electricity consumption in the local hotel industry.			
Chan and Tse (2001)	Hong Kong	To examine the energy usage and cost involved in roasting Chinese BBQ items.	74	Experiment Interview	- Comparing with other BBQ items, the time and energy for roasting a suckling pig were the greatest. - The energy cost per edible kg was also the highest for suckling pigs.
Chan and Lam (2002a)	Hong Kong	To estimate the quantity of pollutants created indirectly by the local hotel industry due to gas consumption.	11	Survey	- Gross floor area was a major and statistically acceptable factor in explaining the gas consumption in new hotels. - A heat pump running on coal-fired electricity and with a coefficient of performance greater than 3 could produce lower lever emissions than a gas-fired boiler.
Chan and Lam (2002b)	Hong Kong	To estimate the quantity of pollutants created indirectly by the local hotel industry due to electricity consumption.	17	Survey	- Gross floor area was a major and statistically acceptable factor in explaining the gas consumption in new hotels. - Average electricity consumption was about 342 $kWh/m^2/year$.
Deng and Burnett (2002a)	Hong Kong	To examine the energy use in quality hotels.	16	Survey	- Total energy use was dominated by electricity, i.e. 73%. - Air conditioning dominated the total electricity use. - Electricity use was affected by both outdoor air temperature and no. of guest, with the former being

					the stronger factor.
Chan and Mak (2004)	Hong Kong	To estimate the quantity of pollutant produced by the HK hotel industry thru diesel oil consumption.	20	Survey	- Environmental cost stabilized at around HK$54,000 per year for consumption of diesel oil in hotels. - GFA was a major and statistically accepted factor in explaining diesel oil consumption.
Chan (2005)	Hong Kong	To establish a benchmark of electricity consumption and model energy demand of hotels.	17	Survey	- Avg. electricity usage was 313 kWh/m^2/year for city hotels in subtropical areas. - Cooling degree day and no. of occupied room would affect the level of electricity consumption.

In 2005, a total of 144,171 terajoule of energy had been consumed by local use (EMSD, 2008), releasing 45 million tones of CO_2 to the atmosphere (Green Sense, 2007). The restaurant industry along had consumed 26,303 terajoule of energy in 2005 (EMSD, 2008), representing nearly 20% of the total energy consumption. Restaurants in general consume 2.5 times more energy per square metre than other types of commercial buildings (Energy Star, 2008). The main uses of energy for foodservice establishments are for heating, air-conditioning, humidification, ventilation, lighting, and operating other equipments in kitchen such as oven and refrigerator. The percentages of energy consumption by different purposes are presented below:

Purpose	Source of Energy	Percentage
Cooking and heating	Towngas; Liquefied petroleum gas; Diesel oil; Electricity	53.0%
Space conditioning	Electricity	29.3%
Lighting	Electricity	6.1%
Hot water and refrigeration	Electricity; Liquefied petroleum gas; Towngas	9.5%
Others	Electricity; Liquefied petroleum gas; Towngas	2.1%
	Total	100%

Source: EMSD (2008)

According to EMSD (2008), average energy consumption for local Chinese restaurants is 12,022 MJ per cubic meter per annum in 2006. Chinese restaurants' consumption rate is far more than other categories of restaurants. One of the reasons is that many Chinese foods require a lengthy time for stewing, steaming, or roasting (Chan and Au, 1998). This increases the energy consumption for cooking. Another reason is that excessive artificial lighting levels are frequently found in Chinese restaurants. Often a large proportion of the cooling load of the air-conditioning system is required to compensate the heat from artificial lighting.

Pollution Control Methods for Energy-related Emissions

Reduction of energy-related emissions can be done in two levels – at power plants and at restaurant premises.

In Hong Kong, the dominant fuel for power generation has been combustion of coal, usually in the form of pulverized fuel, which accounts for 46% of the fuel portfolio (CLP Group, 2006). Other forms of energy source, such as natural gas, nuclear, hydropower and wind power, are also included in the power generation portfolio (CLP Group, 2004). The dominant environmental impacts from such a process are global warming resulting from CO_2 generated and acidification primarily from sulphur and nitrogen oxides released in power plants. Acidification impacts can be reduced by installing flue gas desulphurizer (FGD) as an end-of-pipe measure. However, this involves additional capital and operating costs. It also reduces the efficiency of the electricity generation process, so that acidification is reduced at the expense of increased greenhouse emissions which then becomes a derivative problem. In order to reduce the environmental impacts of electricity generation from coal, it was suggested an integrated gasification combine cycle plant could be used. During the process, coal is gasified rather than burnt. It was pointed out that this gasification process typically would have higher conversion efficiency than pulverized fuel combustion.

Another strategy to reduce the pollution impact of power generation is to switch from coal to liquefied natural gas (LNG) as the main source of fuel. LNG is an abundant resource found all over the world, and is by far the cleanest fossil fuel available for power generation (CLP Group, 2006). Greenhouse gases and acidic gases emissions can be reduced even further by generating power from LNG. Nonetheless, no power generation technology is free of environmental impacts (Royal Commission on Environmental Pollution, 2000). Thus, the most effective measure is by reduction of energy consumption at the restaurant level.

Energy saving issue has been a chief concern of most restaurant operators. It is targeted by the majority of pro-ecological solutions (Bohdanowicz, 2006), because energy cost has been going up in the past three decades. Many energy efficient equipments have been introduced into the market. High efficiency lighting and air-conditioning systems are examples. In addition, many organizations have developed guidelines to industry practitioners on how to save energy in the restaurant operation, such as Energy Efficiency Office (1987) and the Hong Kong Federation of Restaurants & Related Trades (2005). These guidelines provide cheap yet effective ways to cut energy consumption in restaurants.

iv. Noise

Noise, which is measured in decibels, is defined as the audible sound that may generate unpleasant and harmful effects (UN, 1997, p.52). Noise pollution is the sound at excessive levels that may be detrimental to human health. People's perception to noise can vary significant, but if the average sound level is higher than 140 decibels, it may cause permanent damage to our hearing system.

Noise generated from a restaurant can be divided into environmental noise and occupational noise (EPD, 2004). Environmental noise will affect the public, and it is usually generated from the air ventilation system, and activities in outdoor area (such as loading and unloading of goods) (Tennekes, 2002). On the other hand, occupational noise will distress employees. It is usually created during the preparation process in the kitchen (such as chopping, dish washing, cooking, etc) and the activities in the front-of-house area (such as live band performance and background music, etc).

Surprisingly, there is no article about restaurant noise published in hospitality journals, but there are a few in medical journals. For instance, in Lebo, Smith, Mosher, Jelonek, Schwind, Decker, Dursemark and Kurz's (1994) study, noise data from 27 restaurants in San Francisco were obtained. It was found that the loudness level ranged from 59 to 80 decibels. The mean loudness level was 72 decibels, which was comparable to the noise generated by a heavy truck.

Noise Control Methods

To control noise from restaurants, the manager must first identify the sources of noise. In general, noise comes from the cooling tower, the ventilation system, the activities in the kitchen, front-of-house, and outdoor area.

Cooling towers and ventilation system exhaust should be installed as far from residential areas as possible. To reduce the noise, EPD (2004) had made several suggestions to restaurants operators. Some examples include installation of silencers at exhaust hood, use of lubricant at turbines, and utilization of noise-absorbing materials to cover the cooling towers.

The noise from restaurant activities may be more difficult to control. As recommended by EPD (2004), restaurant management should choose equipments that produce less noise. All preparation and washing processes must be done inside the premise. Also, the door should always be kept closed to prevent noise from transmitting to nearby residents.

Appendix 2.2
Water Conservation Programs in the Hospitality Industry

Initiatives	**Assessment Criteria or Initiatives**
Environmental Protection Department (1996)	*Grease Trap Maintenance* Record maintenance activities in a log book. *Waste Minimization* Scrape dirty serving dishes and cooking utensils into a garbage bin before washing. Dispose of floor sweepings and food scraps to a garbage bin before washing floors and food preparation surfaces. Use metal strainers or baskets in all drains. If this slows things down, keep two strainers on hand; quickly place one over the drain while the other is emptied. Never pour waste cooking oil down a drain or toilet. Waste oil and grease should be poured into a storage container which is discarded with other solid kitchen waste. Take care not to discharge excessive quantities of detergent and/or hot water as these are also considered to be pollutants.
Department of Building Services Engineering, The Hong Kong Polytechnic University (1998)	*廚房* 當需要時才打開水龍頭, 不要讓水不停地流 調整水流速度和水溫, 以適應不同廚房的工作要求 洗碗機滿載或接近於滿載時使用, 盡量使得使用次數最小 保持廚房衛生, 以減少用水量 改善供水系統的性能, 較好的系統平衡, 水流量的容易調節, 增強員工對水節約的意識, 和管理 對室內環境的關心 *核算* 了解各部門水消耗用量和成本 對某一部門/建築設備系統用水調查 評估節水投資的效率 用事實和數據提高所有員工對節約用水重要性的認識
Department of Building Services Engineering, The Hong Kong Polytechnic University (2000a)	*Kitchen Food Waste* Cooking oil shall be reused until it is unacceptable for further use. Used oil shall be kept in a metal can for in-house Steward to collect and arrange for recycling. *Kitchen Water Use* Kitchen staff should turn on water taps only when needed and never let water running continuously. Kitchen staff shall keep kitchens clean at all times to reduce the amount of water used before closing at the end of the day. Water may be reused to boil the same food type with same colours and smell. Staff shall not use excessive amounts of

	water for boiling food. Metal strainers or baskets shall be used in all basins to filter out suspended food debris. All kitchen staff are responsible for checking whether all water taps are fully closed before off duty. Head Chefs are responsible for immediately reporting any water leakage to Engineering Department. Stickers and posters are posted on staff notice boards and working areas to draw attention on the significance of water saving. *All Service Section Food Waste* Coffee surplus shall be reused for making iced coffee. Outlet staff shall brew coffee by portion during non-busy hours. Outlet staff shall collect coffee cream / milk surplus from guest tables for reuse or send it to kitchen for cooking purpose. Outlet staff shall serve drinking water to guests upon request. Outlet heads / managers may place water conservation tent cards on guest tables to encourage guests to save drinking water. *All Service Section Waste from Other Consumables* The Chief Steward shall arrange recycling companies to collect recyclable items (waste paper, newspaper, carton box, aluminium can and cooking oil) regularly. The Chief Steward shall check the waste collectors regularly to ensure that the collected wastes are disposed of properly. *All Service Section Water Use* Outlet staff and stewards shall turn on water taps only when needed and not allow water to run continuously. Outlet staff and stewards are responsible for checking whether all water taps are fully closed before going off duty. Stewards shall remove dirt from dishware and pre-soak dirty dishware properly before machine washing to reduce the possibility of re-washing, and reuse pre-soaking water whenever possible. Stewards shall operate dishwashers at or near their full load to minimize the number of operations. The Chief Steward shall arrange the chemical supplier to check regularly whether washing results of dishwashers meet the sanitation requirements. The wash and rinse jets of the dishwashers shall be cleaned at least once a week and temperature settings of the dishwashers shall be maintained at recommended levels. Stewards shall not use running water for general kitchen cleaning. Stewards shall use ice collected from buffet tables for washing kitchen floors whenever possible.

	While cleaning the stoves, ovens and hydro-vent system, stewards shall follow the recommended instructions shown on the chemical labels or the instruction sheet (or refer to Chemical Handling Manual) and use adequate amount of water and chemical. Metal strainers or baskets shall be applied in all basins. Grease traps shall be maintained properly. Dirt shall be removed from the grease traps at least once a week. Outlet supervisors and the Chief Steward are responsible for immediately reporting any water leakage to Engineering Department. Stickers and posters are posted on staff notice board and working areas to draw attention on the significance of water saving.
Department of Building Services Engineering, The Hong Kong Polytechnic University (2000b)	*Purchasing Practices* Purchase environmentally friendly / biodegradable / non-CFC cleaning chemicals (e.g. phosphate-free detergents, non-aerosol cleaners). *Other Engineering / Building Waste* Clean grease traps regularly. Ensure any appointed contractor collects oil and grease in grease interceptors and sump pits into special leakage-free tanks for disposal. *Kitchens* Reuse cooking oil until it is unacceptable for cooking. Store useless oil in a metal can for collection and recycling. *Food Waste from Guest Tables* Serve coffee cream / milk according to number of guests at table. Collect good-conditioned coffee cream surplus / milk for reuse or send it to kitchens for cooking. Serve sauces (e.g. soy sauce and chilli sauce) to guests upon request, to minimize food wastage and disposal of empty containers. Serve drinking water to guests only upon requests. *Waste Handling* Arrange recycling companies to collect recyclable items (waste paper, newspaper, carton box, aluminium and cooking oil) regularly and keep relevant records.
Department of Building Services Engineering, The Hong Kong Polytechnic University	*Kitchens* Turn on water tap only when needed and never let water running continuously. Adjust water flow rate and water temperature to suit different kitchen and cleaning. Hand scrape as much soil from dishware as possible and pre-soak dirty dishware properly before washing in dishwasher to

(2000c)	reduce the possibility of re-washing. Reuse pre-soaking water if possible. Operate dishwashers at or near their full load to minimize the number of operation. Arrangement chemical supplier to check regularly whether washing results of dishwashers meet the sanitation requirements. Check and clean all dishwashers regularly and ensure temperature settings of dishwashers are maintained at recommended levels. Use running water for washing and cleaning is not recommended. Reuse unused ice collected from buffet tables to wash kitchen floor. Keep kitchens clean at all times to reduce the amount of water used before closing at the end of the day. Clean daily and check frequently all kitchen equipment for highest possible efficiency. Follow the operating instructions of kitchen equipment manufacturers. Check whether all water taps are fully closed before going off duty. Report any leaking tap to Engineering Department immediately for repairing. Post stickers and posters on staff notice boards and working areas to draw attention on the significance of water saving. *Engineering Staff* Check and clean plumbing and drainage system components regularly and repair leaking pipes / equipment as soon as possible. Install a chemical fish pool in kitchen to reduce the frequency of changing water. Install a water filter unit on each laundry washing machine to filter out impurities form eh water supply to optimize the performance of the machine. Check and replace the filter regularly. Install a water control system and automatic shut off systems (e.g. automatic water tap) to reduce water use. Record daily water consumption data from water meter(s) to monitor water use. Install water flow meters with sufficient accuracy at different hotel sections such as kitchens and laundry to facilitate more detailed water consumption monitoring whenever budgets permit and space is available. Conduct water audit annually to indicate the current water use profiles.
HKHA (2000)	*Management* For having a water conservation policy and an action plan,

	with the responsibility for implementation vested in a managerial staff. For having carried out a water audit of the restaurant within the previous year, or for undertaking an ongoing water audit. For an water use monitoring and targeting system which sets targets and quantifies savings, together with a water conservation investment budget and suitably trained staff to undertake implementation. Adoption of practices given in the "Good Practice Guide to Water Conservation in Hotels" in respect of non-technical aspects of hotel operations. *Metering* For having adequate meters allowing measurement of water use by major functional zones in the restaurant. *Water Conservation Equipment* For the reuse of water, or new dish-washing technology adopted to reduce water consumption. For installing water flow control devices in faucets in guests' washrooms. For installing water flow control devices in faucets in kitchen. For installing water flow control devices in faucets in dish-washing section. For water consumption based on hotel Water Use Index (WUI) between 3.5 and 5.5 m^3/m^2. For water consumption based on hotel Water Use Index (WUI) below 3.5 m^3/m^2.
Pollution Prevention Unit, New York State Department of Environmental Conservation (2001)	*Reducing, Recycling and Preventing Packaging Waste* Is the grease from pots, pans, grills, and deep fat fryers kept out of the drains and handled separately? *Food processing Operations and Cleanup Procedures* Have opportunities been explored for re-circulating clean rinse water? (i.e. collecting rinse water for use as a pre-wash for the next clean cycle) Are there screens on floor drains to prevent the release of food by-products to the sewer? Does spillage occur from overfilling or mixing activities? To prevent waste produce from entering drains and to reduce the use of cleanup materials, are catch basins being used for collection? Prior to the use of water for cleanup, do you use dry cleanup procedures (i.e. scrapers, shovels, brooms, squeegees, or absorbents) to prevent the bulk of food materials from being washed down drains? When water is needed for cleanup, are high-pressure spray washes used in order to conserve water? Are hoses that are used for cleanup equipped with nozzles

	enabling easy shut off? Have either non-toxic or less-toxic cleaning supplies been identified and used? When detergents/cleaners are needed, have you explored the possibility of using one multi-purpose cleaner rather than several different cleaners that are job specific? If you discharge to a municipal sewer, have you contacted the local wastewater treatment plant for possible requirements concerning the need for grease interceptors and grease trap management? Have you determined whether your food processing facility is required to have a Sate Pollutant Discharge Elimination System General Permit for storm water discharges? *Preventive Maintenance* Do you have a water conservation program which includes items like shutting off water during breaks to prevent it from being left on while unattended? Have all leaks in pumps, piping, valves and tanks been repaired to conserve water?
Deng and Burnett (2002b)	Water management should be fully integrated into the management system and be treated with equal importance to other management functions. There should be a clearly defined water use policy and an action plan, with the responsibility for implementation vested in a senior executive. Water use targets by various functional areas should be established. Water audits should be carried out on a regular basis, preferably once every year. Weekly and monthly monitoring of water use against targets should be undertaken. All staff should be trained and encouraged to be involved in water management. Data and information on water use and its associated cost should be regularly communicated to staff to raise their awareness of water conservation issues. Suitable water sub-meters should be installed or added to monitor water use in major water end-uses. Motivating and encouraging technical staff to adopt new water saving technologies should be given high priority.
Lewis and Brown (2003)	*Dishwashing* Air-dry dishes. Fully load the dishwasher. Keep dishwasher temperature at the correct level. Turn off dishwasher when not in use. Substitute chemical rinses for hot water rinses if codes allow. Clean the dishwasher regularly.

	Functioning at Optimum Efficiency Inspect pipes regularly for leaks. *Preventative Maintenance* Check the ice machine regularly. Ensure the pipes are cleaned regularly. Schedule the regular cleaning of all equipment as part of the kitchen staffing duties.
Water Supplies Department (2003)	Determine water requirements for each production unit. Introduce control checks on usage. Ensure that hot water pipe runs are as short as possible. Cold water pipes are laid clear of heated areas, heated equipment or stream-lines. Reduce water pressure to the minimum practical level. Carry out regular leakage tests on concealed piping and check for overflowing tanks, waste, worn tap washers and other defects of the system. Use reject water for secondary purposes (e.g. water from some processes is still usable for cooling purposes, floor cleaning and yard washing. Use counter current washing and rinsing methods. Turn off system at night and during holidays. Educate employees to save water by use of posters and other publicity materials.
Li (2004)	加強節約用水宣傳, 培訓 建立節約用水指標和保證制度 實施節水獎懲辦法 實施定期檢查制度 樹立經濟用水的思想 實行分區供熱 中水的利用
Katsigris and Thomas (2006)	*Kitchens and Service Areas* Turn off the "continuous flow" feature of drain trays on coffee/milk/soda beverage islands. Do your food thawing and utensil pre-soaking, in tubs or basins of water, not running water. Allow for longer thawing period in refrigeration Adjust ice machines to make and dispense less ice when less is needed. *Restrooms* Repair leaky toilets and faucets. Install aerators, spring-loaded valves, electronic sensors, or timers on all faucets. Replace worn-out fixtures with water-saving ones. Apply water conservation stickers on mirrors to remind both

	employees and customers not to waste water.
Maryland Department of the Environment (2008)	Increase employee awareness of water conservation. Seek employee suggestions on water conservation. Locate suggestion boxes in prominent areas. Conduct water conservation suggestion contests. Assign an employee to monitor water use and waste Determine the quantity and purpose of water being used. Providing table signs urging water conservation.
National Restaurant Association (2008a)	Train employees on water saving procedures and on the importance of water conservation. Install low flow toilets, waterless urinals. If you can't replace existing toilets, adjust the flush valves or install dams. Fix leaks. Repair leaky faucets and toilets. Ask guests if they would like water instead of automatically serving it. Run dishwashers, washing machine only when full. Post water-saving measures and results. Consider a program to reward water-saving efforts. Reduce sink and tap use. Thaw frozen foods in the refrigerator and melt ice naturally instead of running water over them in the sink. Wash vegetables in a water basin and not under running water. Soak pots and pans and scrape dishes and cookware before washing them. Check for leaks by placing a small amount of food colouring in the tank. Install low flow spray valves. It can save up to US$1,000 a year. Wash only full loads as much as possible. Install a rinse-water recycling system or high-efficiency washers and dryers. Replace traditional boiler-based steamers with connectionless steamers, which are 90% more water efficient.
National Restaurant Association (2008b)	Install low-flow toilets and infra-red faucets in the restrooms. Use a large three-compartment sink for washing dishes. Ask employees to place unused ice in the sink at the end of the day so it melts on its own overnight. Teach the employees good water habits Quickly fixed dripping faucets and leaky toilets. The restaurant has a plumber on call who can make repairs within three hours so leaky plumbing does not waste large amounts of water. Start with one project. Knock that out. Then do another one. Once you get into it, conservation becomes part of your operation.

North Carolina Division of Environmental Health (2008)	Check water supply fixtures for leaks regularly. Educate the staff about methods of water conservation and ask them for suggestions to help in the conservation efforts. Obtain beverages in ready-to-use forms (e.g. boxed tea, canned soft drinks, etc). Send laundry to a commercial facility. Use dry surface cleaning methods, followed by damp mopping or wipes. Use refrigeration rather than running water to thaw foods. Before washing dishes, dry-scrape and pre-soak in standing water, instead of under a running water. Install "pedal-activated" hand sinks, which do not need to run during the entire hand-washing process.
Pennsylvania Department of Environmental Protection (2008)	Make sure staff know about and practice water conservation. Read the water bill monthly to monitor usage and water conservation results. Wash vegetables in a basin of water, do not let water run in the preparation sink.
South Florida Water Management District (2008)	Turn off the continuous flow used to wash the drain trays of the beverage island. Adjust ice machine to dispense less ice if ice is being wasted. Pre-soak utensils and dishes in basins of water, rather than in running water. Replace automatic shut-off spray nozzles. Do not use running water to melt ice in bar sink strainers. Turn off food preparation faucets that are not in use. Wash only full loads in the dishwashers. Replace the spray heads to reduce flow. Turn dishwashers off when dishes are not being processed. Reuse the rinse water from the dishwasher as flush water in garbage disposal units. Serve water only upon request. Read water meters monthly. Compare the result to the same month of the previous year. This will help to identify leaks as they occur, as well as monitor your conservation efforts. Check water pressure. If the system pressure is higher than 60 psi, install pressure-reducing valves. Educate employees about the importance and benefits of water conservation. Create water conservation suggestion boxes, and place them in prominent areas. Install signs in restrooms, and display information on tables, encouraging water conservation. Assign an employee to evaluate water conservation opportunities and effectiveness.

Appendix 2.3
Cold Water Thawing in Chinese Restaurants

Cold water thawing is a unique process in Chinese cooking. Food raw materials are thawed by soaking into cold water, so as to remove the odour and impurities. (Hsin Kuang Chinese Restaurant, Wan Tai Sin; August 18, 2006)

Appendix 2.4
Different Types of Microbubble Generation Methods

	Electroflotation (EF)	**Dissolved air flotation (DAF)**	**Dispersed air flotation**	**Electrostatic spraying (ES)**
Main purpose	Used in mineral industry for separation of fine particles from solutions.	Used in treatment of potable water (as an alternative to sedimentation for the removal of low-density particles like algae, clay-size materials or coagulated fulvic acids.	Remove particulate materials, such as quartz particles, with diameters of less than 50 µm.	
Bubble generation	1. Water is split into its molecular constituents by applying a current to the solution being treated. 2. Bubbles of H2 are formed at cathode while bubbles of O_2 are formed at anode.	1. Air is pressurized into solution. The solution is then released through needle valves to atmospheric pressure. 2. After the pressure is reduced, the air transfers out of solution, forming bubbles that rise to the surface of the liquid.	1. Bubbles are produced at the bottom of the column. 2. Compressed air is forced through pores of a fixed size to produce the bubbles.	1. Gas flow thru a capillary and forms bubbles in a liquid medium at the capillary tip. The capillary is charged and acts and an electrode for the application of a high-voltage-induced electric field to the system. The electrical stress applied at the capillary tip causes gas bubbles flowing into solution to break up.
Bubble diameters	From 22 to 50µm	From 10 to 120 µm, avg. 40 µm		From 10 to 180 µm, avg. 30 µm
Advantages				1. Easily controlled flow rate 2. Can disperse any gas in the form of microbubbles.

Disadvantages	Limited to the products of electrolysis.	Amount of power consumed was significantly greater than that consumed in other experiments, due to the larger scale system used for the DAF method.		
Experimental results	1. Increasing power input to the system increases the total gas evolved from the electrolysis reaction. 2. Increasing ionic strength increases the flow rate. 3. Hydrogen bubbles forming on the cathode will have a smaller diameter than Oxygen bubbles from the anode, due to electrostatic effect.			
Bubble size decrease when	Current density is decreased	Pressure of air forced into solution is increased		1. Flow rate is decreased. 2. Power input to the system is increased. 3. Voltage applied to the system is increased.
Uniformity of bubble size	Intermediate range	More uniform bubble sizes		Most distributed → a few very large bubbles are produced, which account for a significant portion of the gas volume in the system.
Average bubble diameters	Smallest	Largest		Intermediate

Appendix 2.5
List of Environmental Assessment Methods for Buildings

- Baldwin, R., et al., (1998). BREEAM 98 for Offices: An Environmental Assessment Method for Office Buildings, Building Research Establishment, Garston, Watford, England.
- Baldwin, R., et al., (1993). BREEAM/Existing Offices, Version 4/93: An Environmental Assessment for Existing Offices Buildings, Building Research Establishment, Garston, Watford, England.
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- CET. (1999). HK-BEAM (Residential): An Environmental Assessment for New Residential Buildings, Version 3/99, Centre of Environmental Technology (CET), Hong Kong.
- CET. (1999). HK-BEAM (New Offices): An Environmental Assessment for New Office Designs, Version 1/96R, Centre of Environmental Technology (CET), Hong Kong.
- CET. (1999). HK-BEAM (Existing Offices): An Environmental Assessment for Existing Office Buildings, Version 2/96R, Centre of Environmental Technology (CET), Hong Kong.
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- Crisp, V. H. C., Doggart, J., and Attenborough, M. (1991). BREEAM 2/91: An Environmental Assessment for New Superstores and Supermarkets, Building Research Establishment, Wartford, England.
- CSA. (1997). Title CSA Plus 1132: BREEAM-Canada: An Environmental Performance Assessment for Existing Office Building, Canadian Standards Association, Toronto, Ontario, Canada.
- HKHA. (2000). Hotel Building Environmental Assessment Scheme (HBEAS): An Environmental Assessment for Existing Hotels, Version 1/00, Hong Kong Hotels Association (HKHA), Hong Kong.
- Liudsay, C. R. T. (1993). BREEAM / New Industrial Units, Version 5/93: An Environmental Assessment for New Industrial, Warehousing and Non-food Retail Units, Building Research Establishment, Garston, Watford (England).
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- Rao, S., et al. (2000). EcoHomes: the Environmental Rating for Homes, Building Research Establishment, Watford, England.
- Wong, K. C., So, A. T.P. and Leung, A. Y. T. (2001). The Intelligent Building Index: ibi Manual: Version 2.0, Asian Institute of Intelligent Buildings, Hong Kong.

(Source: Department of Architecture, University of Hong Kong

http://www.arch.hku.hk/research/BEER/refbook.htm#Environmental%20Assessment)

Appendix 2.6

Summary of Key Issues Covered by Various Hotel EAMs

Key Issues Covered		GG21* [1]	HBEAS [2]	GH [3]
<u>**General issues**</u>				
Environmental policy and system		√	√1	#
Green target				#
Informing and raising awareness				#
Environmental team or representative				#
Set up internal environmental fund				#
Environmental guarantee				#
Environmental audit and reward				#
Environmental training				#
Compliance to environmental regulations				#
Free from environmental pollution				#
Free from fire safety and food safety accident				#
Systematic green management program				# √6
<u>Energy-related issues</u>				
Energy management and conservation			√4	√11
Energy management system			√4	
Operation efficiency of major energy-consuming systems	1. Air-conditioning installations		√6	√25
	2. Lighting installations		√4	
	3. Electrical installations		√4	
Energy consumption		√	√6	√8
Stored fuel				
Application of new energy-saving technology				√7

* -- Equal weightings are assigned to different environmental issues.
# -- Prerequisite item that does not carry any score.
The number after "√" represents the maximum number of score attainable for that particular criterion.

Key Issues Covered	GG21* [1]	HBEAS [2]	GH [3]
Green purchasing			
Product purchase		√5	√2
Pesticides, herbicides and fertilizers	√		√2
Paper products	√		
Cleaning products and process	√		√5
Regular meeting with supplier			√2
Building and building services systems			
Building maintenance		√1	
Operation and maintenance of building services systems		√3	
Mineral fibres		√3	
Radon		√1	
Facilities for servicing building		√2	
Metering and monitoring equipment		√5	
Water purification system for swimming pool			√2
Cooling tower			√2
Hotel design			
Hotel environment design			√6
Building design			√16
Workflow design			√14
Garden design			√11
Indoor environmental quality			
Thermal comfort conditions		√3	
Indoor air quality		√4	√5
Interior lighting		√3	
Indoor noise		√3	
Pollution and emissions			
Noise emissions		√1	√4
Ozone layer		√6	
Discharge from boiler			√4

* -- Equal weightings are assigned to different environmental issues.
# -- Prerequisite item that does not carry any score.
The number after "√" represents the maximum number of score attainable for that particular criterion.

Key Issues Covered	GG21* [1]	HBEAS [2]	GH [3]
Safety and Health Management			
Installation of fire protection facilities			√3
Installation of CCTV system			√3
Installation of smoke detection and alarming device			√3
Contingency plan for fire and food safety			√3
Assurance of safety environment			√7
Regular training for staff on fire and food safety			√4
Green guest room			√53
Green restaurant			√56
Biological contamination		√3	
Other issues			
Application of innovative green technology			√2
Community commitment	√		
Involvement in social welfare / environmental protection activities			√5
Receipt of positive comment from public			√3
Special offer to green consumer			√3
Guest satisfaction on hotel environment			√2
High occupancy rate of green guest room			√2
Award from government			√2
Staff training			√3

* -- Equal weightings are assigned to different environmental issues.
# -- Prerequisite item that does not carry any score.
The number after "√" represents the maximum number of score attainable for that particular criterion.

Sources: [1] Green Globe (2007) [2] Hong Kong Hotel Association (HKHA) (2000) [3] Standardization Administration, PRC (2001)

Appendix 3.1
Field Study Protocol

Field Study Protocol

Title of Thesis

Development of an *Environmental Assessment Method for Water Management in Chinese Restaurants*

Objectives and Purposes

Research Objectives:

4. Investigate the current state of water consumption and sewage generation in local Chinese restaurants;
5. Identify potential areas for improvement in conserving water and controlling sewage in Chinese restaurant operations; and
6. Develop an environmental assessment method for water management in Chinese restaurants.

Purpose of Field Study:

To observe and identify characteristics of local design, operation and maintenance practices in local Chinese restaurants in regard to water usage and sewage generation.

Details of Field Study

Date: ____________________
Location: ____________________
Time: ____________________
Staffing: ____________________

In-depth Interviews

Questions for all interviewees:

1. Are there any environmental measures implemented in your restaurant?
2. Who is responsible for controlling water consumption in your restaurant?
3. What are the most water consuming procedures in your restaurant?
4. Are there any instructions for staff regarding water use in your restaurant?
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?
6. Do you have any water saving suggestions to your restaurant?

1

Additional questions For Restaurant Manager

1. Location of restaurant
2. Operating hours
3. Maximum capacity
4. Peak periods
5. Cuisine
6. Chain / Independent operation
7. Central food processing factory
8. No. of employees

Additional question for kitchen staff:

1. Can you describe your usual practice for cold-water thawing?

Observations

Observe major water end-users / water consuming procedures in the studied restaurants, such as:

- cold-water thawing
- washing vegetables and other food ingredients
- dish-washing
- food preparation and cooking procedures
- serving procedures (front-of-the-house)

Equipment and Stationary Checklist

For Briefing

1. Pen
2. Draft Papers
3. Digital Camera
4. Labels
5. Non-slippery Shoes

For Water Flow Meter Logging

1. Pen
2. Data Collection Sheets
3. Non-slippery Shoes

For Field Measurements, Observations and Interviews

1. Pen
2. Data Collection Sheets
3. Drat Papers
4. Digital Camera
5. Non-slippery Shoes

Data Collection Sheet

Date: ______________________________

Time: ______________________________

Restaurant: ______________________________

Data Collected by: ______________________________

Water Flow Meter No.	Readings on Water Flow Meter
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Remarks:

____

____

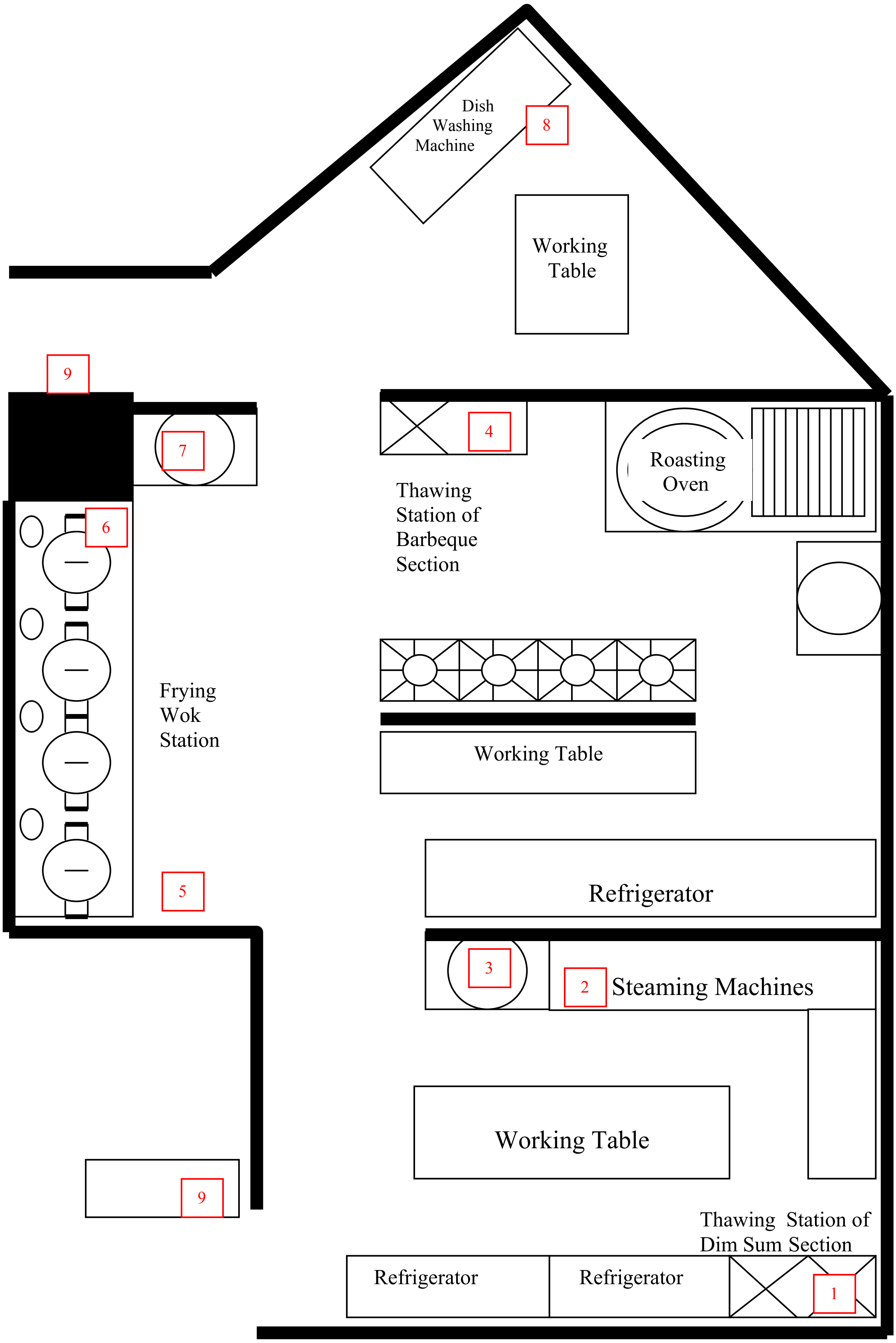
____

____

____

3

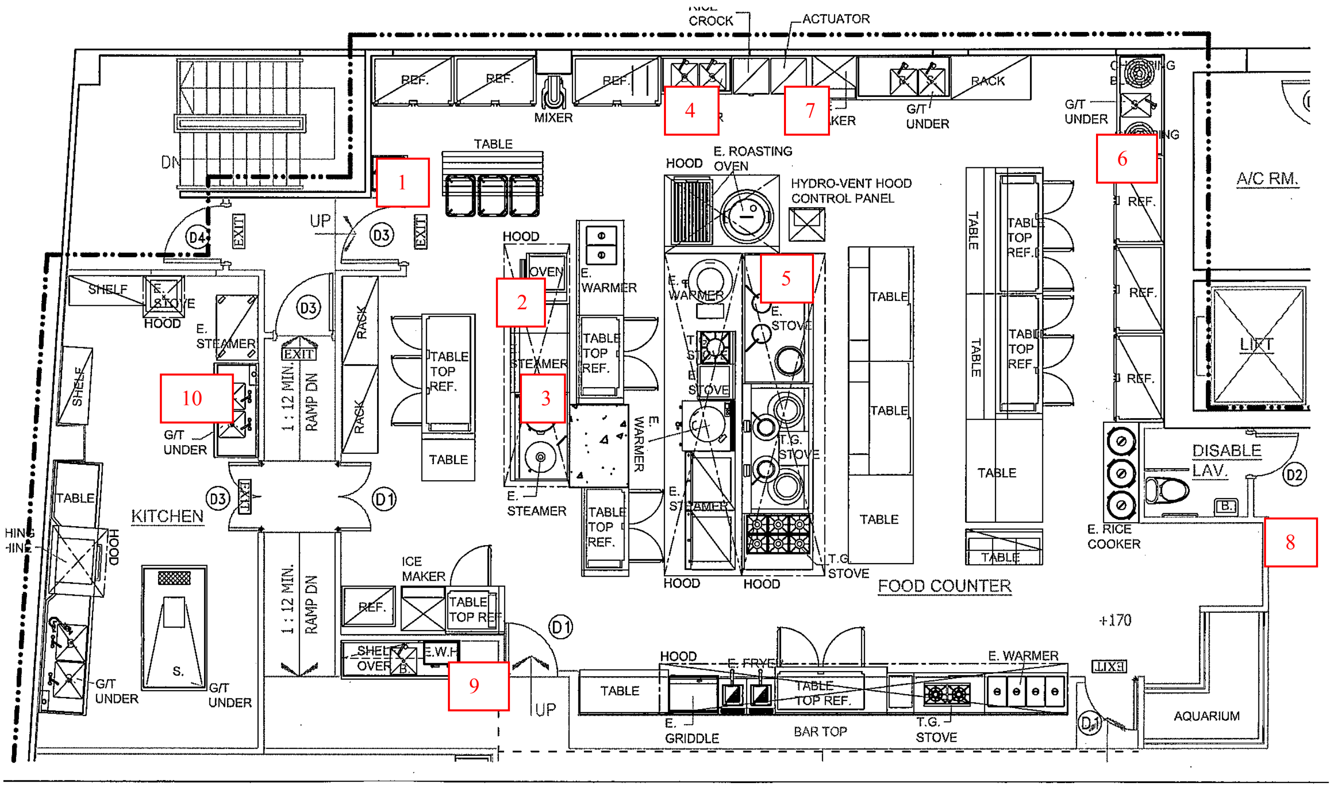
Appendix 3.2
Kitchen Floor Plan and Locations of Water Sub-meter Installation at Restaurant A



	Section	**Location**	**Size of water meter**
1	Dim sum section	Cold-water thawing station	25mm
2	Dim sum section	Steamers	25mm
3	Dim sum section	Sauce making station	25mm
4	Barbeque section	Cold-water thawing station	20mm
5	Main kitchen	Cold-water thawing station	20mm
6	Main kitchen	Hot water supply near frying wok station	25mm
7	Main kitchen	Soup making station	20mm
8	Dish washing section	Dish washing	32mm
9	Front-of-the-house	Hot drinking water machine	20mm
10	Front-of-the-house	Hot drinking water machine	20mm

Total cost of equipment: HK$8,000.00

Appendix 3.3
Kitchen Floor Plan and Locations of Water Sub-meter Installation at Restaurant B



	Section	Location	Size of water meter
1	Dim sum section	Cold-water thawing station	25mm
2	Barbeque section	Cold-water thawing station	20mm
3	Dim sum section	Steamers	25mm
4	Main kitchen	Cold-water thawing station	25mm
5	Main kitchen	Hot water supply near frying wok station	25mm
6	Main kitchen	Water for washing vegetables and other food ingredients	25mm
7	Bar	Ice-making machine	25mm
8	Front-of-the-house	Hot drinking water machine	25mm
9	Front-of-the-house	Hot drinking water machine	25mm
10	Dish washing section	Dish washing	

Total cost of equipment: HK$15,000.00

Appendix 3.4
Sample of Water Sub-meters Log Sheet

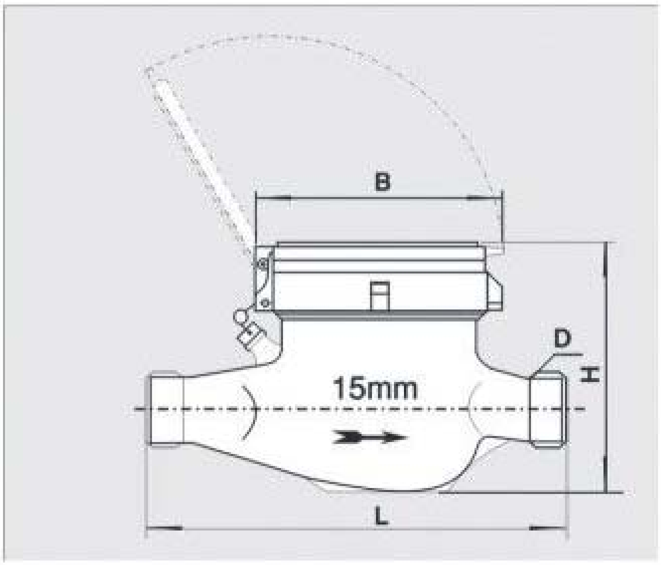
水標 **Water Meter**	日期 **2/4 Date**	**3/4**	**4/4**	**5/4**	**6/4**	**7/4**	**8/4**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

抄錄水錶紀錄時如有任何問題, 請與盧小姐聯絡, 電話 (辦工時間): 34003144

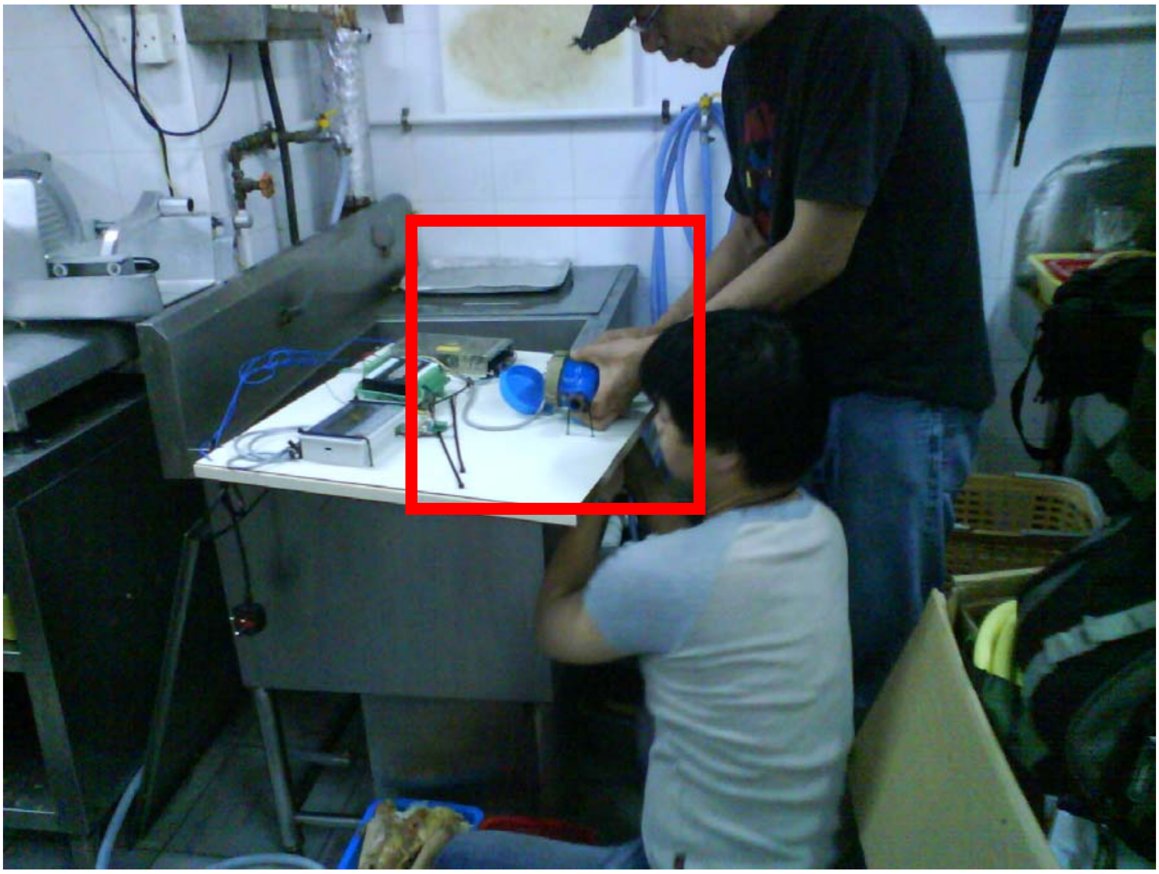
If you encounter any problem in recording the readings on the water meters, please contact Ms Lo on 3400 3144 within office hour.

Appendix 3.5
Specification of Portable Electronic Water Meter

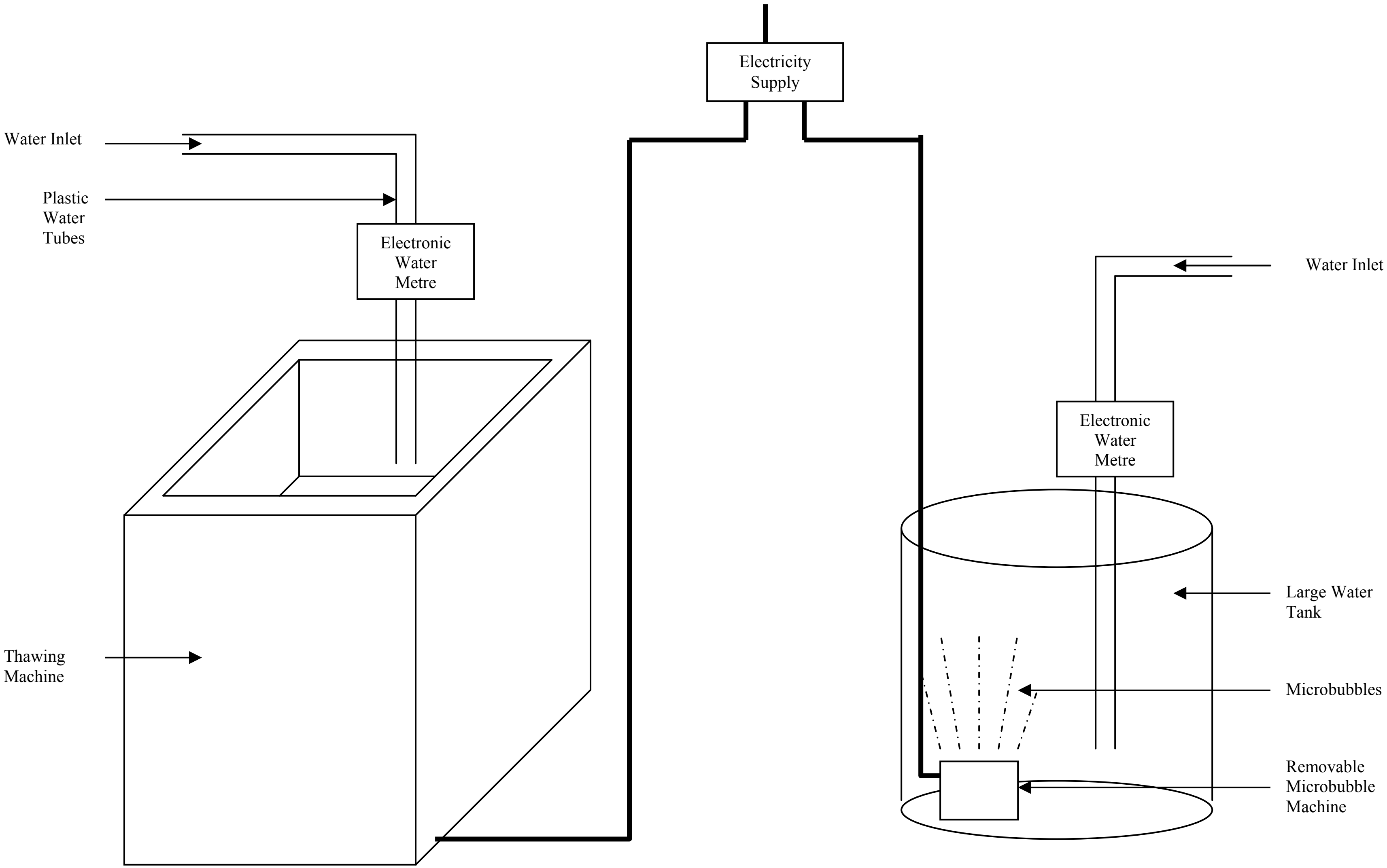
Model No. : LXS15E with pulse output and data reader



Working conditions	
Water temperature:	≤90℃ for hot water meter
Water pressure:	≤1Mpa
Signal:	Square wave at pulse output
Maximum Permissible Error:	a) Minimum zone : Qmin to Qt : ±5% b) Maximum zone : Qt to Qs : ±2% （hot water meter ±3%）


The technicians were installing the water meter for field measurement.

Appendix 3.6: Equipment Set Up for Field Tests in Restaurant C



Appendix 3.7
Transcripts of In-depth Interviews

<u>Interview Questions about water usage</u> (for all interviewees)

1. Are there any environmental measures implemented in your restaurant?
2. Who is responsible for controlling water consumption in your restaurant?
3. What are the most water consuming procedures in your restaurant?
4. Are there any instructions for staff regarding water use in your restaurant?
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?
6. Do you have any water saving suggestions to your restaurant?

<u>Additional questions about thawing</u> (for Kitchen staff only)

1. Can you describe your usual practice for cold-water thawing?

Interviewee 1

Mr Cheung [Case A, Restaurant Manager, 46 years old]

Question	Interviewee's answer
1. Are there any environmental measures implemented in your restaurant? Probing question: What are the measures implemented?	Yes. Recycling of soft drink cans Switch off the lights when they are not in use.
2. Who is responsible for controlling water consumption in your restaurant? Rephrasing: Do you mean no one is assigned to control water use here? Probing question: Will you compare the water bill of your restaurant with other restaurants?	No. Perhaps it is the Restaurant Manager's responsibility to control water consumption. No. We operate this restaurant independently. But may be after the opening of our new branch in Tsim Sha Tsui in mid-2008, we can benchmark with each other.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Washing vegetables. No.
4. Are there any instructions for staff regarding water use in your restaurant?	There is no water use instruction for front-of-the-house staff.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	No. The water consumption is quite stable here.
6. Do you have any water saving suggestions to your restaurant?	I can't think of any suggestion now.

Interviewee 2
Mr Chan [Case A, Head Chef, 50 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. Some of the lights are turned off during the rest time in the afternoon.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef is responsible for controlling water in the kitchen. The Restaurant Manager overlooks and controls water use in the restaurant.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Washing vegetables is the number one water consuming procedure. It may easily cause water wastage. The hot running water near frying wok station also consumes much water.
4. Are there any instructions for staff regarding water use in your restaurant?	Yes. The Head Chef reminds the kitchen staff everyday during morning briefing to reduce unnecessary use of water, electricity and gas; turn off unattended water taps.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	When there are more patrons, usually we use more water.
6. Do you have any water saving suggestions to your restaurant?	Put up some posters to remind the staff to turn off unattended water taps. Water for washing vegetables can be used for cleaning floor.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing? Rephrasing: That means the size of the container varies based on the quantity of food needed. Probing question: Is there any thawing	Thawing is usually done in small quantity, depends on the demand. Therefore usually we use a small container to thaw the food. But when we thaw a large quantity of food commodities, we will use a large container. Yes. No.

machine in your restaurant? Probing question: What kind of food commodities should be thawed? Probing question: How about other food commodities, such as frozen meats?	 Frozen shrimps, prawns and scallops. These food items must be thawed to improve its texture. These items are not thawed by running tap water. Instead, frozen meats are taken out from the freezer the night before, and put it aside at room temperature for thawing.

Interviewee 3
Kin [Case A, Chef, 23 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. We are asked to turn off the water tap which is not in used. The running water taps near stove are turned on only when needed. Some of the lights in the kitchen are switched off during 3:00pm to 6:00pm to save electricity.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and Section Heads.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Washing vegetables and dish washing. Making soups.
4. Are there any instructions for staff regarding water use in your restaurant? Probing question: Could you give me some examples?	Yes. Use running cold-water to thaw foods only when necessary.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	Usually during weekends, we use more water, as there are more customers during weekends.
6. Do you have any water saving suggestions to your restaurant?	No.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing? Probing question: What kinds of food commodities are thawed by cold running water?	The foods are placed in a large container. A plastic tube connecting to the water tap is placed at the bottom of the container. Water is injected from the bottom. The water tap is kept opened until the foods are fully thawed. Frozen shrimps and scallops

Interviewee 4
Wai [Case A, Chef, 27 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. The water for washing vegetables is used for washing the floor.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and Restaurant Manager
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Washing dishes Washing vegetables and other ingredients. Cooking. We need water for making soups, sauces and broths.
4. Are there any instructions for staff regarding water use in your restaurant? Probing question: Could you give me some examples?	Yes. The water for washing vegetables is used for washing the floor.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	The number of customer.
6. Do you have any water saving suggestions to your restaurant?	No. I think so far we have done quite well in controlling water use.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing? Probing question: What is the size of the container?	We put the prawns and scallops into a container. Water is injected from the bottom via a plastic tube connecting to the water tap. It depends. If a large quantity of food stuffs needed to be thawed, we will use a large container. If only a small quantity, of course we will use a small one.

Interviewee 5
Ms Chan [Case A, Dish-washing staff, 52 years old]

1. Are there any environmental measures implemented in your restaurant?	No, I don't know about that.
2. Who is responsible for controlling water consumption in your restaurant?	The Restaurant Manager.
3. What are the most water consuming procedures in your restaurant? Probing question: What is your usual practice of washing dishes?	Washing dishes First of all, the dirty dishes are placed under high pressure spray heads in order to remove the leftovers. Then the dishes are immersed into warm water with detergent. After that, the dishes are washed in water. Usually after this last rinse, the dishes are already quite clean. Finally, we put the dishes into the dish-washing machine for cleaning and sterilization.
4. Are there any instructions for staff regarding water use in your restaurant?	Sorry, I don't know.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	The number of customer. When there are more customers, they needed more bowls, chopsticks and plates. Therefore our workload is usually higher on weekends then weekdays.
6. Do you have any water saving	No.

suggestions to your restaurant?	

Interviewee 6
Mr Lee [Case B, Restaurant Manager, 45 years old]

Question	Interviewee's answer
1. Are there any environmental measures implemented in your restaurant? Probing question: What are the measures implemented?	Yes. Recycling of soft drink cans and beer bottles. Suggest the customers to turn off the hot pot stove when they nearly finish the meal. Switch off the lights when they are not in use.
2. Who is responsible for controlling water consumption in your restaurant? Probing question: Will you compare the water bill of your restaurant with other restaurants?	The Head Chef and all Section Supervisors. Usually this is done by the Head Office. The Head Office collects the operating information from all branches every month, and compares the performances.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Cold-water thawing. Washing food ingredients; The steaming machine in the dim sum section.
4. Are there any instructions for staff regarding water use in your restaurant?	Yes. All unattended water taps must be turned off. Hot water taps near frying wok stoves must also be turned off if they are not in used. Cold water thawing is done only when necessary. The frozen meats are defrosted under room temperature. For hygienic reasons, frozen meats are placed on a tray with a cover. The tray is placed at a well-ventilated place for defrosting over night.

5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	The water consumption is quite stable here. Usually we use more water on weekends than on weekdays.
6. Do you have any water saving suggestions to your restaurant?	I think cold-water thawing procedure is very water consuming. Perhaps we can use other methods to defrost food items. But I am not very familiar with the thawing practice. I suggest you should approach the Head Chef for more details.

Interviewee 7
Mr Ko [Case B, Head Chef, 48 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. There is a policy in our restaurant that food ingredients are thawed only when necessary. Most of the thawing procedures are done in the central food processing factory. The lights in the Dim Sum Section are switched off after 5:00pm.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and Section Supervisors are responsible.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	The two most water-consuming procedures are dish washing and cold-water thawing. Washing vegetables and other food ingredients.
4. Are there any instructions for staff regarding water use in your restaurant?	Yes. As I told you before, we have a policy that cold-water thawing will be conducted only when necessary. Also the unattended water taps must be turned off. Hot running water at the frying wok station must be turned off after peak hours. Water for washing vegetables is used for washing floor.

5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	I can't identify any particular factor. The water consumption here is quite stable.
6. Do you have any water saving suggestions to your restaurant?	No.

C. Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing? Probing question: What are the ingredients thawed in the central food processing factory? Rephrasing: That means nearly all food ingredients are thawed in the factory. Probing question: Is there any thawing machine in your restaurant? Probing question: Is there any thawing machine in the factory? Probing question: How do you or your staff carry out cold-water thawing at the kitchen of your restaurant?	Most of the food ingredients are thawed in the central food processing factory at Fo Tan and Guangzhou. Frozen meats and seafood are thawed in Fo Tan factory. Abalone, sea cucumber, shark's fins and Chinese dim sum items are thawed in Guangzhou factory. Yes. Only a small quantity of scallops, prawns and shrimps are thawed in our restaurant. These three items are thawed here because of hygiene reasons. No. I am not sure. We use traditional cold-water thawing method to thaw the food ingredients. Water is injected from a pipe at the bottom of a large container. The Chef stirs the food stuffs regularly to ensure water flows inside the container. Cold-water thawing is usually done in the afternoon at around 3:00pm to 4:00pm.

Interviewee 8
Ms Wan [Case B, Dish-washing Staff, 43 years old]

1. Are there any environmental	No, I don't know about that.

measures implemented in your restaurant?	
2. Who is responsible for controlling water consumption in your restaurant?	The Restaurant Manager and the Head Chef
3. What are the most water consuming procedures in your restaurant? Probing question: What is your usual practice of washing dishes?	Washing dishes First of all, the leftovers on dirty dishes are removed by hands and high pressure spray heads. In the second rinse, the dishes are immersed into warm water with detergent for a few minutes. After that, the dishes are washed in warm running water. The dishes after the third rinse are put into the dish-washing machine for cleaning and sterilization.
4. Are there any instructions for staff regarding water use in your restaurant?	Turn off the water taps and water showers if they are not in used.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	Sorry, I don't know.
6. Do you have any water saving suggestions to your restaurant?	No. The Restaurant Manager and Head Chef know how to save water.

Interviewee 9
Han [Case B, Chef, 38 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. Water for the third rinse of vegetables is reused. Detergent is added to the water for washing the floor. However, water from the first two rinses is quite dirty and may contain chemicals. It is not suitable to reuse for cleaning purpose.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef
3. What are the most water consuming	Washing vegetables

procedures in your restaurant? Probing question: Approximately how much water is used for washing vegetables daily?	 We use this kind of container (78.632L) to wash vegetables. Usually 4 containers are needed everyday, and totally three rinses are needed.
4. Are there any instructions for staff regarding water use in your restaurant?	Yes. Most of the procedures in the kitchen are standardized. For example, vegetables are washed for three times. Water from the last rinse is used for cleaning the floor. Cold-water thawing is kept at minimum. We all follow the standard procedures set by the company.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	The number of customer will affect water consumption probably. The choice of food items may also affect water consumption. For example, the dim sum items require less water in the preparation and cooking process. But the vegetables for hot pot require much water for washing.
6. Do you have any water saving suggestions to your restaurant?	No. We only use water when necessary. The Head Chef always reminds us to save water, electricity and gas.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing?	I am not familiar with cold-water thawing. My duty is washing and trimming vegetables.

Interviewee 10
Mr Choi [Case B, Head Chef, 48 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. The soft drink cans and beer bottles are recycled. Some of the lights in the kitchen and restaurant are turned off during the rest

	hour (5:00pm to 6:00pm).
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and Section Supervisors.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Probably washing dishes. Washing vegetables and other food ingredients, such as seafood and frozen meats.
4. Are there any instructions for staff regarding water use in your restaurant?	There is a company policy that cold-water thawing procedure is conducted only when necessary. Also the unattended water taps must be turned off. Hot running water at the frying wok station must be turned off after peak hours.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	I am not sure, as I have been working in this restaurant for only 1 month.
6. Do you have any water saving suggestions to your restaurant?	No.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing? Probing question: As the previous Head Chef told me, frozen meats and seafood are thawed in Fo Tan factory, while the sea cucumber, abalone and shark's fins are thawed in Guangzhou factory. Is that true? Probing question: Is there any thawing machine in the factory?	Most of the food ingredients are thawed in the central food processing factories. One of them is loacted at Fo Tan, while the other one at Guangzhou. Yes, exactly. Only a small quantity of scallops, prawns and shrimps are thawed in our restaurant. I am not sure.

Interviewee 11
Ms Au Yeung [Case B, Senior Captain, 40 years old]

1. Are there any environmental measures implemented in your restaurant?	Yes. The soft drink cans and beer bottles are separated from other garbage and recycled. During the rest period (5:00pm to 6:00pm), some of the lights in the front of house area are switched off to save energy.
2. Who is responsible for controlling water consumption in your restaurant?	The Restaurant Manager and the Head Chef.
3. What are the most water consuming procedures in your restaurant?	I guess the dish washing section consumes most of the water.
4. Are there any instructions for staff regarding water use in your restaurant?	There is no instruction in the front of house regarding water use.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	Sorry, I don't know.
6. Do you have any water saving suggestions to your restaurant?	When the customers nearly finish their hot pot dinner, we can help them to turn off the stove, and stop refilling hot water to the pot. In fact, the front of house area does not consume much water.

Interviewee 12
Shing [Case C, Junior Chef, 22 years old]

1. Are there any environmental measures implemented in your restaurant?	I am not very sure about this, as I have worked in this company for only a few months.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and Section Heads.
3. What are the most water consuming procedures in your restaurant?	The three most water-consuming procedures are dish washing, cold-water thawing and washing vegetables.

Probing question: Can you identify any other water consuming procedures in your restaurant?	Washing other food ingredients.
4. Are there any instructions for staff regarding water use in your restaurant? Probing question: But if they are not around you, then…	Not sure. When the Head Chef or Section Heads are near, I will use less water. I will use water just as usual.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	Usually we use more water to wash food ingredients on Fridays, Saturdays and Sundays.
6. Do you have any water saving suggestions to your restaurant?	No.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing?	Yes. I worked in the cold-water thawing and chopping section. This is my work area. When I received order from supervisor, I will defrost the frozen food ingredients by water. For large quantity of food stuff, the thawing machine is used. The thawing machine is particularly suitable for thawing chicken feet, ribs, chicken wings. On the other hand, some food stuffs cannot be thawed by the thawing machine, because the circular motion of the water in thawing machine may break the food stuffs. Therefore, food stuffs such as crab's meat, shrimps and scallops are thawed by running tap water in small water tanks.
Probing question: The tap is kept opened during thawing?	Yes. Until the food is thawed completely.
Probing question: How can you treat the water in the tanks after cold-water thawing?	Usually we just discharge the water.
Probing question: Why not reusing the	Water for thawing meats cannot be

water?	reused, as it is greasy.

Interviewee 13
Chung [Case C, Barbeque Section Head, 46 years old]

1. Are there any environmental measures implemented in your restaurant?	We have installed three thawing machines in the kitchen. These machines can save water and time for cold-water thawing.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef.
3. What are the most water consuming procedures in your restaurant? Probing question: Can you identify any other water consuming procedures in your restaurant?	Dish washing, cold-water thawing and washing vegetables. No.
4. Are there any instructions for staff regarding water use in your restaurant?	No sure. We do not have very clear instructions on water use.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	I guess the number of patrons is the prime factor. It is because when there is more patrons, we have to wash/thaw more food stuffs, and the dishwashing section is busier.
6. Do you have any water saving suggestions to your restaurant?	I think some of the food ingredients need not to be thawed by water. Instead, we can put them in room temperature to defrost, may be the night before. But usually we forget to do so. When we need some ingredients immediately, cold-water thawing is the only option that we can do to defrost.

Additional question for kitchen staff

Question	Interviewee's answer
1. Can you describe your usual practice for cold-water thawing?	Yes. In this restaurant, there are 3 thawing machines installed. This is the thawing machine of the barbeque section.

	The meats for barbeque are frozen when they are delivered to the kitchen. So, everyday, I decide the quantity of meats to be defrosted, and my colleagues put the meats into the thawing machine. By using the thawing machine, we can at least save half of the time and water used for cold-water thawing.

Interviewee 14
Wah [Case C, Engineer, 45 years old]

1. Are there any environmental measures implemented in your restaurant?	We have invested over HK100,000 to install 3 three thawing machines and a dish-washing machine that the water of the last rinse is recycled. The water bills, gas bills and electricity bills are kept at our head office for record. Utility costs of different outlets are compared periodically.
2. Who is responsible for controlling water consumption in your restaurant?	The Head Chef and the Section Heads control water consumption in the kitchen, while the Restaurant Manager and I overlook the water consumption in the whole restaurant, both front- and back-of the house.
3. What are the most water consuming procedures in your restaurant?	Washing food ingredients and washing dishes.
4. Are there any instructions for staff regarding water use in your restaurant?	To be honest, we have no clear instructions regarding water use. But the Head Chef and Section Heads will keep reminding the staffs not to waste water.
5. According to your experience, what is the prime factor affecting water consumption in your restaurant?	The number of patrons definitely. Usually there is a “baseload” of water consumption in every restaurant. This refers to the basic water consumption when there is even no patron. Above

	the baseload, water consumption increases as number of patrons increases according to my experience.
6. Do you have any water saving suggestions to your restaurant?	May be we can ask our staff to give some suggestions on water conservation in our operation.

Rearranged answers of interviewees:

1. Are there any environmental measures implemented in your restaurant?
   - Yes. Recycling of soft drink cans. Switch off the lights when they are not in use.
   - Yes. Some of the lights are turned off during the rest time in the afternoon.
   - Yes. We are asked to turn off the water tap which is not in used. The running water taps near stove are turned on only when needed. Some of the lights in the kitchen are switched off during 3:00pm to 6:00pm to save electricity.
   - Yes. The water for washing vegetables is used for washing the floor.
   - No, I don't know about that.
   - Yes. Recycling of soft drink cans and beer bottles. Suggest the customers to turn off the hot pot stove when they nearly finish the meal. Switch off the lights when they are not in use.
   - Yes. There is a policy in our restaurant that food ingredients are thawed only when necessary. Most of the thawing procedures are done in the central food processing factory. The lights in the Dim Sum Section are switched off after 5:00pm.
   - No, I don't know about that.
   - Yes. Water for the third rinse of vegetables is reused. Detergent is added to the water for washing the floor. However, water from the first two rinses is quite dirty and may contain chemicals. It is not suitable to reuse for cleaning purpose.
   - Yes. The soft drink cans and beer bottles are recycled. Some of the lights in the kitchen and restaurant are turned off during the rest hour (5:00pm to 6:00pm).
   - Yes. The soft drink cans and beer bottles are separated from other garbage and recycled. During the rest period (5:00pm to 6:00pm), some of the lights in the front of house area are switched off to save energy.
   - I am not very sure about this, as I have worked in this company for only a few months.
   - We have installed three thawing machines in the kitchen. These machines can save water and time for cold-water thawing.
   - We have invested over HK100,000 to install 3 three thawing machines and a dish-washing machine that the water of the last rinse is recycled. The water bills, gas bills and electricity bills are kept at our head office for record. Utility costs of different outlets are compared periodically.

2. Who is responsible for controlling water consumption in your restaurant?
- No. Perhaps it is the Restaurant Manager's responsibility to control water consumption. [Will you compare the water bill of your restaurant with other restaurants?] No. We operate this restaurant independently. But may be after the opening of our new branch in Tsim Sha Tsui in mid-2008, we can benchmark with each other.
- The Head Chef is responsible for controlling water in the kitchen. The Restaurant Manager overlooks and controls water use in the restaurant.
- The Head Chef and Section Heads.
- The Head Chef and Restaurant Manager.
- The Restaurant Manager.
- The Head Chef and all Section Supervisors. Usually this is done by the Head Office. The Head Office collects the operating information from all branches every month, and compares the performances.
- The Head Chef and Section Supervisors are responsible.
- The Restaurant Manager and the Head Chef.
- The Head Chef
- The Head Chef and Section Supervisors.
- The Restaurant Manager and the Head Chef.
- The Head Chef and Section Heads.
- The Head Chef is responsible.
- The Head Chef and the Section Heads control water consumption in the kitchen, while the Restaurant Manager and I (engineer) overlook the water consumption in the whole restaurant, both front- and back-of the house.

3. What are the most water consuming procedures in your restaurant?
- Washing vegetables.
- Washing vegetables is the number one water consuming procedure. It may easily cause water wastage. The hot running water near frying wok station also consumes much water.
- Washing vegetables and dish washing. Making soups.
- Washing dishes. Washing vegetables and other ingredients. Cooking. We need water for making soups, sauces and broths.
- Washing dishes. (What are the most water consuming procedures in your restaurant) First of all, the dirty dishes are placed under high pressure spray heads in order to remove the leftovers. Then the dishes are immersed into warm water with detergent. After that, the dishes are washed in water. Usually after this last rinse, the dishes are already quite clean. Finally, we put the dishes into the dish-washing machine for cleaning and sterilization.
- Cold-water thawing. Washing food ingredients; The steaming machine in the dim sum section.
- The two most water-consuming procedures are dish washing and cold-water thawing. Washing vegetables and other food ingredients.
- Washing dishes. (What is your usual practice of washing dishes?) First of all, the leftovers on dirty dishes are removed by hands and high pressure showers. In the second rinse, the dishes are immersed into warm water with detergent for a few minutes. After that, the dishes are washed in warm running water. The dishes after the third rinse are put into the dish-washing machine for cleaning and sterilization.

- Washing vegetables. We use this kind of container (78.632L) to wash vegetables. Usually 4 containers are needed everyday, and totally three rinses are needed.
- Probably washing dishes. Washing vegetables and other food ingredients, such as seafood and frozen meats.
- I guess the dish washing section consumes most of the water.
- The three most water-consuming procedures are dish washing, cold-water thawing and washing vegetables. Washing other food ingredients.
- Dish washing, cold-water thawing and washing vegetables.
- Washing food ingredients and washing dishes.

4. Are there any instructions for staff regarding water use in your restaurant?
- There is no water use instruction for front-of-the-house staff.
- Yes. The Head Chef reminds the kitchen staff everyday during morning briefing to reduce unnecessary use of water, electricity and gas; turn off unattended water taps.
- Yes. Use running cold-water to thaw foods only when necessary.
- Yes. The water for washing vegetables is used for washing the floor.
- Sorry, I don't know.
- Yes. All unattended water taps must be turned off. Hot water taps near frying wok stoves must also be turned off if they are not in used. Cold water thawing is done only when necessary. The frozen meats are defrosted under room temperature. For hygienic reasons, frozen meats are placed on a tray with a cover. The tray is placed at a well-ventilated place for defrosting over night.
- Yes. As I told you before, we have a policy that cold-water thawing will be conducted only when necessary. Also the unattended water taps must be turned off. Hot running water at the frying wok station must be turned off after peak hours. Water for washing vegetables is used for washing floor.
- Turn off the water taps and water spray heads if they are not in used.
- Yes. Most of the procedures in the kitchen are standardized. For example, vegetables are washed for three times. Water from the last rinse is used for cleaning the floor. Cold-water thawing is kept at minimum. We all follow the standard procedures set by the company.
- There is a company policy that cold-water thawing procedure is conducted only when necessary. Also the unattended water taps must be turned off. Hot running water at the frying wok station must be turned off after peak hours.
- There is no instruction in the front of house regarding water use.
- No sure. When the Head Chef or Section Heads are near, I will use less water. (But if they are not around you, then…) I will use water just as usual.
- Not sure. We do not have very clear instructions on water use.
- To be honest, we have no clear instructions regarding water use. But the Head Chef and Section Heads will keep reminding the staffs not to waste water.

5. According to your experience, what is the prime factor affecting water consumption in your restaurant?
- No. The water consumption is quite stable here.
- When there are more patrons, usually we use more water.

- Usually during weekends, we use more water, as there are more customers during weekends.
- The number of customer.
- The number of customer. When there are more customers, they needed more bowls, chopsticks and plates. Therefore our workload is usually higher on weekends then weekdays.
- The water consumption is quite stable here. Usually we use more water on weekends than on weekdays.
- I can't identify any particular factor. The water consumption here is quite stable.
- Sorry, I don't know.
- The number of customer will affect water consumption probably. The choice of food items may also affect water consumption. For example, the dim sum items require less water in the preparation and cooking process. But the vegetables for hot pot require much water for washing.
- I am not sure, as I have been working in this restaurant for only 1 month.
- Sorry, I don't know.
- Usually we use more water to wash food ingredients on Fridays, Saturdays and Sundays.
- I guess the number of patrons is the prime factor. It is because when there is more patrons, we have to wash/thaw more food stuffs, and the dishwashing section is busier.
- The number of patrons definitely. Usually there is a "baseload" of water consumption in every restaurant. This refers to the basic water consumption when there is even no patron. Above the baseload, water consumption increases as number of patrons increases according to my experience.

6. Do you have any water saving suggestions to your restaurant?
   - I can't think of any suggestion now.
   - Put up some posters to remind the staff to turn off unattended water taps. Water for washing vegetables can be used for cleaning floor.
   - No.
   - No. I think so far we have done quite well in controlling water use.
   - No.
   - No.
   - I think cold-water thawing procedure is very water consuming. Perhaps we can use other methods to defrost food items. But I am not very familiar with the thawing practice. I suggest you should approach the Head Chef for more details.
   - No. The Restaurant Manager and Head Chef know how to save water.
   - No. We only use water when necessary. The Head Chef always reminds us to save water, electricity and gas.
   - No.
   - When the customers nearly finish their hot pot dinner, we can help them to turn off the stove, and stop refilling hot water to the pot. In fact, the front of house area does not consume much water.
   - No.
   - I think some of the food ingredients need not to be thawed by water. Instead, we can put them in room temperature to defrost, may be the night before. But

usually we forget to do so. When we need some ingredients immediately, cold-water thawing is the only option that we can do to defrost.
- May be we can ask our staff to give some suggestions on water conservation in our operation.

Addition question (for kitchen staff only):
Can you describe your usual practice for cold-water thawing?
- Thawing is usually done in small quantity, depends on the demand. Therefore usually we use a small container to thaw the food. But when we thaw a large quantity of food commodities, we will use a large container. That means the size of the container varies based on the quantity of food needed. (Is there any thawing machine in your restaurant?) No. (What kind of food commodities should be thawed?) Frozen shrimps, prawns and scallops. These food items must be thawed to improve its texture. (How about other food commodities, such as frozen meats?) These items are not thawed by running tap water. Instead, frozen meats are taken out from the freezer the night before, and put it aside at room temperature for thawing.
- The foods are placed in a large container. A plastic tube connecting to the water tap is placed at the bottom of the container. Water is injected from the bottom. The water tap is kept opened until the foods are fully thawed. (What kinds of food commodities are thawed by cold running water?) Frozen shrimps and scallops.
- We put the prawns and scallops into a container. Water is injected from the bottom via a plastic tube connecting to the water tap. (What is the size of the container?) It depends. If a large quantity of food stuffs needed to be thawed, we will use a large container. If only a small quantity, of course we will use a small one.
- Most of the food ingredients are thawed in the central food processing factory at Fo Tan and Guangzhou. (What are the ingredients thawed in the central food processing factory?) Frozen meats and seafood are thawed in Fo Tan factory. Abalone, sea cucumber, shark's fins and Chinese dim sum items are thawed in Guangzhou factory. (That means nearly all food ingredients are thawed in the factory.) Yes. Only a small quantity of scallops, prawns and shrimps are thawed in our restaurant. These three items are thawed here because of hygiene reasons. (Is there any thawing machine in your restaurant?) No. (Is there any thawing machine in the factory?) I am not sure. (How do you or your staff carry out cold-water thawing at the kitchen of your restaurant?) We use traditional cold-water thawing method to thaw the food ingredients. Water is injected from a pipe at the bottom of a large container. The Chef stirs the food stuffs regularly to ensure water flows inside the container. Cold-water thawing is usually done in the afternoon at around 3:00pm to 4:00pm.
- I am not familiar with cold-water thawing. My duty is washing and trimming vegetables.
- Most of the food ingredients are thawed in the central food processing factories. One of them is loacted at Fo Tan, while the other one at Guangzhou. Only a small quantity of scallops, prawns and shrimps are thawed in our restaurant. (Is there any thawing machine in the factory?) I am not sure.

- Yes. I worked in the cold-water thawing and chopping section. This is my work area. When I received order from supervisor, I will defrost the frozen food ingredients by water. For large quantity of food stuff, the thawing machine is used. The thawing machine is particularly suitable for thawing chicken feet, ribs, chicken wings. On the other hand, some food stuffs cannot be thawed by the thawing machine, because the circular motion of the water in thawing machine may break the food stuffs. Therefore, food stuffs such as crab's meat, shrimps and scallops are thawed by running tap water in small water tanks. (The tap is kept opened during thawing?) Yes. Until the food is thawed completely. (How can you treat the water in the tanks after cold-water thawing?) Usually we just discharge the water. (Why not reusing the water?) Water for thawing meats cannot be reused, as it is greasy.
- Yes. In this restaurant, there are 3 thawing machines installed. This is the thawing machine of the barbeque section. The meats for barbeque are frozen when they are delivered to the kitchen. So, everyday, I decide the quantity of meats to be defrosted, and my colleagues put the meats into the thawing machine. By using the thawing machine, we can at least save half of the time and water used for cold-water thawing.

Appendix 3.8
Cross-case Comparison of Observation and Interview Transcripts

	Case A	Case B	Case C
Water Saving Measures Implemented	Install dish-washing machine Water for washing vegetables is reused for washing floor Turn off water taps that are not in use	Install dish-washing machine Water for washing vegetables is reused for washing floor Use water to thaw food ingredients only when necessary	Install dish-washing machine Install thawing machine
Other Eco-Friendly Measures Implemented	Recycle aluminium cans Switch off lights that are not in use	Recycle aluminium cans Switch off lights that are not in use Suggest customers to turn off hot pot stove when they nearly finish their meal	Utilities bills of different outlets are kept for comparison regularly
Person In-charge of Water Saving in Premise	Restaurant Manager Head Chef Section Heads	Restaurant Manager Head Chef Section Supervisors Head Office	Restaurant Manager Head Chef Section Heads Engineer
Most Water-consuming Procedure	Washing vegetables and other food ingredients Washing dishes Hot running water near frying wok station Cooking	Washing vegetables and other food ingredients Washing dishes Cold water thawing Cooking	Washing vegetables and other food ingredients Washing dishes Cold-water thawing
Water-saving Instructions for Kitchen Staff	Turn off unattended water taps and sprays Thaw frozen food ingredients by cold water only when	Turn off unattended water taps and sprays Thaw frozen food ingredients by cold water only when	Nil

	necessary Water for washing vegetables is reused for washing the floor	necessary Water for washing vegetables is reused for washing floor Hot running water taps near frying wok stoves must be turned off when they are not in use Kitchen staffs must follow standardized procedures	
Water-saving Instructions for Front-of-the-house Staff	Nil	Nil	Nil
Factors Affecting Water Consumption	No. of patrons Weekend	No. of patrons Weekend Choice of menu items	No. of patrons Weekend
Water-saving Suggestions	Posters can be put up to remind staff on water conservation Water for washing vegetables can be reused for washing floor	More eco-friendly methods can be employed to defrost food ingredients Stop refilling hot water to the pot when the customers nearly finish their hot pot dinner	More eco-friendly methods can be employed to defrost food ingredients Invite staff to give more suggestions on water-saving

Appendix 3.9
Data Collection Form for Water Consumption Survey

＜中式食肆用水量研究＞
<Survey on Water Consumption in Chinese Restaurant>

1. 食肆資料 (* -- 請刪除不適合者)
Restaurant Information (* -- Please delete the inappropriate choices)

地區 Location:	* HK / KLN / NT *香港 / 九龍 / 新界	
面積 GFA:	(樓面 Front-of-house area) 平方米 square meter	(廚房 Kitchen) 平方米 square meter

2. 用水量數據
Water Consumption Data

請提供過去 12 個月 貴酒樓的水費資料:
Please provide the water consumption data of the past 12 months.

	2007 年						2008 年					
月份	7 月	8 月	9 月	10 月	11 月	12 月	1 月	2 月	3 月	4 月	5 月	6 月
用水量 (立方米)												
水費($)												

請提供過去 12 個月 貴酒樓的電費資料:

	2007 年						2008 年					
月份	7 月	8 月	9 月	10 月	11 月	12 月	1 月	2 月	3 月	4 月	5 月	6 月
用電量 (kWh)												
電費($)												

請提供過去 12 個月 貴酒樓的煤氣費資料:

	2007 年						2008 年					
月份	7 月	8 月	9 月	10 月	11 月	12 月	1 月	2 月	3 月	4 月	5 月	6 月
煤氣量 (度)												
煤氣費 ($)												

三. 營運資料 (* -- 請刪除不適合者)

請提供過去 12 個月 貴酒樓的營運資料:

	2007 年						2008 年					
月份	7 月	8 月	9 月	10 月	11 月	12 月	1 月	2 月	3 月	4 月	5 月	6 月
顧客量 (人次)												

營運模式	*集團經營 / 獨立經營
	*中央廚房 / 獨立廚房
營運時間	開市時間: 收市時間:

貴酒樓有否使用下列儀器?

☐ 啤水機 ☐ 魚缸 ☐ 洗碗機

貴酒樓有否設立任何形式的節能減廢或環保方案?

☐ 有 ☐ 沒有

貴酒樓有否提供火鍋菜式?

☐ 有 ☐ 沒有

Appendix 4.1
Containers for Washing Vegetables and Other Food Ingredients in Restaurant B

Appendix 4.2
Hot Water Supply at Frying Wok Station
(in red square)

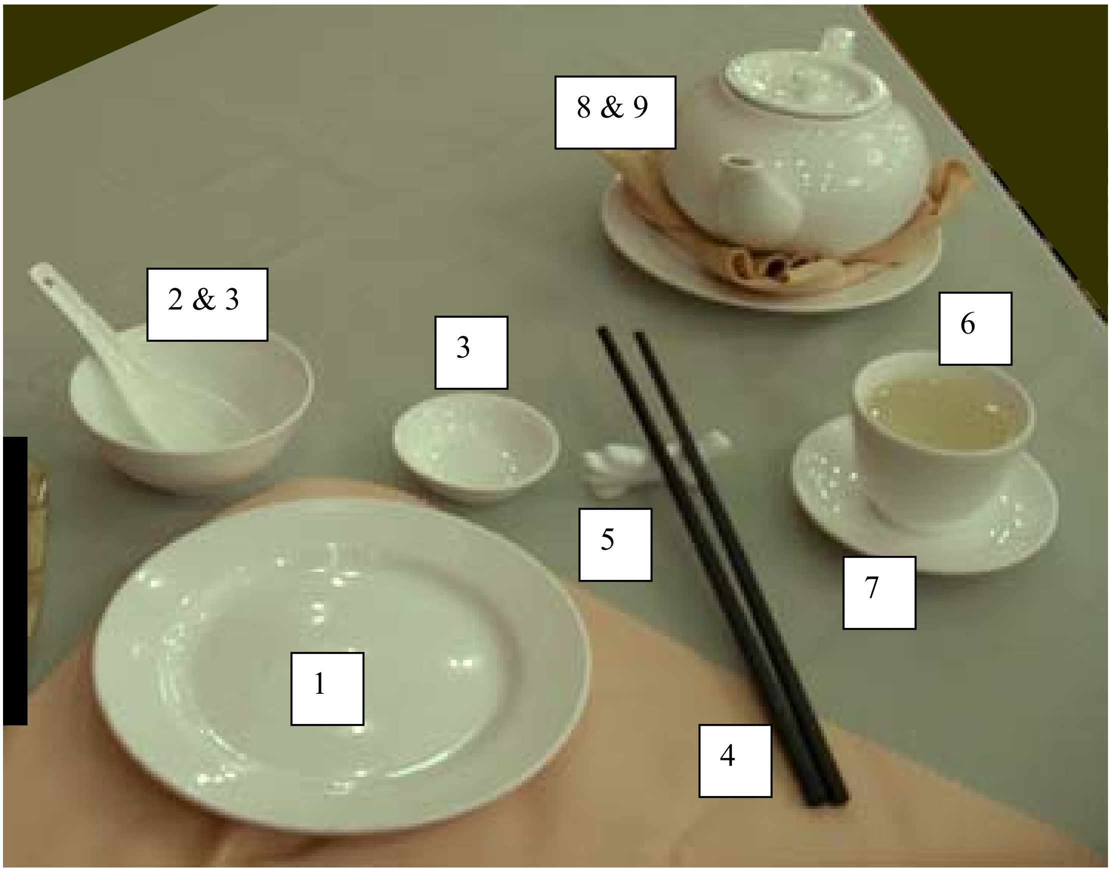
Appendix 4.3
Commercial Steamer used by the Studied Restaurants

Appendix 4.4
Dishwashing Section in Restaurant B

← High pressure spray heads and warm water with detergent.

← Dishwasher, which was used for the last rinse of tableware.

Appendix 4.5:
Standard Table Setting in Studied Restaurants



1. Plate
2. Bowl
3. Spoon
4. Chopsticks
5. Chopsticks holder
6. Tea cup
7. Underplate for tea cup
8. Tea pot
9. Underplate for tea pot

Appendix 6.1
Initial Set of Assessment Criteria for Water Management in Chinese Restaurants

Assessment Criteria	Attainable Score
Overall Water Use Policy and Training	
1. Possessing an overall water conservation policy and an action plan for the restaurant.	1
2. Assigning a managerial staff to monitor water use, and evaluate water conservation opportunities and effectiveness.	1
3. Determining water requirements (quantity and purpose of water being used) for each functional zone.	1
4. Undertaking an ongoing water audit of the restaurant, or carried out a water audit within the previous 12 months.	1
5. Installing adequate meters allowing measurement of water used by major functional zones in the restaurant.	1
6. Reducing water pressure to the minimum practical level.	1
7. Carrying out regular leakage test on concealed piping, and recording maintenance activities in a log book.	1
8. Turning off all water systems at night.	1
9. Providing suitable trainings to staff to make sure they know about the importance of water conservation, and how to practice water conservation in the workplace.	1
10. Using innovative methods to raise staff awareness in water conservation.	1
11. Seeking suggestions from employees and customers on water conservation.	1
12. Setting up a mechanism for reporting leaking tap/pipe to the restaurant's Engineering Department or Chief Engineer.	1
Fish Tanks	
1. Participating in the "Quality Seawater Assurance Scheme" and is accredited as a "Quality Seawater Logo" holder by the Hong Kong Productivity Council.	1
2. Adjusting the temperature and pH value of water for different aquatic species in fish tanks.	1
3. Applying new technologies or innovative methods (e.g. ozone filter) to sanitize water in fish tanks more effectively.	1
Kitchen	
1. Using kitchen paper, instead of hot water, to clean woks	1

at frying wok station.

Dishwashing and Cleaning	
1. Removing all food residues on used utensils and cookware manually and dispose of as solid waste before washing.	1
2. Handling the grease from pots, pans, grills and deep-fryers separately and keep out of the drains.	1
3. Installing sieves on floor drains to prevent the release of food residuals to the sewer.	1
4. Developing a cleaning schedule for grease trap and removing the residual from grease trap regularly.	1
5. Using efficient detergent which contains at least 15% of surface active agent and low phosphorus concentration.	1
6. Providing guidelines to cleaning staff about the appropriate procedures of using bleach.	1
Water Use Index	
1. For Chinese restaurants providing banquet services:	
- WUI_{CR} between 0.96 and 1.32 (1st to 2nd quartile)	1
- WUI_{CR} below 0.96 (1st quartile)	2
2. For Chinese restaurants not providing banquet services:	
- WUI_{CR} between 0.80 and 1.26 (1st to 2nd quartile)	1
- WUI_{CR} below 0.80 (1st quartile)	2
Water Flow Control Devices and Technologies	
1. Using water flow control devices (such as flow regulator, aerator, automatic shut-off spray nozzles and pedal-activated hand sinks) at the water taps in the kitchen and bar areas.	Maximum score: 2 (1 score for each kind of device installed)
2. Using water flow control devices in faucets (such as aerators, electronic sensors and automatic shut-off spray nozzles) in guests’ toilet.	Maximum score: 2 (1 score for each kind of device installed)
3. Adopting new technology, or reuse water, to reduce overall water consumption.	Maximum score: 3 (1 score for each kind of new technology or water reuse)

Appendix 6.2

Chinese Version of *Environmental Assessment Method for Water Management in Chinese Restaurants*

中式酒樓用水管理評核

部份	得分要求	可得分數
甲	整體節約用水及培訓	**18**
i	為酒樓制定節約用水政策及相關行動計劃。	1
ii	部門主管負責監控該部門之用水量, 並評估各項節約用水的方法及其效益。	1
iii	測定每個部門的用水要求, 包括用水量及用水目的。	1
iv	進行前進式的用水審計, 或於過去 12 個月內曾經進行用水審計。	1
v	安裝適量的水標於不同的部門, 以便監控各部門用水量。	1
vi	採用嶄新的方法, 或循環用水, 以減少耗水量。	3
vii	- 有提供酒席服務的酒樓：用水量指數介乎 0.96 至 1.32。 - 沒有提供酒席服務的酒樓：用水量指數介乎 0.80 至 1.26。	1
	- 有提供酒席服務的酒樓：用水量指數低於 0.96。 - 沒有提供酒席服務的酒樓：用水量指數低於 0.80。	2
viii	將水壓減至最低可用程度。	1
ix	定期檢查及測試水管, 並存好維修保養紀錄。	1
x	每晚關上所有水系統。	1
xi	為員工提供適當的培訓, 解釋節約用水的重要性, 以及如何在工作間進行節約用水。	1
xii	用創新的方法提高員工節約用水的意識。	1

xiii	邀請員工及客人就節約用水提出意見。	1
xiv	建立機制 , 向工程部報告水管/水龍頭滲漏 。	1
xv	協助學術研究，提供資金或借出地方作實地量度。	1
乙	用水量	**10**
1	廚房及水吧	**5.1**
1.1	整體用水	
i	在廚房半數的水龍頭加上節流裝置 (如節流器, 加氣裝置, 自動關水系統, 或腳踏控制水喉開關) 。	2
1.2	啤水及洗菜	
i	應用環保水解凍法解凍食物，或安裝啤水機／微泡機。	1
ii	以水槽盛載清水以作洗菜之用, 不要開著水喉長時間沖洗。	1
iii	將食物放於雪櫃內解凍。	1
iv	將洗菜水循環使用。	1
1.3	煮食	
i	使用高效能蒸爐, 替代傳統蒸爐。	1
ii	避免食水因盛載器皿裝滿而溢出。	1
iii	使用自動洗米機。	1
1.4	水吧及製冰	
i	每晚收市後, 將用剩的冰塊放在水槽中, 讓冰塊自然溶化。	1
ii	調較製冰機, 以免製造過多冰塊。	1
iii.	用壓茶渣器, 把剩餘的茶從茶包壓出來。	1
2	**樓面**	**0.1**
2.1	餐樓	

i	在餐桌上放置告示, 鼓勵客人珍惜食水。	1
ii	客人提出要求時才為他們斟水/加水。	1
2.2 i	客人洗手間 在廁所的水龍頭加上節流裝置 (如加氣裝置, 電子感應器, 或自動節流閥) 。	2
3	**洗碗碟及清潔**	**4.8**
i	清洗前, 先把碗碟和用具浸泡在溫水中。	1
ii	將最後一次過水時用的水留下來, 用作清洗碗碟或其他用途。	1
iii	在洗碗房的水龍頭加上節流裝置 (如節流閥) 或高壓花灑。	1
iv	碗碟放滿整個洗碗碟機才進行清洗。	1
v	使用對流方式清洗碗碟。	1
vi	沒有碗碟需要洗潔時, 將洗碗碟機關上。	1
vii	於收市後, 將廚房恆溫儀器 (如汁罉, 熱水罉, 湯罉及蒸爐) 內剩餘的溫水用作清潔用途。	1
viii	用水清潔前, 先用乾洗法 (如使用掃把, 橡膠清潔器或海棉) 。	1
丙	水質管理	**10**
1	**魚缸**	**3**
i	參加由生產力促進局舉辦之 "優質海水計劃", 並獲認可為 "優質海水標誌商戶" 。	1
ii	調較魚缸的溫度及酸鹼度, 以配合不同海鮮品種的需要。	1
iii	採用嶄新科技或方法, 更有效地消毒魚缸內的水, 如加裝臭氧濾水器或微泡製造機等。	1
2	**廚房及水吧**	**1**

	i	減少用尾鑊熱水清洗炒鑊, 改用廚房吸油紙抹淨。	1
3		**洗碗碟及清潔**	**6**
	i	清洗碗碟及用具前, 先用手將固體食物殘渣撥走 。	1
	ii	煮食用具及炸爐內的油脂分開處理, 不能直接棄於污水管。	1
	iii	在地上排水口加設過濾器, 以免食物殘渣隨排水口沖入污水管。	1
	vi	制定隔油池清潔時間表, 定期清理隔油池內的固體殘渣。	1
	v	使用有效的洗潔精, 其表面活性劑含量不少於百分之十五, 並且含低量磷質。	1
	vi	向員工提供正確使用漂白劑的指引。	1

Appendix 7.1

Water Saving Technologies Applicable in Restaurant Establishments

Low flow pre-rinse spray valve

Installing the right prerinse spray valve can save about US$490 on water and sewer charges, as well as US$440 on energy costs, each year. It can also improve the cleaning of dishes and cutlery (Brodsky, 2005; U.S. Department of Energy, 2008). At a cost of about US$50 to US$70, the valve pays for itself in less than 2 months, which is very attractive to hotel and restaurant operators.

A valve used to wash down dishes prior to their placement in a dishwasher. A typical spray valve flows up to 3 gallons of water per minute, while a low-flow pre-rinse spray valve flows less than 1.6 gallons per minute with a cleanability performance of 26 seconds per plate (Food Service Technology Centre, 2008)

The efficiency and effectiveness of low flow valve has also been tested in local hotels (IH&RA, 1996, p10). In June 1995, Hotel Nikko Hong Kong installed the "Platypus System", which was a calibrated water control system. The core element of this system was a compact valve inserted into the hydraulic system to control the flow and temperature of each water tap. After installation, water consumption per guest decreased by an average of 13%, equivalent to HK$13,000 saving per month. The use of fuel for hot water boilers also decreased by an average of 4%, which amounted to savings of around HK5,600 per month. Apart from money savings, this system could also ensure constant water flow, eliminate changes in water temperature, reduce water hammer and velocity noise, and improve the quality of water.

Flow regulator

A flow regulator is the most popularly adopted water-saving measures in Hong Kong hotels (Chan, Wong and Lo, 2008; In Print). Over two-third local hotels have installed this device at the nozzle end of a water tap. Through the spiral structure of a flow regulator, water is directed into the central part of the device. The spiral structure speeds up water movement while introducing air into the water stream, thus the water pressure is kept but the total amount of water is substantially reduced.

It is a popular option as the cost is low (around HK$100 each), but efficiency is high. The flow regulators can be installed in various functional zones of a hotel, such as guest rooms, public toilets, laundry, central and satellite kitchens. The JW Marriot Hotel Hong Kong's experience indicated that the annual water consumption was reduced by 10% from 225,000m3 in 2002 to 218,000m3 in 2003 after installation of flow regulator. The saving for water and sewage charge was up to HK$100,000 per year (Ming Pao, 2004). Another experiment carried out by the Hong Kong Vocational Training Council and EPD found that up to 20%-25% water usage could be cut down in the training kitchen after installation of flow regulators (EPD, 2004). Flow regulators can also be applied in hospitals, motels, schools and factories for water conservation purpose.

Water-recycling system

A water-recycling system is another water conservation options for hotels and restaurants. Water from hotel kitchen and laundry is recycled for non-drinking purposes. Waste water from kitchen cannot be reused directly as it contains FOGs, while that from laundry contains chemicals. Therefore, some treatments have to be done before the discharged water can be recycled. In a recent study about water consumption in local hotels, there was only one sampled hotel possessed a water-recycling system. It is not surprising to discover the unpopularity of water-recycling system due to several reasons. Firstly, this kind of built-in system has to be incorporated in the hotel building design. This means the property owner has to make the installation decision in the design stage. Secondly, the initial cost for a water-recycling system is much higher than other water-saving measures. The cost effectiveness of the system is usually not visible to the property owner during the planning and construction stages. Finally, the limited and costly space in local hotels also inhibits the adoption of

the system. For instance, a four-star hotel in Hong Kong had sacrificed the installation of a laundry water-recycling plant in exchange of converting the space to a car park to generate revenue after a cost-and-benefit analysis (Hsu, 1998).
Low-flow toilets Toilets designed to use 1.6 gallons per flush.
Waterless urinal A men's urinal that uses no water, and instead typically uses a trap system that eliminates the need for flushing.
Connectionless steamer A steamer oven that uses water only when needed as opposite to using a continuous flow of water.
"WaterMill" It is a new technology that turns the atmospheric moisture into drinkable water. When the machine is turned on, it draws air into it. The air is filtered to get rid of dust and particulates. Then the filtered air is cooled. The moisture in air becomes dew. It is collected, and then sanitized by ultraviolet light. By this simple mechanism, the machine can produce 12 liters of drinkable water. Only a small quantity of electrical power is needed in the process. However, the efficiency of "WaterMill" may be reduced where the atmospheric humidity is lower than 30 percent.
"Greasy-spoon cleaner" Engineers from the Hong Kong University of Science and Technology have

developed a compact technology for cleaning restaurant wastewater (*Technology Review*, 2002). The device consists of a set of catalysts and aluminium electrodes fitted inside a small water tank. When the electrodes are powered with electricity, the tiny oil droplets in the wastewater fed to the tank shed their negative charges and clump together. One of the electrodes generates tiny hydrogen bubbles that carry the coagulated grime to the surface, where it can be skimmed off. The project leader claimed that water purified in this way can be used for cleaning and other non-drinking purposes.

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