GLOWBAL WARMING POTENTIAL OF BUILDING DEMOLITION ACTIVITIES

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ABSTRACT

Continuation of urbanization is expected to gradually rise the energy demand for consumption and economic activities. Therefore, a sustainable approach to the development is needed to reduce the consumption of energy. Malaysia has recorded 7.3 tons in carbon dioxide emission per capita in the year 2007. This amount puts Malaysia in the 57th place in the world. This is due to an increase in oil derivatives and gas expenditures in the last decade. Fuel consumption also has a significant role in the demolition of the construction sites as well as their waste disposal. Hence, an increase of demands for demolition has a negative impact on these criteria. Building demolition as a case study for life cycle assessment (LCA) that was conducted for a 18740 m^2 floor area, four-storied office, with one story as the top floor, one bridge for connecting the structures and a two-storey basement car park. Menara Tun Razak as its subject, with a projected life span of 29 years; it is located in the commercial area of Kuala Lumpur. Furthermore, a Building Information Modeling (BIM) system is used to determine the accurate quantity of elements and its simulation. The LCA model analyzes the energy use and greenhouse gas (GHG) emissions associated with demolition and waste disposal. The findings show that as much as 225039.021 kilograms of CO2 equivalent of GHGs were released for 15147862 tons of demolition materials where, 97.633 percent or 219713.1 kilogram CO2 equivalent from the amount was carbon dioxide, followed by 1.358 percent or 3056.47 kg CO2 equivalent of methane, 1.008 percent or 2269.188 kilogram CO2 equivalent of dinitrogen monoxide and 0.001 percent or 0.225 kg CO2 equivalent of other gases such as chloroform and ethane. The processes that contributed significantly to the total GHGs emission were mainly from the burning of 57688.8 liters of diesel fuel during demolition. Besides, it is also shown that demolition and waste disposal had a 71.95 percent and 28.04 percent contribution in reinforce concrete framework structure share in producing GHG.

ABSTRAK

Pembandaran yang berterusan dijangka akan meningkatkan permintaaan tenaga untuk kegunaan aktiviti ekonomi. Oleh itu, satu pendekatan untuk perkembangan mampan diperlukan untuk mengurangkan penggunaan tenaga. Malaysia mempunyai penunjuk mampan sebanyak 7.3 tan pelepasan karbon dioksida per kapita pada tahun 2007. Jumlah ini meletakkan Malaysia di kedudukan ke-57 dunia. Ini adalah kerana peningkatan derivatif minyak dan perbelanjaan gas dalam dekad terakhir. Penggunaan bahan api juga mempunyai peranan penting dalam meroboh dan melupuskan sisa pembinaan. Oleh itu, permintaan untuk meroboh bangunan yang meningkat memberi kesan negatif kepada isu kemampanan. Kajian ini menerangkan satu kajian kes berkaitan perobohan 'life cycle assessment' (LCA) yang telah dijalankan untuk 18.740 m^2 kawasan lantai, pejabat 4 tingkat, 1 tingkat atas, sebuah jambatan sambungan kepada struktur dan 2 tingkat tempat letak kereta bawah tanah. Tambahan pula, sistem 'Building Information Model' (BIM) digunakan untuk menentukan kuantiti yang tepat dan simulasi. Model LCA menganalisa penggunaan tenaga dan pelepasan gas rumah hijau (GHG) yang berkaitan dengan perobohan dan pelupusan sisa. Bangunan kajian kes yang dipilih adalah Menara Tun Razak berusia 29 tahun yang terletak di kawasan komersial di Kuala lumpur. Penemuan menunjukkan bahawa sebanyak 225039.021 kilogram CO2 bersamaan dengan GHG telah dilepaskan untuk pengeluaran 15147862 tan bahan perobohan, 97.633percent atau 219713,1 kilogram bersamaan CO2 daripada jumlah karbon dioksida, diikuti oleh 1,358 peratus atau 3056,47 kg bersamaan CO2 metana, 1,008 peratus atau 2.269,188 kilogram bersamaan CO2 dinitrogen monoksida dan 0,001 peratus atau 0,225 kg bersamaan CO2 gas lain seperti kloroform dan etana. Proses yang paling ketara menyumbang kepada jumlah pelepasan GHG adalah pembakaran 57688,8 liter diesel semasa melakukan aktiviti. Selain itu, ini juga menunjukkan bahawa pelupusan dan sisa perobohan mempunyai 71,95 peratus dan 28,04 peratus sumbangan untuk mengukuhkan rangka kerja bahagian struktur konkrit dalam menghasilkan GHG.

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3D-model	Geometrical model in three dimensions; length, height and width.
AEC	Architecture, Engineering and Construction
BIM	Building information modeling, the activity, when referring to a specific building information model the term "BIM model" is used.
EIA	Environmental Impact Assessment
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
OECD	Organization for Economic Co-operation and Development
UTM	Universiti Teknologi Malaysia ()

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CHAPTER 1

INTRODUCTION

1.1 Introductions

Housing is one of the most important needs of every human being. Without housing one would be exposed to adverse effects resulting from vagaries inherent in an environment. Exposure to bad weather would lead to hill health. Housing fosters the development of other industries. The building industry produces buildings for utilities, shops and communal facilities. Housing is also a tool for economic development.

Today, it is widely accepted that human activities are contributing to climate change. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) estimated that between 1970 and 2004, global greenhouse gas emissions due to human activities rose by 70 percent (IPCC, 2007). While the full implications of climate change are not fully understood, scientific evidence suggests that it is a causal factor in rising sea levels, increased occurrence of severe weather events, food shortages, changing patterns of disease, severe water shortages and the loss of tropical forests. Most experts agree that over the next few decades, the world will undergo potentially dangerous changes in climate, which will have a significant impact on almost every aspect of our environment, economies and societies.

In forty years we need to have reduced our greenhouse gas emissions by at least 50% to avoid the worst-case scenarios of climate change. In eleven years we need to have achieved at least a 25% reduction in emissions. In December 2009 the world's nations are gathered in Copenhagen to negotiate an agreement on a new global protocol that will enable humanity to achieve the necessary global targets. The building sector contributes up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy. Furthermore, 41% of the total energy consumption in the U.S. is emitted 38% of greenhouse gas emissions. Given the massive growth in new construction in economies in transition, and the inefficiencies of existing building stock worldwide, if nothing is done, greenhouse gas emissions from buildings will more than double in the next 20 years. Therefore, if targets for greenhouse gas emissions reduction are to be met, it is clear that people must tackle emissions from the building sector. Mitigation of greenhouse gas emissions from buildings must be a cornerstone of every national climate change strategy (USDOE, 2011).

Of the many environmental impacts of development, the one with the highest profile currently is global warming, which demands changes from government, industry and public. Concerns about the local and global environment situation are rising all over the world. Global warming is the consequence of long term buildup of greenhouse gases (CO_2, CH_4, N_2O, etc.) in the higher layer of atmosphere. The emission of these gases is the result of intensive environmentally harmful human activities such as the burning of fossil fuels, deforestation and land use changes (Buchanan and Honey, 1994)This is generally accepted to be the reason that average global temperatures have increased by 0.74 °C in the last 100 years. Global temperatures are set to rise by a further 1.1 °C in a low emissions scenario, and by 2.4 °C in a high emissions scenario, by the end of the century. It is necessary to reduce Green House Gases (GHG) emissions by 50% or more in order to stabilize global concentrations by 2100 (Houghton et al., 2001)The Tyndall Centre has suggested that a 70% reduction in CO_2 emissions will be required by 2030 to prevent temperature rising by more than 1 °C (Bows et al., 2006).

There are many methods available for assessing the environmental impacts of materials and components within the building sector. Life cycle assessment (LCA) is a tool used for the quantitative assessment of a material used, energy flows and environmental impacts of products. It is used to assess systematically the impact of each material and process. LCA is a technique for assessing various aspects associated with development of a product and its potential impact throughout a product's life (i.e. cradle to grave) from raw material acquisition, processing, manufacturing, use and finally its disposal (ISO, 1997).

1.2 Background of Research

Nowadays there is a growing concern for sustainability. This has led to a change in the otherwise economic approach to resource consumption accounting. In recent years, the tendency has been to use structural optimization criteria to reduce the environmental impact involved in all life cycle stages. Any optimization of design for sustainability should be conducted in accordance with the ISO 14040 standards, which require that an appropriate boundary and scope be set and justified (ISO 1998). Reducing CO2 emissions is one of the most widely used criteria, since data related to the environmental impact of most construction materials have been compiled by distinct organizations (e.g. Goedkoop and Spriensma 2001; Catalonia Institute of Construction Technology 2009)

In design paradigms, trade-offs are made among alternative solutions aimed to optimize building performance for various objectives. On the other hand, environmental objectives are diverse, complex, inter- connected, and usually conflicting. Reducing impacts on one problem (e.g., global warming) may increase impacts on another (e.g., solid waste generation). In order to reach the aim of improving the building performance and decrease destructive effects on global warming, performance of a building material, product, or system should be optimized. It is necessary to weight global warming impacts, normalize sources of similar impacts, and calculate the total environmental performance in order to select the most preferable alternative. Hence a comprehensive assessment system is required to assess confidently the environmental performance of a particular design.

Building Materials and Component Combinations (BMCC) nearly two thirds of the studies listed in Table 1.1 Relate to materials and components. Materials are naturally found in impure form, e.g., in ores, and extraction or purification not only consumes energy but also produces waste (Asif et al., 2007). Many industrialized countries have made steps towards environmental improvement of the construction process, building occupation and demolition, and these steps differ to the extent that building construction is strongly determined by local traditions, local climate and locally available natural resources. As a result, many LCA studies calculating the environmental impacts of BMCC have been done during the last fifteen years.

Researchers have compared timber to other framing materials in buildings. Borjesson et al. compared CO2 emissions from the construction of a multi-storey building with a timber or concrete frame, from life-cycle and forest land-use perspective. The primary energy input (mainly fossil fuels) in the production of materials was found to be about 60-80% higher when concrete frames were considered instead of timber frames (2000). Lenzen et al. analyzed the timber and concrete designs of the same building in terms of its embodied energy using an input-output based hybrid framework instead of the process analysis Borjesson used. Their estimations of energy requirements and greenhouse gas emissions were double (2002). Gustavsson et al. studied the changes in energy and CO2 balances caused by variation of key parameters in the manufacture and use of the materials in a timber- and a concrete-framed building. Considered production scenarios, the materials of the timber-framed building had lower energy and CO2 balances than those of the concrete-framed building in all cases but one (2006).

Table 1.1 Published LCAs applied within the building sector within the last 15 years

Reference	BMCC	WPC	Content, country and year	Environmental impacts studied (see footnote)													
				En	GW	A	E	OD	HT	EL	WC	DA	W	EC	RS	AR	O
Adalberth *et al.*		x	Life-cycle of four dwellings located in Sweden (2001)	x	x	x	x	x	x	x							
Ardente *et al.*	x		LCA of a solar thermal collector, Italy (2005)	x							x		x		x	x	
Asif *et al.*	x		LCA for eight different materials for a dwelling in Scotland (2005)	x	x												
Citherlet *et al.*	x		LCA of a window and advanced glazing systems in Europe (2000)	x	x	x		x									x
Cole and Kernan		x	LCA of a three-storey, office building for alternative structure materials in Canada.	x													
Gustavsson and Sathre	x		LCA Sweden case study: wood and concrete in building materials (2006)	x													x
Junnila		x	LCA for a construction of an office: a Finland case study (2004)	x	x	x	x						x				
Junnila and Horvath		x	LCA of a high end office building in Finland (2003).	x	x	x	x						x				
Junnila *et al.*		x	Comparative LCA of office buildings in Europe and the United States (2006)	x	x	x	x										
Koroneos and Dompros	x		LCA of brick production in Greece (2006)	x	x	x	x			x							x
Koroneos and Kottas		x	LCA for energy consumption in the use phase for a house in Greece (2007)	x	x	x	x						x				x
Morel *et al.*	X		Comparison of energy embodied in local construction materials with imported ones, France (2000)	x													
Nebel *et al.*	x		LCA for floor covering, Germany (2006)	x	x	x	x	x									x
Nicoletti *et al.*	x		LCA of flooring materials (ceramic versus marble tiles), Italy (2002)	x	x	x		x	x			x					x
Nyman and Simonson	x		LCA of residential ventilation units over a 50 year life-cycle in Finland (2005)	x	x	x		x				x				x	
Peuportier		x	Comparison of three types of houses with different specifications in France (2001)	x	x	x	x	x	x	x	x	x	x	x	x	x	
Petersen and Solberg	x		LCA by comparing wood and alternative materials in Norway and Sweden (2005)	x		x	x	x	x								
Prek	x		LCA of heating and air conditioning systems. Dwelling in Slovenia (2004)	x	x			x									
Saiz *et al.*	x		LCA for green roofs located in downtown Madrid, Spain (2006)	x	x	x	x	x	x		x		x				x
Scheuer *et al.*		x	LCA to a new University building in the USA (2003)	x	x	x		x		x			x				x

Abbreviations: WPC, whole process construction; BMCC, building and materials components combinations. Impact categories: En, energy consumption; GW, global warming potential; OD, photochemical ozone creation; WC, water consumption; DA, depletion of a biotic resource; A, acidification; HT, human toxicity; W, waste creation; EC, eco-toxicity; E, eutrophication; EL, energy consumption; RS, resources consumption; O, others; AR, air emissions. Source:(Ortiz et al., 2009)

Xing et al. compared a steel-framed office building in China with a concrete-framed one. The life-cycle energy consumption of the building materials ‘per area‘in the steel-framed building is 24.9% that of the concrete-framed building, whereas, in the usage phase, the energy consumption and emissions of steel-framed building are both larger than those of concrete-framed building. As a result, the energy consumption and environmental emissions achieved by the concrete-framed building over its whole life-cycle is lower than the steel-framed one (2008). Asif et al. calculated the CO2 emissions of eight construction materials for a dwelling in Scotland timber, concrete, glass, aluminum, slate, ceramics tiles, plasterboard, damp course and mortar. The study concluded that 61% of the embodied energy used in the house was related to concrete. Timber and ceramic tiles comes next with 14% and 15%, respectively, of the total embodied energy. Concrete was responsible for 99% of the total of CO2 emissions of the home construction, mainly due to its production process (Asif et al., 2007). Nebel et al. studied the environmental impacts of wood floor coverings manufactured in Germany, and held analyses to help the industry partners to improve their environmental performance and use the results for marketing purposes. The study did not aim to compare products, but to produce an LCI and find the environmental impacts of this industry (2006).

Conservation of energy becomes important in the context of limiting GHG emission into the atmosphere, and reducing costs of materials(Venkatarama Reddy and Jagadish, 2001), and the embodied energy payback period should always be one of the criteria used for comparing the viability renewable technologies (Wilson and Young, 1996). To promote environmental impact reduction the European Commission released the integrated product policy (IPP) (2003), which aimed to enhance the life-cycle of products. The life-cycle of most construction products is long and involves many complicated procedures and stake holders (e.g., designer, manufacturer, assembly, construction, marketing, sellers, and final users).

Many researchers have been interested in studying the environmental benefits of using recycled, reused or recyclable, reusable materials in the building industry. A study by Erlandsson et al. set a new method for reused materials, and confirmed that using reused materials is better for the environment than building with new, their case study data showing a reduction in environmental impact by up to 70% (2004). Selecting durable and renewable materials could also be an alternative for grouping materials, as well as recycling, reusing and recovering materials for optimum waste disposal (Sun et al., 2003). A study comparing plastics to wood and concrete in Swedish dwellings found that although plastics were only 1%–2% by weight, their manufacturing energy was 18%–23% of the entire amount required for the three dwellings(Adalberth, 1997). Researchers classified building materials in different ways. For example, Asif et al. categorized them into main families, i.e., stone, concrete, metals, wood, plastics and ceramics (Asif et al., 2007). Junnila and Horvath studied the significant environmental aspects of a new high-end office building with a life span of over 50 years. In this study functional unit is considered as 1 kWh/m2/year and location of study was at Southern Finland (Northern Europe). The LCA performed here had three main phases inventory analysis for quantifying emissions and wastes, impact assessment for evaluating the potential environmental impacts from the inventory of emissions and wastes, and interpretation for defining the most significant aspects. In this study life cycle of a building was divided into five main phases; building materials manufacturing, construction process, use of the building, maintenance, and demolition. GHG emissions were estimated to be 48,000 ton CO2eq/m2.50yr.(Junnila S and A., 2003)

Four of the studies listed in Table 1.2 deal with dwellings. Adalberth studied the energy use during the life-cycle of three single-unit dwellings, built in Sweden in 1991 and 1992 (1997). The houses were prefabricated and timber framed. The study emphasized the importance of LCA, to gain an insight into the energy use for a dwelling in Sweden. The functional unit was m2 of usable floor area (i.e., gross area minus walls area), and the study assumed a 50 years life-span. The life-spans of different building components and materials were collected from the maintenance norm of the Organization for Municipal Housing Companies in Sweden to estimate how many times each would be replaced during the life of the dwelling. The study showed that the difference between percentage energy and percentage by weight for materials (e.g., the concrete used was 75% by weight of the whole, while the energy used to produce it is only 28% of the production energy of the whole dwelling). Adalberth performed a sensitivity analysis on the building material data, energy use and electricity mix, which had been discovered to be of a greatest environmental burden. This study concluded that the greatest environmental impact (70%–90%) occurs during the use phase. Approximately 85% and 15% of energy consumption occurs during the occupation and manufacturing phases, respectively (Adalberth, 1997).

A study carried out in France as part of the EQUER project (evaluation of environmental quality of buildings) considered different phases of dwelling‘s life-cycle, using the functional unit of m2 living area, with the sensitivity analyses based on alternative building materials, types of heating energy, and the transport distance of the timber. This study showed that the dwellings with greatest environmental impact were not those whose area is larger, and emphasized the importance of choosing materials with low environmental impact during the pre-construction phase (i.e., employing LCA as a decision making supporting tool during the design stage) (Adalberth, 1997).

Involving the recycling potential scenarios within the life-cycle of low energy dwellings had been studied by Thormark, for energy efficient apartment housing in Sweden. Over a 50 year life-span, embodied energy accounted for 45% of the total energy requirement, and about 37%–42% of this embodied energy could be recovered through recycling (2002). In a Japanese urban development case study, Jian et al. suggested that to reduce life-cycle CO2 emissions timber dwellings were preferred to other materials, and that open spaces such as parks and green areas should be maximized to work as a breathing lung inside the development (Jian et al., 2003).

In terms of LCA for offices Scheuer et al. studied a new university building (75 years life-span, six storeys, and 7,300 m2 area, in USA). They identified 60 building materials and showed that the operational energy amounted to 97.7% of the whole energy consumption, which can be explained by the long life-span. The energy of the demolition phase was only 0.2%. The study translated the energy consumed in the life-cycle into environmental impacts-global warming 93.4%, nitrification potential 89.5%, acidification 89.5%, ozone depletion potential 82.9%, and soil categories waste generation 61.9%. Data were taken from Simapro, Franklin associates, DEAMTM, and the Swiss Agency for the Environment, Forests and Landscape. The study emphasized the need for data on unusual performance characteristics, or detailed evaluations of building features in the design stage, which they say is impossible with current building data (Scheuer et al., 2003).

Guggemos and Horvath compared environmental effects of steel and concrete framed buildings using LCA. Two five-storey buildings with floor area of 4400 m2 were considered which were located in the Midwestern US and were expected to be used for 50 years. In this study two methods, process based LCA and EIO-LCA, were used to evaluate life-cycle environmental effects of each building through different phases: material manufacturing, construction, use, maintenance and demolition phase. The results showed that concrete structural-frame had more associate energy use and emissions due to longer installation process(2005). Blengini performed LCA of building which was demolished in the year 2004 by controlled blasting. The adopted functional unit used in the current case-study was 1 m2 net floor area, over a period of 1 year. This residential building was situated at Turin (Italy). In this study demolition phase and its recycling potential were studied. The life cycle impact assessment (LCIA) phase was initially focused on the characterisation and six energy and environmental indicators were considered, GER (Gross Energy Requirement), GWP, ODP (Ozone Depletion Potential), AP, EP and POCP (Photochemical Ozone Creation Potential). SimaPro 6.0 (2004) and Boustead Model 5 (Boustead I, 2004). were used as supporting tools in order to implement the LCA model and carried out the results. The results demonstrated that building waste recycling is not only economically feasible and profitable but also sustainable from the energetic and environmental point of view (Blengini, 2009).

Scheuer et al. performed LCA on a 7300 m2 six-storey building whose projected life was 75 years at SWH (Sam Wyly Hall). The building is located on the University of Michigan Campus, Ann Arbor, Michigan, US. LCA has been done in accordance with EPA (Environmental Protection Agency), SETAC (Society for Environmental Toxicity And Chemistry), and ISO standards for LCA (Vigon BW, 1993; ISO, 1997). Primary energy consumption, GWP, ODP, NP (nitrification potential), AP, and solid waste generation were the impact categories considered in the life cycle environmental impacts from SWH. An inventory analysis of three different phases: Material placement, Operations and Demolition phase was done. Results showed that the optimization of operations phase performance should be primary emphasis for design, as in all measures, operations phase alone accounted for more than 83% of total environmental burdens (Scheuer et al., 2003).

Table 1.2 Environmental impacts associated with different buildings.

S. no.	Year	Specification of building	Place	Type	Life time (year)	Floor a rea (m^2)	Energy use ($MJ/m^2.50yr$)	GHG emissions ($CO_{2eq}/m^2.50yr$)
1	1996	Malmo	Sweden	R	50	700	23,040	1.30 ton
2	1996	Helsingborg	Sweden	R	50	1,160	26,640	1.35 ton
3	1996	Vaxjo	Sweden	R	50	1,190	33,120	1.51 ton
4	1996	Stockholm	Sweden	R	50	1,520	2,590	1.40 ton
5	2006	Low-density building	Toronto, Canada	R	50	–	53,400	5365 kg
6	2006	High-density building	Toronto, Canada	R	50	–	46,830	3885 kg
7	2005	Steel framed	Midwestern US	R	50	4,400	20,900	–
8	2005	Concrete framed	Midwestern US	R	50	4,400	46,950	–
9	2004	Via Garrone building	Turin, Italy	R	–	6,110	49,930	3340 kg
10	2003	High-end	South. Finland, Europe	C	50	15,600	–	48,000 ton
11	2003	Sam Wyly Hall, University of Michigan	Michigan, USA	C	75	7,300	–	67,500 ton
12	2008	Office building	Thailand	C	50	60,000	–	5,600,000 ton
13	2003	School building	Mendoza, Argentina	C	50	–	–	34,000 μPE*

R: residential, C: commercial.

Source: (1),(2),(3),(4) (Adalberth K et al., 2001) (5),(6)(Norman J et al., 2006) (7),(8)(Guggemos AA, 2005) (9) (Jian et al., 2003) (10) (Junnila S and A., 2003) (11) (Scheuer et al., 2003) (12) (Kofoworola and Gheewala, 2008) (13) (Arena and Rosa, 2003)

While carbon is a motivation for policy of BIM, the connections between digital technologies and sustainability are not well developed in policy and practice. There is however research activity that is beginning to develop new tools to use BIM in order to address a range of sustainability concerns. Russell-Smith and Lepech (2012), for example, develop an activity based method for lifecycle assessment, through modeling and benchmarking of building construction. The sustainability concerns addressed by such tools include: the assessment of environmental impacts (Lu et al., 2012); consideration of waste management issues (O'Reilly, 2012; Rajendran and Gomez, 2012) guidance to designers on environmental issues(Capper et al., 2012; Firoz and Rao, 2012; Geyer, 2012; Hetherington et al., 2012; Kanters et al., 2012; Mirani and Mahdjoubi, 2012) and a response to a government strategy for carbon reductions in both current and future building stock (McAuley et al., 2012).

Recent studies were also examining the use of BIM throughout the lifecycle of construction projects, addressing and looking at the life-cycle of particular materials such as concrete(Borrmann et al., 2012). There are also a few studies on renovation and on reconstruction and on waste management and minimization (O'Reilly, 2012; Rajendran and Gomez, 2012; Yeheyis et al., 2012)

There is also a literature that sets out frameworks for guidance of quantity surveyors there were expectations that this work will be changed by the widespread use of BIM and consideration of how these activities can be achieved through the new tools.

1.3 Problem Statement

Since 1751 approximately 337 billion tons of carbon have been released to the atmosphere from the consumption of fossil fuels and cement production. Half of these emissions have occurred since the mid-1970s. The 2007 global fossil-fuel carbon emission estimate, 8365 million metric tons of carbon, represents an all-time high and a 1.7% increase from 2006. Globally, liquid and solid fuels accounted for 76.3% of the emissions from fossil-fuel burning and cement production in 2007. Combustion of gas fuels (e.g., natural gas) accounted for 18.5% (1551 million metric tons of carbon) of the total emissions from fossil fuels in 2007 and reflects a gradually increasing global utilization of natural gas. Emissions from cement production (377 million metric tons of carbon in 2007) have more than doubled since the mid-1970s and now represent 4.5% of global CO_2 releases from fossil-fuel burning and cement production. Gas flaring, which accounted for roughly 2% of global emissions during the 1970s, now accounts for less than 1% of global fossil-fuel releases.(Boden et al., 2010)

The over-dependence on fossil fuels and over-exploitation of earth's natural resources has now become obstructions for sustainable development in many countries. Global energy related emissions of CO_2 are anticipated to rise from 20.9 billion t in 1990 to 28.8 billion t in 2007. It is then projected to reach 34.5 billion t in 2020 and 40.2 billion t in 2030, an average growth rate of 1.5% per year. Moreover, Kyoto Protocol announced significant portions of CO_2 emitted by the United States (22%), China (18%), E.U.(11%), Russia (6%), India(5%), and Japan (5%). Furthermore, The European Union has agreed upon climate targets to decrease the emissions of greenhouse gases by 20% by 2020 and 50% by 2050 compared with the 1990 level (International Energy Agency, 2009) (United Nations 2007) (European Commission)

Comprising data from CDIAC in 2000 and 2007 are shown significant issue. Rank of Malaysia decreased from 69 in 2000 with 5.4 metric tons of CO_2 per capita to 57 in 2007 with 7.3 metric tons of CO_2 per capita. This trend shows that Fuel consumption in Malaysia had increased rapidly since 2000 until 2007.

Nowadays there is a growing concern for sustainability. This has led to a change in the otherwise economic approach to resource consumption accounting. In recent years, the tendency has been to use structural optimization criteria to reduce the environmental impact involved in all life cycle stages. Any optimization of design for sustainability should be conducted in accordance with the ISO 14040 standards, which require that an appropriate boundary and scope be set and justified (ISO 1998). Reducing CO_2 emissions is one of the most widely used criteria, since data related to the environmental impact of most construction materials have been compiled by distinct organizations (Goedkoop and Spriensma, 2001).

Also the construction industry is one of the main contributors towards the development of Malaysia, providing the necessary infrastructure and physical structures for activities such as commerce, services and utilities. The industry generates employment opportunities and injects money into a Malaysian's economy by creating foreign and local investment opportunities(Agung, 2010). However, despite these contributions, the construction industry has also been linked to global warming, environmental pollution and degradation. Due to the alarmingly decreasing land for construction, Malaysia is calling for the use of developed sites and conversions of existing buildings to meet current demands. Therefore on a broad spectrum, demolition can be predicted to be playing a major role in future nation building. Deconstruction, waste of this process and unsustainable tools, are also linked to the adverse environmental impacts of the construction industry.

1.4 Aim of Research

The aim of this study is to calculate the generation of GHG per 1 square meters in reinforced concrete building in Malaysia. This study is done by determining the crucial processes that contribute to the total GHG impacts during the demolition and waste disposal include landfill treatment that used diesel as the main source of energy.

1.5 Objective of Research

The objectives for this case study:

1. To identify the methods and processes of a demolition.
2. To analyze the relevant contribution of Building Information Modeling's Tool (revit structure software) to accurate estimation materials produced after deconstruction.
3. To measure the relevant plant's fuel consumption on demolition and waste disposal phase, and calculation GWP of activities by simapro software as the tools for LCA.
4. To evaluate the GHG per square meter of the case study subject and weight of materials that were demolished and under wastage treatment.

1.6 Scope of Research

The scope of the LCA mostly consists of the functional unit, the system boundary, allocation procedures, data requirements and assumptions or limitations. The functional unit of the study was defined as 1 square meter gross floor area of Menara Tun Razak building.

The boundary of this study includes the stages of the demolition and waste disposal. In order to suit the objective of the study and based on the system boundary, the study only focus on emissions that contribute to the greenhouse effects from demolition site including emissions from activities, which consist of fuel. Figure 1.1 shows the general outline of inventories involved in the study.

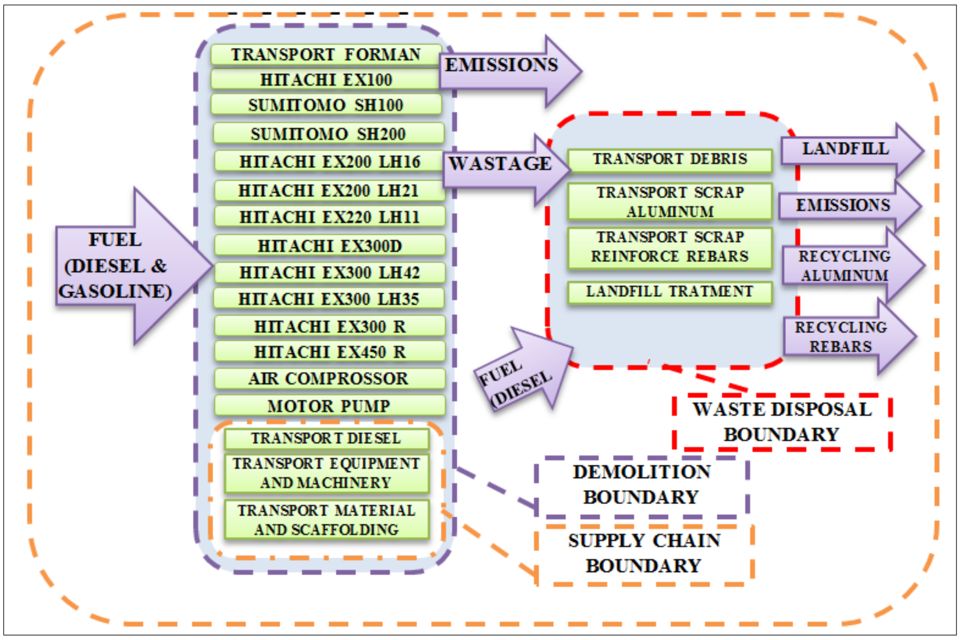

Figure 1.1 System boundary MENARA TUN RAZAK

Moreover for LCA database is chosen Ecoinvent 2.01 version (2007) of this research. Datasets are offered for a Swiss (CH) and a European (RER) supply situation also BEES V4.02 as impact assessment methodology to assess the environmental impact. The Bees methodology uses the environmental problems approach that was developed by the society for environmental toxicology and chemistry (SETAC). Therefore, this study was focused on LCA of fuel used and

GHGs emission based on the demolition and wastage scenario in case study Menara Tun Razak in Kuala Lumpur.

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