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Assessment of Tyres Waste Disposal Processes In Gaza Governorates

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Dedication

To my country Palestine to the Palestinian people who are steadfast and patient on the beloved land of Palestine

I dedicate this study

To my late mother, my father, my brothers, my sisters and my wife

Without their support this work could not have been done

Thank you all. From the deepest of my heart, I express to you all my sincere love and appreciation

Khalil I. Hassanein

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed ……..

Khalil I. Hassanein

Date: December / 2008

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Abstract

Tyre waste and its disposal is a worldwide problem. Tyres are not biodegradable; hence the time required for their decomposition is undetermined. Due to their chemical composition, when tyres are burnt, they release organic and inorganic pollutants to the air and soil, including hydrocarbons, dioxins, and other toxic substances. Tyre disposal requires special and expensive technology. The purpose of this research is to assess the current situation of waste tyres disposal process in the Gaza Governorates, in order to provide data base for future interventions. The study was carried out through tow questionnaires that targeted the owners of the tyres repair-shops and the professionals working at relevant local institutions, over a period of three months. The total sample was 101 owners of tyres' repair-workshops and sixteen professionals from different ministries and municipalities. The study illustrates that in Gaza governorates there are weaknesses in all stages of the waste tyres management process which includes collection, storage, transportation and treatment. The study revealed that there is no activities done in the fields of recycling and energy recovery. The absence of a national strategy for waste tyres management is represented in the lack of cooperation among the institutions who issue the work license and the repair-shops owners. No specific regulation had been developed, absence of database system and no enforcement activities from the government to regulate this field. The absence of monitoring system for the waste tyres disposal activities is an additional weak point that makes the possible alternative methods for end use of waste tyres difficult to implement. There is a potential for future waste tyres industry in Gaza since there is about 250,000 tyres or more that can be collected every year. This study is the first to be conducted in Gaza Governorates and provides first-hand data in the field of waste tyres disposal process. It's recommended that an integrated process for waste tyres management including establishment of new collection system, storage facilities, cooperation among the stakeholders, treatment options and the bylaws for waste tyres disposal. Among the recommended treatment options are reuse and recycling of waste tyres in several fields such as engineering constructions and recreational areas.

ملخص الدراسة

التخلص من إطارات السيارات الهالكة هي مشكلة عالمية لان الإطارات لا تتحلل بيولوجيا بسهولة ، كما أن الوقت اللازم لتحللها غير محدد وذلك يعود إلى تركيبها الكيميائي ، عندما يتم حرق الإطارات الهالكة ينطلق نتيجة ذلك العديد من الملوثات العضوية وغير العضوية إلى الهواء والتربة ، من هذه الملوثات المواد الهيدروكربونيه والديوكسين ، وغيرها من المواد السامة ، لذلك تهدف هذه الدراسة إلى تقييم الوضع الحالي لعملية التخلص من الإطارات الهالكة في محافظات غزة.

شملت المنهجية التي تمت الدراسة على أساسها كل أصحاب ورش تصليح و تبديل الإطارات في محافظات غزة بالإضافة إلى الوزارات و البلديات ذات العلاقة بموضوع تنظيم ترخيص و جمع الإطارات الهالكة و التي شملت 101 ورشة تصليح وتبديل الإطارات كذلك المختصين من البلديات و الوزارات ذات العلاقة تم جمع المعلومات من خلال تعبئة الاستبانة التي صممت خصيصا لهذا الغرض.

بينت نتائج هده الدراسة أنة في محافظات قطاع غزة يوجد الكثير من نقاط الضعف في كل مراحل عملية إدارة الإطارات الهالكة والتي تشمل عملية الجمع والتخزين والنقل و مرحلة علاج الإطارات الهالكة.

- كشفت الدراسة عن عدم وجود أنشطه طبقت في مجال إعادة التدوير و عملية تلبيس الإطارات الهالكة و استخدامها في التطبيقات الهندسية المختلفة.
- غياب إستراتيجية وطنية لإدارة الإطارات الهالكة أدى إلى قلة وجود تعاون بين المؤسسات.
- أظهرت الدراسة أيضاً أنة لم يتم وضع أي لوائح قانونية محددة لعملية التخلص من الإطارات الهالكة و كذلك عدم و جود إلزام من طرف الحكومة لتنظيم هذا المجال.
- كما أظهرت الدراسة عدم وجود نظام قاعدة بيانات.
- عدم وجود نظام مراقبة للأنشطة الناتجة عن عملية التخلص من الإطارات الهالكة و هي نقطة ضعف إضافية تجعل من إمكانية الاستفادة من الأساليب البديلة لإنهاء استخدام الإطارات الهالكة أكثر صعوبة في عملية التنفيذ.
- تشير الدراسة إلى أنة في محافظات قطاع غزة هناك أمكانيه لنمو و تطور صناعة إعادة الاستخدام و الاستفادة من الإطارات الهالكة ، حيث أن هناك حوالي 250000 إطار أو أكثر يمكن جمعها كل سنة في محافظات قطاع غزة.

توصى الدراسة أن يتم وضع عملية متكاملة لإدارة الإطارات الهالكة تشمل إنشاء نظام جديد لجمع و تخزين الإطارات الهالكة في مرافق خاصة بذلك و أن يتم التعاون فيما بين أصحاب الورش التي تتعامل بتبديل الإطارات الهالكة و المؤسسات ذات العلاقة كذلك استحداث خيارات العلاج واللوائح الداخلية و القوانين التي يجب أن يؤخذ بها للتخلص من الإطارات الهالكة. ومن بين هذه الخيارات العلاجية الموصى بها إعادة استخدام وتدوير الإطارات الهالكة في العديد من المجالات الهندسية والإنشاءات والمناطق الترفيهية.

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List of Appreciations

BTU	British Thermal Units
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EQA	Environment Quality Authority
ESM	Environmentally Sound Management
ETRA	European Tyre Recycling Association
EU	European Union
GC–MS	Gas chromatography–mass spectrometry
GEF	Global Environment Facility
IACSTMC	International Association of Fire Chiefs and the Scrap Tyre Management Council
MJ/kg	Millions of Joules/Kilogram
MEnA	Ministry of Environmental Affairs
MOE	Ministry of Economy
MOH	Ministry of Health
MOPIC	Ministry of Planning and International Co-operation
MOT	Ministry of Transportation
MW	Molecular Weight
NIST	National Institute of Standards and Technology
NGOs	Non Governmental Organizations
NDDH	North Dakota Department of Health
ODNR	Ohio Department of Natural Resources
PCBS	Palestinian Central Bureau of Statistics.
PAHs	Polycyclic Aromatic Hydrocarbons
RESC	Roads and Environment Safety Center
SPSS	Statistical Package for Social Science
SBR	Styrene butadiene rubber
UNEP	United Nations Environment Program
UNRWA	United Nations Relief and Works Agency

Definition of Terms

The sources of the definitions are the Basel convention text books (UNEP, 2002)

Civil engineering applications

the use of whole, shredded, or granulated tyres in construction projects including the manufacture of noise absorbers for tram or rail lines, underlayments for roads, drainage areas, porous asphalt mix, among others.

End-of-life

The point at which a tyre is consigned to waste management for recycling or recovery.

Energy recovery

Incineration to extract the fuel or heat value from whole or processed tyres.

Environmental impact

Any change to the environment, whether adverse or beneficial, wholly or partially resulting from the activities, products or services of an organisation.

Environmental management

That part of the overall management system which includes the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources to develop, implement, achieve, review and maintain an environmental policy.

Landfill

A disposal site for the deposit of waste onto or into land, including internal waste disposal (i.e. landfill where a producer of waste carries out its own waste disposal at the place of production) and excluding facilities where waste is unloaded in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere, and temporary (i.e. less than one year) deposit of waste prior to recovery, treatment or disposal.

Part-worn tyre

A used tyre which retains a minimum of 1.6mm of visible tread depth in its most worn groove and which when subjected to inspection of the structural soundness of the casing and/or proper repair can be safely returned to its originally intended purpose.

Pyrolysis

The thermal decomposition of rubber in the absence of oxygen which chemically breaks the tyre into its original components of oil, gas, and char.

Retreating

The generic term for reconditioning a used tyre by replacing the worn tread with newly vulcanised material.

Re-use

Any way in which a tyre is used for the same purpose for which it was originally intended.

Shredding

Any mechanical process by which tyres are fragmented, ripped or torn into irregular pieces more than 2.5mm.

Chapter (1)

Introduction

1.1 Background

Since the beginning of the industrial revolution in late 18th and early 19th century that began in Britain and spread throughout the world. Since that time, a huge and endless dangerous environmental problems have emerged and grew very rapidly in a way that made it very difficult to control (UNEP, 2000). In addition to its great advantage in improving and making the human life easier and smooth, the development of industry has a strong negative impact on the environment and on the human life. The modern life and the huge range of industrial activity such as extraction and refining of petrol, the chlor-alkali industry, rubber and plastic industry, batteries and full cells industry and so many other industrial activities have all badly affected and contributed to the damage of the environment in a very significant way; which in turn caused a various environmental and health problems and a wide range of dangerous diseases such as the different types of cancer (Heaton, 1996).

There is a great international awareness of the dangers on both the human life and the environment from the hazardous waste and other wastes. This is reflected by the legislation introduced by many governments and by international organizations such as United Nations Environmental Program (Roch, 1999). In 1989 an international agreement known as Basel Convention has been singed to control, monitor transboundary movement and set the best ways of managements of the hazardous wastes and their disposals (UNEP, 2002).

The scope of the hazardous wastes is very wide. However, the hazardous waste in general can be defined as, any substance, such as nuclear waste or an industrial by-product including organic and inorganic materials and chemicals in any of their physical forms i.e. gas, liquid or solid states, that is potentially damaging to the environment and harmful to humans and other living organisms (Blackman, 2001).

As mentioned above the scope of the wastes is very wide and hard to be listed and discussed in this introduction. However a small part of the wide hazardous wastes range with an extremely important health and environmental impacts, is the disposal of the waste tyres. The issue of the tyres waste is extremely important due to the harmful impact of the irresponsible and wrong way of disposal of the waste tyres on human's life and environment. The issue of identification and management of waste tyres is not restricted or limited to a particular country or state; it is an international problem that is reflected by Article 10 of the Basel Convention on the control of transboundary movements of Hazardous Wastes and their Disposal (UNEP, 2002).

In Australia (Australian Government, 2001), approximately 18 million waste tyres need to be disposed of annually, while in Newzeland and according to the national production of used passenger tyres it is estimated to be 32,000 tonnes per annum (Firecone, 2004). Every year in the UK alone, over 32 million car tyres and 3.8 million scrap truck tyres are produced (NESTA, 2004). This amounts to around 380,000 tonnes of tyres to be disposed of every year. Unfortunately; and to the best of our knowledge which based on the basic internet search, in the Arab region of the Middle East, the issue of the waste tyres and its negative impact on the human and the environment has not received a considerable attention inspite of the huge threat of the waste tyres and other wastes on the human and environment in the Arab countries.

On the basis of the above and due to the lack of research and studies that deal with the waste tyres management and disposal and solving or at least minimizing the problems resulting from the improper management and disposal of the waste tyres, this study will be conducted to evaluate and assess the tyres waste problem in the Gaza Governorates.

1.2 Research Problem

The Gaza Governorates are of the most densely populated territories on earth, with about 1.4 million residents in an area of about 378 km² (UNEP, 2003). Due to many factors, particularly the political issues, the Gaza Governorates has suffered from so many different problems and catastrophes. Health and environmental problems are the most dangerous issues that threaten and still threating Gaza Governorates as a result of not good enough and improper treatment of the environmental problems due to the lack of fund and to the obstacles caused by the Israeli control over Gaza Governorates borders.

Figure 1.1: Photos for waste tyres in Gaza taken by the researcher, 2008

According to a national survey, in Gaza Governorates there are about 59,147 (Ministry of transport, 2006) Licensed Road Vehicles (see Annex 6) of different types of cars, buses and trucks. Unfortunately there are no previous surveys or even an estimation of the amount of the waste tyres produced in Gaza Governorates. As a result of the lack of researches, studies and surveys dealing with the issue of waste tyres, there is no data available on the environmental impact of the waste tyres.

1.3 The Overall Goal and Objectives

The overall goal of this research is to assess the current situation of waste tyres disposal process in Gaza Governorates.

1.3.1 Research Objectives

The main objectives of the study are:

1) To illustrate the waste tyres disposal process in Gaza Governorates;
2) To recognize the methods used in collection, transporting, treatment of waste tyres in Gaza Governorates;
3) To identify the strength and weakness points of the waste tyres disposal process in the existing situation with special focus on disposal options in Gaza Governorates;
4) To provide a set of recommendations that help in improving the cycle of waste tyres management.

In general, this study aims to contribute, in a scientific way, in reducing the negative impact of wastes in Gaza Governorates in order to enable the residents to live in a clean, safe and healthy environment.

1.4 Research Questions

1. What is the current process of the waste tyres disposal used in Gaza Governorates?
2. What is the waste tyres management process that the people of Gaza Governorates are using?
3. What are the strength and weakness points that exist in current practices of the process of waste tyres management?
4. What are the possible alternatives to solve the disposed tyres problems?
5. What are the possible recommendations for the decision makers to reduce the negative impacts of waste tyres problem and improve the current situation?

1.5 Rational Statements

The justification of conducting this research is attributed to the random and irresponsible disposal of the waste tyres in Gaza Governorates, for example the burning of the tyres in open areas. This act has resulted in very negative health and environmental impacts. The scarcity of the land for land-filling of the waste tyres as the Gaza Governorates is a small area and the land is very essential for many other purposes such as agriculture and houses construction. There are accumulation of waste tyres over the time in Gaza Strip due to the lack of technology and the suitable industry to recycle and reuse the tyres waste.

1.6 General Review of the Study Chapters

This study is divided into seven chapters as follows:

Chapter one includes introduction about the waste tyres problem globally, regionally, and in Palestine, in addition to a background about environmental management in Palestine, problem statement, justification of the study, study aim and objectives and study questions.

In chapter two, the alternative methods for end use of waste tyres management, main studies regarding environmental issues and population globally, regionally, and in Palestine the (West Bank and the Gaza Governorates), are highlighted.

In chapter three which concern with conceptual framework the researcher will display the main part of this study which involves description of environmental knowledge and attitude. Through chapter four of this study, the researcher will describe the main methodological parts in the study, which include: study design, study sample (study population, sample size, sampling process) study area, ethical consideration, study instruments, pilot study, data collection, processing and analyzing the data, and limitation of the study. In chapter five the researcher will present the main study results based on the

results of the statistical analysis, which involves distribution of the study population, the results of the study questions. The study results will be discussed in chapter six, and based on the study results, the researcher in chapter seven, will suggest recommendations and further researches.

Chapter (2)

Literature Review

2.1 Introduction

Large quantities of waste tyres are generated every year. The improper disposal of the tyres creates an increasing problem that needs to be addressed. Because of the increase of motor vehicles, the numbers of discarded tyres in many countries have increased markedly. Improper treatment and disposal of scrap tyres leads to pollution and hazards to the environment and mankind and wastes a great quantity of recoverable energy and materials (Gordon and Yang, 2003). Growing environmental impacts, backed by lack of legislation, and inefficient methods for disposing of waste tyres have drown the attention of many scientific researchers and research institutions all over the word (Fletcher and, Wilson, 2003). Waste tyres have been recognized as one of the most difficult waste products to manage in a modern society. They are not difficult individually, but are difficult collectively. Waste tyres are generated in industrialized societies at an annual rate equal to the human population which discards them, one scrap tire per person per year. The lack of adequate disposal methods and management systems in past years had lead to widespread, cumbersome collection of scrap tires in unmanaged or poorly managed waste tyre piles. For example; estimates are that 250,000,000 post-consumer tyres are accumulated each year in the 15 member State of the European Union and comparable amounts amassed in Eastern Europe, North America, Latin America, Asia, the Meddle-East, totalling 1,000,000,000 new arising per year (ETRA, 2004). In the United States, in particular, over 270 million scrap tyres, approximately 3.6 million tons are generated each year (Siddique and Naik, 2004). In the West Bank, approximately one million waste tyres are generated annually. Waste tyres that are illegally dumped or improperly stored can pose a serious threat to public health and safety according to the Roads and Environment Safety Centre

RESC located in the West bank (RESC, 2004). According to the Ministry of the Environment in Israel, it is estimated that some 50,000 tons of waste tyres (6.5 million passenger tyres equivalent) are produced in Israel annually. Until recently, Israel was hard pressed to provide a solution to its ever-growing quantities of scrap tyres and waste tyres found their ways to roadsides, riverbeds and landfills and were associated with pest proliferation, uncontrolled fires and landscape blight (Israel Ministry of the Environment, 2008). In Palestine, yet the change may be on the way. The Ministry of the Environment has placed waste tyre treatment as one of high priority issues for solid waste management.

Therefore this problem has been a disposal problem and continues to accumulate throughout the world today (Jang, et al., 1998). Hence, this chapter will provide a scientific background on the composition of the tyre, its general properties, alternative tyre disposal methods, reuse and recycle methods are briefly reviewed with particular emphasis on the management of the end-of-life tyres.

2.2 Environmental Management in Palestine:

Environmental management in Palestine has been supervised in the last decades by several institutions. Since 1994, Environmental Planning Directorate had been established within the Ministry of Planning and International Co-operation (MOPIC), to deal with environment in Palestine at all levels. In the same time some ministries of the Palestinian Authority had established environmental departments to deal with environmental activities. Ministry of Health has had a department of environment which is responsible for licensing activities to ensure more quality of food and drinks, Ministry of Agriculture whose role is to overcome agricultural pollution hazards, and Ministry of Local Government which is responsible of supporting the municipalities in dealing with the environmental issues in cooperation with UNRWA who provides environmental services to the refugee camps in

the West Bank and Gaza Stripe. This had created responsibilities distributed among too many departments and institutions (MENA, 2000).

In 1996 Palestinian Environmental Authority had been established to be the focal point for all environmental issues in Palestine. On August 1998 Ministry of Environmental Affairs had been established by a presidential decree. This gives the Ministry all responsibility in the field of planning, monitoring, licensing and enforcement to promote a sustainable environmental development and protect the environment to prevent the risks on public. In August 2002, the Ministry of Environmental Affairs has changed to the Environment Quality Authority without any change in the responsibilities.

In any national environmental strategy, the critical element in the environmental management is to establish transparent environmental legislation, which should be consistent with the laws of other sectors. In this concern the environment protection law had been enacted in 1999. The objectives of this law include:

(1) The protection of the environment against all forms and types of pollution,

(2) The protection of public health and welfare,

(3) The insertion of the bases of environmental protection in the social and economic development plants,

(4) The encouragement of sustainable development of vital resources in a manner that preserves the rights of the future generations.

Concerning air environment, article (19) of environment law has stated that " (a) The Ministry, in cooperation with the competent agencies, shall specify standards to regulate the percentage of pollutants in the air which may cause harm or damage to public health, social welfare and the environment. (b) Each facility which will be established in Palestine, shall abide by these standards, every existing facility shall make necessary changes in a manner that makes it conform to these standards within a period that does not exceed three

years". Article (20) has emphasized the protection of workers health; it says "Every facility owner shall provide all means to ensure the necessary protection for workers and the neighbours of the facility in compliance with the conditions of occupational safety and health, against any leak or emission of pollutants in or out side the working place". Concerning the inspection and administrative procedures, article (50) states "The Ministry, in coordination with the competent agencies shall monitor the variant institutions, projects, and activities to verify their compliance with the requirements, standards and instructions prescribed for protecting the environment and the vital resources in compliance with the provisions of this law" (Sisalem, Muhann and Dahdoh, 2004).

The Ministry of Environmental Affairs adopted a policy to establish an environmental assessment process for the major development projects in Palestine, such as cement plants, industrial estates, hazardous and solid waste disposal sites, power plants, so as to achieve sustainable development in Palestine through conserving and enhancing environmental quality by encouraging and promoting economic and social development that conserves and enhances environmental quality. Further more, it seeks to facilitate stakeholders consultation in the environmental assessment of development activities to be carried out within Palestine. An environmental assessment committee is established from members of governmental agencies affected by or interested in a development activity such as the ministries of industry, agriculture, health, transport, local government, tourism and antiquities, planning and international cooperation, water authority, energy authority, in addition to Ministry of Environmental Affairs. Most of the developments that have been carried out in Palestine were prepared and implemented without any environmental considerations, some of these developments have significant environmental impacts. Environmental auditing has been designed to deal with such existing developments to mitigate negative environmental impacts through evaluating their environmental

management and performance. An environmental auditing is prepared by the owner or operator of the development activity, and focuses on mitigation measures for existing environmental impacts to comply with relevant environmental standards and regulations. Decisions resulting from the environmental auditing report can include one of the following priorities:

(1) Suspension of the permit for the development activity by the permitting authority until specified measures are implemented.
(2) Agreement on conditions that will be applied to the development activity including a plan of implementation.
(3) Exemption of the development activity from further compliance with the environmental assessment policy (MENA, 2000).

2.3 Status of Hazardous Waste Management in the Gaza strip and the West Bank

In Palestine, there are inadequate procedures for hazardous waste management, and there is no inventory for hazardous waste or HW identification list. So it is difficult to determine which waste is hazardous and non hazardous. There are hazardous waste cells in Gaza used for expired medicine and chemical laboratory waste, and is currently operating. The concrete cell has a life span of eight years only and the chemical wastes involved are both liquids and solids. Meanwhile there are no facilities in the West Bank for temporary storage, treatment or long term storage of hazardous waste (UNEP 2003 & EQA, 2004). It is difficult to estimate the amounts of hazardous waste generated in the West Bank and Gaza Strip, in part because of the absence of separation, segregation and inventories. In the West Bank, and Gaza Governorates the amount has been estimated at 2,500 tons per year. This amount refers to waste that has been clearly identified as hazardous. The true amount is likely to be much higher (UNEP, 2003).

2.4 General Properties of the Vehicle's tyre

A tyre is a rubber article with a complex structure. The tyre transmits to the road the motor forces necessary for propulsion. Together with the suspension the tyre dampens the unevenness of the road surface and thus ensures driving comfort. The tyre serves as a container to keep air under pressure. Passenger car and truck tyres represent about 85% of the total number of manufactured tyres. Depending on their size and utilization, tyres vary in design, construction and total weight. Shown in the table 2:1, the weight of used passenger tyre in Europe is about 6.5-9 Kg and that of a truck tyre is about 50 Kg (UNEP, 2002). The most common rubber used in the production of passenger car tyres is styrene-butadiene co-polymer (SBR), which contains about 25% by weight of styrene in combination with (SBR). Other elastomers eg. natutal rubber (cis-polyisoprene) synthetic cispolyisoprene , and cispolybutadiene are used in varied amounts (Shulman, 2004).

Table 2.1: Examples of new Tyre weights in the EU

Type of Vehicle	**Wight in kg**	**Tyre Per ton**
Passenger car	6.5-9	100-154
Light utility vehicles	11	91
Heavy goods vehicles	50	20
Long – haul trucks	55-80	12-18
Agricultural Tyres	100	10

Source: (Shulman V., 2004)

2.4.1 Thermal Properties

The net calorific value of a tyre is between 32 and 34 MJ/kg (Million Joules/Kilogram). A ton of tyres is equivalent to a ton of good quality coal or 0.7 ton of fuel oil. It is therefore, an excellent potential as a fuel, which is not surprising since tyres are mainly composed of oil products.

T able 2.2: Comparison of the Energy Content of Tyre Derived Fuel and Other Fuels

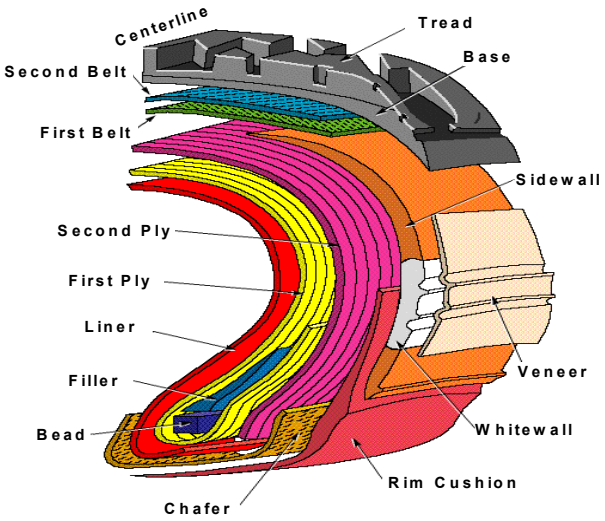
Fuel	**Grade**	**Heat content**
Gas	Natural	1.000 BTU/ft3
TDF	Tyre Derived Fuel	15.500 BTU/lb
Coal	Sub-bituminous	15.500 BTU/lb
Coal	Bituminous	12.700 BTU/lb
Wood	Wet wood >hog fuel	4.375 BTU/lb

Source: (UNEP, 2002)

The combustion of a tyre, like the combustion of any hydrocarbon, produces principally, carbon dioxide, water, plus inert residues. The sulphur content of tyres (approx. 1%), is comparable to a low sulphur content coal or very low sulphur content fuel oil and, therefore, the level of the sulphur dioxide is as low as these other fuels. A tyre is very difficult to ignite. The temperature at which the ignition induced by the pilot flame may be maintained was 33°-350°. There is no possibility of self ignition for tyres. The tyre burns completely at 650° and only ash and slag remain (UNEP, 2002).

2.4.2 Chemical Composition of the Tyres

A wide range of chemical compounds, such as natural rubber, styrene butadiene rubber (SBR), and butadiene rubber, can be found in the tyre rubber of road vehicles. Chemical analysis of tyre material has also revealed that metals such as Zn, Fe and Ca can be present in different concentrations. A large variety of other chemical substances are also added to tyre rubber: vulcanising agents, accelerators, retardants, pigments, fillers, reinforcing agents, softeners, anti-oxidants, anti-ozonants and desiccants (Wang, Li, Lambert, and Yong C. 2007). Figure 2.1 illustrates the composition of a typical tyre.



***Source**: The Cooper Tyre & Rubber Company, 2003*

Figure 2.1: Example of components of a typical radial tire

The following table illustrates the typical composition of tyre vehicles manufactured in Europe as mentioned by the European Tyre Recycling Association.

Table 2.3: The Composition of Tyres in the European Union

Material	**Passenger Cars**	**Trucks / buses**
Rubbers / Elastomers	48%	43%
Carbon Black	22%	21%
Metal	15%	27%
Textile	5%	-
Zinc oxide	1%	2%
Sulphur	1%	1%
Additives	8%	6%

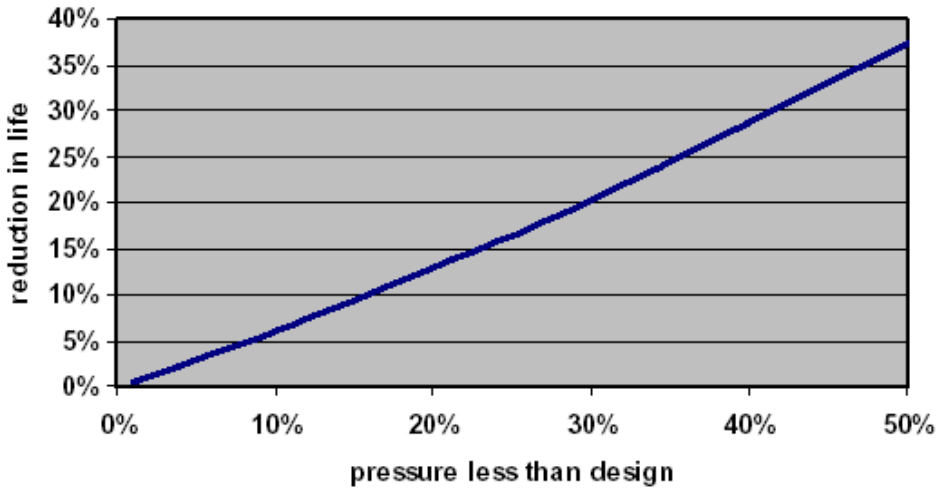
Source: (Shulman, 2004)

2.4.3 Increasing the Tyre Life Cycle

The tyre life cycle can be increased by: Firstly, proper manufacturing and quality of delivery which reduces waste at production, secondly, direct distribution through retailers, which reduces inventory time and ensures that the life span and the safety of the products are explained to customers, thirdly, consumer use and maintenance choices like tyre rotation which affect tyre wear and safety of operation, fourthly, manufacturers and

retailers set policies on return, re-tread, and replacement to reduce the waste generated from tyres and assume responsibility for taking the 'tyre to its grave' or to its reincarnation, in addition to recycling tyres by developing strategies that combust or process waste into new products, which creates viable businesses, and fulfilling public policies (ODNR, 2007).

The effect of tyre maintenance or, as appears to be more often the case; lack of maintenance provides perhaps the best opportunity for reducing the quantity of waste tyres generated. Tyre maintenance includes maintaining appropriate pressure, tyre rotation and maintaining correct wheel alignment. Tyre pressure in particular is an area that could be significantly improved. By applying the relationship between the effect of incorrect tyre pressure (typically low pressure) to the entire passenger vehicle fleet (Figure 2.2), the generation rate for waste tyres is estimated to be approximately 6% higher than if correct tyre pressures were maintained.



Source: Atech Group (2001)

Figure 2.2 Effect of low pressure on tyre life

2.5 Health and Environmental Impacts of Waste Tyres Management

UNEP (2002) has considered the waste tyres as part of the hazardous waste. According to Abdelhady (2002), hazardous waste is defined as: "Waste of activities and processes or its ashes which retain the properties of hazardous substances and have no subsequent original or alternative uses, like clinical waste from medical treatments or the waste resulting from the manufacture of any pharmaceutical products, drugs, organic solvents, printing fluids, dyes and painting materials". Therefore waste tyres is potentially hazardous to human health, plant or animals, soil, air, or water which may cause diseases and harm to the environment and public health.

2.5.1 Environmental Impact of Waste Tyres

According to the Commonwealth Department of Environment (CDE) study, it is generally only practical to discuss the impact in terms of potential. This is because local factors are critical to the realization and significance of the potential. For example, tyres contain a range of toxic materials, but these materials are tightly bound in a stable matrix (vulcanized rubber). The rate at which these toxic substances are released to the environment is in most circumstances very low. The rate depends on local environmental factors and the magnitude of any impact is dependent on the sensitivity of the receiving environment and the presence of plants, animals or humans that may be affected. All of these factors vary from one location to another, and therefore the impacts also vary (Commonwealth Department of Environment, 2001).

2.5.2 Environmental Concerns

Due to heavy metals and other pollutants in tyres there is a potential risk for the leaching (leachate) of toxins into the groundwater when placed in wet soils. This impact on the environment varies according to the Ph level and conditions of local water and soil.

Research has shown that very little leaching occurs when shredded tyres are used as light fill material, however limitations have been put on the use of this material; each site should be individually assessed determining if this product is appropriate for given conditions (Liu, Mead and Stacer, 1998). Incineration methods are becoming increasingly important from the view point of the need to minimize the environmental impact of waste tyre disposal. Combustion of waste tyre, one high ash coal and tyre-coal blends with 10, 30 and 50% waste tyre were investigated by means of thermo gravimetric analysis carried out at 20 K min−1 in the temperature range from ambient temperature to 1273 K. The results indicate that the combustion of waste tyre is controlled by the emission of volatile matter. Also as compared with the case of burning only high ash coal, the incorporation of waste tyre can improve the combustion characteristics of high ash coal, especially the ignition performance and the peak weight loss compared with the separate burning of waste tyre and coal. (Xiang , et al, 2006)

Experiments were designed to evaluate the feasibility of using discarded automotive tyres in conjunction with lime to remove aluminium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc from aqueous solutions. Continuous bench-scale studies showed that removals in excess of 99.5 per cent for most of the metals can be achieved by treatment with lime and discarded automobile tyres (Netzer, et al., 2003).

2.5.3 Potential Impacts of Uncontrolled Fires

Uncontrolled tyre fires have major environmental impacts on air, water and soil.

Air pollution

Some studies have confirmed that burning of tyre in medium size, such as using tyres in passenger car leads to spread about of 100ppm from lead oxides in addition to 26000ppm

from zinc and cadmium compounds and also many of toxic gases such as SOx, N2 and HCl (RESC, 2004).

Open burning of waste tyres are large sources of air pollution in many countries. On 15 August 2001, a tyre fire took place at the Pneu Lavoie Facility in Gatineau, Quebec, in which 4000 to 6000 new and recycled tyres were stored. Comprehensive gas chromatography–mass spectrometry (GC–MS) analyses were performed on the tyre fire samples to facilitate detailed chemical composition characterization of toxic polycyclic aromatic hydrocarbons (PAHs) and other organic compounds in samples. It is found that significant amounts of PAHs, particularly the high-ring-number PAHs, were generated during the fire. In total, 165 PAH compounds including 13 isomers of molecular weight (MW) 302, 10 isomers of MW 278, 10 isomers of MW 276, 7 isomers of MW 252, 7 isomers of MW 228, and 8 isomers of MW 216 PAHs were positively identified in the tyre fire wipe samples for the first time. Numerous S-, O-, and N-containing PAH compounds were also detected, and all these substances can be mutagenic (Lemieux, Lutes and Santoianni, 2003).

2.5.4 Water Pollution

Incomplete combustion of rubber leads to pyrolitic fragmentation followed by a recombination of the fragments of the various chemical compounds, some of which are liquids (of the aromatic, paraffin or naphtenic oil variety) carried by the water if water is used to put out the fire. The same is true of certain components of the combustion residues, such as zinc salts which always contain traces of cadmium and lead under these conditions. These substances can cause harm to flora and fauna. Experience shows that, for the most part, they are sufficiently diluted in the water used to extinguish the fire not to

cause harm to the aquatic environment. Otherwise, the water needs to be treated before it is disposed of (UNEP, 2008).

2.5.5 Soil Pollution

Residues that remain on the soil after a fire can have an impact in two different ways, i.e . immediate pollution caused by liquid decomposition products penetrating the soil, and gradual pollution caused by leaching of ash and other unburned residues. Both of them are caused mainly through rainfall and water infiltration at the site (UNEP, 2008).

2.5.6 Impact on Public Health

Emissions from an open tyre fire can represent significant, acute and chronic health hazards to fire-fighters and nearby residents. Unprotected exposure to the visible smoke plume can cause serious problems to the human aspiration system. Open tyre fire emissions are estimated to be 16 times more mutagenic than residential wood combustion in a fireplace. One of the key contaminants is benzene (NDDH, 2007).

According to the (RESC, 2004) the sources of open tyre fire resulting from human activates affect human as:

- Effervescing eyes, mucus membrane for reparatory system.
- Help on generating cancer cells.
- Decrease the range of vision and increase the teardrop of eyes.
- Big effects on plants life, where it causes the destruction of the texture of the plant Leaves and decreases the productivity of crops.
- Contribution in increasing the greenhouse effect phenomenon.
- Contributing in generation of acid rain.

Mosquito related diseases

It is well established that water pooled in tyres provides an ideal breeding ground for some types of mosquito. In overseas jurisdictions piles of whole tyres stored above ground have therefore proved to be of considerable concern. Mosquitoes are capable of carrying serious diseases that are known to breed in tyres. If establishment of a population occurred, above-ground tyre piles near urban centres would be a significant concern, as spraying them against mosquitoes is costly and ineffective (Sweet, 2004).

In August 2002, a new species of mosquito, previously unknown in Israel, was found in a tyre lot at Moshav Ginaton near Lod during routine monitoring operations by the Ministry of the Environment. The new mosquito was identified as the Asian tiger mosquito (Aedes albopictus), a species which lays its eggs in water-containing receptacle such as tyres. This mosquito is active during the day and is known for its painful bites. It is also associated with the transmission of dengue disease and other diseases. The spread of this mosquito from eastern Asia to other parts of the world is attributed to commerce in used tyres (Israel Ministry of the Environment, 2008).

2.6 Waste Tyres Management Process

Waste Tyres management attracts the attention of the scientists all over the world. In the absence of protective facilities, aggravated by weak regulatory and enforcement frameworks as well as inadequate regional cooperation, the problem of waste tyres will continue to be a serious developmental and environmental challenge in the Arab countries. To face this challenge, UNEP is striving towards the development of national and regional policies that integrate hazardous chemicals and wastes management including waste tyres management (Williams, and Shahzad, 2002).

When tyres have reached the end of their useful life and re-use as a part-worn tyre is not possible, the tyres enter a waste management system. The recovery and eventual final disposal should take place in an environmentally sound manner. This means that an appropriate collection system should take care of these tyres. In most cases the separately collected end-of-life tyres are still valuable for other applications and are not necessarily destined for land filling.

Based on UNEP (2002) the management of end-of-life tyres depends very much on local economic and industrial conditions including: product recycling, material recycling, energy recovery and landfill. The direct disposal of end-of-life tyres in landfills is to be used only where economically viable alternatives for the materials or energy recovery are not available. In some countries the land filling of end-of-life tyres is a prohibited storage.

2.6.1 Collection and Storage of Whole Tyres

Rules for the proper collection and storage of end-of-life tyres are obligatory in a number of countries, and those drawn up by the International Association of Fire Chiefs and the Scrap Tyre Management Council in the United States of America (IACSTMC), found in (UNEP, 2002).

Precautions must be taken against the deliberate or accidental igniting of tyre stock piles. The major risk is that a fire could gather pace without it being possible to prevent it from spreading to all of the tyres being stored. In such an eventuality, several different types of pollution of the air, water and soil can occur. Their scale will depend upon the quantity of the tyres being stored. Placing whole tyres in landfills (rather than quartering or shredding them) frequently causes practical difficulties. Whole tyres are very bulky for their mass. They also frequently trap gases and can slowly ‘float’ to the surface, these factors mean that placing whole tyres in landfills leads to the available space being filled up more

quickly, and the landfill potentially becoming unstable. As a result the landfill management is more difficult and costly (UNEP, 2002).

2.6.2 Retreaded Tyres

The term “retreading" refers to replacing the wearing surface of the tyre. Three different types of processes, i.e. top-capping, recapping and bead to bead are described (UNEP, 2008):

a) Re-topped tyres are those in which the tread is removed and replaced with a new arranged one.
b) Re-capped tyres also have their tread removed; however in this case the new tread used is larger than in the re-topped tyre, as it covers part of the tyre’s sidewalls.
c) Bead to bead tyres are those in which the tread is removed and the new one goes from the one side to the other, covering all of the lower part of the tyre, including the sidewalls.

An important criterion in tyre retreading is to control the number of times a tyre may be retreaded. According to United Nations regulations ECE 108 and ECE 109, which establish the requirements for approval of the production of retreaded tyres, automobile tyres may be retreaded just once, while truck tyres may be retreaded a limited number of times. In addition, the lifetime of an original tyre casing should be considered and must not exceed seven years (UNEP, 2008).

2.6.3 Land Filling and Stockpiling

Tyres can be efficiently used to prevent damage to the landfill cover, to avoid side-slope erosion, to protect drainage piping and to allow the regular flow of landfill percolating fluid and gases. Advantages of disposing of end-of-life tyres in landfills are low investment and running costs, the ease of management, and the possibility to use the end-of-life tyres for better landfill management.

Stockpiling facilities require investments in transport, handling and fire prevention. Stockpiling with proper control can be used only for temporary storage before an end-of-life tyres is forwarded to a recovery operation. As in the case of storage, the landfill site must be sealed off and managed to prevent malicious actions. To avoid any risk of fire, the following rules should be followed:

- Prevent any dumping of waste which represents a potential source of fire.
- Ban smoking or any activity which represents a fire risk.

The shape of the tyres and their elasticity necessitate certain precautions when they are being buried if instability or the creation of areas likely to help a fire spread, or serve as a haven for rodents or other pests (mosquitoes), are to be avoided (UNEP, 2002).

2.7 Options for End Use of Waste Tyres Management

There are several options for treating the waste tyres worldwide. The most common alternatives are retreading, recycling, energy production, land filling, and exporting. Table 2.4 shows the different options used in selected countries.

Table 2.4 Options for end use of waste tyres

	France 1996	**Germany 1996**	**Italy 1996**	**UK 1996**	**Belgium 1996**	**Netherlands 1996**	**Sweden 1996**	**US 1994**
Retreading	20.0%	17.5%	22.0%	**31.0%**	20.0%	**60%**	5.0%	0.0%
Recycleling	16.0%	11.5%	12.0%	16.0%	10.0%	12%	12.5%	28.0%
Energy	15.0%	**46.5%**	23.0%	27.0%	**30.0%**	28%	**64.0%**	**72.0%**
Landfill	**45%**	4.0%	**40%**	23.0%	5.0%	0.0%	5.0%	0.0%
Export	4.0%	16.0%	2.0%	2.5%	25.0%	0.0%	7.0%	0.0%
Others	0.0%	4.5%	1.0%	0.5%	10.0%	0.0%	6.5%	0.0%
Total	**1%**	**100.00%**	**100.00 %**	**100.00 %**	**100.00 %**	**100.00%**	**100.00 %**	**1%**

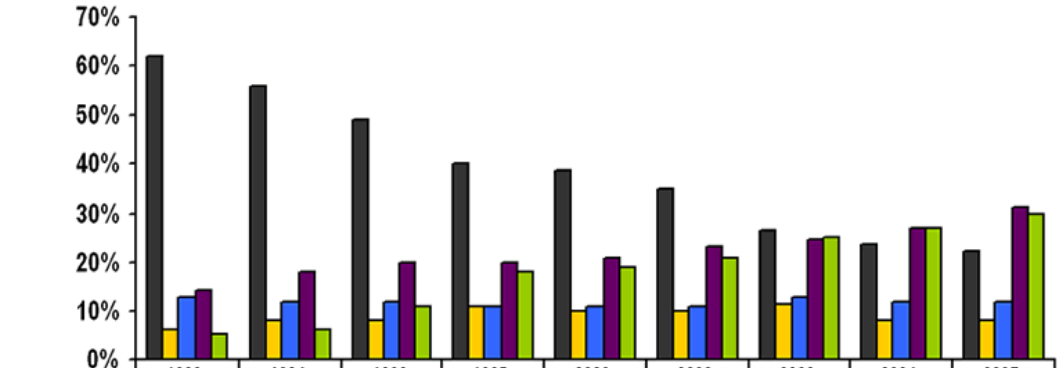
Source: Adhikari and Maiti (2000) found in Atech Group (2001).

It is obvious that retreading is the major industry in the UK and in the Netherlands. Energy production is one of the important options in Germany, Belgium, Sweden and USA. While disposing the used tyres in the land fills are the major option in France and Italy. Therefore

in the following section the study will review the related literature on the different options for managing the waste tyres.

2.7.1 Recycling of Waste Tyres

Recycled tyre materials are increasingly defined as a valuable commercial resource as well as a viable means of achieving sustainable growth and development. Recycling plays a significant role in meeting EU resource use objectives – reducing the use of energy and new materials. Current and potential users are re-evaluating the materials in comparison with more traditional ones – frequently discovering that it is significantly more economic, environmentally sound and efficient to recycle tyres than to attempt to duplicate the characteristics of virgin materials. The markets for these materials have grown exponentially in recent years because they have been shown to be the most appropriate and effective for a wide range of applications, while meeting or exceeding performance specifications. Recent research has helped to identify a broad spectrum of new products and applications that rely on the chemical and physical properties of recycled tyres (ETRA, 2004).



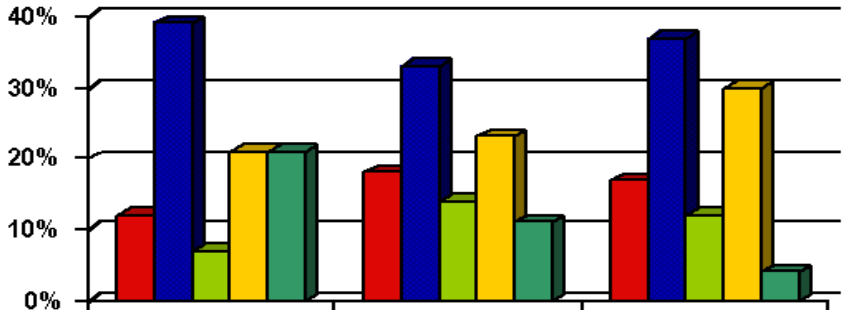
	1992	1994	1996	1998	2000	2002	2003	2004	2005
Landfill	62%	56%	49%	40%	39%	35%	26,4%	23,8%	22,0%
Reuse/export	6%	8%	8%	11%	10%	10%	11,4%	8%	8%
Retreading	13%	12%	12%	11%	11%	11%	12,6%	12%	12%
Energy	14%	18%	20%	20%	21%	23%	24,4%	27,1%	31%
Recycling	5%	6%	11%	18%	19%	21%	25,0%	27,1%	29,7%

Source: ETRA, 2004

Figure 2.3: The evolution of tyre recycling 1992-2005 in Europe

Tyre Recycling in the EU

In 2004 - 2005, European recyclers processed almost 1,000,000 tones of car and truck tyres – nearly one-third of the annual amount arising in the 25 States. Evolution of tyre recycling 1992 – 2005, illustrates the steady growth of recycling since 1992 when ±62% of tyres were land filled – and only 5% materially recycled, to 2005 when ±62% were either materially recycled or used for energy. During that period, the quantity of tyre arising and the catchments area also grew, from ±2 million tones in 12 States, to ±3.1 million tons in 25 States (ETRA, 2004). Due to the high cost of rubber (equal in cost per ounce to silver), starting in 1910 and continuing well into the 20th century, 50% of rubber content was recycled (ODNR, 2005). Several studies have been carried out to reuse scrap- tyres in a variety of rubber and plastic products, incineration for production of electricity, or as fuel for cement kilns, as well as in asphalt concrete (Siddique and Naik, 2004). The following sections illustrate recycling fields of waste tyres mainly in civil engineering fields.



	1992 - 1996	1996 - 2000	2000 - 2005
civil engineering	12%	18%	17%
sport/play surfaces	39%	33%	37%
construction	7%	14%	12%
products	21%	23%	30%
other	21%	11%	4%

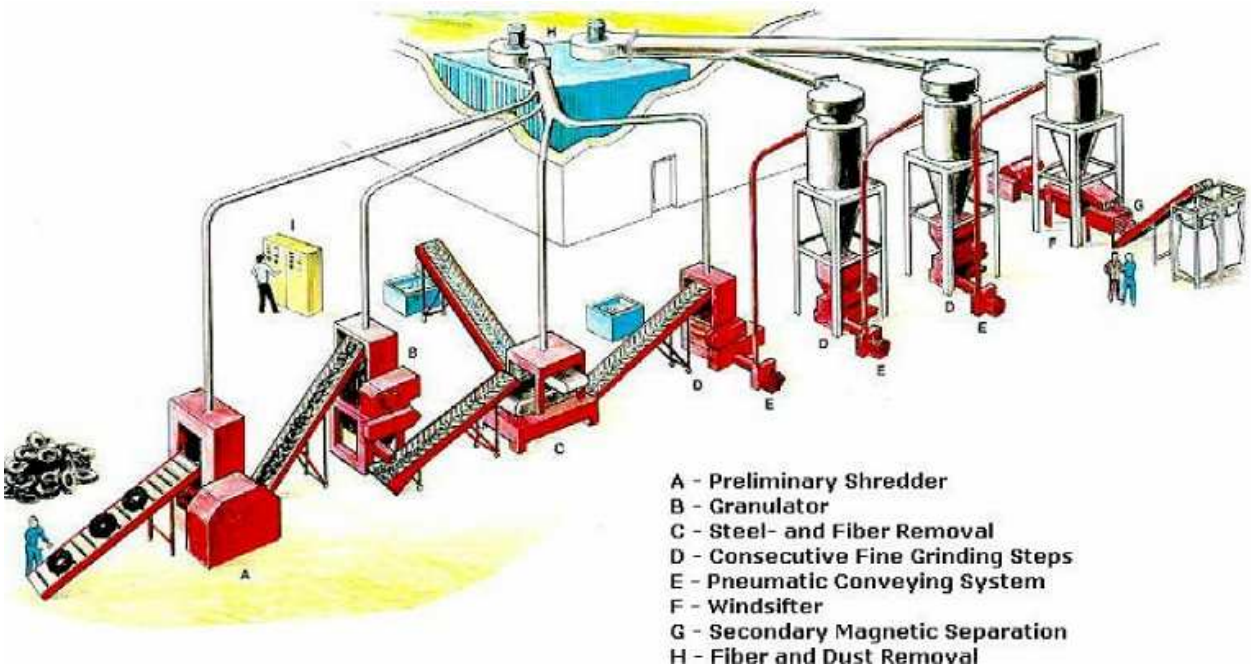
Source: ETRA, 2004

Figure 2.4: Material uses 1992 – 2005 in Europe

Figure (2.4) shows the ways in which material use has grown and shifted towards two principal market sectors. Today, a minimum of two-thirds of all recycled tyre materials are

used for some form of construction - including civil engineering, road and non-road construction, sports and play surfaces. Generally, civil engineering and construction applications use large materials, i.e., whole treated or untreated tyres, shred and chips. However, as road applications have become more prevalent, greater quantities of smaller sized materials are being used including granulate for road furniture, curbing, surrounds and parking areas – as well as powders for sealants and coatings (ETRA, 2004).

In order to recycle the waste tyres there are several approaches and systems. One of the famous system is the ambient scrap tyre processing. The process consists of eight steps as shown in Figure 2.3.



Source: UNEP, 2008

Figure 2.5 – Schematic of an Ambient Scrap Tire Processing Plant

Currently, there are studies being made to equip tyres with electronic chips called Radio Frequency Identification Device (RFID) that record information about their conditions of

use. If their efficiency can be proven, RFID may provide a means to identify the appropriate conditions for re-using used tyres (UNEP, 2008).

2.7.2 Recycling Methods

The following are the most common methods of recycling the waste tyres worldwide.

Recycling through retreading

Retreading involves either replacing only the tread section or replacing rubber over the whole outer surface of the tyre. Manufacturing a retread tyre for an average car takes 4.5 gallons less oil than the equivalent new tyre and for commercial vehicle tyres the saving is estimated to be about 15 gallons per tyre (Colway, 2008). Car tyres can only be retreaded once but truck tyres can be retreaded up to three times. Despite the improved quality of retreads, there has been a continuing decline in the passenger car retread market. While the truck retread UK market remained steady at about 1 million tyres in 2000, car retread fell by 800,000 to 2.2 million tyres (Colway, 2008). The emergence of the budget tyre, leading to the disappearance of the price differential previously enjoyed by retreads has been one cause. It isn't always possible to retread tyres, for example some imported tyres are of a quality which is unsuitable for retreading and 60% of replaced tyres in the UK have been subject to excessive wear beyond the (UK) 1.6mm tread depth limit, which then makes them unsuitable for retreading (Colway, 2008). The Retreaters Manufacturers Association (RMA) would like to see enforcement of the tread depth law and the raising of public awareness to the dangers of driving on illegal tyres as this would result in tyres being recovered from vehicles before they suffer too much damage.

Recycling through grinding

This process produces a range of crumb sizes through the progressive size reduction process with the energy used to break up tyres increasing as the particle size decreases.

Crumb is used in sports and play surfaces, brake linings, landscaping mulch, carpet underlay, absorbents for wastes and shoe soles. Crumb can also be recycled in road asphalt. Grinding is the most widespread materials recovery process in the UK. In 1999 it is estimated that 83,000 tonnes of tyre were granulated (Colway, 2008).

Recycling through cryogenic fragmentation

During cryogenic fragmentation, tyres are shredded and cooled to below minus 80 degrees C. A hammer mill then pounds the chips to separate the components. The resultant rubber granules can be used for athletics tracks, carpet underlay, playground surfaces and rubberised asphalt for road surfaces. The energy input required for such low temperatures is relatively high (UNEP, 2008).

Recycling through de-vulcanisation

Treating vulcanised rubber with heat or chemicals can produce devulcanised rubber, which can be used to replace part of the virgin material in automotive and cycle tyres, conveyor belts and footwear. However Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) has recently developed a process that alters the molecular bonding properties of the rubber and produces a material similar to PVC with a 50% recycled rubber content. Possible uses are for automotive components, building products, coatings, sealants and containers for hazardous waste (CSIRO, 2008).

Recycling through microwave technology

Advance Molecular Agitation Technology (AMAT) had developed a prototype using microwave technology. This breaks the tyres into their original components. The steel is of grade (A) quality and can therefore be sold for recovery, the carbon and oil are also reusable. The amount of emissions produced is minimal. The first commercial scale prototype has a capacity of 2,000 tones of tyres a year (Colway, 2008).

2.7.3 Reuse

Reuse in one of available options to minimize the environmental damaging impact of tyres wastes by reusing old tyres to establish children's playgrounds. Roads and Environment Safety Center (RESC) located in the West Bank implemented a demonstration project aiming at reuse the excessive waste accumulation of old car tyres "2000 old car tyres" to establish two children's playgrounds in Abu Qash and Kuffer AlDeak villages in West Bank.

Reuse in Landfills

A study by Warith, Evgin and Benson (2004) support the use of tyre chips as an alternative to crushed stone in the leachate collection system of a landfill. The study proved the suitability of shredded tyres or tyre chips for use in the leachate collection drainage layer of a municipal solid waste landfill was investigated in terms of the: (1) compressibility of the tyre chips and resulting limited changes in hydraulic conductivity under varying applied loads, and (2) limited effect of leachate pH on the shredded tyres compressibility and hydraulic conductivity behaviour.

Reuse in Modified Concrete Mixes

The use of crumb rubber and tyre chips in Portland cement concrete has been the subject of many research projects over the last years. (Christos, et al., 2006) studied the use of steel beads, a by-product of the tyre recycling process, in concrete mixtures. The experimental results indicate that although the compressive strength is reduced when steel beads are used, the toughness of the material greatly increases. Moreover, the workability of the mixtures fabricated was not significantly affected.

A research by Batayneh, Marie and Asi, (2007) focused on using crumb tyres as a replacement for a percentage of the local fine aggregates used in the concrete mixes in

Jordan. Different concrete specimens were prepared and tested in terms of uniaxial compression and splitting tension. The test results showed that even though the compressive strength is reduced when using the crumb tyres, it can meet the strength requirements of light weight concrete. (Michael, et al, 2004) studied the use of two types of waste tyre modified concrete experimentally. One was in the form of chips, or particles and the other was in the form of fibers. For the waste tyre chip modified concrete, surface treatment by saturated NaOH solution and physical anchorage by drilling a hole at the center of the chips were also investigated. For the waste tyre fiber modified concrete, fibers with various aspect ratios were utilized. A hybrid fiber reinforcement using waste tyre fiber and polypropylene (PP) fiber was also investigated. The effect of waste tyre resources (car tyres or truck tyres) on the strength and stiffness was evaluated. Accepted results in terms of compressive strength, compressive modulus of elasticity, Poisson's ratio, and split tensile strength tests were obtained. Study by (Siddique et al, 2004) confirmed the pervious results and reveled that workable rubberized concrete mixtures can be made with scrap-tyre rubber.

Reuse in Modified Asphalt Mixtures

The addition of recycled tyre rubber in asphalt mixtures using dry process could improve engineering properties of asphalt mixtures, and the rubber content has a significant effect on the performance of resistance to permanent deformation at high temperature and cracking at low temperature (Weidong, 2006). The decrease of the zinc stearate on the treated rubber surface explains the improvement in the adhesion of this material to the cement matrix, observed in a previous research (Segre, Monteiro1, and Sposito G. 2002). The promising results of this study are a starting point for future research on incorporating rubber particles into cement materials as a means of successfully utilizing the vast amounts of tyre waste currently in landfills.

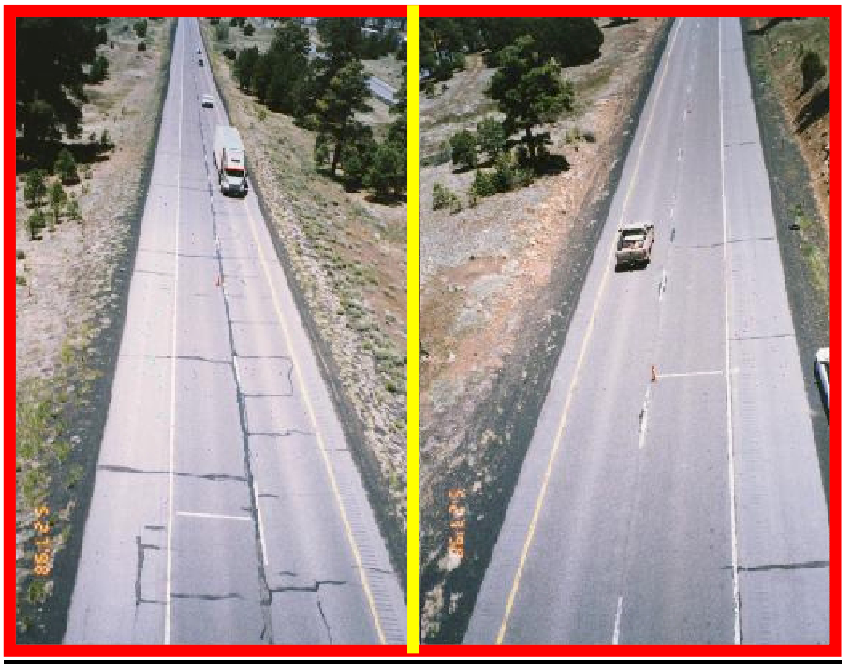


Figure 2.6 – Using recycled waste tyres in Modified Asphalt Mixture

Source: US Interstate 40 near Flagstaff, Arizona. 4" conventional asphalt (left) and 2" asphalt rubber overlays on Portland Concrete Cement placed in 1990, photo taken 1998.

Reuse in Backfilling for Retaining Walls

Cecich et al., 2002 examined using shredded tyres as a lightweight backfill material for retaining walls. When the author compared the overall cost for the retaining wall using shredded tyres with the retaining wall using sand, a substantial cost saving was realized by the use of shredded tyres. An increase in the factor of safety was also a result of using shredded tyres instead of sand as backfill. Hence, shredded tyres have a definite potential to be used as a backfill and cover material (Rubber Manufacturers Association, 2008).

Reuse in Preparing Activated Carbon

Activated carbons were prepared from waste tyres by gasification with steam and carbon dioxide and their characteristics were investigated. A two-stage activation procedure (pyrolysis at 800 °C in N2 atmosphere, followed by steam or carbon dioxide activation) was used for the production of activated samples (González, et al, 2005).

Although the prepared carbon had a larger micropore volume than the commercial carbon, it showed a slightly lower phenol adsorption capacity. On the other hand, the prepared

carbon showed an obviously larger dye adsorption capacity than the commercial carbon, because of its larger mesopore volume (Ariyadejwanich et al., 2002).

Reuse in Removal of Trace Metals from Wastewaters

Discarded automotive tyres, a solid waste disposal problem of enormous proportions, may provide the answer to another environmental headache—the removal of trace metals from wastewaters. Experiments were designed to evaluate the feasibility of using discarded automotive tyres in conjunction with lime to remove aluminum, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, silver and zinc from aqueous solutions. Continuous bench-scale studies showed that removals in excess of 99.5 % for most of the metals can be achieved by treatment with lime and discarded tyres (Netzer, et al., 2003).

2.7.4 Dispose the Waste Tyres in the Landfills

It is not desired to dispose the waste tyres at landfills due to their large volumes, 75% void space, which quickly consumes valuable space (Price, et al., 2006). Tyres can trap methane gases causing them to become buoyant, or 'bubble' to the surface. This 'bubbling' effect can damage landfill liner that has been installed to help keep landfill contaminants from polluting local surface and ground water (Liu, et al., 1998).

2.8 Policies and Regulations for Waste Tyres Management

A large number of policies used by United Nations Agencies, Canada, Mexico-USA and New Zealand considered internationally, and grouping them under headings for convenience has been identified:

2.8.1 Adoption of Basel Convention

Several key principles with respect to ESM of waste were articulated in the 1994 Framework Document on Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention (UNEP, 2008). To achieve

ESM of wastes, the Framework Document recommends that a number of legal, institutional and technical conditions (ESM criteria) be met, in particular that:

a) A regulatory and enforcement infrastructure ensures compliance with applicable regulations;

b) Sites or facilities are authorized and of an adequate standard of technology and pollution control to deal with hazardous wastes in the way proposed, in particular taking into account the level of technology and pollution control in the exporting country;

c) Operators of sites or facilities at which hazardous wastes are managed are required, as appropriate, to monitor the effects of those activities;

d) Appropriate action is taken in cases where monitoring gives indications that the management of hazardous wastes has resulted in unacceptable releases;

e) People involved in the management of hazardous wastes are capable and adequately trained in their capacity.

2.8.2 Broader Measures to Reduce Supply

The Canadian government started education, information, research and marketing strategies for waste tyres. It also established advisory bodies and encouraging the creation of advisory bodies by stakeholders. Several measures had been taken in Canada to improve tyre life (i.e. measures to improve tyre quality and education about matters such as correct inflation, enhance public transport options and improve the retread rate).

2.8.3 Enhanced Regulatory Requirements

In the year 1999 the Canadian government stared banning of whole tyres in landfills. It permitted only shredded (not quartered) tyres in landfills and published specific storage

standards for tyre mono-fills (Environment Canada, 2008). These sanders can be summarized in the three points:

- Limits on maximum number of tyres in any one-tyre pile site.
- Limits on maximum number of tyres on any one property.
- Storage requirements for outdoor tyre piles (security; shielding from public view; pile size limits; berms; fire control provisions; fire breaks).

2.8.4 Strengthened Compliance Mechanisms

In Canada the registration of all tyre collectors, shredders and tyre piles is an obligatory issue. This includes documentation of movement of tyres through 'supply chain'. Also accreditation of scrap pile operators and processors, heavy fines for illegal dumping, promulgation of industry standards for storage and making it compulsory for retailers to accept scrap tyres (take-back schemes).

2.8.5 Subsidization of Collection, Storage, or Transformation

New Zealand government had established tax credits, low-cost loans and central government grants to subsidize the collection, storage and transformation of the waste tyres. Therefore the New Zealand government subsidize the registered firms working at waste tyres by payment per tonne of tyres recycled and earmarked funds for site clean-ups (New Zealand Tyre Industry, 2003).

2.8.6 An Effective Monitoring

Registration and auditing of all sources of tyres one of the main features of the waste tyres management in New Zealand. There are around 600 retail tyre outlets in New Zealand (New Zealand Tyre Industry, 2003). These outlets are register accredited users only and kept as accurate destinations of all tyres bought and sold accrediting of all tyre collectors, processors and storage facilities. For the registration process to be effective, New Zealand

Environment Authorities enforce all users of tyres to be accredited to ensure that their use of tyres was acceptable otherwise rogue collectors/processors would be likely to emerge.

2.8.7 An Effective Policy

According to Environment Protection Agency in USA, (EPA, 2004) the U.S.-Mexico Border Scrap Tyre Integrated Management Initiative Border 2012 Waste Program. The U.S. and Mexico agree that implementation of the following five basic principles is necessary for proper management of scrap tyres in the U.S.-Mexico border region:

Action 1: Gather information to better understand scrap tyre .

Action 2: Consider federal, state, and local-level regulatory options to administer scrap tyre management programs.

Action 3: Encourage development and implementation of a variety of environmentally acceptable and economically promising end-use markets for scrap tyres to increase recycling and reuse

Action 4: Abate tyre piles by seeking funding to eliminate legacy scrap tyre piles ,and invest in and adequately manage temporary storage and transfer stations to facilitate recycling and/or reuse of scrap tyres.

Action 5: Establish and implement educational outreach programs on scrap tyre recycling and reuse opportunities geared towards a diverse audience of stakeholders.

2.9 Case Study of Waste Tyres Reuse Project in the West Bank, Palestine

In the West Bank, approximately one million waste tyres are generated annually (RESC, 2004). Waste tyres that are illegally dumped or improperly stored can pose a serious threat to public health and safety, as well as to the environment. The result can be urban blight

and significant costs to residents. Waste tyres can serve as a nesting area for pests and a breeding ground for mosquitoes which can spread encephalitis and other illnesses. Waste tyres can also catch fire and release toxic smoke. In the West Bank and Gaza there are no plans or action aiming to reduce or eliminate the accumulated waste tyres problem (RESC, 2004). Roads and Environment Safety Centre (RESC) has many experiences dealing with waste tyres, it has constructed more than 18 playing areas using waste tyres as playing models; three of these playing areas were funded by GEF. These playing areas are considered to be successful projects in finding short term solutions for waste tyres problem in West Bank and Gaza. This study supports GEF's strategies about "Climate change & non degradable Pollutants". Also Promote Dissemination of Accessible, sustainable, climate-friendly technologies and measures as one of the objectives. Therefore the RESC has initiated a project for tyre shredding in west bank. Tyres are first shredded, cut into chunks approximately 5 cm long. These tyre chips are often then fed through a series of granulators which reduce the chips further, often down to about 1 cm long.

The main goals of the project include:

- Answering the question on the feasibility of using the shredding process as a way of tyres reuse in Palestine.
- Minimize the problems resulting from accumulated waste tyres by shredding and reuse the waste tyres.
- Reduce the amount of waste going to landfill sites, this will reduce the hazards resulted from waste tyres.
- Help municipalities and industries deal with the problem of discarded tyres.

- Create new job opportunities for local community members in both recycling and shredding operations and tyres collecting. Also tyres crump will open new industries.
- Applying the shredded tyres as a safety layers under the playing tools instead of using sand and small crushed stones.

RESC started to construct a playground at Beit 'Ur near Ramallah. There are about 1500 children (age below 15) in Beit 'Ur, most of them are suffering from Israeli continuous siege, these children need necessary assistance in social, educational, vocational, psychological, and physical needs (See Figure 2.4). The aim of the project is to introduce the community to new concepts towards their own environment that will help them develop positive attitudes and better understanding through their own participation.

Source: RECS, 2004

Figure 2.7 – Photos for re-using waste tyres in the West bank

2.10 Concluding Remarks

The dangers of the waste tyres and their bad and damaging effect on the human and on the environment are not limited to random burning of the tyres but also to inefficient waste tyres management process. The complete and full analyses of the chemical composition of

waste tyres are well studied by several researchers worldwide. In addition to that the damaging effects of the chemicals that are contained in the waste tyres are also known, so probably but not certainly; further investigation is not essential to learn more about the chemical composition of the current different types of tyres. The more important is to assess the scale of the problem in our country and find a scientific integrated process for better tyres waste management that enabled the advanced treatment options such as reuse, recycle for better environment. The literature review revealed many alternative options for managing tyres waste which are known well in the developed countries, however, it is still needed to be implemented in Palestine and other Arab countries. Therefore we need a conceptual framework that study the whole process of the tyres waste management in order to help us in assessing and analysing the current situation of waste tyres in Gaza in order to proposes affordable and available options for better environment.

The next chapter will search for a conceptual framework that introduce an integrated approach on waste tyres management that consists of different elements and methods linked to each other aiming at developing a decision making process. The proposed framework may help the relevant institutions to identify the weak and strong points of our management process.

Chapter (3)

Conceptual Framework

3.1 Introduction

The issue of the tyres waste management process is extremely important due to the harmful impact of the irresponsible and wrong way of disposal of the tyres waste on human's life and environment. The issue of identification and management of tyres waste is not restricted or limited to a particular country; it is an international problem that is reflected by the Article 10 of the Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal (UNEP, 2002).

In spite of the deficiencies in the information available, the message from this chapter is quite clear. Waste tyres do constitute a 'problem' and there is a considerable room for improvement in the practices associated with waste tyres and expansion of the markets worldwide and uses of products derived from waste tyres. The problem is not directly due to the physical and chemical nature of waste tyres. Rather the problem arises from the failure to recover value from the resource to an adequate extent, as well as the high levels of inappropriate disposal which pose the greatest threats to the environment.

It is a prerequisite or an absolute requirement to achieve improvements in the availability and quality of data and periodic reporting as well as the existence of framework that identify clearly the process of waste tyres management in order to improve decision-making and policy development. Therefore this chapter will develop a conceptual framework that will help in assessing the current situation of the waste tyres and proposing the optimal process that could be implement able for Gaza waste tyres.

3.2 Integrated Tyres Waste Management

"Integrated tyres waste management" means the systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery, recycling, transfer and disposal of tyres waste (UNEP, 2008). The process can't be considered as an integrated process without enhancing rules and regulation, public awareness of the end users, financial resources, law enforcement, public compliance, and monitoring/evaluation system. Based on his understanding of the integrated tyres waste management process used worldwide the researcher has developed a conceptual framework for this study. Figure 3.1 illustrates the conceptual framework that the study will consider to assess the current situation of the tyres waste management in Gaza governorates.

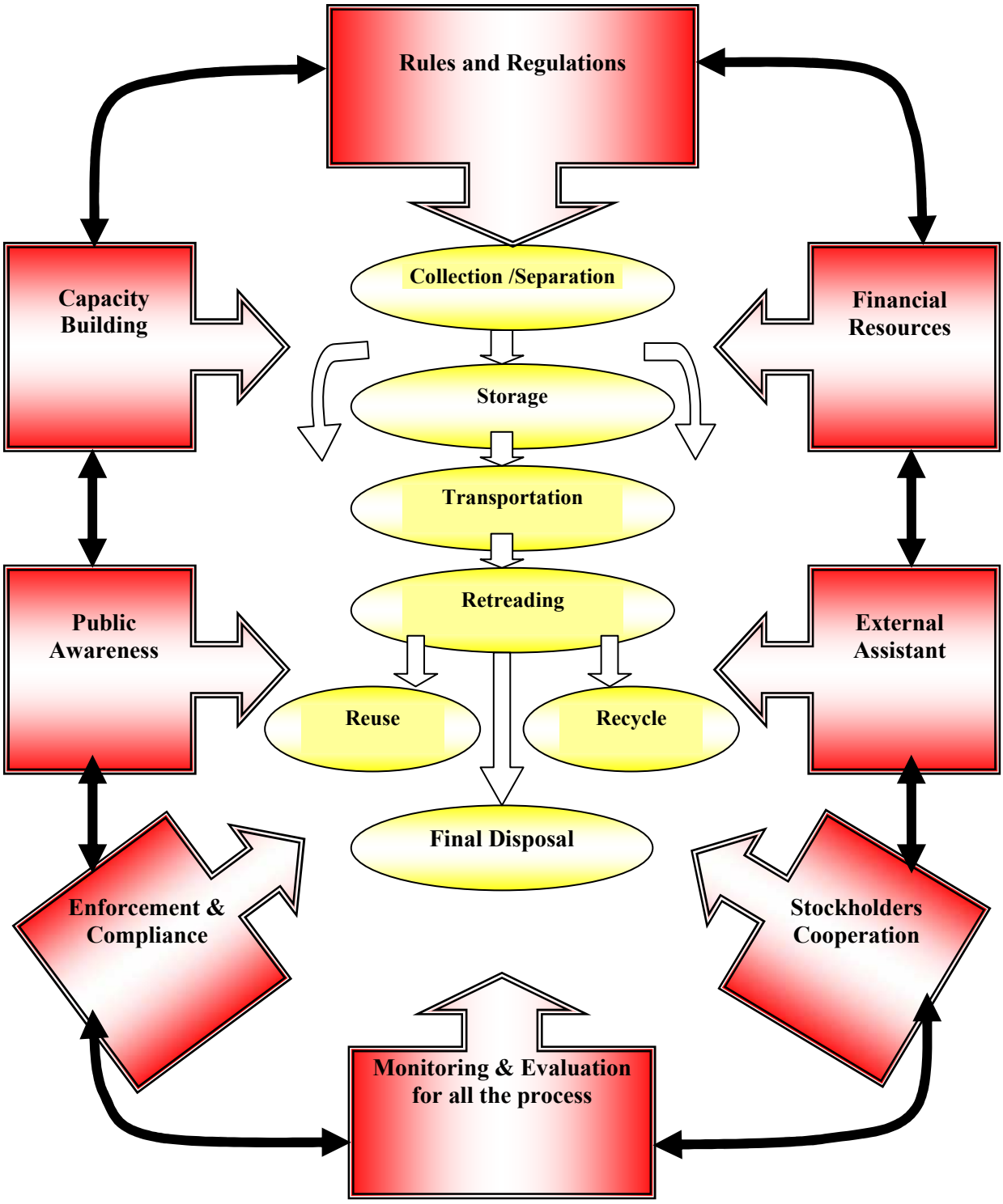
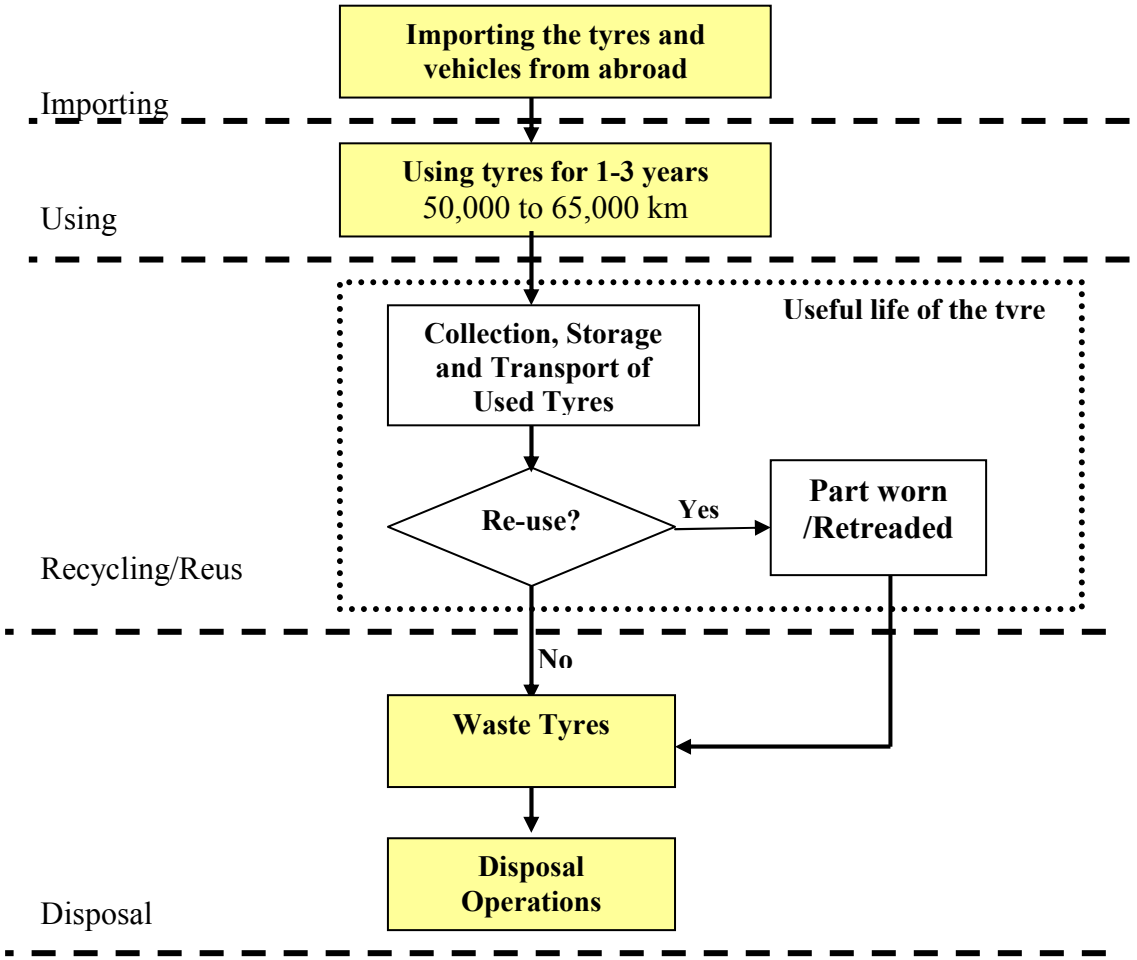


Figure 3.1: Conceptual framework for tyres waste management process

3.3 Conceptual framework Elements

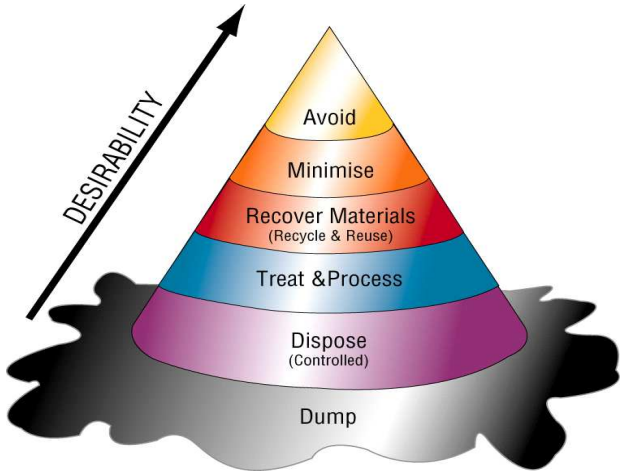
This section provides an overview of the conceptual framework elements that formulate the management process of the waste tyres. The term option in this section is reserved for activities under the general umbrella of policies, strategies and frameworks that might be considered by governments or industry to promote a greater uptake of certain practices. It is important to consider all of the above-mentioned options to ensure the optimal waste management approaches. For the purpose of this discussion the life cycle of waste tyres is as illustrated in Figure 3.2.



Source: Modified from UNEP, 2008

Figure 3.2: Stages in the Life of a tyre

A concept that has been adopted widely to assist in assessing and prioritising options for dealing with waste is the waste management hierarchy. The waste management hierarchy provides a framework within which different options for managing waste are listed in order of preference. A commonly used form of the waste management hierarchy is given in Figure 3.3. A hierarchy for managing the process of the tyres waste consists of six steps; avoiding large quantities of tyres waste, minimizing the tyres waste quantities, recovering materials by recycling and reusing the used tyres, treating and processing the used tyres, controlling the final disposal and dumping the unused parts of the tyre in controlled sites.



Source: Wilson (2001)

Figure 3.3 A hierarchy for managing the process of the tyres waste

Before assessing the current situation of the waste tyres, it is worthwhile to review the major activities that are an integral part of the management chain for a waste tyre to arrive at whatever end-point.

3.4 Waste Avoidance and Minimization

In the case of tyres, avoidance means reducing the rate at which waste tyres are generated. The means by which this can be achieved are to either reduce the distance travelled or extend the life of the tyre by decreasing the rate of wear. This could also include buying

tyres with a long tread life and providing tyre maintenance (proper pressure, alignment, rotation, etc.) to optimize tyre wear and life (Atech Group 2001).

3.5 Reducing the Distance Traveled

Other things being equal, the generation rate for waste tyres is determined by the distance travelled. There is considerable pressure to reduce the level of road traffic for reasons not primarily associated with the generation of waste tyres, such as the costs of infrastructure to provide capacity to meet peak demand and environmental impacts including the greenhouse effect. To a minor extent, changes to the type of vehicles can reduce the volume of waste associated with tyres or even the number of tyres. For example a small car tyre weigh less than a large car tyre and a B-double truck has 34 tyres and carries nearly twice the weight/volume of a standard semi-trailer which has 18 to 22 tyres.

3.6 Reducing the Rate of Wear

This includes replacing the wearing surface of the tyre by re-topped, re-capped and bead to bead tyres. It is beneficial to the environment from the perspective that it minimizes the generation of waste, because it increases the useful life of tyres, thereby postponing their final disposal. However, this reasoning is only valid if the tyre casings that serve as raw material for retreading are originated domestically. If imported, used tyres displace domestic suppliers of casings. Thus, tyres retreaded with imported casings will replace new tyres and tyres retreaded with domestically generated casings. Because tyres can only be retreaded a limited number of times, these imports can result in an increase in the overall volume of waste tyres the importing country will have to dispose of. The design wear life of a good quality passenger tyre is currently in the order of 50,000 to 65,000 km while the wear life of a truck tyre is considerably longer, in the order of 150,000 km for a drive wheel and longer for a trailer wheel (Atech Group, 2001). The expected life of tyres

has increased considerably over recent decades with the introduction of radial belted tyres and improvements in tyre manufacturing technology.

The life of road tyres should be considered in two separate parts:

- **The tread**, when this reaches the wear limit – 1.6mm for a passenger tyre – the tyre reaches the end of its 'first' life (Atech Group, 2001).

- **The casing,** a good casing can remain serviceable for a number of new treads.

A good car tyre casing has a life of between 100,000 to 200,000 km while a good truck casing has a life of 650,000 to 750,000 km. Generally, a car tyre can only be retreaded once, but truck tyres are routinely retreaded up to five times (Atech Group, 2001).

3.7 Collection, Transport and Storage

Collection, transport and (where appropriate) intermediate storage are very significant components in the management of waste tyres. Regardless of the ultimate fate of a waste tyre, arrangements have to be put in place for its collection and transport. The costs, difficulties and other factors associated with this part of the waste tyre chain have a direct bearing on the opportunities and viability for the various use, processing and disposal practices that may be considered (UNEP, 2002). It is also noted from the literature review that this stage of the waste management chain is perhaps the most critical in terms of the level of illegal or inappropriate disposal. It is worth observing at this point that not all waste tyres are 'generated' at tyre retail outlets. Operators of large fleets may obtain their tyres through wholesalers and make their own arrangements for the disposal of waste tyres generated by their operations. A fleet owner who contracts for the disposal of waste tyres directly with a tyre collector assumes much the same role as the tyre dealer in the more common situation. Conversely, a fleet owner who manages waste tyres directly become in

effect the tyre collector (in the case of disposal to a remote site) or receival facility (in the case of on-site management). In either case, it would appear that there are no special issues from a regulatory or policy point of view. However, the economies of scale and other considerations may open up opportunities for innovative management solutions. In any case, advice from the trucking industry is that the aggregate number of waste tyres managed directly by the tyre owner is likely to be small in relation to the totals for any country (UNEP, 2008).

Pick-up costs are largely independent of the ultimate fate of waste tyres, so are not likely to influence decisions as to which management practices to adopt. Transport costs, on the other hand, effectively define a catchment region for a particular waste tyre receival facility. The magnitude of transport costs for tyres generated outside the catchment preclude transport to the facility on a commercial basis, depending on the gate fee/payment at the receival facility. On the other hand, pickup and transport costs are usually quoted as one price, and market considerations may result in some cross subsidisation in cases where a contractor offers a discount to secure business.

3.8 Treatment of Waste Tyres

3.8.1 Reuse

Used tyres can be reused without further treatment from the following sources: as

UNEP, 2002 recommended.

- Tyres fitted to second-hand vehicles that are sold and from vehicles that are scrapped;
- Old (out of date) tyres that are used for less demanding applications such as on trailers;

- Tyres that are exchanged for reasons other than that the tyres have reached the end of their life, such as fitting a set of high performance tyres or different wheels.

It could be argued that these used tyres do not fit within the definition of waste since they will continue to be used for their original purpose (as a tyre) even though they are no longer on the original vehicle. The continued ability to meet their design function is determined by safety considerations and personal taste rather than waste reduction objectives. A major sink for worn tyres is used car sale-yards. The aggregate number of tyres involved is relatively small and the current informal arrangements deal with these tyres in a satisfactory way. It is considered that they do not warrant special waste policy attention.

3.8.2 Retreading

Of rather more importance than the direct reuse of partly worn tyres is retreading. Retreading is a general term that includes a range of technologies to replace the wearing surface of the tyre. Of all the beneficial uses of waste tyres, retreading has the potential to extract the greatest value. The process of retreading involves the removal of the residual tread (which has no further value in relation to the tyre function) while retaining the full value of the casing. Casings do not wear out due to friction, as with the tread, but are subject to fatigue, which ultimately renders the casing unserviceable, and also suffer from traumatic damage due to impacts. It is of interest to note that due to the smaller diameter a passenger tyre is subject to more deflections per unit of distance and will therefore suffer fatigue failure/damage at a greater rate than does a truck or bus casing. This is one of the reasons that truck tyres tend to be able to be retreaded more often than passenger tyres(UNEP, 2008).

3.8.3 Recycling

For tyres, recycling is the use of the materials in the waste tyres for different purposes, which may be, but are not necessarily, tyres themselves. It is the very characteristics of rubber that makes it so suitable for use in tyres (strength, flexibility, chemical stability and durability) that is the source of much of the difficulties in recycling waste tyres. Rubber is vulcanised during manufacture and this process is effective in making rubber relatively inert and difficult to bond or combine with other substances. For the purposes of this study the recycling practices have been structured along the lines of the preliminary process used to break the tyre down into an end or intermediate product. There is no particular objective basis for the approach adopted other than for convenience and other authors have adopted different structures (Wikipedia, 2008).

3.8.4 Energy Recovery

Tyres have a relatively high specific energy content (slightly higher, when the steel is removed, than coal), which makes them a valuable fuel source. Worldwide, energy recovery makes up one of the largest end uses of waste tyres, particularly in the US. Tests suggest that the use of waste tyres as a substitute for coal results in lower emissions of oxides of nitrogen and sulphur, as well as greenhouse gases. Concerns regarding dioxins and furans need to be addressed by attention to furnace design and operation.

3.8.5 Other Uses of the Whole Tyres

Whole tyres or tyres that are split or processed in some way have a wide variety of uses ranging from artificial reefs to water tanks. The current uses in Palestine and potential markets include:

- artificial reefs and breakwaters;

- erosion control and bank stabilisation;
- on farms as weights on plastic sheet over silage;
- as sound barriers and crash barriers;
- in engineered retaining walls; (Rubber Manufacturers Association, 2008).

3.8.6 Disposal in a Permitted Landfill

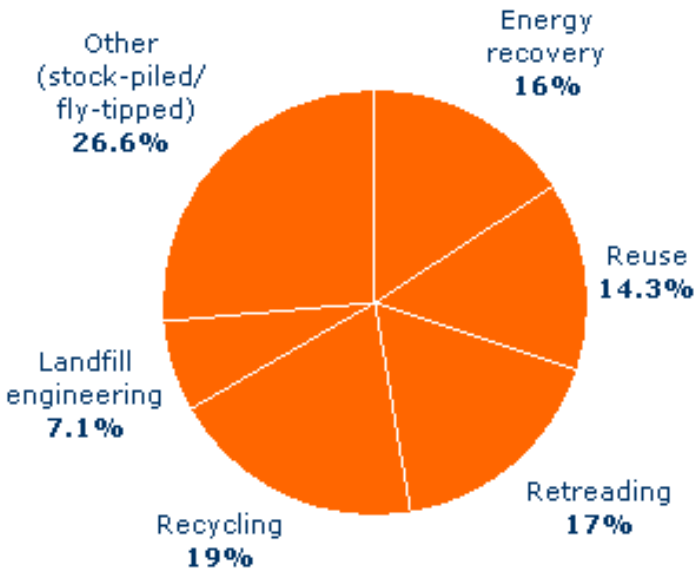
It is a less desired element in the strategy; however, it is preferred to stockpiling or dumping tyres. The concept of the waste management hierarchy should be considered as providing broad guidance only and the ordering above is not intended to convey a preference for individual waste tyre management practices. This study takes the position that decisions need to be made on the results of soundly based assessments of individual practices on a case by case basis taking into consideration option-specific factors. Some of the issues that may need to be considered have been discussed in Section 6.

Currently, by far the most widely used practice is disposal to landfill (as well as illegal dumping), followed by retreading (which can be considered a form of reuse) and waste to energy. Aside from disposal, waste to energy is the only option that provides an immediate large-scale solution.

3.9 Conclusion Remarks

From this chapter it is noted that the conceptual framework for waste tyres management has several elements that any assessment should take into consideration. It is worth highlighting that a combination of several options is being used in many countries. The clear example of tyres waste management exists in the United Kingdom where only 9.1%

of tyres waste are being disposed to the landfills while the bulk amount (19%) of tyres waste are recycled. Figure 3.4 shows the current disposal methods in the UK.



Source: Used tyre working group-UK, 2001

Figure 3.4: Disposal Routes for Tyres

The following chapter will focus on the methodology of assessing the current situation of waste tyres that exists in Gaza taking into consideration the above-motioned conceptual framework that paved the road in front of designing the topics of the field survey as the major component of this study.

Chapter (4)

Methodology

4.1 Introduction

Due to the absence of an efficient large industry in Gaza Governorates and due to the lack of scientific research centres, the current study will stay away from practical experiments. To achieve the research objectives, only a theoretical study will be conducted to assess the tyres disposal process. Within the domain of the possibilities, and the facilities available in Gaza.

To implement this study, the researcher followed the proper steps of the methodology mentioned in the thesis preparing guideline in Al-Quds University, which includes the study design, the study sample, the study instrument, pilot study, data collection, and data processing and analysis.

A pilot study was carried out on a sample of 10 of the owners of tyres repair-shops in Gaza city who have been selected randomly, the methodology of the study is based on the following:

1) Carrying out a questionnaire targeting all the owners of tyres repair-shops in all Gaza Governorates to investigate the management process of waste tyres. This questionnaire will give indication about the current process towards the disposal of the waste tyres issue.
2) Interviewing 16 officials working in the field of solid waste management in Gaza as follows: five key officials from the 4 relevant ministries (Ministry of Health, Ministry of Transportation, Ministry of Economy, and Environment Quality Authority) and eight other officials from 5

municipalities will be interviewed (Gaza, KhanYunis, Rafah, Dair El-Balah, Jabalia), also three key persons from different Councils for Solid Waste managment in Gaza Governorates.

4.2.1 The Study Design & Sample Size

In order to implement the study, this descriptive design has follow the current geographical distribution of Gaza Governorates; which consists of five governorates (Gaza, KhanYunis, Rafah, Middle and the North Gaza). All of the 124 owners of the tyres repair-shops were interviewed, in addition to, interviewing sixteen officials from relevant institutions.

4.2.2 Sampling Method

All the repair-shop owners working in the five Gaza Governorates were interviewed to answer the questionnaire.

4.3 Setting of the Study

The study was implemented in the Gaza Governorates and has cover all of the five governorates.

4.4 Study Population

All the target groups were the sample under study i.e.(tyres repair shops owners) and other key officials from relevant municipalities (Gaza , Khan-Yunis , Rafah ,Dair El Balah ,Jabalia), and 4 ministries (Health, Transportation, , and Environment Quality Authority). Such as this sample is enough and convenient to emphasise the problem and to enable us to suggest possible solutions and produce useful recommendations.

4.5 Study Instrument

The official language in Gaza Strip is the Arabic language, so due to English language difficulties the questionnaire was designed in Arabic language. To ensure clear and accurate results, simple and direct and unambiguous questions were provided to the participants in the questionnaire, so a questionnaire in Arabic was designed to accomplish the objectives of this research;. two types of questionnaires targeting the owners of the tyres repair-shops and professionals working at relevant local institutions. To assess the current situation of waste tyres management process in the Gaza strip, the questionnaire consists of five parts: personal data, collection of waste tyres, transportation, treatment, monitoring and awareness, and that targeting the professionals consists of tow parts, the disposal methods and administrative and legal system (See Annexes 3 and 4).

4.6 Ethical Consideration

During the conduction of the study the ethical consideration was strongly considered.
This included the obtaining of the ethical approval from Helsinki committee (Annexes 5).
Written acceptance from the participants is essential before the start of the study; however an oral permission is acceptable. A previous notice was sent to some of target group when an interview is required. Also the researcher gave a short introduction about the research and its objectives. Insure confidentiality, mention the right to stop or withdraw, to consider the consequence of the information and to make sure not to harm the informant.

4.7 Eligibility Criteria

The participants who answered the questionnaire of this study were selected on the basis of their current involvement in the field of tyres market for a period of at least 12 months from the date of the field research.

4.8 Piloting

For the purpose of ensuring validity and reliability of instruments, the researcher distributed the questionnaire to experts in environmental and public health sciences for their comments (Annex 1).

The researcher made a pilot study before starting data collection which was considered as pre-test using a sample of ten owners of tyres repair shops who were selected randomly from Gaza city and officials from the municipality of Gaza. They were asked to participate in filling the questionnaire to identify any problem in the design. The result were useful in estimating the construction of the questionnaire validity and suitability of the questionnaires as well as areas that need modification.

4.9 Data Collection

The major method of data collection was based on carrying out surveys and questionnaires. The field survey was conducted in the period of April-May 2008. On the other hand the time for answering the questionnaire was not be longer than 20 minutes to avoid disturbing the participants.

4.10 Statistical Analysis

Quantitative statistical analysis of the date was conducted by using the Statistical Package for Social Sciences (SPSS), by defining and coding variables, entering data, cleaning data, frequency tables for variables, cross tabulation for results, and finally, the statistical tests of significance were used. The results were accepted as statistically significant when the P-value was less than 5%($P<0.05$).

4.11 Limitations of the Study

In addition to the unstable political and economical situation in Gaza, some obstacles had faced the researcher during carrying out the study including:

- The misunderstanding of the target group to the researcher objectives.
- Some of the target group did not cooperate with the researcher.
- Some of the target groups gave false answers to avoid any consequences of the project results.
- Lack of resources i.e. references, previous studies in Palestine and in neighbouring countries related to this research topic.

Chapter (5)

The results

5.1 Introduction

This chapter presents the results of the field investigation including descriptive analysis of the data gathered from two types of questionnaires that targeted the owners of the tyres repair-shops and professionals working at relevant local institutions. The total sample was 101 owners of tyres' repair-workshops and sixteen professionals from different ministries and municipalities including six officials from the relevant ministries, three from solid waste councils and seven officials from selected municipalities. The results will mainly focus on the geographical distribution of the tyres repair-shops, the general characteristics of the owners of the repair-shops, the current collection methods, the storage, transportation, reuse, recycling and the final disposal of the waste tyres.

5.2 Geographical Distribution of the Study Sample

Based on PCBS, 2007, there are 124 tyres repair shops in Gaza Governorates. During the field survey the researcher questioned 101 shops. Only 6 shops did not cooperate with the researcher and refused to answer the research questionnaires. Hence, there are 23 repair shops who did not participate in this research. These shops either they are in unreachable areas or they are currently closed and no more existed. Therefore the total sample of this research is 82% of the owners of tyres repair-shops with a response rate of 94% of the questionnaires. Figure 5.1 shows the geographical distribution of the owners of the tyres repair-shops.

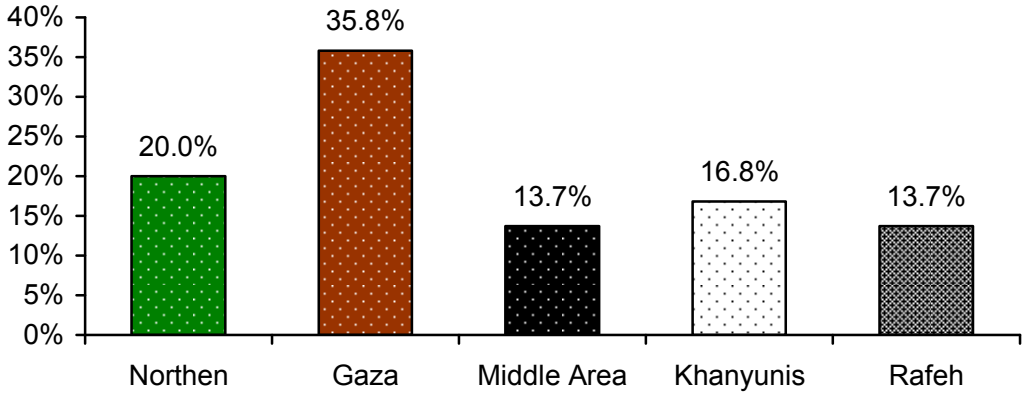


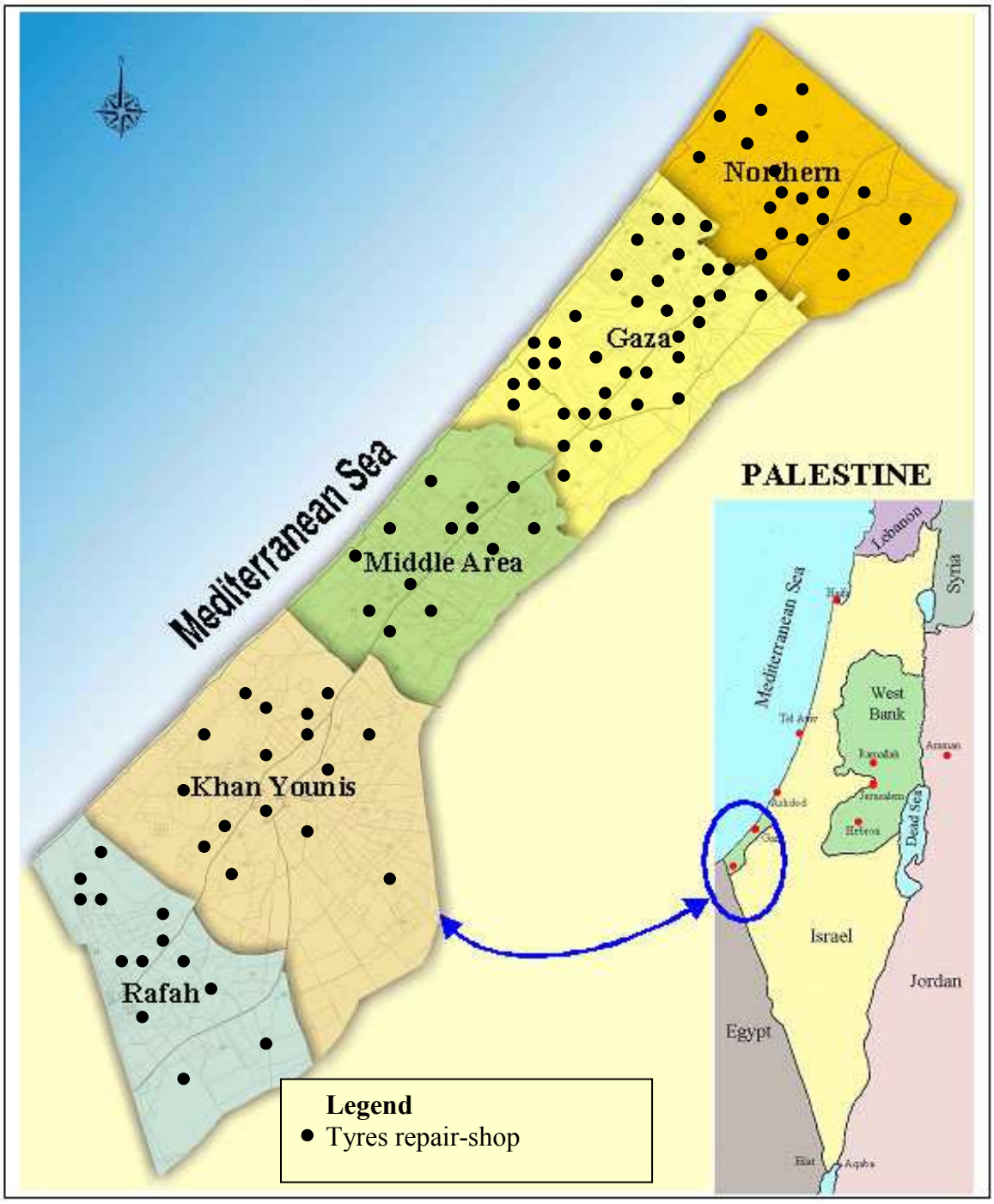
Figure 5.1: The Geographical Distribution of Studied Tyres Repair-Shops

Source: Researcher's field survey conducted in April 2008.

The field survey showed that the majority of the tyres repair-shops (55.8%) are located in both Gaza and North Gaza Governorates. Only 13 shops are located in Middle Governorate mainly in Dair El-Balah city. Most of these repair shops are in Gaza and KhanYounis cities and located on both sides of the regional road of Salah El-Deen Street. The repair-shop in North and Rafah Governorates are mostly located in the centre of the cities and refugee camps (see Figure 5.1). In addition to the owners of the repair-shops the researcher interviewed sixteen officials from different relevant institutions distributed geography as shown in the following table:

Table 5.1: Responsible People From Ministries and Municipalities.

Governorate	Number of interviewed officials	Institutions
North Gaza	2	▪ North Gaza Governorate ▪ Council for Solid Waste
Gaza	8	▪ Gaza Municipality ▪ EQA ▪ Ministry of Health ▪ Ministry of Economy ▪ Ministry of Transportation
Middle Area	2	▪ Middle area council for solid waste ▪ Dair El-Balah municipality
Khan Younis	2	▪ KhanYounis Council for Solid Waste ▪ KhanYounis Municipality
Rafah	2	▪ Rafah Municipality ▪ EQA
Total	**16**	



(Source: Base map from MOPIC, 2001)

Figure 5.1: The Geographical Distribution of the Tyres Repair-Shops

5.3 General Characteristics of the Interviewed Persons

The following sections will illustrate the general characteristics and conditions of the owners and their shops in respect to their education, number of workers, sources of licenses and daily working hours in each repair-shop and also the characteristics of the interviewed officials from diferent ministries and municipalities regarding tyres waste disposal process and their knowledge in this field.

5.3.1 Educational Level of the Interviewed Persons

The majority of the interviewed the owners of the tyres repair-shops have less than secondary educational levels. The owners with secondary educational level represented approximately (36.8%) of the total sample followed by low and preliminary educational level (about 33.7%). It is found that (8.4%) of the interviewed owners had university education. Figure 5.2 shows the educational levels among the interviewed owners of tyres repair shops.

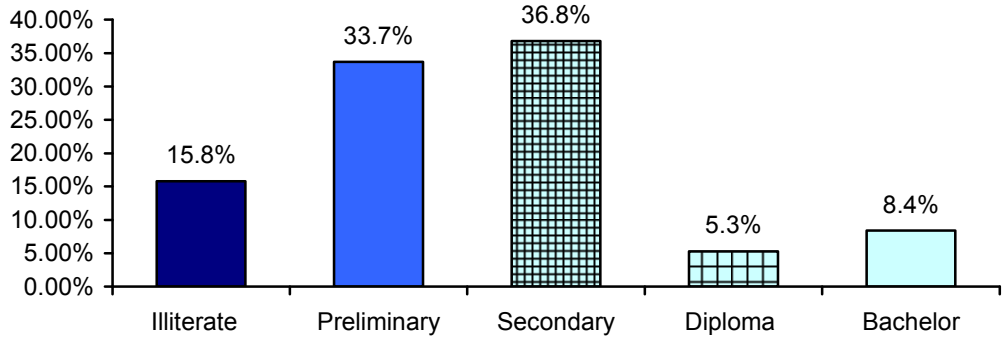


Figure 5.2: The Educational Level of the Owners of the Tyres Repair-Shops

The educational background of the sixteenth interviewed professionals showed that the majority of respondents 12 persons have bachelor degree (75.0%) and three of them have master degree (18.8%) while one person have a diploma (6.3%) from the total respondents.

This indicates that there are high levels of educational backgrounds among the interviewed professionals.

5.3.2 Working Experience of the Repair Workshops' Owners

Figure 5.3 illustrates the working experience of the respondents among the owners of repair-workshops. It was found that 66.3% have been in the business for around 6 to 19 years. Only 20% of the owners spent more than 20 years in the field of tyres repairing.

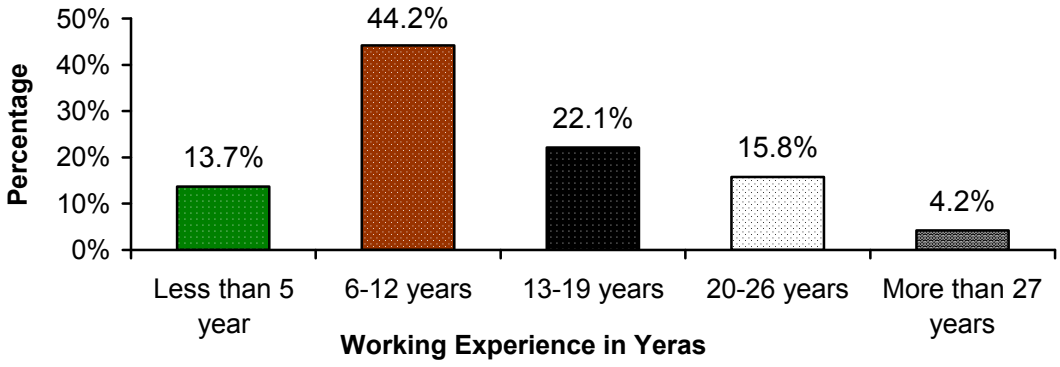


Figure 5.3: Distribution of Study Population by Experience in General

5.3.3 Tyres Traders and Importers

Figure (5.4) below illustrates the percentages of importers of tyres from abroad to Gaza Governorates and the local traders among the interviewed repair-shops owners. There are only 9 importers of the tyres among all respondents and all of them deal with daily tyres' changes and repair. Most of the interviewed owners (95%) are local traders who are buying the new tyres from the importers and selling them to the vehicles owners.

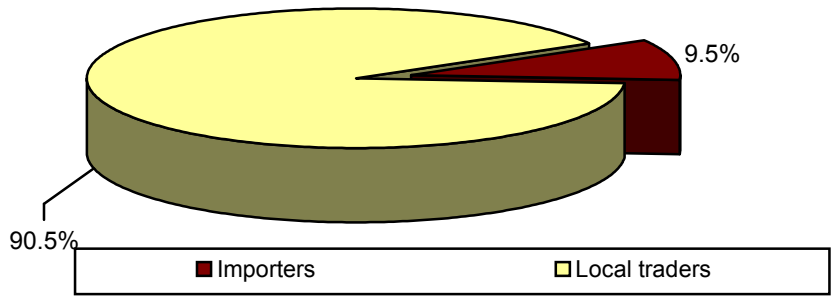


Figure 5.4: Importers and Local Traders Among the Owners of Tyres Repair-Shops

5.3.4 Number of Workers in the Existing Tyres Repair-Shops

The majority of the cases are employing one to two workers, which represents around (56.8%) of the total sample. The second category has three to four workers representing around (36.8%), while only 6.4% of the tyres repair-shops have more than five workers. Figure (5.5) shows the distribution of study population by number of workers.

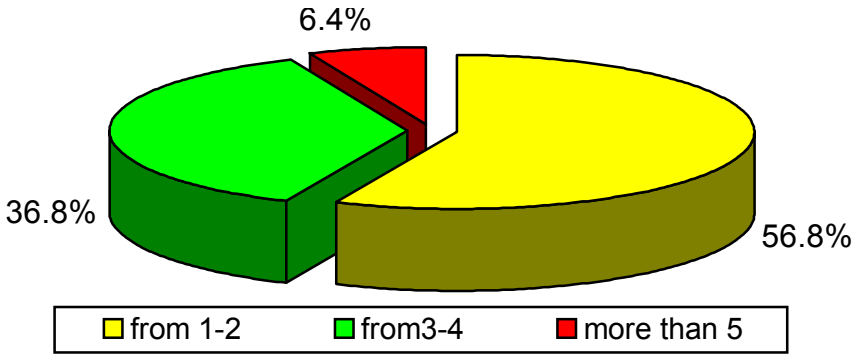


Figure 5.5: Number of Worker at the Tyres Repair-Shops

5.3.5 Number of Daily Working Hours at the Tyres Repair-Workshops

Most of Gaza Governorates tyres repair-shops work six days a week with more than twelve hours per day. Figure (5.6) shows the number of daily working hours at the tyres repair-workshops only 13.7% work less than 10 hours a day while 67.4% work from 12 to 14 houres .

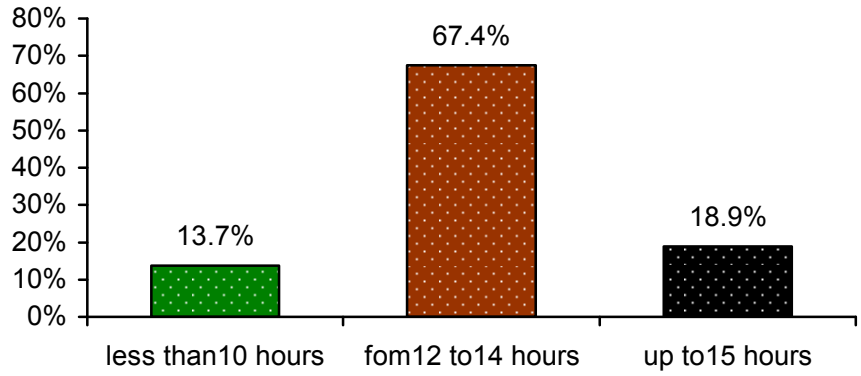


Figure 5.6: Distribution of Study Population by Daily Work Hours

5.3.6 Source of Licensing for the Tyres Repair-Workshops

The majority of the existing repair-shops have licenses from the Municipality where the shop exists. Municipal records showed that 70 repair-shops have licenses from the municipal license departments. This figure is consistent with the figure found in the field survey. Also the ministry of transportation issued about 65 licenses for tyres repair-shops. The following table shows the distribution of the licensed repair-shops in the different municipalities.

Table 5.2: Number of Licensed Tyres Repair-Shops

Municipality	**No. of licensed workshop**
Gaza Municipality	26
Jabalia Municipality	12
Dair-El-Balah Municipality	6
KhanYouniss Municipality	15
Rafah Municipality	7
Other Municipalities and Village Councils	4
Total	70

Source: Unpublished records from different Municipalities of Gaza Governorates, 2008

Table (5.3) shows that the majority of cases have got the working licenses from both the municipalities and MOT (55.8%) while (17.9%) have licenses from municipalities only. In Gaza Governorates 26.3% of tyres repair-workshops do not have any kind of licenses or permits for working.

Table 5.3: Distribution of Study Population by Source of License

source of license	Number of repair-shop	Percent
Municipality	17	17.9%
MOT and Municipality	53	55.8%
With No license	25	26.3%
Total	**95**	**100.0%**

5.3.7 Pre-Conditions for Issuing the Working License for the Tyres Repair-Workshops

The Ministry of Transportation and the Municipalities are the main institutions issuing the working licenses for the tyres repair-shops in Gaza Governorates. There is a list of pre-conditions in these institutions to license the establishment of any tyres repair-shop. These conditions are:

- Suitable location based on traffic circulation and accessibility without any violation to the pedestrian pathways.
- Suitability of the floor area that should not be less than 80 square meters.
- Approval of the neighbourhoods that surround the proposed repair-shop site.
- Approval of the civil defence department based on safety measures.
- Provision of the first aide kits before establishment of the repair-shop.
- Evidence on health insurances for all workers.
- Approval from the environmental health department in the relevant Municipality.

- Commitment from the owner to follow any other conditions that could be proposed by the municipality in the future.

The field survey examined whether the owners of the workshop have the knowledge about these conditions or not. The results from table (5.4) below describe if there are pre-conditions of issuing working licenses for tyres repair shops or not. Around 80% of the respondents confirmed that there are pre-conditions for issuing the working license, while 20.0% have no idea about any pre-conditions for working license in this field.

Table 5.4: Knowledge About Pre-conditions for Issuing the License

Category	Number of respondents	Percent
Have knowledge about the license pre-conditions	76	80.0%
Have no idea about the pre-conditions	19	20.0%
Total	**95**	**100.00%**

Among the pre-conditions mentioned-above the researcher did not find any condition regarding the tyres waste disposal obligations. Therefore the questionnaires verify this point from the repair-shops owners' perspectives as shown in the following table:

Table 5.5: Knowledge of the Working Pre-conditions

Category	Number of respondents	Percentage
There are obligations for tyres waste disposal	0	0%
There are no obligations for tyres waste disposal	76	80.0%
Have no ideas about any obligations for tyres waste disposal	19	20.0%
Total	**95**	**100%**

Around 80% of the repair-shop owners declared that there are no pre-conditions for the tyres final disposal that should be taken into their consideration. The rest of the

respondents (20%) have no idea whether there are any pre-conditions for final disposal or not. Similar answers had been given by the professionals at the relevant institutions.

5.4 Tyres Waste Management Process

Based on the conceptual framework in chapter three, the researcher investigated the current tyres waste disposal process in Gaza Governorates. The preliminary investigations of the waste tyres management process in Gaza showed that there are limited collection, separation, storage, transportation, recycling/reuse and final disposal. The detailed investigation is illustrated in the following section.

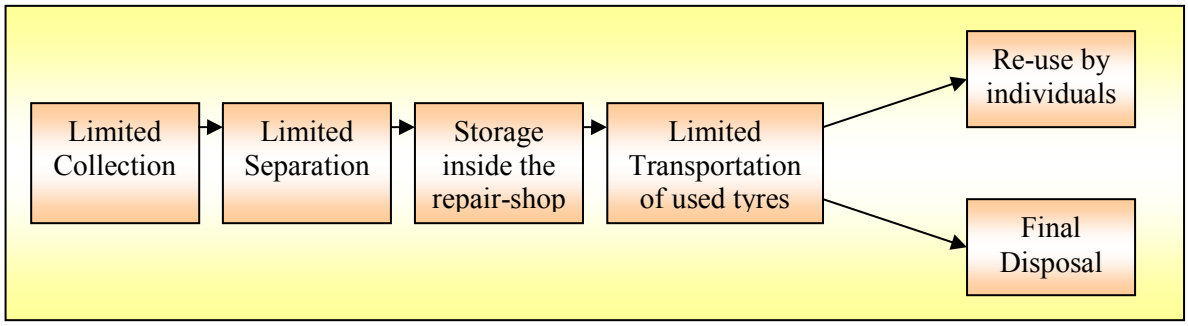


Figure 5.7: Preliminary Investigation of Tyres Waste Management Process in Gaza

5.4.1 Number of Used Tyres Collected by the Tyres Repair Workshops

The two figures below highlight the number of daily collection of used tyres and its distribution by each governorate.

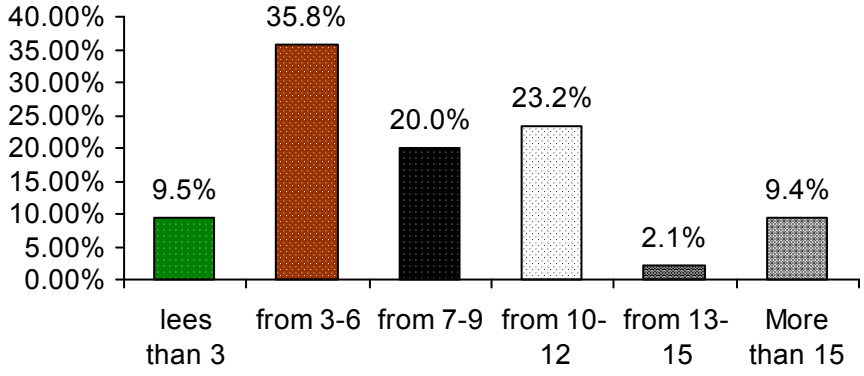


Figure 5.8: Distribution of study population by daily tyre change

The result from the above figure shows that highest frequency of the daily collection of used tyres is about 35.8% of the total number of surveyed repair-shops collected from 3-6 used tyres/day. The second group who collected from 10-12 tyres/day is about (23.2%), while (9.4%) collect more than 15 tyres per day. The mean of daily collected tyres was 8.46 tyres/day with a standard deviation (SD) of 5.4.

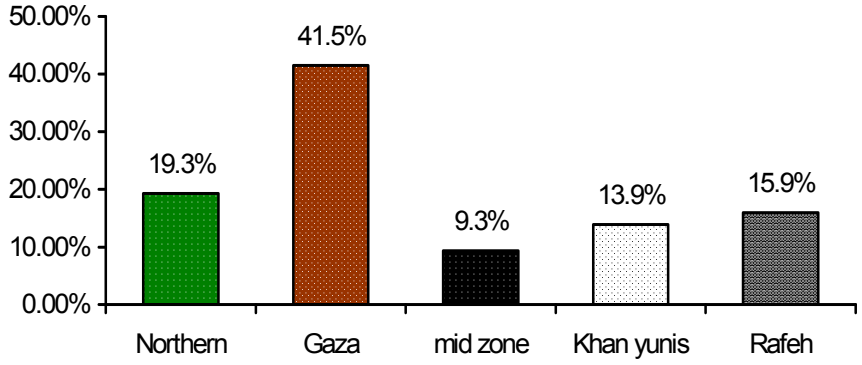


Figure 5.9: Number of Daily Tyre Change by Governorate

Table (5.6) shows the distribution of daily changed tyres in Gaza Governorates. The largest number of changed tyres was found in Gaza city where 334 tyres were being changed every working day; about 41.5% of the total changed tyres in the whole Gaza governorates. The lowest number was found in the Middle area where only 75 tyres were being changed every working day, around 9.33% of the total.

Table 5.6: Number of Daily Changed Tyres

Governorate	**Number of daily changed used tyres by new ones**	**Percent**
North Gaza	155	19.3%
Gaza	334	41.54%
Middle Area	75	9.33%
KhanYounis	112	13.93%
Rafah	128	15.9%
Total	**804**	**100.00%**

If we assume that the tyres repair-shops work around 311 days per year, then, there are around 250,000 tyres are being changed by new ones in the year 2007 and are considered as waste tyres.

Figure (5.10) shows the distribution of drivers tendency to buy tyre according to quality or cost. The majority of cases tend to buy tyre according to the cost (60.0%) while (9.5%) according to quality and (30.5%) of the total interviewed said that drivers prefer to buy tyre according to quality and cost.

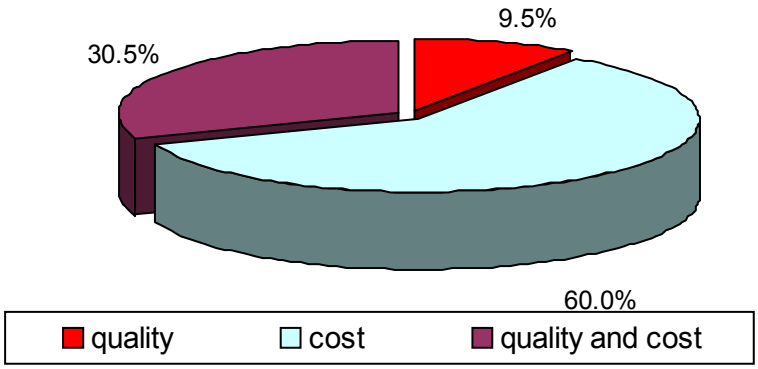


Figure 5.10: Replacing the Used Tyres by New Ones According to Quality and/or Cost.

The research examined the knowledge of tyres waste collection activities with the officials working with solid waste management, mainly the municipal officials. Table 5.7 shows that the majority of the officials mentioned that there are no collection activities taking place to collect the tyres waste from the repair-shops.

Table 5.7: Tyres Waste Collection from the Official Point of View

Answer	Number of respondents	Percentage
Yes, There is a collection of tyres waste	3	18.7%
No, there is no collection of tyres waste	9	56.3%
Have no idea whether there is collection or not	4	25.0%
Total	16	100%

5.4.2 The Current System for Collection and Separation of the Used Tyres

It is obvious from figure (5.11) that the majority of the owners of the repair-shops have no system of collection and separation of the used tyres inside their repair-shops according to the tyre's size.

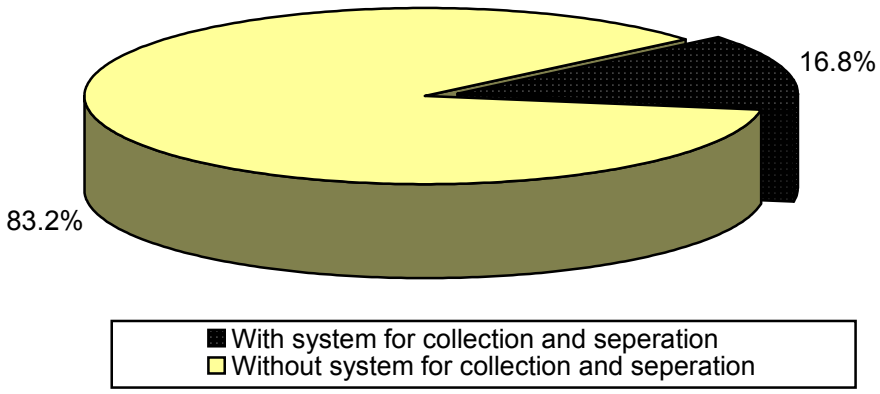


Figure 5.11: Separation According to the Tyre Waste Size

All respondents confirmed that the individuals are the most interested people in the collection of tyres waste, and there is no cooperation with any relevant institution in the collection process.

5.4.3 Storage for Waste Tyres

Figure (5.12) below shows that there are only 19% of the repair-shops with a safe storage place for the waste tyres. The majority of them had not designated any space for storing the used tyres.

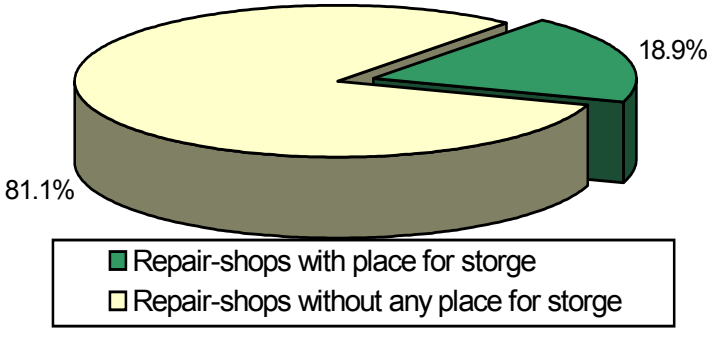


Figure 5.12: Storage of the Tyres Waste

The research examined the correlation between education levels of the repair-shops owners and the existence of safe storage for tyres waste:

Table (5.8) shows a cross tabulation technique with Chi-square test to explore if there is a correlation with significant difference between education levels and safe storage of the tyres waste in the workplace.

Table 5.8: Relationship Between Education Levels and Safe Storage of Tyres Waste

Variables		**Is the storage in a safety place**						**Total**		**Chi Square**	**P-Value**
		Yes		**No**		**don't know**					
		N	%	N	%	N	%	N	%		
Educational levels of the repair-shop owners	Bachelor	2	40%	3	60%	0	0%	5	100%	10.88	0.208
	Diploma	2	66.7%	1	33.3%	0	0%	3	100%		
	Secondary	8	44.4%	5	27.8%	5	27.8%	18	100%		
	Preparatory	2	12.5%	9	56.3%	5	31.3%	16	100%		
	Illiterate	4	57.1%	3	42.9%	0	0%	7	100%		
Total		18	36.7%	21	42.9%	10	20.4%	49	100%		

N = Number of respondents

It is obvious that there is no statistically significant difference between education level and safe storage with chi-square value = 10.88, (P – value=0.208) and degrees of freedom = 8.

The research also examined the correlation between separation of the used tyres and storing it as shown in Table 5.9.

Table 5.9: Separation According to the Size and Storage of the Tyres Waste

Variables		Storage of the used tyres						Total		Chi Square	P-Value
		Yes		No		sometimes					
		N	%	N	%	N	%	N	%		
Separation of the used tyres according to their sizes	**Yes**	**13**	**81.3%**	**3**	**18.8%**	**0**	0%	**16**	100%	10.750	0,005
	No	**29**	**36.7%**	**48**	**60.8%**	**2**	2.5%	**79**	100%		
Total		**42**	**44.2%**	**51**	**53.7%**	**2**	2.1%	**95**	100%		

N = Number of respondents

The Chi-square test reveals a strong positive relationship between separation according to the size and storage of the tyres waste with Pearson Chi-Square value = 10.750, (P–value = 0.005) and degrees of freedom = 2. The relationship is with statistically significant difference. Figure (5.13) shows the distribution of the repair-shops' who separate the tyres waste according to the size and storage of the tyres.

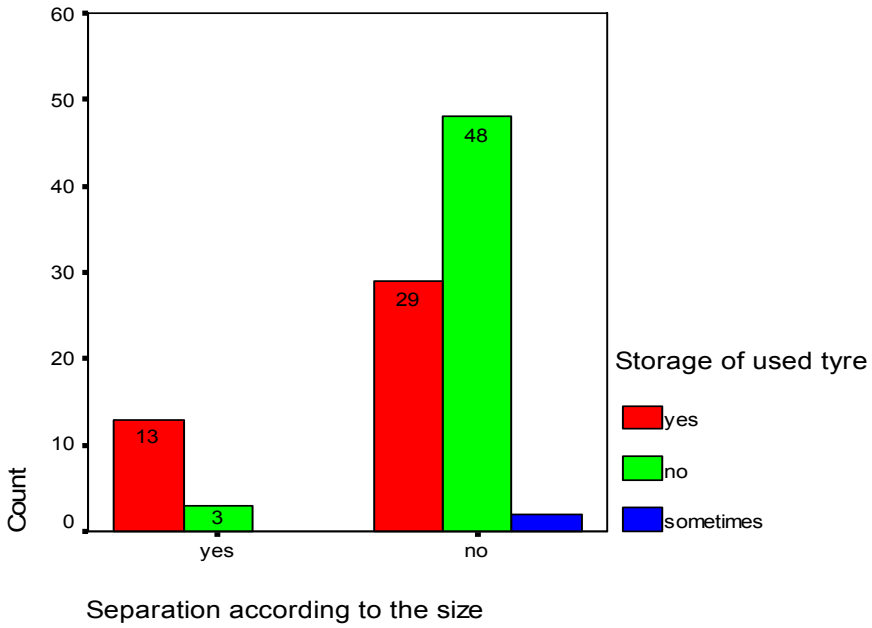


Figure 5.13: Separation and Storage of the Tyres Waste

5.4.4 Disposal of the Used Tyres

Most of the repair-shops who collect the used tyres, prefer to store it inside their repair-shops. About 35% of them dispose the used tyres in municipal containers while only 16.8% dispose the used tyres illegally on the street sides.

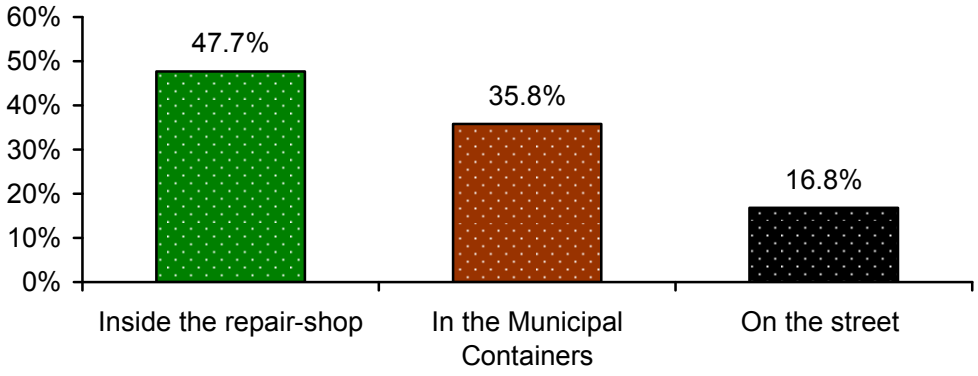


Figure 5.14: Disposal of Used Tyrse by Work-shops Owners

The researcher examined the correlation between education level among the owners of the repair-shops and the random disposal of waste tyres using cross tabulation to identify if there is a difference between education levels and random disposal of the tyres waste.

Table 5.10: Education Level and Random Disposal of the Tyres Waste

Variables		Random disposal						Total		Chi Square	P-Value
		Yes		No		sometimes					
		N	%	N	%	N	%	N	%		
Educational levels of the repair-shop owners	bachelor	**1**	**12.5%**	**7**	**87.5%**	**0**	0%	**8**	100%	9.07	0.337
	Diploma	**0**	**0%**	**3**	**60%**	**2**	40%	**5**	100%		
	Secondary	**5**	**14.3%**	**26**	**74.3%**	**4**	11.4%	**35**	100%		
	Preparatory	**4**	**12.5%**	**18**	**56.3%**	**10**	31.3%	**32**	100%		
	Illiterate	**3**	**20%**	**10**	**66.7%**	**2**	13.3%	**15**	100%		
Total		**13**	**13.7%**	**64**	**67.4%**	**18**	18.9%	**95**	100%		

N = Number of respondents

Chi-square test was used to explore the Relationship between education level and random disposal of tyres waste. Table (5.10) above shows that there is no relationship with statistically significant difference with Pearson Chi-Square value = 9.07, (P–value = 0.337) and degrees of freedom = 8.

Similarly the relation between professionals' education and responsibility for tyres waste management were examined to make sure that if there are significant differences between education levels of the officials who have relations with tyres waste in the deferent municipalities and ministries and having responsibilities for disposing the tyres waste. The

table (5.11) below shows that there is no relationship with statistically significant difference between education levels for the official involved in this field from municipalities and ministries and tyres waste management with (P–value = 0.126) and degrees of freedom = 2.

Table 5.11: Professionals' Education and Responsibility for Tyres Waste Management

Variables		is there any special home response to dispose tyres waste				Total		Chi Square	P-Value
		No		I don't know					
		N	%	N	%	N	%		
Education levels	master	3	100%	0	0	3	100%	4.148	0.126
	bachelor	5	41.7%	7	58.3	12	100%		
	diploma	1	100%	0	0	1	100%		
Total		**9**	**56.3%**	**7**	**43.8**	**16**	**100%**		

N = Number of respondents

5.4.5 Reuse of Waste Tyres

All respondents confirmed that there are seven ways in the current reuse of the used tyres that are well known by the owners of the repair-shops. These reuse ways can be summarized in the following:

1) Re-trading for non-motor transportation means, mostly carts driven by donkeys.
2) Stoppers for Fishermen boots and floating bridges at the sea shore area.
3) Building fences for agriculture land.
4) Retaining walls and embankment where there are high cliffs in topography.
5) Decoration of schools, kindergarten, houses and beach gardens after colouring them.
6) Military training camps during the training stage.
7) Fixing the metallic ceilings of the houses in the refugee camps.

5.4.6 Recycle

No recycling activities have been reported by the owners of the tyres repair-shops. As mentioned in chapter two, there are many fields for recycling of the waste tyres worldwide such as in preparing activated carbon, in modified concrete mixes, and in modified asphalt mixtures. These three fields were not practically tested in Gaza due to the lack of advanced laboratories and lack of financial resources for such experiments. One of the encouraging points, the field survey revealed that the majority of the repair-shop owners (56.8%) know about the economic and environmental benefits of waste tyres reuse (see figure 5.15).

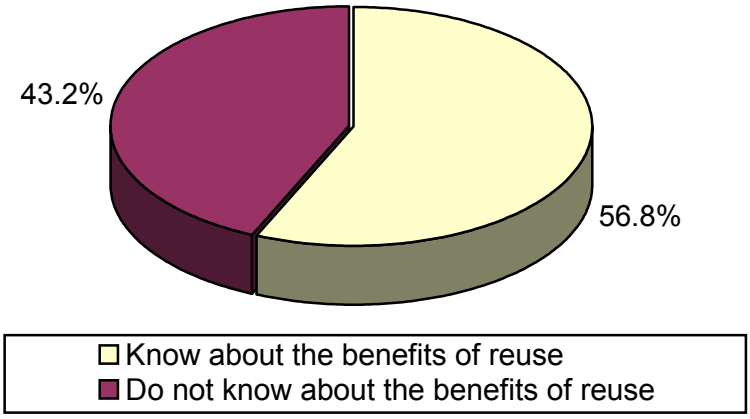


Figure 5.15: Knowledge of the Benefits of the Tyres-Waste-Reuse

5.4.7 Retrading

The results of the field survey showed that only 2.1% of the tyres repair-shops owners practice re-trading the used tyres. The majority of them did not agree on feasibility of re-trading from financial and technical aspects. While 29.5% of them practice the re-trading of the tyres waste in some specific cases and for non-motor transportation means or for other purposes.

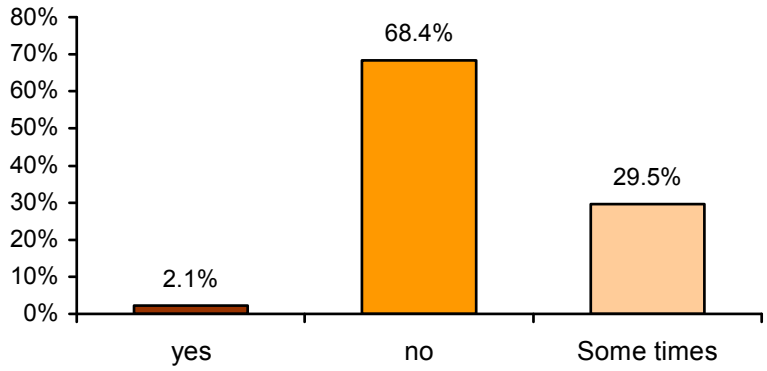


Figure 5.16: Re-trading the Tyres Waste

To explore the correlation between storage and selling of tyres waste at tyres repair-shops, cross tabulation was performed to find out if there is a relationship between storage of tyres and selling of tyres waste

Table 5.12: Relationship Between Storage of Tyres and Selling of tyres

Variables		Re-trading (selling of used tyres)						Total Number	Chi Square	P-Value
		Yes		No		sometimes				
		N	%	N	%	N	%			
storage of tyres	Yes	2	4.8%	25	59.5%	15	35.7%	42	10.137	0,038
	No	0	0%	40	78.4%	11	21.6%	51		
	Sometimes	0	0%	0	0%	2	100%	2		
Total		2	2.1%	65	68.4%	28	29.5%	95		

N = Number of respondents

As shown in the above table the Chi-square test reveals strong positive relationship between storage of the tyres waste and selling of tyres waste with Pearson Chi-Square value = 10.137, (P–value = 0.038) and degree of freedom = 4, The relationship is statistically significant. Figure (5.17) shows the distribution of the repair-shops' owners who tend to store the tyres waste at there shops and selling of tyres waste.

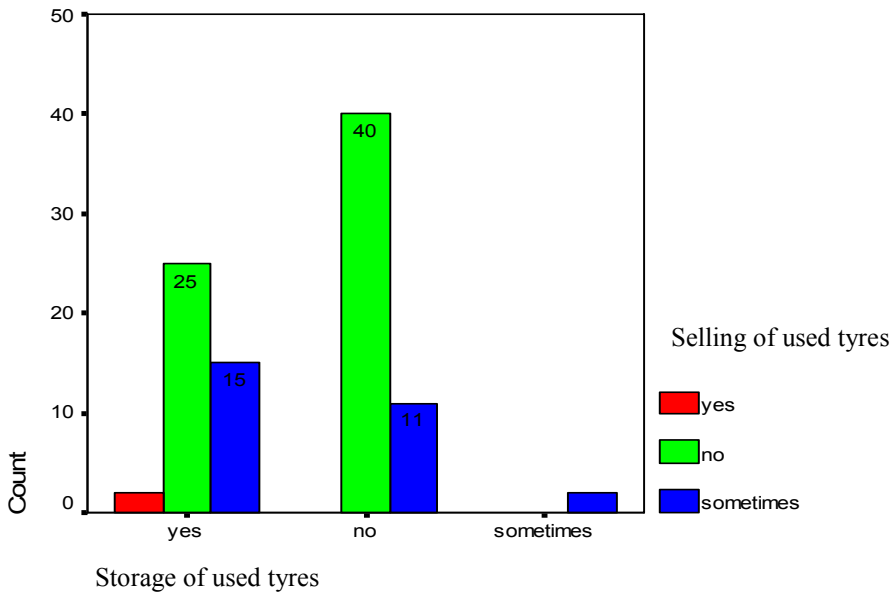


Figure 5.17: Re-trading and Storage of the Tyres Waste.

5.4.8 Stakeholders Cooperation for Tyres Waste Disposal Process

Based on the field survey, there is some cooperation between the owners of the tyres repair-shops and the relevant institutions. Around 56.3% of the interviewed officials said that there is cooperation between the different institutions and the owners of the repair-shops, while the rest of them did not have any cooperation with the owners (see Table 5.13).

Table 5.13: Cooperation with the Relevant Institutions

Is there any cooperation between your institution and tyres repair-shops		
Answer	**Number of respondents**	**Percentage**
Yes – There is cooperation in certain stages	**9**	**56.3**
No- There is no cooperation at all	**7**	**43.7**

The researcher investigated at which stage there are some cooperation with the relevant institutions and the owners of the repair-shops. The following sections assess the relations of cooperation at each stage of the tyres waste disposal process:

The Licensing Stage:

The Municipalities and Ministry of Transportation officials confirmed that, at the licensing stage, there is a cooperation between these institutions and the repair-shops owners. The owners are cooperating in applying all pre-conditions required by the relevant institutions (see Table 5.14). On the other hand, 43.8% of the interviewed officials do not know if there is cooperation between their institutions and the repair-shops owners.

Table 5.14: Stage of Cooperation *Between the Institution and the Tyres Repair-Shop Owners*

	Number of respondents	Percentage
At license stage	**8**	**50.0%**
At collection stage	**1**	**6.2%**
I don't know	**7**	**43.8%**

The Collection Stage:

According to the respondents from the officials of the relevant institutions and the owners of the repair-shops there is no cooperation among the stockholders for collection of used tyres (see Table 5.14). Only Rafah municipality reported that there is some cooperation at the collection stage especially when the municipality needs a number of used tyres for the implementation of some projects.

Transportation Stage:

The majority of the respondents (around 96%) agreed that there are no specific transportation arrangements or means to transfer the tyre waste to the final disposal sites. While only 4.0% believed that there is some arrangement done by the municipalities to transfer the tyres waste from the repair-shops (Figure 5.18) .

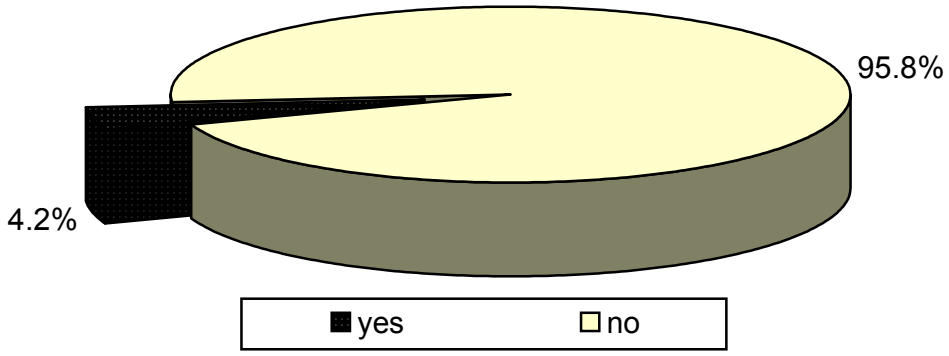


Figure 5.18: Existence of Specific Transportation for Tyre Waste

The Recycle and Reuse Stage

Similar to the previous stage there is no cooperation among the stockholders in the recycling and reusing of the used tyres. However, this cooperation may exist on add-hock basis and according to the needs of any institution that require used tyres to implement some of its projects that needed this material.

The Final Disposal Stage

Currently there is no cooperation among the stakeholders in the final disposal. A very limited number of used tyres reached the solid waste landfills in Gaza and Dair El-Balah. The repair-workshop owners agreed to cooperate with the municipalities for better management of tyres waste in the future. Figure 5.19 shows that most of the respondents (around 82%) agreed to cooperate with the reverent institution in all stages of tyres waste management process. Only 2.1% refused to establish any kind of cooperation with the relevant institutions for better management, and 15.8% of them asked for incentives such as payments by the governmental institutions to the owners of the repair shops in order to cooperate. The last group of the repair-shop owners believes that the used tyres are commodities for sharing business.

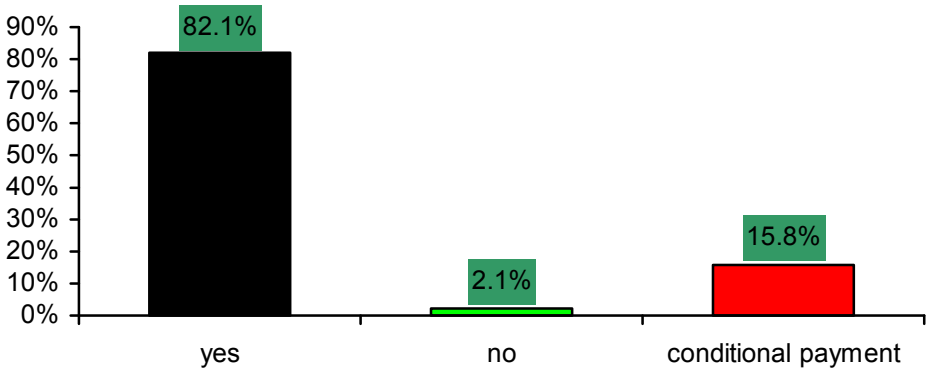


Figure 5.19: Willingness for Cooperation in the Disposal of Used Tyres

The officials from the five Municipalities, the North Council for Waste Management, KhanYounis Council for Solid Waste and Middle Area Council for Waste Management confirmed that there is no special methods they apply to the disposal of the tyres wastes. These institutions are not working on collecting of the tyres waste. Most of the used tyres found on the street will simply be sent to the landfill with the domestic waste.

As shown in table (5.15) the Chi-square test reveals that there is no relationship between the institution who gives the approval/license and cooperation with the tyre repair shops with a P-value = 0.054. The relationship is statistically not significant.

Table 5.15: Relevant Institutions and Cooperation with Tyre Repair-Shop

Variables		Is there any cooperation between your institution and tyres repair shop							
		Yes		No		Total		Chi Square	P value
		N	%	N	%	N	%		
Institution	municipalities	**7**	87.5%	**1**	12.5%	**8**	100%	9.303	0.054
	EQA	**0**	0%	**2**	100%	**2**	100%		
	MOH	**0**	0%	**1**	100%	**1**	100%		
	MOT	**1**	100%	**0**	0%	**1**	100%		
	MOE	**0**	0%	**1**	100%	**1**	100%		
Total		**8**	**61.5**	**5**	**38.5**	**13**	**100%**		

N = Number of respondents

5.4.9 Awareness of Tyres Waste Disposal Methods

The vast majority (90.5%) of the owners of the repair-shops do not have the knowledge about the different methods or opportunities of the end use and disposal of the tyres waste. Only 9.5% are aware about the different disposal methods and the opportunities of the end use of the used tyres.

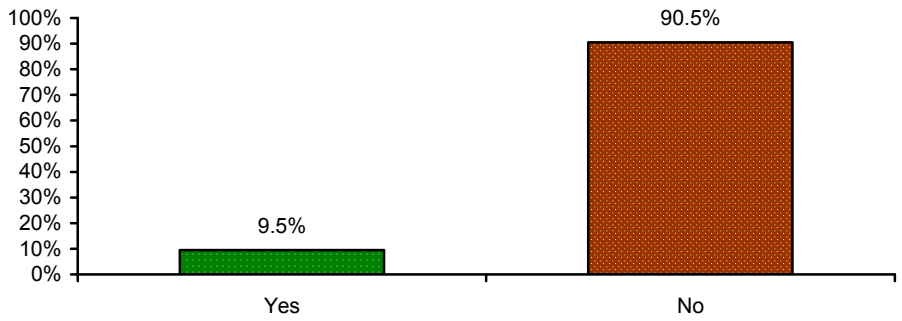


Figure 5.20: Knowledge of Tyres Waste Disposal Methods.

On the other hand, figure (5.21) shows the willingness of the repair-shop owners to know about the disposal methods. Around 66.3% are not welling to know, while 33.7% are keen to know these methods.

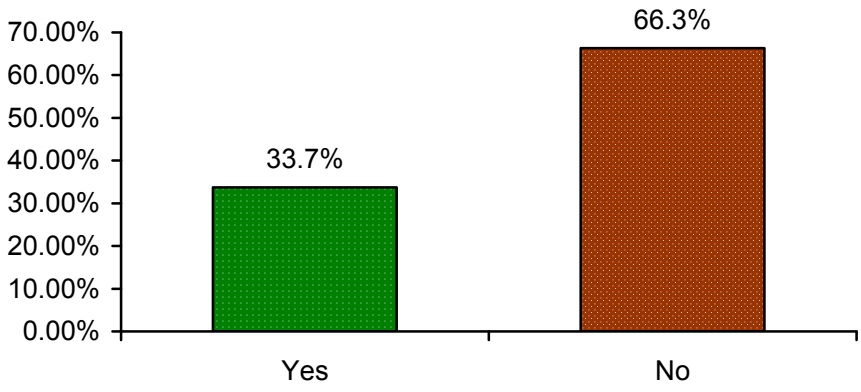


Figure 5.21: Willingness to Know the Tyres Waste Disposal Methods

The researcher examined the awareness of the owners of the tyres repair shops of public health impact of used tyres. The researcher found a common agreement among all the respondents in the following four points:

1. The tyres waste is considered one of the hazards threatening the public health.
2. Tyres waste will be harmful for public health in case of random burning inside the residential areas.
3. The government did very few activities to increase the awareness of the waste tyres hazards and its impacts on public health.
4. There is no enough monitoring activities done be the government to decrease the negative impacts of the tyres waste.

To explore the correlation between education of tyres repair-shops' owners and their intention to know the disposal methods of tyres waste, cross tabulation was performed to test "If there are significant differences between education level and the intention to know about the different methods of tyres disposal?". Chi-square test revealed that there is

relationship with statistically significant difference with P–value = 0.010, a degree of a freedom = 4 and chi-square value = 13.32. Figure (5.22) shows the distribution of the repair-shops' owners intention to know about the different disposal methods based on their educational levels.

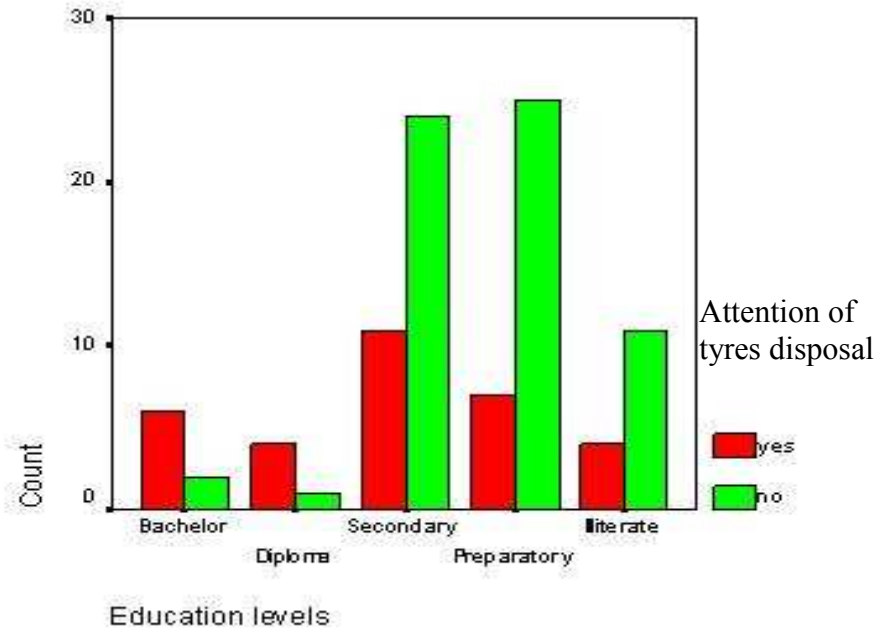


Figure 5.22: Educational Levels and Knowledge of Tyres Disposal

5.4.10 Rules and Regulations

According to the environment law number 7 of 1999, the tyres waste is considered as hazardous and it needs special treatment. No specific regulation had been developed for tyres waste process. The researcher examined this point with the officials working at solid waste management and the owners of the repair-shops. The survey revealed that around 80% of the repair-shop owners declared that there are no regulations for the tyres final disposal. Similar percentage had been given by the professionals at the relevant institutions. The table below shows that there is no statistically significant relationship between the relevant institution and knowledge of existence of regulation regarding tyres waste disposal (P–value = 0.202).

Table 5.16: Relevant Institution and Knowledge of Existence of Regulation

Variables		Is there any rule or regulation							
		No		I don't know		Total		Chi Square	P-Value
		N	%	N	%	N	%		
Institution	Municipalities	**6**	75%	**2**	25%	**8**	100%	5.958	0.202
	EQA	**2**	100%	**0**	0%	**2**	100%		
	MOH	**0**	0%	**1**	100%	**1**	100%		
	MOT	**0**	0%	**1**	100%	**1**	100%		
	MOE	**1**	100%	**0**	0%	**1**	100%		
Total		**9**	69.2%	**5**	30.8%	**13**	100%		

N = Number of respondents

5.4.11 Monitoring System of Tyres Waste Process

The majority of the interviewed officials (56%) confirmed that there is no monitoring system in Gaza to monitor the waste tyres disposal process. While 44% of the officials have no idea on whether there is a monitoring system or not.

Table 5.17: The Existence of Monitoring System

Is there any Monitoring to the tyres shop during tyres disposal		
Answer	**Number of respondent**	**Percentage**
Yes	0	0%
No	9	56.3%
I don't know	7	43.7%

5.4.12 Information and Registration System for Tyres Waste

The only information available in the field of tyres waste is the number of repair shops in Gaza (PCBS, 2007). All the interviewed persons argue that there is no data base system or

they do not know about any kind of registry system for tyres waste (see table 5.18). Moreover there is no exchange of information among relevant stockholders. The absence of registration system makes it difficult for the relevant institutions to plan and mange the recycling and reusing of the waste tyres.

Table 5.18: The Existence of Registry System

Is there any registration system for the quantities of tyres waste disposal		
Answer	Number of Respondents	Percent
Yes	0	0.0%
No	7	43.8%
I don't know	9	56.3%

The officials from the relevant institutions confirmed that they need to have a data base system that contains all the information related to tyres waste, in order to help in planning, management and analysis of the cost-effectiveness for each proposed treatment method to get the maximum benefit.

5.4.13 Enforcement and Compliance for Better Environment

Since there are no specific regulations for tyres waste management, the officials from the relevant institutions confirmed that there is no enforcement from the government to regulate this field. Similarly, public compliance is never existed during the last decades.

5.4.14 Financial Support for Better Management of Waste Tyres

According to the officials from relevant institutions there were no financial aids that had been dedicated for tyres waste disposal in Gaza Governorates.

5.4.15 External Technical Assistance to Support the Re-use and Recycling

Based on the above points and the answers of the officials working in the waste management fields, there was no direct external technical assistance that had been dedicated to the transfer of know-how and technologies of recycling and reuse of the tyres waste to the relevant institutions in Gaza.

Chapter (6)

Discussion

6.1 Introduction

Based on the data presented in chapter five, this chapter explains the results in order to explore and interpret the obtained results. The purpose of this study is to assess the current situation of tyres waste disposal process in the Gaza Governorates including collection, transporting and treatment methods. The management process of waste tyres is considered as a global problem and it is not restricted or limited to a particular country; that is reflected by the Article 10 of the Basel Convention on the control of trans-boundary movements of Hazardous Wastes and their Disposal (UNEP, 2002).

In order to achieve the research goals; the researcher has conducted a field survey that covered all of Gaza Governorates. The researcher received a very good response and high co-operation from the tyres repair shops owners. This high response rate was considered as good indication about their intention to participate in the current study. The field study has shown that most of the tyres repair shops are located in both Gaza and North Governorates. Most of the repair shops are distributed along Salah El-Deen road. On the other hand the lowest numbers of repair shops exist in Middle and Rafah Governorates mainly in the centers of cities and in refugee camps.

In the present study; the researcher has recorded two different educational levels for the people involved in the study survey. The lower educational level was recorded among the tyres repair shops owners. On the other hand, a university educational level was recorded for most of the interviewed professionals. This indicates that there are high levels of

educational background among the interviewed professionals from ministries and municipalities employees.

The study showed a good experience of the respondents in the filed of tyres repairing due to the reasonable financial benefits for their families and securing jobs for the male members of the owner's family.

The study showed that among the total number of the respondents there are nine major importers of brand new tyres in Gaza Governorates, while the remaining are local traders. The vast majority of the tyres repair-shops work around 12 hours a day and most of them have licenses from the Ministry of transportation and the Municipalities. However; non of the repair shops have a license from the Palestinian Environment Quality Authority (EQA), which is responsible for monitoring any shop that deals with storage and/or transfer of any kind of waste, according to the Palestinian Environmental law. The researcher did not find any role for EQA in the whole process regarding waste tyres management in the Gaza Governorates. The absence of co-operation among EQA, ministers and municipalities is considered as a weak point.

The researcher found that the vast majority of customers i.e. vehicles owners prefer to buy tyres based on the cost regardless of its quality. This can be attributed to the bad economical situation on one side and to the absence of rules and regulations that control the quality factors determined by PSI (Palestinian Standard Institution) on the other side. However any standard must take into consideration that some types of tyres are suitable for specific conditions. The on-road life of a passenger car tyre is estimated to be between 40,000 and 50,000 kilometres, depending on upon the type of vehicles (ETRA, 2004). Different factors are playing roles in the process of the tyres selection, for example the

local geographic conditions, variations in weather, the legal speed limits, as well as road structure and surfacing.

6.2 Waste Tyres Management Process

To assess the current situation of waste tyres disposal process in the Gaza Governorates and to explore the strong and weak points in this process, the following sections will generate more discussions about the disposal process.

6.2.1 Pre-Conditions for Issuing Licenses

The research results showed that there is a set of pre-conditions for issuing the working licenses for the tyres repair-workshops and the workshops owners have the knowledge about these conditions, but there isn't any obligations for disposal methods of the waste tyres. Hence, this point has weakened the waste tyres disposal management system in Gaza Governorates. In comparing these preconditions with those in Israel, the researcher found that there is an Israeli ministerial policy on waste tyres disposal that defined a long list of pre-conditions for licensing of the repair-shops including the disposal of tyres waste. The Israeli ministerial policy puts "full responsibility on the owners of the repair-shops to dispose of the tyres waste in environmentally sound methods" (IMOI, 2008).

6.2.2 Daily Tyres Waste Collection

According to the data presented in chapter five, the daily used tyres exchange by new ones in all Gaza governorates is equal to 804 tyres. This means that around 250,000 used tyres supposed to be collected during the year 2007. The average weight of each tyre is equal to 8 kilograms, hence, the annual amount of tyres waste in the year 2007 was about 2000

tons. This number may increase during the coming years as a result of the rapid increase of the population density, which in turn will increase the number of vehicles.

In regional studies as shown in the literature review; the West Bank produces around one million tyres every year (RESC, 2004). While Israel produce, 50,000 tons of waste tyres (6.5 million passenger tyre equivalent) annually. This figure roughly equals the number of population living in Israel. Similarly, in the industrialized countries, mainly in European Union and United States of America, the annual rate equals to one scrap tyre per person per year (ETRA, 2004). It is obvious that the waste tyres generation in Gaza Governorates is lower than the international standards. Gaza generates only 18% of the total number that should be produced according to the international figures. This ratio is attributed to the absence of regulations and enforcement to enforce the vehicles' owners to replace their cars' tyres upon certain driving distance, taking into consideration ETRA recommendations. The on-road life of a passenger car tyre is estimated to be between 40,000 to 50,000 kilometres (ETRA, 2004).

According to the interviews with the governmental officials, most of the private car owners in Gaza Governorates are replacing their car tyres after a long period of time (100,000-150,000 km), the period exceeds the production instructions and the life time set by the manufacturing company.

The present study showed that individuals are the most interested in waste tyres collection while there is no governmental or municipalities' responsibility to deal with the collection of waste tyres from their preliminary sources. The research study indicates that the number of waste tyres that reach the landfill site is insignificant, though the municipalities officials do not pay attention to this issue. However if there are a regulations to control the process of getting rid of the waste tyres, the municipalities will face obstacles in sorting out

the waste tyres accumulating problems because landfills capacities are limited and the tyres will consume a huge area of land, and sorting out this issue is costly and time consuming. However the random disposal and the lack of regulation to control the collection process prevent the municipalities from creating strategic plans to deal with the tyres waste managements. Also the research revealed that there are no corporations or authorities interested in the collection of tyres waste from tyres repair shops. This reflects that there is a lack of investments in this field from the governmental, non governmental organization and local investors.

6.2.3 Separation of Waste Tyres

The obtained results from the field study indicates that tyres repair-shops do not separate the tyres waste according to their sizes, while the vast majority of the respondents tend to collect tyres inside their tyres repair-shops. This reflects the absence of the rules and regulations what organize the ways to deal with waste tyres, also it reflects the lack of knowledge of the proper separation methods for suitable pre- treatment of waste tyres for better waste managements.

6.2.4 Safety Storage of Waste Tyres in the Repair Work-shops

The tyres repair workshops' owners tend to dispose of used tyres by storing them inside their shops for re-selling those tyres again. The study outcome indicated that the respondents who store tyres inside their work places have no background about the safety regulations. In other words they have no idea about the safe methods for the waste tyres storage. It is obvious that there is no regulation to encourage safety storages and increase the knowledge of the owners about the optimal ways of tyres waste storage in order to avoid the fires risks. Rules for the proper storage of end-of-life tyres in Gaza governorates

must be obligatory according to the International Association of Fire Chiefs and the Scrap Tyre Management Council in the United Sates of America.

6.2.5 Transportation of Tyres Waste to the Final Disposal Site

The results show that there is no specific transportation system to transfer the waste tyres to the final disposal sites. Also the study indicates that there is no special dumping site available for tyres waste in Gaza governorates. The results from the field study indicate that there is not any kind of specific methods applied to dispose of tyres neither from the shops owners nor from the official institutions that are responsible for disposing of solid waste. However, in case the tyres are found in the waste they are disposed of by land filling. This way of disposal disagrees with the guidelines for the prevention and management of scrap tyres mentioned in Basel Convention (UNEP, 2002).

6.2.6 Treatment Process of Waste Tyres

Treatment processes including retreading, recycling, and reuse were practiced in limited number of tyres. The major activities in Gaza Governorates were limited to exchange the old tyres by new ones or by used ones. However, the researcher found that there are good possibilities to benefit from the accumulated number of waste tyres in the same manner that other countries have benefited mainly recycling and energy recovery (UNEP, 2002). The lack of funds is the major obstacle that prevents the implementation of recycling and reuse activities.

6.2.7 Reuse

The reuse of the waste tyres is the most common implemented activity among the other methods in Gaza Governorates. However, the reuse process still requires more attention at

both governmental and non-governmental levels, since the reuse activities are only carried out by individuals. No cooperation among the stakeholders in reusing the used tyres was recorded by the research during the field survey. However, this cooperation exists on add-hock bases and according to the needs of any institution that requires used tyres to implement its projects that need this material without any scientific methods. The study results show that just individuals collect the tyres waste for reusing process such as:

- Trading
- Fishermen use waste tyres to fix their boats
- Farmers use waste tyres to siege their agriculture land
- To make schools, kindergarten, houses and beach gardens tidy and beautiful.
- Tyres waste is used in military camps during the training stage.
- Tyres waste are used to fix the metallic ceiling of houses in the refugee camps

The researcher considers this kind of collection of the tyres waste for reusing is a positive step specially when there is no support from governmental and non-governmental institutions. Also the researcher considers the collection of the waste tyres by individuals one of means to reduced the load in the final disposal sites. The practical implementation in the Gaza governorates can be useful and beneficiary if the scientific methods to reuse the waste tyres similar to the project implemented in the West Bank are applied as mintion in the literature (RESC, 2004).

6.2.8 Recycling

The obtained results during the filed study show that there are no recycling activities in Gaza governorates. This reflected the poor knowledge about the methods implemented internationally, as indicated in chapter two of this study, as well as the lack of knowledge

about both the financial benefit of waste tyres recycling and environmentally sound management.

6.2.9 Land filling

The study indicated that there is no special dump site for waste tyres in the Gaza Governorates; however, very limited number of used tyres reache the solid waste landfills in Gaza and in Dair El-Balah. The field study showed that the vast majority (82%) of repair-workshops' owners agreed to cooperation with municipality for better management of waste tyres once they required to do so. The researcher considers this as positive sign for a better investment in this field as well as for the policy makers. In the other hand 15.8% of repair-workshops' owners asked for incentives to help them in implementing the treatment process in acceptable manner. Also some of the repair-shop owners believe that the used tyres are commodities for sharing business. This indicates that there are possibilities to generate shared business between the private sector and the government in waste tyres process.

6.2.10 Re-selling

The majority of repair-shop owners did not agree on the feasibility of re-selling from financial and technical aspects, while 29.5% of them are practicing the re-trading of the waste tyres in some specific cases and for non-motor transportation means or for other purposes. But if there is a governmental attention, the benefits and revenue will be more if the emerging technologies are used to develop a reprocessing sector for the designated waste streams as indicated in chapter two of this study.

6.2.11 Stakeholders Cooperation for Tyres Waste Disposal Process

Based on the field survey, there is no cooperation between the owners of the tyres' repair-shops and the relevant institutions at the disposal stage. The cooperation with the owners was limited to the licence stage only. The results also indicate that there is low level of cooperation at collection stage among the municipalities, Ministry of Transportation (MOT) and tyres repair workshops' owners. For instance, there is a limited cooperation at collection stage with Rafah municipality when it needs some tyres during the implementation of some projects. The present results demonstrate that all tyres repair work-shops' owners are willing to cooperate with the municipality to dispose of tyres without conditional payments, which indicate that the tyres repair work-shops' owners are concerned to encourage investors to invest in this field. This reflects the weakness that might need more efforts to strengthen the relations among the relevant stakeholders and to initiate the regulations for better disposal process.

6.2.12 Awareness of Waste Tyres Disposal Methods

Regarding the knowledge of waste tyres disposal, the present study shows that respondents are not interested to know about the waste tyres disposal methods. The vast majority (90.5%) of the owners of the repair-shops do not have the knowledge about the different methods or opportunities of the end use and disposal methods of the waste tyres. Only 9.5% are aware about the different disposal methods and the opportunities of the end use of the used tyres. This reflects the carelessness from the government side to raise the awareness about health and environmental impacts of tyres waste disposal and the value of this waste. Also the researcher examined the awareness of the owners of the tyres repair shops about the public health impact of used tyres. The study showed that there is common agreement among all the respondents on the following points:

- The tyres waste is considered one of the hazards threatening the public health.
- Tyres waste will be harmful for public health in case of random burning inside the residential areas.

This indicates that the respondents have good knowledge about the hazards of waste tyres for health in case of random disposal of waste tyres. This agrees with other studies such as Lemieux, Lutes and Santoianni, (2003). It is clear that the government had conducted limited activities to increase the awareness of hazards of the waste tyres and its impacts on public health. This is considered as a weak point from the governmenta side in the management process. Preventing open burning of waste tyres will minimize toxic substances generated during the fire.

6.2.13 Rules and Regulations

The survey revealed that around 80% of the repair-shop's owners and the professionals at relevant institutions declared that there are no regulations for the tyres final disposal. According to the definition of environment law number (7) issued in 1999, the tyres waste is considered as hazardous and it needs special treatment. No specific regulation had been developed for tyres waste process.

6.2.14 Monitoring Process From the Governmental Institutions

The study examined the existence of governmental monitoring system to monitor the tyres repair work-shops during waste tyres disposal stage. The interviewed officials and the owners of tyres repair-shops agreed that there is no existence of any monitoring system for the waste tyres disposal activities. This reflects the weakness point regarding monitoring activities done by the government in order to observe the negative impacts of the current waste tyres disposal management.

6.2.15 Information and Registration System for Waste Tyres

The only information available in the field of waste tyres is the number of repair shops in Gaza published by PCBS (2007). All the interviewed persons argue that there is no database system or they do not know about any kind of registry system for waste tyres generation in Gaza governorates. Moreover there is no exchange of information among relevant stakeholders. The absence of registration system makes it difficult for the relevant institutions to plan and mange the recycling and reusing of the waste tyres.

The officials from the relevant institutions confirmed that they need to have a database system that contains all the information related to waste tyres, in order to help them in planning, managing and analysing of the cost-effectiveness for each proposed treatment method and implementing the optimal solutions.

6.2.16 Enforcement and Compliance for Better Environment

The absence of enforcement and compliance affect negatively all stages of the tyres waste management process, hence, creating many environmental problems specially giving the opportunities for random burning of the used tyres.

6.2.17 Financial Support for Better Management of Waste Tyres

According to the officials from relevant institutions there were no financial aids allocated for tyres waste disposal in Gaza Governorates. This could be due to the absence of management plan, clear policies and solid waste strategies and data base for tyres waste generation in Gaza Governorates. Another reason could be that the tyres waste is not the top priority issue at the moment if compared to other environmental problems like water

and wastewater and domestic solid waste. Private sector participation is very limited in Palestine since it mainly depends on stable political situation.

6.2.18 External Technical Assistance to Support the Re-use and Recycling

Based on the above discussions and the answers of the officials working in the waste management fields, there was no direct external technical assistance that had been allocated to the transfer of know-how and the technologies of recycling and reuse of the waste tyres to the relevant institutions in Gaza Governorates. Therefore there it is obvious that Gaza officials still in need of technical assistant that would help them in environmentally sound management of waste tyres. Also the absence of external technical assistant in recycling and reuse of waste tyres will create many difficulties for local authorities to establish new facilities for recycling and reuse of waste tyres. International agreements and conventions are not effectively implemented or applied in Gaza which will encourage PNA to apply environmental management system.

Chapter (7)

Conclusion and Recommendations

7.1 Conclusion

After reviewing the literature, the researcher described the most common process that could be implemented in the Gaza governorates for better future. The present study provides the first data on the waste tyres management. The purpose of this descriptive study aimed to assess the current situation of waste tyres disposal process in the Gaza governorates where the response rate was high as 94% of the total sample which was 101 owners of tyres' repair-workshops and sixteen professionals from different ministries and municipalities.

It is clear from the study that there are many weaknesses in the process of waste tyres management process. Firstly, there is no authorized body responsible for waste tyres collection, transportation, storing and disposal in the Gaza governorates. Secondly, There are no clear procedures for managing tyres waste or a special institutional setup to deal with waste tyres. Most of the waste tyres in Gaza governorates are mixed with municipal waste if it reached the final disposal sites due to the absence of segregation at the source. Accordingly the amounts of tyres waste are increasing rapidly in Gaza Governorates. This will result in the depletion of natural resources, mainly the land, and the associated high costs for later remediation.

From visits and meetings with many officials from the relevant institutions, it was clear that there is a lack of coordination among different ministries and even among the departments of the same institution.

The study identified the following weaknesses of waste tyres management process:

1. There are weaknesses from the governmental or municipal sides to deal with collection of tyres waste.
2. Large number of tyres are stored in private sites (with no controls over their management).
3. Lack of knowledge of the proper separation methods of waste tyres.
4. No specific transportation to transfer the waste tyres to the final disposal sites.
5. No recycling activities exist in Gaza Governorates.
6. There is no special dumping site for waste tyres in the Gaza Governorates.
7. There is a considerable illegal dumping of tyres.
8. There is a limited cooperation between the owners of the tyres' repair-shops and the relevant institutions at the disposal stage.
9. Government had conducted limited activities to increase the awareness of hazards of the waste tyres and its impacts on public health.
10. Absence of legislations, laws, policy and enforcement.
11. No specific regulation had been developed for tyres waste process.
12. Current monitoring controls are insufficient and the government institutions are facing enforcement problems.

13. No database system about the number of tyres waste generation in Gaza governorates.

14. No financial aids had been allocated for tyres waste disposal in Gaza Governorates.

15. Potential commercially viable recycling options face financial and technical difficulties. A potentially valuable resource may not be used as efficiently as possible.

The strength points of waste tyres management process in the Gaza Governorates

- Awareness of the owners of the tyres repair shops about the public health impacts of used tyres is very high.

- The number of waste tyres that reach the land filling site is insignificant, because individuals are the most interested in waste tyres collection. If all the tyres reach the landfill it will consume a huge area of the limited available land in Gaza Governorates, and hence solving the problem will be very expensive.

7.2 Recommendations

The researcher recommends that the relevant ministries and institutions at the Palestinian National Authority should take the lead of the issue of tyre disposal process in Palestine by developing a scheme which encourages an integrates tyres waste management process. Several types of waste tyres management process already exist and being implemented in many developed and developing countries that could be a guide for developing waste tyre disposal process in Gaza. A process that is suitable for the current situation in Gaza governorates that would take into consideration the available resources and technologies, is summarized as follows:

7.2.1 Collection

Collection presents the first recommended stage to deal with waste tyres. Collection should be primarily the responsibility of tyre dealers who import and sell the tyres. Registered private tyres repair-shops should cooperate with the municipalities for end use or disposal to avoid any illegal dumping of waste tyres. At the same time, generators of waste tyres should be encouraged to develop techniques and processes that minimize the generation of waste tyres. If the production of tyres waste cannot be avoided, the tyres waste should be recycled or re-used for other purposes.

- Municipalities must facilitate and cooperate with owners of the workshops to implement the efficient collection system with identified times and responsibilities.

7.2.2 Storage

Owners of workshops should have enough space for the safe storage of waste tyres. A suitable area should be allocated for storage equipped with low-technology and proper storage facilities. Governmental ministries in cooperation with the private sector must

provide all support and encouragement to provide suitable locations for storage of tyre waste and have effective monitoring based on well prepared bylaws and regulations in this regard.

7.2.3 Transport

Suitable vehicles should be designated to collect waste tyres from tyre repair shop and transfer them to the final disposal site. Infrastructure facilities mainly roads need more attention in order to increase the tyre life time.

7.2.4 Recycling

It is recommended to establish a centralized facility for recycling the waste tyres, with two main stages. The first recommended process for the waste tyres recycling is shredding of scrap tyres. The tyre shredding process involves the use of large machinery that cuts up tyres into small pieces (one to two inch and larger). At this stage, tyre shred can be used for a variety of civil engineering projects (e.g. lightweight fill material for road pavement projects or leachate collection material for new landfill sites), or it can be used as feedstock for the production of crumb. The second stage of the process is crumbing. During this stage, machinery is used to remove the steel and fiber from the shred, by grinding the material into fine pieces. The steel is removed by magnets, with the fibers are removed by aspiration. At this stage, crumb can be used for a variety of loose applications, including top dressing for sports fields (it protects the crown or growth layer of grass), as a replacement for sand in playgrounds (outperforms sand three to one), or it can be used as a feedstock for the production of manufactured products.

7.2.5 Reuse

New uses for old tyres are providing some creative ways to reduce waste, cut costs, and improve the quality and safety of public works projects. The potential uses for waste tyres are endless. The cost-effectiveness and the state of development for end use markets vary considerably. One of the common uses of the waste tyres could be in schools and kindergartens after colouring them in improving the views of the public gardens and streets

Rubber reclaimed from the tyres may be used as filler in the making of rubberized asphalt or to make stable and rubber mats. Rubber reclaimed from tyres may also be used as fuel for high energy users such as cement plants in case the government decided to encourage the construction of a cement plant in Gaza. Because in Gaza we don't have a variety of industries, the main reuse option for the waste tyres will be using them as a replacement for sand in playgrounds or retaining walls for cliffs especially along the coastal road, see figure (7.1), and reuse of the tyres waste as scaffolds to prevent soil erosion and sliding. If waste tyres are used in construction of playgrounds it will help in creating suitable places for kids. This will help children to feel better and unstressed especially at difficulties faced by the Palestinian children (siege, hermetic closure and destruction of the streets). Few playground places if any are available for the community in Gaza. The playground will be safe, calm, and nice place for kids to play.

The Current situation of the site The proposed solution

Photos made by the researcher, 2008

Figure 7.1: Proposed Solution for One Cliff at Dair El-Balah Area

There are also many other recommended long-term uses of waste tyres that should be encouraged by the government:

- Reuse of the tyres waste in fixing the plastic layers which act as isolator in the solid waste landfills during the winter season in order to prevent the leaching of rain water; this will help in reducing the amount of leached liquid wastes.
- Reusing of waste tyres as energy sources through controlled burning in monitored containers away from the residential areas.
- Reuse of tyres waste in roads pavements, as it can be mixed with concrete and asphalt.

7.2.6 Retreading

Incentives must be provided to invest in waste tyres retreading by private sector. Such investments will decrease the number of tyre imported from abroad and have the number of waste tyres generated each year. This will decrease the annual running cost paid by the drivers for changing the tyres of their cars. Also the economic revenue will be high for the investor.

7.2.7 Land filling

It is recommended that the Government continue to work with both private sector and local municipalities landfill operators to develop guidelines for storage and disposal of tyres that are disposed of in the landfills. It is recommended also to establish an advanced disposal fee, to be applied to tyres at point of import and encouragements of the private sector to invest in the recycling of tyres waste

7.2.8 Stakeholders Cooperation for Tyres Waste Disposal Process

Effective cooperation between the relevant stockholders mainly, municipalities, government, NGOs, private sector and tyres repair-shops to establish new business and investments in waste tyres as a source of job creation and income generation projects.

The Government should continue to provide support for local councils and municipalities to limit the illegal dumping of tyres. Mechanisms for this support includes enforcement against illegal tyres dumping through enhancing the monitoring system for waste tyres process. In addition to encouraging local councils to use existing municipal plan provisions and environmental field officers to investigate possible illegal tyre dumps and, where possible, prosecute the offenders.

7.2.9 Awareness of Tyres Waste Disposal Methods

Community participation and public awareness must be encouraged and enhanced by related ministries, and environmental NGOs to increase their knowledge about the health and environmental impacts of illegal burning and random disposal of such waste. Training and capacity building programs and activities in waste tyres management should target the public, municipalities and decision makers. The Government must continue to support development of viable alternative end-uses for tyres. This includes support for additional

research into the environmental effects of alternative end-uses, including recycling and reuse of waste tyres; provide education on all aspects of product environmental performance for example, the roles of customers, retailers and landfill operators in adopting environmentally responsible tyre disposal methods. It is also recommended to enhance the public awareness towards the environmental and public health risks of open burning of tyres.

7.2.10 Rules and Regulation

Tyres waste regulations or bylaws should be developed to provide strict controls for collection, treatment, storage, transport, disposal and monitoring of waste tyres. The bylaws are the effective mechanism for controlling the location and management of waste tyres. Therefore strong legislation and bylaws must be developed to stop the illegal burning of waste tyres due to the serious health and environmental impacts.

7.2.11 Monitoring System of Tyres Waste Process

Public health is one of the major reasons or justifications for improved waste tyres services coordination and effective monitoring. Full duties and responsibilities should be given to the Environment Quality Authority to monitor the activities output from the tyres repair work shops with qualified employees by weakly or by time schedule determined for their daily field survey work.

7.2.12 Information and Registration System for Tyres Waste

Promote an integrated tyres waste management information systems in Palestine. This can be done through creating of database that contains all the information related to tyres waste, in order to help in planning, management and studying the cost-effectiveness for each proposed method to get the maximum benefit. We could benefit from the experience

of the neighbour countries such as Egypt and Jordan, and encourage bilateral agreements in the field of exchanging knowledge and information on establishing database for waste tyres.

7.2.13 Enforcement and Compliance for Better Environment

Effective mechanisms and enforcement activities should be implemented for preventing tyre dumping in public and private properties, including tighter penalties under the low or the polluters pay principle.

7.2.14 Financial support for Better Management of Tyres Waste

Incentives must be provided to the tyres rapier-shop owners and vehicles owners to encourage them to deal with waste tyres in a proper and suitable manner. It is recommended that the Palestinian Government carry out further studies to evaluate the implementation of a waste disposal fee such as;

- evaluating the scope of the waste disposal fee in terms of the products that it applies to;
- determining the organizational structure requirements to support the waste disposal fee – for example, expanding the law of the Palestine Authority;

7.2.15 External Technical Assistance to Support the Re-use and Recycling

Previous experience and knowledge regionally and internationally must be adopted to suit the local conditions and situations by implementing international agreements and conventions mainly Basel convention to establish a hazardous waste management system in Palestine.

7.3 Further Recommended Research Studied

According to the study results and limitations, the researcher recommends the following suggestion for further researches:

1- Further research is necessary to determine the financial benefit of recycling and reusing the waste tyres compared to random disposal.

2- Further study should also be undertaken to analyze the health impacts of random burning of the waste tyres.

3- Further experimental studies should be undertaken by the local universities on the extraction of valuable materials from waste tyres.

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More and Further information regarding scrap tyre issues is available through the Scrap Tyre Management Council of the Rubber Manufacturers Association (RMA) at www.rma.org.

Other information on tyres, including fire control, health, and safety issues is available at:

http://www.epa.gov/epaoswer/non-hw/muncpl/tires.htm

http://www.epa.gov/jtr/docs/r9tirerecommend.pdf

Information on disease hazards (including encephalitis, west Nile virus, , rabies, etc.), associated with uncontrolled tire accumulations is available through the CDC at http://www.cdc.gov (do a search for “tires, disease”).

Annex (1)

List of Expert Names who Review Study Questionnaires.

Dr.	**Yousef Abu Safieh**	chairman of Environment Quality Authority
Dr.	**Khalid Qahman**	Assistance of chairman of Environment Quality Authority
Dr.	**Zaher Salem**	Expert in Environment, Director Department of Projects Proposals Environment Quality Authority-Palestine
Dr.	**Bassam Abu Hamad**	Associated Professor, School of Public Health Al- Quds University
Dr.	**Ramy Y. Morjan**	B.Sc., M.Sc, Ph.D, Chemistry
Dr.	**Yehia Abed**	Associated Professor, School of Public Health Al- Quds University
Mr.	**Atef Jaber**	Director of solid waste department in EQA
Mr.	**Mohammed Shobair**	Director of public health department in EQA
Mr.	**Wael Safy**	Director of GTZ office, GAZA

Annex (2)

Consent Form

بسم الله الرحمن الرحيم

دعـــــــوة

عـزيزى المشــارك:

أنا الطالب **خليل ابراهيم حسنين** أدرس بكلية الصحة العامة – جامعة القدس أبو ديس، أقوم بإعداد بحث بعنوان:

تقييم طرق التخلص من الإطارات الهالكة في قطاع غزة

يهدف هذا الاستبيان إلى معرفة طرق الجمع و الترحيل و المعالجة لإطارات السيارات الهالكة في قطــاع غــزة من خلال المقابلة المباشرة مع نحو 124 صاحب منشأة تغيير إطارات السيارات. ستستخدم هــذه المعلومــات لأهداف البحث العلمي فقط. لذا يرجي من أصحاب منشآت تغيير إطارات السيارات بالإجابة علــى أســئلة هــذا الاستبيان.

باعتباره متطلب للتخرج والحصول على درجة الماجستير

تهدف هذه الدراسة إلى تقييم طرق التخلص من الإطارات الهالكة في قطاع غزة

ونشكر لك مشاركتك في هذه الدراسة بالإجابة على بعض الأسئلة خلال المقابلة، مع العلم أن المقابلة لن تستغرق أكثر من 15 دقيقة تقريبا ، **في حال** أن الوقت غير مناسب الرجاء تحديد موعد آخر يناسبكم.

مشاركتكم تطوعية يمكنكم رفض الإجابة على أي سؤال وأرغب أن أؤكد لكم أن المعلومات التي تذكروها ستكون مصدر ثقة وسرية وستستخدم فقط لغرض البحث العلمي وبدون ذكر الأسماء ولذا أرجو أن تكون الإجابات دقيقة.

وشــكراً لكــم علـى حســن تعاونكــم

Annex (3)

استبيان تقييم طرق التخلص من الإطارات الهالكة في قطاع غزة

يهدف هذا الاستبيان إلى معرفة طرق الجمع و الترحيل و المعالجة لإطارات السيارات الهالكة في قطاع غزة من خلال المقابلة المباشرة مع نحو 124 صاحب منشأة تغيير إطارات السيارات. ستستخدم هذه المعلومات لأهداف البحث العلمي فقط. لذا يرجي من أصحاب منشآت تغيير إطارات السيارات بالإجابة على أسئلة هذا الاستبيان.

رمز المحافظة ( ) **رقم الاستبيان ( )**

الجزء الأول (معلومات عامة):

1)مستوى التعليم

□ جامعة □ دبلوم □ ثانوية عامة □ مرحلة إعدادية □ غير ذلك

2) أنت تعمل في مجال استبدال أو تصليح الإطارات منذ ؟

حدد المدة في هذا المكان.....

مدة الخدمة عموماً.....

3) اهتمامك بالإطارات يأتي من منطلق كونك ؟

□ مستورد إطارات □ تاجر محلى □ صاحب ورشة لصيانة الإطارات □ أخرى

4) حدد عدد العمال في هذه المنشاة؟

.....

5) **حدد عدد ساعات العمل ؟**

.....

6)ما هي مساحة المنشأة ؟

.....

7) هل المنشأة حاصلة على ترخيص ؟

□ نعم □ لا □ لا أعلم

8) من هي الجهة التي تمنح الترخيص ؟

□ **البلدية** □ **سلطة البيئة** □ **وزارة الموصلات** □ **وزارة الاقتصاد** □ **وزارة الصحة**

□ **الدفاع المدني** □ **لا أعلم**

9) هل يوجد هناك شروط لمنح الترخيص ؟

□ نعم □ لا □ لا أعلم

10) **إذا كانت الإجابة نعم هل يوجد شروط لكيفية التخلص من الإطارات الهالكة ؟**

□ نعم □ لا □ لا أعلم

11) كم تقدر بالأرقام ما يتم استبداله يوميا من الإطارات الهالكة ؟

.....

12) حسب خبرتك في هذا المجال كم تقدر العمر الزمني للإطار الذي يجب على السائق استبداله؟

□ **الأجرة أكثر من سنة** □ **الملاكي أكثر من سنتين** □ **الشاحنات الكبيرة سنة**

13) حسب خبرتك في هذا المجال من هي أكثر السيارات تغير واستهلاك للإطارات؟

□ **الأجرة** □ **الملاكي** □ **الشاحنات الكبيرة**

14) هل رغبة السائقين في شراء الإطارات حسب التالي ؟

□ الجودة □ السعر □ الاثنين معا

الجزء الثاني (نظام الجمع):

15) هل يتم فرز وتصنيف الإطارات المستهلكة حسب أحجامها ؟

□ نعم □ لا □ لا أعلم

16) أين يتم تجميع الإطارات الهالكة بمنشأتك؟

□ أماكن خاصة داخل منشأتك □ حاويات البلدية □ **رميها في الشارع بشكل عشوائي**

17) هل التخزين للإطارات المستخدمة في أماكن آ منة ؟

□ نعم □ لا □ لا أعلم

18) حدد فترة تخزين الإطارات الهالكة لديك؟

.....

19) هل يوجد أي جهة تهتم بجمع الإطارات الهالكة منك ؟

□ نعم □ لا

20) إذا كانت الإجابة نعم حدد هل هي ؟

□ **جهة حكومية** □ **مؤسسات غير حكومية** □ **جهة من مؤسسات القطاع الخاص (تجار)** □ **أفراد**

21) حسب اعتقادك لماذا يتم جمع الإطارات (الهالكة) ؟

□ تجديدها بغرض الاستعمال □ بيعها خارج قطاع غزة □ بيعها داخل قطاع غزة □ أخرى حدد

.....

22)هل لديك استعداد للتعاون مع الجهات المسئولة في مجال التخلص من الإطارات الهالكة؟

□ نعم □ لا

23) في حال طلب منك أن تجمع الإطارات الهالكة بدون مقابل فهل موقفك سيكون؟

□ نعم سأتعاون □ لا لن أتعاون □ سأشترط دفع مقابل

الجزء الثالث:عملية (الترحيل):

24) هل يوجد آليات نقل متوفرة لدى المنشأة لنقل الإطارات إلى أماكن التخلص منها؟

□ نعم □ لا □ لا أعلم

25) هل تتخلص من الإطارات الهالكة عن طريق رميها في الشارع بشكل عشوائي؟

□ نعم □ لا □ أحيانا

26) هل تتخلص من الإطارات الهالكة عن طريق تخزينها؟

□ نعم □ لا □ أحيانا

27) هل تتخلص من الإطارات الهالكة عن طريق بيعها؟

□ نعم □ لا □ أحيانا

28) هل تعلم كيف يتم التخلص من الإطارات الهالكة ؟

□ نعم □ لا □ لا أعلم

29) هل تهمك طريقة التخلص من الإطارات الهالكة؟

□ نعم □ لا □ لا أعلم

الجزء الرابع (المعالجة):

30) هل تقوم المنشأة بتجديد الإطارات الهالكة ؟

□ نعم □ لا □ لا أعلم

31) هل تقوم المنشأة بتبديل الإطار الهالك بإطار جديد للمستهلك ؟

□ نعم □ لا

32) هل تقوم المنشأة بتبديل الإطار الهالك بإطار مستعمل ؟

□ نعم □ لا □ أحيانا

33) هل تقوم المنشأة بالتخلص من الإطارات الهالكة بالتعاون مع البلدية ؟

□ نعم □ لا □ لا أعلم

<u>الجزء الخامس (الوعي البيئي والمراقبة)</u>

34) في رأيك هل تعتبر الإطارات الهالكة خطر على الصحة والبيئة ؟

□ نعم □ لا □ لا أعلم

35) **إذا كانت الإجابة نعم حدد متى تكون خطر في حال؟**

□ **الدفن** □ **الحرق** □ **إعادة الاستخدام** □ **طرق أخرى** □ **حدد**

.....

36) هل تعلم أن الإطارات الهالكة تستخدم في توليد الطاقة واستخراج الفحم النشط وفى رصف الشوارع وتعبيد الطرق وفى العديد من المجالات الهندسية الأخرى ؟

□ نعم □ لا □ لا أعلم

37) هل تستخدم أي من المواد الإعلامية للتوعية عن أهمية التخلص من الإطارات؟

□ نعم □ لا

38) هل يوجد جهات معينة تقوم بمراقبة المنشأة ؟

□ نعم □ لا □ حددها

39) هل يوجد سجلات تحتوى على عدد الإطارات الجديدة ؟

□ نعم □ لا □ لا أعلم

دون من فضلك أية اقتراحات تجدها مناسبة لتحسين عملية التخلص من الإطارات الهالكة في قطاع غزة؟.....

.....

.....

Translation of Annex 3
Questionnaire

Assessment of tyres Waste Disposable Processes in Gaza Governorates

Governorate code ( ) **Questionnaire No.( )**

Part 1 (General information)

(1)Education level

□ University degree □ Diploma □ Secondary School □ Pre. School □ Other

(2)Are you working in the field of replacement and repair of tyres since?

Determine the period in the work place ……

Period of Service in general ……

(3)Your interest in tyres coming because of you are?

□ Importer of tyres □ Owner of tyre shop □ local supplier □ Others □

(4)Determine Number of Workers in work Place?

……

(5) Determine Daily hours of Work

……

(6) What is the space of the workshop?

……

(7) Does the workshop are lenience?

□Yes No □ □ I don't Know

(8) Where are you getting the license from ?

□Environmental quality Authority □ Municipality □ Ministry of Economies

□Ministry of Transportation □ Ministry of Health □ Civil Defence □ I Don't know

(9) Is there any condition for giving a license?

□Yes □ No □ I don't Know

(10) If the answer yes, is their any pre-conditions for disposal of the waste tyers?

□Yes □ No □ I don't Know

(11) How much approximately the daily used tyer replaced by new one ?

……

(12) According to your experience in this field what is the life time of the tyre to be replaced?

□Taxi less than one year □ Privet more than two years □ Big Trucks one year

(13) According to your experience in this field what is the most exhausted and replaced tyres ?

□ service Taxi □ Privet Cars □ Big Trucks

(14) The will of Drivers to buy the tyres coming according to?

□ Quality □ Price □ Both

Part 2 (Collection system)

(15) Does The waste tyres separated and sorted according to their size?

□Yes □No □ I don't Know

(16)Where does the waste tyres collected in your workshop

□ Random Disposal in the Street □ Municipality containers □ special places inside the workshop

(17) Does the store of the waste tyre in your workshop in safe places?

□No □Yes □I don't Know

(18) Determine the period of tyre waste storing in your workshop?

……

(19) Is their any institution concern of tyre waste collection?

□No □Yes □I don't Know

(20) If the answer yes determine these institutions?

□ Governmental □ institution from the privet sector (Traders) □Individuals □ NGO's

(21) According to your knowledge the wasted tyres collected for the purpose of?

□ Selling outside Gaza □ Selling inside Gaza □ Recycling for the reuse

Others (determine)

……

(22) Are you ready to cooperate with the institutions concerned in tyre waste collection?

□No □Yes

(23) In case you requested to cooperate in tyre waste collection, you will?

□ I will cooperate □No, I will not Cooperate □ I will cooperate with condition payment

Part 3 (Transportation)

(24) Is their any available vehicles to transport the tyre waste to the disposal places?

□Yes □No □ I don't Know

(25) Do you get rid of the tyre waste through random disposal in the street?

□Yes □No □Sometimes

(26) Do you get rid of the tyre waste through storing it?

□Yes □No □Sometimes

(27) Do you get rid of the tyre waste by selling it?

□Yes □No □Sometimes

(28) Do you Know the way of tyre waste disposal?

□Yes □ No □ I don't Know

(29) Do you interested in the process of tyre waste disposal?

□Yes □ No □ I don't Know

Part 4 (Treatment)

(30) Does the workshop renew the tyre waste?

□Yes □ No □ I don't Know

(31) Does the workshop replace the tyre waste in to anew tyre for the consumer?

□Yes □ No □ I don't Know

(32) Does the workshop replace the tyre waste in to used tyre for the consumer?

□Yes □ No □ Sometimes

(33) Does the workshop disposed tyre waste in the cooperation with the municipality?

□Yes □ No □ I don't Know

Part 5 (Environmental awareness and monitoring)

(34) In your opinion do you think that the tyre waste hazardous to health and environment?

□Yes □ No □ I don't Know

(35) If yes , determine when it's hazardous in case of ?

□ land filling □ Open burning □ reuse □ Others □ Determine

(36) Do you Know that tyre waste used in energy generation, extraction of activated carbon, road pavement, and other engineering fields?

□Yes □ No □ I don't Know

(37)Does media used in awareness about tyre waste disposal?

□Yes □ No □ I don't Know

(38)Is their any institution monitoring the workshop?

□Yes □ No

Determine

……

(39) Is their any documents contain the number of new tyres ?

□Yes □ No □ I don't Know

Please note any suitable suggestions to improve the processing disposal of tyre waste in Gaza Governorates.

……

……

……

Annex (4)

مقابلة مباشرة مع المسئولين في الوزارات والبلديات و المؤسسات ذات العلاقة

رقم الاستبيان ( )

الاسم _____ (اختياري)

رمز المحافظة ( ) المؤسسة ( ) الوظيفة ( )

مستوى التعليم .....

1) هل انتم جهة مانحة للترخيص للمنشأة التي تتعامل في مجال استبدال الإطارات الهالكة بإطارات جديدة لسيارات ؟

□ نعم □ لا □ لا أعلم

2) إذا كانت الإجابة نعم هل يوجد شروط لتخلص من الإطارات الهالكة ؟

□ نعم □ لا □ لا أعلم

3) هل يوجد لوائح وتشريعات بخصوص التخلص من الإطارات؟

□ نعم □ لا □ لا أعلم

4) هل تعلمون كيف يتم تجميع الإطارات المستهلكة من المنشأة ؟

□ نعم □ لا □ لا أعلم

5) هل تجدون إطارات هالكة في الحاويات إثناء عملية الجمع اليومي لنفايات المنزلية من الشوارع ؟

□ نعم □ لا □ أحيانا □ نادرا □ لا أعلم

6) هل توجد مكبات خاصة للتخلص منها؟

□ نعم □ لا □ لا أعلم

7) هل تقوم البلدية بالتخلص من الإطارات الهالكة؟

□ نعم □ لا □ لا أعلم

8) إذا كانت الإجابة نعم هل يتم التخلص عن طريق ؟

□ الدفن □ الحرق □ إعادة الاستخدام □ طرق أخرى □ حدد

.....

9)هل يتم مراقبة الإطارات الهالكة في عملية الجمع لدى المنشأة ؟

□ نعم □ لا □ لا أعلم

أولاً: طرق التخلص من الإطارات الهالكة

10)هل باعتقادك أن موضوع التخلص من الإطارات مهم وجدير بالاهتمام؟

□ نعم □ لا □ لا أعلم

11)هل هناك جهة خاصة مسئولة عن التخلص من الإطارات؟

□ نعم □ لا □ لا أعلم

12)هل يوجد تنسيق بين المنشأة للإطارات وبين مؤسستك؟

□ نعم □ لا □ لا أعلم

13) **إذا كانت الإجابة نعم متى يتم التنسيق؟**

□ عند الترخيص □ عند الجمع

14)هل أنت كمسئول راضي عن التخلص من الإطارات بشكل الحالي و ما هو الطريقة الأمثل من وجهة نظركم؟

.....

ثانياً: الإطار القانوني و المؤسساتي

15) ها هناك نظام إداري لهذا النوع من المخلفات ؟

□ نعم □ لا □ لا أعلم

16) هل هناك نظام تسجيل لكمية النفايات من الإطارات الهالكة؟

□ نعم □ لا □ لا أعلم

17) باعتقادك يمكن تحسين الوضع الحالي؟ كيف؟

□ نعم □ لا

.....

18) ما هي خطتكم واقتراحاتكم التي تتبعونها في عملية التخلص من الإطارات الهالكة؟

.....

دون من فضلك أية اقتراحات تجدها مناسبة لتحسين عملية التخلص من الإطارات الهالكة في قطاع غزة؟

.....

.....

.....

Translation for Annex 4

Questionnaire
Interview with Officials from the relevant institutions

Number of Questionnaire ( )
Name _____

Code of the ( ) Institution ( ) Position ( ) Govern.

(1) Education level

……

(2) Does your institution give licenses for workshops which work in tyre replacement?

□Yes □ No □ I don't Know

(3) If yes , is there any conditions regarding to the tyre waste disposal ?

□ Yes □ No □ I don't Know

(4) Is there any rules and regulation regarding to the tyre waste disposal processing?

□Yes □ No □ I don't Know

(5)Do you know how the tyre waste collected from the workshop?

□Yes □ No □ I don't Know

(6) During the daily collection of the wastes do you find tyre waste in the waste containers?

□ yes □ No □ Sometimes □ rarely □ I don't Know

(7) Is there any specific land filling for tyre waste disposal?

□ No □ I don't Know

□Yes

(8) Does the municipality dispose the tyre waste?

□Yes □ No □ I don't Know

(9) If yes , the disposal process carried out by ?

□ land filling □ Open burning □ reuse □ Others □ Determine

……

(10) Is there any monitoring of tyre waste in the collection process in the workshop?

□Yes □ No □ I don't Know

First (Disposal processes of tyre waste)

(11) Do you think the issue of tyre waste disposal is very important and deserve more care?

□Yes □ No □ I don't Know

(12) Is there any especial institution responsible for tyre waste dispose?

□Yes □ No □ I don't Know

(13) Is there any coordination between the workshop of tyres and your institution?

□Yes □ No □ I don't Know

If yes, when that coordination happens?

□ at license stage □At collection stage

(14) As responsible person are you satisfied from the current process of tyre waste disposal , and in point of view what is the ideal process for tyre waste disposal?

Yes □ No □ I don't Know

…… □

Second (Administrative and legal system)

(15) Is there an administrative system for this kind of wastes?

□Yes □ No □ I don't Know

(16) Is their and registration system for the quantities of tyre waste disposal?

□Yes □ No □ I don't Know

(17) Do you think that current situation can be improved and How?

□Yes □ No

……

(18) What is your plans and suggestions you follow in tyre waste disposal?

……

Please note any suitable suggestions to improve the processing disposal of tyre waste in Gaza Governorates.

……

……

……

Annex (5)

Palestinian National Authority
Ministry of Health
Helsinki Committee

السلطة الوطنية الفلسطينية
وزارة الصحة
لجنة هلسنكي

Date: 1/7/2008

التاريخ: ٢٠٠٨/٧/١

Name: Khalil Hassanein

الاسم: خليل حسنين

I would like to inform you that the committee has discussed your application about:

نفيدكم علما بأن اللجنة قد ناقشت مقترح دراستكم حول:-

Assessment of Tyres Waste Disposal Processes in Gaza Governorates

In its meeting on July 2008
and decided the Following:-
To approve the above mention research study.

و ذلك في جلستها المنعقدة لشهر يوليو ٢٠٠٨
و قد قررت ما يلي:-
الموافقة على البحث المذكور عاليه.

Ministry of Health Helsinki Committee
Signature
توقيع

Member
عضو

Member
عضو

Chairperson

Conditions:-

- Valid for 2 years from the date of approval to start.
- It is necessary to notify the committee in any change in the admitted study protocol.
- The committee appreciate receiving one copy of your final research when it is completed.

Gaza Etwam – Telefax 972-7-2878166

Annex (6)

Licensed Road Vehicles in Gaza Strip by Area and Type of Vehicle, 2006

Area	Private Cars	Taxis	Motorcycles and Moped	Buses	Trailers and Semi-Trailers	Agricultural Tractors	Road Tractors	Trucks and Commercial Cars	Other Vehicles	Total
Northern Area[1]	32,220	2,031	180	190	383	579	250	8,337	291	**44,461**
Southern Area[2]	10,152	1,361	39	13	52	553	34	2,451	31	**14,686**
Gaza Strip	**42,372**	**3,392**	**219**	**203**	**435**	**1,132**	**284**	**10,788**	**322**	**59,147**

[1]Northern Area includes both Gaza, and Gaza North governorates
[2] Southern Area includes Deir Al-Balah, Khan Yunis, and Rafah governorates.
Source: Ministry of Transport, 2006