Staff Perceptions and Practice for Hospital Waste Management With Reference to Recycling in the UK versus Libya, a Comparative Study

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DECLARATION

I hereby declare that the content of this document submitted by me is in fulfilment of the requirement for degree of Doctor of Philosophy and has not been previously submitted in support of an application for any degree or qualification of Liverpool John Moores University or any other University or Professional Institution.

DEDICATION

This work is dedicated to my late parents and my little princess Nuria. They have given me support, advice and always stood by me during the stages of my life, and were particularly supportive in my education.

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ABSTRACT

Green hospitals with improved hospital waste recycling practices can be a key solution to the potential problems associated with hospital waste disposal and management. Recycling of household hospital waste could significantly impact on the overall waste disposal management systems and how hospital waste is segregated and eventually disposed. The involvement of hospital staff is of key importance in improving recycling performance, however, the perceptions of hospital workers towards recycling of hospital waste is still not clear and there is a lack of research in this area. The factors that determine the recycling behaviour are not adequately described in the medical literature, and differences between hospital workers perceptions of recycling in developing versus developed countries have not previously been extensively studied.

This thesis was designed to examine the factors influencing the knowledge and attitudes of hospital workers towards toward recycling of hospital waste, using a novel questionnaire. A pilot study was first performed to test the efficiency of the questionnaire, conducted via sending the self-administered questionnaires to 12 experts. Their views were considered in the development of the final version of the questionnaires. These were distributed randomly in 2 pre-selected hospitals in the UK and 3 similar hospitals in Libya. A total of 453 questionnaires were returned.

The response rates were generally low in both counties (less than 20%). Females and nurses responded significantly more frequently than men and physicians. In general there were relatively low levels of knowledge about waste management and recycling practice. In this study, none of the Libyan hospitals practiced any recycling and the

hospital workers in Libya were significantly less enthusiastic towards recycling than their UK counterparts. Training in hospital waste management and education were found to be weak predictors of positive attitudes. Results showed that it is difficult to predict the recycling behaviours among hospital workers, however, waste management staff were more positive towards recycling than those without training in waste management. The study has shown similar results to previous studies, in that hospitals in developed countries generated much less waste compared to hospitals in developed countries. Unexpectedly, knowledge was weakly linked to attitudes in both UK and Libyan hospitals. This may be due to the fact that the attitudes of clinicians and hospital workers are not necessarily related to their knowledge but rather affected mostly by the hard working hours and busy atmosphere which makes recycling more challenging.

The study opens doors for further studies to investigate factors influencing recycling attitudes, and encouraging hospitals in developing countries to commence recycling practice and provide whatever infrastructure is needed to make this possible. More education and training on hospital waste management should be encouraged in developing countries. Introducing new technologies in hospital waste management, particularly recycling of hospital house hold waste may change the future prospective of hospital waste disposal in developed and developing countries. More studies intervening with educating the hospital workers in waste management, particularly in recycling of hospital waste and it's relatively safety should be encouraged.

Key words: Healthcare waste, hospital household recycling, knowledge, attitudes, hospitals, healthcare workers, waste management.

ABBREVIATIONS

Department of Health	DH
ECO-Management and Audit Scheme	EMAS
Electronic Health Records	HER
Environment General Authority	EGA
European Union	EU
First World War	WWI
Food and Drug Administration	FDA
Green Guide for Health Care	GGHC
Gross Domestic Product	GDP
Global Environment Outlook	GEO
Hazardous Waste	HW
Health Belief Model	HBM
HealthCare Waste	HCW
High Density Polyethylene	HDPE
Hospital Household Waste	HHW
Human Immunodeficiency Virus	HIV
Infection Control Risk Assessment	ICRA
International Geosphere Biosphere Programme	IGBP
International Council for Science	ICSU

Leadership in Energy & Environmental Design	LEED
Municipal solid waste	MSW
National Health Service	NHS
Non Hazardous Waste	NHW
North West	NW
Organization for Economic Co-operation and Development	OECD
Poly vinyl chloride	PVC
Policy, Segregation, Recycling, Safety	PSRS
Reduce, Reuse and Recycle	3Rs
Royal College of Nursing	RCN
Second World War	WWII
Single-Use Device	SUD
Statistical Package for Social Science	SPSS
Sustainability Recycling Model	SRM
The Health Expenditure	THE
United Nations environment programme	UNEP
United States of America	USA
United Kingdom	UK
Waste Generation Rate	WGR
Waste-to-energy	WTE
World Commission on Environment and Development	WCED
World Health Organization	WHO

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Chapter 1

1 Introduction

Healthcare systems still face real challenges with healthcare waste management despite all the advancements in biomedical technology and continuing improved medical management, (Jang *et al.*, 2005;Taghipour H, 2009). Healthcare care waste is given several different names such as clinical waste and hospital waste. For the purpose of avoiding confusion, healthcare waste (HCW) has been used throughout this thesis.

Thousands of tonnes of infectious and dangerous hospital waste and considerably more non-hazardous waste are produced every year in the developed countries (Blenkharn JI, 2006) and to a lesser extent in the developing countries (Solid Waste Management, 2005). Significant parts of hazardous and non hazardous waste are still not managed optimally even in a developed country such as the UK (Blenkharn JI, 2006). Numerous problems are still encountered in most of the developed countries with regards to healthcare waste (HCW) management such as waste segregation, collection, transportation and management, recycling, adherence to the national guidelines as well as often excessive costs (Tudor *et al.*, 2006; Prüss A *et al.*, 1999). Research from the developing countries about the HCW is much less than similar research that comes from the developed countries (Shekdar AV, 2009). Dumping solid hospital waste in to hospital household waste (HHW) disposal sites and landfills after sterilization still occurs even in many developed countries such as UK without any preceding recycling and separation steps (Blenkharn JI, 2006). This means that the individual hospital trusts as well as the whole healthcare system are losing a unique opportunity of recycling the HHW before it gets contaminated with the hazardous waste. However, the situation in

most of the developing countries is worse although the situation varies from one developing country to another (Van Beukering and Bouman MN, 2001). Waste generation and recovery rates for developed countries are widely available in the database of the United Nations environment programme (UNEP); Global Environment Outlook (GEO); Data Portal; and World Research Institute Earth Trends (Throschinetz AM and Mihelcic JR, 2009).

These available data scores allow for quantitative data analysis of recycling efforts between developed countries. These cross country information on HCW generation and recycling rates is unfortunately not available for most of developing countries (Van Beukering and Bouman MN, 2001; Throschinetz AM and Mihelcic JR, 2009; Shekder AV, 2009).

It is a subtle balance for hospital waste managers to maintain high standards of hygiene while trying to reduce the impact on the environment, applying the new concepts of sustainability and recycling as well as minimizing disposal costs. Practical measures of sustainable hospital management are a reduction of hospital waste, controlling of polluting and toxic emissions, avoidance of unnecessary disinfection procedures and disposables, and implementing of energy and water saving technologies (Troschinetz AM and Mihelcic JR, 2009; Shekdar AV, 2009). It has been shown that the non-hazardous HHW represents up to 60-90% of the total waste generated by different hospitals' premises, which is a substantial amount (Tudor T *et al.*, 2006; Jang YC *et al.*, 2005). Focusing on recycling of non-infectious and non-dangerous HHW involves adherence to the new concept of hospital waste segregation into the main dangerous and non-dangerous lines (The Royal College of Nursing, 2007).

In order to optimise the segregation and recycling of HCW, it is pivotal to have good understanding and positive attitudes towards recycling options of hospital management (Tudor *et al.*, 2007). The factors that might affect the behavioural attitudes and perception of health workers towards recycling management of hospital waste seem to be complex and need more exploration. The differences in the orientation and attitudes between healthcare workers of different categories concerning the management of HCW including recycling of the HHW have received some attention and attempts were made to explain the different attitudes and attribute them to different factors (Barr S *et al.*, 2003; Goddu VK *et al.*, 2007).

Some studies have compared the status of HCW management practices in developing and developed countries and between the developing countries themselves. Goddu *et al.*, (2007) compared HCW management between two comparable hospitals in India and the UK. The authors have conducted case studies in both hospitals where they have monitored via site visits the segregation, handling, collection, storage practices at various units HCW management practices in the UK and India. In addition, they interviewed 96 hospital workers from the UK hospital only, who are involved in HCW management from different departments to evaluate their awareness and perception. Although this study was based on a pilot work and involved unilateral evaluation of the awareness and perception of the UK staff without interviewing the Indian counterparts, it has demonstrated important points of views. The study has shown that the UK hospital staff lack basic knowledge of implications involved in improper handling of the infectious waste. This study has also shown that the personnel involved in the handling of HCW from India and the UK and that the HCW practices in both countries are untrained and the entire HCW practices are being carried out unsupervised; beside that the storage points are badly managed and is unsecure,

Uiterkamp *et al.*, (2011) have performed a comparative analysis of sustainable recycling of the municipal between India and Tanzania. One of the aims of this study was to make a first attempt to produce a Sustainability Recycling Model (SRM) among countries can be ranked using six criteria and applied this model in comparing the waste generation and recycling rates. The SRM components are Governmental actions, composed of three scoring items; Economic conditions, composed of two scoring items; Social conditions, composed of two scoring items; Production conditions, composed one scoring item, Technological conditions, composed of one scoring item and International trade, composed of one scoring item. The system could be useful for academic and governmental comparisons for evaluation and comparing general municipal waste generation and recycling but not applicable for evaluation of HCW management and recycling.

The above literature survey analysis shows that comparing the awareness and perceptions of healthcare workers between developed and developing countries have not been objectively studied and there is no SRM model to evaluate the recycling process of healthcare in hospitals. It has been shown that there are numerous factors involved in determining the recycling attitudes of health workers such as work category, gender, age, seniority, employment duration, education and training in waste disposal but predicting the recycling behaviour among the general public and even hospital workers seems to be difficult and to vary from one place to another (Hines JM *et al.*, 1987; Schultz PW *et al.*, 1995). Tudor T, *et al.*, (2007) suggest that main factors influencing staff recycling behaviour were linked to both individual attitudes and circumstance and to the culture of the organisation. This suggests that in order to improve recycling behaviour these two factors would need to be targeted when planning the HCW management and policy. A better incorporation of recycling and

other sustainable practices is required at the organisational level into the focus, policies and practices of the organisation if low waste generation level and high recyclable levels wanted to be reached. Under the individual attitudes and circumstances, many factors may come such as the personal mode, age, sex, education, profession, position, training in waste management. Likewise under the organisational, many factors may be considered such as the type of the waste policy the organisation has adopted, level and ways the organisation follow to encourage best practice of HCW and recycling, economy of the organisation and setting of the organisation.

This thesis aims to study the knowledge and attitudes of hospital workers towards HCW management and HHW recycling in two different countries, one developed country (the UK) and the other a developing country (Libya). The thesis compares the knowledge and attitudes between selected hospitals in each country and also makes comparisons between the two countries. The effect of recycling practice and the different settings in the two countries is examined. The thesis also scrutinises the numerical data of hospital waste management in these two different countries with different cities in an attempt to correlate the knowledge and attitudes of the hospital workers in the two settings to the factual data. The thesis examines different factors that might affect involved in HCW management and HHW recycling searching for factors of predictive values. The aims and objectives are explained in more details under the appropriate section in the thesis.

1.1 The history of recycling in general

Recycling, reuse or recovery are not new concepts and have been common practice for most of the history of mankind. It has been practiced in different ways, mainly for economic reasons with recorded advocates as far back as Plato. Resources were scarce

and products were not as abundant as they are now. This made people in those ages tend to keep resources for as long as possible and not to waste them easily. It was generally cheaper to reuse items as opposed to buying new ones and when materials did become worn beyond further use, recyclable ones (eg. metal, wood and glass) were recycled into new items. There is archaeological evidence that it was very common to melt down swords, pots, and other metal products in order to reproduce the same products or new items such as coins, statues and other house hold items (Siegle, 2006). Scrap bronze and other metals were collected in Europe and melted down for perpetual reuse (The Economist, 2007).

Before the evolution of the industrial era and mass production flooded the market with lots of materials and products, recycling was mainly motivated by the economic benefits of using recycled feedstock instead of virgin material. The people from these times would probably cringe if they saw how much recyclable material was being squandered today. In modern history, industrialization spurred demand for affordable materials; ferrous scrap metals were coveted as they were cheaper to acquire than was virgin ore. Railroads both purchased and sold scrap metal in the 19th century, and the growing steel and automobile industries purchased scrap in the early 20th century. Many secondary goods were collected, processed, and sold by peddlers who combed dumps, city streets, and went door to door looking for discarded machinery, pots, pans, and other sources of metal. A major part of the war efforts during the First World War (WW I), second World War (WWII) and other wars were drives to recycle metals so that wartime production could be maximized. In fact, the importance of recycling was realized by people even before the green movement evolved. These drives were the foundation of organized recycling programmes that began to crop up all over the world following WWII (Zimring C, 2005).

Two decades ago, it was common in North America and many other countries to purchase milk in glass bottles via the milkman who delivered them to the door step and collected the empty glass bottles. With the industrialisation process and the availability of small and multiple stores, glass milk bottles have been replaced mostly with milk cartons and plastic jugs in most countries of the world. Glass milk bottles delivered to the doorstep by the milkman are typically pint-sized and are returned empty by the householder for repeated reuse. In the UK, since the late 1990s, the classic milkman, who travels his local milk route using a milk float during the early hours and delivers milk in 1 pint glass bottles with aluminium foil tops directly to households, has almost disappeared. The main reasons for the decline of UK home deliveries by milkmen are probably household refrigerators, which lessen the need for daily milk deliveries and private car usage, which has increased supermarket shopping. Almost 95% of all milk in the UK is thus sold in shops today, most of it in plastic bottles of various sizes, but some also in cartons (Coughlan S, 2006). Table (1.1) shows how milk is distributed in selected countries in the world and denotes whether recycling of glass milk bottles is being practiced.

Table 1.1 Milk distributions in different parts of the world

Country	Packaging	Recycling Glass milk bottles	Recycling Milk packages
Libya	UHT* milk cartons	No	No
UK	Aseptic cartons or HDPE bottles.	Yes	Yes
USA	Gallon containers of Natural-coloured HDPE	No	Yes
Turkey	UHT milk Milkmen Delivery.	No	Yes
Sweden	Cartons Plastic or glass milk bottles.	No	Yes
Hong Kong	Glass bottles cartons ,Plastic jugs aseptic cartons	No	Yes
China	Small plastic bags complete with straw	No	Yes
Canada	Aseptic cartons plastic Bags plastic jugs	No	Yes
Australia	Aseptic cartons plastic screw-top bottles Milk bags	No	Yes

*** UHT: Ultrahigh temperature**

Unfortunately many of these bulky plastic containers wind up in with the trash. The reasons range from laziness to ignorance. However, recycling attitudes start to improve again with the modern doorstep recycling practice and the abundance of automatic machines that issue a bar coded print slip that can be cashed at the cashier desk or deducted from the total sum upon shopping (Coughlan S , 2006).

It is interesting to note how the attitudes of people towards recycling have changed along with the change in shopping patterns (Deborah S and Ron W, 1990). Due to the increased demand for recycling of household waste, many central governments in the developed countries have set ambitious targets to increase the recycling practice. Although local government can provide facilities for recycling, the attitudes of residents are always crucial if these targets are to be realistically met. Barr *et al.*, (2003) has developed an effective framework for studying how households decide to recycle or not and tested this framework in Exeter in south-west England. They have found that people are much more likely to recycle if they had access to a structured kerbside recycling scheme (Barr S*et al.*, 2003).

They have also showed that many other factors influenced the attitudes and behaviours of people towards recycling, including their acceptance of the activity and their perception of the benefits and problems of recycling as a whole. The research uses the quantitative and qualitative data from the survey to demonstrate how individual attitudes can impact on recycling and how such research can yield useful data to enable policy-makers to adapt measures accordingly (Barr *et al.*, 2003). Other research has shown that general environmental concern and specific attitudes regarding recycling became more favourable over time with recyclers exhibiting stronger pro-environmental attitudes than non-recyclers (Vining J and Ebreo A, 1990).

1.2 The history of healthcare waste recycling

Recycling of old medical devices and systems have always been part of the medical-device life cycle in both the developed and the developing countries (Zhang J*et al.*, 2004). It began during the period 1960 to 1970, when hospitals started to sterilise and reuse medical devices mostly because the equipment in that period was made of

stainless steel, ceramics or other durable material that could withstand sterilisation (Tudor *et al.*, 2007 ; Borstein, J, 2010). In both developed and developing countries reuse of hospital equipment is a cost saving feature. However, in developing countries, there is a lack of regulatory bodies to ensure patient safety (Sawalem M, *et al.*,2009). In the developed countries, especially in North America and Europe, it is a systematic science regulated by the governmental bodies such as Food and Drug Administration (FDA) in the USA and the Department of Health (DH) in the UK, and one that promises to reduce healthcare spending in the long-term, provide cost savings within a year and provide respite to the shrinking bottom lines of hospitals. The recycling of medical devices and the reuse of devices labelled as single-use device (SUD), although in its nascent stage, is expected to change the medical device industry over the next five years (Hailey D *et al.*, 2008). With the emergence of plastic materials, hospitals' sterilization techniques needed to change; they became more complex and focused on safety. Recycling is now taken up as a third-party process. Companies specialising in reprocessing promise to ensure cost savings for hospitals and help increase their bottom lines. The American Society for Healthcare Central Service Professionals describes reprocessing as any process which renders a used, reusable or SUD to be patient-ready or which allows an unused product that has been opened to be made patient-ready (Kwakye, G*et al.*, 2010). Three categories of devices currently lend themselves to reprocessing in the US. Class I devices have a relatively low associated risk to patients and include elastic bandages, pressure infuser bags, tourniquet cuffs, and general-use surgical scissors. These are exempt from premarket submission requirements. Approximately 65% to 75% of reprocessed SUDs fall into Class II (medium risk) which requires in the USA a submission of a premarket notification report providing evidence of equivalence to devices already on the market in terms of safety,

effectiveness, and intended use. Class II devices include pulse oximeter sensors, ultrasound catheters, drills, compression sleeves, and most laparoscopic equipment. The last group, Class III (high risk) devices, requires valid scientific data proving safety and effectiveness, in addition to a satisfactory inspection of the reprocessing facility in order to obtain FDA premarket approval. Devices that fall into this category are balloon angioplasty catheters, per-cutaneous tissue ablation electrodes, and implanted infusion pumps. Given the high patient risk associated with Class III devices and the strenuous approval process, most health care organizations refrain from reprocessing these items. FDA's post market activities involve .inspection of reprocessing establishments and reviewing device safety reports, including reports of adverse events (Lee RC *et al.*, 2007).

Medical device reprocessing although in its early stages on the global level has already been shown to provide significant benefits for healthcare providers. Most of the catheters used for cardiovascular and nephrology purposes, orthopaedic blades, endoscopic devices, fixation devices, electrophysiology catheters, electrosurgical electrodes, endotracheal tubes and ophthalmic knives are now subject to reprocessing (Lee RC *et al.*, 2007; Hailey D *et al.*, 2008). They form a substantial 30% of the supplies used in hospitals, which are saving hospitals money. On average, reprocessed medical devices are 50% cheaper than new devices. A survey of nearly 3,000 hospitals in the USA showed that over $150 m in savings were generated for each year through reprocessing (Krüger CM, 2008). In the USA in 2007, nearly 45% of hospitals had agreements with third-party reprocessing companies, a number that increased to 70% in 2008 after the economic recession. Most of the medical devices that are now reprocessed are being reused under FDA surveillance by reprocessing companies. Industry experts note that devices such as external fixators also enable substantial

savings, while operating room equipment was shown to be the most commonly reprocessed equipment saving large amounts of money through the reprocessing of laparoscopic trocars, ultrasonic scalpels and multichip appliers (Malchesky PS *et al.*, 1995; Hailey D *et al.*, 2008).

Along with the increase of awareness of green hospitals and the concern about the environment, non-hazardous waste has been the focus of many researchers. Rayner W, (2003) concluded that nearly 25% of HCW could actually be classified as HHW, but this is clearly an underestimation as it has been shown by others. Tudor T *et al.*, (2007) demonstrated in the UK that the quantities of HHW could be reduced by up to 60% through segregation of items such as paper, plastic and biodegradable materials. This suggests the need for better separation of HCW to prevent HHW type being contaminated with hazardous waste streams. There is another indirect pathway of recycling of HCW as well as municipal waste, which is the recovery of value from materials after they have had a service life postconsumer, this is called post-use recycling.

This demonstrated more clearly when recovery of energy takes place from waste materials; this is called Waste-to-energy and abbreviated as (WTE). This may occur by two methods: incineration with energy recovery (heat and power); and production of refuse-derived fuel pellets that can be used in furnaces along with more conventional sources of energy, such as coal (Singer J, 1995).

1.3 Attitudes and behaviours towards recycling hospital waste

Generally, attitude is a positive or negative feeling toward specific objects; it exerts an influence on behaviour.

Whether consciously or not, behavioural decisions are frequently based upon attitudes (Fabrigar L, 2004). Herremans I and Allwright DE, (2000) demonstrated that posture, which includes awareness and attitude, leads to action and performance behaviour regarding environmental management issues.

The attitudes and behaviours of healthcare providers and administrators towards the recycling of hospital waste were studied by some researchers. Tudor T *et al.*, (2007) showed that the levels of recycling behaviour did not affect the way Cornwall NHS managed their waste. However, despite managers and staff stating that they were environmentally conscious, triangulation of these reports with data from the waste bin analyses and ethnography observations demonstrated that subjects' description of their recycling behaviours were not evident in quantitative or qualitative measures that tracked that behaviour. The main factors that influenced staff recycling behaviour were linked to both individual attitudes and circumstances and to the culture of the organisation. This suggests that any attempt to improve recycling behaviour would have to target both of these factors. Tudor T *et al.*, (2007) suggested that recycling and other sustainable practices need better incorporated into the focus, policies and practices of the organization if high recycling levels and low waste generation levels are to be achieved. The attitudes of health workers are crucial if government targets are to be met. Barr S *et al.*, (2003) have set a framework for studying how HHW can be recycled or not. It is based on the classical 'theory of reasoned action' set out by Fishbein M and Ajzen I, (1975). At the core of this framework of human behaviour is the relationship between intention and action, the so-called 'value–action gap, (Fig 1.1). This framework was tested in Exeter in south-west England where a major survey found that respondents were much more likely to recycle if they had access to a structured kerbside recycling scheme (Barr S, *et al.*, 2003). Many other factors

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influenced the attitudes and behaviours towards recycling, including their acceptance of the activity and their perception of the benefits and problems of recycling as a whole.

Figure 1.1 S. Barr, N *et al.*, 2003, Conceptualisation of environmental behaviour

The model is constituted of three main groups of variables involved in the determination of attitudes and behaviours towards recycling environmental values, situational factors and psychological variables.

Environmental values represent respondent's perception towards the environment (O'Riordan T, 1985). Schema of eco-centric to techno-centric values (Dunlap RE and van KD, 1978; Dunlap RE *et al.*, 2000; Thompson SCG and Barton MA, 1994). These scales quantitatively position an individual according to their score on a range of statements representing, for example, an eco-centric world view. It has been shown generally that those who hold a more intrinsic value of environment (eco-centric value) appear to take environmental matters more seriously. While those who have techno-centric values with an understanding that technology may solve any problem, were found to behave in a less environmentally conscious manner. The situational factors, the variables which represent a person's situation at a given time, also have importance in shaping their environmental action. These factors might relate to contextual factors, such as access to appropriate services (Ball R and Lawson SM, 1990; Derksen and Gartell, 1993; Guagnano *et al.*, 1994), or to socio- demographic factors, such as age,

gender, education and income (Hines *et al.*, 1987; Schultz *et al.*, 1995). In addition, an individual's knowledge of both the environment in general and the behaviour in particular may also be significant (Schahn and Holzer, 1990), as will be the related experience the individual has in undertaking other environmental actions (Danes vary *et al.*, 1998). Finally, psychological variables are likely to be significant when examining environmental action. This reflects the personality and perceptions of individuals concerning the behaviour. These might also include altruistic personality factors (Hopper and Nielsen, 1991); an intrinsic motivation to act, such as behavioural satisfaction (De Young, 1986); subjective norms to act (such as social pressure, (Chan, 1998); environmental threat (perceived threat to welfare from the environmental problem; (Baldassare and Katz, (1992); response efficacy the belief that individual actions make a difference; (Arbutnot, 1977); self-efficacy and logistical factors the belief that the individual has the capacity to act, (Tucker, 1999); and finally citizenship factors such as balancing environmental rights with appropriate environmental responsibilities (Selman, 1996). (Fig 1.2) shows how these factors can be integrated into the skeletal framework. There is a logical movement from environmental values to environmental behaviour. It is argued that this logic is a 'rational' form of human behaviour, since behaviour is based upon an intention to act and underlying values (Barr S, *et al.*, 2003); in recognition of the bounds to rationality which exist, the other variables are placed at extraneous parts of the framework. Thus, situational and psychological factors intervene to modify behavioural intention and more importantly to provide a holistic view of behaviour. Such a framework has the benefit of both providing a clear and utilitarian conceptualization ideal for policy-makers and being flexible enough to reduce or increase the prevalence given to certain factors. Barr's framework although outlined for general households, seem to be practical and with

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some modification could fit as a model to study the attitudes of healthcare workers towards hospital waste disposal and management including recycling practices.

Figure 1.2 S. Barr, N *et al.*, 2003, The Barr's conceptual Framework

Amanullah A and Uddin J, (2009) have studied the usefulness of the Health Belief Model (HBM) and other confounding factors in determining health behaviour of individuals involved in hospital waste management and tested four components of HBM in relation to demographic variables, knowledge, and occupational practices of the respondents. The study revealed that the waste pickers had a lower level of knowledge, attitude, and safe practices than nurses and sweepers. Perceived

Susceptibility and Perceived Severity were moderately associated with safe occupational practices among the respondents. In addition, respondents with higher levels of education and income were more likely to have higher levels of perceived susceptibility, severity, and benefits. The study findings indicate that individuals with greater economic vulnerability might be at greater risk for not using proper protective measures in handling or picking hospital wastes in Bangladesh (Amanullah ASM and Uddin J, 2009).

1.4 Research motivation

The seeds of this work go back to the year 2001, when I served as the hospital general manager of the Al-Nour hospital, which was at that time a 60-bed hospital belonging to the Libyan Red Crescent. This was my first post in a hospital environment outside of my academic work at the university. It came after I finished my master education at Gothenburg University and worked at the high institute of Medical Technology in Miusrata as the head of the department of environment. From the first days of my work, I was astonished with the improper dealings with the healthcare waste (HCW) produced by the hospital. The collection procedures were extremely unsafe with untrained workers employed by private firms collecting hospital waste in ordinary black plastic bags that are used for normal home waste disposal. The nurses and doctors troughed the sharps and needles in the same pins used for the other hospital waste including the household waste (HHW). There was no policy or hospital protocol that regulated the waste collecting and disposal or even showed the potential risk for the patients, hospital personnel and the whole community. No one seemed to care about making any educational or training sessions to the hospital personnel or doing any effort to change the situation. There was no attempt to make any segregation at all and

all HCW were collected in one place and treated in the same way. The catastrophe was not limited to the collection and transport procedures but extended to disposal procedures. Most of the waste is burned in furnaces but sometimes the HCW was thrown in the sea or buried under land (land filling) and was very rarely burned in a closed atmosphere. The single burning unit in the hospital in the city of Misurata has stopped functioning for years and no replacement was planned at the time. After investigating the state of HCW waste management in Misurata and in other hospital via field visits to different hospitals in Libya, I became convinced that the situation in the whole country is almost the same. This has stimulated me to study more about the waste management procedures and I have started applying some basic rules such as using ordinary plastic jugs of 2-5 lifters size, using plastic gloves when collecting the HCW, separating the household waste from the clinical waste and further separating the clinical waste into risky and non risky waste. These changes were made mandatory and were imposed on the private collectors. I was very frustrated as I felt that my effort was like a drop in the ocean. Whatever changes I could make were limited in effect because the final disposal is out of my hands. I realised that this should be done at a national level. When I read the literature and the modern trends, I felt that we are very back-ward when it comes to the HCW management. However, I was very surprised to find out that most of Al Nour HCW was actually HHW. This made me think of the potential for recycling HHW with the aim to reduce the burden of the HCW disposal. I have realised during my discussions with the physicians and nurses and other hospital workers that there is another real problem, which is that a lack of knowledge and the negative attitudes towards this problem are predominant. In Libya, this is emphasized by the fact that there are other priorities to HCW in health sector to be considered. When I read the literature, I found that this is a persistent problem even in the

developing countries and was mostly attributed to the busy clinical atmosphere, which creates a tendency to ignore small details.

It was very surprising to read that the researchers in many developed countries express with factual data that despite of all the advances achieved in their hospitals that management of wastes are still not optimal. I have studied the literature from all countries but I have focused on research comes from the UK because the Libyan hospital system, hierarchical healthcare payroll and medical education syllabus were all similar to the UK.

I have found out that NHS (National Health Service) in the UK has revised the guidance document Safe Disposal of HCW and as a result of this, the Department of Health (which serves like the ministry of health in Libya) published the consultation joint-agency guidance 120- page document, in November 2005, under gateway reference 6537, (Department of Health Consultations, 2005). In order to test the responses of healthcare professionals on these new guidelines, the Department of Health has asked 200 experts from organizations, professional bodies and individuals concerned with waste management on the key points of this joint-agency guidance and published the responses on a separate document (Department of Health consultations, 2005). Based on this, the Department of Health updated the joint-agency guidance and published it in its final form as a 119-page document on the 30th November 2006, under the gateway reference 6874 (The Department of Health, 2006). This document is considered the most recent governmental reference concerning the best practice of hospital waste management. I have read this document when it was first published and I found that it was very thorough and provides details of all aspects of waste management, and shows the obligatory and optional settings. Since then, I was motivated to conduct research comparing the status of HCW in Libya to that in the UK

including the possibility of recycling the HHW. We will refer to this document hereafter in this thesis as DH guidance. The DH guidance actually replaces the Health Services Advisory Committee's (1999) guidance document 'Safe disposal of clinical waste' (Health Services Advisory Committee, 1999). The motivation of revising and updating the 1999-guidance was to take into account the changes in legislation governing the management of waste, its storage, carriage, treatment and disposal, and health and safety (The Management of Health and Safety, 1999). Based on the DH guidance, the Royal College of Nursing has published concise 17-page guidance on HCW (The Royal College of Nursing, 2007). The DH guidance concentrated mainly on the hazardous waste with the aim to eliminate the risks of infectious, chemical and radiation wastes. Although this guidance is very extensive, we noted that the waste recycling and sustainable hospital issues were not discussed enough. Household waste, which is classified as non-hazardous waste and shown to be subjected to recycling, was not mentioned in the guidance.

The increasing usage of highly-developed medical devices, drugs, solutions, blood products, and disposable products is a drain on natural resources as well as financial ones and needs special arrangements and standard control policy not only to prevent infections, but also reduce the environmental effects, reduce the costs and maintain a sustainable management (Escaf and Shurteff , 1996). Although environmental auditing was approved in 1993 by the Council of the European Communities for industry (Eco-Management and Audit Scheme-EMAS), (Dettenkofer *et al.*, 2000), it has not been used correctly as a tool to control and reduce environmental pollution emanating from hospitals. Furthermore, it has been demonstrated that there is resistance and restrictions upon environmental auditing in hospitals such as the lack of basic environmental data, staff motivation (especially of physicians), cooperation of the organizational

substructures, and granting funds for pre-financing the improvements in ecology (Dettenkofer *et al.*, 2000). A number of studies have indicated the potential for waste reduction, recycling and ultimately cost-reduction opportunities within healthcare waste management (Mohammadi B, 2000; Rayner W, 2003; Barratt, *et al*, 2004;Townend and Cheeseman, 2005; Tudor *et al.*,2006; DOH, 2006). For example, Tudor, (2007) demonstrated that the quantities of domestic waste in the overall healthcare waste stream could be reduced by as much as 60% through careful segregation of items such as paper, plastics and biodegradable waste. Rayner, (2003) concluded that nearly 25% of HCW could be classified as domestic (HHW) waste.

In 2007, Tudor *et al.*, (2007) used a holistic perspective to include both the waste management systems and the behavioural drivers for action among medical staff. This approach is important, because it is the behaviour of each individual staff member that will determine its success. The results showed that the concepts of sustainability are not a key role in the way that the studied NHS hospital managed its hospital waste. There is therefore a research gap in exploring the knowledge and attitudes of healthcare providers and workers towards recycling practices in the waste management. A study comparing the status and perceptions of the recycling practices between developed countries with established health services to a developing country with fragile health service has never been previously done.

During all these years from 2002 to 2007 when I got my acceptance at John Moore's university in Liverpool, I spent hours reading and preparing for this work. After I have arrived to the UK, I did not only see the hospitals and how they work but I met many key researchers for whom I read many papers such as Ian Blenkarts, Terry Tudor and others. I spent considerable time until I produced my final proposal based on the

accumulated readings, preparations, recommendations of my supervisors and researchers in this field.

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1.5 General aims and specific objectives of the study

1.5.1 General aims

The aim is to study the knowledge and attitudes of hospital workers towards (HCW) focusing on (HHW) recycling in the UK and Libya, in order to be able provide recommendation on suitable means to increase recycling rate in hospital. Thus this has been investigated in an EU country known for longstanding and well established health services such as the UK and compared to a rich developing country but with fragile health services such as Libya.

The contrast between the health services and HCW practices of the two countries was expected when designing this study to bring about important observations and conclusions that could improve waste management policy and practice in hospitals, particularly in a developing country such as Libya.

1.5.2 Specific objectives

- Evaluate and compare the status of Healthcare waste and Household waste recycling between the UK and the Libyan hospitals via administering questionnaires to waste managers of the studied hospitals. In order to assess this, four fields were included in this factual questionnaire, which are; policy, segregation, recycling and safety in such a way that they all together evaluate the status of the HCW waste and recycling from different points of views. These fields represent an evaluation model that will be referred hereunder as PSRS.
- Correlate the knowledge and attitudes of hospital workers of different categories in the two different countries involving seven factors including age, sex, education, hierarchical position, training in waste management and duration of employment using self administered questionnaires.
- Conduct comparisons between the UK hospitals and Libyan hospitals on the one hand and between the UK versus Libyan hospitals on the other hand.

1.6 Research expectations

This research is designed to address two main problems and to see how much they are related to each other in a research model involving two different countries with 5 different hospital setting. The first is the knowledge and attitudes of hospital staff concerning recycling approach in hospital management and the second is how far the recycling is implemented as a tool in hospital waste management. It is expected to answer many questions behind these two main concerns and compare them between the two countries. For example, does an accurate knowledge about hospital waste recycling affect the attitudes towards the recycling process and is there any difference in this

relationship between a developed and a developing country? Are there any differences in the attitudes due to demographic factors such as gender and age? Do the clinical waste workers have a different attitude in general compared to the healthcare providers? Within the healthcare providers, do physicians agree with nurses in general? Do senior physicians have a similar attitude to junior ones? And what about nurses themselves, do they agree or does age and seniority also affect their attitudes? It is expected that this investigation will demonstrate any correlations between the level of recycling practice and the knowledge and attitudes of hospital staff, and to elaborate on the relation between the management's vision and policy and what is practiced in reality.

1. Yousef Elgitait[1], Marjan Sarshar[2], Ivan Gee [3] (2008) Dose Hazardous Waste Management Have An Influence On Infection Spread In Hospitals. Liverpool BEAN Conferences (May, 2008) School of Built Environment, Liverpool John Moores, Byrom Street, Liverpool L3 3AF, UK.

2. Yousef Elgitait[1], Marjan Sarshar[2], Ivan Gee [3] (2009) Determining The Best Practice In Clinical Waste Management. Liverpool BEAN Conferences (May, 2009) School of Built Environment, Liverpool John Moores, Byrom Street, Liverpool L3 3AF, UK.

3. Yousef Elgitait[1], Ivan Gee[2], Ross Andrew[3],Wilfred Matipa[4] , (2010) Staff Perception And Hospital Practices Towards Recycling Of Hospital Waste In North West. Liverpool BEAN Conferences (May, 2010) School of Built Environment, Liverpool John Moores, Byrom Street, Liverpool L3 3AF, UK.

Chapter 2 Sustainable development

2.1 Historical background

Sustainable development has emerged as a science following the proposal of the World Commission on Environment and Development (WCED) in 1987 (Clark WC and Dickson NM, 2003), which defined Sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This WCED approach has led to enormous worldwide scientific support and the argument that development must always ensure the coexistence of both economy and the environment together. It has started to attract not only scientists and academic centres but also corporate business, governmental and non-governmental organisations as well as lay people.

Today, sustainability is recognised all over the world as a key issue facing twenty first century society. It has, however also been remarked that the idea of sustainable development increasingly seems to be linked to political agendas, raising concerns about the solidity of its analytical basis; as a consequence the scientific and technological underpinnings of the concept remain unclear to many (Cohen *et al.*, 1998). From environmentalists to politicians, people are realising that sustainable development is a concept that has to be incorporated into concrete actions if we want a life for our children that is as good as, or even better than the one we are living now.

In order to achieve the goals of sustainable development, every fabric that makes up our society needs to be examined. One area that needs close scrutiny is the issue of waste. Waste management is an important consideration in the pursuit of sustainable development, because if it is handled properly, it has potential to turn obstacles into

solutions through the recovery and recycling of many valuable resources. The application of new recycling strategies in the management of HCW, particularly the (HHW) opens the way to the creation of new business and employment opportunities in the health sector, including collection, handling, segregation, storage, transport and even information technology; reduced emissions of greenhouse gases from waste management operations, such as landfills; and conversion of waste to energy (Themelis, NJ., 2003). About 130 million tonnes of municipal solid wastes are combusted annually all over the world into waste-to-energy (WTE) facilities that generate electricity and steam for district heating and also recover metals for recycling (Themelis, NJ., 2003).

The investigation of the knowledge and attitudes of the health workers is a key factor in this notion. This is true in health premises that apply recycling fully or partially in developed or developing countries and in similar health premises that do not apply any recycling at all (Tudor *et al.*, 2007; Goddu VK, *et al.*, 2007). The contrast between the two and the variations in the attitudes even within the same country could open the doors for more understanding of the hindrance and encouragement factors that may make the recycling policy of HHW improved and more applicable (Barr *et al.*, 2003).

Sustainability emerged as a new science following the proposal of the concept of sustainable development during the World Commission on Environment and Development (WCED) in 1987, also known as the Brundtland Commission. This gained tremendous support due to its declaration that development must ensure the coexistence of both economy and the environment. The WCED 1987, referred to sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Kates *et al.*, 2005). However, it took 14 years more before sustainability was officially recognized as a new science at the World Congress "Challenges of a Changing Earth in

Amsterdam in 2001, which was organized by the International Council for Science (ICSU), and the International Geosphere Biosphere Programme (IGBP) (Kates R, 2001). Since the emergence of sustainability as a concept, many different publications have tackled this new discipline from different angles (Holling, 2000). There were many attempts to define sustainability and sustainable development. As the science was developing from different aspects and from different disciplines, it was not an easy task agreeing a conceptual definition. Researchers working to address environmental and development issues tend to use sustainability and sustainable development almost interchangeably. Sustainability is a word derived from Latin sub tenere, where sub means under or toward while tenere means to support to keep. There are several lexical definitions of sustainability but most of them imply supporting or keep going. Sustainability remains a term that is often used in a misguided way depending on the context, some definitions of sustainability as science are vague and incompatible (Clayton and Radicliff, 1997); a universally accepted definition of sustainability remains elusive because it needs to be factual and scientific, a clear statement of a specific destination. The simple definition of sustainability is improving the quality of human life while living within the carrying capacity of supporting eco systems. Sustainable Development refers to a mode of human development in which resource use aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for generations to come. The term 'sustainable development' was used by the Brundtland Commission which coined what has become the most often-quoted definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987; World commission, 1987). This definition introduced by the United Nation (UN) was not consensually accepted

and has undergone various interpretations (International Institute for Sustainable Development, 2009; EurActiv, 2004; Kates *et al.*, 2005). The definitions of sustainability and sustainable development, the ultimate goals of sustainability, how these could be decided, and how these goals could to be achieved are all open to discussion (Holling, 2000). Many environmentalists look at sustainable development as an oxymoron as development seems to entail environmental degradation (Redclift M, 2005). Herman Daly, an ecological economist has wondered, "What use is a saw mill without a forest?" (Daly and Cobb, 1989) From this overview, the economy is a subsystem of human society, which is itself a subsystem of the biosphere, and a gain in one sector is a loss from another (Porritt J, 2006). This was repeatedly demonstrated as an illustration with three overlapping circles, where ecological environmental, economic and social aspects overlap (Fig 2.1) Economic aspects are looked upon as only one of a number of domains that includes politics and culture.

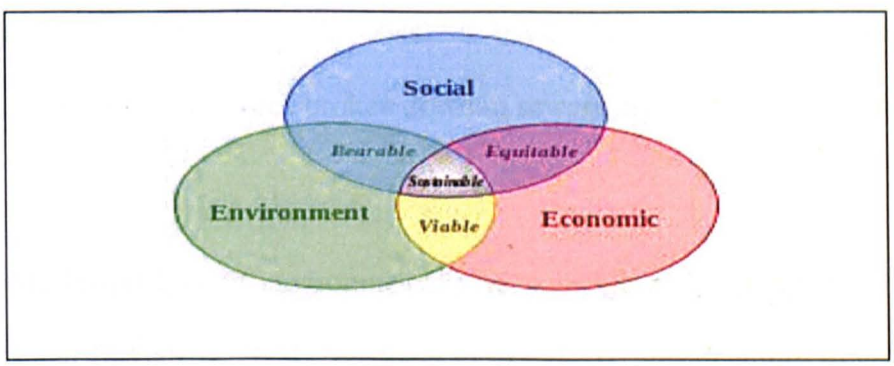

Figure 2.1 Schematic illustration of sustainable development

Today, sustainability is recognized by leading scholars as a key issue facing 21st century society in almost all aspects of life. As a science, sustainability has provided a framework for sustainable general practices (Komiyama H and Takeuchi K, 2006). Sustainability measurements on the other hand provide the evidence-based quantitative data needed to guide sustainability governance.

2.2 Sustainable hospitals

There has been a trend towards safer waste disposal in hospitals since the 1990s when it was found that the incinerators contributed a large proportion of mercury and dioxin emissions leading to the closure of 5000 medical waste incinerators (Marchwiniska E, 2002; Themelis, N.J and Gregory, A. 2002). It seems to be difficult for healthcare providers and managers to accept that hospitals, which in their perception are primarily life saving institutes, can be sources of harmful pollution for the environment and may represent a major risk to people. In pursuance of a sustainable hospital, environment it is vital that hazardous waste is separated from non-hazardous waste, which can be easily recycled as HHW, or materials that may be reused (Marchwiniska E, 2002; Bal AS and Dhagat NN, 2001). Despite this, most hospitals in the world, particularly in developing counties still send the majority of their waste to municipal incinerators that contribute to health threats, (Bal AS, and Dhagat NN, 2001). It is important to note that waste from many hospitals still contains toxic chemicals and pharmaceutical compounds, most of which aren't broken down in sewage-treatment plants (Labib *et al.*, 2005).

A sustainable hospital is an environmentally responsible and healthy place to work (Korashy H and El-kadi A, 2004; Needham *et al.*, 2005). Sustainability in general can mean many things, all of which are significant in their own right. At a 1987 UN conference, it was stated that sustainable developments are those that "meet present needs without compromising the ability of future generations to meet their needs" (WCED, 1987).

The core principle of sustainability involves accountability, planning and foresight, and it is crucial that it takes place in every industry, at every level, and by every individual.

There are hospitals that began their green movement with the ambition of only a small number of employees, who were concerned about the sustainable management of the hospital waste and interested in the potential for recycling to reduce the amount of yielded waste (Cifuentes *et al.*, 2005). Other aspects of sustainability, such as bringing in more natural daylight, designating meditation areas and other environmental changes associated with striving to attain sustainability can lead to shortening the length of patients' stay and thereby reduce the reliance on medication, even lessening mental and physical stress (Korashy, H and El-Kadi A, 2004; Needham *et al.*, 2005).

To only build hospitals according to strict environmental standards is not sufficient; they must also operate while holding the same environmental principles in mind. It appears that the stiffer regulations over chemicals and heavy metals such as dioxin and mercury have resulted in some changes, especially with regards to using incinerators to dispose of hospital waste (Korashy H and El-Kadi A, 2004; Needham *et al.*, 2005). The argument against hospital sustainability claims that in a time of ever rising costs it isn't economically prudent to spend more just for the sake of being green. Also there is a great deal of concern over patient safety specifically with regards to recycling medical devices and chemicals.

It is true that many of the innovations have a higher cost, however in the long run they have the potential to reduce operating costs over time and make a significant reduction in waste. Many hospitals have operated recycling programmes that have reached an extremely low-cost or no-cost waste management through achieving significant reductions of their waste production, cost of waste management and recycling and waste reuse, (Wilson R, 1994). With reference to expensive sustainable installations in healthcare, rubber flooring, for example costs more to install than Polyvinyl chloride (PVC), however as it does not require the frequent stripping with chemicals and re-

waxing, it is considered as a more economic choice over time (Laing *et al.*, 2006). In the USA, the industry launched several major construction programmes to re-establish decaying facilities and to meet growing demands. Due to local and state pressure, as well as healthcare architects and designers and their own environmentally conscious donors, a growing trend is being noticed towards more eco-friendly sustainable hospitals (Wilson R, 1994). Some pioneering groups such as Kaiser Permanent began the move to green hospital construction in the mid 1990's. This follows the study of Marianne, T *et al.*, (2011) which demonstrated that using electronic health records (EHR) reduces carbon emissions, waste and water consumption by as much as 1.7 million tonnes across the entire U.S. population. This study emphasises the importance of the link between the utilization of EHR and sustainable healthcare and shows that the use of EHR leads into many positive environmental effects, such as reductions in paper use, transportation fuel, some toxic chemicals, and water consumption.

Despite the increased use of energy, technology can potentially support a greener health care sector if it is used to change practice work flows and care delivery and is not simply implemented as a substitute for paper records. When this is the case, the use of electronic health records can both change the face of health care and help reduce its environmental footprint (Laing *et al.*, 2006). Kaiser Permanente also entered into agreement with Bloom Energy to deploy four megawatts of solid oxide fuel cell generated power across seven California facilities and sets ambitious waste reduction targets to reduce, reuse, and recycle at least 40% of the organization's waste by 2015 (Tudor TL, *et al.*, 2007).

Many healthcare facilities have been built or are being designed and constructed to standards such as those set by the Green Guide for Health Care (GGHC), modelled on a certification system developed by the U.S. Green Building Council (Wilson R, 1994), a

coalition of builders, architects, government agencies and non-profit groups (Cifuentes *et al.*, 2005). When Kaiser Permanente's new medical centre in Modesto, California was completed in 2008, solar panels cut energy costs, permeable pavement materials filter chemicals from rainwater runoff, floors are covered with natural rubber covered floors, carpets are backed with recycled safety glass and even toilets are fitted with special fixtures to conserve water (Diderichsen F, 1995).

The new centre is part of a $20 billion-plus facilities programme at the Oakland, California-based healthcare giant that includes building or replacing 27 hospitals over the next nine years. In Skane, in southern Sweden, considerable work has been done over the years to improve the sustainability of the regional hospitals (Diderichsen F, 1995).

Pollution prevention and occupational safety and health have traditionally been approached as separate issues. Therefore a solution for one would often result in creating a new problem with the other. The underlying premise of hospital sustainability is that integrating pollution prevention with occupational safety and health results in more sound and appropriate solutions (Tooher *et al.*, 2005).

In this thesis, we focus on the sustainable management of the hospital waste in the form of recycling in two different settings, in a developing country versus a developed country. The contrast between the two settings may emphasize the importance of recycling as a method of waste disposal in both.

2.3 Building the basis for sustainability as a science

Hospitals play a pivotal role in protecting people's health and are a necessary part of our society and as such must be examples of economic, environmental and social

responsibility (Serb C, 2008). As stated previously, hospitals may also have a surprisingly unhealthy side that inadvertently contributes to illness and pollution by exposing patients and hospital staff to harm from building materials, medical waste, hospital supplies and cleaning products (Daschner *et al.*, 1997; Armbuster DA, 1990). Environmental health experts warn that materials that cover floors, walls and ceilings release hundreds of chemicals into hospital air; and chemicals used to clean and maintain hospitals add more volatile organic compounds such as formaldehyde, acetaldehyde, naphthalene and toluene into the air, which are inhaled by patients and staff (Boyce *et al.*, 2007). PVC, which releases the carcinogen dioxin during its manufacture, is still widely used in the production of intravenous cannulas and blood bags, plastic tubing and other hospital products, as well as carpets (Choi *et al.*, 2007). In addition, inadequate ventilation and generally high energy consumption have contributed to poor air quality and pollution, with effects ranging from longer patient recovery times to more sick days for staff (Wilson *et al.*, 2006; Hiipakka DW and Buffington JR, 2000). Studies show that environmental improvements associated with sustainable buildings, such as bringing in more natural daylight, meditation areas and "healing gardens," can shorten patients' length of stay, reduce reliance on medication, and lessen mental and physical stress (Korashy H and El-Kadi A, 2004; Needham *et al.*, 2005).

Studying the knowledge and attitudes of healthcare providers and other related stakeholders towards the new visions of healthcare sustainability is very important if a change is planned. Unfortunately, it seems that it is still hard for many healthcare providers and organisers to accept that hospitals themselves could be harmful polluters, with spewing smokestacks and waste going out the back door (Levin LS and Gustave L., 2013). Comparing hospitals that apply some or fully sustainable strategic

approaches may emphasise the importance of the concept of sustainable hospitals and sustainable healthcare management. The contrast between hospitals in developed and developing countries in the way that HCW is being managed for example may help to convince the states in developing countries to increase budgets and invest in a more sustainable approach. This contrast may be demonstrated in a very clear way via comparing the perception of hospital workers.

This study focuses on the knowledge and the attitudes of hospital workers towards sustainable waste management of hospital waste, particularly recycling HHW. In this respect, separating hazardous waste and infectious waste and solid waste is extremely important step in order to allow for different treatment of the different categories and accordingly different disposal, as well as for recycling or reclaiming chemicals for medical use, to consider hospitals as non-polluters (Marchwińska E, 2002; Bal A and Dhagat N, 2001). The fact is that most hospitals still send their waste to municipal incinerators that contribute to health threats (Bal A and Dhagat N, 2001). Waste from most hospitals still contains toxic lab and cleaning chemicals and pharmaceutical compounds, many of which aren't broken down in sewage-treatment plants (Labib *et al.*, 2005).

Currently, as the industry embarks on multi-pound billion construction programmes over the next decade to replace or rebuild decaying facilities and meet growing demand from ageing baby boomers, that is starting to change. Under pressure from local and state governments, as well as health-care architects and designers and their own environmentally conscious donors, hospitals are building more efficient, eco-friendly facilities with "sustainable" design features that conserve energy, use natural light and materials and reduce potentially dangerous emissions.

The Green Guide for Health Care is the healthcare sector's first quantifiable toolkit for sustainable design, construction, and operations. Modelled, with the Leadership in Energy & Environmental Design Rating System (LEED), the Green Guide is tailored to work within the framework of specific health care regulatory requirements, such as Infection Control Risk Assessment (ICRA) that control aspects of acute care hospital physical' environment and facility operations. Traditionally, pollution prevention and occupational safety and health have been approached as separate issues. As a result a solution for one may merely shift a new problem into the other. The underlying premise of the hospital sustainability is integrating pollution prevention with occupational safety and health which results in more sound and appropriate solutions.

2.4 The concept of recycling for sustainability

The first fundamental rule of ecology is that everything is connected, it is a holistic concept. Practising recycling to protect the natural environment is connected to everything and everywhere (Clark, W C, *et al.*, 2003; Binder C and Wiek A, 2005) Sustainability, which is considered as the broadest and most inclusive conception of environmental protection or stewardship, is all about meeting the needs of the present without compromising opportunities for the future. Sustainability is not just about maintaining the health and productivity of the natural environment but also maintaining the health and productivity of the social environment, because nature and society are critically interconnected. Sustainability therefore is involved in every aspect of life. It is about societies, communities and families as well as air, water and earth. Sustainability within this context embraces the holistic reality of the biosphere. In addition, sustainability is inescapably about economics. The economy is the means by which we as individuals relate to our natural and social environments (Jackson M, 2002).

Sustainability is also ultimately about energy because energy is involved in everything that sustains human life on earth. Environmental pollution, peak oil production, and global warming are in reality energy concerns. Energy is required in all aspects of human life. All things that we make use of, our houses, clothes and food require energy to make, energy to use, and in fact, are made of energy. All things that we do, thinking, and managing also requires human energy. Although less widely recognized the same basic principles apply to social energy as well as physical energy (Shah T, 2000).

Our social relationships lead to all human resources such as labour, management, and innovation. Without the help of other people, no one of us can be born. It takes a great deal of social energy to maintain a productive human society, and this energy is not available for any other use. This is actually the essence of social entropy and it is also inevitable (Bailey K, 1990; Shah T, 2000).

Currently, the fundamental challenges of sustainability originate directly from our working system of economics, the system via which people conduct their individual relationships with each other and with their natural environment. The dominant capitalist economy today, inevitably disperses, disorganises, and depletes both physical and social energy towards the process of producing things that are of use to us. However, such an economy does nothing to re-concentrate, re-organize and re-generate the extracted energy from nature and society. Everything we know about the basic nature of natural ecosystems and human societies suggest that today's economic planning horizons are simply too short to ensure the long run sustainability of humanity (Shah T, 2000; Minsky H, 1992). No matter how much we might wish otherwise, we must confront the reality that little purely economic incentive exists to support recycling, particularly the type of recycling activities necessary for long run sustainability. However, the economic incentives make the risks of recycling

investments more acceptable. Ultimately, the sustainability of human life on earth depends upon the willingness and ability of both individuals and businesses to look beyond their individual economic self-interests and to act with true ecological and social integrity. Recycling has in fact the potential to be an important strategy for long run sustainability, if we are willing to look beyond short run economics. Firstly, recycling most certainly can enhance the health and productivity of natural ecosystems. Recycling that reduces toxic waste and environmental pollution obviously provides immediate benefits to human health. By reducing waste, recycling also conserves natural resources, protects natural ecosystems, and encourages biological diversity, all of which enhance the long run sustainability of the biosphere. Waste is in fact energy that has been transformed, but not used, in the process of doing something useful. In fact, waste means wasted energy, Toxic waste or pollution is negative energy in the sense that it takes energy to mitigate the negative impacts of polluted air or water. Entropy is inevitable but waste is not and recycling reduces wasted energy. The tremendous material progress of the industrial era has been possible only because of the relative abundance of fossil energy (Bailey, K, 1990; Fenge T, 1996). However, the days of plentiful, low cost fossil energy are nearing an end, if not already over. Global petroleum is expected to be the first fossil energy source to peak, if it hasn't already, and after the peak, to slowly but inevitably decline. Other sources of fossil energy, including natural gas and coal also will peak and decline, more quickly if they are substituted for petroleum, more slowly if we reduce our total energy use.

One of the most effective means for reducing future energy use is recycling, which simply implies turning energy wastes into energy resources. Recycling turns wasted energy into useful energy, reducing our reliance on declining fossil energy and enhancing long run sustainability.

The attitudes of health workers towards recycling of hospital waste represent an important way of understanding and thinking about energy savings and concerns about environment.

Chapter 3 Hospital waste management

3.1 Definition of hospital waste

All the wastes generated by medical activities come under healthcare. They are involved in diagnostic activities and preventive, curative and palliative treatment in both the human and veterinary fields of medicine. In short healthcare waste is all the waste produced by medical institution (public or private), a medical research facility or a laboratory (Graikos *et al.*, 2010).

HCW is defined as any waste, which consists wholly or partly of human or animal tissues; blood or other body fluids; excretions; drugs or other pharmaceutical products, swabs or dressings; syringes, needles or other sharp instruments (Blenkharn , 2006) WHO has originally classified hospital waste into 5 (A to E) main categories as shown in (Table 3.1). Waste management in general has been posing major concerns for the sanitary authorities in developed as well as developing countries, and this is particularly true when it comes to healthcare waste (Taghipour H and Mosaferi M, 2009).

It is very important therefore to impose a hospital policy in each hospital to follow the current guidelines in the management of healthcare waste through meticulous segregation, proper handling and safe transport of this waste in order to ensure the health and safety of the staff, patients, public and indeed the environment. (Hall AG, 2008). This can only be achieved if the process is subjected to a continuing revision of practice, to ensure that best practice is being followed (Baillie J, 2008).

Table 3.1 WHO classification of HCW

Group	Details
Infectious	Material containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This includes waste from surgery and autopsies on patients with infectious diseases
Sharps	All Sharp materials used during providing healthcare, such as needles, scalpels, etc
Pathological	Tissues, organs, body parts, human flesh, fetuses, blood and body fluids;
Pharmaceuticals	Drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required.
Radioactive	Solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goiter
Others	Waste from the offices, kitchens, rooms, including bed linen, utensils, paper, etc.

Hospital household waste (HHW), unlike other categorized HCW, does not pose the traditional hazards of transmission of infectious diseases (Graikos, *et al.*, 2010). HHW is divided according to the WHO's classifications into 2 main groups: group A, includes office and kitchen use and group B, which includes broken glasses and used aerosols, (Table 3.2).

Table 3.2The classification of HHW

Groups	Details
Group A	Office waste, e.g. paper, cardboard, packaging that is not contaminated with blood/body fluids, used paper towels that are not contaminated with blood/body fluids, newspapers & magazines, and discarded flowers
Group B	Broken glass & used aerosols

In 2007, the Royal College of Nursing published a concise 17-page booklet aiming to provide information to healthcare providers about the safest methods of dealing with healthcare waste (The Royal College of Nursing, 2007). This booklet proposed a new system of classifying hospital waste (healthcare waste, infectious waste, medicinal waste and offensive/hygiene waste) hazardous or non-hazardous waste. It defines the previous A-E system as old and invalid.

However, this does not eliminate the segregation of the hospital waste into different categories, but rather it divides it into two main sections; hazardous and non-hazardous waste. The hazardous could be further classified into infectious, cytotoxic, sharps, etc and non-hazardous could be further classified into hospital household waste, safe non-infectious healthcare waste, etc. In terms of managing waste disposal this new classification is decidedly more efficient and safe, as it will help in avoiding iatrogenic accidents during the different processes of collecting, transportation and disposal (WHO, 2000; The Royal College of Nursing, 2007)

Many environmental and economic leaders support reduction in the volume of HCW produced by hospitals. This waste is costly in disposal, and strategies to reduce expenditure through improved segregation and elimination of non-hazardous items from this waste stream may afford significant savings. However, some waste reduction

strategies may extend beyond safe limits and create additional risks to deliver a "sting in the tail" for healthcare waste management. Recycling has potential environmental and financial benefits, but it is hampered by convenience, technology, lack of knowledge, concerns about environmental safety, and statutory regulation (Tonglet *et al.*, 2004; Tudor *et al.*, 2007; Do Valee *et al.*, 2004;Olko, P and Winch, R., 2002).

This also opens the potential for new trends in hospital management such as recycling non-hazardous waste, which we are examining in this thesis, particularly to understand the knowledge and attitudes of healthcare staff and waste management staff towards recycling of the HHW. The reduction of hospital HHW has been identified as a key component of waste management strategies throughout Europe. A number of theoretical approaches and research methods have been employed to investigate why people behave the way they do as the first step towards improving HHW behaviour and in this thesis we aim to do this for hospital staff.

Reducing HHW has become an area of prime concern for national governments, policymakers and local communities across the globe. Indeed, research investigating elements of waste management behaviour, as a precursor to understanding how to change that behaviour positively, has been considered before in Resources, Conservation and Recycling (Barr *et al.*, 2005; Martin *et al.*, 2006; Davies *et al.*, 2005; Meneses and Palacio, 2005).

Paper and plastic comprise the largest proportion of hospital waste but these are not recycled in many hospitals although paper and plastic recycling is becoming a part of today's culture in many nations around the world. Other hazardous, large-quantity products that we use in hospitals include small batteries. Yet, as is true of most hospitals, there was no programme to recycle these small batteries which contain a

wide range of potentially toxic metals including cadmium, lithium, mercury, and lead (Schultz *et al.*,1995; Miller, G.T, 2000).

3.2 Methods of clinical waste disposal

The majority of the HCW (75-90%) is similar to domestic waste, for example paper or packages, and these fall under HHW. Around 10-15% is hazardous waste, which poses a risk to human health and the environment (The Royal College of Nursing, 2007). Therefore it is crucial to ensure the correct disposal of HCW which starts at the ward and needs proper understanding and expertise from the healthcare professionals in the establishment. Failure to segregate infectious/hazardous waste from non-infectious/hazardous waste leads eventually to the labelling of the entire waste stream as infectious, which causes further economic and managerial impacts on the hospital (Blenkharn JI, 2007).

No matter what techniques are involved in the final disposal of HCW, it should be segregated into two main categories; hazardous and non-hazardous, regardless of the original nature of the waste (The Royal College of Nursing, 2007). This makes the disposal of the largest portion of HCW much easier and safer. It also facilitates the process of disposal of the hazardous waste, as this will be of a smaller volume. This thesis focuses on the non-hazardous portion of the HCW, which categorised under HHW. However, hospitals that don't apply the new concept of segregation into hazardous and non-hazardous will end up sending a large proportion of HHW along with the hazardous waste. It is important therefore to go through the different techniques used in the disposal of hazardous HCW.

a. Incinerators

Incinerators for medical and municipal waste have been linked to severe public health threats and pollution (Wassermann D, 1999). Intense public opposition combined with the increasingly stringent environmental protection laws have led to the closure and cancellation of many incinerators in the UK (Wassermann D, 1999). The remaining incinerator operators are now faced with strict emission limits that were implemented from June 2000.

Incineration is not the same as burning. Proper incineration is a highly advanced technology that can adequately treat all types of special HCW (Lee *et al.*, 2004) about 49–60% of medical waste is treated by various incinerations, 20–37% by autoclave sterilisation, and 4–5% by other methods. Incineration and steam autoclave sterilisation are the main methods currently being used and are considered mature technologies (Jolly, *et al.*, 2004).

The technology of small-capacity incinerators, for use by a single medical facility, is often rudimentary. These installations are not recommended, since they may constitute a serious air pollution hazard to the surrounding area. WHO recommends closing down small incinerators that are not operating satisfactorily Incineration is an option for certain types of HCW (and is the preferred method for some substances such as cytotoxins and other pharmaceuticals) but it needs to be carefully operated and controlled. Regulatory agencies in the United States and the European Union have adopted emissions limits for medical waste incinerators that include, among others, values for dioxins. It is recommended that incinerators installed under any major project pay attention to national regulations and/or look to the examples set in other countries such as in the EU Member States (Davies AR 2005; Alvim F *et al.*, 2000).

b. Steam autoclaving

Steam Autoclaving is the most broadly used and most efficient alternative medical-waste-treatment technology. Most available autoclaves are able to handle both biohazard and normal hospital waste. However, the disadvantage is that they cannot treat pathological animal waste, chemotherapy waste, and low level radioactive waste. Thus these types of waste have to be treated separately. Medical waste autoclaves generally jointly operate with a shredder, and a compactor (to minimize the waste volume).

In autoclaves, the effects of heat from saturated steam and increased pressure decontaminate medical waste by deactivating and destroying microorganisms. There are two types of autoclaves, gravity displacement and pre-vacuum. Those designed for medical waste are mostly pre-vacuum types (Jolly, *et al*, 2004).

c. Chemical treatment

In chemical treatment systems, an anti-microbial chemical, such as sodium hypochlorite, chlorine dioxide, or peracetic acid, decontaminates the medical waste. Most chemical treatment systems, currently in use, operate at ambient temperature (Cheong, *et al.*, 2007).

d. Microwave radiation

In Microwave Radiation, medical waste enters the system by batch or continuous mode, where it is wetted with steam or water and heated by microwave radiation at de-contaminating temperatures (Hoffman PN and Hanley MJ, 1994).

e. Other treatment systems

Infrared radiation and forced hot air convection are combined to treat healthcare waste which is then compacted and prepared for the landfill. Some systems use gamma

radiation and a part of the residue is recycled while the rest is disposed. Other systems use steam, oil, electricity or other forms of radiation as a heat source (Daronch et al., 2006).

f. Disposal of Pathological Waste

Pathological waste (body parts, research animals, etc.) cannot be disposed of by autoclaving. For disposal of such waste, either Cremation (burning of the body) or burial should be performed (Zarbo PJ and D Angelo R, 2005)

3.3 Safety of recycling healthcare waste in developed and developing countries

The safety of the recycling process of HCW depends primarily on the procedure used and on how much the procedure is monitored. The recycling of HCW, since it was introduced, has been practiced and monitored by the concerned authorities in the developed countries. This is to ensure that the hazardous waste is segregated separately and is not mixed at all with non-hazardous. However, uncontrolled recycling of HCW in some developing countries takes place by collection of dumped HCW by scavenger boys and other collectors. Abdul Mujeeb *et al.*, (2003) who studied recycling of equipment for injections in Pakistan found out that a large proportion of clinical laboratories dump the used syringes in the general municipal waste sites instead of designated HCW sites. Some clinical laboratories reported selling the used syringes to local dealers. Scavenger boys collect HCW, including the used syringes and sell them to HCW dealers, who reported selling them in turn to the plastic ware industry. Most of the used syringes were crushed into small granules for the manufacture of plastic items (eg, coat hangers or buckets). It has been noted that most customers cannot distinguish between used repackaged syringes and new sterile syringes (Abdul Mujeeb *et al.*, 2003).

The World Health Organization WHO, (2003) recommends that sharps waste management be ensured through (1) a policy framework that states that healthcare systems should manage the waste that they produce as part of their duty of care; (2) the development of a comprehensive system from waste production to waste disposal that includes waste reduction through preventing unnecessary use of sharps; (3) training at all levels; and (4) choice of a waste treatment option that includes incineration and non-incineration technologies (Pruss A, *et al.*, 1999; WHO, 2000).

Khan AJ *et al.*, (2000) have shown that the uncontrolled use of recycling of syringes for injections has caused transmission of hepatitis B and C in periurban communities in Pakistan. In India an outbreak of a dangerously mutated strain of hepatitis B that could kill its victims in an unusually short time was linked to the use of recycled syringes.

Over the past two decades in the developed countries, concerns about the risk of prion transmission and sterility have led to large increases in both the amount of aseptic anaesthetic packaging and the use of disposable devices. Most of the waste was thus incinerated, although some of it is potentially recyclable. The UK government and the British Medical Association have published strategies for greener health care in 2008. Although recycling has potential environmental and financial benefits, it is hampered by convenience, technology, lack of knowledge, concerns about environmental safety, and statutory regulation. Clinicians might cut the amount of waste they produce by reducing, reusing, and recycling resources and suggest ideas for future research (WHO, 1999; WHO, 2000; DETR, 2000).

Fear of the microbiological aspects of recycling of HCW may represent a psychological hindrance preventing the healthcare providers, workers and organizers from practising recycling. There have been calls for waste minimization and for a return to reusable rather than single use items where possible despite the convenience of the latter

(Tieszen ME, and Gruenberg JC, 1992). Difficulties encountered in decontaminating some reusable equipment means that hospitals have to be willing to commit space, equipment and personnel to a decontamination unit. The transport of liquid waste containers such as suction bottles within the hospital is hazardous because of the quantity of fluid (often bloodstained) involved and the risk of breakage or leakage.

3.4 Hospital waste in UK hospitals

Much of the research work into the overall management of hospital and general HCW has been done outside of the UK, in countries such as the United States of America (Health Care Without Harm, 2001), (Lee *et al.*, 2004), India (Patil and Shekdar, 2001), Saudia Arabia (Almuneef and Memish, 2003), Tanzania (Mato and Kassenga, 1997), The Netherlands(Dijkema *et al.*, 2000) and Finland (Ponka *et al.*, 1996). This has been due primarily to stricter legislation and higher landfill costs, compared to the UK. Hospital waste management is closely monitored by the healthcare authorities. The valid legislation includes the Environmental Protection Act 1990 (Part II), Waste Management Licensing Regulations 1994, and the Hazardous Waste Regulations (England & Wales) 2005, as well as the Special Waste Regulations in Scotland. However, Hospitals in the UK have been shown to be amongst the highest producers of hospital waste amongst developed countries, one of the most comprehensive surveys states that the NHS produces some 600,000 tonnes of clinical, pharmaceutical, infectious and domestic waste per year, at a cost of £42 million (Coote, 2002). Hence despite the many policy documents within the NHS aimed at greater resource efficiency, quantities of waste continue to rise rapidly (Woolridge *et al.*, 2005; Tuder*et al.*, 2008).

UK is the largest producer of HCW in Europe. In 2007-2008 hospitals in UK produced approximately 190000 tonnes of HCW. In addition to that a lot of HCW is generated from the 20000 care homes and 40000 beauticians operating around the country (Tudor et al., 2009). (Table 3.3) below shows that hospitals in UK on an average generate 5.5kg of medical waste per person per day, which is very high when compared to the other developed countries.

Table 3.3 HCW generation in selected countries

Healthcare waste generation in Kg per patient per day

Country	kg/patient/day
UK	5.5
Ireland	2.6
USA	2.2
France	1.9
Portugal	1.5
Belgium	1.4
Greece	1.4
Italy	1.0
Spain	0.6
Netherlands	0.6
Taiwan	0.5
Germany	0.4

Sources: Krisiunas *et al.*, (2000), Chung and Lo (2003).

The medical waste disposal in the UK has become very expensive and it is estimated that UK spends more than £125 million for the treatment of HCW (Tudor *et al.*, 2009).

Hence, there has been a growing interest among the various hospitals to find out different strategies to reduce the amount of medical waste generated. Also, there has been increase in development of recycling programs for HCW in recent years (Wen and Eaves, 2003; NHS Estates, 2002).

A good example of changes to hospital waste management comes from Scotland, there were over 150 small incinerators located on different hospital premises a decade ago, operated mainly by portering staff with poor combustion and no gas cleaning equipment (James R. 2010). At that period, incinerations were the main means of hospital waste disposal. Other alternatives were at that time very expensive (Lee C, G. L. Huffman, 1996). A strategic study at the time proposed the installation of 12 centralized modern incinerators on the mainland and three on the islands: one per Scottish Health Board. Some health boards proceeded with new installations well ahead of dead-lines for closure of old plants. Others adopted a more passive policy and were overtaken by political changes. These resulted in a cutback in government-funded capital investment followed by a shift of non-core services to the private sector. HCW disposal was contracted out as a service contract and some private sector companies offered alternative low-temperature technologies for HCW treatment. As a result of this the opportunity to compare the efficiency and benefits of incineration, sterilization, dry heat disinfection and other techniques arose. Technological change has also demanded revised waste segregation methods within the hospitals. At the same time there has been a general reduction in the quantities of waste. The remaining incinerator operators are now faced with more stringent emission limits and laws which were implemented in June 2000. This has resulted in the closure of incinerators that had been operating for only a few years. The situation continues to change (Wassermann D, 1999). In 2006, a study by Blenkharn suggested that substantial improvement is required in the management of HCW in the UK hospitals. UK regulatory guidance promotes the classification of HCW into hazardous and non-hazardous streams. His suggestions in this study and in other similar works may have contributed in the changes that have

taken place in relation to hospital waste disposal in the following years, such as the concept of segregation of HCW into two main streams.

3.5 Hospital waste in Libyan and other North African hospitals

Very little is published about hospital waste and waste management in general in Libya. Altabet, (2004) has presented repeatedly some data in different local conferences between 2002 and 2009 but none of his work was published in an academic journal. Sawalem et al., (2009) published a case study about HCW management in Libya that involved 14 healthcare facilities in three cities, Tripoli, Misurata, and Sirt, which are all located in the north western part of Libya. This showed that the average waste generation rate was 1.3 kg/patient/day, and comprised of 72% general HCW (non-risk) and 28% hazardous waste. The average general waste composition was: 38% organic, 24% plastics, and 20% paper. Sharps and pathological elements comprised 26% of the hazardous waste component. Hamoda et al., (2005) and Mohee, (2005) offer a comparison of waste generation rates reported in different countries. This comparison shows that developing countries have low waste generation rates when compared to industrialized countries in Europe or the Americas. The difference is consistent with different living habits and standards, and due to the availability of treatment facilities (Almuneef, M and Memish, Z.A., 2003).

This study was conducted during the tyrant Qaddafi's regimen. All environmental issues were completely neglected during that regime's time in office. The whole waste management system in the country is decades out of date and the concept of recycling in general were shunned. The waste management strategy in Libya is determined by the Environmental General Authority (EGA), which reports to the Ministry of Public Health and Environment. A major short term goal for EGA is to improve the standard

of landfill operations. In the longer terms alternative disposal technologies are sought. However, the strategy has no measurable targets and non-compliance does not carry a penalty.

Recently, Etriki and Deutz, (2012) reported a short summary about general waste management in the capital city of Tripoli, focusing on the financial aspects of waste collection and disposal. According to this short report, since 1990 private companies were involved in waste collection on behalf of the municipality. Residents have been exempted from collection charges since 2009. The role of these collecting companies is purely to collect the waste and transport it to the municipality's disposal sites. The mode of transport often involves open lorries. Neither health and safety equipment nor staff training is required by the municipality.

Studies concerning knowledge and attitudes towards HCW management and concerning waste management in general are very scarce in the North African region and the countries neighbouring Libya. Most of these reports are concerning with specific aspects such as sharps and needle disposal and dental managements, rather than considering the knowledge and attitudes or exploring the subject of hospital waste management as a whole.

Massrouje HT. et al have published a study in 2001 concerning healthcare problems in Gaza (Massrouje HT. 2001) demonstrating system inconsistency in HCW management in Gaza. Segregation was only conducted for sharps and there were no use of colour-coded bags. Medical waste was stored and disposed of with domestic waste in primary health care clinics and was incinerated in hospitals, but there were no emission control or safety measures. Most importantly, their results, in parallel with the results of this thesis, showed gaps in knowledge and attitudes of healthcare workers and inadequate

practices. However, there is generally a positive attitude to improving medical waste management among those surveyed and interviewed. A national programme for medical waste management was considered essential in Palestine. (Massrouje HT 2001).

Mostafa GM et al have published a very alarming report from Egypt concerning the knowledge and attitudes of healthcare workers towards HCW management (Mostafa GM et al,. 2009). His cross sectional study involved eight surgical units at Al-Mansoura university hospital, which is one of the leading hospitals in the country. Similar to this study concerning the Libyan health workers, the majority of the Egyptian health the workers demonstrated low scores of knowledge and even lower scores in the attitudes and practice. Similar to this thesis, training was found to be an important factor affecting both knowledge and practice. Mostafa GM et al,.(2009) have intervened to provide training and showed that the knowledge and attitudes improved significantly after attendance of training programme, however no recycling practice was reported in their study.

MM Abdel Salam et al (2010) have shown that almost two-thirds of the HCW of 8 randomly selected Egyptian hospitals in Damanhour City of El-Beheira Governorate was HHW. This means that this amount is potentially recyclable. However, no recycling was practiced in any of the studied hospitals.

Bendjoudi Z, et al (2009) have published a study about the HCW management in Algeria that involved 95 hospitals across the country and demonstrated that the WGR ranges between 0.7 to 1.22 kg/bed/day, with no evidence of any recycling practices.

Mbarki A, et al (2013) has recently published a qualitative study in Morocco exploring the knowledge and practices of physicians, nurses and housekeepers using

questionnaires and interviews. The study showed that WGR ranges between 0.4 to 0.7 kg/bed-day with a an average of 0.53 kg/bed-day. Although 69.5% was HHW, no recycling practices were demonstrated. Surprisingly in this study, the housekeepers demonstrated the best knowledge, followed by nurses and physicians who showed the lowest levels of knowledge.

Reviewing all of these studies from neighboring countries to Libya, shows clearly that despite the high percentage of HHW, recycling of HCW is not a common practice in Libya or the North African region as a whole.

Chapter 4 Household waste

4.1 Definition of household waste

Within the healthcare network, the term HHW is simply used to describe non-infectious, non-hazardous waste. It is similar to the domestic or municipal waste that comes from homes (Feuilade F, *et al.*, 2008).

This definition becomes more practical after the introduction of the unified approach in the classification of HCW on the basis of hazardous characteristics and point of production, which recognises only two types of HCW, hazardous and non-hazardous regardless of the waste category (Costa-Font J, *et al.*, 2008; The Department of Health, 2006). HCW is composed of hazardous waste (HW) and non hazardous waste (NHW). HHW is part of the NHW, which according to the current guidelines should be segregated from the HW from the first chain of collection point (Royal College of Nurses, 2007). The logistics management of HCW include collection, transportation, interim storage, and disposal, whether HW or NHW. The segregation and separation processes of HW and NHW should be carefully instituted continuingly during all of these stages of HCW management (Belnkarn J, 2006). In fact, identification, separation and segregation of HCW are inevitable if recycling is planned (Tudor T, *et al*, 2006: Belnkarn J, 2007). Different case studies performed in different hospital setting in developing and developed hospitals have demonstrated that HHW represents substantial proportion of HCW. Rayner, 2003, suggested that about 25% of the HCW could be classified as domestic (HHW). Tudor T *et al.*, (2006) showed that with carful segregation, the percentage of the HHW in the HCW main stream could be reduced by as much as 60%. The same author showed that the proportion of HHW in HCW stream

varied from department to another with an average percentage of 50% (Tudor T, *et al.*, 2006). In addition, the same authors demonstrated in the same study that as much as 40-50% of the HHW stream consisted of recyclable items such as office papers, cardboard, newspaper/magazine, metal and plastics. Swalem M *et al.*, (2009) who published case studies from different Libya hospitals, showed that the hospital waste analysis comprised of 72% general waste and 28% HW. When looking at what they called general waste, it was comprised of 38% organic waste, 24% plastic, 9% textile, 8% glass and 1% metals, which suggests that this is actually domestic HHW. This suggests that up to 62% of the HCW in the Libyan hospitals are recyclable. Jang YC *et al.*, (2005) have suggested that with good waste management, HHW may represent up to 90% depending on the healthcare setting and local hospital policy therefore is considered the largest waste stream for hospitals.

4.2 Household waste management in hospitals

Hospitals have shown to be slower in instituting recycling programmes of their HHW compared to the general public where increasing number of people are recycling their domestic waste. The UK government and British Medical Association have published clear strategies for sustainable healthcare (NHS Sustainable Development Unit, 2008). HHW is highly recyclable and although its recycling has potential environmental and financial benefits, it is hampered by convenience, technology, lack of knowledge, concerns about environmental safety and statutory regulation.

There are generally three methods applied for the management of the HHW, which are categorised under the three R rules; Reduce, Reuse and Recycle (La Rue, 1997). This is in addition to the rendering safe rule for the management of the HCW.

All healthcare providers of all categories as well as hospital waste collectors have an important role in the management of HCW and should not be discouraged by either lack of knowledge or the threat of legal liability (Massrouje,H, 2001). As at home, the same principles of reducing waste are applied at work and in healthcare settings, and these are be responsible, reduce, reuse and recycle (WHO, 2004; Griffiths J, 2008). Hospital trusts, healthcare providers, other hospital employees, hospital purchase, pharmaceutical and hospital supply companies are among many other factors affecting the waste management (Coote A, 2008).

The best management practice for HCW is to prevent and minimize the generation of waste (Jang *et al.*, 2005). The management of HCW must be consistent from the point of generation to the point of final disposal. According to (WHO, 1999; WHO, 2000; WHO, 2004), the correct point for segregation of waste is at the point of generation. To encourage segregation at source (reusable) containers or baskets with liners of the correct size and thickness must be placed as close to the point of generation as possible (WHO, 2000).

Healthcare providers are very busy with their clinical work and so consideration for what happens to the waste they generate in the course of caring for their patients is generally not a high priority (WHO, 2004). However, generated waste is considerable and decisions about its final disposition can have a great impact on environment and on human health. The knowledge and perception of healthcare providers and other hospital workers are therefore essential to understand when planning for adoption of a policy in the management of HCW. Previous research has shown that physicians did not know that HHW represents the highest proportion of HCW that may reach up to 75% of all HCW (Tudor, *et al.*, 2005; Jang Yong-Chul., *et al.*, 2005; Rayner, 2003; Barratt *et al*, 2004).

In most of the developing countries, the infrastructure for recycling practices is still marginal both in public and in healthcare sectors (Begun RA, *et al.*, 2009; Uiterkamp BJS, *et al*, 2011; Kumar R, *et al.*, 2010)

There is little practical thought about recycling due to fear of transmitting diseases and other hazards. There is thus a clear gap in the medical literature concerning what the healthcare providers and managers think about the best way of dealing with hospital waste. In developing countries, it seems that there is now a clear pathway for waste management planning that can avoid repeating the same mistakes that hospital managers did in the developed countries e.g. use of poorly designed and operated incinerators (Sawalem M *et al.*, 2009). Very little is known about the hospital procurement, purchase policy and waste management in developing countries. Hospitals are the key institutions in any national healthcare system and their waste-management decisions are just as important as their purchasing decisions and involvement of healthcare providers in this process is essential particularly in order to reduce waste generation. In the last 10 years, there has been remarkable progress in waste management from an environmental health perspective. The waste management efforts of the late 1990s have also included emphasis on thoughtful waste disposal as described by what environmental protection scholars like to call the "3 Rs" to guide waste management, which are detailed in the following sections:

1. Reduce

The most efficient method to reduce waste is to make proper use and control of the amount of resources used in the first instance (La Rue, 1997). As an example of this, it has been shown that single wrapping of sterilised instruments is as effective as double wrapping in preventing bacterial contamination; therefore many hospital trusts have changed their purchase policies to order single wrapping of sterilized instruments (Barr

S *et al.*, 2001; Webster J, *et al.*, 2005). This reduces the annual running costs as well as generated waste without compromising the quality of patient care. In Libya, the purchasing policy is not left to individual hospitals to decide but rather the ministries of health purchase via large tenders and in most of the cases, there is no plan and no policy that responds to what has been shown feasible by evidence based medicine (Deutz and Frostick, 2009). In the UK, the National Health Service (NHS), which has considerable financial power concerning drug and equipment purchase, could insist that companies reconsider their packaging strategies without compromising product sterility or performance. Paperless practice using electronic medical and patient records has shown a remarkable reduction in the paper-waste generation, which is part of HHW and can even make the clinical work easier, more accurate and more secure (DETR, 2000). Purchase of durability is also another way of reducing waste generation and is achieved by purchasing durable equipment instead of disposing of items and purchasing new ones (WHO, 2004;WHO, 2002). Durability is also achieved by use of consumables such as rechargeable batteries and refillable ink cartridges, using oral medications rather than intravenous preparations whenever possible results in significant reductions in the use of needles syringes and dressing materials.

It also makes a big difference being meticulous in filling sharps bins full before disposal. There are many other suggested methods and ideas in reducing the hospital waste:

- Use small aperture sharps bins
- Use large waste receptacles
- Unpack equipment only when it is needed
- Consider whether equipment is actually needed

- Keep ward and theatre temperature to a safe minimum
- Turn off electronic equipment that isn't being used
- Avoid the use of nitrous oxide
- Avoid plastic bags for collecting dry waste

2. Reuse

Single use devices (SUD) have frequently replaced reusable devices and appliances in the healthcare settings all over the world, particularly in the developed countries where the budget allows this. This is due to continuing concerns about cross infection. However, it remains unclear whether the risk of infection is real or perceived (Rowley E and Dingwall R, (2007), particularly with regard to prior transmission (Blunt MC and Burchett KR, 2003). Many clinicians and microbiologists have started to wonder whether what actually required with regards for keeping aseptic environment are effective sterilisation procedures rather than disposable devices (Laupu W *et al.*, 2006). Reusing single use devices has been shown to save money, provided no adverse events occur and would also reduce packaging and HCW. However, there could be legal ramifications against prolonged single use devices concerning patient safety (Carey D, 2001; Jacobs P *et al.*, 2008). The Medicines and Healthcare Products Regulatory Agency in UK has stated that "Anyone who reprocesses or reuses a device intended by the manufacturer for use on a single occasion, bears full responsibility for its safety and effectiveness," exposing doctors and hospitals to civil liability (Medicines and Healthcare Products Regulatory Agency, 2006). The following are some ideas and thoughts on how to apply more reuse practices in healthcare settings:

- Use unpackaged but unused equipment if it is safe to do so

- Consider reusing devices with low risk of passing infection (eg, calf compressors)
- Drink from china cups not plastic disposable cups
- Consider using washable sharps bins and waste containers, emptied into a central hospital collection point
- Consider schemes where companies collect and refill used receptacles

3. Recycle

Recycling seems to be a key topic that brings the attention of stakeholders within the healthcare settings and starts to gain an increasing response. It is the process of transforming one item into another usable item, is less energy efficient than reduction or reuse because it takes energy to transport and transform materials (Schultz P, W *et al.*, 1995). However, given the sterility concerns about reducing packaging and reusing equipment, recycling becomes important for medical waste. It is very important to make the segregation as early as possible during the process of HCW disposal to avoid contamination with infectious waste, which makes the recycling more complicated if not impossible (Health-Care Without Harm (HCWH), 2001).

Papers and plastic waste are highly potentially recyclable and should be separated immediately at source and flat packed for transfer. Lee *et al.*, (2002) have estimated that about 30% of surgical HCW is plastic, mainly from packaging (Lee BK, *et al.*, 2002; Ball, R. and Lawson, S. M, 1990). Recycling plastic is expensive, but plastic has a high recycling potential, and financial savings are possible. Globally, recycling plastic reduces the demand for oil, which is still the main soruce of energy. It has been shown that 4% of annual global oil use is as a raw material for plastic; another 4% provides energy for the production process, and reduces the hazardous waste pollutants

produced by new plastic production. It has been suggested that recycling of glass is more advanced than that of other materials (Lee BK, 2002; Medicines and Healthcare Products Regulatory Agency). In 2007, the UK recycled 57% of the glass it used. It is interesting to note that glass can be recycled an unlimited number of times without adversely affecting quality (Tudor TL *et al.*, 2007). Reduced quarrying and transport costs and lower furnace temperatures mean that for every tonnes of recycled glass produced, 1.2 tonnes of raw materials are conserved, compared with the production of virgin glass. Glass products used in anaesthesia may be contaminated with potentially hazardous materials (for example drugs). Nevertheless; contaminated glass may be safe to recycle because of the high furnace temperatures (1500°C) used in the recycling process. In practice, recycling of an anaesthetic bottle has been found to be achievable and financially viable (Gaiser R, *et al.*, 2003; Lee, *et al.*, 2002).

Improved disposal systems, waste reduction, recycling, and staff training was proposed as an integrated, sustainable approach to managing hospital waste, that has financial and environmental benefits. Cornwall NHS Trust, for example, reduced domestic bag and clinical waste by about 15%, and estimates that waste could be reduced by up to 30%, with a similar percentage saving in disposal costs (Tudor TL, *et al.*, 2005).

4.2.1 Advantages of recycling HHW:

- Reduced volumes of HHW requiring disposal.
- Consequent savings to budget for HHW disposal.
- Earnings from reused and recycled materials such as papers, glass plastic.
- Reduced environmental problems associated with disposal and reduced consumption of natural resources.

4.3 Household waste in UK

Waste management in the UK is undergoing rapid change as national and European legislation, combined with the ever diminishing landfill capacity, forces a move towards a more integrated, sustainable system for managing waste (Read *et al.*, 1996). According to the UK government, the options available for diverting waste from landfill include, in increasing order of preference: incinerating waste to produce energy, recycling waste, reusing materials and minimising waste production (Lee, B *et al.*, 2004; Health-Care Without Harm, 2001). Of these four options, recycling is by far the most well-known and best established practice, but despite improvements in England 78% of MSW was buried in the ground (landfilled) in 2000/2001. This is not the best way of dealing with our waste as it impacts on our health and the environment, and with waste growing at about 3% per year nationally there will be twice as much to deal with by 2020.

The publication of the UK government's Waste Strategy (DETR, 2000; Price, 2001) for England and Wales in June 2000 placed recycling targets as its priority and by 2005, the government wished to see 25% of waste recycled, with 30% recycled by 2010. To realistically achieve these ambitious targets, the government set targets for local authorities, related to their current recycling rate.

During the late 1980s and early 1990s, it was common place for yellow bag clinical waste to be incinerated in municipal plants run by local authorities (Sim , 1999). Along with continuing development of hospital waste management, came a mandate for greater segregation of HCW and also strict regulations (by 1996) for incinerators accepting this waste. The high costs of implementing these new restrictions resulted in the closure of several incineration plants in the late 1990s. Since then, the NHS has

begun to record and monitor bagged general and HCW as a result of contracts put in place for the removal of these wastes by registered contractors (Coote , 2002). On an annual basis the NHS produces 600,000 tonnes of clinical, pharmaceutical, infectious and domestic waste, at a cost of £42 million. The legislative requirements, the costs involved and the improved awareness of issues amongst the public and staff via sustainable development targets, have served to raise the profile of waste in the NHS nationally over the last decade.

With regards to the recycling of hospital waste, several hospitals in the UK including the hospitals included in this study have started to examine options for waste minimization, waste segregation; alternatives to disposal (NHS, 2001b; NHS Estates, 2002). Despite the progress there has been a lack of emphasis on the reduction of waste and long term planning for waste minimization; this leaves the NHS behind other sectors of the community including industry and householders who have been targeted in a more holistic way by local authorities (Tonglet *et al.*, 2004).

This has directed the focus to the management of disposal procedures, HCW reduction and quick win diversions of material from the domestic waste routes into low or no cost recycling (Rayner, 2003; Barr, 2003; Tudor *et al.*, 2005).

4.4 Household waste in Libya

In Libya, there has not yet been any widely published research that has described attitudes to recycling. In fact, there has been very little published work about municipal waste management from Libya.

According to Etriki, J and Deutz, P, (2012) both the national government and the Municipality of Tripoli have expressed an interest in promoting recycling. Just under a

third of waste collected is being sent to waste sorting facilities. However, separation is a manual process and only the most conspicuous and easily separated items can be salvaged. Currently, there are no reprocessing facilities in Libya. The major markets for recycling are in the neighbouring countries of Tunisia and Egypt. Tripoli has a composting plant that has been in operation since the 1980, but owing to the inefficient separation process, the compost is commonly contaminated with glass and especially plastic, which limits the potential market. (Etriki, J and Deutz, P, 2012).

According to Sawalem *et al.*, (2009) 24% of the average general waste composition was plastics, 20% was paper and 38% was organic. This is similar to the results demonstrated by Tudor TL, *et al.*, (2007).

According to this, we estimate the percentage of the potential recycling waste to range between 44 to 74%, depending if the organic waste is included or not. Plastics and papers were no doubt highly recyclable materials.

Chapter 5 Methodology

5.1 Study design

Research methodology is a means to systematically solve research problems and ensures the research process will be carried out scientifically. The role of this process is to consider the logic behind the methods used by researchers and its justification (May 1997; Kumar, 2010). The application of an appropriate research methodology strengthens and advances research and the research field. The adoption of a particular research methodology is done in order to clarify the research process to meet the research requirements (Kumar, 2010). Furthermore, it seeks to design, develop, validate the research process, and organize the knowledge used (Saunders *et al.*, 2009; Miller 1983). In this research a quantitative approach, was utilized that aimed to maximise the strengths, and also reduce the weaknesses of the data collection and analysis.

The employed research methodology includes a philosophical consideration and a general description of quantitative research. The purpose of this part of the chapter is to identify the appropriate research methods used to achieve the research objectives including a description of the research philosophy.

When addressing alternative research philosophies and methods available, the researcher should choose the appropriate one to reflect the nature of the work and the social variables around him/her. This should come from the special characteristics of each approach (Nachmias, C. F, and Nachmias D, 2008; Pansiri J, 2009), given that the purpose of carrying out any research is to produce and enhance knowledge. However

this requires an understanding of the nature of the processes necessary to create this knowledge (Bryman, A and Bell, E, 2007).

In this study, data were obtained via two self-administered questionnaires, one to collect factual information about hospitals, and the second, which was the main questionnaire, was used to assess the levels of awareness and attitudes of hospital workers concerning HCW management and HHW recycling. Results were tabulate and analysed using SPSS, version 17.0 and conclusions were extracted from these results. The design of this study is represented in schematic illustration, Fig 5.1.

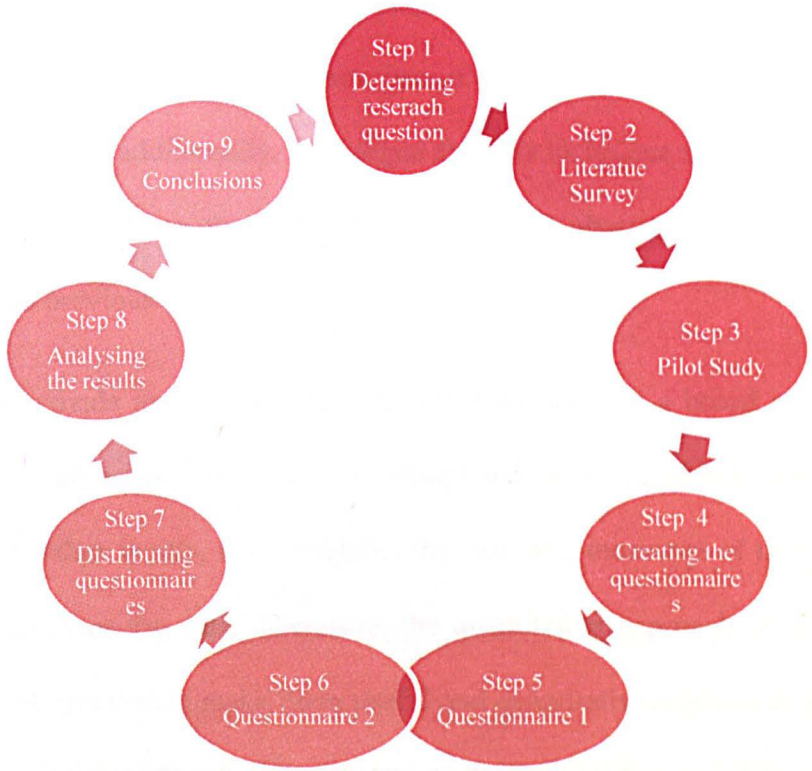

Figure 5.1 Schematic representation of the study design

Questionnaire 1: to the waste team managers, aimed to get factual information
Questionnaire 2: to the hospital employees aimed to assess knowledge & attitudes

5.1.1 Quantitative methodology

The quantitative method is considered to be the most important approach in waste management research, and can determine what is appropriate to be studied in the field (Sarantakos, 1998; Bryman, A, and Cramer, D, 2001). Additionally, strategies of quantitative research can investigate the data and allows the statistical testing of empirical hypotheses and it is helpful in discourse analysis in research (Jefferies, J, And Diamond I, 2001). Quantitative research involves counts and measures of things to produce quantifiable numerical data. Fellows, R and Liu, A, (2009) suggest that quantitative methods are based on positivism as they support hypotheses which aim to uncover natural laws additionally, they argue that this technique seeks to gather factual data in order to examine the relationships between observed facts. It studies the relationships to previous theories in literature.

Quantitative methods as Creswell, (2009) stated are used as a broad explanation for behaviour and attitudes, and may be completed with variables, constructs, and hypotheses. In other words, it investigates the data and measures of things related to process and analyses the data. Therefore, the quantitative approach works to process the data and information to make them useful and quantitative analysis techniques help researchers to explore, present, describe and examine the different relationships within the data (Saunders *et al.,* 2009; Creswell, 2003). Additionally, they argue that this technique assists researchers to answer questions and meet objectives. Tharenou, P, *et al.*, (2007) mentioned two main characteristics of quantitative methods as follows.

1. Quantitative analyses are appropriate for questions involving how many or how much; that is, questions of incidence and measurement

2. Quantitative analyses are best used when the aim is to test theoretical predictions with precise measures of variables.

According to Collis and Hussey, (2003) quantitative analysis is appropriate with the numerical data which can be classified as discrete or continuous. Regarding the theoretical aspects Sarantakos, (1998) pointed out some facts in relation to quantitative methods as follows:

- The restricting of experience in quantitative research in two ways: first by what is perceived by the senses which can direct the research to its objectives, while the second is by standardised tools employing only quantifiable data to test hypotheses.
- The reality in quantitative research represents some aspects of numerically measured out comes. It seeks to achieve its main objective related to the quantification and measurement of social events.
- This method works on the principles of natural science and takes the natural sciences as a model.

Quantitative methods data collection strategies build on the strength of existing individual methods to construct an approach that has key advantages for some types of research problems (Axinn and Pearce, 2006). The nature of data usually includes a wide variety of forms to use in the research. Data might come from many sources and may take many different forms (Bryman, A and Cramer, D, 2001; Creswell, 2005). In addition, data might be related to different levels and dimensions in different sessions, and places.

Primary sources are obtained by collection of the data by the researcher. This type of data is usually based on survey questionnaire (Zikmund, W *et al.*, 2009). Secondary sources are typically referred to as using data that was gathered by other people. It usually represents the use of existing data and information in research (Mellenbergh, GJ, 2008; Creswell, 2009).

Quantitative data are collected by closed-ended questions. Using questionnaire instruments enables the measurement of individuals' performance and attitudes toward self-esteem scales of individuals. Creswell and Clark, (2011); Bryman, A, and Cramer, D, (2001); Schensul, J,(1999) argue that the process of collecting valid and reliable quantitative data usually requires a set of questions that are carefully selected using an appropriate research style. This provides understanding of how to frame these questions to reflect the attitudes and behaviours in doing the research.

5.1.2 Data collection

The research explored in this project involves Staff perception and hospital practice towards HCW management and HHW recycling. This study was designed as a descriptive quantitative study using two research tools in order to collect the required data about the studied hospitals in the two countries of Libya and the UK. This study has used quantitative research methods utilising two self administered closed-ended questionnaires. The first questionnaire was designed to obtain factual information from the waste managers of each hospital; hence this was called a data request from hospital waste managers. The second questionnaire was used to assess the knowledge and attitudes of hospital workers concerning HCW management and HHW recycling. Hereunder, more details about these two questionnaires:

I Questionnaire 1 Date request from hospital waste managers

This tool was designed as a structured self-administered questionnaire that was left to each waste manager in each hospital in both UK and Libya. In order to evaluate recycling practice in the studied hospital, a set of questions was designed as part of this questionnaire, introducing a new simple model for hospital recycling assessment in hospitals, as shown in more detail below.

Factual information about the hospitals including bed numbers, weight of annual total waste generation, waste generation rate (WGR) and the total annual weight of recycled HHW were obtained from the hospital management via these questionnaires, Appendix I. The data request did not include any personal issues about patients nor about staff, but rather general factual data. The waste manager of each hospital completed these questionnaires and provided a copy of the waste register that contained detailed information about waste generation and recycling. Information about the hospital employees and bed numbers were obtained from the hospital administration in collaboration with the hospital waste managers. The completed questionnaires were collected directly by the researcher after a few days. Some of the information was sent later by the waste managers or the concerned hospital staff to the researcher.

There were two main aims of these questionnaires; first: to get factual information about the hospitals' capacity such as hospital waste disposal including WGR and HHW recycling, and second to make an objective evaluation of the HHW recycling practice. A section was designed a section in this questionnaire in such a way to obtain information about four key themes related to recycling: policy, segregation, recycling (direct questions about recycling) and safety. This was used as a model of recycling assessment and called this the PSRS model based upon the first letter of the main 4 themes. The PSRS model is formed of 21 nominal-dichotomous questions with yes or

no answers. Yes answers were considered positive responses and were given a score of 1. No answers on the other hand were considered negative and were given a score of 0. This gives a total score of 21, distributed as follows: Policy: 7 questions, Segregation: 7 questions, direct Recycling questions 4 questions and Safety: 3 questions. Questions about policy, segregation and safety are related to recycling and are aimed to evaluate these themes in relation to recycling. Missing answers were considered negative. We have used the total scores yielded of this model to compare the recycling practices between the two UK hospitals, between the three Libyan hospitals and between the UK and Libyan hospital.

II Questionnaire 2 Exploring knowledge and attitudes of hospital workers concerning HCW management and HHW recycling

The second tool focused on the knowledge and attitudes of the hospital workers towards the best practice of HCW disposal HHW recycling practice. This formed the core of the study, where we have collected the main parts of the results that answer together the research question and address the study aims and objectives.

The factual information collected from the questionnaire 1 was used as supplementary information to support the main stream results of knowledge and attitudes along with the factors that might influence them, which were all obtained from questionnaire 2, Appendix II.

Questionnaire II was carefully designed to fit the purposes of this study to explore the knowledge and attitudes of the respondents towards waste management and recycling in two different settings of a developed versus a developing country with reference to seven variables. Other questionnaire models were considered during the creation of this questionnaire but we opted to use a self administered closed-ended questionnaire.

This type of questionnaire has been shown to be easier for the participants to complete and provide objective data, which all together fit with the study's settings, aims and objectives (Mellenbergh, G.J, 2008). Other studies that have assessed awareness, recycling behaviours and attitudes of hospital and general public have also used self administered closed-ended questionnaires (Michaels KB and Willett WC, 2009; Lozar, M,*et al.*, 2002; Couper, M.P, 2001). The results of this type of questionnaires are easily aggregated and that comparisons can be made with confidence between sample groups in the different hospitals and countries involved in this survey. Also, in the rush of the critical working hours of healthcare personnel dealing with daily patients care, it is understandably quite difficult to take a long time answering detailed questions.

Questionnaire II was randomly distributed among hospital workers in the studied hospitals in the UK and Libya. Responses have been analysed quantitatively, initially using descriptive statistics to provide an indication of opinions and knowledge about various recycling procedures of hospital waste among staff groups. In order to assess if there were statistical differences in knowledge and opinion further tests were anticipated. Initially a univariate series of analyses was utilised that will allow us to identify potentially significant factors that may influence knowledge and opinions. As the majority of variables are categorical, we have utilised Chi Squared test as the test of significance, further testing was then conducted using a multivariate linear regression model.

5.2 Ethical approval

An official application was submitted online according to LJMU requirements on the 26th November, 2008 to the North West 3 Research Ethics Committee - Liverpool East

via the web site (https://www.myresearchproject.org.uk) and a meeting was arranged to discuss the intended research with a panel of specialists.

The approval was then granted on 03rd December/2009. Based on this approval, another obligatory application was submitted to the ethical committee of the Liverpool John Moores University. This was granted on 8th December/2009. Following these two ethical approvals, three Research and Development applications were submitted to the relevant UK Hospitals, R&D departments, UK Hospital (1), UK Hospital (2) and UK Hospital (3).

The following evidence was provided to each of the hospitals in order for approval for the research to take place at each hospital site:

- Proof of Ethical approval from the NHS. Proof of obtaining a research passport
- An occupational health record
- A cleared CRB check
- 'Good clinical practice in research training course' certificate
- All thesis related documentation

Management approvals from these hospitals were granted on the following dates respectively, 04th December/2009, 2nd February 2010 and 17th September 2010. In Libya, similarly, three applications were submitted to Libyan Hospital (3), and Libyan Hospital (2), Libyan Hospital (1). Approvals from these hospitals were granted on the following dates respectively, 20/September/2010, 03rd October/2010, and 04th October/2010 respectively.

5.3 Hospital details

The 6 hospitals were pre-selected. They were chosen as the project needs considerable involvement from the hospitals, particularly waste management departments, so

hospitals were selected partly on the basis of existing contacts within waste management departments. We appreciate that the lack of randomisation way make extrapolation to the rest of the North West less valid, although there is no particular reason to expect staff at these hospitals to have different views from the wider North West hospital staff population.

UK hospitals were chosen due the fact that they were seen to be appropriate institutions for conducting the research intended, particularly as they are teaching hospitals which means that they have a facility for teaching/training resulting in staff who are highly specialised. This requires a number of facilities such as staff and medical equipment which can usually only be found in a well-established institution which is what was required for such a study. Furthermore, in addition to being well known amongst the general public, these three institutions are large in size with the capacity for a large number of hospital beds indicating that they should have significant capacity to recycle as a hospital. The fact that these hospitals have a large number of staff and patients suggested that more data was likely to be gathered which was an important factor. There were initially 3 hospitals selected however one was eliminated due to the fact that the response received in the number of questionnaires was considerably less than expected. With regards to the hospitals chosen in Libya, they were chosen based on the same factors stipulated above.

5.4 Questionnaires development

In order to develop questionnaire II to fit this study, we have considered previously published research in this field that has used a similar methodology (Michaels KB, 2009; Lindolf and Taylor, 2002; Patton, 1991).The mailed questionnaire is probably the most frequently used method for surveying in the field of health services research

(Maheux Legault,and Lambert 1989; Kanuk and Berenson1975; Linsky, 1975; Warwick and Lininger 1975); however, they tend to result in lower response rates (Hurd, *et al.*, 1990; Shosteckand Fairweather, 1979; Dillman, 1978). They are thus more likely to obtain results that are biased in favour of the sample population most interested in the survey topic (Fowler, 1988; Stinchcombe and Sheatsley, 1981). Based on these reviews and on our study objectives, two different structured close-ended self-administered questionnaire models were obtained, one for the waste managers and the other for the hospital workers. Questionnaire II consisted of three parts: a) ID and demographic information, b) Knowledge on waste disposal including recycling management and c) Attitudes towards HCW management and HHW recycling. We have checked other models when creating this questionnaire and opted to use this model above any other questionnaire type to make it easier for the waste managers in each hospital to provide the information and to make the collected data easier to analyse (Mellenbergh, 2008).

The process of dividing the questions into sections can assist the respondents to understand all questions and answer the questions (Brace, 2004).

The process of conducting a pilot test is an important method for reviewing the effectiveness of the questionnaire. It examines the design of the questionnaire, thus it can provide a clear picture about adequacy of the questions (Krueger, R. and Casey, M. 2000). It also provides feedback, critiques, and comments of the participants, which can inform the questionnaire development (ABS, 2001).

5.4.1. Pilot study

Questionnaire II was first sent to 10 UK experts in hospital management and the questionnaire was revised according to their recommendations.

A pilot study was then conducted, where we distributed 20 copies of questionnaire II amongst UK selected hospital workers, including 5 hospital waste experts. All 20 questionnaires distributed were completed and returned as per arrangement. The results of the pilot study concluded that the questionnaire was considered suitable in terms of the time needed to complete it, the extent to which it is self-explanatory and the extent to which it is relevant to the intended area of research.

A scoring system was adopted in evaluating the responses of these 20 completed questionnaires with numbers from 1-6 where number 1 = poor, and 6= excellent.

Q1. How long did it take to complete the questionnaire? (arange of 6 scores from 15 to 20 Minutes.

Q2. How easy to read and complete the questionnaire (a range of 6 scores where 6 is the top score and 1 is the lowest): 1 2 3 4 5 6.

Q3. How much do you think the questionnaire covers the knowledge and attitudes points related to the research? Same scores 1-6

Some changes were made in questionnaire II based on the feedback from the respondents a final version of the questionnaire II was then made ready, Appendix II.

The final version of Questionnaire II that we used consisted of three parts; part A (general information) with seven questions on demographic characters and individual data representing the seven factors that might affect knowledge and attitudes, Part B (knowledge) with eight questions assessing the awareness of the participants about HCW management and HHW recycling, and Part C (attitudes) with 13 questions assessing the perception and practices of the participants towards HCW management and HHW recycling. This gives a total of 28 questions.

Five questions of part B were followed by a two- point and three point Likert scale, which were given the following scores: No=0,yes=1 and not sure = 0. The rest three questions were followed by three answer options and the participants were asked to select the most appropriate option. The correct answers were considered good knowledge, and incorrect answers were weak knowledge. Out of the total scores extracted from the eight knowledge questions, scores of four or below were considered weak and above 4 were considered good.

All questions of Part C were followed by a five-point Likert scale. The participants were asked to select one of the three in part B and one of the five points in part C, which represented the most suitable answer. They were given the following scores: agree=positive, strongly agree= highly (very) positive, disagree= negative, strongly disagree= very negative, I have some interest= neutral.

A Likert scale was chosen for the majority of questions on the questionnaire. This was done in order to provide respondents with the opportunity to express the relative strengths of their knowledge and attitudes. Providing a range of options for the respondent. However as with all social questions the validity of the measurement can be affected by social desirability. This was minimised by the use of anonymous questionnaires (Bowling, 2009).

5.5 Questionnaire distribution

Covering letters that contained participants' information sheets were enclosed along with the questionnaire II. Participants were asked to read participants' information carefully before deciding whether to proceed with the questionnaire.

A participants' information sheet included instructions required to give a clear picture on many important issues such as the title of study and study objectives and to explain the main elements of the research so that participants fully understood their role in the project and what was expected of them.

The covering letter was included on the front page of the questionnaire so there was no danger of it becoming separated (Brace, 2004). It included a statement by the researcher to attract respondents into answering the study questions and also to motivate them to write their comments at the end of the questionnaire, Appendix III.

All the questionnaires were distributed completely anonymously in Libya and the UK and did not require any personal information to be disclosed by participants. All information was treated confidentially and for research purposes only.

In the UK and Libya hospitals, 500 prepaid addressed envelopes with an enclosed questionnaire were handed to a predetermined key person in each of the three selected hospitals in each country. All key persons were not involved in the study and were supplied with full lists of the healthcare providers, pharmacists and waste disposal workers by their hospital administration. Each person sent the envelopes to 500 randomly selected persons of hospital workers in his/her hospital. Thus a total of 1500 were sent to the three hospitals in each country. The 3000 questionnaires were based on a sample size calculation, which was used previously (Creative research systems, 2009). This assumed 95% confidence level and a predictive interval of 10%. If the typical hospital staff population is 1500-2000 then a predicted sample size (n) is between approximately 90-100 individuals. We therefore sought to recruit 100 staff per hospital to allow suitable statistical resolution.

After the ethical approval was granted by both the NHS and the relevant hospitals in the UK, a meeting was arranged with the manager of hospital waste in each hospital as this role was directly related to my study. The most appropriate method of questionnaire distribution in the hospital was discussed, and the following decisions were made. The same procedure was followed in Libya.

a1. UK Hospital 1

The questionnaires were prepared in a pre-paid postage envelope with a cover letter inside explaining the purpose of the research etc. A total number of 500 questionnaires were distributed randomly by the HCW manager, 75 were completed and returned by post using the pre-paid envelope. These were then delivered to my student pigeon hole at university. No blank questionnaires were returned.

a2. UK Hospital 2

The questionnaires were prepared in a pre-paid postage envelope with a cover letter inside explaining the purpose of the research etc. The infection control team and HCW manager were responsible for distributing the questionnaires. A total number of 500 questionnaires were distributed randomly, 75 were completed and returned by post it using the pre-paid envelope. These were then delivered to my student pigeon hole at university. No blank questionnaires were returned.

a3. UK Hospital 3

The questionnaires were prepared in a pre-paid postage envelope with a cover letter inside explaining the purpose of the research etc. The HCW manager distributed the questionnaires randomly. A total number of 500 questionnaires were distributed, and 7 were completed and returned, 25 blank questionnaires were returned. These were then delivered to my student pigeon hole at university. As a result of the poor feedback

which would not be sufficient for the intended analysis, this hospital was eliminated from the research.

b1. Libyan Hospital 1

There was a need to provide an Arabic version of the questionnaire to participants in order to provide them with clear direction .The questionnaires included a cover letter however there was no pre-paid envelope as this system is not used in the country. The HCW manager was responsible for distributing the questionnaires randomly and there was a box at the hospital, which could not be accessed by anyone else other than the researcher in which these were kept ready to be picked up after a number of days.500 questionnaires were distributed and 100 were completed and returned. No blank questionnaires were returned.

b2. Libyan Hospital 2

The questionnaires included a cover letter however there was no pre-paid envelope as this system is not used in the country. The HCW manager was responsible for distributing the questionnaires randomly and there was a box at the hospital which could not be accessed by anyone else other than the researcher, in which these were kept ready to be picked up after a number of days. 500 questionnaires were distributed and 101 were completed and returned. No blank questionnaires were returned.

b3. Libyan Hospital 3

The questionnaires included a cover letter however there was no pre-paid envelope as this system is not used in the country. The HCW manager was responsible for distributing the questionnaires randomly and there was a box, which could not be accessed by anyone else other than the researcher, in which these were kept ready to be picked up after a number of days.500 questionnaires were distributed and 102 were

completed and returned. No blank questionnaires were returned, (Fig 5.2), Displays the distribution of questionnaires and the number retuned from each hospital.

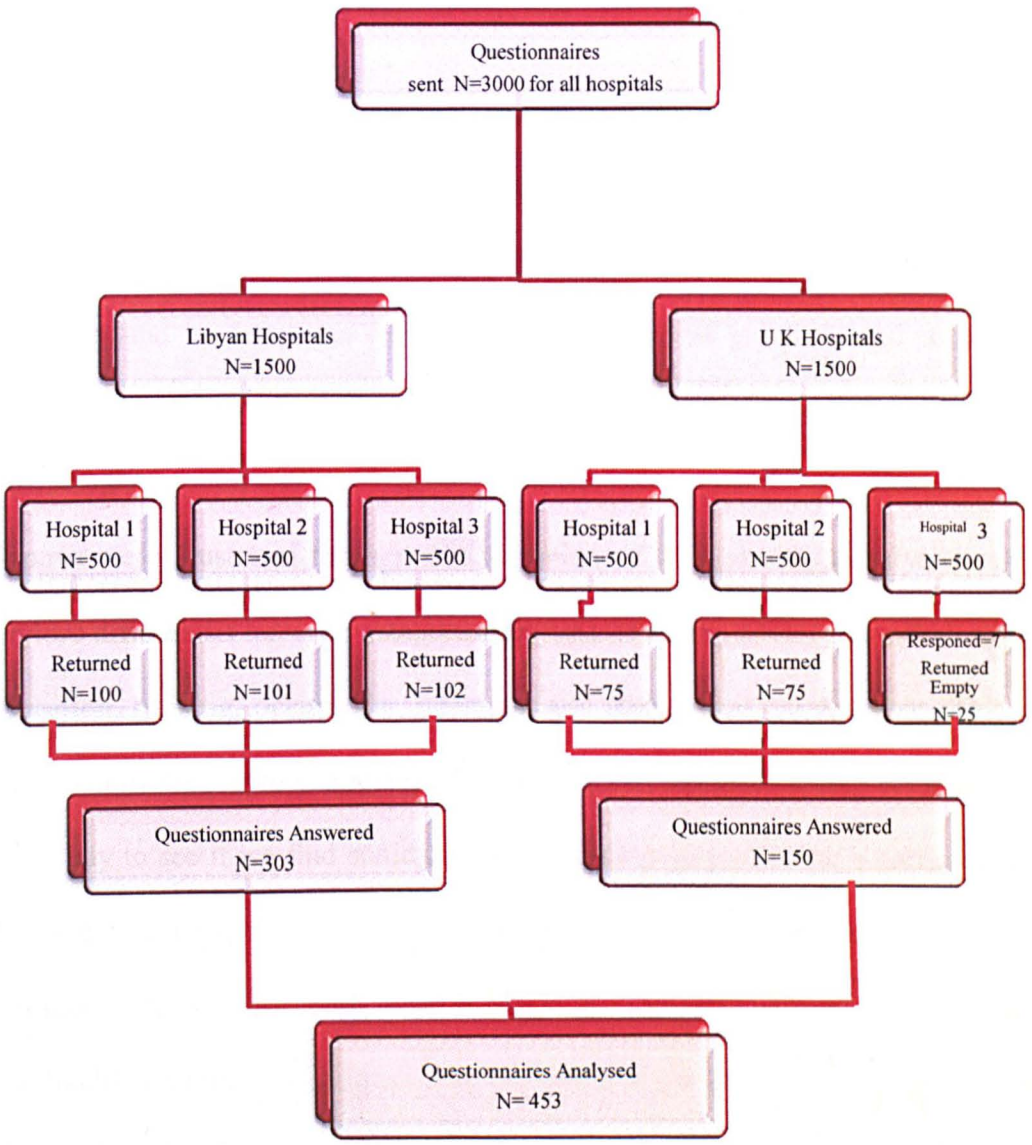

Figure 5.2 The Questionnaires distribution for UK and Libyan Hospitals

5.6 Data analysis

All raw data of the hospital details and questionnaires were tabulated into SPSS statistics version 17.0, which were used to perform the statistical analysis. Quantitative data were represented in the form of numbers (No.) and percentages (%).

The results were tabulated and analysed statistically to determine the proportions of respondents answering questions in a similar manner, the attitudes and behaviours of the waste workers and healthcare providers towards HCW management and HHW recycling and to determine the adherence to the best practices and to evaluate the acceptance and behaviours towards recycling and sustainability and conclusions drawn accordingly.

Figures were illustrated through SPSS graphics. Chi-square (χ^2) analysis was used to explore differences between categorical groups including country, hospital, age, gender, education, training, occupation, positions and duration of employment. This allowed the assent of the recorded number of occurrences of variables within different groups of this study to see if we find statically more or fewer responses for a particular category than we might expect to occur by chance and allowed us to determine the level of confidence that a relationship exists between two variables (Bryman and Bell, 2007).

The likelihood ratio was used if more than 25% of the cells had an expected count < 5.

The level of significance was considered at P-value ≤ 0.05.

There are some limitations in determining the data degree of confidence but our data are very comparable to previous studies. Our studies for example showed that the WGR in the Libyan hospitals are 1.36 compared to the study of the Sawalem *et al* 1.3 with a difference of 4.42% (Sawalem M, *et al.*, 2009).

5.6.1 Cross tabulation

Age, gender, profession, training in waste management, seniority, duration of employment and education status were cross tabulated with knowledge and attitude scores of participants. Associations between knowledge and attitude about various HHW management and recycling processes in different hospitals in the UK and Libya were also analysed separately using Chi-square testing. Overall mean knowledge and attitude scores among participants in England and Libya were analysed using Chi-square test. Recycling practices were assessed quantitatively using a closed-ended questionnaire distributed among the hospital waste managers (Table 5.1, Fig 5.3).

Table 5.1 Tabulations of different variables and statistical test

Variable comparisons	Significance test
Age × Knowledge Score	Chi Square
Age × Attitude Score	Chi Square
Gender × Knowledge Score	Chi Square
Gender × Attitude Score	Chi Square
Educational Status x Knowledge score	Chi Square
Educational Status x Attitude score	Chi Square
Professional x Knowledge score	Chi Square
Professional x Attitude score	Chi Square
Training x Knowledge score	Chi Square
Training x Attitude score	Chi Square
Seniority x Knowledge score	Chi Square
Seniority x Attitude score	Chi Square
Duration of Employment x Knowledge score	Chi Square
Duration of Employment x Attitude score	Chi Square

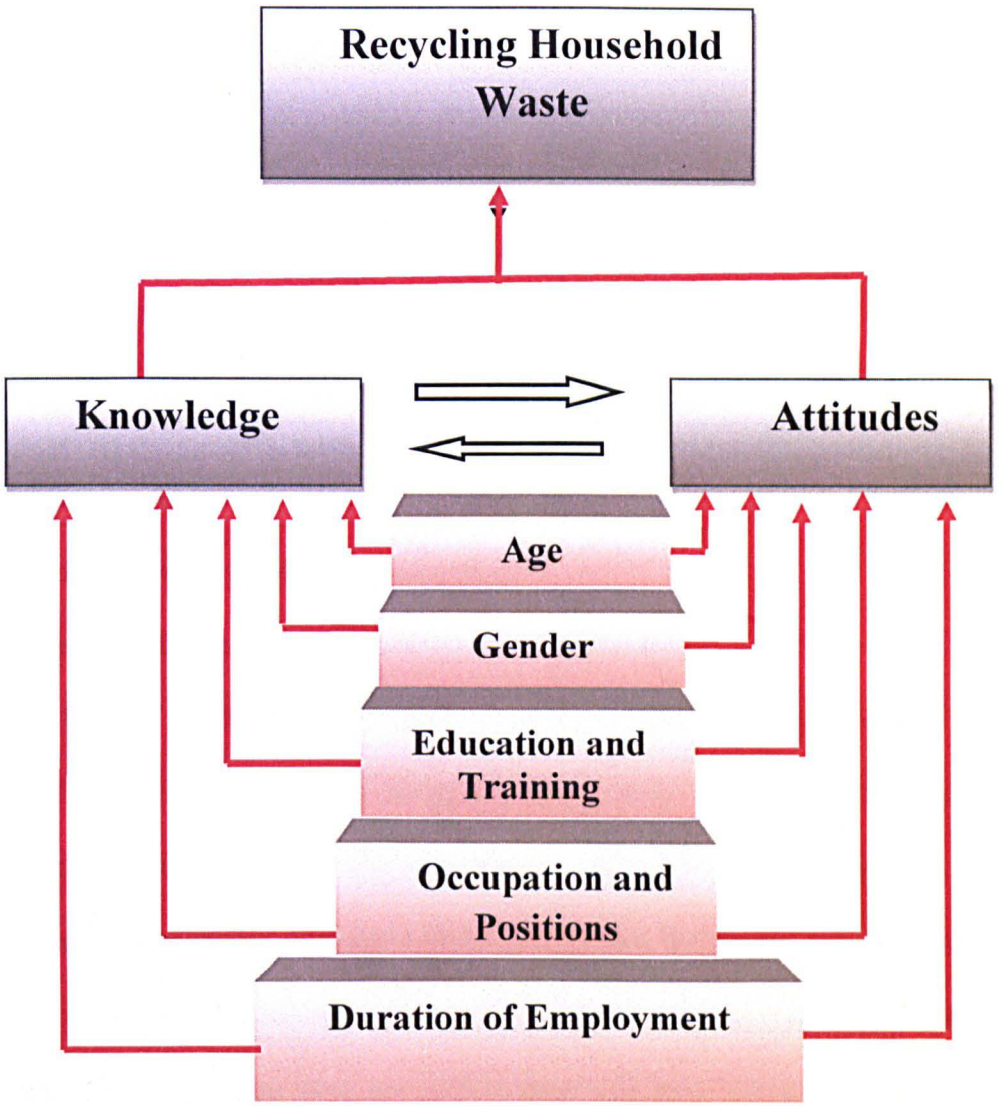

Figure 3.3 Framework Analysis

5.6.2 Regression analysis

A multivariate linear regression analysis model was used to study the correlations between each factor that might predict if participants have knowledge of recycling practice and the extent that they support or oppose the recycling concept.

A statistical model was created to analyse the results of the questionnaire considering the following parameters as predictive factors for supporting recycling options in healthcare disposals:

1. Good knowledge about the subject

2. Age group

3. Gender

4. Profession (physician/nurse/waste specialist or worker)

5. Education level

6. Training

7. Seniority

8. Duration of Employment

6. Hospital Updates with most recent waste policies

7. Hospital Size according to the total beds

The study was focused on the hospitals included in this particular study only, and the results obtained should therefore not be generalised further. A regression analysis model was used to study the correlations between each factor with supporting or opposing the recycling concept. Variables were entered into the model together using the Enter method in SPSS rather than a stepwise fashion, as this is considered more suitable for initial testing where there are no preconceived ideas about precedence of different variables (Field, 2009).

Chapter 6 Results

6.1 Study sample

The information about the study sample was extracted from the hospital capacity section of the structured self-administered survey, which was completed by the waste manager/administrator of each studied hospital.

A. UK Hospitals

A1. UK Hospital 1(UKH1): Upon the conduct of this study in 2010, UK hospital 1 had 1172 beds and there were 6608 staff working in this hospital. Out of them, 16.8% were medical doctors and dentists (n=1116), 48% were nurses (n=3177) and 35% were other professionals, administrators and employees of different categories (n=2315), table 6.1.

A2. UK Hospital 2 (UKH2): Upon the conduct of this study in 2010, UK hospital 2 had 833 beds and there were 4793 staff working in this hospital. Out of them, 8.5% were medical doctors and dentists (n=409), 37.5% were nurses (n=1796) and 54% were other professionals, administrators and employees of different categories (n=2588), table 6.1.

B. Libyan Hospitals

B1. Libyan Hospital 1 (LBH1): Upon the conduct of this study in 2010, Libyan hospital 1had 1438 beds and there were 2891 staff working in this hospital. Out of them, 52.4% were medical doctors and dentists (n=1516), 34.3% were nurses (n=993) and 13.2% were other professionals, administrators and employees of different categories (n=382), table 6.1.

B2. Libyan Hospital 2 (LBH2): Upon the conduct of this study in 2010, hospital 2 had 1200 beds and there were 1304 staff working in this hospital. Out of them, 40% were

medical doctors and dentists (n=524), 40.6% were nurses (n=530) and 19% were other professionals, administrators and employees of different categories (n=250), table 6.1.

B3. Libyan Hospital 3 (LBH3): Upon the conduct of this study in 2010, Libyan hospital 3had 480 beds and there were 841 staff working in this hospital. Out of them, 38.7% were medical doctors and dentists (n=326), 41% were nurses (n=345) and 20.2% were other professionals, administrators and employees of different categories (n=170), table 6.1.

These results show that our targeted hospitals in the two countries are all teaching hospitals, and range between medium and large hospitals with comparable capacity as estimated by bed numbers and number of employees, (table 6.1).

Table 6.1 The details of the UK and Libyan Hospitals

	UK Hospitals		Libyan Hospitals		
	1 *% (n=)*	*2* *% (n=)*	*1* *% (n=)*	*2* *% (n=)*	*3* *% (n=)*
Beds	1172	*833*	*1438*	*1200*	*480*
Physicians	16.8% (n=1116)	8.5% (n= 409)	52.4% (n=1516)	40% (n=524)	38.7% (n=326)
Nurses	48% (n=3177)	37.5% (n=1796)	34.3% (n=993)	40.6% (n=530)	41% (n=345)
Others	35% (n=2315)	54% (n=2588)	13.2% (n=382)	19% (n=250)	20.2% (n=170)
Total employees	6608	4793	2891	1304	841

6.2 Details of waste management and recycling

The details of the amounts of waste production, waste generation rate (WGR) and amounts of recycling waste were also extracted from the structured self-administered surveys that were completed by the waste manager of each studied hospital in the UK and Libya.

The total weight of the annual waste, WGR and recycled waste in the UK and Libyan hospitals are summarized in (table 6.2). UKH1 produced significantly more waste and

higher WGR compared to UKH2, ($p<0.0001$), (table 6.2). Concomitantly, UKH1recycled significantly more waste compared to UKH2, ($p<0.01$), (table 6.2).

Among the 3 Libyan hospitals, LBH1 produced the largest amount of hospital waste compared to LBH2 and LBH3, $p<0.05$, table 6.2. None of the Libyan hospitals reported any recycling practice, (Table 6.2).

UK hospitals produced significantly more waste and demonstrated significantly more WGR (11.8 kg per patient per day) compared to the Libyan hospitals, which had an average WGR of only 4.1 kg per patient per day, $P<0.001$, (table 6.2).

UK hospitals recycled 1031.869 Tonnes per year, compared to the Libyan hospitals, which did not conduct any recycling at all, P=00001, (Table 6.2).

The Pearson correlation coefficient showed a very strong association between total waste volume and the WGR for the five studied hospitals in both UK and Libya, as would be expected. The hospitals with a high waste production volume have a higher WGR per person, (Table 6.2).

Table 4.2 Total and recycled waste in the UK and Libyan hospitals during 2010

	Total Waste/year *(Tones)*	Generation Rate *Patient/day (Kg)*	Recycled Waste per year *(Tones)*	Recycled *(%)*
UKH 1	3693.577	8.6	865.039	23.4%
UKH 2	985.290	3.2	166.830	16.9%
LBH 1	828.288	1.6	Nil	0%
LBH 2	604.800	1.4	Nil	0%
LBH 3	190.08	1.1	Nil	0%

Pearson correlation 0.9857

The apparent data inconsistency between the UK1 and UK2 hospitals in the amounts of total waste production and in the WGR is relatively attributed to the fact that UK2 hospital is smaller than UK1 (822 vs 1172 beds). In addition, it seems that UK2

hospital follows a stricter purchase policy than UK1 hospital, which results in a less waste production and eventually a less WGR per person per year.

6.3 Policy, segregation, recycling and safety (PSRS scores)

Information about the preselected 4 themes, policy, segregation, recycling and safety (PSRS score) were collected from section 2 of the close-ended questionnaire to the waste managers, appendix I.

UK hospitals recorded generally high PSRS scores. UKH1 demonstrated slightly higher scores compared to the UKH2, but this was not statistically different, Table 8. Libyan hospitals, on the other hand recorded low PSRS scores. LBH 2 recorded the highest score followed by LBH 1 then LBH 3, but with no significant statistical differences between these 3 hospitals. When comparing the UK hospitals to the Libyan hospitals, the UK hospitals demonstrated significantly higher PSRS scores than the Libya hospitals, $p<0.0001$, table 6.3.

However, due to the relatively small samples in both countries, these results should be taken with some caution and these conclusions cannot be assumed to be generally applicable in the UK and Libya.

Table 6.3 PSRS scores in the UK versus Libyan hospitals

		UK Hospitals		Libyan Hospitals		
	Score	*UKH 1*	*UKH 2*	*LBH 1*	*LBH 2*	*LBH 3*
Policy	7	6	6	2	3	2
Segregation	7	6	6	2	3	1
Recycling	4	2	1	0	0	0
Safety	3	2	2	1	1	1
Total scores	21	16	15	5	7	4
Percentage (%)	100	76	71.4	23.8	33.34	19

6.4 UK and Libyan respondents to self-administered questionnaires

Figure 6.1 shows the numbers of respondents from UK and Libyan hospitals. As shown in this figure, 20.2% (n=303) returned completed questionnaires from all Libyan hospitals compared to 10.4% (n=157) from UK hospitals, $p<0.001$, Fig 6.1.

In the UK, almost the same number responded from UKH 1 and UKH 2 were out of the 500 questionnaires distributed to each hospital, 15% (n= 75) were returned from UKH 1 and 15% (n= 75) from UKH2compared to only 1.4% (n=7) returned completed questionnaires from UKH 3, $p<0.001$.

Out of the 500 questionnaires distributed to each hospital, 20% (n=100) responded from LBH 1, 20.2% (n=101) responded from LBH 2 and 20.4% (n=102) responded from LBH 3 with no statistical differences between the three involved hospitals, table 6.4.

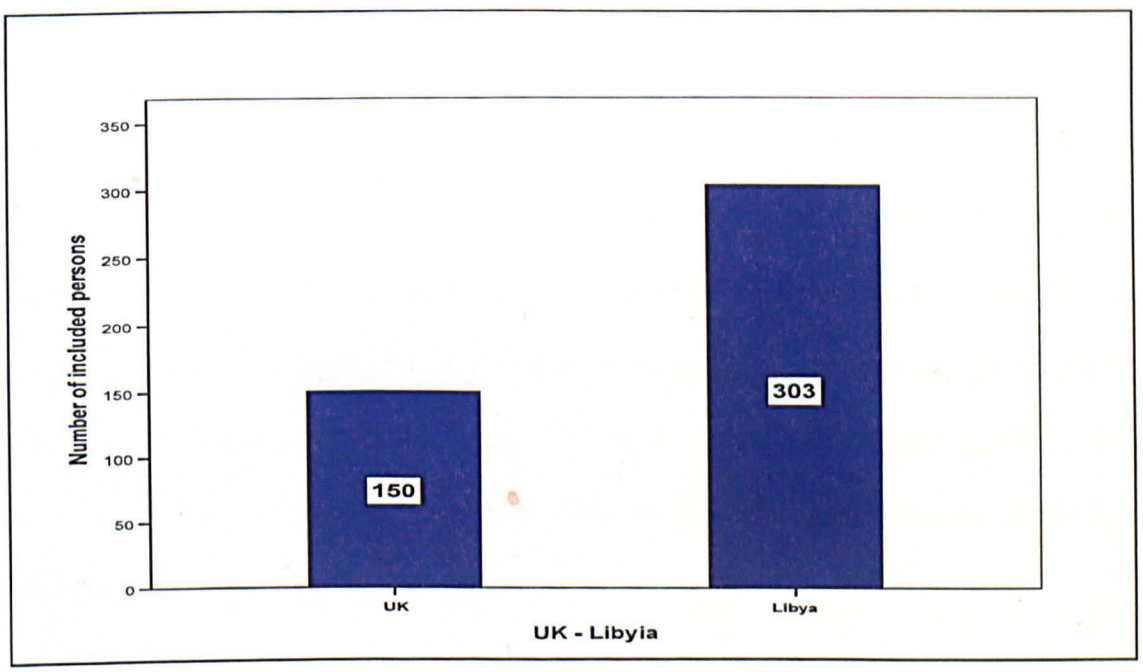

Figure 6.1 The UK and Libyan respondents

The completed questionnaires returned from the worker sin UKH 3 were not used in this study due to the very low response. Only 7 completed questionnaires and 25 blank questionnaires were returned. As a result of this poor feedback, which would not be sufficient for the intended analysis, this hospital was eliminated from this study and will only be referred to in the rest of the thesis when the response rates are mentioned.

Table 6.4 Number of respondents from all hospitals

Hospital		Number of respondents	Percentage
		N	%
UK	UKH 1	75	15
	UKH 2	75	15
	UKH 3	7	1.5
Libya	LBH 1	100	20
	LBH 2	101	20.2
	LBH 3	102	20.4

6.4.1 The influence of age on the response rate

Libyan respondents below 30 years were the most respondents; 67.7% (n=205) compared to their respective age group among the UK hospitals 32.7% (n=49) in the UK, $p<0.001$). UK respondents above 40 years were the most respondents among UK hospitals; 46.7% (n=70) compared to their respective age group among the Libyan hospitals; 9.6% (n=29) in Libya, $P<0.0001$. The respondents of the age group 30-40 years were comparable in both countries, 20.7% (n =31) in the UK and 22.8% (n=69) in Libya respectively, Overall significant differences in the age distribution of the two countries were seen ($p<0.0001$) Fig, 6.2.

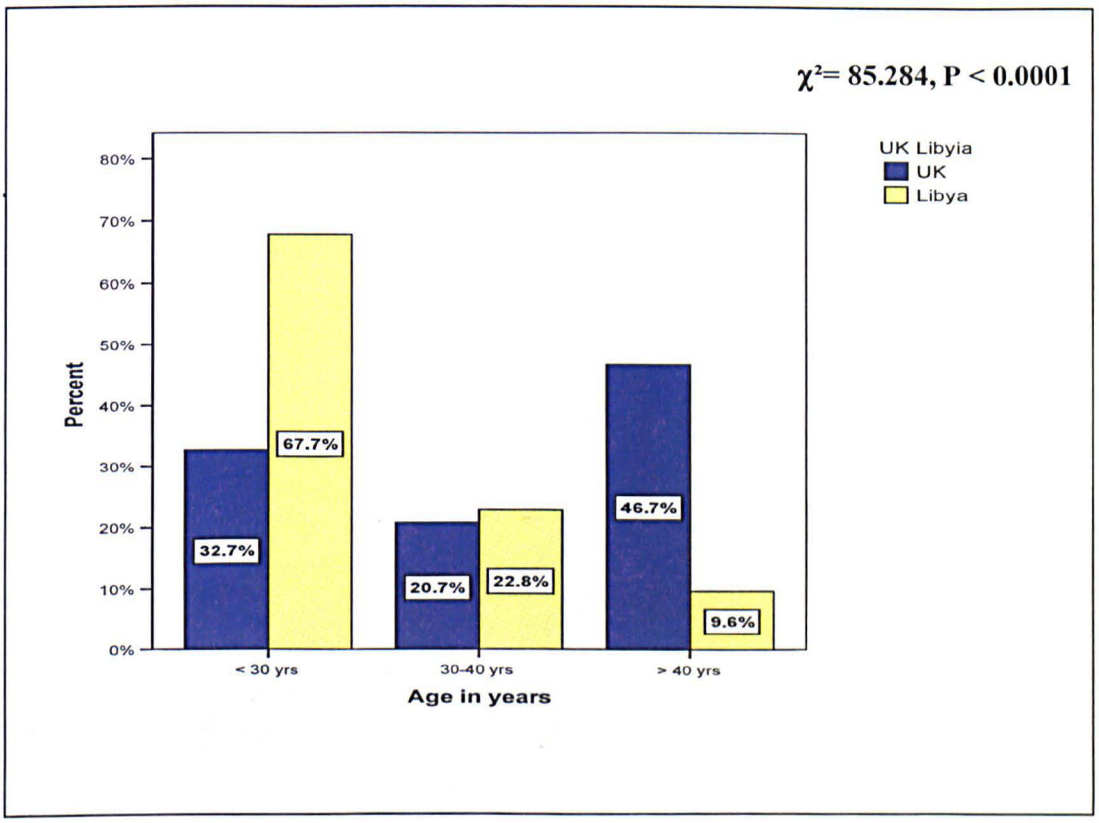

Figure 6.2 The age on the response rate

6.4.2 The influence of gender on the response rate

Female respondents in the UK were 79% (n=119) compared to 21% males (n=31), p<0.001. In Libya, female respondents were 68% (n=206) compared to 32% males (n=97), p<0.001, Fig 6.3. This gives a female to male ratio of 3.84/1in the UK and 2.12/1 in Libya respectively. The UK female respondents (79%) were slightly more than the Libyan female respondents (68%), the male respondents in Libya 32% (n=97) were slightly more than the male respondents in the UK 21% (n=31). Overall, there were significant differences between the gender balance in the UK and Libya, P=0.001.We would also expect to see higher responses from women in UK and Libyan hospitals due to the higher proportion of women staff in hospitals, particularly among nurses who also formed the majority of respondents in the sample Fig 6.3. However

this gender difference might also be influenced by the possibility that women might be more likely to respond to questionnaires or perhaps having a greater interest in recycling.

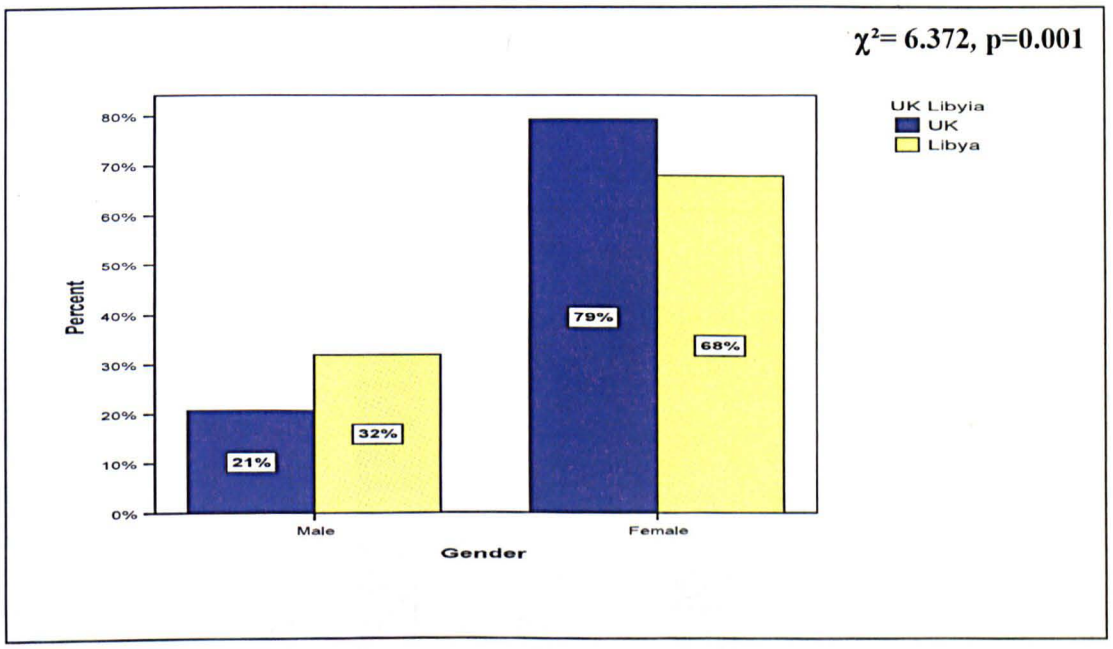

Figure 6.3 The gender on the response rate

6.4.3 The influence of the educational levels on the response rate

Most of the respondents have either a college or university education in both countries. In the UK 42% (n=63) have a college education compared to 42.6% (n=129) in Libya. In the UK, 41.3% (n=62) have a university education compared to 48.2% (n=146) in Libya. The high school education and the postgraduate education are as shown in, Fig 6.4.There was a statistically significant difference between education levels in UK and Libya ($p<0.0001$). The statistical test does not indicate where the difference lies but the chart suggests that differences are related to more UK postgraduate education and more Libyan staff having a high school qualification.

The better responses of women to the questionnaires in relation to women can not be simply explained by the higher proportion of women in the studied samples, because this was a consistent finding in all the hospitals in the UK and Libya. It seems that women in general are more responding to the research questionnaires.

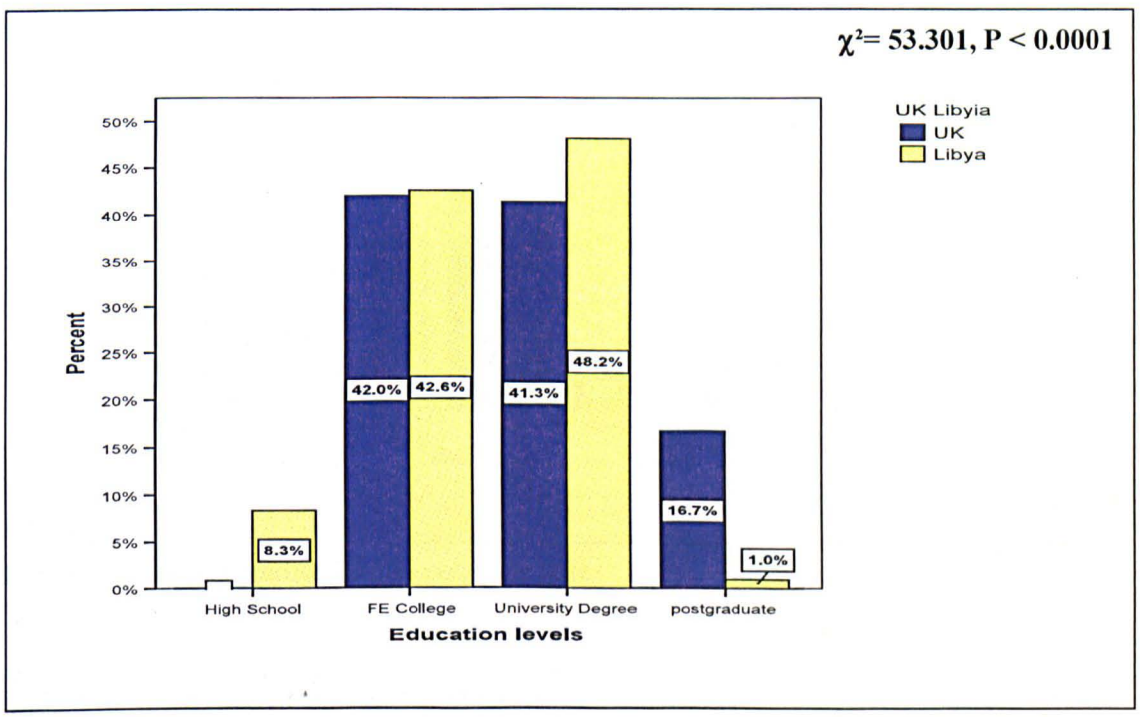

Figure 6.4 Education levels on the response rate in Libya and UK

6.4.4 The influence of occupation on the response rate

Nurses in both countries were the most respondents, significantly more in the UK where 59% (n=89) responded compared to 34% (n=103) in Libya, P<0.001, Figure 6.5. It is interesting to note that 17% of the respondents were waste team and 9% were pharmacists in both countries.

The Libyan physicians responded significantly more than the UK physicians, 27% (n=83) versus 8% (n=12), p<0.001, Fig 6.5. The Libyan technicians responded significantly more than the UK technicians, 7% (n=10) versus 14% (n=41). The chart

shows that there are differences in responses between UK and Libyan physicians, nurses, technicians and overall there is a significant difference in the distribution of responses from UK and Libya, p<0.001, Fig 6.5.

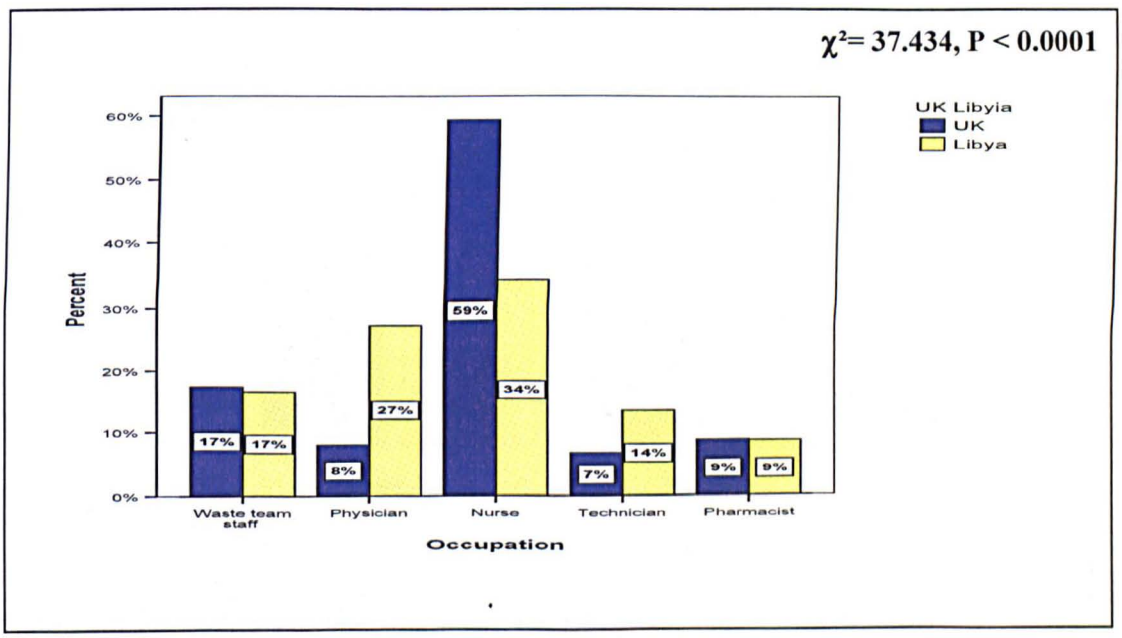

Figure 6.5 The occupation on the response rate

6.4.5 The influence of hierarchical position on the response rate

Juniors responded significantly more than seniors in both countries, p<0.0001, Table 12. Libyan junior respondents were 83.2% (n=252) compared to 63.3% (n=95) UK junior respondents UK, p<0.01, table 12. UK senior respondents were 36.7% (n=55) compared to 16.8% (N=51), p<0.001, Fig 6.6.

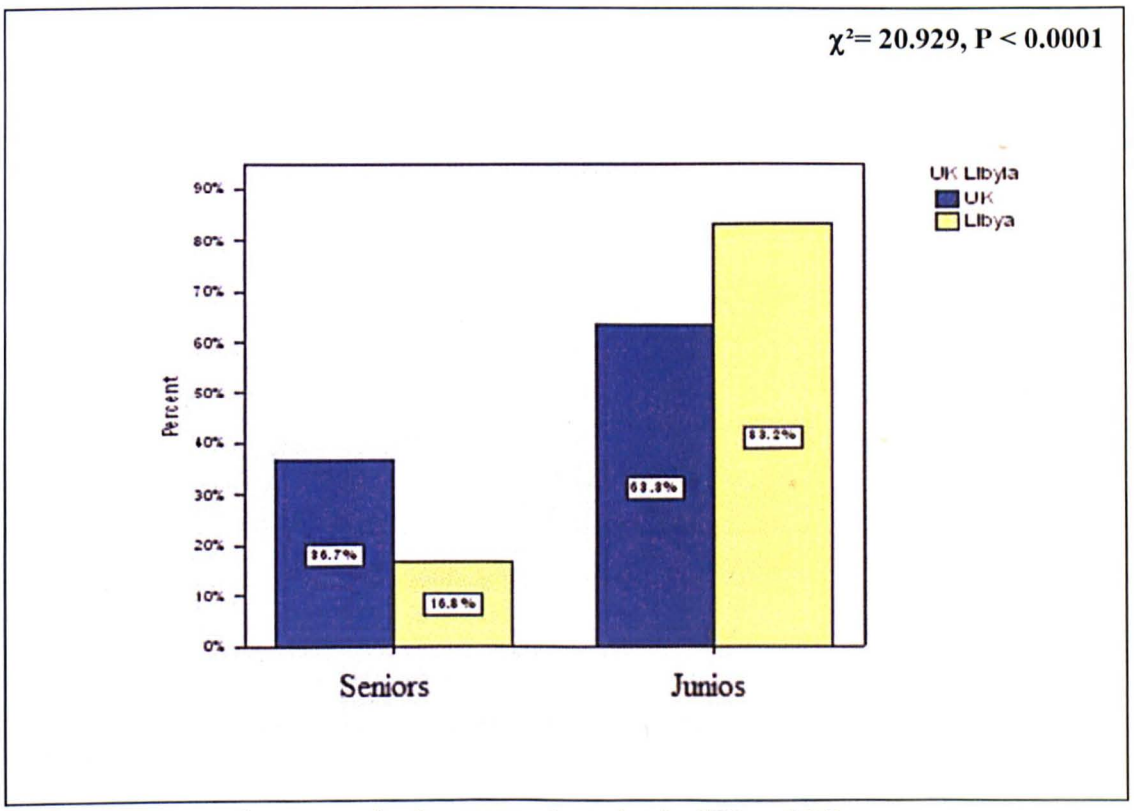

Figure 6.6 The senior versus junior respondents in the UK and Libya

6.4.6 The influence of participating in waste management training on the response rates

There were no significant differences in the response rates between those who participated in waste management training and those who did not in both countries. Comparing UK respondents who participated and those who did not participate in such training to their respective Libyans showed no significant differences, P>0.05, Fig 6.7.

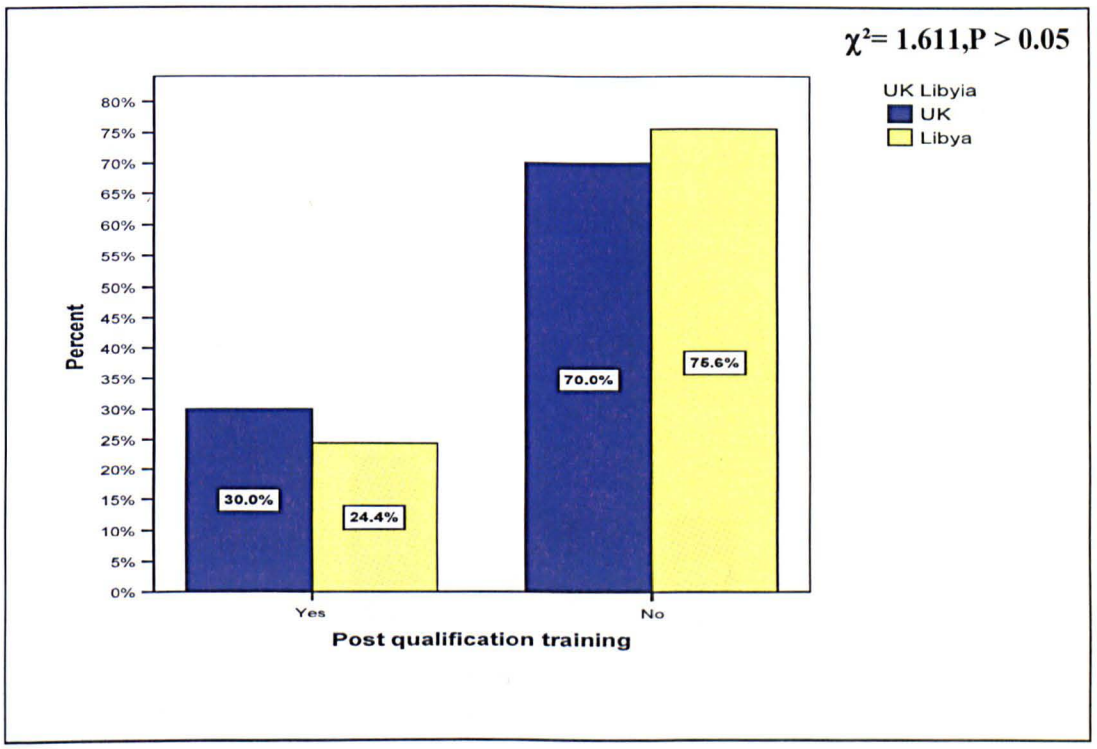

Figure 6.7 The responses of participants versus non participants in waste management training

6.4.7 The influence of the duration of the employment on the response rates

Those who were employed for less than 10 years were the most respondents in both UK and Libya. The Libyan respondents with less than 10 years employment were 75% (n=226) compared to 46% (n=69) in the UK, $p<0.001$, Fig 6.8. The respondents who are employed for 11-20 years in both countries were comparable, 23% (n=35) in the UK compared to the 19% (n=58) in Libya. UK respondents with employments periods between 21-30 years were significantly more than their respective Libyan, $p<0.001$, Fig 6.8.

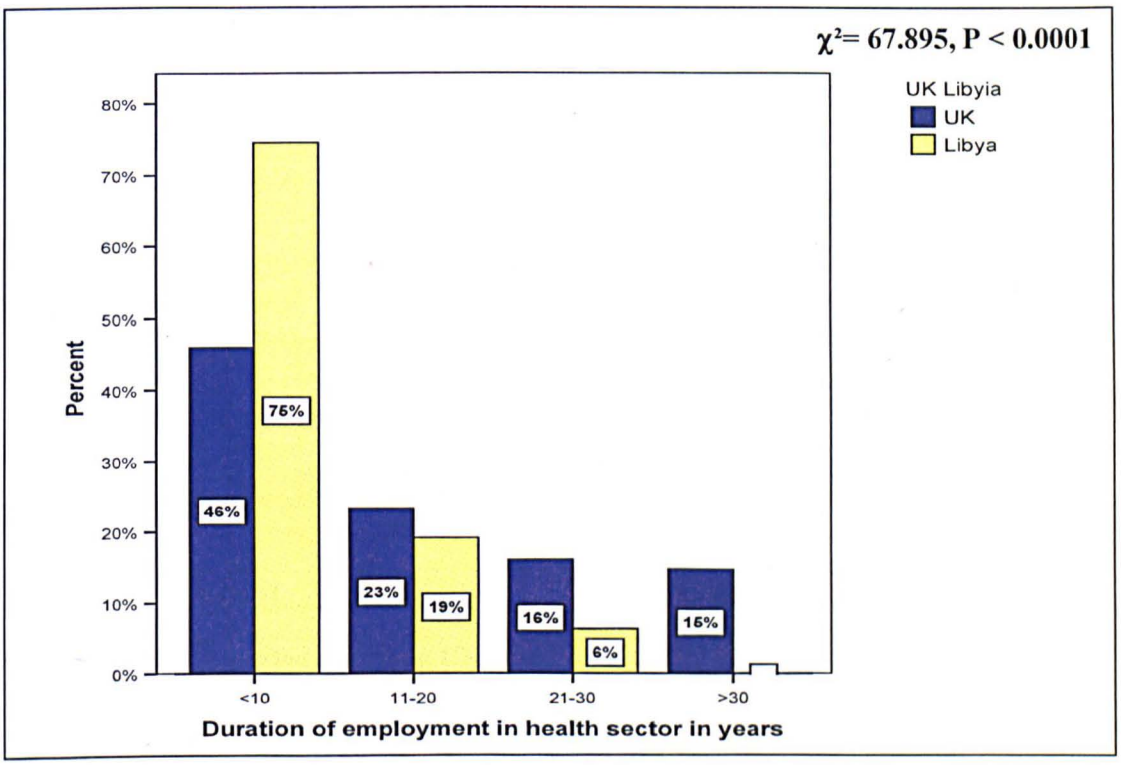

Figure 6.8 The different employment durations of the respondents

6.5 The awareness of HCW management and HHW recycling

6.5.1The Knowledge of UK respondents

The level of knowledge of waste management including waste recycling among the UK respondents was high and very similar in the two hospitals included in the study, where 77.3% (n=58) of respondents from UKH1compared to78.7% (n=59) of respondents from UKH2 demonstrated good knowledge and 21.3% (n=16) of respondents from UKH2 compared to 22.7% (n=17) of respondents from UKH1, demonstrated weak knowledge, p>0.05, Fig 6.9, table 6.5.

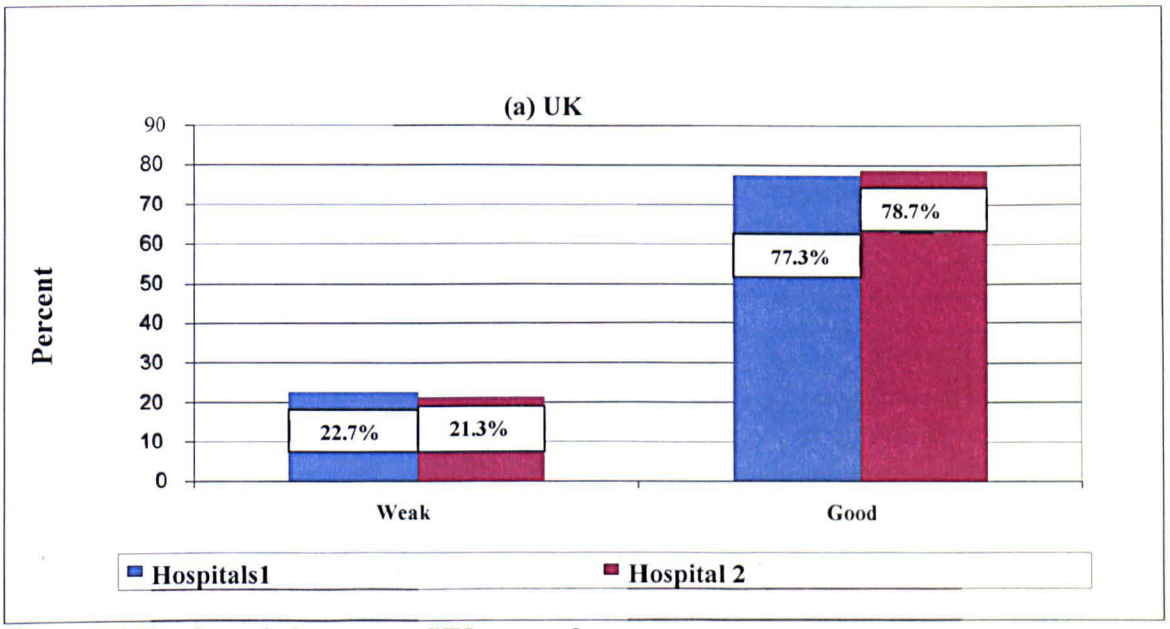

Figure 6.9 The knowledge among UK responders

6.5.2 The knowledge of the Libyan respondents

The level of knowledge in waste management including waste recycling among the Libyan respondents was generally low and comparable in the three hospitals included in the study. LBH3 demonstrated the lowest knowledge, where 99% (n=101) demonstrated weak knowledge compared to 84% (n=84) and 84.2% (n=85) in LBH1 and LBH2 respectively demonstrated weak knowledge, ($p<0.0001$), Fig 6.10, table 6.5.

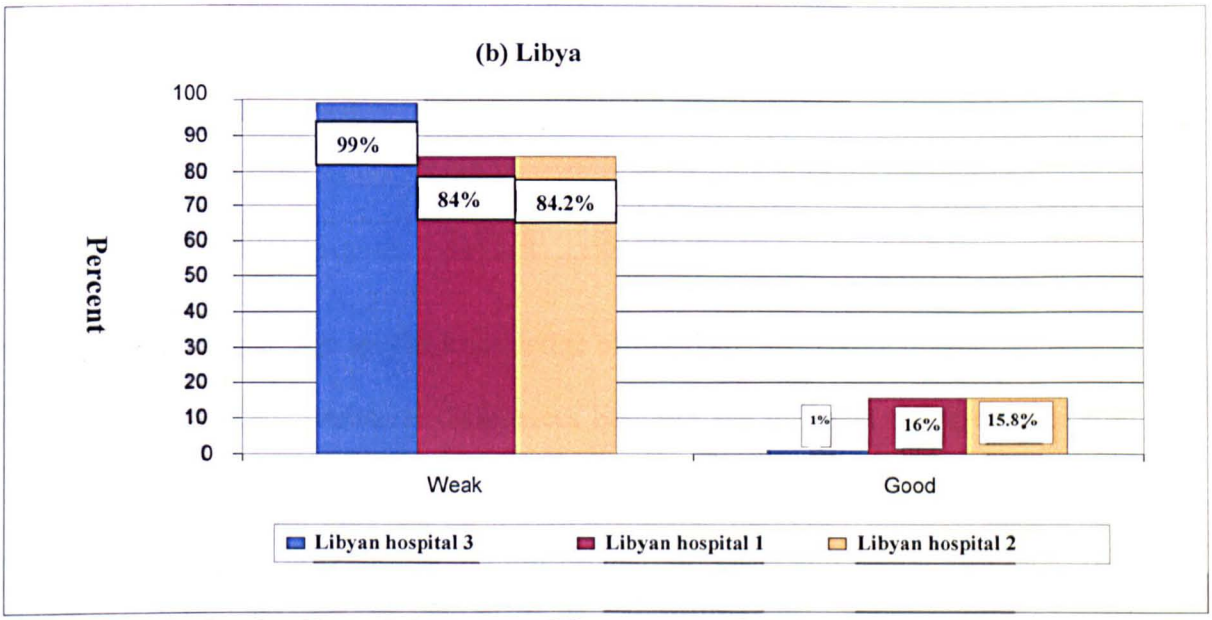

Figure 6.10 The levels of knowledge among Libyan respondents

Table 6.5 The Knowledge of the respondents of different hospitals in each country

Knowledge		Weak	Good	Chi-square	
		No. (%)	No. (%)	χ^2	P-value
UK	UKH1	16(21.3)	59(78.7)	0.039	P> 0.05
	UKH2	17(22.7)	58 (77.3)		
Libya	LBH1	84(84)	16(16)	15.56	P< 0.0001
	LBH2	85(84.2)	16(15.8)		
	LBH3	101 (99)	1 (1)		

6.5.3 Knowledge of UK versus Libyan respondents

The UK respondents demonstrated significantly higher level of knowledge compared to their respective Libyans. There were 78% (n=117) of the UK respondents who demonstrated good knowledge compared to 10.9% (n= 33), among the Libyan respondents who demonstrated good knowledge, p<0.0001, table 6.6.

Table 6.6 The knowledge of British versus Libyan respondents

		UK (n=150)	Libya (n=303)	Chi-square	
		No. (%)	No. (%)	χ^2	P-value
Knowledge	Weak	33 (22)	270 (89.1)	204	P< 0.0001
	Good	117 (78)	33 (10.9)		

6.5.4 The influence of age on the knowledge of the respondents

There were significant statistical differences between the different age groups in the UK respondents. The staff at middle age (30-40 years) demonstrated the best knowledge compared to the other 2 groups below 30 years and above 40 years. The staff aged 40 years and above demonstrated significantly better knowledge compared to those below 30 years, $p<0.05$, table 6.7.

On the other hand, Libyan respondents demonstrated no significant differences at all in the knowledge between the different age groups. The middle age group demonstrated slightly better level of knowledge followed by the youngest and oldest groups respectively, but with no significant differences, table 6.7.

Table 6.7 The Knowledge of age groups in the different hospitals in each country

Knowledge		Age (years)			Chi-square	
		< 30 yrs	30-40 yrs	> 40 yrs	χ^2	P-value
		No. (%)	No. (%)	No. (%)		
UK	Total	49 (100)	31 (100)	70 (100)	6.15	P< 0.05
	Weak	16 (32.7)	3 (9.7)	14 (20)		
	Good	33 (67.3)	28 (90.3)	56 (80)		
Libya	Total	205	69	29	0.049	P> 0.05
	Weak	183 (89.3)	61 (88.4)	26 (89.7)		
	Good	22 (10.7)	8 (11.6)	3 (10.3)		

6.5.5 Knowledge of the different age groups of the UK versus Libyan respondents

UK respondents showed significantly better knowledge compared to the Libyan respondents in all age groups, particularly the middle age groups, table 6.8.

Table 6.8The knowledge of age groups of the UK versus Libyan respondents

Knowledge		UK	Libya	Chi-square	
		No. (%)	No. (%)	χ^2	P-value
< 30 yrs	Total	49 (100)	205 (100)	74.72	P< 0.0001
	weak	16 (32.7)	183 (89.3)		
	good	33 (67.3)	22 (10.7)		
30-40 yrs	Total	31 (100)	69 (100)	57.54	P< 0.0001
	weak	3 (9.7)	61 (88.4)		
	good	28 (90.3)	8 (11.6)		
> 40 yrs	Total	70 (100)	29 (100)	41.32	P< 0.0001
	weak	14 (20)	26 (89.7)		
	good	56 (80)	3 (10.3)		

6.5.6 The influence of gender on the knowledge of the respondents

There were no significant differences in the knowledge between males and females in both countries. Females, however demonstrated slightly better knowledge than males in the UK group, while males demonstrated slightly better knowledge than females in Libyan group, but with no statistically significant differences, P<0.05, table 6.9.

Table 6.9 Comparing the knowledge of the different gender groups in the UK and Libya participants

Knowledge		Gender		Chi-square	
		Male	Female	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	31 (100)	119 (100)	0.33	P> 0.05
	Weak	8 (25.8)	25 (21)		
	Good	23 (74.2)	94 (79)		
Libya	Total	97 (100)	206 (100)	0.93	P> 0.05
	Weak	84 (86.6)	186 (90.3)		
	Good	13 (13.4)	20 (9.7)		

Males and females in UK demonstrated significantly better knowledge compared to their respective Libyans, table 6.10.

Table 6.10The gender on the knowledge of the UK versus Libyan respondents

		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
Male	Total	31 (100)	97 (100)	42.948	P< 0.0001
	weak	8 (25.8)	84 (86.6)		
	good	23 (74.2)	13 (13.4)		
Female	Total	119 (100)	206 (100)	158.99	P< 0.0001
	weak	25 (21)	186 (90.3)		
	good	94 (79)	20 (9.7)		

6.5.7 The influence of education on the knowledge of the respondents

The UK respondents demonstrated statistically significant differences in the knowledge between different educational levels. The knowledge level correlated positively with the level of education; the higher education level, the better the knowledge. The postgraduate participants demonstrated the best knowledge followed by the university graduates and the college graduates, $p<0.005$. There were no high school graduates in the UK respondents group, table 16. The Libyan participants demonstrated a similar pattern, where the more educated showed a better knowledge. The postgraduates demonstrated the highest level of knowledge followed by the university graduates. The high school graduates demonstrated a slightly higher level of knowledge compared to the college graduates, but not up to a statistically significant difference, table 6.11.

Table 6.11The knowledge of the respondents according to their educational levels

Knowledge		Education levels				Chi-square	
		High School	College	University Degree	Post graduate	χ^2	P-value
		No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	0	63 (100)	62 (100)	25 (100)	12.02	P< 0.005
	Weak	0	21 (33.3)	12 (19.4)	0		
	Good	0	42 (66.7)	50 (80.6)	25 (100)		
Libya	Total	25 (100)	129 (100)	146 (100)	3 (100)	4.52*	P> 0.05
	Weak	22 (88)	120 (93)	126 (86.3)	2 (66.7)		
	Good	3 (12)	9 (7)	20 (13.7)	1 (33.3)		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

When comparing the level of knowledge of the UK versus respective Libyan respondents according to their educational levels, it has been shown the UK respondents demonstrated better knowledge than their respective Libyans at all educational levels, P<0.005 between postgraduates and 0.0001 between all other educational levels, able 6.12.

Table 6.12The knowledge of the UK versus Libyan respondents according to their education levels

Education levels		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
High School	Total	0	25 (100)	(a)	
	weak	0	22 (88)		
	good	0	3 (12)		
College	Total	63 (100)	129 (100)	77.312	P< 0.0001
	weak	21 (33.3)	120 (93)		
	good	42 (66.7)	9 (7)		
University Degree	Total	62 (100)	146 (100)	87.355	P< 0.0001
	weak	12 (19.4)	126 (86.3)		
	good	50 (80.6)	20 (13.7)		
postgraduate	Total	25 (100)	3 (100)	9.305*	P< 0.005
	weak	0	2 (66.7)		
	good	25 (100)	1 (33.3)		

(a) cannot be computed. *Likelihood ratio is used as > 25% of the cells have expected count less than 5

6.5.8 The influence of the occupation on the knowledge of respondents

The knowledge of respondents with different occupations showed highly significant statistical differences.

In UK, waste team staff demonstrated the best knowledge compared to all working groups, P<0.0001, table 18. None of the waste workers in the UK hospitals demonstrated any single weak pattern of knowledge. They were followed by physicians, then nurses, then pharmacists and last the medical technicians, p<0.0001, table 6.13.

The Libyan respondents demonstrated a similar pattern, where the waste workers recorded the highest knowledge, followed by physicians, then nurses, then medical technicians and lastly the pharmacists. Libyan pharmacists demonstrated the lowest

knowledge compared to all other groups, where none of them demonstrated any single positive pattern, p<0.0001, table 6.13.

Table 6.13The knowledge of the respondents according to their occupations

Knowledge		Occupation					Chi-square	
		Waste team staff	Physician	Nurse	Technician	Pharmacist	χ^2	P-value
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	26 (100)	12 (100)	89 (100)	10 (100)	13 (100)	25.38*	P< 0.0001
	Weak	0	1 (8.3)	22 (24.7)	7 (70)	3 (23.1)		
	Good	26 (100)	11 (91.7)	67 (75.3)	3 (30)	10 (76.9)		
Libya	Total	50 (100)	83 (100)	103 (100)	41 (100)	26 (100)	54.23	P< 0.0001
	Weak	30 (60)	76 (91.6)	98 (95.1)	40 (97.6)	27 (100)		
	Good	20 (40)	7 (8.4)	5 (4.9)	1 (2.4)	0		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

When comparing the level of knowledge of the UK versus respective Libyan respondents according to their different job categories, it has been shown the UK respondents demonstrated better knowledge than their respective Libyans at all job categories, P<0.0001, table 6.14.

Table 6.14The knowledge of the UK versus Libyan respondents according to their occupations

		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
Waste team staff	Total	26 (100)	50 (100)	25.774	P< 0.0001
	weak	0	30 (60)		
	good	26(100)	20 (40)		
Physician	Total	12 (100)	83 (100)	47.294	P< 0.0001
	weak	1 (8.3)	76 (91.6)		
	good	11 (91.7)	7 (8.4)		
Nurse	Total	89 (100)	103 (100)	101.03	P< 0.0001
	weak	22 (24.7)	98 (95.1)		
	good	67 (75.3)	5 (4.9)		
Technician	Total	10 (100)	41 (100)	5.066*	P< 0.05
	weak	7 (70)	40 (97.6)		
	good	3 (30)	1 (2.4)		
Pharmacist	Total	13 (100)	26 (100)	26.897	P< 0.0001
	week	3 (23.1)	27 (100)		
	good	10 (76.9)	0		

6.5.9 The influence of hierarchical position on the knowledge of the respondents

In UK as well as in Libya, the senior respondents demonstrated significantly better levels of knowledge compared to their respective juniors, $p<0.05$ (in the UK) and $p< 0.0001$ (in Libya), table 6.15.

Table 6.15The knowledge of the respondents according to their hierarchical positions

Knowledge		Senior position holder		Chi-square	
		Senior	Junior	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	55 (100)	95 (100)	4.35	P< 0.05
	Weak	7 (12.8)	26 (27.4)		
	Good	48 (87.2)	69 (72.6)		
Libya	Total	51 (100)	252 (100)	13.47	P< 0.0001
	Weak	38 (74.5)	232 (92.1)		
	Good	13 (25.5)	20 (7.9)		

Comparing the respondents in the two countries according to their hierarchical positions, the UK seniors expressed significantly better knowledge than their respective Libyans, $p<0.0001$, Table 21. Likewise, the UK juniors demonstrated significantly better knowledge compared to their respective Libyans, $p<0.0001$, table 6.16.

Table 6.16The knowledge of the UK versus Libyan participants according to their hierarchical positions

Seniority		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
Senior	Total	55 (100)	51 (100)	41.35	P< 0.0001
	weak	7 (12.7)	38 (74.5)		
	good	48 (87.3)	13 (25.5)		
Junior	Total	95 (100)	252 (100)	151.4	P< 0.0001
	weak	26 (27.4)	232 (92.1)		
	good	69 (72.6)	20 (7.9)		

6.5.10 The influence of waste training on the knowledge of the respondents

Those who attended waste management training courses in the UK and Libya demonstrated significantly better knowledge than those who did not attend such courses, P<0.0001table 6.17.

Table 6.17 The attending waste training courses on the knowledge of the respondents

Knowledge		Waste management training		Chi-square	
		Yes	No	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	45 (100)	105 (100)	14.65	P< 0.0001
	Weak	1 (2.2)	32 (30.5)		
	Good	44 (97.8)	73 (69.5)		
Libya	Total	74 (100)	229 (100)	22.05	P< 0.0001
	Weak	55 (74.3)	215 (93.9)		
	Good	19 (25.7)	14 (6.1)		

Comparing those who attended waste management courses in the UK their respective Libyans, the UK respondents demonstrated significantly better knowledge, p<0.0001, table 6.18.

Table 6.18 The knowledge of the UK versus Libyan respondents according to their participation in waste management training courses

Waste management training		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
Yes	Total	45 (100)	74 (100)	58.39	P< 0.0001
	weak	1 (2.2)	55 (74.3)		
	good	44 (97.8)	19 (25.7)		
No	Total	105 (100)	229 (100)	150.3	P< 0.0001
	weak	32 (30.5)	215 (93.9)		
	good	73 (69.5)	14 (6.1)		

6.5.11 The influence of duration of employment on the knowledge of the respondents

The duration of employment did not affect the level of knowledge among the UK respondents. Those who worked between 21-30 years demonstrated the best knowledge, followed by those who worked 11-21 years, followed by those who worked for less than 10 years and followed by those who worked for more than 30 years, but no statistical differences were found between these different groups, P>0.05, table 6.19.

On the other hand, the Libyan respondents demonstrated significant differences between the respondents with different durations of employment. The highest knowledge was recorded among those who were employed for less than 10 years and followed by those who were employed between 11-20 years. Libyan respondents who were employed between 21-30 years did not demonstrate any good knowledge. None of the Libyan respondents was employed for more than 30 years, table 6.19.

Table 6.19 The duration of employments on the knowledge of the respondents

Knowledge		Duration of employment				Chi-square	
		<10	11-20	21-30	>30	Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	99 (100)	33 (100)	11 (100)	7 (100)	2.037	P> 0.05
	Weak	24 (24.2)	6 (18.2)	1 (9.1)	2 (28.6)		
	Good	75 (75.8)	27 (81.8)	10 (90.9)	5 (71.4)		
Libya	Total	256 (100)	37 (100)	10 (100)	0	6.504	P< 0.05
	Weak	224 (87.5)	36 (97.3)	10 (100)	0		
	Good	32 (12.5)	1 (2.7)	0	0		

Comparing the UK to the Libyan respondents, the UK respondents with different durations of employments demonstrated significantly better knowledge compared to their respective Libyans, P<0.0001. As noted above, there were no Libyans employed for more than 30 years, therefore the comparison at this length of employment is not statistically valid, table 6.20.

Table 6.20The knowledge of the UK versus Libyan respondents according to the duration of their employment

Current hospital tenure		Knowledge		Chi-square	
		UK	Libya	χ^2	P-value
		No. (%)	No. (%)		
<10	Total	99 (100)	256 (100)	135.7	P< 0.0001
	weak	24 (24.2)	224 (87.5)		
	good	75 (75.8)	32 (12.5)		
11-20	Total	33 (100)	37 (100)	45.491	P< 0.0001
	weak	6 (18.2)	36 (97.3)		
	good	27 (81.8)	1 (2.7)		
21-30	Total	11 (100)	10 (100)	17.355	P< 0.0001
	weak	1 (9.1)	10 (100)		
	good	10 (90.9)	0		
>30	Total	7 (100)	0	(a)	
	week	2 (28.6)	0		
	good	5 (71.4)	0		

(a) cannot be computed

6.6The Attitudes

6.6.1 UK respondents

Almost half of the UK respondents showed positive attitudes towards good practice of waste management including recycling, and to a lesser extent neutral with no statistical differences between the two studied hospitals (UKH1 and UKH 2).Respondents from UKH2 demonstrated 56% (n=42) positive attitudes compared to 50.7% (n=38) of the respondents of UKH1, 48% (n=36) of the UKH1 respondents demonstrated neutral attitudes compared 40% (n=30), of the respondents of the UKH2. There were a few respondents who showed "very positive attitudes", 1.3% in the UKH1 compared to 4% in the UKH2. No respondents in either hospital expressed negative attitude, $p<0.001$, Fig 6.11, table 6.21.

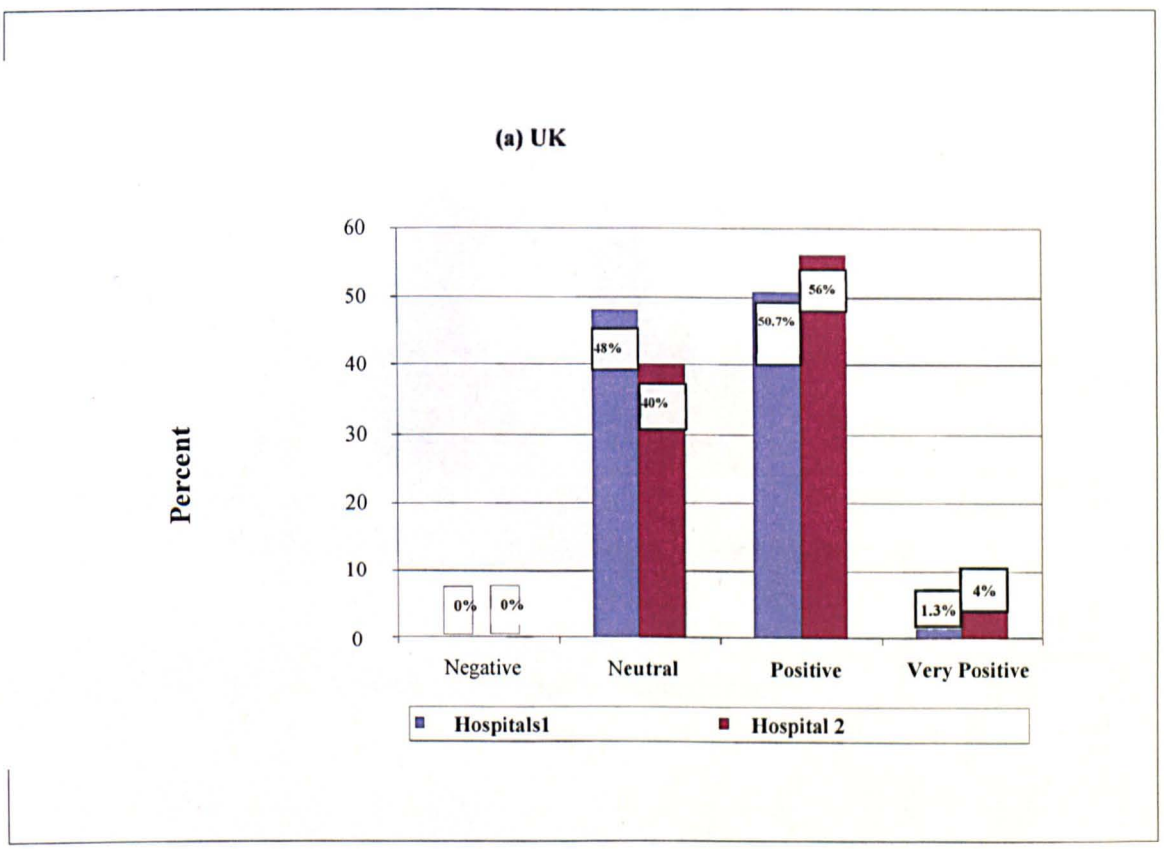

Figure 6.11 The general attitudes of the UK responders

6.6.2 Libyan respondents

The general attitudes of the Libyan respondents were generally low. The Libyans demonstrated a more neutral rather than positive attitude, where 44.1% (n=45) to 69.3% (n= 70) of all the Libyan respondents demonstrated neutral attitudes versus 23.8% (n=24) to 55.9% (n=57) who demonstrated positive attitudes, $p<0.0001$, table 21. Very few Libyan respondents demonstrated negative attitudes; 6.9% (n=7) from LBH2 and 1% (n=1) from LBH1. No single respondent from LBH 3 demonstrated negative attitudes and no single Libyan respondent from any of the three hospitals showed "very positive attitude". Respondents from LBH 3 demonstrated the most positive attitudes compared to the other two studied hospitals LBH 1 and LBH 2, $p<0.0001$, Fig 6.12, table 6.21.

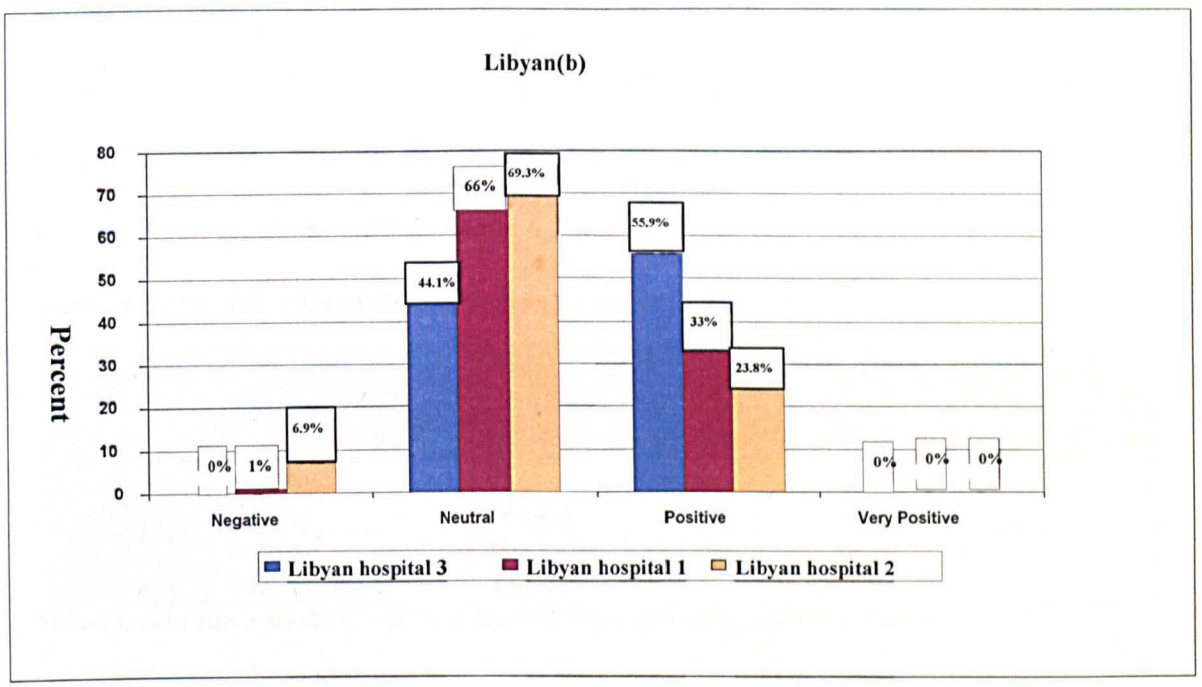

Figure 6.12 The general attitudes of the Libyan respondents

Table 6.21The attitudes of all respondents of all hospitals

Attitude		Negative	Neutral	Positive	Very Positive	Chi-square	
						Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)	No. (%)		
UK	UKH 1	0	36 (48)	38 (50.7)	1 (1.3)	1.79	P> 0.05
	UKH 2	0	30 (40)	42 (56)	3 (4)		
Libya	LBH1	1 (1)	66(66)	33(33)	0	32.65	P < 0.0001
	LBH2	7 (6.9)	70(69.3)	24(23.8)	0		
	LBH3	0	45 (44.1)	57(55.9)	0		

6.6.3The attitudes of the UK versus Libyan respondents

The UK respondents demonstrated significantly better attitudes compared to the Libyan respondents, where 53.3% (n=80) of the UK respondents demonstrated positive attitude compared to 37% (n=114) in the Libyan respondents, p<0.0001, table 6.22. The results show also that 44% (n=66) of the UK respondents demonstrated neutral attitude compared to 59.7% (n=181) in the Libyan respondents, p<0.0001. No single respondent in the UK group demonstrated any negative attitude compared to 2.6% (n=8) in the Libyan group, p<0.0001, Table 6.22.

Table 6.22The attitudes of British versus Libyan respondents

		UK (n=150)	Libya (n=303)	Chi-square	
		No. (%)	No. (%)	χ^2	P-value
Attitudes	Negative	0	8 (2.6)	25.6*	P< 0.0001
	Neutral	66 (44)	181 (59.7)		
	Positive	80 (53.3)	114 (37.6)		
	Very positive	4 (2.7)	0		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

6.6.4 The influence of age on the attitudes of UK and Libyan respondents

The UK respondents above 40 years showed significantly better attitudes than the other age groups. While the staff younger than 30 years showed lower attitudes compared to the other age groups, table 6.23.

The Libyan respondents demonstrated a similar pattern where respondents above 40 years showed the most positive attitudes compared to the other two younger groups, p=0.001, table 23. There were 3.9% of the group younger than 30 years, who demonstrated negative attitude. None of the respondents in the groups above 30 years demonstrated negative attitudes. Most of the Libyan respondents below 30 years demonstrated neutral attitudes (I have some interest); 65% (n=134) compared to 50.7% (n=35) in the age group 30-40 years and to 40.4% (n=12) in the group above 40 years, p=0.001, table 6.23.

Table 6.23The influence of age on the attitudes of respondents in both UK and Libya

Attitude		Age (years)			Chi-square	
		< 30 yrs	30-40 yrs	> 40 yrs	Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)		
UK	Total	49 (100)	31 (100)	70 (100)	11.55	P< 0.05
	Neutral	30 (61.2)	13 (41.9)	23 (32.9)		
	Positive	18 (36.7)	18 (58.1)	44 (62.9)		
	Very positive	1 (2)	0	3 (4.3)		
Libya	Total	205	69	29	18.06	P= 0.001
	Negative	8 (3.9)	0	0		
	Neutral	134 (65.4)	35 (50.7)	12 (41.4)		
	Positive	63 (30.7)	34 (49.3)	17 (58.6)		

6.6.5 The influence of age on the attitudes of the UK and Libyan respondents

Comparing the UK to Libyan respondents in relation to age, the UK respondents demonstrated significantly better attitudes than their respective Libyans, table 6.24.

Table6.24 The attitudes of the different age groups of the UK versus Libyan respondents

Attitudes		UK	Libya	Chi-square	
				χ^2	P-value
		No. (%)	No. (%)		
< 30 yrs	Total	49 (100)	205 (100)	7.258*	P> 0.05
	Negative	0	8 (3.9)		
	Neutral	30 (61.3)	134 (65.4)		
	Positive	18 (36.7)	63 (30.7)		
	Very positive	1 (2)	0		
30-40 yrs	Total	31 (100)	69 (100)	0.662	P> 0.05
	Neutral	13 (41.9)	35 (50.7)		
	Positive	18 (58.1)	34 (49.3)		
> 40 yrs	Total	70 (100)	29 (100)	2.549*	P> 0.05
	Neutral	23 (32.9)	12 (41.4)		
	Positive	44 (62.9)	17 (58.6		
	Very positive	3 (4.2)	0		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

6.6.6 The influence of gender on the attitudes of the respondents

There were no significant differences between the attitudes of males and females in neither country, P>0.05, table 6.25.

Table 6.25 Comparing the attitudes of the different gender groups in the UK and Libyan respondents

Attitudes		Gender		Chi-square	
		Male	Female	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	31 (100)	119 (100)	0.098*	P> 0.05
	Neutral	13 (41.9)	53 (44.5)		
	Positive	17 (54.8)	63 (52.9)		
	Very positive	1 (3.2)	3 (2.5)		
Libya	Total	97 (100)	206 (100)	3.73	P> 0.05
	Negative	1 (1)	7 (3.4)		
	Neutral	53 (54.6)	128 (62.1)		
	Positive	43 (44.3)	71 (34.5)		

***Likelihood ratio is used as > 25% of the cells have expected countless than5**

The attitudes of the UK female respondents were significantly better than Libyan respondents. On the other hand, there was no significant difference in attitude of the UK males versus Libyan males, table 6.26.

Table6.26 The effects of gender on the attitude of the UK versus Libyan respondents

Attitude		UK	Libya	Chi-square	
				Likelihood ratio	P-value
		No. (%)	No. (%)		
Male	Total	31 (100)	97 (100)	4.695	P> 0.05
	Negative	0	1 (1)		
	Neutral	13 (41.9)	53 (54.6)		
	Positive	17 (54.9)	43 (44.3)		
	Very positive	1 (3.2)	0		
Female	Total	119 (100)	206 (100)	22.799	P< 0.0001
	Negative	0	7 (3.4)		
	Neutral	53 (44.5)	128 (62.1)		
	Positive	63 (52.9)	71 (34.5)		
	Very positive	3 (2.5)	0		

6.6.7 The influence of education level on the attitudes of the respondents

There were no significant differences between the attitudes of the UK respondents versus their respective Libyans of different educational levels, P>0.05, table 6.27.

Table6.27 The attitudes of the respondents according to their educational levels

Attitudes		Education levels				Chi-square	
		High School	College	University Degree	postgraduate	Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	0	63 (100)	62 (100)	25 (100)	5.04*	P>0.05
	Neutral	0	22 (34.9)	31 (50)	13 (52)		
	Positive	0	39 (61.9)	29 (46.8)	12 (48)		
	Very positive	0	2 (3.2)	2 (3.2)	0		
Libya	Total	25 (100)	129 (100)	146 (100)	3 (100)	0.242*	P>0.05
	Negative	0	7 (5.4)	1 (0.7)	0		
	Neutral	14 (56)	76 (58.9)	89 (61)	2 (66.7)		
	Positive	11 (44)	46 (35.7)	56 (38.3)	1 (33.3)		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

Those with a College education in the UK respondents demonstrated significantly better attitudes than their respective Libyans. There was no significant difference between the attitudes of the UK versus Libyan respondents of those who have a university and a postgraduate degree, table 6.28.

Table 6.28The attitudes of the UK versus Libyan respondents according to their educational levels

Education levels		Attitude		Chi-square	
		UK	Libya	Likelihood ratio	P-value
		No. (%)	No. (%)		
High School	Total	0	25 (100)	(a)	
	Neutral	0	14 (56)		
	Positive	0	11 (44)		
College	Total	63 (100)	129 (100)	21.377	P< 0.0001
	Negative	0	7 (5.4)		
	Neutral	22 (34.9)	76 (58.9)		
	Positive	39 (61.9)	46 (35.7)		
	Very positive	2 (3.2)	0		
University Degree	Total	62 (100)	146 (100)	7.216	P> 0.05
	Negative	0	1 (0.7)		
	Neutral	31 (50)	89 (60.9)		
	Positive	29 (46.8)	56 (38.4)		
	Very positive	2 (3.2)	0		
Postgraduate	Total	25 (100)	3 (100)	0.237	P> 0.05
	Neutral	13 (52)	2 (66.7)		
	Positive	12 (48)	1 (33.3)		

(a) cannot be computed

6.6.8 The influence of occupation on the attitudes of the respondents

In the UK, waste workers, followed by nurses and followed by technicians demonstrated significantly better positive attitudes compared to physicians and pharmacists, $p<0.05$. None of the physicians, pharmacists and technicians expressed "very positive attitude", table 6.29.

In Libya, waste workers, nurses and physicians had a higher positive attitude compared to technicians and pharmacists, $p<0.05$, table 34. Among all professional groups, only nurses demonstrated "very positive attitude", table 6.29.

Table 6.29The attitudes of the respondents according to their occupations

Attitudes		Occupation					Chi-square	
		Waste team staff	Physician	Nurse	Technician	Pharmacist	Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	26 (100)	12 (100)	89 (100)	10 (100)	13 (100)	16.76	P< 0.05
	Neutral	4 (15.4)	7 (58.3)	42 (47.2)	4 (40)	9 (69.2)		
	Positive	20 (76.9)	5 (41.7)	45 (50.6)	6 (60)	4 (30.8)		
	Very Positive	2 (7.7)	0	2 (2.2)	0	0		
Libya	Total	50 (100)	83 (100)	103 (100)	41 (100)	26 (100)	16.58	P< 0.05
	Negative	0	1 (1.2)	4 (3.9)	0	3 (11.5)		
	Neutral	24 (48)	53 (63.9)	62 (60.2)	29 (70.7)	13 (50)		
	Positive	26 (52)	29 (34.9)	37 (35.9)	12 (29.3)	10 (38.5)		

UK Respondents from all job categories except pharmacists demonstrated significantly better attitudes compared to their respective Libyan, $p<0.005$, table 30. Libyan pharmacists demonstrated better positive attitudes; 38.5% (n=10) versus to their respective UK respondents; 30.8% (n=4). However, 11.5% (n=3) of the Libyan pharmacists demonstrated negative attitudes compared to none of the UK pharmacists and 69.2% (n=9) of the UK pharmacists demonstrated neutral attitude compared to 50% (n=13) of the Libyan pharmacists, table 6.30.

Table 6.30The attitudes of the UK versus Libyan respondents according to their occupations

		Attitude		Chi-square	
		UK	Libya	Likelihood ratio	P-value
		No. (%)	No. (%)		
Waste team staff	Total	26 (100)	50 (100)	11.697	P< 0.005
	Neutral	4 (15.4)	24 (48)		
	Positive	20 (76.9)	26 (52)		
	Very Positive	2 (7.7)	0		
Physician	Total	12 (100)	83 (100)	0.449	P> 0.05
	Negative	0	1 (1.2)		
	Neutral	7 (58.3)	53 (63.9)		
	Positive	5 (41.7)	29 (34.9)		
Nurse	Total	89 (100)	103 (100)	11.948	P< 0.01
	Negative	0	4 (3.9)		
	Neutral	42 (47.2)	62 (60.2)		
	Positive	45 (50.6)	37 (35.9)		
	Very Positive	2 (2.2)	0		
Technician	Total	10 (100)	41 (100)	2.115	P> 0.05
	Neutral	4 (40)	29 (70.7)		
	Positive	6 (60)	12 (29.3)		
Pharmacist	Total	13 (100)	26 (100)	3.129	P> 0.05
	Negative	0	3 (11.5)		
	Neutral	9 (69.2)	13 (50)		
	Positive	4 (30.8)	10 (38.5)		

6.6.9 The influence of hierarchical position on the attitudes of the respondents

The attitudes of the UK senior respondents were almost similar to the juniors as assessed by their very positive, positive, neutral and negative parameters, P>0.05, Table 6.31.

The Libyan senior respondents showed significantly better attitudes compared to juniors, where 52.9% (n=27) of the senior respondents demonstrated positive attitudes compared to 34.5% (n=87) of the juniors, 43% (n=22) of the senior respondents demonstrated neutral attitudes compared to 63.1% (n=159) of the juniors and 3.9% (n=2) of the senior respondents demonstrated negative attitudes compared to 2.4% (n=6) of the juniors, P< 0.05, Table 6.31.

Table 6.31The attitudes of the respondents according to their hierarchical position

Attitudes		Senior position holder		Chi-square	
		Senior	Junior	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	55 (100)	95 (100)	0.275*	P> 0.05
	Neutral	24 (43.7)	42 (44.2)		
	Positive	30 (54.5)	50 (52.6)		
	Very Positive	1 (1.8)	3 (3.2)		
Libya	Total	51 (100)	252 (100)	7.034	P< 0.05
	Negative	2 (3.9)	6 (2.4)		
	Neutral	22 (43)	159 (63.1)		
	Positive	27 (52.9)	87 (34.5)		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

When comparing the attitudes of the UK senior respondents to their respective Libyans, no significant differences were demonstrated between the two groups, P>0.05, Table 6.32.

The UK junior respondents showed significantly better attitudes compared to their respective Libyan juniors, where 52.6% (n=50) of the UK juniors demonstrated positive attitudes compared to 34.5% (n=87) of the Libyan juniors, 44.2% (n=42) of the UK juniors demonstrated neutral attitudes compared to 63.1% (n=159) of the Libyan juniors. No single UK junior respondent demonstrated any negative attitude compared to 2.4% (n=6) of the Libyan juniors who demonstrated negative attitudes, P< 0.0001, Table 40.None of the participants from Libya had excellent attitude while non from UK had wrong attitude in both groups, table 6. 32.

Table 6.32The attitudes of the UK versus Libyan respondents according to their hierarchical position

Senior position holder		Attitude		Chi-square	
		UK	Libya	Likelihood ratio	P-value
		No. (%)	No. (%)		
Senior	Total	55 (100)	51 (100)	4.253	P> 0.05
	Negative	0	2 (3.9)		
	Neutral	24 (43.6)	22 (43.2)		
	Positive	30 (54.5)	27 (52.9)		
	Very Positive	1 (1.8)	0		
Junior	Total	95 (100)	252 (100)	21.51	P< 0.0001
	Negative	0	6 (2.4)		
	Neutral	42 (44.2)	159 (63.1)		
	Positive	50 (52.6)	87 (34.5)		
	Very Positive	3 (3.2)	0		

6.6.10 The influence of waste training on the attitudes of the respondents

There were no significant differences in the attitudes of the UK respondents who attended training in waste management compared to those who did not attend such courses, P>0.05, table 6.33.

When comparing the attitudes of the Libyan respondents who participated in waste management training to those who did not, we found that those who participated in such courses showed significantly better attitudes compared to those who did not participate, where 52.7% (n=39) of the participants demonstrated positive attitudes compared to 32.8% (n=75) of the non participants, 44.6 % (n=33) of the participants demonstrated neutral attitudes compared to 64.6% (n=148) of the non participants and 2.7% (n=2) of the participants demonstrated negative attitudes compared to 2.6% (n=6) of the non participants, P< 0.01, table 6.33.

Table 6.33The attitudes of the respondents according to their participation in waste management training courses

Attitudes		Waste management training		Chi-square	
		Participated	Did not	χ^2	P-value
		No. (%)	No. (%)		
UK	Total	45 (100)	105 (100)	4.76*	P> 0.05
	Neutral	16 (35.5)	50 (47.6)		
	Positive	26 (57.8)	54 (51.4)		
	Very Positive	3 (6.7)	1 (1)		
Libya	Total	74 (100)	229 (100)	9.68	P< 0.01
	Negative	2 (2.7)	6 (2.6)		
	Neutral	33 (44.6)	148 (64.6)		
	Positive	39 (52.7)	75 (32.8)		

When compared the UK and Libyan respondents who participated in waste management courses, The UK respondents demonstrated significantly better attitudes, P<0.05, table 34. Similarly, the UK respondents who did not participate in waste management courses demonstrated significantly better attitudes compared to their Libyan respective who did not participate in such courses, P=0.001, table 6.34.

Table 6.34 The attitudes of the UK versus Libyan respondents according to their participation in waste management training courses

Waste management training		Attitude		Chi-square	
		UK	Libya	Likelihood ratio	P-value
		No. (%)	No. (%)		
Yes	Total	45 (100)	74 (100)	8.433	P< 0.05
	Negative	0	2 (2.7)		
	Neutral	16 (35.6)	33 (44.6)		
	Positive	26 (57.8)	39 (52.7)		
	Very Positive	3 (6.7)	0		
No	Total	105 (100)	229 (100)	16.691	P= 0.001
	Negative	0	6 (2.6)		
	Neutral	50 (47.6)	148 (64.6)		
	Positive	54 (51.4)	75 (32.8)		
	Very Positive	1 (1)	0		

6.6.11 The influence of duration of employment on the attitudes of the respondents

The UK respondents who worked between 11-20 years demonstrated the most positive attitudes compared to the other respondents who worked for less or more than 11 or 20 years. Those who worked for more than 30 years showed the worst attitudes compared to the others who worked for less than 30 years. Those who worked for less than 10 years demonstrated comparable attitudes to those who worked between 21-30 years, which suggest that the UK workers lose their interest by the time process, P= 0.001, Table 35.

Similar to the UK respondents, the Libyan respondents who worked in the health services for 11-20 years showed the most positive attitudes compared to those who worked less than 10 years and those who worked more than 20 years, P<0.001, table 6. 35. However, those who worked less than 10 years demonstrated significantly better attitudes than those who worked more than 20 years, P<0,001, table 6.35. There was no Libyan respondent who worked for more than 30 years.

Table 6.35The attitudes of the respondents according to the duration of employment

Attitudes		Duration in the current hospital				Chi-square	
		<10	11-20	21-30	>30	Likelihood ratio	P-value
		No. (%)	No. (%)	No. (%)	No. (%)		
UK	Total	99 (100)	33 (100)	11 (100)	7 (100)	23.97	P= 0.001
	Neutral	51(51.5)	5 (15.2)	5 (45.5)	5 (71.4)		
	Positive	45 (45.5)	28 (84.8)	6 (54.5)	1 (14.3)		
	Very Positive	3 (3)	0	0	1 (14.3)		
Libya	Total	256 (100)	37 (100)	10 (100)	0	14.39	P< 0.01
	Negative	7 (2.7)	1 (2.7)	0	0		
	Neutral	161 (62.9)	19 (51.4)	1 (10)	0		
	Positive	88 (34.4)	17 (45.9)	9 (90)	0		

When comparing the effects of employment's duration on the attitudes of the UK versus Libyans, the UK respondents who worked for less than 10 years and those who worked between 11-20 years showed significantly better attitudes than their respective Libyans , P=0.001 and p=0.005 respectively, table 6.36.

There was no statistical difference between the UK and Libyan respondents who worked for 21-30 years, P>0.005. No single Libyan respondent worked for more than 30 years, therefore no valid comparison could be done between the UK and Libyan respondents who worked for more than 30 years, table 6.36.

Table 6.36The attitudes of the UK versus Libyan respondents according to the duration of their employment

Current Hospital Tenure		Attitude		Chi-square	
		UK	Libya	likelihood ratio	P-value
		No. (%)	No. (%)		
<10	Total	99 (100)	256 (100)	16.083	P= 0.001
	Negative	0	7 (2.7)		
	Neutral	51 (51.5)	161 (62.9)		
	Positive	45 (45.5)	88 (34.4)		
	Very Positive	3 (3)	0		
11-20	Total	33 (100)	37 (100)	12.681	P< 0.005
	Negative	0	1 (2.7)		
	Neutral	5 (15.2)	19 (51.4)		
	Positive	28 (84.8)	17 (45.9)		
21-30	Total	11 (100)	10 (100)	3.467	P> 0.05
	Neutral	5 (45.5)	1 (10)		
	Positive	6 (54.5)	9 (90)		
>30	Total	7 (100)	0	(a)	
	Neutral	5 (71.4)	0		
	Positive	1 (14.3)	0		
	Very Positive	1 (14.3)	0		

(a) cannot be compute

6.6.12 The knowledge and attitudes towards clinical waste recycling

The UK respondents showed significantly better knowledge and more positive attitudes towards recycling waste than their respective Libyans, table 6.37.

There was no statistically significant difference between the knowledge and the attitudes of the respondents within the two countries, table 6.37.

Table 6.37 The effects of knowledge on the attitudes of the British versus Libyan participants

Attitudes	UK Knowledge		Chi-square	
	Week (33)	Good (117)	χ^2	P-value
	No. (%)	No. (%)		
Neutral (66)	17 (51.5)	49 (41.9)	2.70*	P> 0.05
Positive (80)	16 (48.5)	64 (54.7)		
Very positive (4)	0	4 (3.4)		
Attitudes	Libya Knowledge			
	Week (270)	Good (33)		
Neutral (8)	8 (3)	0	5.06	P> 0.05
Positive (181)	166 (61.5)	15 (45.5)		
Very positive (114)	96 (35.6)	18 (54.5)		

***Likelihood ratio is used as > 25% of the cells have expected count less than 5**

6.7 Correlations between the knowledge and attitudes concerning hospital workers about HCW and HHW recycling

Table 6.38 and 6.39 shows that both in the UK and Libya, statistically significant correlations exist between knowledge and attitudes; i.e. good knowledge and awareness about HCW and recycling are associated with more positive attitudes. However the correlation coefficients (r) though significant are not very strong (0.164 from Libyan staff and 0.237 for UK staff), suggesting that other factors are more important and that knowledge is not of a predictive value in determining the attitudes, Table 6.38, table 6.39. The lack of strong correlation between knowledge and attitudes is to some extent surprising, but this may reflect a possible separation between recycling as a positive concept for hospital staff and something they have good knowledge of, and recycling in practice (reflecting attitudes) which they may be less able to implement in a busy workplace.

Table 6.38 Correlations between knowledge and attitudes among Libyan hospital staff

Correlations

		Knowledge	Attitudes
Knowledge	Pearson Correlation	1	.164**
	Sig. (2-tailed)		.004
	N	303	303
Attitudes	Pearson Correlation	.164**	1
	Sig. (2-tailed)	.004	
	N	303	303

**. Correlation is significant at the 0.01 level (2-tailed).
a. UK Libya = Libya

Table 6.39 Correlations between knowledge and attitudes among UK hospital staff

Correlations

		Knowledge	Attitudes
Knowledge	Pearson Correlation	1	.237**
	Sig. (2-tailed)		.004
	N	150	150
Attitudes	Pearson Correlation	.237**	1
	Sig. (2-tailed)	.004	
	N	150	150

**. Correlation is significant at the 0.01 level (2-tailed).
a. UK Libya = UK

6.8 Regression modeling

6.8.1 Awareness of hospital workers about HCW and HHW recycling

Results of univariate testing show considerable differences between respondents' awareness from UK and Libyan hospitals and it is likely that these represent very different populations. Regression modelling was therefore performed separately on the two populations (UK and Libya). This shows that 32.8% of the variation knowledge seen in the Libyan respondents can be explained by the model, Table 6.40.

Table 6.40 Model summary for linear regression model for predictors of knowledge in Libyan hospital staff

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.573[b]	.328	.305	1.32769

a. UK Libya = Libya

b. Predictors: (Constant), Current Hos Tenure, Post qual training, Nurse, Senior position holder, Pharmacist, Gender, Technician, waste team, Age, Health tenure

The significance value (Sig) indicates which of the modelled variables are the most important in explaining the variation in knowledge observed in the Libyan participants. In this case training and occupation are the most important factors in explaining knowledge. Table 6.41.

Table 6.41 Individual details of model predictors of knowledge in Libyan hospital staff

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.107	.313		9.914	.000
	Gender	-.091	.191	-.027	-.476	.635
	Age	.242	.149	.108	1.624	.105
	Post qual training	.901	.188	.243	4.781	.000
	Waste team	.856	.250	.200	3.428	.001
	Nurses	-.901	.204	-.268	-4.417	.000
	Technician	-.887	.265	-.191	-3.347	.001
	Pharmacist	-1.001	.304	-.176	-3.288	0.001
	Senior position holder	.240	.219	.057	1.097	.273
	Health tenure	-.336	.224	-.124	-1.501	.135
	Current Hos Tenure	-.201	.248	-.059	-.809	.419

a. UK Libya = Libya

b. Dependent Variable: Knowledge

Modelling for UK staff indicates that 36% of the variation in knowledge seen in the UK respondents can be explained by model. Table 6.42.

Table 6.42 Model summary for linear regression model for predictors of knowledge in UK hospital staff

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.601[b]	.361	.315	1.26994

a.UK Libya = UK

b. Predictors: (Constant), Current Hos Tenure, Technician, physician, Gender, Post qual training, Senior position holder, Pharmacist, waste team, Age, Health tenure

The significance value (Sig) indicates which of the modelled variables are the most important in explaining the variation in Knowledge. In this case training and occupation most predictive variables for UK staff. Table 6.43.

Table 6.43 Individual details of model predictors of knowledge in UK hospital staff

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.886	.358		13.639	.000
	Gender	-.164	.266	-.043	-.617	.538
	Age	.261	.147	.193	1.777	.078
	Post qual training	1.419	.251	.425	5.647	.000
	Waste team	.880	.318	.218	2.772	.006
	Physician	.851	.395	.151	2.155	.033
	Technician	-.839	.434	-.137	-1.932	.055
	Pharmacist	.194	.406	.036	.477	.634
	Senior position holder	.182	.237	.057	.769	.443
	Health tenure	-.177	.168	-.127	-1.056	.293
	Current Hos Tenure	.103	.178	.055	.577	.565

a. UK Libya = UK

b. Dependent Variable: Knowledge

6.8.2 Attitudes towards hospital workers about HCW and HHW recycling

The previous data indicates that some of the variations in knowledge can be explained by referring to variables such as occupation and levels of training.

However similar modelling for attitudes of hospital staff indicates that we cannot use these sorts of variables to predict people's attitudes to recycling, knowledge is predictable but attitudes less so. Within the adjusted model we see very little of the variance in the attitudes can be attributed to the modelled variables (adjusted R^2=0.061), Table 6.44.

Table 6.44 Model summary for linear regression model for predictors of attitudes in Libyan hospital staff

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.605[b]	.366	.061	5.18534

a. UK Libya = Libya

c. Predictors: (Constant), waste team, Age, Full degree, Pharmacist, Post qual training, Technician, Senior position holder, physician, Current Hos Tenure, Gender, Short course, Health tenure

When examining the individual variables contribution to the model, none of the variables can significantly predict the variation in attitudes amongst the participants from Libya, Table 6.45.

Table 5 Individual details of model predictors of attitudes in Libyan hospital staff

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	33.464	7.094		4.717	.000
	Gender	1.891	2.652	.152	.713	.483
	Age	1.590	1.391	.216	1.143	.264
	Post qual training	-1.844	5.602	-.056	-.329	.745
	Physician	-2.755	3.582	-.141	-.769	.449
	Technician	-3.082	4.138	-.130	-.745	.463
	Pharmacist	-5.637	6.248	-.171	-.902	.376
	Senior position holder	-.507	2.050	-.045	-.247	.807
	Health tenure	-1.133	2.028	-.120	-.559	.581
	Current Hos Tenure	4.751	3.830	.243	1.241	.226
	Short course	1.739	2.150	.165	.809	.426
	Full degree	-.958	2.931	-.070	-.327	.746
	Waste team	3.640	2.292	.344	1.588	.125

a. UK Libya = Libya

b. Dependent Variable: Attitudes

Similarly for the UK, we cannot use these sorts of variables to predict people's attitudes to recycling, Knowledge is predictable but attitudes are not, Table 6.46.

Table 6.46 Model summary for linear regression model for predictors of attitudes in UK hospital staff

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.533[b]	.284	.073	6.74412

a. UK Libya = UK

b. Predictors: (Constant), waste team, Current Hos Tenure, physician, Full degree, Senior position holder, Gender, Age, Short course, Pharmacist, Health tenure

Again, as for the Libyan staff, none of the variables can significantly predict variation in attitudes of UK respondents, Table 6.47.

Table 6.47 Individual details of model predictors of attitudes in UK hospital staff

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	38.018	3.643		10.437	.000
	Gender	-1.494	3.036	-.086	-.492	.626
	Age	1.078	1.520	.154	.709	.483
	Physician	1.851	7.068	.039	.262	.795
	Pharmacist	-13.822	6.822	-.411	-2.026	.051
	Senior position holder	1.216	2.448	.085	.497	.623
	Health tenure	-.262	1.647	-.040	-.159	.875
	Current Hos Tenure	2.206	1.949	.265	1.132	.265
	Short course	4.028	3.364	.222	1.198	.239
	Full degree	4.558	7.322	.097	.623	.538
	Waste team	2.430	2.599	.170	.935	.356

a. UK Libya = UK

b. Dependent Variable: Attitudes

Overall the regression modelling indicates that knowledge can be partially predicted based on two main variables: training and occupation in both the UK and Libya. Attitudes however are not amenable to prediction based on the variables explored in this study. Clearly attitudes are a more complex construct than knowledge which is likely to be more influenced by fewer factors.

Chapter 7 Discussion

7.1 Waste generation rate

This study has demonstrated that the UK hospitals were found to generate significantly (statistically) more waste compared to the Libyan hospitals. It is well known in the medical literature that developed countries generate much more waste per capita compared to developing countries (Solid Waste Management, 2005). Not only that, but there are higher contents of plastics, metals, and paper in the municipal solid waste stream in the developed countries, which makes the waste in these countries more suitable for recycling (Solid Waste Management, 2005). Diaz L, *et al.*, (2006) showed that as developing countries continue developing, the life style of the people and the general marketing trends tend to change, which results in increasing the waste generation with more industrial proportions of the waste and less biological solid waste and ash (Diaz, L. *et al.*, 2006). Waste generation has increased per capita in member countries to the convention of Organisation for Economic Co-operation and Development (OECD) by 14% as measured in 1990 compared to 2006 and 35% from 1980 compared to 2006 (Improving Recycling Markets, OECD, 2006).

This difference in generation of waste per capita between the UK and Libya is consistent with different living styles and socioeconomic parameters between the developed and developing countries (Liu C, 2010). In the case of HCW, it has also been shown that hospitals and healthcare premises in the developed world generate more waste compared to developing counties (Diaz, L. *et al.*, 2006). Beside the general life style, this could be attributed to the higher health expenditure in the developed countries, which results in producing larger amounts of HCW. Baker, (2004) have

shown that developed countries, which comprise 22% of the world's population consume more than 60% of the world industrial raw materials (Baker, E, 2004). The USA generates more waste than any other nation in the world with 2.04 kg of Municipal Solid Waste (MSW) per capita per day, 55% of which is contributed as residential garbage (Cashing in on Climate Change, 2008).

The total health expenditure (THE) as a proportion of the Gross Domestic Product (GDP) in the developed countries is approximately 8% (WHO 1999; WHO 2000; WHO 2002). In some countries like USA, it can reach 17.4% and in the UK, this index was reported in 2009 to be 9.7% (Chunling L *et al.*, 2010) and during 2011 to be 10.3 (Hawe E, *et al.*, 2011).

Libya has reported the fourth highest GDP per capita in Africa during 2009, behind Seychelles, Equatorial Guinea and Gabon (Annual Statistical Bulletin, 2004). Libya has the 10th-largest proven oil reserves of any country in the world and the 17th-highest petroleum production (Annual Statistical Bulletin, 2004). THE as a proportion of GDP has dropped in Libya down from 3.3 in 2002 to 3 in 2008 (WHO, 2011) and the human development report has shown that THE did not exceed 3.3% of GPD (Human Development Report, 2011). This may explain the lower production of HCW in Libyan hospitals compared to the UK hospitals demonstrated in this study, as more consumption usually results in more waste. It has been reported that public financing of health in developing countries increased by nearly 100% from 1995 to 2006, which was attributed to rising GDP (Chunling *Let al.*, 2010). However in Libya, this index has dropped from 3.3 in the 1980's to 3 in 2010 (Economic & Social Transformation Plan 1981-1985, Ministry of Planning, Libyan Government; Altabet A, 2004; Health Information Centre Tripoli, 2001). Reductions in public financing of health may affect

the amount HCW and WGR. ISESCO has shown in 2011 that GDP in Libya has increased then to 4,884.71 US $ http://www.icpsr.org.ma.

This study shows the two UK hospitals that recycled most had also generated more waste. However, the two UK hospitals recycled 23.4% and 16.9% respectively, which fall below the target for recycled waste as set by the government, which set a target of 25% by 2005 and 30% by 2010, 33% by 2015 (DETR, 2000; Price JL, 2001). Although some segregation takes place in the Libyan hospitals as shown in this study, particularly in Libyan 2 hospital, none of the Libyan hospitals practiced any recycling of the HCW. Research about HCW management and recycling in Libya is very rare. Very few studies have dealt with this problem. Sawalem M, *et al.*, (2009) is the only comprehensive case study that provides some information about the status of HCW in Libyan hospitals. However, Swalem *et al.*, (2009) did not consider the recycling status in the Libyan hospitals. With regards to WGR, the results were similar to Sawalem's results. There was no previous study before the studies that estimated the WGR in Benghazi hospitals. Gebril AO, *et al.*, (2010) have estimated WGR of the whole city of Benghazi as 0.75-0.95 kg/person/year. We reported for the first time the WGR of the LBH2, which were1.4 kg/ patient/day. Althabet, (2004) and Al Hamroush, (2005) have published two similar Master theses about the status of HCW management in Libyan hospitals. They showed that there was low orientation among the waste collectors in the Libyan hospitals. They have also showed that there was no governmental support to improve the HCW management: According to them, there was no training programmes, no legislation that controls HCW disposal and no hospital policy. They have not addressed the recycling of hospital waste at all. These are the only studies identified about hospital waste management. Etriki and Deitz P, (2012) have shown that recycling

is not being practiced at all in Libya, even when dealing with the public waste and Libyan waste has been a market for recycling in neighbouring countries.

Gaddafi's regimen that dictated power in Libya for 4 decades between 1969 and 2011 has deprived the country from its natural resources and provided scarce budgets for all sectors of life. HCW and general municipal waste disposal were not an exception to this and no serious attempts were made to follow up with the current trends and updates that have happened in the world during the 4 decades of Gaddafi's government (Etriki and Deitz P, 2012). It is therefore not all together surprising to find out that the waste management is not optimal in either the public sector or the healthcare sectors.

It seems that the lack of knowledge and experience that was caused by long years of ignorance and working with scarce budgets and the lack of healthcare policies and plans are all behind the failure to establish good practice for disposal and recycling of HCW, even when willingness to improve the HCW exists among some enthusiastic healthcare leaders.

The results of this study show also that there was no purchasing policy and no consideration of how to reduce WGR or how to apply recycling and systematic quality control and auditing. The absence of such a policy that regulates HCW disposal and the lack of auditing system that controls the process of waste collection and disposal make it clear that there is no order or good practice in hospital management in Libya. This study shows that Libyan hospitals do not practice any recycling of hospital waste.

There are some studies that have demonstrated the inadequate management of hospital waste in other developing countries and in most of these, recycling was not even mentioned. Some studies have made comparisons between hospitals in developing and

developed countries (Shinee E *et al.*, 2007; Askarian M *et al.*, 2004; Kumar R *et al.*, 2010).

The results of this study show the WGR (measured per patient per day) in both the UK and Libyan hospitals correlated positively with the number of beds. However, good management of hospitals' waste using appropriate segregation and increasing recycling have been shown to reduce hospital waste to the extent that a larger hospital that practices recycling may produce less waste than a smaller hospital that does not practice recycling (Kaplan S*et al.*, 2012). There were some discrepancies in the waste generation between the two UK hospitals showing that one of the hospitals produces significantly more waste compared the other despite they are of similar size. This was most likely attributed to the better policy procedure that the less waste producing hospital is following. On the other hand, the collection of the data from the Libyan hospitals was associated with some problems such as the difficulties of reaching to the mandate records and the uncertainty about the total waste.

Hospitals in developing countries may raise the WGR with increased expenditure on healthcare unless they combat this with a suitable waste management policy. With an increase in recycling practices in the developed countries, WGR could be reduced. Recycling and reuse are the essentials that developing countries need to face the increased WGR in expanding hospitals. For example Zhen-Shan *et al.*, (2009) has shown that in Beijing, China, mass solid waste has considerably increased over the last three decades in a system that does not extensively recycle and is expected to continue to increase.

7.2 Recycling practices

Evaluating recycling of HCW is more than just estimating the amounts of waste being recycled. It involves other important aspects such as what exists in the hospital policy concerning HCW management and recycling. The practice of segregation is another fundamental aspect that should be considered when evaluating recycling of HCW. Ensuring safety is no less important and is an aspect that should not be neglected when evaluating recycling of HCW. The recycling process itself and how it is being performed, how much is recycled and what is recycled are all pillars when it comes to evaluating recycling. A number of hospital policy instruments concerning HCW management exist for ensuring good control of all hazardous associated with the HCW. Some of these policies are command-and-control instruments; economic or market-based instruments; voluntary agreements; and information-based strategies (Perman *et al.*, 2003; Sterner, 2003). Command and-control instruments are composed of direct regulation and focus essentially on the utilisation of regulatory instruments, such as standards, authorisations (licences/permits) and land-use controls. Environmental regulation is a relatively new approach to HCW control, with most environmental legislation having been existed in the last 20-30 years in developed countries, and about 10 years in developing countries (Goodstein, 2002). A governance shift away from the traditional 'policing' to a modern approach of co-operating has seen the adopted in some developed countries with a number of 'softer', alternative, policy instruments, (Sterner, 2003). Regulatory controls have been considered the predominant solution to controlling pollution in developed and developing countries. This has been mainly due to the failure of traditional command and-control approaches (Sterner, 2003). In developing countries, the old regulatory controls still represent the main way of HCW control management; however, failures in compliance and in the enforcement of waste

legislation have generally resulted in deterioration in the management of waste (Sterner, 2003). The introduction of alternative policy instruments in developing countries is often unsustainable in the short- to medium-term. This is made complicated by the political and economic situations in the developing countries, which makes it difficult for hospitals to adhere to any policy, therefore, even if a policy is made, its regulations do not come to practice. Instruments instituted in developed countries are often adopted or applied within developing countries without consideration of the context they were developed in and without realising the differences in the settings and circumstances. Financial and human resources in the developing country governments are also blamed for the failure of institution and applying of hospital policies. According to Ball J., (2006), "waste management in developing countries is characterised by a general lack of resources and reliable operating systems". This leads to sub-optimal or bad management of hospital waste. Ball J., (2006) has identified based on personal experience 7 important factors affecting hospital policy making, political will, lack of resources, which are priority standing, local factors, systems and information, unacceptable waste management practices and donor funding.

Recycling cannot be evaluated properly without evaluating segregation and how much it is fitting with the recent updates with regards to separating the HCW waste into hazardous and non hazardous. In order to evaluate the recycling practices in the studied hospitals, a scoring model consisting of 21 points has been specifically designed by the author out of a set of questions focusing on four mainthemes, policy, segregation, recycling and safety. The model was called the PSRS-Hospital Recycling Score. UK hospitals achieved significantly higher PSRS scores compared to Libyan hospitals. This is not all together surprising as we have shown in this study that Libyan hospital did not practice any waste recycling.

There are few studies that compared waste management in general and HCW but most of these focus on safety, awareness and general attitude (Goddu VK *et al.*, 2007; Uiterkamp B J *et al.*, 2011). Very few studies have compared developing and developed countries. Goddu VK, *et al.*, (2007) have compared HCW management and recycling between one hospital in the UK and another India. The study did not compare the awareness and attitudes between the hospital workers in the two countries but rather studied these parameters only in the UK via interviewing the 96 personnel in the UK hospital and performed case studies reviewing the segregation, handling, collection, storage practices in both UK and Indian hospitals via site visits. The conclusions were more descriptive of the findings with no focus on the differences between the two practices, showing that the waste management at the UK hospital's staff were found to lack basic awareness of implications involved in improper handling of the infectious waste. Kumar R, *et al.*, (2010) have studied the HCW management in Pakistan, where about 250,000 tonnes of HCW is being produced per year. They have shown that staff were neither aware nor practiced proper waste segregation and concluded that hospitals in Pakistan do not follow and oblige proper guidelines in the management of HCW. Recycling is not likely to take place with bad segregation.

7.3 Response rates

The response rates to the questionnaires by the healthcare workers were generally low in both UK and Libya. The Libyans responded significantly better. Responding to questionnaires has always been a big limitation when conducting research based on surveys and questionnaires, particularly when sending the questionnaire via post delivery (Alderfer CP and Simon AF, 2008; Thomas A.H and Robert B, 1978; Fowler,

1988; Grady and Wallston, 1988). The implications of this issue for this are discussed extensively under study limitations (section 7.5).

Age, gender, occupation, seniority, duration of employment and training in waste management were found to be important factors that influence the responses of both Libyans and Britons to the questionnaire, although these were not uniform between the 2 countries. Younger and junior Libyans responded significantly better than the older and senior Libyan respondents, while older and junior Britons responded significantly better than younger and senior respondents.

White E, *et al.*, (2004) has shown that young generations are often harder to get feedback from compared to older generations, which corresponds with the experience from UK respondents in this study. Libya is a country with a large young population and the young people are generally more educated and probably easier to communicate with (Edwards P, *et al.*, 2002). In a developing country, the younger generations are generally more educated and enthusiastic than the older generations. The hospital population in Libya is strongly represented by the younger generation, particularly for the most educated staff: physicians, pharmacists, nurses and lab technicians (Sawalem M *et al.*, 2009). The better responses of the Libyan younger candidates may be attributed to these special considerations in the developing countries.

Females in both countries responded significantly more frequently than males. This is not altogether surprising. Women have been shown to be generally more likely to answer questionnaires (Linsky, A, 1975; Kanuk, L, and Berenson, C, 1975; Linkshy, Arnold S, 1975; Sax L J, 2003). The results show that the UK women had a better response to the questionnaires than the Libyan women. It goes beyond the scope of this

research to discuss the possible socioeconomic and cultural background that could have led to these differences.

This study shows also that the college and university educated responded more than the high school educated on one hand and better than the postgraduates on the other hand in both countries. Higher education does not necessarily mean better responsiveness, as is shown in this study, the postgraduates responded similarly to the high school educated. Suchman EA and McCandless, B, (1940) described in an old survey published in 1940 that the better educated, the greater the return of completed questionnaires. The results show that nurses in the UK and Libya responded better than all other occupational groups followed by physicians. Nurses in the UK responded significantly better than nurses in Libya and vice versa with regards to physicians, where our results show that Libyan physicians responded significantly better than the UK physicians. It is very interesting to note that the workers in hospital waste disposal responded very similarly in both countries.

Those who work in senior positions responded significantly less than those who work in junior positions in both countries. Young Libyans responded better than the young Britons and senior Britons responded better than the senior Libyans.

This suggests that the effect of the hierarchical position on the responsiveness rate might be simply related to age. Alderfer CP and Simon AF, (2008) have shown that non response rates varied by respondents' hierarchical level and questionnaire topic. There was also an interaction between employee job level and questionnaire item response rate.

Alderfer and Simon also demonstrated that the hourly employees responded less than those normally employed. The results however did not show that the duration of

employment has positive effects on the responses to the questionnaire. On the contrary, there was a negative correlation between the duration of employment and the response to the questionnaires, particularly in the Libyan group. The best respondents were those who were employed for 10 years and less. The longer duration of employment and the more senior the position are associated with lower response to the questionnaires. This inverse relationship between the seniority and duration of employment in one hand and the responsiveness to the questionnaire on the other hand may be attributed to the greater involvements and responsibilities of the seniors and those who have been employed for long periods.

7.4 Knowledge and attitudes towards recycling

This study has demonstrated a weak association between knowledge and attitudes among both UK and Libyan candidates but not at a statistically significant level. This may appear a surprising finding because it seems that it is alogical consequence that a good knowledge leeds to a good attitudes and practice. However this is not always true in life. Tuder in his extensive study exploring the factor affecting the health workers attitudes and practices towards recycling of HCW has found that the most important factors are the individuals' attitudes and the culture of the organization.Tudor TL *et al.*, (2007) Knowledge per se does not imply necessarily positive individuals attitudes.

In this study, a regression modelling was applied has demonstrated that education and training were predictive of good awareness and positive attitudes towards good practice of HCW management in HHW recycling both in Libya and the UK. This study also shows that hospital environment and setting and the individuals' perception are important factors that explain how health workers explain their attitudes towards recycling in both Libya and the UK. The differences between the hospital environments

and settings in this study are shown in different aspects between the UK and the Libyan hospitals such as recycling practices and existence of waste hospital policy.

This study, it seems that factors that may play a role in determining positive perception of hospital workers about good practice in HCW management including recycling in this study, based on Chi square testing were age, work category, hierarchical positions, education level and previous training in waste management. Gender has not been shown in this study to play a significant role although females demonstrated slightly better attitudes than males in Libya and UK. A weak association was found between knowledge and attitudes in this study among both UK and Libyan candidates but not at a statistically significant level. However, regression modelling applied in this study demonstrated that education and training were predictive of good awareness and positive attitudes towards good practice of HCW management in HHW recycling both in Libya and the UK. Teo and Loosemore, (2001) showed that the behaviours and attitudes of hospital staff towards waste recycling are influenced by organizational culture, waste management policies and size of waste subcontractors.

Previous studies showed that environmental concern has a positive impact on the recycling behaviours as cited in Schultz *et al.*, (1995). This study has found possession of knowledge on recycling attitudes of recyclers (the UK candidates) and non-recyclers (the Libyan candidates), similar to results demonstrated by Vining and Ebreo, (1990) who claimed significant differences in the attitudes between recyclers and non-recyclers (Vining and Ebreo, 1990 ; Schultz *et al.*, 1995).

Cossins RJ, (2004) has shown that the main organisational challenges at hospital level with regards to HCW management in developing countries are lack of education, knowledge and empowerment of HCW management, no direct responsibility for addressing the problem of HCW management at the hospital level, and no serious

direction or instruction from the health authorities regarding HCW. In this area, Cossins RJ, (2004) recognised that the main improvements stemmed from reorganising existing resources rather than adding more changing work practices, disposal habits, improving awareness and education on hospital waste team, and creating a formal structure that assigned direct responsibility for waste management.

The intervention with educating the hospital workers about HCW, HHW, recycling telling the audience the truth behind it seems to be an important approach. Karout N and Altuwaijri, (2012) have provided educational sessions for 320 randomly selected participatnts in Beirut, Lebanon and showed that their awareness and even attitudes were improved following the education session. It seems that educational training dedicated to inform the hospital workers about HCW management and recycling increases the awareness and improves the attitudes of the hospital workers. The study shows a link between training and good knowledge and attitude.

This study shows that the attitudes to recycling are not easy to predict. There were no clear variables that could predict attitudes to recycling in any of the staff groups. Other factors are probably involved between Libyan versus UK candidates concerning recycling attitudes, but the absence of recycling process seems to be a prominent factor that cannot be easily neglected. This should be studied in future research, particularly if some Libyan hospitals start recycling, so that an internal comparison between recycling and non-recycling hospitals could be performed. Schultz pointed out that the relationship between demographic variables like age and education level and recycling behaviours were generally unclear (Schultz *et al.*, 1995), except for gender whereby men and women were equally likely to recycle (Vining and Ebreo, 1990; Gamba, and Oskamp, 1994 ; Schultz *et al.*, 1995).

Studies performed to find relationship between personality construct and recycling behaviour tended to agree that recyclers seemed to have a higher sense of social responsibility (Simmons and Widmar, 1990 ; Schultz *et al.*, 1995).

It was not among the aims of this study to intervene with the recycling attitudes but rather to observe and compare. However, various interventional manoeuvres such as rewards and feedbacks have been widely investigated and research findings suggested both strategies caused an increase in recycling behaviours and to encourage recycling behaviours with some positive effects (Needleman and Geller, 1992; Katzev and Mishima, 1992 ; Schultz *et al.*, 1995). Karout, N and Altuwaijri, S, (2012) have studied the effects of education on the attitudes and behaviours towards solid waste management in Lebanon and found out that the intervention group showed highly significant improvements in all items (Karout, N and Altuwaijri, S, (2012).

The results of this study showed that participation in training and development opportunities in environmental management could also be a key factor to improve recycling attitudes and behaviours (Robbins 2000). The results show no strong links between education level and attitudes towards HCW management and HHW recycling. However, those who have undergone training in waste management showed statistically significant increases in awareness and attitudes. Teo and Loosemore, (2001) showed that the size of waste contractors may affect recycling behaviours, and attitudes towards waste are influenced by organizational culture and waste management policies. In this study, we did not involve the waste management contractors but the waste management teams showed a high perception of waste management and recycling processes and were generally positive.

The behavioural intentions of respondents show that the respondents are likely to be willing to recycle in both countries. This is more significant in the UK than in Libya.

The UK health workers were significantly better oriented than the Libyans. This could be attributed to more frequent education in waste management in which UK health workers are participating, compared to the Libyans and also to the existence of a waste policy in the UK hospitals that workers are obliged to read during their work. In the Libyan hospitals there are no waste management policies and the more extensive practice of waste management and recycling in the UK hospitals makes the personnel more exposed to learn about the waste management and disposal methods and settings. The absence of recycling practice in Libyan hospitals may contribute to the lower orientation and lower attitudes towards good practice of HCW management including the recycling.

The unacceptable waste management practices observed in this study in the three studied Libyan hospitals have been reported in developing countries and their adverse affects have been observed (Ball J, 2006). Providing donor funding was proposed aiming to improve poor practice and contribute to addressing the associated problems (Ball J, 2006). Donor funding is provided sometimes via experts from developed country who promote sophisticated developed country approaches, such as aspects of Integrated Waste Management. Sustainability is often not achieved this way, because basic cleansing systems are not in place in most of the developing countries, and therefore these systems are inappropriately imposed.

7.5 Study limitations

This study was limited by certain issues that were partly beyond the researchers control and these are discussed as follows:

7.5.1 Low number of respondents

The first limitation was the number of respondents to the questionnaires. Despite having distributed 500 questionnaires to each studied hospital in the UK and in Libya, the returned completed questionnaires did not exceed (453) questionnaires from all hospitals. However other studies investigated the knowledge and attitudes of hospital workers have also utilised relatively small samples and this study is the largest conducted to date on healthcare workers attitudes to recycling. Kumar R., *et al,* 2010, who studied the HCW in Pakistan has interviewed 117 staff members. Tudor T., *et al* who studied the relationship between HCW management and the risk of infection's spread, has based their study partly on only 13 interviews. Goddu VK *et al.,* (2007) who compared the HCW between the UK and India, have studied 96 hospital workers.

This is thus a relative limitation and the number of the study sample is acceptable. The study shows a trend and disclosed a set of knowledge, way of thinking and perception of the management of HHW and particularly recycling. Despite the limitation of the small number of the study sample, the variety of questions addressing the subject from different aspects have partly overcome this problem showing us how the healthcare providers and waste workers perceive the recycling of HHW. Also being a comparative study between two different healthcare settings and focusing on a certain type of hospital waste, namely HHW, these results formulate a baseline of understanding of the situation concerning the knowledge and attitudes of healthcare providers and waste workers exploring what factors may affect their perception of the management of HHW and recycling and how certain factors such as age, gender, education, training, seniority and hierarchical positions may affect the perceptions of the healthcare workers in UK and Libya towards the management of HHW including recycling.

The response to the questionnaires was higher among Libyans compared to Britons. Moreover, respondents from the different Libyan hospitals represented almost the same percentage of about 20%, while in the UK they ranged from an extremely low percentage of 1.5% to 15%. The low response to surveys was discussed previously by many researchers and was attributed to many factors (Thomas A.H and Robert B, 1978). Accumulated research evidence suggests that response rates to mailed physician questionnaires have been declining over time (CASRO 1982; Cartwright 1978). However, no gold standard for an acceptable response rate was suggested Warwick and Lininger, (1975) and Grady and Wallston, (1988) suggest that response rates of 50% are very good for mailed questionnaires. Isaac and Michael, (1971) disagreed and suggested that a response rate of at least 80% is necessary to obtain good estimates. This argument was supported by Gehlbach, (1993) who reported that although response rates of at least 80% are very good, rates below 80% are not necessarily unacceptable if above 40%. Other researchers however, report that even response rates of 80 percent may be unsatisfactory if non response bias is present (DeMaio, 1980; Fowler, 1988). Non response bias is, in fact, the most important factor in assessing the effect of a response rate on the validity of a study (Fowler 1988; Grady and Wallston, 1988). If non respondents are similar to respondents in every way, the response rate will not affect the generalist ability to the surveyed population (Fowler, 1988; Grady and Wallston, 1988). Thus, even questionnaires with relatively low response rates where no systematic differences between respondents and non-respondents exist they could be considered valid. Unfortunately, similarities between non respondents and respondents are often difficult to assess because there are usually overlapping between these factors and subjectivity in the assessment of the different significant levels depends on the utilised statistical approach and on the applied methodology.

Many researchers attempt to address this problem by increasing the amount of follow-up as a means of increasing the response rate. However, two studies of physicians have concluded that late respondents do not differ significantly from earlier respondents, suggesting that non response bias is not necessarily reduced by increasing the follow up period (Sobal and Ferentz, 1989; Berk , 1985). Any type of systematic bias in response has the potential to result in biased conclusions even when response rates are high (DeMaio, 1980; Guadagnoli and Cunningham, 1989; Gilbert and Branch, 1992). Reporting whether there is any systematic bias between respondents and non-respondents, is therefore essential to determining the validity of published research (Fowler 1988; Grady and Wallston, 1988; Gehlbach, 1993). In this study, the diversity of the target groups could be one of the factors contributing to the general low responsiveness in both the Libyan and UK hospitals.

7.5.2 The type of the questionnaire

After several consultations and discussions with the study supervisor and other experts in the field, it was decided to use a close-ended self-administered questionnaire and perform quantitative research in order to address the hypotheses and attempt to provide the best answers for the research question. Interviewing the study candidates, who could have added more depth to this study, but this, was not possible to accomplish due to the busy schedules of the hospital workers, particularly the physicians that does not permit time consuming interviews. To overcome this we tried to make our questionnaires very precise and clearly focused as well as having some general questions that covered as much as possible information about the level of the knowledge and attitudes towards the good practice of HCW and the recycling of HHW. Tudor T, *et al.*, (2007) have used ethnography and interviews accomplishing both quantitative and qualitative research to possible strategies for improving recycling

behaviour with a selected region in NHS in the UK. Most of the researchers in this area have used quantitative research and when applicable combine it with qualitative research (Tudor T *et al.*, 2007; Askarin M *et al.*, 2004; Barr S, 2001).

7.5.3 Factual information about hospitals

Despite the very good cooperation of all the waste managers, it was difficult to gather information about waste management at the studied hospitals, particularly in Libya. In the UK, the problem was mainly due to the different ways that each hospital arranges the requested data. We overcame this partly by adapting our requested data in order to get comparable results that fitted the study aims and objectives. In Libya, with the incomplete hospital records of the waste generation and employment, the results were partly incomplete. However, the hospital authorities did their utmost to provide as accurate information as they could by contacting the waste collecting companies and getting the paper records. The absence of recycling practice in Libya was also an obstacle, as it was impossible to compare the attitudes of the respondents in the two countries about something that is not being practiced. However, many of the Libyan physicians have worked abroad in hospitals that practice recycling, which helped in overcoming this problem.

7.6 Conclusions

Based on the results of this study, we conclude the following points

7.6.1 Significantly lower WGR in Libyan hospitals compared to the UK hospitals

This study confirms that Libyan hospitals produce low WGR in comparison to UK hospitals.

7.6.2 No recycling in Libyan hospitals

This study is the first to show that Libyan hospitals do not practice any recycling upon disposal of HCW and that even HHW is being disposed almost like other types of HCW. Recycling is a relatively new trend in the management of HCW and requires knowledge and infrastructure to segregate the HCW into hazardous and non hazardous waste, and then recycle the HHW and other recyclable waste. This study shows that very limited segregation is being practiced in Libyan hospitals, but not up to any standard level.

As a result of the lack of recycling in Libyan hospitals-UK hospitals clearly recycle significantly more than the Libyan hospitals.

7.6.3 UK hospitals recycle less than the government targets

UK hospitals recycle between 16.9%-23.4% of the produces HCW, which is less than the government's 30% target for 2010 (Deter, 2000).

7.6.4 Low levels of awareness

This study is the first study to demonstrate the low level of awareness about HCW, management and HHW recycling among hospital workers in Libya. It is also the first study to explore the levels of awareness of hospital health workers on this subject, and to compare the levels of awareness between Libyan hospital workers to the UK. It has shown that the UK respondents were significantly more aware about the subject compared to the Libyans. The study also shows awareness among the UK respondents despite being higher than their respective Libyans, is in itself relatively low.

7.6.5 Lack of positive attitudes

This study is the first study to report the low levels of positive attitudes towards good disposal and recycling practices for HCW among Libyan hospital workers. This study

is also the first study to compare Libyan and UK hospital workers' attitudes towards HCW management and recycling of HHW. Libyans demonstrated significantly lower attitudes compared to the Britons. The attitudes of UK hospitals themselves workers were also relatively low.

7.6.6 Weak link between knowledge and attitudes

This study showed when using regression analysis, a weak link between the level of knowledge about hospital waste in general and the attitudes towards HCW and recycling of HHW.

7.6.7 Predictable knowledge

This study is the first study to demonstrate that the occupation and the waste training of staff are the variables that are most predictive of the level of knowledge in Libyan and UK hospital workers.

7.6.8 Non predictable attitudes

The study demonstrates, for the first time, that attitudes towards good HCW management and HHW recycling practice are unpredictable. Age seniority, training in waste management and duration of employment were significantly associated with positive attitudes when tested by Chi square analysis. However when applying regression analysis no correlation were found between any of these variables and the staff attitudes.

Practicing recycling in hospitals may help bring about more knowledge and may improve attitudes. In this study, it was not feasible to compare recycling practices between the UK and Libya because none of the three Libyan hospitals practiced recycling.

7.6.9 UK respondents have significantly better knowledge and more positive attitudes

The study allowed comparisons between the level of awareness and attitudes towards HCW management and HHW recycling.

UK staff demonstrated significantly better knowledge and were more positive in all comparisons.

7.6.10 Introducing a new model for hospital recycling assessment

In order to assess the recycling practice in the studied hospital, a new model that takes in consideration direct and indirect questions on recycling was developed. The indirect questions involved questions on hospital policy, segregation and safety measures. The model was given the name of PSRS based on the first letters of the main four themes: Policy, Recycling, Segregation and Safety. The PRSR model has been used in this thesis collectively to compare the total recycling scores between the different hospitals.

7.6.11Gender has no influence on knowledge nor on attitudes

This study established that gender has no effects on the knowledge or attitudes in either country.

7.6.12 Waste team has the best knowledge and most positive attitudes

The waste teams in both UK and Libya demonstrated the best knowledge compared to other hospital staff and showed the most positive attitudes towards good practice of HCW management of HHW recycling. .

7.6.13 Summary of factors determining level of knowledge and attitude

The following factors may affect the level of awareness and type of attitudes towards HCW management and HHW recycling: age, work category, higher education, hierarchical position, and previous training in waste management. However, when

testing all factors using regression analyses modelling, two factors were found to have some predictive value in both countries: occupation and training in waste management.

7.7 Recommendations

7.7.1 The Libyan government's ministry of health should consider regulation of HCW disposal according to the latest international guidelines. This should take in consideration the safety regulations and training of the waste personnel as well as other hospital workers involved in waste disposal at any chain from collection to disposal. Consultations and cooperation with hospital waste disposal experts from the NHS in the UK is highly recommended in order to prepare such an act and utilize the accumulated UK experience in this field.

Further research that involves larger study sample and more hospitals is encouraged to study the attitudes of healthcare workers towards recycling in Libya and the UK as well as comparison to the neighboring countries. Use of interviews to obtain deeper information about attitudes of staff would also be beneficial. Qualitative research is particularly recommended.

7.7.2 The Libyan government and its ministry of health should develop a plan of action to improve the HCW collection and disposal. UK hospitals should take all measures to reduce waste generation to reduce the magnitude of the HCW.

7.7.3 Libyan government and its ministry of health should start HHW recycling as part of a national recycling programme to provide the settings and infrastructure that are required in order to provide a successful HHW recycling programme.

7.7.4 Libyan government and its ministry of health should set up a national health products purchase policy that regulates the purchase in such a way that it takes

in consideration the basic characters such as efficacy, safety and being environmentally friendly.

7.7.5 Each Libyan hospital should develop a local waste policy for HCW disposal with consideration of safety principles and with the institution of HHW recycling. Those policies should follow the national waste management regulation and conform to the local hospital needs and budget.

7.7.6 Both UK and Libyan hospitals should provide more educational and training programmes and events in the good practice of HCW management and HHW recycling to increase the awareness of the hospital workers. These programmes could be monitored with pre- and post evaluation to insure good effects on improving good HCW disposal and HHW recycling behavior. Sharing these programmes between UK and Libya should be supported to exchange ideas, experiences and create common events.

7.7.7 Introducing HCW disposal syllabus including recycling into the medical education curriculum of physicians, dentists, pharmacists and nurses as well as into the curriculum of medical technology and health administrators, aiming to improve the basic knowledge of the healthcare providers and managers.

7.7.8 Instituting continuing audit programmes in the Libyan and UK hospitals to monitor the process of HCW disposal and HHW recycling.

7.7.9 Further research that involves larger study sample and more hospitals is encouraged to study the attitudes of healthcare workers towards recycling in Libya and the UK as well as comparison to the neighboring countries. Use of interviews to obtain deeper information about attitudes of staff would also be beneficial.

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Appendix

Appendix I: Date Request From Hospital Waste Managers

Appendix I: Date Request From Hospital Waste Managers

Hospital Details

Name of the Hospital: .... City: .....

Type of Hospital: District Hospital .....Teaching Hospital .....

No. of beds: ..... No of ICU beds: .....

No of Patients admitted during:

2006: ..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of working waste team collectors during:

2006:..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of working waste team supervisors during:

2006: ..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of working Physicians during:

2006: ..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of working Nurses during:

2006: ..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of working Paramedics during:

2006: ..... 2007: ..... 2010: .....
2008: ..... 2009: .....

No of Clinical staff:

2006: ..... 2007: ..... 2010: .....

2008: ..... 2009: .....

Details of the Waste management:

Amount of Waste:

What is the total weight of waste generated yearly by your Hospital during the years:

		Recycling
2006/ 2007:	Kg	.....
2007/ 2008:	Kg	.....
2008/ 2009:	Kg	.....
2009/ 2010:	Kg	.....

Policy Plan:

1) Do you apply a purchasing policy that aims to consider recycling and reduced waste amounts?
   a) Yes
   b) No

2) Have you estimated the amount of waste reductions in weight since you started this policy?
   a) Yes
   b) No

3) Does your Hospital have a specific waste management policy/plan?
   a) Yes
   b) No

4) To the best of your knowledge, is this policy developed in line with the current published best practice as shown with the best available evidence medicine?
   a) Yes
   b) No

5) Do you consider that recycling is well represented in this policy?
   a) Yes
   b) No

6) Do you always include clear waste management responsibilities that reflect your selected waste policy in the job descriptions of all hospital employees?
   a) Yes
   b) No

7) Do you consider your Waste Management Policy as reliable and updating?
   a) Yes
   b) No

Waste classification & Segregation:

8) Do you keep records of the total annual weight of each of these lines for years 2006, 2007 and 2008?
    a) Yes
    b) No
9) Do you analyse or have ever analysed the contents of your household waste?
    a) Yes
    b) No
10) Do you use the colour-coded segregation charts to identify different stream lines?
    a) Yes
    b) No

11) Do you apply the colour-coded waste segregation guide?
    a) Yes
    b) No

12) Do you apply the colour-coding of sharps receptacles?
    a) Yes
    b) No

13) Do you apply the Hazardous waste technical guidance WM2?
    a) Yes
    b) No

14) Do you apply the European waste catalogue (EWC) codes:
    a) Yes
    b) No

Recycling and Disposal practices:

15) Do you segregate the households and/or pharmaceuticals?
    a) Yes
    b) No

16) Do you keep records of the successfully recycled items and their respective weight over the last 3 years?
    a) Yes
    b) No

17) Do you get any items back from the recycling firm?
    a) Yes
    b) No

18) Do you keep record of the disposed non infectious materials items during the past 3 years?
    a) Yes
    b) No

Safety and Integrity:

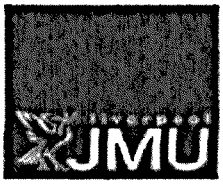
19) Do you make it obligatory in the contract and job description that your waste collecting personal use always protecting clothes and appliances during collection?
    a) Yes
    b) No

20) In your purchasing policy, do you make it a rule that you purchase safer and environmentally friendly items?
    a) Yes
    b) No

21) Do you make it obligatory in the employments contracts that your waste collecting personal are vaccinated against contagious diseases such as hepatitis B?
    a) Yes
    b) No

Thank you very much for your participation

Appendix II: Exploring knowledge and attitudes of hospital workers concerning HCW management and HHW recycling



Appendix II: Exploring knowledge and attitudes of hospital workers concerning Healthcare waste (HCW) management and Household waste (HHW recycling

A) General Information

i) Hospital Details
Name of the Hospital: ....City: ....

ii) Demographic Data
Age: .....<20
20-30
31-40
41-50
>50

Gender: Please tick as appropriate Male ☐ Female ☐

iii) Education and training
Please select your background education as appropriate

- < high school ☐
- High School ☐
- FE College ☐
- University Degree ☐
- Postgraduate degree ☐

Have you followed any education or training in waste management or disposal?

a) Yes ☐
b) No ☐

If yes, please provide more information about this training:
.....

a) In hospital basic training ☐
b) Short courses outside the hospital ☐
c) Full educational degree programme ☐

Iv) Occupation & Positions

Please select your working category as appropriate

a) Waste team staff ☐

b) Physician ☐

c) Nurse ☐

d) Paramedic ☐

e) Pharmacist ☐

f) Other ☐ *Please Specify.....

**We will not be able to proceed with this questionnaire without having your work category!*

Do you hold a senior or leading position?

a) Yes ☐

b) No ☐

How long have you been working in health sector? ..... years

How long have you been working in this hospital? ..... years.

B) Knowledge:

1) To the best of your knowledge, do you know if your hospital uses incinerators to dispose of hospital waste?

   a) Yes ☐

   b) No ☐

   c) Not sure ☐

2) Are you familiar with the A-E clinical waste classification system that was developed by WHO in order to classify and segregate the hospital clinical waste?

   a) Yes ☐

   b) No ☐

3) Are you familiar with the new classification of hospital waste into Hazardous/non Hazardous waste (unified approach)?

   a) Yes ☐

   b) No ☐

4) Which system is applied at your hospital?

   a) The A-E system ☐

   b) The New unified approach System ☐

c) Another system: please give the title of the system or describe it briefly if possible: ☐

.....

d)Not sure ☐

5) Do you agree with the following statement: Dioxin emitted from incinerators is a carcinogen of particular health concern?

a) Yes ☐

b) No ☐

6) Which of the following do you think is the amount of hospital waste that can be considered to be non-harmful household type waste?

a) 25% ☐

b) 50% ☐

c) 75% ☐

7) What reduction in household waste in hospitals do you think is achievable through careful segregation of items such as paper, plastics and biodegradable waste?

a) 20% ☐

b) 40% ☐

c) 60% ☐

8) To the best of your knowledge, do you know if your hospital practices any kind of recycling of hospital wastes?

a) Yes ☐

If yes please provide details of materials recycled:

.....

b) No ☐

c) Not sure ☐

C) Attitudes towards sustainable management:

1) Do you consider yourself to be environmentally friendly?

a. Strongly disagree ☐

b. Disagree ☐

c. I have some interest ☐

d. Agree ☐

e. Strongly agree ☐

2) Do you generally support sustainable approaches to save energy and materials and reduce the risk of toxic substances?

   a. Strongly disagree ☐
   b. Disagree ☐
   c. I have some interest ☐
   d. Agree ☐
   e. Strongly agree ☐

3) Do you generally consider recycling as a positive approach in waste management?

   a. Strongly disagree ☐
   b. Disagree ☐
   c. I have some interest ☐
   d. Agree ☐
   e. Strongly agree ☐

4) Are you worried about the contamination of potentially recyclable hospital waste by toxic, carcinogenic and infected materials?

   a. Strongly disagree ☐
   b. Disagree ☐
   c. I have some interest ☐
   d. Agree ☐
   e. Strongly agree ☐

5) In your practice, do you think sustainability should be a key focus or priority for your hospital?

   a. Strongly disagree s ☐
   b. Disagree ☐
   c. I have some interest ☐
   d. Agree ☐
   e. Strongly agree ☐

6) Non-hazardous household type waste represents about 25% of total hospital waste. This could be reduced to 10% by careful recycling. Given this do you think recycling of household waste is important for your hospital?

   a. Strongly disagree ☐
   b. Disagree ☐

c. I have some interest ☐

d. Agree ☐

e. Strongly agree ☐

7) Do you support adopting a good pharmaceutical recycling policy at your hospital and local community?

a. Strongly disagree ☐

b. Disagree ☐

c. I have some interest ☐

d. Agree ☐

e. Strongly agree ☐

8) In your practice, are you involved in any kind of recycling process related to hospital waste?

a. Not at all involved ☐

b. Not involved ☐

c. Occasionally involved ☐

d. Involved ☐

e. Very involved ☐

9) Would you support adapting a purchasing policy that considers purchasing items in large quantities to reduce packaging and hence hospital waste?

a. Strongly disagree ☐

b. Disagree ☐

c. I have some interest ☐

d. Agree ☐

e. Strongly agree ☐

10) If your hospital decides to adopt a comprehensive recycling policy for hospital waste, will you support this approach?

a. Strongly disagree ☐

b. Disagree ☐

c. I have some interest ☐

d. Agree ☐

e. Strongly agree ☐

11) In general, how do you consider your hospitals waste management policy?

a. Extremely unreliable ☐
b. Not good and needs lots of updating ☐
c. Good but needs some updating ☐
d. Very good but needs some updating ☐
e. Optimal, updated and in line with the best available evidence ☐

12) What could prevent recycling intervention at your hospital most?

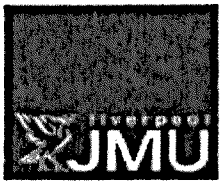
a. Financial costs ☐
b. Technical difficulties ☐
c. Administrative bureaucracy ☐
d. Agreements with waste collectors ☐
e. Other, please specify: .....

13) In your opinion, do you think that improving recycling waste policy will be cost effective?

a. Strongly disagree ☐
b. Disagree ☐
c. I have some interest ☐
d. Agree ☐
e. Strongly agree ☐

Thank you very much for your participation

Appendix III: Covering letter



Appendix III

Dear Sir/ Madam

My name is Yousef Elgitait a research student at Liverpool John Moores University, UK. I am presently conducting a study entitled "Staff Perceptions and Practice for Hospital Waste Management with Reference to Recycling in the UK versus Libya, a comparative Study"

This research aims to evaluate the recycling practices in the management of healthcare waste and attitudes and knowledge of the hospital workers towards sustainable waste policy in the three UK North West hospitals and three Libyan hospitals.

All data are anonymous and will not include any information that could identify an individual hospital. All information will be treated confidentially and for research purposes only.

Your cooperation to complete this data request is highly appreciated.

Should you have any questions or queries, please don't hesitate to contact me by the given E mail: Y-Elgitait@2007.ljmu.ac.uk.

Thank you very much for your participation.

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