T.R.
ONDOKUZ MAYIS UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
DEPARTMENT OF ENVIRONMENTAL ENGINEERING

USE OF ALTERNATIVE FUELS FROM RECYCLED WASTE AND CLEANER PRODUCTION AT CEMENT PRODUCTION INDUSTRY

Master's Thesis

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Supervisor

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SAMSUN
2023

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ÖZET

ÇİMENTO FABRİKALARINDA ÜRETİM VERİMLİLİĞİ ARTIRMAK İÇİN SİYAH YAĞ YERİNE GERİ DÖNÜŞÜM ATIKLARININ ALTERNATİF YAKIT OLARAK KULLANILMASI

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Kaynakların, özellikle de petrol kaynaklarının kullanımından elde edilen enerji tüketiminin artması nedeniyle, aynı kalitede ve daha az maliyetli alternatifler bulmak gereklidir ve bu alternatiflerden en önemlisi, artık olarak atıklardan elde edilen bir malzemedir. Özellikle dünyada insanoğlunun tüketimini durduramadığı enerji talebi için, üretim süreçlerinde sıcak fırınları nedeniyle yüksek ısıl enerji gerektiren özellikle çimento sektörü başta olmak üzere çeşitli endüstrilerde kullanılabilecek düşük maliyetli en önemli ısıl enerji türlerinden biri Atık Türevli Yakıt'dır. (ATY). Bu araştırma, Çimento Sanayiinde üretim verimliliği (teknolojik değişim ile) iyileştirmeleri sağlamayı ve benzin veya siyah yağ yerine atık türevli yakıtın (ATY) kullanımını araştırmayı amaçlamaktadır.

Üretim verimliliğindeki iyileşmenin derecesini belirlemek için istatistiksel analizlerin kullanılmasının yanı sıra, bu araştırmada ucuz atık bir alternatif ekonomik kaynak olarak kabul edilmiş ve ayrıca çevresel indeks MIP'nin (birim başına girdi malzemeleri ve birim / hizmet) kullanımı daha temiz üretim ve çevresel iyileştirmenin boyutunu hesaplayarak araştırma sonuçları olumlu bulunmuş ve sanayi ürünlerinin üretiminde kullanılan diğer doğal kaynaklara oranla yarı yarıya daha az olduğu belirlenmiştir. Bu da toplam çimento üretim maliyetinin %8,4 azalmasına ve üretim verimliliğinde %5,1 artışa neden olmuştur ve bu oran yüksek olup, MIP miktarı kişi başı 0.167 kg yani çıkarılan tüketilen doğal kaynak miktarı anlamına gelmektedir. Bir kişi için (0,85) kg/gün ile karşılaştırıldığında, bu durumda kişi başına tüketimin daha az olduğu, dolayısıyla daha temiz üretim ve sürdürülebilirlik sağlandığı ve ATY'nin çevre dostu bir malzeme olduğu anlamına gelir. Bu nedenle bu çalışmadan en önemli öneri atıkların (ATY) alternatif olarak kullanılmasıdır çünkü sanayiinin üretim verimliliğini artırmaya ve üretim maliyetlerini düşürmeye, daha temiz üretime ve çevreye katkıda bulunarak, ülke ekonomisinin gelişmesine de katkıda bulunur. Bu araştırma ile, ATY 'lerin yüksek verimli ve ekonomik olması, atıklardan sağlıklı ve düşük maliyetle kurtulunmasına, artıkların tarımda veya inşaatta kullanılması, yeni istihdam yaratması ve işsizliği azaltması nedeniyle tüm çimento fabrikalarında uygulanabileceği ortaya konmuştur.

Anahtar Sözcükler: Katı atık yönetimi, (RDF) Atıktan türetilmiş yakıt, Teknik verimlilik, Tahsis edici verimlilik, Yaşam döngüsü maliyeti, Çevre yönetim sistemi, Hizmet/birim başına malzeme girdisi.

ABSTRACT

USE OF ALTERNATIVE FUELS FROM RECYCLED WASTE AND CLEANER PRODUCTION AT CEMENT PRODUCTION INDUSTRY

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Master, Feburary/2023
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Because of the increased consumption of resources, especially the energy generated from the use of oil resources, it was necessary to find alternatives characterized by the same quality as well as being of lower cost, and the most important of these alternatives is the use of waste as an alternative fuel (Refused Derived Fuel RDF). It is the essential type of low-cost thermal energy that can be used in various industries, especially the cement industry, as it uses furnaces that require high thermal energy during production processes.

Waste characterizes by the fact that it is inexhaustible because man cannot stop consuming. This research aims to achieve improvement in production efficiency (technological change) and the use of waste recycling (RDF) instead of gasoline or black oil to reduce production costs, As well as using statistical analysis to determine the extent to which improvement in production efficiency achieved. Therefore, waste in this research is one of the alternatives and economic resources. As in the use of the environmental indicator MIP (resources input per unit, unit/service) To calculate the achievement of cleaner production and environmental improvement, The results of the research were positive and achieved less than half of the percentage of other natural resources used in the production of industrial goods. All of that led to a reduction in the total cement production costs by 8.4%, achieving an increase in production efficiency by 5.1%, so the percentage considers high. The amount of MIP is 0.167 kg per person, Which means that the quantities of natural resources consumed and extracted from nature are very few if compared with the per capita consumption of resources, which is (0,85 kg/day); the per capita consumption share in this case is less than what achieves the cleanest production and thus sustainability, meaning that RDF is an environmentally friendly material. Using waste (RDF) as alternative energy is one of the essential suggestions because it helps the company's production efficiency while reducing clean production costs and improving the environment. It also strengthens the national economy because of its high economic returns and taking advantage of landfills for agriculture or construction.

Keywords: Solid waste management, (RDF) Refused derived fuel, Technical efficiency, Allocative efficiency, Life–cycle costing, Environmental management system, (MIP) Material input per service/ unit.

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Mustafa Amer Mustafa AL-SAMMARRAIE

CONTENTS

SYMBOLS AND ABBREVIATIONS

AC	: Average Cost
AE	: Allocative efficiency
API (HSR) CLASS G	:High Sulfate Resistant (HSR) cement, to American Petroleum Institute
BTU	: British Thermal Unit
CO^2	: Carbon Dioxide
DEA	: Data Envelopment Analysis
DMI	: The directional movement indicator
DNV	: International certification body and classification society with significant expertise in technical assessment, consulting, and risk management
ECOCEM	: Irish company specializing in the manufacturing of high-performance cement
EMA	: Environmental Management Accounting
EMS	: Environmental Management System
ER	: Ecological Rucksack
FDH	: Free Disposal Hull
G	: class G HSR (High Sulfate Resistant)
GCC	: Gassin Cement Company
GDP	: The gross domestic product
HESC	: High Early Strength Cement
LCC	: Life–Cycle Costing
LIE	: A French industrial company specializing in three main products: cement, aggregates, and concrete
MFCA	: Material Flow Cost Accounting
MI	: Material Input
MIP	: Material Input Per Service/ Unit
MOE	: The Ministry of the Environment Japan
MRF	: Materials Recovery Facility
MSW	: Municipal Solid Waste
OE	: Overall efficiency
OPC	: Ordinary Portland Cement
PW	: Product Weight
RDF	: Refused Derived Fuel

RMX	: Ready-mixed concrete
S	: Service Unit
SRC	: Sulphate-resistant cement
SWM	: Solid Waste Management
TDS	: Texas Disposal Systems
TE	: Technical efficiency
TMR	: Total Material Required

FIGURES LEGENDS

TABLES LEGENDS

1.RESEARCH METHODOLOGY, PREVIOUS STUDIES AND WHAT THE RESEARCHER HAS CONTRIBUTE

The first chapter is the first step from which the researcher started. It contains a brief presentation of the most important previous studies related to the research topic and which can help the researcher view them and benefit from them in the research topic. The possibilities of using them, and what sets this study apart from previous studies.

1.1.Methodology of the Research

In order to solve a problem, one must follow the steps outlined by the scientific method, so the researcher puts possible solutions or possible answers for it, represented in a hypothesis, and then testing the validity of the theory and reaching a particular result either by proof or denial. The method that the researcher relies on upon to test his hypothesis includes the following:

1.1.1.Research Problem

Iraq's industrial sector appears to have a low interest in improving production processes through technological change and the search for cheaper methods and alternatives to achieve economic efficiency, preserve natural resources, and find alternative fuels with lower costs and less environmental impact. How can we cut down on waste that is bad for people's health, the economy, the environment, and society? Does the use of Refused Derived Fuel (RDF), which is a new technology, make production more efficient? Does the waste recycling process (RDF) reduce production costs? Does the recycling process (RDF) achieve environmental improvement through cleaner production?

1.1.2.Research Objective

This research aims to use waste recycling (RDF) as alternative energy and an alternative raw material (technological change), which has improved production efficiency and environmental improvement through cleaner production. The research objectives are summarized as follows:

1. Recognize the role that recycling plays in reducing waste disposal costs.

2. Clarify the possibility of its contribution to improving the country's economic situation by increasing revenues, reducing expenditures, and creating new job opportunities.
3. It analyzes the recycling activity and determines its economic impact.
4. Because there are not enough projects in this area, we are adding to the field of scientific research. Obtaining a master's degree in environmental engineering

1.1.3.Research Hypothesis

The research includes the central hypothesis that recycling waste (RDF) leads to improving production efficiency, and the following ideas branched from it:

1. Technological change (using RDF) leads to production efficiency.
2. The waste recycling process (RDF) achieves a reduction in production costs.
3. The waste recycling process (RDF) achieves environmental improvement through cleaner production.
4. How do we reduce waste disposal costs despite the continuous increase in it?
5. How do we create jobs through our daily waste?

1.1.4.Research Importance

1. The importance of the research lies in improving production efficiency by using technological change in waste treatment to become alternative energy (derived fuels RDF) or alternative raw materials and considering it a resource from natural resources to achieve sustainability, to achieve with it.
2. Reducing production costs.
3. Environmental improvement through cleaner production.

1.1.5.The Research Area

Karbala Cement Factory / Lafarge Iraq Company - in Karbala Governorate, southern Iraq, was chosen as a research community and the scope of its consumer

impact. The cement product was selected as a research sample for the study, analysis, and results in extraction.

1.1.6.Research Method

Following the descriptive and inductive approach in the theoretical aspect of the research, through books, publications, research, previous studies, letters, and dissertations related to the research subject and the international information network (the Internet).

Follow the descriptive analytical approach in practice and investigate the administrative, financial, and final accounts of the research sample company, then use regression to assess the extent of future cost reduction—cleaner production achieved with Material Input Per Service/ Unit (MIPS).

1.1.7.Sources of Data Acquisition and Research Application Area

A variety of sources were consulted for the study's findings: the laws and regulations of Iraq and the Arab world; books and articles from Iraqi and Arab libraries; and information networks (the Internet) that have a direct connection to the study's subject matter. The practical side also relied on the financial data of the research sample's economic unit. For the year 2021, available from its historical records, as it was:

1. Personal interviews are the primary means of gathering information and determining the validity of our hypotheses.
2. A visit to the location and an examination of the mechanism of the sample unit.
3. Examine the publications, seminars, and activities of the company.

1.1.8.Research sample (To determine environmental costs using Environmental Management Accounting Techniques)

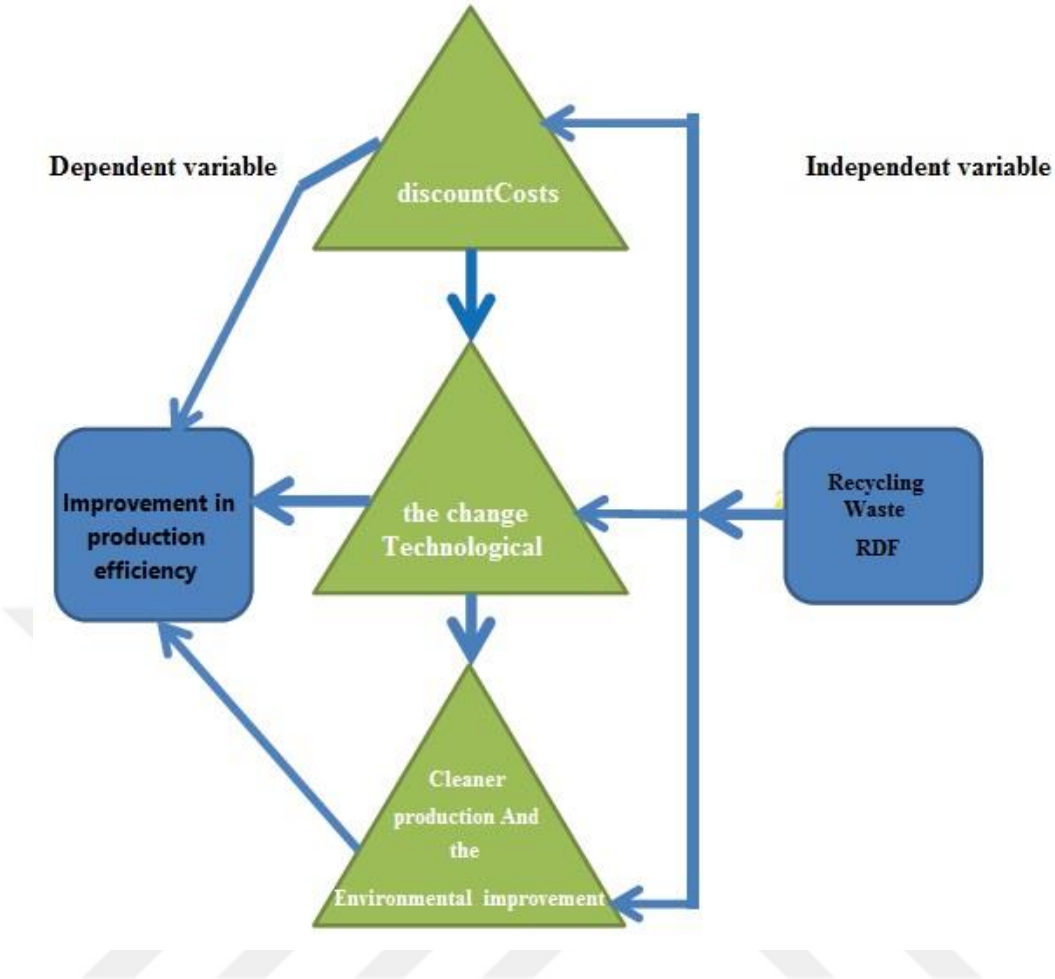


Figure 1.1. Research sample (Prepared by the researcher)

1.2. Previous Studies

A summary of previous studies related to the research topic will be presented, which the researcher can view and benefit from in the subject of the investigation. The studies have divided into two parts: Arab studies and foreign studies:

1. Study (Ali and Ali / 2012) Title of the study: (The Possibility of Exploiting Agricultural Residues and Annual Plants in Iraq)

Purpose of the study: Finding alternative energy resources by recycling the available agricultural waste that can be a source of energy or converting it into fertilizers or animal feed.

The most important conclusion is that Iraq's land is rich in vast quantities of untapped raw materials that can convert into economic value products.

The failure to adopt projects to exploit these resources means that Iraq will remain an importer of products whose import costs exceed two billion dollars annually.

Most important recommendations: The study recommends starting with grain crop wastes because of their quantity and ease of collection, given that they are farmed in vast areas.

That the state undertakes the establishment of these projects, as they have high costs, and it is okay to establish joint-stock companies through which it is possible to achieve this goal, which has multiple economic, social, and environmental dimensions.

2. (Abbood et al.,2009) Study title: (Characteristics and compositions of solid waste in Baghdad)

Purpose of the study: Description and knowledge of the components and types of waste and from what it came. Where Solid waste data survey for the period from 1977 and 2002 has been collected and analyzed, while the solid waste generated in six regions in Baghdad, which were selected and estimated to be 1435 houses and 28643 households for the period 2000-2005 was studied. The growth of Baghdad's population, increasing urbanization and rising standards of living have all contributed to an increase in both the amount and the variety of solid domestic wastes.

The most important results: Waste generated in Baghdad changes according to the economic situation, season, climate, and municipal services.

The rate of waste generated by high-income families is more than three times that of low-income families. The war and siege also changed the way of life, especially in poor areas.

Bad economic conditions contributed to waste reduction and the presence of waste collectors for recycling, but without concern for the health situation.

The increase in solid waste in Baghdad created a significant environmental problem.

With some forethought, more than 65% of waste materials such as metals, glass, and paper can recycle. It would reduce demand and import and eliminate severe environmental problems using a combination of technological options and on a case-by-case basis.

3. Study (Abed and Zumaya / 2014) Study title: (Integrated Solid Waste Management and its Strategy in City Municipalities - Baghdad City)

Purpose of the study: Shedding light on effective waste management systems that lead to strategies to reduce solid waste and its costs, thus reducing pollution resulting from it with economic efficiency. Where the importance of research is based on the importance of protecting the environment from the damage caused by solid waste and the extent to which municipal departments carry out their duties efficiently, effectively and economically, and the extent to which environmental laws are adhered to reporting on the environmental performance of these departments and disclosing deficiencies in performance and the damage they may cause. The absence of a clear framework for the methods of collecting data and information on environmental auditing in general, and the lack of a clear-cut policy for solid waste management in particular in the relevant institutions and in all stages of its flow led to ignoring the diagnosis of weaknesses and lagging in the performance of these institutions in addition to the impact the negative impact of this waste and its treatment methods on the environment and society.

The most important conclusions: The total cost of managing solid waste broke down into the following categories:

Operational costs include the costs of the stages of waste management operations and the expenses and wages of workers, in addition to the management and indirect costs.

The costs associated with purchasing the land, the tools, and the machinery.

Social costs are the costs of the adverse environmental effects borne by the community, which result from the depreciation of the natural resource and resulting from pollution associated with environmental damage.

There is an inverse relationship between the costs of waste management programs and the population size in the city, and this is due to economies of scale that help large residential communities achieve lower waste management costs.

Most important recommendations: Four distinct waste management strategies have been unified (reduction, reuse, recycling, recovery, and converting waste into energy).

They are reducing the amount of solid waste by reducing the consumption of raw materials from the source, increasing recovery rates, and using recycling.

4. The study of (Aljaradin et al., 2011) Title of the study: (Public awareness and willingness for recycling in Jordan)

Purpose of the study: The extent of awareness of the population and willingness to recycle in Jordan, focusing on the social, economic, and environmental foundations.

The most important results: The study proved that there is no awareness about recycling and what materials were recycled.

The majority of the population has information through schools and universities.

The population accepts to learn more about recycling, but without making an effort to achieve this, especially if the recycling sites are far from their place of residence. Therefore, the government should start developing training and awareness programs to demonstrate the economic and health importance to them and the country.

5. Study (Wali, 2014) Title of the study: (Investigation into the public perception of the solid waste management system in Erbil city)

Purpose of the study: The study was conducted on the expectation and attitude of the scientist towards the ground control department in the city of Erbil.

The most important results: The average weight of local solid materials generated in the city of Erbil in the first half of 2012 reached 0.6 kg/person/day, which results in the average municipal solid waste being 1 kg/person/day.

Social and economic factors affect the generation of waste with the increase in the family's monthly income, any positive relationship.

The study showed people's attitudes toward solid waste management, and by using the basic principles of waste management in school curricula and academic levels, awareness can raise. To achieve that, this responsibility rests with the government and community members alike.

6. Study (Hadi, 2014) Title of the study: (Estimation of municipal solid waste generation rate case study of Hilla city)

Purpose of the study: Estimating the municipal solid waste rate for the city of Hilla for five years (from 2012 to 2016), which is the minimum period for the operation of the sanitary landfill site. Where GIS techniques were used to prepare a map for the city of Babylon to find the area of each of its five regions and their geographical

distribution. The number of civilized population and their density in a city were found Babel for each area of the population projection studies. And based on economic studies of population wealth and household output change Total in Babylon.

The most important results: With the increase in the population, the quantities of solid waste generated increase with it. It expects that the daily amount generated will be 698.109 tons/day, and this is to know the critical area of land for landfills.

The annual increase in solid waste is 4% depending on the estimated population increase.

Compared with the percentage of solid waste generation for the city of Hilla with studies and other cities in Iraq, this places Iraq among the middle-income countries.

Compared with the percentage of solid waste generation for Hilla city with other countries, this places Iraq among the middle-income countries.

7. Study (2015, Elfeki & Tkadlee): Title of the study: (Treatment of municipal organic solid waste in Egypt

Purpose of the study: An overview of the problem of treating municipal solid organic waste in Egypt, which constitutes about 56% of the destruction, and focusing on the benefits of managing this waste in Egypt.

The most important results: Fertilizer/ It found that about 11.2 – 12.8 tons/year can produce from fertilizer, with an increase in Egypt of about 54% that contributes to compensating the demand for fertilizer, and this increase increases annually with the increase in waste.

Biogas Generating approximately 13.34 of biogas, equivalent to (12.94) of natural gas, amounts to 21% of the total gas production in Egypt.

Environmental Sustainability and Job Opportunities/ The use of organic waste treatment in the right way will reduce the harm to public health and the environment. As a result, producing organic fertilizer and biogas will create job opportunities for many people.

8. Study (Zhou, 2010) Title of the study: (Improving algal biofuel production through nutrient recycling and characterization of photosynthetic anomalies in mutant algae species)

Purpose of the study: Production of biofuels from green algae *(Chlamydomonas Reinhart)*

The most important results suggest an alternative fuel production system that uses algae biomass and wastewater treatment to make crude oil. The amount of fat in the crude oil will be low, but the number of algae in the wastewater will increase. It shows the uniqueness and benefits of combining energy production and environmental protection in one process.

Biophysical and biochemical characterization of a random sample of transforming green algae has many features in improving photo productivity, light utilization efficiency (when light is low), and protection against oxidation. These unique features help accelerate the development of biofuel production processes to meet global fuel demands.

9. Study (Chinedu, 2011) Title of the study: (Improving energy efficiency in the steel industry through scrap recycling)

Purpose of the study: Investigating the energy consumption in steel production by recycling scrap, saving the necessary energy, and comparing it with other methods of steel production.

The most important result: Is preserving natural resources by recycling raw materials such as iron, coal, limestone, and water.

They preserve the environment by extracting and refining raw materials and reducing air and water pollution.

Disposing discarded steel parts in the environment causes environmental pollution, which also provides sums for people working in the field of scrap.

Steel is an inexhaustible material, as it can be repeated and recycled more than once without losing its properties, quality and value.

10. A study (Mancini et al., 2012): Title of the study: (Application of the MIPS method for assessing the sustainability of production-consumption systems of food)

Purpose of the study: The study aims to estimate the consumption of natural resources due to nutrition from the supply and demand sides using the MIP method (material inputs per unit/service), where we analyzed the use of natural resources along

the supply chain for three basic Italian foodstuffs: wheat, rice and oranges, and by applying these materials to evaluate sustainability of the diet of 13 European countries.

The most important results: The use of water and air, for example, can be seen at varying amounts across the many stages of food production, making this aspect of food production more significant in terms of the consumption of natural resources. Growing populations and improved economies present a new challenge for agriculture, particularly in the area of MIP-financed natural resource management and food financing. The program is proposed to improve agricultural enterprises' environmental efficiency and shift them to use fewer external inputs. Double the environmental benefit, lessen the need for inputs, cut production costs, and place more attention on human health are all possible results of this. Costs to the public health system will go down, and beneficial organic ingredients will be prioritized.

11. Study (Forbid, 2012): Title of the study: (Thermal recycling of plastic waste using pyrolysis –Gasification process for energy production)

Purpose of the study: Using the appropriate technology to convert plastic waste into a gaseous mixture, producing massive energy without pollution.

The most important results: Classifying the types of plastic waste, starting with manual sorting and evaluating the available options.

Design and build the appropriate technology for pyrolysis processes to convert plastic waste into energy.

They evaluate technology efficiency based on engineering, mass, and energy analysis, including social, economic, and environmental impacts. PG technology has given the best result at reasonable prices. This technological approach can improve fuel and combustion efficiency and reduce gas purification costs in engines and combustion plants.

12. Study (Manoharan et al., 2013) Title of the study: (Waste minimization and cost reduction in process industries)

Purpose of the study: The study aims to reduce the losses in angle iron and zinc in the coating processes of angle iron before finishing operations.

The most important results: Researchers safeguarded all production stages by decreasing damage and cutting production costs using magnets built to specified specifications. It reduces waste and boosts production.

13. Study (Feit, 2013) Title of the study: (Curbside trash and recycling collection on Lenox. Massachusetts: A Cost-Benefit Analysis)

Purpose of the study: Study and analyze the cost and benefit of implementing the waste collection and recycling program in the city of Leonex by residents or using a third party through a contract to carry out these tasks.

The most important results: According to the study and analysis, recommend that the city of Leonex adopt the implementation program of waste collection and recycling, and the adoption of such a program will have a great benefit to the residents of the city of Leone in the short and long term, and even in the worst case, it is beneficial even if the percentage is lower.

14. Study (Andersson et al., 2014) Title of the study: (Sulfur recirculation for increased electricity production in waste -to- energy plants)

Purpose of the study: Recycling sulfur, reducing hydration corrosion rate, and increasing waste electricity production.

The most important results: Recycling sulfur can be used in the waste plant and convert waste into energy through thermal boilers by cleaning it with flue gas without increasing the corrosion of the thermal boilers, which leads to a significant reduction in boiler damage by one-third.

15. Study (Elnour & Laz, 2014) Title of the study: (Tire hazardous disposal and recycling)

Purpose of the study: The study focused on tire recycling and how to dispose of the hazardous waste it generates.

The most important results: Without frequent reports and information management systems, there is a lack of knowledge regarding hazardous waste tires. It is possible that the authorities and concerned parties can determine the extent of waste disposal or recycling, so there must be information management to collect and analyze information correctly.

The problems of hazardous waste tires and their adverse effects on the environment and finding solutions to them are far from the authorities and concerned authorities.

A lack of coordination among government agencies, business associations, nongovernmental, and neighborhood groups organizations. To our knowledge, no Arab country is doing enough to spread information and educate its citizens about proper trash management and recycling.

Some waste technology, such as outdated incineration, may have environmental impacts, not in one city but the whole country.

Inadequate legal legislation for hazardous waste, as there are no specialized people to set up workshops, is a necessary process. There is also a shortage of workforce in this field and a lack of information, experience, and essential modern techniques for decision-makers that significantly impact the management of hazardous waste, as well as a massive shortage of funding the financial necessary for such work.

16. Study (Mahapatra, 2015): Title of the study: (Study of municipal solid waste of Delhi for energy content)

Aim of the study: Discuss the energy content of municipal solid waste in Delhi so that some appropriate techniques for waste disposal can adopt.

The most important results: The energy content was less than the developed countries, and then burning waste alone cannot be the solution to the problem of waste disposal in the capital of India, Delhi, where this waste must convert into value-added products such as (liquid fuels, chemicals, commodities as well as electricity) and to do that we need for more efficiency than just incineration, modern technological options must consider improving waste management.

17. Study (Krüger et al., 2014): Title of the study: (Separation of harmful impurities from refused derived fuels (RDF) by a fluidized bed)

Purpose of the study: Using new technology to separate the impurities from the derived fuel (RDF) using the cradle, depending on the circular motion of the cradle and as a result of gas injection, and in an engineering way, the RDF particles suffer from the centrifugal force, and this allows cutting the impurities into tiny particles, which will enable them to be isolated because it has a higher density than RDF.

The most important results: The new technology for separating unwanted impurities from RDF, and unlike the existing methods, is to increase the quality of RDF or any other similar materials while continuing to improve the design to ensure the efficiency of separation and accuracy, as the work was done in batches and not in the form of sets of mass flow processes. The latter needs continuous work and unexpected complications may occur, so this will take into account in the future.

1.3.Benefiting from Previous Researches

The previous studies are the starting point because they represent a presentation of the theoretical and practical aspects. Through them, the researcher can complete what the researchers started, but from a different window, considering the cognitive development that achieves new and tangible additions. Summary of the studies:

1. There has been a lot of research and studies on waste management, treatment, recycling, characterization, or conversion into alternative energy, whether thermal or electric. In particular, Abd and Zumaya's research shows that successful solid waste management leads to strategies to minimize trash and expenses, which in turn reduces the amount of pollution produced by it, and does so in a manner that is both environmentally friendly and economically efficient.
2. Mancini et al., (2012) :780 study estimated food consumption using MIP to assess diet sustainability in 13 European countries.
3. Manoharan and Feit's et al., (2013) study focused the first on reducing spoilage and cost reduction in industrial processes and the second on the cost-benefit analysis of recycling.
4. A study by Krüger et al., (2014) on the quality of fuels made from RDF improved and grew.

What distinguishes the current study and the contribution it makes?

1. The study included counting waste as a natural resource, which achieved three essential variables: achieving production efficiency and reducing production costs, as well as achieving environmental benefit, and this is the most critical characteristic of the current study from previous studies, as it did not include such variables.

2. What is different about choosing a research goal and how to get there? The research was mostly about how to save money by recycling trash.
3. The current study emphasized the achievement of productive efficiency.
4. Use of cleaner production through technological change.
5. The current study also distinguished itself from its predecessors by using the environmental indicator MIP, which came to improve environmental performance and is a global framework for measuring environmental performance and product life cycle monitoring. Through the research, the researcher did not find any Iraqi or Arab study that dealt with the use of MIP and RDF to prove that waste is a resource of natural resource and it achieves productive efficiency and reduces costs. Thus, this study is considered one of the leading studies in this field.

2.RECYCLING WASTE AND ITS ROLE IN REDUCING COSTS, IMPROVING PRODUCTION EFFICIENCY, AND PRESERVING THE ENVIRONMENT

It may come to mind that measuring the success of the economic unit depends only on the quantities of products or on the extent of the possibility of achieving profits by simply relying on the income statement. There must be more than one indication used to evaluate the scope of an economic unit's success. Productivity is one of the most critical indicators distinguished organizations look for as a means of economic and competitive progress. One of the essential points of productivity is efficiency, as it shows the company's general performance by evaluating the monetary unit's ability to achieve outputs with the lowest level of inputs. One of the most important ways to reduce production costs and improve production efficiency is through technological change, which includes either the production of a new type of commodity or the modernization of the production method. Cement production stages can replace by the use of the RDF waste recycling method (RDF) as an alternative to gasoline for cleaner production, and technological developments and changes are the main engines of growth, which then leads to economic development. This research defined technological change as introducing the RDF waste recycling method (RDF) as an alternative to gasoline to achieve cleaner production.

2.1.Recycling Concept

Reducing trash and its buildup to limit the impact of these wastes and their accumulation on the environment, as well as reducing energy consumption, reducing pollution, reducing water and air pollution, and reducing greenhouse gas emissions, is the goal of waste management. The raw ingredients are classified and separated for this process, and each fabric is re-manufactured individually. During World War I and World War II, the concept was born. An acute lack of some fundamental commodities like rubber pushed governments to gather these items from waste for recycling. Throughout the years, recycling has become one of the most critical waste disposal strategies due to the many environmental benefits this process provides. For all sectors, one of the challenges currently is dealing with the depletion of non-renewable resources, the increase in waste and environmental pollution, and the search for alternatives and solutions. The core idea of recycling is to create or complete closed

circuits. To benefit from products and wastes by reusing or recycling them (EPA, 2015). As the pillars of waste recycling (management) (The Golden Rule)

1. Reduction: is to reduce the raw materials used, and thus reduce waste, and this done:

a. Either using natural materials.

b. Or by using raw materials that produce less waste.

c. Or by reducing the number of materials used in packagings, such as plastic, paper, and metal, and calling attention to the environment. For example, in the United States, many manufacturers of liquid soap have stuck to its concentration until it comes in smaller packages or toothpaste made without its outer carton packaging, which is what called. (waste minimization).

2. Reuse: this means, for example - reusing bottles of plasticfor mineral water after sterilization and refilling the bottles after use, this leads to reducing the volume of waste, but it calls for environmental awareness among the general public on how to dispose of their waste and a simple sorting process for each of the plastic, paper, glass, and metal waste before disposal. In Japan and the USA, colorful trash cans are in every district and street, so paper waste is dumped in green bins, plastic, glass, and metal waste in blue bins, and food waste or what is called biological waste in black bins.
3. Recycling: Recycling is the reuse of waste; To produce other products of lower quality than the original product.
4. Recovery: Heat recovery technology in many countries use, especially in Japan; For the safe disposal of solid waste, hazardous solid and liquid waste, and sludge resulting from sanitary and industrial sewage by burning these wastes under certain operating conditions such as temperature and combustion duration, to control emissions and their compliance with environmental laws. This method was characterized by the disposal of 90% of solid materials and converting them into heat energy that can be used in industrial processes or to generate steam or electrical energy.
5. Upcycling is converting useless waste that cannot recycle into better quality materials or products for better aesthetic and environmental value (EIA,2012:1). The terms "Solid Waste Management," "Municipal Solid Waste," and "Waste Recycling" will be defined, as will the benefits of these practices, as well as the

approaches taken to treat waste in countries all over the world, including Iraq and Turkey.

2.1.1.Solid Waste Management (SWM)

Solid waste management deals with health, the environment, used lands and resources, and economic concerns related to the proper disposal of waste. Population growth, continuous civilizational development, and the rise in the standard of living have significantly accelerated the increase in solid waste in developing countries, which are unable to keep pace with this growth; the same old methods of waste disposal (landfill) are still used (Ouda et al., 2015:2).

Waste management is collecting, transporting, and disposing garbage, sewage, and other waste products. Waste management includes the management of all resource operations for properly handling waste materials, from the maintenance of waste transport trucks to landfills that comply with the health requirements of environmental regulations. (Business dictionary, 2015).

Solid waste management is concerned with increasing the generation, collection, transportation, repair, and disposal of continuous waste. It is a very complex task that requires a lot of collaborative work between organizations and the public and private sectors. The management of these sectors includes the collection, transportation, treatment, recycling, recovery, and disposal of Solid waste municipality (Babader, et al. 2012:1-2).

Waste collection costs comprise the most significant part of the total cost of the waste management system. Any cost savings must start with the collection costs, especially since management is not very good at controlling the other expenses. Any changes or improvements to the collection and transportation system, such as improving the transmission network, must start with the collection costs. Waste is a good example. Figuring out the best route for the garbage truck will have a direct effect on the total cost.

Usually, there are three types of fees or costs in the collection, storage, transportation, treatment, and final disposal of solid waste:

1. Users pay based on how much trash they throw away or how much space it takes up.

2. The expense of pharmaceuticals and trash disposal in sanitary landfills, as well as advances in technology.
3. Production costs represent construction containers, packages, bags, operating costs, and transportation mechanisms.

Depending on the country's currency, solid waste treatment costs can be expressed in dollars or euros. For example, a dollar/person/day or dollar per ton can represent the costs of all stages and methods of solid waste treatment.

The social costs, also known as the external costs, are the prices of the community's negative environmental impacts. These costs result from the depreciation of the natural resource associated with the pollution that causes environmental damage. Environmental pollution caused by solid waste can involve issues such as groundwater contamination and the deterioration of land utilized as a landfill. These additional expenses must be factored into the calculations and added to the overall cost of the waste management activities to provide an accurate picture.

The cost of trash management programs inversely correlates to the city population. Economies of scale assist large population centers in achieving cheaper pricing for waste management, which encompasses the collection, transportation, and final disposal, including recycling. (Abed & Zumaya, 2014:43-45:).

2.1.2.Municipal Solid Waste (MSW)

In the industrialized world, municipal solid waste (MSW), abbreviated as waste, is considered a renewable energy source since it may be re-converted into energy that can utilize in the production or processing of residential areas after the sorting process is complete. By employing it as an alternate energy source at a reduced cost, we can cut the overall cost of energy production. A landfill or incinerator would be unproductive and dangerous waste disposal if this material were not collected and reused. There are many types of municipal solid waste (MSW), including domestic junk such as appliances and furniture and home garden waste, as well as a hazardous material that the local council declined to remove from street sweeps, commercial waste, and construction and demolition debris. (Remy, 2012).

Municipal solid waste refers to materials disposed of in urban areas, including household and sometimes commercial waste collected by the municipality. Municipal solid waste (MSW) contains a large portion of the paper, food scraps, wood, tree and

garden residues, and cotton. Leather and all materials derived from fuel (oil), such as plastic, rubber, and fabrics, are also all found in municipal solid waste (Cheng & Hu, 2010: 3816).

Municipal solid waste is any unwanted or produced materials rejected by various human activities and society. It generally consists of foodstuffs, garden waste, paper, plastic, demolition, and construction waste. The waste generation rate varies from place to place as it depends on several factors, including the level of Income, cultural status, and geographical location (Jain & Singhal, 2014:374).

Waste contains organic (fruits and vegetables) and inorganic (plastic, paper, and glass) materials that do not have any medical, industrial, radiological, or agricultural waste (Haider et al., 2015: 100). According to his definition (Bajaj & Kumar, 2013:2), it consists of anything that has been discarded, including solid, liquid, and semi-solid materials as well as gaseous waste from byproducts, scrap, ash, and sewage waste. Direct land pollution is caused by industrial, commercial, agricultural, and agricultural operations and other community activities, and indirect air and water pollution is caused by these same processes and activities.

2.2.Recycling and Technological Change

One way to reduce the environmental effects of production processes is to use technological change. This can be done in three ways: first, by making services more efficient (inputs minus outputs) with less polluting technology; second, by substituting less polluting inputs with technological change or by replacing production processes with cleaner alternatives; and third, by defining environmental change as a process with three main stages (González, 2009: 861).

It can also mean new processes, policies, technologies, systems, or products that help avoid or reduce adverse effects on the environment. It includes all changes in the product or production process that affect sustainability, such as waste management, ecological efficiency, reducing harmful gases, and recycling, i.e., all improvements. Activities that keep happening affect the environment (Marchi, 2012: 615).

The understanding of the process of technological change is essential for two reasons; the first is that the environmental impact on social and economic activity is greatly affected by the speed and direction of technological change. New technology may create or increase polluting activities. Also, many environmental problems and

policies are evaluated and studied over a long period to figure out the effects and uncertainty of these policies and future technological changes to reduce future environmental issues and know the importance of improvements needed to avoid these problems, such as improvements in energy efficiency in terms of cost to reach specific policy goals. Second, environmental policy inputs create new obstacles and make it harder to achieve policy goals. (Jaffe et al., 2003:463).

Because of the continuous increase in population growth, the consumption of all materials used by humans increased, and then the amount of waste increased with it, which led to a litter of raw materials, and energy. Finding ways to profit from this waste was necessary to obtain alternatives trash. There are many types of recycling, such as: recycling household waste (municipal solid waste), recycling industrial waste, recycling building materials, recycling agricultural residues and using them in construction or producing other agricultural products from them, and recycling water, and Prior to the advent of modern recycling technologies, most municipalities just dumped their garbage in a landfill or burned it, but now there are a variety of options for properly recycling this material.

Waste today is a source of income for many countries in the world through recycling operations, and recycling is the third element in the waste hierarchy, as shown in Figures (2-1). The scale classifies waste management options according to what is best for the environment, as it gives the most significant priority is prevention in the first place. Waste generated gives priority to preparing waste for reuse, then recycling, then recovery (reform), and last is waste disposal landfilling (Derfa, 2011:2-3)).

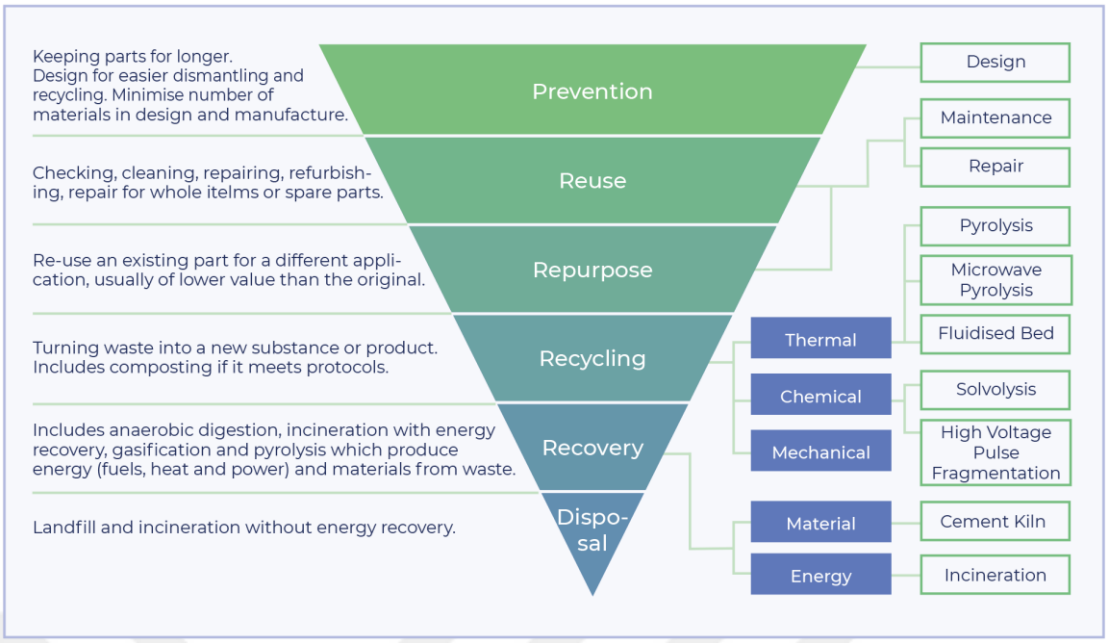


Figure 2.1. Waste hierarchy (Defra 2011)

Recycling is converting waste into usable products to prevent waste in valuable materials and reduce the consumption of primary raw materials, energy use, and air and water pollution by reducing the need as little as possible to reduce greenhouse gas emissions. Recycling is the third element in the waste hierarchy, and in Figure 2.2. the international mark refers to the waste recycling process.

Figure 2.2. Waste hierarchy

The recycling process includes treating waste as raw materials in the same process that generates it or in other methods. Recycling is one of the best alternatives to managing municipal and agricultural waste. Waste recycling depends on the

economic feasibility of these processes and the demand for different products. The scraps subject to recycling are: (paper, glass, bone, cloth, plastic, metallic waste, and organic waste) (Abed al-Zahir, 2011:98).

Recycling is the collection of waste materials and the process or recycling of them into either (biological, mechanical, chemical, or thermal) new products and marketing them (Zhuo & Levendis¸ 2014:1-3) The benefit or purpose of recycling (EPA, 2015:1) is:

1. Reducing the amount of waste sent to landfills or incineration.
2. Preserving natural resources such as wood, water, and minerals.
3. It helps to find good-income jobs in the field of recycling and manufacturing.
4. Energy-saving.
5. Reduces greenhouse gas emissions that contribute to global climate change.
6. It helps preserve the environment for future generations.
7. It helps to find new job opportunities in manufacturing and recycling.

A solution to some of the waste problems found in recycling, which reduces landfill and burning operations and the number of lands utilized for this purpose, is a factor in preserving the environmental and healthy balance to gain a cleaner environment and lower prices for alternative materials. For example, raw materials account for 60% to 90% of manufacturing expenses in the chemical sector. Thus, the low-cost raw materials from chemical recycling opened a new way to reduce the cost of value-added manufacturing products. (Zhuo & Levendis¸, 2014:3)

2.3.The Importance of Waste Recycling and Its Experience in the Developed World, Turkey, And Iraq:

Conserving energy is crucial if we are to successfully mitigate the effects of global warming in the years to come. Regardless of the energy needs of individual TVs or environmental considerations, the energy saved by rotating a single metal plate is sufficient to power a TV set for around three hours (forests, rivers). It has become increasingly important in the issue of recycling. About half a million trees are thrown away each week in the United States, and minimizing the amount of waste dumped in

landfills is critical to preserving the ecosystem. He previous paragraph indicates the large volume of waste sent weekly to landfills. This estimate is for only one product (the daily newspaper), so how about combining the rest of the products? (Moss,2011:2).

Helping to protect the environment through recycling can be done in several ways. It is important to be aware of the importance of refining some materials to reduce not only the existing landfills but also the creation of landfills in the future that will establish as a result of the excess volume of garbage. In addition to improving the environment by conserving forests and rivers, we reduce deforestation to preserve the environment and wildlife from the danger of demise, as one of the main reasons for relying more on refining. (UMICH,2014:2).

1. Energy-saving.
2. Cleaning nature from industrial waste.
3. Reduce waste in landfills.
4. Preserve and help the environment

2.3.1.Waste Treatment Methods in the Developed World

The process of waste disposal has become a source of concern in industrialized countries with high population density and technological progress. Therefore, these countries have created safer ways to dispose of waste, as some of them cause health and environmental risks. Accordingly, some countries have developed laws and regulations for disposal methods. These methods are:

1. Incineration: garbage to produce gas and ash. Filters prevent pollution in less expensive waste recycling plants.
2. Sanitary Landfill: Waste that cannot be recycled is disposed of by landfill using modern methods, where a protected lining is placed under the waste to prevent harmful chemicals from leaking into the groundwater and covered with sand or building materials such as cement or asphalt to seal each layer from the other To avoid leakage, and they are usually on lands outside residential areas (Antonangeli, 2015:1-2).
3. Recycling: It is one of the well-known methods of waste management, and it is not very expensive, significantly as it will save energy and sources of raw

materials, then reduce pollution and can save money on the materials that can recycle: (paper, glass, aluminum, and plastic) and the most developed countries Encourage residents to recycle by providing tools and places for sorting.

4. Composting: It is a natural process free from dangerous secondary materials. This process includes breaking the materials into organic compounds so that they can be used later as fertilizer after leaving these organic materials to decompose for several months.
5. Plasma gasification: It is one of the methods of treating solid waste, including hazardous waste, and can recover energy. Using gaseous plasma gasification, the organic breakdown of solid raw materials turns into high-energy gaseous materials that can operate as fuel or chemicals. Inorganic materials become solid and can't clean. They can be thrown away safely or used again as building materials. (Janajreh, Raza & Valmundsson, 2013:801).

There are many questions about how the recycling system works. It may seem at first glance that it is complicated. Still, it is straightforward after the collection of waste, which carries out by the municipality (official) or specialized companies (informal), and sometimes contracts are made between official and unofficial authorities. Which is (collecting, sorting, and recycling waste) sorted according to the specific and recyclable items. Each item is sent to the concerned authorities to melt and reuse in the industry and the relevant party. There are three main recycling processes (DPW, 2015:1-2) which are:

1. Collection and process: The recycling cycle begins with the process of assembly, and the collection of recyclable materials varies from one community to another, but there are five primary methods, collected on the sidewalk before sorting, displayed on the unsorted sidewalk, collection centers, buy-back centers, deposit, and financing programs, When separating recyclable materials, this is called (pre-sorted), and when the waste collector separates them from dirt, this is called (unsorted).
2. Manufacturing: Regardless of how recyclable materials are collected, the post-assembly stages are the same. Recyclable materials are delivered to material recovery centers for processing and preparation and then marketed for production. Recyclable materials are bought and sold like any commodity, and

their prices change according to the market situation. After cleaning and sorting, the materials are ready for the next stage of the recycling cycle.

3. Purchasing Recycled Products: Purchasing recycled products completes the recycling cycle by purchasing recycled materials. Government agencies, as they are companies and consumers, play an essential role in the success of the recycling process, as consumers demand more friendly products. For the environment, manufacturers will keep trying to meet these demands by producing new, high-quality recycled products.

2.3.2.Recycling in EU

Waste affects the life of every human being, and on average, every 50 million people in Europe throw away about half a ton of household waste annually. Among the list of enormous waste generated from activities such as industrial (360 million tons) and construction (900 million tons);. In comparison, water supply and energy production generate Together (95 million tons), and the European Union produces (3 billion tons) of waste annually.

European waste management policies aim to reduce waste's environmental and health impacts to improve European resource efficiency. The long-term goal is to transform Europe into a recycling society that avoids the formation of destruction and the use of unavoidable waste as a resource whenever possible, to achieve the highest level of recycling, and reduce the extraction of additional natural resources. Proper waste management is essential in ensuring resource efficiency and the sustainable growth of the European economy.

The European Environmental Action Sixth Program (2002 - 2012) defines waste prevention management as one of the top four priorities in the program. The directive focuses on waste prevention, from waste being an unwanted burden to seeing it as a valuable resource. It places it among the new goals that will help Europe achieve its goals of being a society based on recycling. These goals include recycling 50% of municipal waste and 70 % of construction waste by 2020 (EU, 2010:1-4).

According to a previous study on behalf of the European Commission, implementing the measures outlined in the directive of member states would reduce waste production in Europe by 4%. It will decrease by approximately 50%. Moreover,

this will enable member states to achieve annual savings of more than (72 billion euros) (EWWR, 2015:4-6).

(What a waste) the magazine forecasts that by 2025 the daily production of municipal solid waste in Asia will be about (1.8 million tons). These estimates are still accurate, as the daily generation of garbage in South and East Asia and the Pacific is approximately (1 million tons per day). The low-income countries continue to spend the solid waste management budget on waste collection to eliminate it, unlike the high-income countries that benefit from it (Worldbank, 2012: 2).

2.3.3.Recycling in Turkey

Turkey started recycling its waste quite late compared to some countries, which is not too bad, although there is room for improvement. By 2012, there were 672 waste management facilities in Turkey, of which 589 Oriente toward recycling. These facilities handle about 60% of the country's waste. About 39% of the waste goes to landfills, and 38% of the waste is recycled. Turkey produces about 25 million tons of domestic and 1.2 million tons of industrial waste annually from the total waste it recycles, 43% of paper, 27% of plastic, 12% of glass, 8% of textile, and 4% of metal.

2.3.3.1.Reducing reuse in Turkey

Turkey is not a particularly wealthy country, so it tends not to have a lot of "craps." Turkey's food makes from fresh produce, so packaging waste is not a big deal. Many of these products are grown and purchased locally, automatically reducing the carbon footprint of food that needs importing. Many Turkish people make their products.

Solar energy is widely used for water heating to make use of abundant sunlight. Thermal heat from the earth using to provide heating and hot water. There are examples of recycling initiatives in Turkey ،Where schools in Bursa participated in recycling and garbage sorting projects.

In the major industrial city of Eskişehir, companies collect and recycle products for profit. A thriving industry has the added advantage of providing local people with jobs. The mobile phone company, Nokia, has been recycling old cell phones, batteries, and chargers since 2008. In Konya, there are battery recycling points in schools, shopping malls, and hospitals.

The EU will also work with the Turkish government and industry to develop best practices in waste management and establish a legal framework for regulations to support any initiatives. As Turkey's industry becomes cleaner, more environmentally friendly, and more efficient, it will help them become more competitive. (EBRD, 2018.)

2.3.4.Recycling in Iraq

After years of wars, economic sanctions, and conflicts, the situation in Iraq is still fragile and still suffering from the repercussions of economic stagnation and lack of access to essential services. The population of Iraq is about 33.8 million people; 71% of the Iraqi population lives in urban areas, where more than half of them live in semi-random conditions; the population of Iraq will reach about 50 million people by 2030, which will put more pressure on access to adequate housing (UNDP, 2014:1).

The Iraqi environment has been subjected to significant damage, including drought, desertification, and increased soil salinity, as 39% of the Iraqi lands suffered from a lack of suitable lands to grow crops in the period (2007-2009). 1.6 million Iraqis (UNICEF,2011:4).

These empty lands incorrectly led to a large gathering of waste, and then the lack of these lands could have using for agriculture or housing purposes instead of landfilling. This large gathering of waste helps the spread of different types of rodents and insects. The primitive methods of waste treatment, such as burning or landfilling In areas aren't allocated correctly, have increased the pollution of the environment and spread diseases and harmful insects.

The latest reports of the Iraqi Ministry of Health to the World Health Organization indicate that 198 government hospitals in the country contain 139 incinerators. Only 40% of them are partially working, and the rest are not working. At the same time, the number of health centers is 1,750 centers in which there are 51 incinerators, of which only 5% are working. Municipal waste includes waste from kitchens, hotels, groceries, shops, construction and construction demolition, and glass, plastic, paper, cardboard, and metal cans. Its daily generation and heterogeneity characterize it. It is a suitable medium for bacterial growth and emits unpleasant odors if accumulated for a long time (Al-Assaf, 2010: 1-2).

In Baghdad, a waste sorting and recycling plant was opened in Mahmudiya, the first recycling plant in Iraq, with 50 acres and a design capacity of 200 tons per meal, for 15 million dollars. You are compressing it and transforming it into materials that are returned and sold in the market, a plant for the treatment of waste juice, and the process of sanitary landfill. It also includes many mechanisms, presses, a wood chopper, a tire shredder, a machine for extracting iron from tires, and a medical waste treatment plant. (Baghdad Governorate Message, 2013).

The researcher's research and questions about the lab, how long it worked, what stages it went through, and its results found that the lab stopped working because of the situation in Iraq's governorates.

2.3.4.1.The Applicable Recycling Process in Iraq

The municipal regulations in Iraq are still the same; However, there are attempts to introduce recycling operations through establishing special centers and laboratories, but they are not complete due to the country's circumstances. The recycling process in force in Iraq can be summarized as follows (Ministry of Environment, 2014: 2-6):

1. Waste collection: Various garbage collects from residential areas, general stores, and streets using the following systems:
   a. Personnel who work for the city of Baghdad or its local municipal directorates sweep up trash using specialized vehicles.
   b. Collected by the people in the areas not served by the municipal system, where the people throw garbage in the bins on the streets if available or throw it randomly on the roads inside residential neighborhoods or open squares.
2. Lifting and transporting municipal waste: After collecting waste from different sources and containers in the streets, it is transported by municipal cars to temporary collection centers (intermediate stations) and transported to open dumping sites by carrying cars.
3. Solid waste treatment: There is no natural treatment for solid waste except for some attempts made by certain people to sort materials such as metal and glass cans and others used when selling them. It is a significant threat to the environment and human health due to the escalation of gases and toxic compounds into the atmosphere, such as dioxin and others. The executive authorities are currently working to establish laboratories for recycling municipal waste.

4. Methods of final disposal of solid waste: Most Iraqi governorates lack the infrastructure to build sanitary landfills; hence open (informal) dumps like Al-Ammari and Al-Sabiyat in Baghdad and elsewhere are used to dispose of municipal waste. Landfills. As for the general situation of these sites, they lack many specifications and environmental conditions, such as lining and proper disposal of the filtrate, as well as the absence of fences surrounding it, the waste balance, or any other services. As for the sanitary landfill sites, it is a landfill site in Baghdad, and it is under rehabilitation, as it stopped working for its theft, and the clean landfill site in Kirkuk, A modern website affiliated with Diyala, was opened. Still not using it so far. Table (1) shows the number of approved and unapproved landfill sites and stations.

Table 2.1. The numbers of approved and unapproved landfill sites and stations in Iraq (The Republic of Iraq, Ministry of Environment - Municipal Waste Management in Iraq for the year 2014)

Sites that do not have environmental approval	Environmentally Approved Sites	The number of landfill sites
148	44	192
Stations without environmental approval	Stations with environmental approval	Number of transfer stations
74	17	91

2.4.The Punitive Measures of the Ministry of Environment

Waste management is not a priority in developing countries, and it depends a lot on policies and laws, social and environmental culture, economic factors, and the availability of resources. It needs to be studied and cared for, and environmental laws and legislation should make for them. Some developing countries already have environmental laws and regulations that are on par with those in developed countries, but the main problem is that they aren't following them. (Al-Khatib et al., 2010:1).

The most important is control of production, consumption, waste collection, and disposal because it affects health, the environment, and society, as well as cost savings. and landfills. Through this management, it is possible to know how to invest in waste and recycling. (Shamshiry et al.,2014:161).

Solid waste management is primarily concerned with protecting human health, the environment, and the state's and businesses' economic and financial interests. Waste management must maximize natural resource usage while safeguarding human health and the environment. Environmental pollution caused by the rubbish in open locations has led to a mandate from the Ministry of Health. Because of the benefits to human health and the economy that come from using new technology, particularly in trash recycling operations, it has become necessary. From the researcher's point of view, some essential issues must be taken into account when recycling:

1. Acceptance of recyclable waste accomplishes through a variety of methods.
2. Recycling costs money (as opposed to the cost of waste disposal).
3. Recyclables' price in the marketplace (as opposed to manufacturing the product from raw materials).
4. The cost of resources, such as primary raw materials (plastic, glass, metals, wood), energy, and water wasted in the garbage. "
5. Workers' salaries, trash disposal fees, and transportation charges include treatment costs.
6. Relying on processing to replace primary raw materials results in variable quality and quantity of waste.
7. Compare how much recycling costs and how much it saves compared to how the old landfills worked.
8. It educates the population and prepares the necessary supplies for them from the municipality, such as special containers.
9. Rather than transforming it into heat or electricity, focus on converting it into energy.

2.5. Environmental Improvement Through Cleaner Production Using the Environmental Indicator MIP:

As a result of human actions and behaviors, environmental contamination was directly linked to man's consumption of natural resources. Many industries produce carbon dioxide and CO_2 gas, a dangerous gas that contributes to environmental pollution; one of these sectors is the cement industry. This continual consumption leads to waste formation, which results in environmental damage. The global cement industry generates 5% of the total generation of CO_2 gas, contributing to a considerable extent to the worldwide warming process (Mandal & Madheswaran, 2010:1).

2.5.1.The Preservation of the Environment

Cement production in the world generates a carbon emission rate of 0.81 kg of CO_2 per kg of cement produced (Huntzinger & Eatmon, 2009:668). Suppose the population at 7 billion people. Expected that in 2050 it will be about 10-9 billion people (Bradshaw et al., 2009:1) and man annually consumes 220 billion tons of natural resources (Robinson, 2011:2), so how if the population becomes about 10 billion people, what will be its consumption? That is why the European Union focused on a low-carbon economy in 2050 and has Targeted to reach an 80% reduction in greenhouse gas emissions (Siviter et al., 2015: 161) as CO_2 is believed to remain in the atmosphere for 100 years (Hazeldine& Hammond, 2015: 559-560).

The main problem is that as the population grows, so does the amount of waste produced per person. Worst of all is the way waste is treated: about 10 million tons of fuel end up in rivers and industrial facilities every year, releasing 1 billion tons of toxic gases and ash, and 70 percent of waste ends up in landfills, which is terrible for people's health, especially between the ages of 0 and 19 (Skenderovic et al., 2015:2-3). An open dump is the main problem affecting health and the environment, especially the air we breathe. When these kinds of landfills are close to homes, they affect crops, animals, food products, water, and smells. It makes bacteria work harder on biodegradable materials, which burn to eliminate unsanitary and illegal waste.

2.5.2.Finding Solutions

As it was discussed previously, open areas for waste will directly affect human health, generating the so-called “triangle of death” area and causing diseases in the short and long-term. These diseases include stress, anxiety, headaches, irritation of the respiratory system and eyes, heart disease, kidney disease, and cancer (Triassi et al., 2015, 1217:).

Because of this endless waste, the developed world today is constantly trying to find solutions to these wastes and began to turn to prevention until reaching zero waste; these countries tend to put taxes and bills related to environmental (Smith, 2011) for example:

1. In 1992, Sweden taxed industrial boiler emissions, and the UK, Austria, the Netherlands, Norway, and Belgium taxed waste disposal with litter heaters.

2. Environmental taxes on products reflect exorbitant taxes on motor fuels (gasoline and petroleum).
3. Emissions trading rights/tradable licenses for industrial effluents leaked to the Fox River polluter branch in Wisconsin (USA) in 1981. The European Union emissions trading system for carbon used by power plants and large corporations started in 2005.

According to studies, it is possible to combine environmental management (which is concerned with environmental laws and standards and their impact on raw materials, energy, waste, and emissions) and an energy management system (which takes into account the cost of power and efficiency of transformation and generation). The quantities of waste generated and the impact of the company's products on the environment (Gordic et al., 2014:3).

2.5.3.Exhaustion of Resources

The consumption of fuel dominates human welfare and technological development in Europe to obtain energy, and this tremendous dependence on fuel in Europe led to finding alternatives to this fuel (Europa, 2013:4). In America, 90% of the energy is from fuel and 10% from hydro and nuclear power. Fuel is a non-renewable resource. Today, the world depends 40% on fuel for energy. The world's crude oil consumption is about 31 billion barrels annually or 85 million barrels/day. Believed that the world will consume half of the crude oil (extraction and use) between 2050-2020, and it is about to expire in 2100. Suppose it reaches 35 billion barrels/day. We expected that crude oil would begin to reach its peak between 2015 and 2030 (Keller, 2012: 538-558). Figure (2-3) shows the extent of the world's consumption of fuel in the past 200 years per unit (BTU) (Gupta et al., 2013/44).

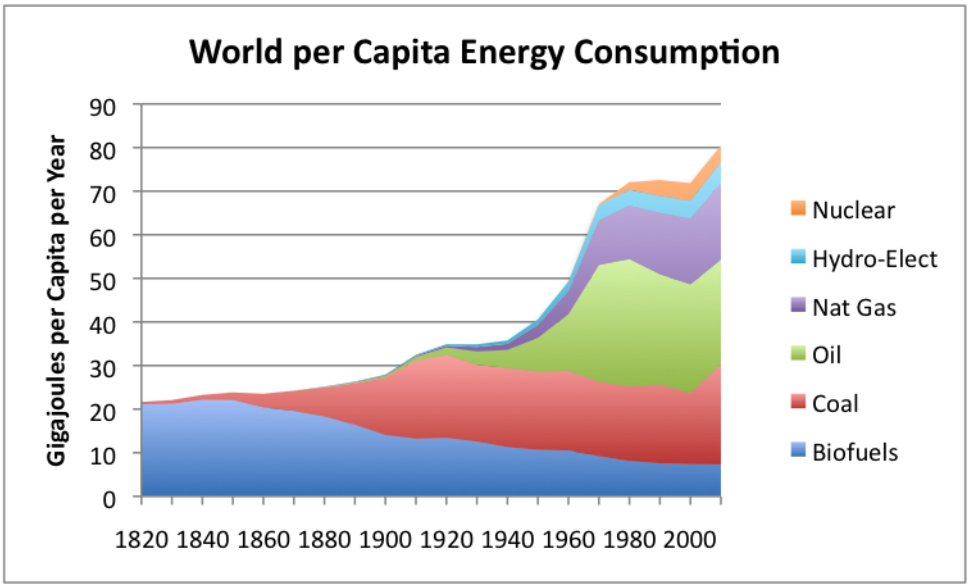


Figure 2.3. Shows the world's energy consumption over the past 200 years (Gupta, V., RA and L. AP. 2013.)

The age of the resources (minerals) is also estimated: gold 20 years, copper 34 years, iron 70 years, nickel 50 years, and manganese 56 years (USGS / 2010). All this leads us to urgently need to reduce natural resources in production processes and use waste as resources—alternative honest.

2.5.4.Environmental Management Accounting and its Relationship to Preserving the Environment:

Due to how technology has changed in recent years and how it has hurt people and the environment, it was essential to pay attention to these effects, study them, and find ways to fix them. Accounting was the most critical area to look at because it has the most impact on lowering environmental costs and the economy as a whole... Environmental elements and financial aspects. Environmental Management Accounting (EMA) is defined as ecological accounting that provides financial data that is affected by the environmental activities of the economic unit. For internal decisions of managers that lead to improved financial and environmental performance (Wahyuni, 2009:3), it also provides a more comprehensive approach to management accounting with a particular focus on costs associated with environmental issues and wasted raw materials (Laforest, 2008:33).

Sociology says a decent lifestyle is necessary to avoid poverty by maintaining average consumption. In most Western countries, the current rate of consumption is

environmentally unsustainable. On the other hand, ecologists debate whether the level of consumption of natural resources and CO_2 gas, emissions reduce sustainability by changing people's lifestyles (Lettenmeier et al., 2014: 682).

Many techniques characterize environmental management, accounting for the implementation of various purposes such as (reducing waste, following the flow of materials, reducing emissions) and others. The Japanese MOE has classified them according to the following (Abdullah, 2009: 97):

1. Environmentally Conscious Target Costing.
2. Life-Cycle Costing (LCC).
3. Environmental Conscious Investment Appraisal.
4. Material Flow Cost Accounting (MFCA)

2.5.5.Environmental Management Accounting and its Relationship to Cleaner Production

Cleaner production is one of the main ways to include the environment in production and operations management. The United Nations Environment Program introduced this idea in 1989 in response to the need to reduce pollution and industrial waste. Its primary goals are to raise awareness of the concept of cleaner worldwide and help governments and industries develop programs for cleaner production. Promoting cleaner production and making it easier for clean technology to be shared (Najm, 2008: 184).

The United Nations Environment Program defined cleaner production in 1996 in the World Declaration on Cleaner Production as the continuous application of an integrated strategy for environmental protection applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment (Berkel et al., 2011:161). There have been numerous descriptions of the concept of cleaner production by researchers. (Ab Rahman et al., 2009:188). Cleaner production basing on a set of practices or options adopted by economic units for its implementation, and the literature in this field indicates that cleaner production practices include the following (Al-Naama, 2007: 77), (Berkel, 2011: 161), (Lee, 2011:85), (Pandey & Brent, 2008:179), (Soulalay, 2006:10):

1. Good operational practices: referred to as Housekeeping, are the procedural and administrative measures of the economic unit that can use to reduce emissions and pollutants, improve efficiency and reduce costs, and practices implemented in all sections of the monetary unit.
2. Changes in raw materials: Changes in raw materials lead to the achievement of cleaner production by reducing and eliminating hazardous/toxic materials that enter the production process and thus reducing the emission of waste and pollutants. Substantive changes are introduced in the form of filtering and replacing materials.
3. Technological change: the changes directed towards making modifications in machines and equipment to reduce the emission of waste and pollutants, and these changes can range from simple improvements implemented at low costs to replacing operations that entail enormous capital costs, such as changing the production process, modifying the interior design for equipment, machinery and the use of automation.
4. Reduction of waste emissions during or after the product's use as a result of adjustments made to the product's design (disposal). Changes to the product's quality criteria, composition, production reliability, and replacement are all part of the development process.
5. Reduce, reuse and recycle: These terms refer to preventing the generation of waste from its source, starting with reducing the use of raw materials and energy, and reusing the waste generated from it to recycling and making it valuable materials through a group of treatments, meaning the repeated use of the product through changing its original use.

Cleaner production increases production efficiency by using raw materials, like conserving energy and water. It helps reduce risks to people and the environment by reducing waste and pollution, especially from using dangerous materials. Or not to use it (by replacing it with other materials). The concept of cleaner production requires changing the orientations of decision-makers in the industry to realize its importance and financial benefits. It also requires awareness of sound environmental management and works to promote technological change.

Material Input Per service/ Unit (MIP) : A method that measures natural and derived resources (material inputs) to provide a specific service or benefit determined by the service unit (Rohn et al., 2014:2).

It is a comprehensive method for measuring the system of resource use in a wide range of production and consumption. (Lettenmeier et al., 2016:2) And MIP can provide the basis for developing different sustainability strategies and pathways related to the (service/product) system (Wiesen et al., 2014:357).

Today, the MIP is referred to as the material imprint and is used to compare the levels of current household consumption and the long-term goals of achieving environmental sustainability (Lettenmeier et al., 1427:2012).

About 90% of the materials taken from nature do not appear in a final form, meaning that the physical footprint for each (kilogram) of industrial goods is used, on average, more than (10 kilograms) of natural resources. The physical print indicates the environmental burden resulting from the use of resources (Liedtke et al., 2013:5).

The Material Input (MI) consists of five categories: biotic materials, abiotic materials, water, air, and erosion (movement of soil in agriculture and forests) and includes biotic resources (from agriculture), non-biological resources (metals and fuels), and water (surface, Under the surface of the earth and the depths of the world), the air (chemical changes) and soil changes in agriculture and forests. Non-vital also includes the total extracted resources used and unused, and the values are expressed in units of mass per unit (service/product), e.g., kilogram, kilometer, and ton.

The concept of MIP has based on the premise that the product is not the end itself but rather a product to fill a need or a limited service. It is not required to measure all of them but rather according to the classification and importance of the calculated materials (Ritthoff & Saurat, 2013:582-583), (Samus et al., 2013:178) (Wiesen et al., 2013:506) (491-490: Lettenmeier et al.,2014).

$$MIP = \frac{MI}{S} \qquad \textbf{(2.1)}$$

The equation 1 is the inverse of material productivity

So, (MI) includes all materials and energy that flow from natural systems to the field of technologies in the form of service units (S). It also includes environmental bags (ER), which are the benefits of using tangible and intangible goods (Ecological

Rucksack). They are the total amounts of material flows added to and counted as part of economic output but are also needed for production, like recycling. (Mancini et al., 2012:780). Or it is the number of natural materials transported away from their original place in the biosphere during the life cycle of raw materials for a particular product (product or service), and it also includes the natural resources used indirectly (Mancini et al., 2010:1834)). The following equation can find the value of (MI):

$$MI=ER+PW \quad \textbf{(2.2)}$$

Where (ER) is the environmental bags (Ecological Rucksack) Eq.2 (PW) is the weight of the product (sample) (Mancini et al., 2012:780)

Implementation of resource efficiency indicators refers to the resource productivity of countries and sectors at the aggregate level. It depends on the established methods' availability and the databases' presence. It allows us to monitor specific materials' economic wealth (export). Still, it does not account for extracted unused materials reflected in resource productivity (GDP/TMR) and total materials required (TMR) to GDP (545: Liedtke et al., 2014).

The portfolio represents the sum of the required economic resources, and this in itself is an indicator for calculating the national economic resources:

$$ER= MI\ (TMR) - Net\ Weight\ (Product) \quad \textbf{(2.3)}$$

$$TMR=Erision + Biotic + Abiotic \quad \textbf{(2.4)}$$

The MIP allows small and medium-sized enterprises to increase profits by reducing the inputs of materials to produce their products or services. It also helps develop an environment for innovative products and services and improves the physical footprint. (Benson, 2014:1-2).

In summary, what was discussed in this topic is that with the continued existence of developments in technology and the improvement of the standard of living of the individual, the consumption of natural resources is increasing day by day, so the countries of the modern world have tended to encourage and encourage recycling, prevention and prevention of waste formation and then reaching zero-damage, For the purpose of calculating the efficiency of resource use through continuous improvement and the use of cleaner production, the environmental indicator (MIP) is used, which came in order to improve environmental performance and is a global framework for

measuring environmental performance and measuring product life cycle monitoring from cradle to grave, i.e. from the first process of extracting it from nature to become in the form of a product, which represents the physical footprint and is an indication of the environmental burden resulting from the use of resources The (MIP) consists of five basic materials: biological, non-biological, water, air and erosion. This indicator will be used in the practical aspect in Chapter Three to demonstrate the efficiency of using RDF waste as a resource from natural resources and a practical application of cleaner production. The cleaner production is:

1. The essential components are being protected.
2. Energy and water conservation.
3. Excluding dangerous, harmful materials and replacing them with less hazardous and toxic materials.
4. There will be less pollution, garbage, and emissions because of our efforts.

3. MATERIAL AND METHODS

3.1 Recycling Waste Using Alternative Fuels (RDF) and Achieving Production Efficiency by Applying the Environmental Indicator MIP to Waste

As we saw in the last chapter, a more productive workforce is an indication of economic and competitive success, and it may also increase earnings and the value of the currency. Household, industrial, commercial, and agricultural waste all have detrimental effects on human health and the environment; we also discussed how the cement industry is the most harmful to the atmosphere. Solutions for these wastes are being proposed in an effort to improve the environment, reduce costs, and enhance national wealth through technological development.

This chapter introduces the corporation, its products, and factories to minimize cement production costs. The MIP environmental indicator applied to the waste (RDF fuel), the benefits of using RDF, and the extent of achieving cleaner production. To attain the required reduction percentage, calculate the product's total cost and compare it to gasoline production costs. To see how efficient, the presentation was.

3.1.1. Bazian Cement Company (French Lafarge) in Iraq

Lafarge was established in 1833 AD in France as a limestone mining company and expanded to become a leader in manufacturing cement, gravel, sand, concrete, and plaster. It has worked in 68 countries worldwide and owns 166 production sites in 50 countries with 1100 work sites worldwide; its production capacity is more than 200 million tons, its direct employees are 3500 employees, and indirect employees are 10000 employees.

The company started its work in Iraq in 2008 in the cement market, after that the field of ready-made concrete in 2011, then producing gravel in 2013. Hospitals, medical services, and agriculture. Today, Lafarge enjoys an advanced position in the market in all its fields of business. It ranks third in the cement industry in the Iraqi market. It is one of the largest non-oil companies operating in Iraq. It currently operates three cement factories, one under construction with 3000 direct and indirect employees. Figure No. (3-1) Shows the extent of Lafarge's spread worldwide using Alternative Derived Fuels (RDF).

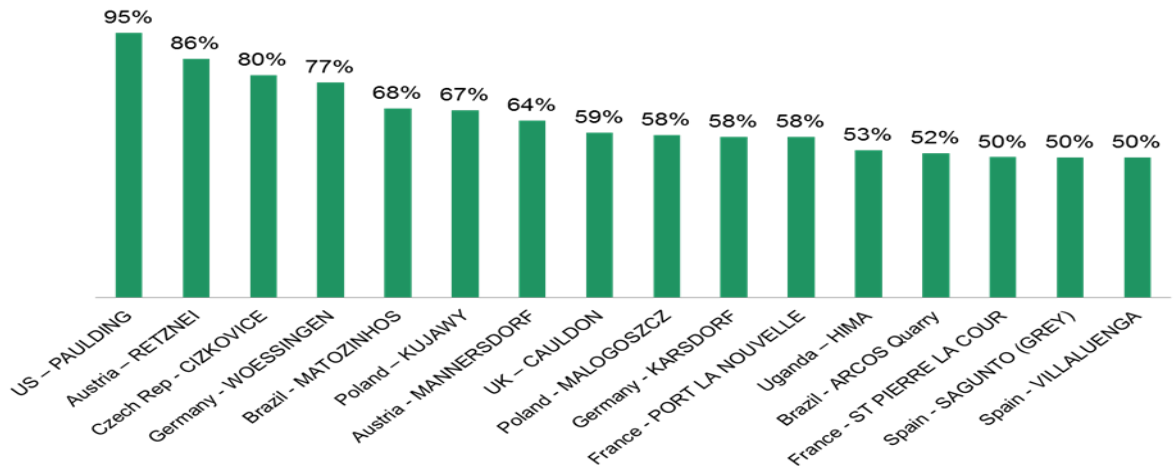


Figure 3.1. It shows how much Lafarge works with alternative fuels all over the world. (Source: company bulletins)

The company's factories in Iraq are:

1. Bazian Cement Factory: The factory locates in Sulaymaniyah, Iraqi Kurdistan. It was built between 2007-2009 to produce Ordinary Portland cement (OPC) and salt- and sulfate-resistant cement, with a production capacity of 2.5 million metric tons/year.
2. Jason Cement Factory (GCC): Projects to improve the capacity of Iraq's cement plant network launch. situated in Sulaymaniyah, close to the Bazian Cement Factory. It is an investment for Lafarge's local partner, Al-Farouq Holding Group. Lafarge is in charge of the plant's construction and management capacity of 2.4 million metric tons annually. Karbala Cement Factory: It is located about 80 km north of the holy city of Karbala and about 180 km south of Baghdad, with a production capacity of 1.8 million metric tons/year of cement. The factory produces resistant adhesives. Figure (3-2) shows the locations of Lafarge's cement factories in Iraq.
3. Tasluja cement factory is located in Sulaymaniyah and was renovated in 2005. Cement facilities and brands associated with this company are well-known throughout Iraq. Ordinary Portland Cement Multipurpose (OPC) designed for the construction of Stone molds; Quick Hardening Cement (HESC) developed to boost production capacity to 2.3 million metric tons per year, and Salt and Sulfate-Resistant Cement (SRC) produced.

Figure 3.2. Shows the locations of cement factories in Iraq. (Source: company bulletins)

3.1.2 Lafarge, industrial ecology and waste and waste management

During 2011-2013, the Bazian and Tasluja cement plant developed the Environmental Management System (EMS), which covers all environmental aspects. International certification bodies DNV awarded ISO 14001 certification to the Tasluja plant in 2012, the Bazian 20B plant, the Karbala plant in 2014, and the Lafarge Group's environmental policy circulated to all Lafarge Iraq operations. Lafarge Industrial Company (LIE) is a subsidiary of the Lafarge Group specializing in waste and waste management. It works to take advantage of the exceptional opportunities of the cement industry to use and treat waste and waste in an environmentally responsible and safe manner. The company is backed by Lafarge's experience and expertise in 64 countries worldwide.

The production processes in the cement factory operate at a high temperature compared to boilers or incinerators, so they can burn fuels that are difficult to burn without any increase in harmful gaseous emissions compared to raw fuels. The added value to waste and waste by using it as an alternative fuel or alternative raw materials achieves the following:

1. Reducing our consumption of nonrenewable natural raw materials and raw fuels aids in the prevention of global warming (gasoline, oil, coal).
2. By decreasing my reliance on the conventional fuels market, I am able to save expenses and increase energy diversity.
3. Recycling rubbish and waste that has been handled and detrimentally placed in landfills is a form of community service.
4. Building sustainability (economic).
5. Here, an indirect economy is being constructed (environmental).

Factories have started using alternative fuels, reaching more than 30%, and assumed that 50% of the energy mix would be achieved (Jasch, C. 2011, 27:256-258).
Lafarge Products

Lafarge Iraq provides a range of building materials for local housing and large-scale infrastructure projects. Distribution networks allow the efficient movement of the company's products and multiple services along with a tight supply chain. The company ensures that all its products comply with the highest local and international specifications. The company works to find tailored solutions to meet customers' needs and provides cement, concrete, gravel, precast concrete, and construction chemicals to all major markets. The company has developed relationships with local suppliers of additional components such as (coal fly ash, silica dust, and low carbon cement). It provides a continuous and reliable cement, concrete, and gravel supply. Cement product offerings guarantee the best possible cost of use as well as contribute to sustainable development. Product development sectors give customers new and innovative products, such as Super Block Cement for the block factories sector. Providing cement for ready-mix concrete customers and sulfate-resistant cement for the main contractors doing infrastructure work is a reliable part of rebuilding Iraq. The company's products include Tasluja, Kersta Cement, Bridge cement, Oil well cement, Concrete, Consistent Quality Gravel Products, and Lafarge Precast Products.

3.2.Cement Industry

The cement industry, in general, is one of the most critical industries in the world, and the demand for it has increased in recent years until it has become the most consumer material. In 2000, about 1.6 billion metric tons of cement producing worldwide, which grew to 4 billion metric tons in 2013, as cement is an essential

material for all types of cement. Construction, such as homes, roads, schools, and hospitals, are among the indispensable basics of life (Albarkoly & Park, 2015:1865). Cement consists of three basic raw materials in which the proportions vary with the different types of cement, which are:

1. Limestone contains calcium carbonate, which is a naturally occurring mineral.
2. Sand contains silica compounds.
3. Aluminum oxide (alumina).

With the addition of gypsum (5-4%) with some iron ores and Table No. (3-1) shows the percentages and materials added in the cement industry and within the Iraqi specifications (Ministry of Environment / Technical Department, 2009).

Table 3.1 A table showing the proportions and materials added in the cement industry and within the Iraqi specifications (Source, Ministry of Environment / Technical Department, 2009)

Materıal	Lımestone %	Clay %	Gypsum %	Kıln Feed %
$CaCO_3$	38.22	23.66	26.33	35.88
SiO_2	7.94	35.56	4.57	13.83
$Al2O_3$	1.13	12.56	0.46	3.12
$Fe2O_3$	0.6	5.2	0.5	2.4
CaO	49.32	16.84	25.11	41.11
MgO	1.41	3.38	1.72	2.13
SO_3	0.63	1.56	40.76	0.77
Total				**99.24**

The basic steps in the cement industry are:

1. It was crushing, grinding, and mixing the basic raw materials into a homogeneous powder.
2. The raw materials mixture is being heated to above 1400 degrees Celsius in kilns to create clinker.
3. Grinding the formed material (clinker) into a fine powder, mixing it with additives, and producing cement. (Harvey, 2010: pp)

Energy use in the cement industry has constantly improved for economic reasons, so the possibility of further reduction is relatively low. The International Energy Agency

has shown that energy efficiency at the global level can only contribute to a minimum of 10% of CO2 emissions in the global cement industry (Schneider, 2015: 14-15).

3.3.Waste Alternative Energy and Its Relationship to The Cement Industry

Municipal solid waste is a mixture of household waste and a few industrial and agricultural wastes. This waste is a good resource for renewable alternative energy as it contains large quantities of vital materials such as paper, wood, and food. Minimizing trash production and maximizing recycling are cornerstones of sustainable waste management, both of which contribute to mitigating greenhouse gas emissions and slowing the rate at which the planet is warming. Unfortunately, not all of this stuff can be recycled, thus cutting down on garbage is an absolute must. When it comes to incineration waste, the best way to maximize the overall energy efficiency is to use advanced technology such as derived fuels (RDF) to produce energy from the waste. This results in high thermal energy, which is the best option. Cut down on your reliance on fossil fuels. (Ryu, 2010: 176).

It is estimated that in 2011, the cement industry provided 65.7% of the fuel used in the European Union, while the use of biological materials such as animal food waste and sewage sludge provided 8.7% and the use of fossil fuels provided 25.6%. (RDF). (RDF) has become popular as an alternative fuel because it is made from municipal solid waste and has a lot of thermal energy. The ratio of organic to inorganic materials is a meaningful way to assess carbon dioxide (CO2), in the burning process, especially in the cement industry, and employing RDF as an alternative to fuel because of the homogenous gas that burns directly in the pre-calcination stages, alone or as a co-fuel. Each kilogram of biogas equals 2.5 cubic meters at standard temperature and pressure. (Saigures (3-3) and (3-4) Fuel Flow and Technology Change (RDF) in Cement Production Processes.

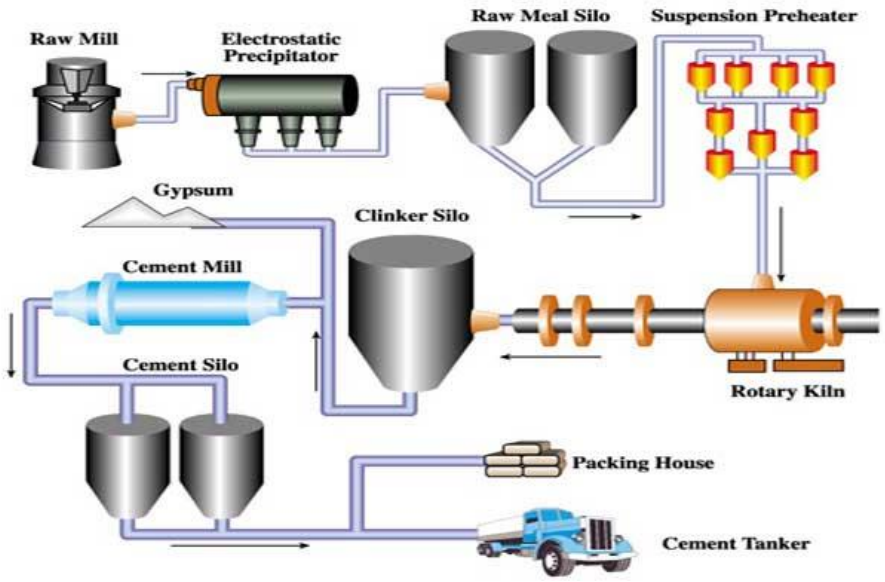


Figure 3.3. Production flow using regular fuel (Source: company bulletins)

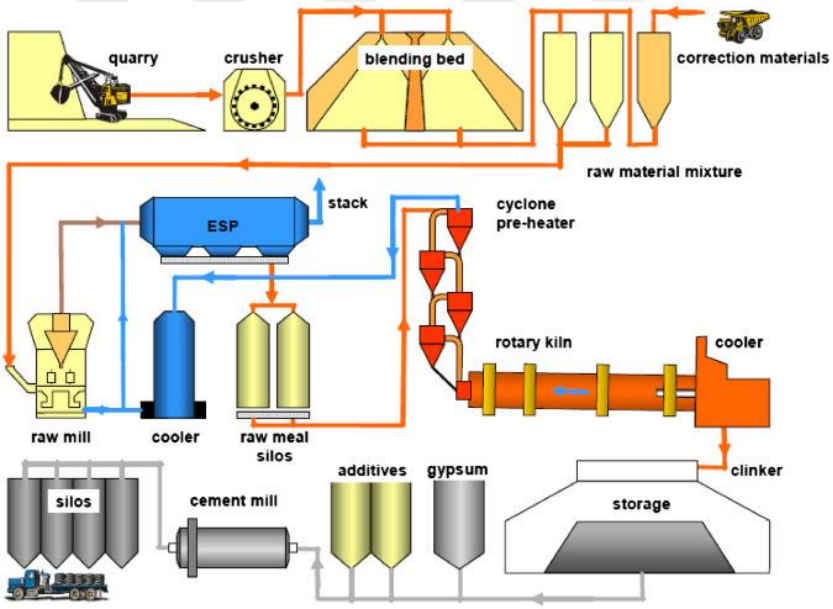


Figure 3.4. Technological change and RDF flow in cement production processes (Source: company bulletins)

3.3.1.The Process of Converting Waste into Alternative Energy (RDF):

There are several steps of the mechanical processes for the production of RDF, which are as follows (Kruger et al., 2014: 392-390).

– The first step: The waste sorted, and this usually takes place in the waste treatment plant, where wastes that conflict with the RDF are removed and are

prohibited, such as: (radioactive waste, waste containing asbestos, contaminated medical waste, peroxide, and strong oxidants, chemical or biological weapons, and entire batteries (mercury), unknown waste and waste containing polychlorinated vinyl. And Figure 3.5. shows the processes of sorting and production of (RDF).

– The second step: The waste is cut and sieved to prepare the waste stream for subsequent sorting techniques, after which the waste stream divides into higher and lower thermal parts. The methods used in this step are air pumps, wind sieves, and ejectors, then the chlorine materials are removed by detection using infrared radiation.
– The third step: Here, the sorting processes carrying out in several stages; ferrous and non-ferrous materials are carried out magnetically and removed from the stream. After the sorting process completing, the grinding process occurs, where the (RDF) size reduces to the required extent. The materials are taken: (used tires, used motor oil, and other materials Commercial industrial such as plastic, packing bags, municipal solid waste, biomass, and agricultural and animal waste).

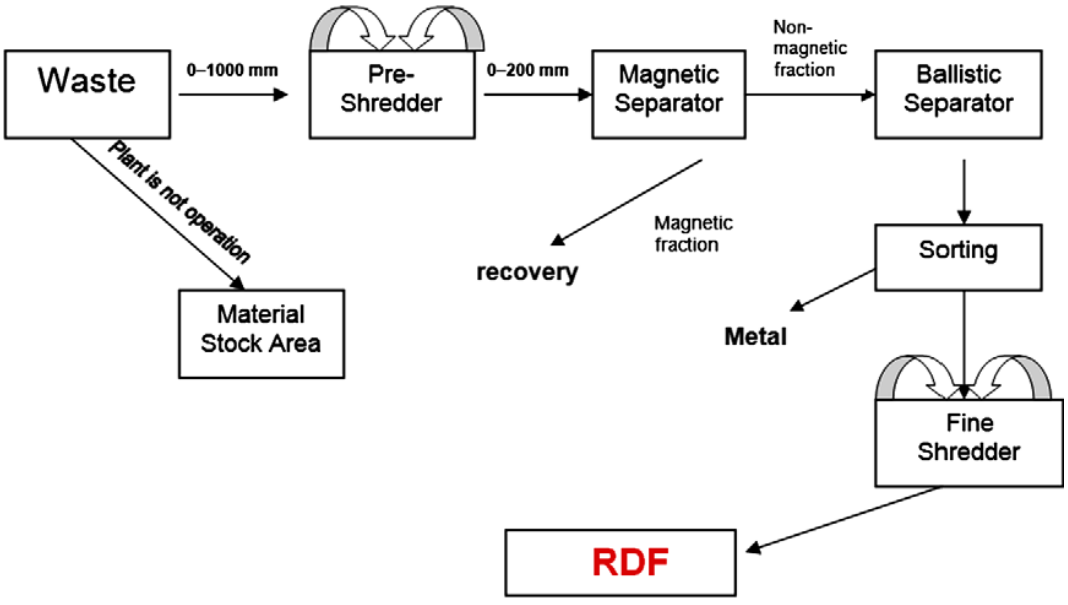


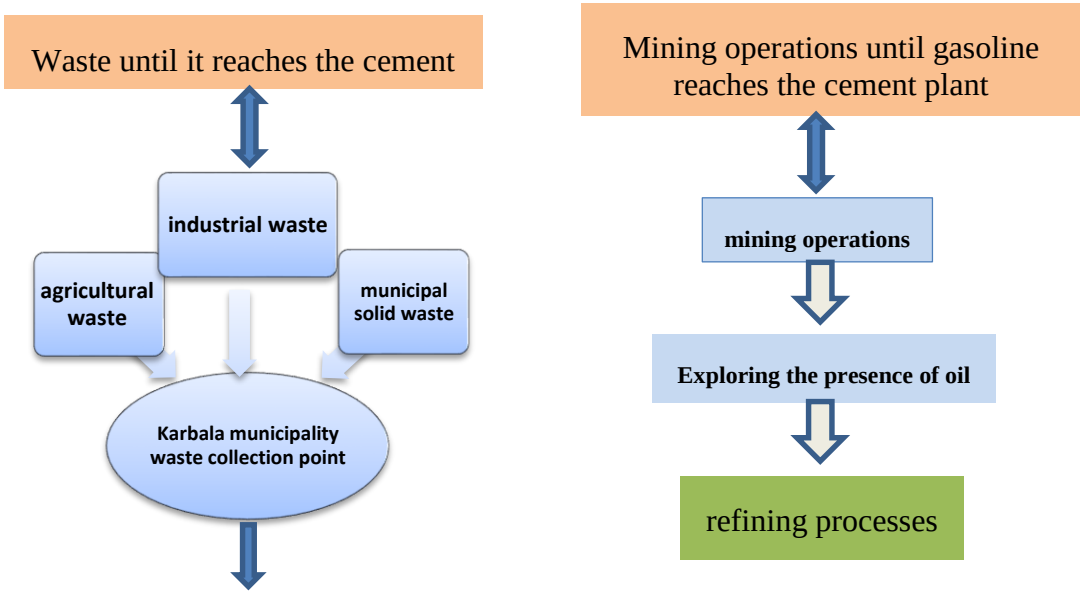
Figure 3.5. Shows the processes and stages of RDF production (Kruger et al., 2014:392).

3.4.Applying The Environmental Indicator MIP to Waste

Within the processes of continuous improvement from the environmental side and by using the cleaner production of the environment, there are ecological indicators that achieve this purpose. Among these indicators used is the MIP indicator. The purpose of applying the MIP indicator requires several steps that we will present in detail with an explanation of each step so that the reader can understand this aspect:

The first step: Is to choose the input items and the essential waste components for this reason, we have decided to adopt the MIP. Since the Karbala governorate is home to over 2 million people,, each person's waste counts as one unit (S) of (service or product [a]).

The second step: Drawing an illustrative chart to show the basic steps in the production process, starting with the extraction of fuel and natural resources from the earth; here, we will focus on waste and energy (gasoline) and the arrival of these two products and their transformation into fuel to enter the cement industry, noting that mining and gasoline extraction operations are much more expensive than RDF and here it is only focus on the steps without referring to the costs, as shown in Figure (3-6).



[a] Personal interview with the director of Karbala city municipality.

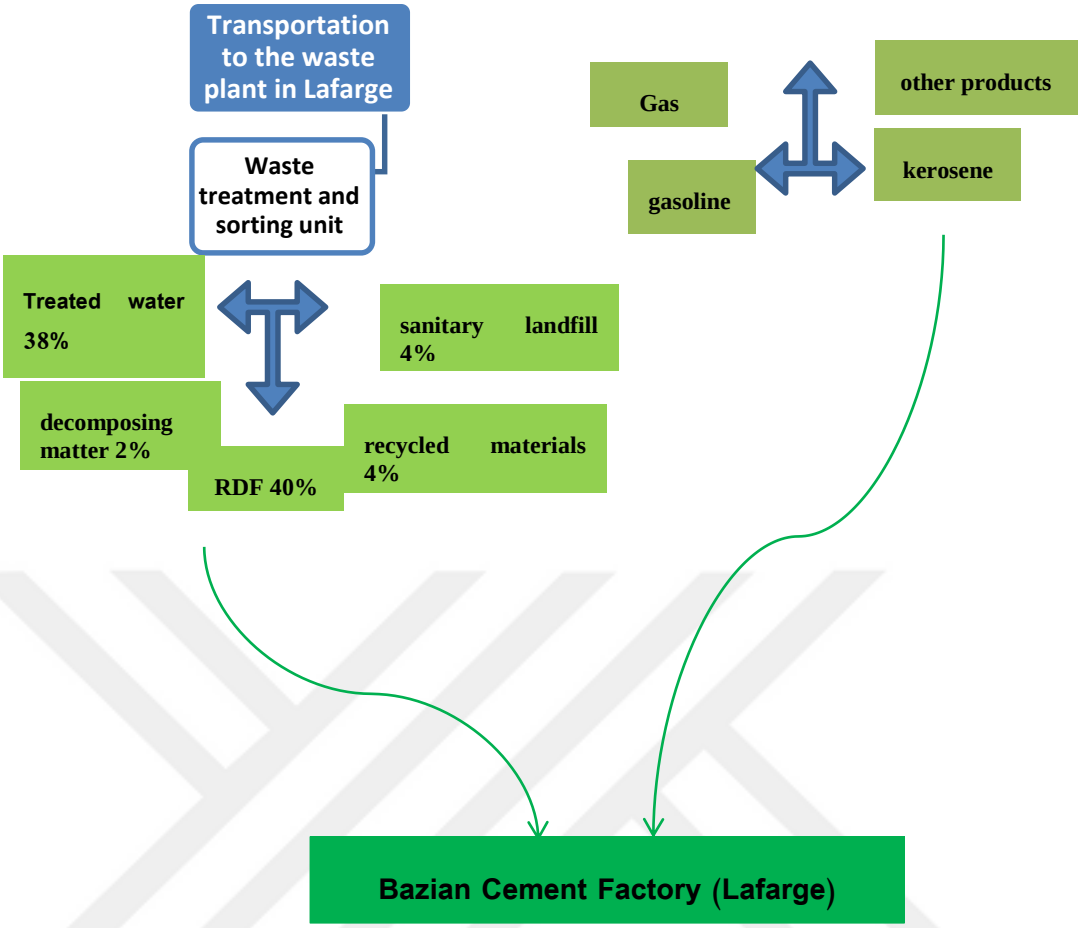


Figure 3.6. Shows the stages of the production process (Source/ prepared by the researcher)

The third step: Using the MIP table for inputs and outputs. This table gives the complete picture of the input materials and services provided in the production process, which is, in another way, a process of data collection, bearing in mind that the amount entered is 1200 tons of waste (Which comes from the local county waste):

Input table: In it, the flow of materials is in quantitative units, and here the weight is used in tons and all the materials involved in the production process place, which consists of the five introductory paragraphs of the MIP. Here we took the biotic and non-biogenic raw materials only for the absence of water and air or any erosion processes or effects in agriculture and forests.

Table 3.2. Inputs Source / prepared by the researcher based on the company's bulletins

Information Gathering Sheet Dated 2021					
natural input	Input	Units	Quantities	Source Karbala	Year 2021
A.	non-biological raw materials				
AA	plastic	tons	**60**		
AB	Rubber	tons	**24**		
AC	glass	tons	**120**		
B.	Vital raw materials	tons	**-**		
BA	feed	tons	**240**		
BB	paper	tons	**324**		
BC	texture	tons	**36**		
BD	leather	tons	**24**		
BE	Garden remnants and others	tons	**264**		

Output table**:** The main outputs include waste from recyclable materials, water, and air.

Table 3.3. Outputs Source / prepared by the researcher based on the company's bulletins

	Output	Units	Quantities	Source Karbala	Year 2021
M	main product	tons	----		
MA	RDF	tons	**504**		
N	by-products	tons	----		
O	minerals	tons	**48**		
OB	Waste for final disposal/landfill	tons	**168**		
P	Sewage	tons	----		
PA	sewage without treatment	tons	**456**		
Q	Polluted air	tons	----		
QA	Polluted and treated air	tons	**0.96**		

The fourth step: Here, we use the so-called MI calculation sheet for one unit of material inputs, which extract from the product of multiplying the quantity by the

material density of the input materials for each of the paragraphs of the table (3-4) and then finding the sum of each of the five sections in the table, after which the total of the resulting sum divided by the MI which is 334723.92[b] based on the (S) value of 2 million which is the population of Karbala Governorate to find the value of the MIP.

$$MIP = \frac{MI}{S} = \frac{334723.92^{b}}{2000000} = 0.167 \qquad \textbf{(2.5)}$$

This value is 0.167 kg per person, which means that the quantities of natural resources consumed and extracted from nature are very few if compared with the consumption of the individual, which is (0.85) kg/day.

The Fifth step: Here, the natural resources required for production are calculated, i.e., from the cradle to the point of sale, i.e., summing and extracting the environmental bag. Calculating the ecological pack is the quantitative calculation and comparison between the environmental impacts of the goods and services available in the market. This help uses alternatives with lower costs and quantities and a higher bag number: environment, the more significant the negative environmental impacts. The bag represents the sum of the required economic resources, which is an indicator for calculating the national financial resources. When figuring out the TMR, water and air were left out because they have so many different uses and need to figure out separately. Here, in this case, we do not need to figure it out because it does not fall within the priorities of the resources we want to access.

When applying the eco-bag equation:

$$MI = ER + PW$$

$$ER = MI - PW \qquad \textbf{(2.6)}$$

$$ER = 6994.44^{c} - 552^{d} = 6442.44$$

[b] Taken from Table (3-4) ∑ MI = 334723.92
[c] From Table (3-4), the sum of the MI is taken and the values of air and water are subtracted from it.
[d] It is taken from Table (3-3) from the sum of the amounts of RDF and minerals.

This quantity is equivalent to 5.37 tons per ton of waste, which is less than the average percentage, as the average rate of industrial goods is more than (10) kg per (1) kg, which is almost equivalent to less than half. Indicates the use of waste as a raw material is an excellent and environmentally friendly alternative as it does not use the original resources and rids the environment of garbage harmful to human health, and preserves the real help from running out. Suppose the use of waste as a raw material or alternative energy applies at the country's level. In that case, this will undoubtedly have a compelling economic role in saving much-wasted money.

The Sixth step: The use of RDF alternative fuels, and for calculation and ease of tracking costs, profits, and efficiency, the following assumption made:

a. Changing the variable costs of energy and raw materials.
b. The stability of fixed costs.
c. Stability of production quantities, as the actual production capacity is 6 million tons/year, given that the company works on the basis that the planning and real power are the same and what produce is sold, and it seeks in the future to increase this capacity to 10 million tons/year.
d. Stability of sales because the quantities are fixed, and the selling price is fixed, which is $50/ton.

The income statement for the fiscal year 2021 shows the changes and differences when applying alternative fuels (RDF) and compares them when using gasoline, as shown in Table No. (3-5), the amounts are in US dollars.

Table 3.4. It shows finding the values of MI (Input Materials) / prepared by the researcher based on the company's bulletins

	Non-Biological Materials				Biomaterials		Air		Water		Earth Movement	
The name of the material / basic materials	**unit**	**Quantities**	**MI factor (physical density) unit/kg**	**ton/unit main product**	**MI. factor (physical density) unit/kg**	**ton/unit main product**	**MI. factor (physical density) unit/kg**	**ton/unit main product**	**MI. factor (physical density) unit/kg**	**ton/unit main product**	**MI. factor (physical density) unit/kg**	**ton/unit main product**
plastic	tons	60	2.51	150.60	/		2.80	168	164.04	9842.4	/	
Rubber	tons	24	4.61	110.64	/		3.32	79.68	24.24	581.76	/	
glass	tons	120	2.95	354	/		0.74	88.8	11.65	1398	/	
feed him	tons	240	3.01	722.4	6.44	1545.6	0.96	230.4	109.03	26232	3.01	722.4
paper	tons	324	1.86	602.64	0.75	243	0.33	106.92	93.56	30313.44	/	
texture	tons	36	8.60	309.6	2.90	104.4	2.74	98.64	6,814.00	245304	5.01	180.36
leather	tons	24	9.20	220.8	12.60	302.4	2.40	57.6	446.00	10704	/	
garden remnants	tons	264	0.68	179.52	4.72	1246.08	0.16	42.24	9.40	2481.6	/	
∑ = MI 334723.92				**2650.2**		**3441.48**		**872.28**		**326857.2**		**902.76**

[e] The values are found by multiplying the quantities by the MI factor (material density) based on the global tables of material density

Table 3.5. Income statement for the fiscal year 2021/ Prepared by the researcher based on the company's financial records.

Details	Using benzene ($)	Using RDF ($)
Revenue	300,000,000	300,000,000
Deduct Variable costs Fuel/ RDF	55,690,017	44,552,014
Power	27,845,008	27,845,008
Raw. Mat.	48,728,765	46,292,327
Production Supply	6,961,252	6,961,252
Total Variable Costs	139,225,042	125,650,601
Contribution Margin	160,774,958	174,349,399
Deduct Fixed Costs	148,627,507	148,627,507
Profit	12,147,451	25,721,892

From Table 3.5. Using the RDF resulted in a decrease in variable costs from (139,225,042) to (125,650,601), resulting in an increase in profit margin of (13,574,441). This is especially useful when determining how much to charge for cement in order to remain competitive.

4. RESULTS AND DISCUSSION

The practical aspect focused on the company's sample, its history, and the types of products it produces in Iraq and the cement industry because of its economic importance in building basic facilities in the state and society, such as homes, hospitals, schools, and universities. However, it is one of the most environmentally damaging businesses because it is the only one that creates RDF alternative fuel used to reduce CO2 emissions by the corporation at a rate of 5% of total gas emissions generated by the company's operations.

The company achieves several benefits by applying MIP by using RDF to reduce production costs:

1. When gas prices rise and the cost of garbage does not, the company saves 8.4% of total production expenses, which is a respectable figure given that the municipality provides the company with the waste at no additional cost. The corporation charges recycling and treatment fees in exchange for a set amount.
2. As a result, the profit margin grew by 13,574,441$ or two times as fast as the company's total variable costs dropped from (139,225,095$) to (125,650,601$).
3. Achieving an economic efficiency of 9.3% after its efficiency was 4.2%, meaning its efficiency increased by 5.1%. And it achieved production efficiency as it achieved a relative decrease in the possible inputs for a certain level of output, in addition, to attaining technical efficiency by using recycling (RDF) and thus achieved part of the hypothesis.
4. The cost per ton of cement decreased by $2.27, and there remains a difference of $1.71 to reach the target cost, which is a slight difference that the company may be able to get in the future by continuing to improve.
5. Because of the country's fiscal deficit and inability to create integrated recycling plants for waste disposal, as well as its affordability, safety, and environmental friendliness, the alternative fuel RDF extracted from waste is an excellent solution for the country's current conditions. The MIP's amount of 0.167 kg per person means that the amounts of natural resources consumed and extracted from nature are tiny compared to an Iraqi person's consumption of resources, which is (0.85) kg/day, which means that the proportion per capita consumption is lower in this case. Therefore, the environmental impact of

using RDF is shallow. That means it is an eco-friendly material, and by using MIP, we can find out how much the product uses natural resources and how much it is an eco-friendly impact. Technologically, namely, making adjustments and additions to production processes and presenting these additions with RDF. Its production costs also compare favorably to fuel production. Due to the lack of data on the costs of producing alternative fuels, RDF and gasoline, the researcher could not calculate these costs when we calculate the costs of setting up independent waste treatment plants that have RDF; in addition to this, consider an economical material as:

a. It is a cheap material compared to the cost of extracting resources from nature.
b. According to the previous Table 3.5. cutting the price of gasoline from $55690017 to $44552014 saved consumers $11,138,003, or 20% of the original price.
c. They are available and inexhaustible because stopping human consumption of natural resources is almost impossible.
d. It does not need large stores to store it as it is a lightweight material and can be pressed into bales when it is not required to use directly.
e. It is considered a safe substance as it is not flammable; thus, it is safe when stored and transported.
f. When used, it does not generate carbon dioxide like other fuels.
g. They use in industrial and residential areas for heating.
h. Eliminating the use, purchase, and maintenance of purification equipment and devices (harmful emissions) reduces environmental costs (prevention costs).
i. Using the MIP environmental indicator achieves a good reputation among investors, the public, and the community when presented in the financial statements at the end of the fiscal year and the extent of its contribution to reducing environmental pollution and preserving the environment.
j. Technological change achieved productive efficiency and cleaner production, as technological change is part of the concept of efficiency and cleaner production. Thus, it achieved part of the hypothesis by completing cleaner production.

k. Continually taking the trash out of the city will eliminate hygiene contracts, making the town rich enough to buy the equipment needed to collect waste and sell it to labs that can use it for recycling. It makes money for the city and eliminates more than 80 percent of landfill operations.

Additional benefits include a lower cost per ton of recycled material and the ability to use less land than a landfill (which would otherwise waste) while also creating more jobs and reducing trash production. Income and job opportunities for the unemployed significantly since unemployment has been rising in recent years, and the disposal of waste that is bad for the environment and people's health, as well as the provision of landfills and landfills that become unlivable because they are full of pollution from the trash, bacteria, and bad smells that are left behind, turning them into an environment full of bugs and rodents., if we do not count the expenses allocated by the Ministry of Health to provide health services to citizens who contract diseases due to such places harmful to health.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

1. Achieving production efficiency requires reducing costs, maximizing profits, and achieving competition in the market. Reducing costs may be by using lower-cost alternatives, or we increase the outputs with the same amount of inputs to reach standard production with zero damage. Here, the reduction achieves using the RDF.
2. The cement industry is the best solution globally in terms of its use of RDF alternative energy because of its high-temperature kilns as the best technical and effective solution in terms of cost and efficiency, as well as being an environmentally friendly material.
3. The cost of RDF for Bazian Cement Factory is zero because the factory receives waste from the municipality of Karbala Governorate in exchange for fees for treatment and recycling and for ridding the city of garbage at the same time. The value of these fees is $18.8 per ton of waste, meaning the state bears the cost of collecting and transporting waste to the recycling plant in Bazian.
4. It is declining factory variable costs after using RDF by 20% for fuel and 5% for raw materials. That is, it achieved a reduction in production costs by 25%, and considered a good percentage if it is taken into account that the price of gasoline may increase in the future and that the waste does not increase in cost, mainly since the company receives it from the municipality for free.
5. Using the RDF, the variable costs decreased. At the same time, the production efficiency increased by achieving fewer inputs than outputs, as well as achieving technological change, which achieved cleaner production and economic efficiency from 4.2% to 9.3%, a high percentage that raises the factory's ability to compete in the market.
6. Waste affects human health and the surrounding environment, and disposal processes are expensive; at the same time, recycling some materials is costly. It is also challenging to implement the recycling system in Iraq at present, as it needs awareness programs for people with the provision of its equipment.
7. The use of RDF reduces landfill operations from 100% to 20%, thus avoiding the generation of odors, insects, and rodents in waste areas and the cost of the

damage they generate and the exploitation of landfill lands in other sites, as the cost of a landfill in the city of Karbala is $60,000 per month.

8. As a result, the cost of renting warehouses and containers for fuel will reduce because RDF waste is carried to the production site daily, eliminating the need for storage facilities. RDF is also safer to store than dangerous gas.
9. The combustion processes of waste generate toxic gases that harm human health and the environment in which they live. As for the combustion processes that take place on RDF, they do not contain these toxic gases.
10. We are reducing the import operations of various industrial resources and products and foodstuffs, relying on national development, and increasing the export of petroleum products to support the national economy.
11. The establishment of sorting and recycling companies using the RDF provides new job opportunities and helps reduce unemployment.
12. Reducing the budget for cleaning contracts in municipalities since given to outside contractors. The cost of cleaning contracts in the city of Karbala governorate is 1,452,957 dinars / Iraqi / day, which equals 17,435,484 dinars / Iraqi / year. These costs are on top of what the city of Karbala can afford and can avoid if labs do not use RDF.
13. Using the RDF, the company reduces environmental costs (prevention costs), such as the cost of air purification filters, eliminating the use, purchasing, and maintaining purification equipment and devices.
14. By applying the environmental indicator MIP to the RDF, we note that its environmental impact is minimal compared to the rest of the raw materials used in the industry, as it is affected by the population and the amount of waste they generate.
15. Using the MIP environmental indicator achieves a good reputation among investors, the public, and the community when presented in the financial statements at the end of the fiscal year and the extent of its contribution to reducing environmental pollution and preserving the environment.
16. The amount of MIP per person is 0.167 kg, which means that the amount of natural resources used and taken from the earth is tiny compared to the amount of food that one Iraqi person eats every day, which is 0.85 kg. It means a share of per capita consumption, in this case, is less than 1%. Therefore, the

environmental impact of using RDF is minimal, meaning it is an environmentally friendly material.

17. Using the MIP, we can know the extent of the product's consumption of natural resources and the time of its environmental impact. The lower the proportion, the lower the environmental impact. Employing RDF has achieved continual improvement and cleaner production by using technical change, which is by making modifications and additions in the manufacturing processes.
18. The environmental bag is equivalent to half of the ecological bag for industrial goods. It is an achievement and a good indication that RDF is an alternative with a lower cost and less environmental impact.
19. If the consumption of the Iraqi citizen is 0.85 kg/day and the total waste of the Iraqi population is 1,782,584 tons/day. This amount increases with the increase in the population, i.e., about 641,730,240 tons/year annually. The following are the benefit ratios for the cement industry and the country as a whole from utilizing this waste:
    - 14% for sanitary landfills 89,842,233.6 tons/year
    - 40% RDF 256,692,096 tons/year
    - 38% Treated water 243,857,491.2 tons/year
    - 4% recycling 25,669,209.6 tons/year
    - 2% biological treatment 12,834,604.8 tons/year

It's easy to forget that cutting down on garbage and ancient dumping practices can positively impact global warming and environmental pollution.

5.2.Recommendations

1. It is preferable to use RDF as an alternative fuel for the research sample company, mainly Iraqi cement factories in general, and any company that can benefit from the thermal energy generated by burning RDF.
2. Using RDF means that cleaning contracts may be abolished in all Iraqi municipalities, saving the state a lot of money.
3. In order to cut costs, they are concentrating on material inputs, particularly variable industrial prices, and developing more cost-effective and efficient alternatives.

4. It uses modern international technologies to find energy alternatives in companies and government laboratories because of its positive material, health, and environmental impact.
5. They are allocating funds for research and development in companies and government departments and focusing on them as they are affected by the industry concept, product design modernization, and competition.
6. Extending agricultural or construction use of landfills, removing odors and insects, preventing disease, and giving the money needed to cure illnesses caused by detrimental environmental effects on human health are only some of the reasons why landfills can be a valuable resource.
7. Creating new job opportunities, reducing unemployment, and a good investment for waste scientifically and thoughtfully.
8. The use of metal materials left over from sorting in recycling the relevant laboratories, preserving natural resources, reducing imports, and moving towards sustainability.
9. Spreading awareness about recycling and using waste as alternative energy, benefiting from global experiences, and setting plans and training courses.
10. Since thermal or electrical energy is the most expensive material in the industry, I'm trying to find substitutes for it. Developed countries have turned to alternative uses that are better for the environment, like using air and water to make electricity, which Iraq needs because it has trouble getting enough electricity to meet all of its people's needs.
11. Paying particular attention to the cultural awareness of the people and residential areas, notably government and non-government organizations and civil society groups, helps with waste collection and sorting as well as the issuance of fines for violators.
12. Continuing with applied research from researchers, which can be considered a complementary work to this research, whether in converting landfill materials after biologically treated to be safe that benefit the land and soil as fertilizer and to help from the water and the resulting gases.

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