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Compensating Fund Allocation for Industrial Sectors in Gaza Strip Using AHP and Goal Programming.

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Abstract

The process of compensating the damages of industrial sectors in Gaza Strip resulted from the war 2008/2009 is considered at this research. The study goal is to identify the optimal amount of funds that should be allocated for each industrial sector in any future rehabilitation process of Gaza Strip. A general surveying of previous related literature and interviews with experts from the industrial field are held to identify the evaluation criteria needed to prioritize the industrial sectors. Multi Criteria Decision Making (MCDM) is suggested to handle the prioritization process. Analytic Hierarchy Process (AHP) has been used as the MCDM tool. Experts in the industrial field made the pair wise comparisons of the eleven industrial sectors in Gaza Strip with respect to seven main criteria and twenty four sub criteria. These main criteria are economic, financial, marketing, technical, environmental, social/political and scale of damage. The alternatives were identified by Palestinian Federation of Industries (PFI). These alternatives are eleven industrial sectors which are construction industries, food industries, textiles industries, chemical industries, plastic industries, paper industries, wood industries, metal industries, traditional industries, leather industries and pharmaceutical industries .The pair wise comparisons are used as the data for the Expert Choice (EC) software to get a final rank of industrial sectors. The overall ranking of industrial sectors got from the AHP model is then considered by the Goal Programming model (GP) by allocating funds to the top ranked sectors in the AHP model.

The study indicates that the “construction industries”, “food industries”, “wood industries” and “metal and engineering industries” are the top ranked sectors with percentages of 18.1%, 17.4%, 13.4% and 13.3% respectively, and these sectors have been prioritized in the early stages of any rehabilitation processes by the GP model.

ملخص الرسالة Abstract in Arabic

عنوان الرسالة: توزيع أموال التعويضات على القطاعات الصناعية في قطاع غزة باستخدام طريقة التحليل الهرمي و برمجة الأهداف

تتناول الدراسة عملية تعويض القطاعات الصناعية في قطاع غزة عن الأضرار التي تعرضت لها خلال حرب 2009/2008. تهدف الدراسة إلى تحديد كميات أموال التعويضات التي يجب توزيعها على كل قطاع صناعي خلال مراحل إعادة الإعمار. تم إجراء مسح عام للدراسات السابقة المرتبطة بالدراسة، كما أجريت مقابلات مع خبراء في المجال الصناعي من قطاع غزة لتحديد المعايير اللازمة لتقييم القطاعات الصناعية لتحديد أولوية و ترتيب كل قطاع للتعويض. تعتبر طريقة إتخاذ القرار متعدد المعايير هي الطريقة المناسبة للدراسة، و تم استخدام طريقة التحليل الهرمي كأداة من أدوات اتخاذ القرار متعدد المعايير. قام الخبراء بتعبئة نماذج المقارنات الزوجية للقطاعات الصناعية بالنسبة لسبعة معايير رئيسة و أربعة و عشرين معياراً فرعياً، هذه المعايير الرئيسة هي معايير إقتصادية و مالية و تسويقية و فنية و بيئية و إجتماعية/سياسية و معايير حجم الدمار. كما تم تحديد البدائل و هي أحد عشر قطاعاً صناعياً في قطاع غزة بواسطة الإتحاد العام للصناعات و هي الصناعات الإنشائية و الغذائية و الخشبية و المعدنية و الخياطة والنسيج و البلاستيكية و الورقية و الكيميائية و الجلدية و الحرفية و الدوائية. تم إدخال المقارنات الثنائية إلى برنامج "Expert Choice" و هو البرنامج المحوسب المبني على أساس نظرية التحليل الهرمي، و كانت نتائج البرنامج عبارة عن ترتيب للقطاعات الصناعية حسب الأولوية للتعويض بناء على رأي الخبراء. نموذج البرمجة الخطية اعتمد الترتيب النهائي الناتج عن نموذج التحليل الهرمي و استخدم الأوزان الناتجة منه في عملية تحديد كمية أموال التعويضات لكل قطاع صناعي في كل مرحلة من مراحل الإعمار.

أشارت الدراسة إلى أن الصناعات الإنشائية و الغذائية و الخشبية و المعدنية حصلت على أعلى أولوية من نموذج التحليل الهرمي بنسب 18.1% و 17.4% و 13.4% و 13.3% على الترتيب، و قد تم تعويض هذه القطاعات في المراحل الأولى حسب نتائج نموذج البرمجة الخطية.

Dedication

Especially dedicated

to my beloved family

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List of abbreviations:

AHP	Analytic Hierarchy Process
CGP	Chebyshev Goal Programming
CI	Consistency Index
CR	Consistency Ratio
EC	Expert Choice
GDP	Gross Domestic Product
GP	Goal Programming
GPSR	Gaza Private Sector Rehabilitation
IDB	Islamic Development Band of Jeddah
LDC	Low-income Development Country
LGP	Lexicographic Goal Programming
LP	Linear Programming
MCAL	Multi Choice Aspiration Level
MCDA	Multi Criteria Decision Analysis
MCDM	Multi Criteria Decision Making
MODM	Multi Objective Decision Making
MOGP	Multi Objective Goal Programming
NGO's	Non Governmental Organizations
PFI	Palestinian Federation of Industries
PGP	Pre-emptive Goal Programming
QFD	Quality Function Deployment
SMART	Simple Multi Attribute Rating Technique
UNRWA	United Nations Relief and Works Agency
USD	United States Dollar
WGP	Weighted Goal Programming

Chapter One: General Background

First: Introduction

Second: Research Problem

Third: Research Objectives

Fourth: Research Importance

Fifth: Research Methodology

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First: Introduction:

Gaza strip was exposed to different economic crises which caused negative effects on the Palestinian economic sectors in general and on the industrial sector especially. The Palestinian economy moved from one crisis to another which increased the negative effects on overall economy. The severe crises started with the tight siege in June, 2007. Nearly one year after the siege, one of the most difficult and destructive crises is what happened in the last war on Gaza strip in 2008-2009. The industrial sector has been affected with siege, raw materials and machines needed for the production and delivering products were prohibited from entering Gaza, moreover, exporting local products was prevented, this caused in closing nearly 95% of industrial companies (3700 from 3900 factories), the rest of the factories work with production capacity does not exceed 15%. The sales have been affected with the low purchasing power of the people in Gaza. The number of workers in the industrial sector reached 35,000 workers before the siege, this number decreased to 1500 workers means reduction with nearly 95% in all industrial sectors in Gaza after siege [42].

The Israeli war highly destroyed the industrial sector by targeting more than 324 factories resulting in direct losses to the industrial sector nearly 87 million dollars. Based on previous assessments concluded by PFI, 324 industrial establishments were directly hit during the operation, with 44% of which were totally damaged and 56% were slightly to considerably damaged [41].

After the war on Gaza strip, the industrial sectors suffered from severe damages in facilities, equipment, tools and machinery. As a result of these damages the economical sector was affected directly. Different studies [3, 42] were made after the war especially by PFI to search for precise statistics about the losses of economic sectors; these studies resulted in statistics about the losses of different sectors like industrial, agricultural, construction and contracting, banking, tourism and investment.

The overall capacity of all Palestinian industrial sectors in Gaza Strip had been decreased; in addition, many losses have been resulted from the continuous Israeli siege, which has led to a decrease in the production rates.

The percentage contribution of the industrial sector in total GDP has increased from 8% in the mid eighties to 17% in the late-nineties, then dropped down during the first years of the intifada (2000) and approached nearly 16%. During 2007, the industrial sector has employed an average of 81586 sector workers, an average of 13% total work force. These numbers reflect a vital role of the industrial sector in the Palestinian Economy [44].

The retreat of Palestinian industrial sector performance is not only resulting from Israeli occupation policy and the last War on Gaza strip in 2008-2009, but also from the absence of suitable development programs.

The last war on Gaza Strip and the big destruction resulted from it has necessitated a rehabilitation process in the future. This rehabilitation process is the process of presenting compensating fund to the destroyed sectors in Gaza Strip in order to restart their work of producing and delivering products to the different markets.

It is worth mentioning that until now the different donors and international promises to help people in Gaza, especially the 4.5 billion USD which were pledged in the International Conference in Support of the Palestinian Economy for Reconstruction of Gaza in Sharm El-Sheikh, Egypt; which was held on the 2nd March 2009. A scientific approach is necessitated for the allocation of these amounts of funds during the rehabilitation process.

The previous rehabilitation projects aimed at the industrial sectors such as European Union's Gaza Private Sector Rehabilitation (GPSR) project, Islamic development bank of Jeddah (IDB), were built on neither a scientific method nor a mathematical model. Even when these projects were built on criteria to evaluate the status of the industrial facilities, it was only one criterion while the process should be based on different multi criteria. This situation makes a very high motivation to find a scientific multi criteria study that can be as a basis for the future compensating fund allocation for the rehabilitation processes after the war and any other crisis.

The use of single criterion to prioritize the industrial sectors for compensating after the war is process loses the effectiveness and accuracy, this because of neglecting other criteria that may have a more important effect on the goal of the rehabilitation process

which is vitalization development. For example; the use of sector's damage as a criterion for compensating, such that the sector with higher damage will take the first priority process will neglect other different criteria like contribution to the economic situation, decreasing the unemployment, contribution to GDP and other important criteria which are not less important than the damage criterion.

These criteria may differ from expert to other, i.e. the criteria supposed by Government may be different from the criteria suggested by donors and also by factories owners. The research here will try to determine all criteria that may be suggested, then selecting the most important ones from them according to the experts who work in different places like Government, Non Governmental Organizations, donors, factories owners, academics and consultancy companies.

The research uses Analytical Hierarchy Process (AHP) and Goal Programming (GP) Multi Criteria decision Making (MCDM) tools to achieve the objective of prioritizing industrial sectors in Gaza Strip and allocating compensating funds to these sectors.

Second: Research Problem

The compensation process should be based on a scientific method that guarantees presenting the funds to the sectors that will make the highest contribution to the local economy development. The problem arises here from identifying the most critical criteria that should be used to identify the priority of compensating each sector to get a rank of industrial sectors, then allocating the compensating fund to each sector so that it can restart its work and deliver products to the different markets.

The problem of the study can be summarized as:

How can the industrial sectors be prioritized to allocate funds of compensation process during the rehabilitation of Gaza Strip after the war using AHP and GP?

Third: Research Objectives:

The main objective of this study is to rank the compensating priorities of industrial sectors in Gaza strip using (AHP), then identifying the optimal fund for each sector using GP; the study also includes the following sub objectives:

1. To study the general situation of industrial sector and its importance for the economy of Gaza Strip.
2. To investigate the effects resulted from the siege and last war on the performance of industrial sectors including identifying damage volume, types of damage, unemployment rates, possibility of reconstruction and other different effects.
3. To find a scientific study that can be a basis for allocating compensating funds and other funds in any future rehabilitation of funding process.
4. To determine the criteria that can be used as a basis for ranking and prioritizing industrial sectors according to their importance to Gaza Strip.
5. To use the science of MCDM techniques which are AHP and GP to get a rank of industrial sectors according to experts and previous worldwide studies criteria.

Fourth: Research Importance:

The importance of this study lies in selecting a vital subject that is very important to the whole society in Gaza Strip and for the Palestinian economy, as it was mentioned previously; the industry sector contributes 17% in GDP in 2007 and employs 13% of the total workforce. The study focuses on the future rehabilitation to the industrial sectors to restart their work and deliver products the markets.

The big motivation of this study is because of its high importance which can be explained in the following points:

1. The very high necessity for the rehabilitation and reconstructing of Gaza Strip after the continuous crises, which lastly was the war in 2008-2009.

2. The time of this study is very critical and important especially after the unity agreement in May, 2011 and after the facilitations and ease of access of the construction and raw materials to Gaza Strip in the last months.
3. The real need for a mechanism based on scientific approach to allocate the funds in a process guarantee the funding to the highest priority and need.
4. This study is considered as one of the new studies that use the science of operations research in this field.
5. The recommendations of this study can help the decision makers to make correct decisions required to the processes of rehabilitation and revitalization of Gaza strip after the war and siege.

Fifth: Research methodology:

The research methodology explains the road map needed to reach the research goal. Starting with goal definition, then data collection, in which, criteria and alternatives are identified and finishing with the application, which include the application of AHP and GP. The detailed description of the research methodology is shown in chapter four and this is a brief view of it.

Figure 1.1 explains the research methodology.

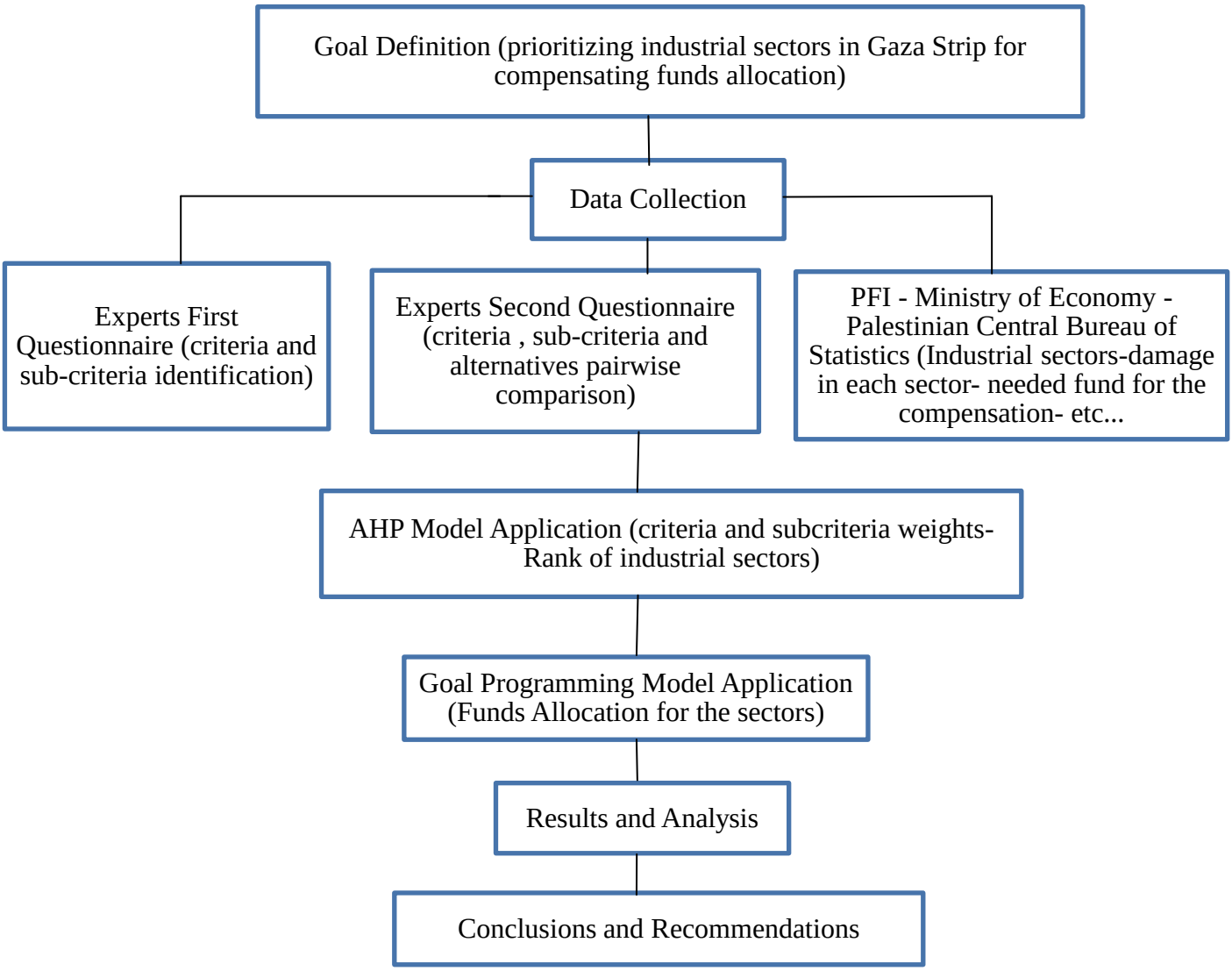

Fig 1.1: Research methodology

1. Goal Definition

The goal of this research is to rank the compensating priorities of industrial sectors in Gaza strip using (AHP), and then identifying the optimal fund for each sector using GP. After the goal has been defined, a preliminary picture of the methods to be used to achieve the goal has been developed. A (MCDM) method was chosen to perform the study which is (AHP). AHP will be used to obtain the weight of criteria and alternatives then to rank alternatives, and GP will be used to determine the amount of fund for each industrial sector (alternative).

2. Data Collection

The data needed for the research are: the criteria, sub-criteria, and the alternatives. The required data can be collected from: (I) Palestinian Federation of Industries (PFI). (II) Palestinian Central Bureau of Statistics. (III) Interviews with experts from academic positions, UNRWA, private sector and government. The required data for the research, their types and sources is explained in Chapter four.

3. Criteria Definition

To prioritize the industrial sectors and get a rank for them according to sector's importance and role in the economy, A Multi Criteria Decision Analysis (MCDA) should be used, these multiple criteria can be identified according to previous related studies and also according to the opinions of experts in the economy. A questionnaire is designed seeking the views of experts from academic positions, UNRWA, NGO's, private sector and government. These criteria may differ from one expert to other one. An expert works in the academic position may suppose different criteria than the criteria supposed from NGO's expert. In this study an investigation of the previous studies resulted in different criteria, these criteria are arranged in a questionnaire to the experts. The experts determined whether the criterion should be included in the comparison or not, moreover that they can add any new criterion they think that it should be included.

Once the criteria, sub criteria and alternatives are identified, the application of AHP is made.

4. AHP application

One of AHP strengths is the possibility to evaluate quantitative as well as qualitative criteria. During the study period, interviews with experts to present the governmental view for the comparisons needed for AHP model were conducted. These pair wise comparisons are substituted in the Expert Choice 11 (the software of AHP), the software output makes the final weight of each sector in each criterion and sub criteria, thus gaining the result of AHP model rank.

Now the priorities and weights for each sector resulted from the AHP model can be inserted in the GP model to satisfy the priority of sector and allocate the fund according to each priority.

5. GP Application

GP is a well-known modification and extension of linear programming (LP). LP deals with only one single objective to be minimized or maximized, and subject to some constraints; therefore, it has limitations in solving a problem with multiple objectives. GP, instead, can be used as an effective approach to handle a decision concerning multiple and conflicting goals. Further, the objective function of a GP model may consist of non-homogeneous units of measure.

The GP mathematical model manages a set of conflicting objectives by minimizing deviations between the target values and the realized.

The AHP model provided the priorities (weights) of all criteria and sub criteria, these priorities will be the coefficients of objective function of the GP model as minimizing the deviations about the goals, the deviation may be overachievement or underachievement of the goal. The minimization is for one of two deviations; overachievement or underachievement.

In this study, there are different constraints that are related to the criteria and sub criteria, also the total compensation fund constraint, these constraints with the objective function will be made as a GP model and solved using one of the software of the GP to get the final amount of fund that should be allocated to each sector in the rehabilitation process.

Sixth: Research structure:

Chapters are organized as follows:

- Chapter one: presents the research background including an introduction about the industrial sectors in Gaza Strip including their contents, products produced, crises and problems and their vital role in the Palestinian economy, research problem, objectives, importance, methodology, structure and ends with the scope and limits.
- Chapter two: presents a literature review on industrial sectors, concepts and types of them, their status in Gaza Strip and different statistics about the before and after the war 2008/2009 situation of them. Finally the criteria definition according to different previous and related studies.
- Chapter three: provides a general background about the history, concepts and theories of AHP, and GP.
- Chapter four: presents the methodology followed in the study, which is the process of obtaining weights by applying AHP methodology to prioritize industrial sectors, then allocate funds for the compensation by applying GP.
- Chapter five: presents the analysis of data and the final rank of industrial sectors including the amount of fund that should be allocated to each sector.
- Chapter six: presents the conclusions and recommendations.

Seventh: Previous Studies

There are a lot of related studies; these studies are one of three types of studies:

The first: are the studies that use both AHP and GP in prioritization and allocation decisions.

The second: are the studies that use only AHP in prioritization and ranking decisions.

The third: are the studies that use only GP in prioritization and allocation decisions. These studies are as discussed below and ranked according to the degree of nearness, relationship to this study and the number of subjects included in the study:

1. AHP and GP studies:

The study of Ramanathan and Ganesh, (1995) titled "**Energy Resource Allocation Incorporating Qualitative and Quantitative Criteria: An Integrated Model Using Goal Programming and AHP**"

Energy resource allocation presents a MCDM problem with the criteria being quantitative and/or qualitative. Solving such a problem requires an integrated approach. In this paper, an integrated model using GP and the (AHP) has been developed for energy resource allocation. It incorporates nine quantitative and three qualitative criteria . The model has been applied to the household sector of Madras, India. A detailed sensitivity analysis has also been carried out. Three additional scenarios have been developed. Use of the model suggested: natural gas, fuel wood and solar thermal for cooking; biogas and electricity generated from fuel wood for water pumping; and all decentralized electricity generation technologies for lighting and operating household appliances. Grid electricity was preferred only for lighting [46].

The study of Badri, (1999) titled "**Combining the Analytical Hierarchy Process and Goal Programming for Global Facility Location-Allocation Problem"**

The Strategic global facility location-allocation decisions which involve many factors that may be conflicting in nature, and can pose a difficult selection problem was investigated. Recognizing the multiple and conflicting objective nature of the location-allocation problem in an international setting, this paper proposes the use of the AHP and multi-objective goal-programming methodology as aids in making location-allocation decisions. The methodology presented can help facility planning authorities to formulate viable location strategies in the volatile and complex global decision environment. A demonstration of the application of these methodologies in a real life problem is presented.

The paper offers two methodologies for the location selection decision. The AHP is presented "first as a stand-alone methodology and then a combined AHP and GP model is presented as an extension to consider additional criteria in decision making process.

The petrochemical company is evaluating six potential plant location sites in six Middle Eastern countries, namely Saudi Arabia (KSA), the United Arab Emirates (UAE), Bahrain

(BAH), Kuwait (KUW), Qatar (QAT), and Oman (OMN). Four criteria for the location identification had been identified which are political situation of foreign country, global competition and survival Government regulations and economics related factors.
The combined AHP-GP approach attempts to minimize the overall deviations in the objective function (preemptive goals) given the various goals and objectives [9].

The study of Badri, (2001) titled "**A Combined AHP-GP Model for Quality Control Systems**"
This study identified five sets of quality measures. These indicators or measures, through the (AHP), are then accurately and consistently weighted. The Priority weights are, in turn, incorporated in a goal-programming model to help select the best set of quality control instruments for customer data collection purposes.
The paper proposes a decision aid that will allow weighting (prioritizing) of a firm's unique service quality measures, consider the real world resource limitations (i.e., budget, hour، labor, etc.), and select the optimal set of service quality control instruments.
The paper addressed two important issues: how to incorporate and decide upon quality control measures in a service industry, and how to incorporate the AHP into the model. A real world case study illustrates the application of this combined AHP and goal-programming (AHP-GP) model. The department store management implemented the suggested results obtained from the combined AHP-GP model in the summer of 1998. After almost one year of its implementation, the top management of the department store has conveyed its complete satisfaction with the results [10].

The study of Yurdakul, (2003) titled "**Selection of Computer-Integrated Manufacturing Technologies Using A Combined Analytic Hierarchy Process And Goal Programming Model**"
Investment in computer-integrated manufacturing (CIM) is a multi-attribute problem, which includes both qualitative and quantitative factors. In order to select the best set of CIM alternatives among the competing ones it is necessary to make a tradeoff between the quantitative and qualitative factors some of which may conflict. Selection of appropriate CIM alternatives is vital in manufacturing companies' long-term competitiveness, and it requires development of selection models. The selection model must consider various

quantitative and qualitative objectives and constraints simultaneously. For example, companies have generally limited funds to invest in new advanced technology. The size of the allocated fund limits the types and number of CIM alternatives a company can select in a given time period. In this article, a combined model of the AHP and GP is proposed to consider multiple objectives and constraints simultaneously. A real-world example is provided to illustrate the application of the combined approach [62].

The study of Bertolini and Bevilacqua, (2007) titled "**A combined GP—AHP Approach to Maintenance Selection Problem**"

This paper presents a 'Lexicographic' GP (LGP) approach to define the best strategies for the maintenance of critical centrifugal pumps in an oil refinery.

For each pump failure mode, the model allows to take into account the maintenance policy burden in terms of inspection or repair and in terms of the manpower involved, linking them to efficiency-risk aspects through the use of the classic parameters occurrence (O), severity (S) and detectability (D), evaluated through an adequate application of the (AHP) technique. An extended presentation of the data and results of the case analyzed is proposed in order to show the characteristics and performance of this approach.

The combined AHP-GP model embodies AHP results in the GP model. In particular, in the model described here the AHP analysis provides the priority vector of the possible maintenance policies (corrective, preventive and predictive) for each failure type revealed. The use of AHP allows to define a three level hierarchical structure: the top level represents the goal of the analysis (in this case the maintenance policy definition), the second level is relative to the relevant criteria used (occurrence، severity and detectability), the third one defines the possible alternatives. The use of a combined AHP-GP model allows to investigate the maintenance selection problem in detail, taking into account the resource burden and providing the analyst with a tool to assess the priority level of the different maintenance alternatives [14].

The study of Saaty and others, (2007) titled "**The Analytic Hierarchy Process and Human Resource Allocation: Half the story**"

The study used the (AHP) to provide a way to rank the alternatives of a problem by deriving priorities. A question that occurs in practice is: what is the best combination of alternatives that has the largest sum of priorities and satisfies given constraints? This leads the researchers to consider the interface between the AHP and the combinatorial approach inherent in LP. The priorities of the alternatives often serve as coefficients of the objective function of an LP problem. The constraints are determined from existing measurements, such as the range for the number of employees needed and the salaries required for various jobs. Another way to use the AHP might be to determine the coefficients of the constraints. This paper addresses the first half of the problem. Through various examples, the researchers showed how to apply the absolute measurement mode of the AHP together with LP to optimize human resource allocation problems. For example, one can determine which positions to fill، or which mix of candidates to hire. The researchers also gave an example of how to allocate resources to maximize the returns to a corporation of its training programs. Finally, they showed that the combined AHP and LP model is capable of solving hiring problems involving synergy, such as when two persons with different complementary skills work as a team [49].

The study of Sarfaraz, (2011) titled "**An integrated Multi-objective Decision Making Process For Supplier Selection with Volume Discounts**"

The objective of this paper is to solve the supplier selection problem considering both tangible and intangible factors. If suppliers have capacity or other different constraints, the problem is to identity the potential suppliers and to allocate the optimal order quantity among the selected suppliers. In this paper an integrated model of AHP and PGP is proposed. The AHP model considered 7 evaluating criteria which are *Low Initial Price, Cost Reduction Activities, Conformance Quality, Consistent Delivery, Delivery Speed, Product Volume Changes and Short Setup Time*. The model attempts to incorporate volume discount in a conflicting multi-objective scenario wherein one needs to maximize the total purchase value and minimize the total cost. The framework of the model was illustrated by

means of a numerical example. In the example 4 suppliers are considered and prioritized by the AHP model, then the allocation of 950 units is made by the PGP model [50].

The study of Gandpa and others (2011) titled "**An integrated analytic hierarchy process-linear programming (AHP-LP) model for capital budgeting**"

In this study, an (AHP-LP) model was developed to address the capital budgeting problem. AHP, which has the capability of catering for both quantitative and qualitative factors, was used to prioritize the competing projects according to the subjective judgments of top management and planning managers. Subsequently, a LP model was constructed; using the priority ratios (weights) obtained from the AHP model as the coefficients of the decision variables to allocate the available capital in an optimal manner that ensured the maximization of the desired benefits. The combined model was then applied to an organization based in Nigeria. A comparison of the result of the traditional LP methods and that of the combined AHP-LP method clearly shows that qualitative factors have a significant impact on capital budgeting. It was discovered that some projects selected by the traditional LP methods were dropped when the qualitative factors were introduced using AHP. The AHP-LP budget also reflected the objectives set for the organization by the top management. The combined method was also found to be more flexible ،efficient and easily modifiable [26].

2. AHP studies

The study of Arbel, (1982) titled "**A University Budget Problem: A Priority-Based Approach**"

The budgeting problem in a university environment is considered, using the (AHP) developed by Saaty. This approach allows the prioritization of all relevant budget considerations both from the benefit to the school's future evolution and from the cost of operation viewpoints. This approach allows using the derived priority structure to arrive at a budget allocation. In addition to the systematic manner by which this budget is determined, the approach also provides an "audit trail" that is very important in explaining the specific allocation. The budgeting approach presented in this paper was

tried on that part of the school's budget directed toward starting and supporting various teaching and research activities . The school consists of six departments, each requesting a budgetary allocation that will support all their planned activities. Usually, however, the total school's budget is less than the total request for appropriations . This situation calls for allocation under limited resources. Problems of this sort are usually dealt with in a mathematical programming context, typically, in a linear programming (LP) formulation[4].

The study of Ehie and others, (1990) titled "**Prioritizing Development Goals in Low-Income Developing Countries**"

This paper outlines a systematic approach to prioritizing the multiple and often conflicting development goals and objectives in a typical low-income developing country (LDC). First, a hierarchy of development goals and objectives is developed from an extensive review of the literature. Then ، (AHP) is utilized to analyze the judgment elicited from World Bank experts and a priority structure established reflecting the perceived importance of these development goals and objectives. This methodology can assist development planners in LDCs in formulating development plans consistent with national objectives [22].

The study of AL Hammad and others, (2005) titled " **A Model to Assist Decision Making of Public Private Partnership in Electricity Projects**"

In this study the Electricity sector was studied in the Kingdom of Saudi Arabia which is considered one of the highly progressive sectors. The growth of demand of electricity is estimated to be over 7% annually. Therefore, partnership of public and private sectors (PPP) is necessary. Since the Kingdom is planning for PPP, Experiments of other countries in the field of infrastructure projects and in particular in electricity projects were investigated. Forty five criteria governing success or failure of such projects worldwide in addition to main criteria affecting local electricity projects were derived and classified into 3 phases. In order to evaluate these criteria and assist the decision maker to apply or not to apply PPP, a model was developed making use of the AHP accompanied with the EC program and of the assessment of the criteria by a group of experts. Three decisions may

be obtained: apply PPP if the weight of the model is greater than 70%, do not apply PPP if the weight of the model is less than 60%, and the decision is left for the decision maker in between [2].

The study of Wong and Li, (2008) titled "**Application of The Analytic Hierarchy Process (AHP) in Multi-Criteria Analysis of The Selection of Intelligent Building Systems**"

The availability of innumerable intelligent building (IB) products, and the current dearth of inclusive building component selection methods suggest that decision makers might be confronted with the quandary of forming a particular combination of components to suit the needs of a specific IB project. Despite this problem, few empirical studies have so far been undertaken to analyze the selection of the IB systems, and to identify key selection criteria for major IB systems. This study is designed to fill these research gaps. Two surveys: a general survey and the (AHP) survey are proposed to achieve these objectives. The first general survey aims to collect general views from IB experts and practitioners to identify the perceived critical selection criteria, while the AHP survey was conducted to prioritize and assign the important weightings for the perceived criteria in the general survey. Results generally suggest that each IB system was determined by a disparate set of selection criteria with different weightings. Work efficiency is perceived to be most important core selection criterion for various IB systems, while user comfort, safety and cost effectiveness are also considered to be significant. Two sub-criteria, reliability and operating and maintenance costs, are regarded as prime factors to be considered in selecting IB systems. The study contributes to the industry and IB research in at least two aspects. First, it widens the understanding of the selection criteria, as well as their degree of importance, of the IB systems. It also adopts a multi-criteria AHP approach which is a new method to analyze and select the building systems in IB. the study finally suggests further research to investigate the interrelationship amongst the selection criteria [60].

3. GP studies

The study of Kalu, (1998) titled "**Capital Budgeting Under Uncertainty: An Extended Goal Programming Approach**"

The researchers addressed that mathematical programming techniques have long been recognized as the most suitable approach to the complex problem of capital budgeting in corporations. This is because contrary to conventional single-project appraisal techniques such as the net present value method, financial planners do not normally engage in project-by-project analysis to determine the projects that would be included in capital budgets. In addition, the existing chance-constrained (both single and multiple objectives) models developed to deal with the problem of uncertainty in capital budgeting are grossly defective, since they, indeed, address the problem of risk, rather than uncertainty. This paper presents an extended GP methodology to address the problem of capital budgeting under uncertainty to overcome the defects of chance-constrained capital budgeting models. In particular, since financial planners frequently deal with the complex problem of capital budgeting by aggregating large numbers of small investment proposals into families of large projects، the paper presents necessary and sufficient conditions for the acceptance of a set of investment projects by a business enterprise. The results indicate that under uncertainty, firms faced with capital rationing are less economically efficient than others that are not so faced. Also, the results show that optimal allocation policy under uncertainty requires the actual discount rate to be greater than the market cost of capital, a finding which is consistent with corporate practice [34].

The study of Chowdary and Slomp, (2002) titled "**Production Planning under Dynamic Product Environment: A Multi-objective Goal Programming Approach**"

The objective of this study is to develop a multi objective GP (MOGP) model to a real-life manufacturing situation to show the trade-off between different sometimes conflicting goals concerning customer, product and manufacturing of production planning environment. For illustration, two independent goal priority structures have been considered . The insights gained from the experimentation with the two goal priority structures will guide and assist the decision maker for achieving the organizational goals

for optimum utilization of resources in improving companies' competitiveness. The MOGP results of the study are of very useful to various functional areas of the selected case organization for routine planning and scheduling. Some of the specific decision making situations in this context are:

(i) The expected quality costs and production costs under identified product scenarios

(ii) Under and over utilization of crucial machine at different combinations of production volumes. (iii) The achievement of sales revenue goal at different production volumes.

The ease of use and interpretation make the proposed MOGP model a powerful communication tool between top and bottom level managers while converting the strategic level objectives into concrete tactical and operational level plans [19].

The study of Asadpoor and others, (2009) titled "**Designing a Multi-objective Decision Making Model to Determine the Optimal Cultivation Pattern in Dasht-e Naz Region in Sari City**"

In this paper the researchers addressed a general (GP) model with linear objective, convex constraints and arbitrary component wise no decreasing norm to aggregate deviations with respect to targets. In order to have a better allocation of production resources like water, land, labor force and so on among various farming activities. The researchers used the GP model that can take different objectives of managers based on their importance and priority in agricultural units. In this paper using true information about production resources and existing cultivation pattern in Dasht-e Naz Sari, this site is located in eastern north of Sari in Mazandaran province, Iran. Findings based on analyzing model outcomes, showed that changing cultivation pattern based on model suggestion, the gross income can be increased as much as 336100 per hectare considering the manager's opinion. Also model showed that regarding the limited water and land resources in optimal cultivated pattern, making a suggestion to increase the cultivation area of the spring crops, summer crop yield drops and fall crop yield increases, like wheat and canola [6].

4. Local studies:

The study of Al Sorani (2005) "**The status of industry and trade in the West Bank and Gaza Strip"**

A general review of industry and trade is presented including the historical development of them since 1948. An explained analysis of the industrial facilities status in terms of their numbers, workforce, geographical distribution, investment, production, marketing, profitability and competitiveness. The reduction of industrial sectors' contribution to GDP was reviewed in the study which was decreased from 15.7% at 2000 to 12.6% at 2001. The number of workers decreased with a percentage of 8% at 2001 and 5.8% at 2002. Industrial exports were 206.7 million dollar at 2000 with a percentage of 14.5% from the industrial sales. The vital role of metals and engineering, food and beverages, textiles and clothing and furniture industrial sectors is explained, these sectors represented a percentage of 79.2% from total number of facilities, 80% from total workforce and 75.3% from total exports, and this ensured that these sectors are the highest important sectors between all industrial sectors [3].

The study of PFI (2009) titled **"The Current Status of Industrial Sector in Palestine"**

The purpose of this research was to assess the challenges and obstacles on developing the industrial sector, through the process of reviewing the current status of the industrial sector and drawing a strategic upgrading plan, by focusing on different sectors within industry as a whole. The study used a combination of methodologies and tools in performing the research. Reviewing the secondary data, field visits and interviewing key players and using a questionnaire as a major tool. A conclusion was presented that industrial sector plays an important role in the process of economic development in Palestine. An explanation has been introduced that the quality level of industrial production in Palestine has improved greatly in the last decade. The percentage contribution of this sector in total GDP has increased from 8% in the mid-eighties to 17% in the late-nineties, then dropped down during the first years of the intifada and approached nearly 16% in recent years. During 2007, the industrial sector has employed an average of 81586 sector workers, an average of 13% total work force. The 11 classifications of industrial sectors are viewed with each sector's specifications in terms of number of firms, total investment, GDP percentage, number of employees, market share and employee productivity. The major obstacle is the

political instability and movement obstacles. Moreover, industry has institutionalized problems in terms of administrative and financial management, production, quality, competition, knowhow and difficulties in exporting. The study suggested national integrated program for industrial development to develop and improve industries and help them achieve their national and individual roles and targets [44].

Comments on the previous studies:

There is large number of foreign studies regarding to the prioritization and ranking of industrial sectors and projects based on MCDM. These studies proved that the MCDM tools are very effective in the field of prioritization and ranking, while the GP method is good in the allocation decisions. These results represent a motivation to use AHP and GP in the process of compensating industrial sectors for the rehabilitation process.

The local studies do not exceed that they are statistical studies about the role of industrial sectors in the general economy, the volume of damages, the types of damages and other different statistics.

Some of local studies addressed the process of reconstruction of industrial sectors; this reconstruction process was based on single criterion which is the volume of damage in the sector.

This study benefits from the foreign studies to overcome the lack of local studies by applying a scientific approach to prioritize industrial sectors for the compensating fund allocation during the process of the rehabilitation of Gaza Strip after the war.

Chapter two: Literature Review

First: Introduction

Second: Industrial Sector in Gaza Strip

1. **Status of industrial sector in Gaza Strip**
    a. **Industrial sector status before the war**
    b. **Industrial sector status after the war**
2. **Damage in the industrial sector**
3. **Financing needed for reconstruction**
4. **Availability of raw materials and machinery**

Third: Criteria identification in the previous studies

Fourth: Research Criteria identification and definition

Fifth: Summary

First: Introduction:

This chapter presents a literature review on industrial sectors, concepts and types of them, their status in Gaza Strip and different statistics about the before and after the war 2008/2009 situation of them and the inputs. This is followed by an investigation of the identification and definition of criteria for evaluating projects, economic and industrial sectors in the previous studies. Finally, the research criteria are set and defined as adapted from the previous studies.

Second: PFI and Industrial Sectors

The PFI is the national institution representing the Palestinian industrial sector through its federated associations. Founded in 1999 as a permanent private sector organization, PFI facilitates industrial development as the basis for economic performance. PFI's representational role is to educate, advocate, and communicate the value of a developed, socially-responsible and globally competitive industry. PFI's strategy of industrial development within industry associations leads to a stronger membership base that is capable of delivering valuable member services, effective policy formulation, and integrated communications.

Industrial sectors represented by PFI include food and beverage, construction, stone and marble, pharmaceuticals, chemicals, metal and engineering, textiles and garments, leather, paper, printing and packaging, handicrafts, plastic and rubber, and furniture. The industrial sector in Palestine includes some 14,000 registered companies in the West Bank and Gaza. The majority of these are small family-owned businesses. Only about 100 of the manufacturing, mining and construction enterprises in Palestine have a workforce of more than 100 employees. The contribution of the industrial sector to GDP is approximately 17%, and the industrial sector absorbs around 13% of the total work force in 2007 [43].

1. Status of industrial sector in Gaza Strip

The status of industrial sector in Gaza Strip is divided into two situations; the first is before the war and the second is after the war.

a. Industrial sector status before the war

The private sector was once the provider to one third of the population in the Gaza Strip. It employed more than 110,000 people and presented hope for thousands of job seekers every year. Previous to the year 2000, the industrial sector registered an annual growth of about 5 percent. Prior to the siege, the industrial sector employed 20 percent of Gaza's labor force. One year after the siege began; the PFI reported that "61% of the factories have completely closed down. 1% was forced to change their scope of work in order to meet their living expenses, 38% were partially closed (sometimes means they operate with less than 15% capacity)" [44].

The World Health Organization report of the year 2010 states: "In the Gaza Strip, private enterprise is practically at a standstill as a consequence of the blockade. Almost all (98%) industrial operations have been shut down. The construction sector, which before September 2000 provided 15% of all jobs, has effectively halted. Only 258 industrial establishments in Gaza were operational in 2009 compared with over 2400 in 2006. As a result, unemployment rates have soared to 42% (up from 32% before the blockade)." Since the year 2000, it passed through; an obvious decline leading to increased unemployment among a mostly poor population. The private sector had already lost an estimated USD 400 million in direct losses due to the closure policy even prior to the assault beginning in December 2009 [40].

The tight siege which was imposed on the Gaza Strip after the events of June, 2007, placed the private sector in great hardship and left its industrial sector almost paralyzed. According to a recent study released by PFI, 97 percent of industrial establishments were shut down and 98 percent of employees were laid off [41].

b. Industrial sectors status after the war

It is significant to note that the Gaza private sector situation prior the Dec./Jan 2009 war was not ideal and was heavily affected by the constraints of the 18 previous months (June 2007 – December 2008). These included restrictions on the amounts and types of goods allowed through the borders, and total banning of export operations which lead to the closure of most of the industrial establishments and the complete halt of construction work. The war formulated a systematic destruction of the productive capacity in the Gaza Strip, causing more suffering and considerable losses for the owners and workers of the demolished industrial establishments which were targeted during the war. This led to the worse overall economic situation. Moreover, the strict blockade imposed on Gaza Strip since June 2007 took its toll on the already weakening economy. Only 7% of the industrial establishments were in operation in November 2008 with less than 20% utilized capacity. Over 30,000 employees were laid off due to the shutting down of industrial establishments adding to the already high percentage of unemployment and poverty rates. As a result of destruction caused during the war the economic sector in Gaza suffered direct losses of USD 309,089,188. The industrial sector losses were 84,209,712 USD as shown in figure 2.1 [40].

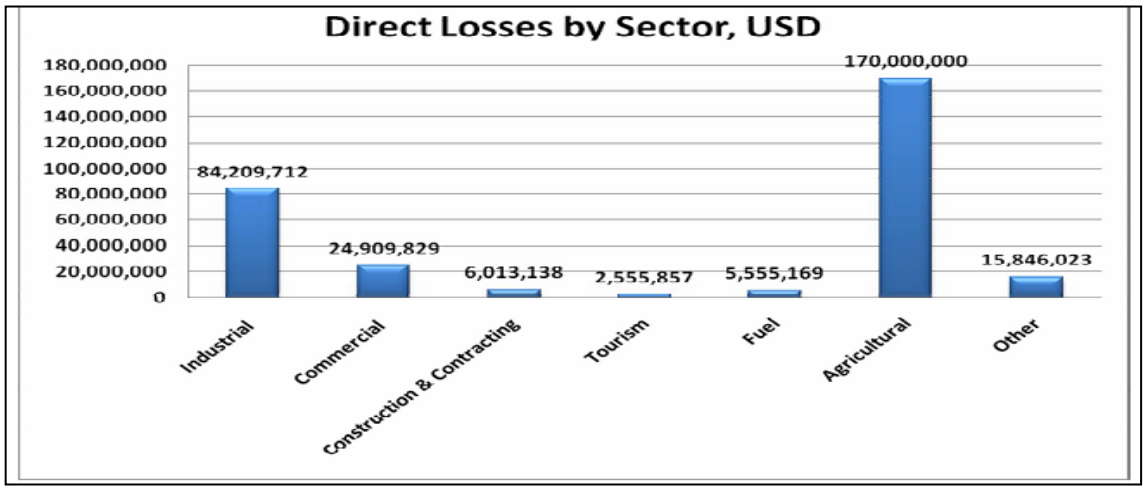

Fig 2.1: Losses of the economic sector in Gaza Strip caused by the war [40].

2. Damage in the industrial sector

According to the PFI assessment report concluded in May 2009, the productive sector bore over 40% of the total losses, as a result of the Israeli military war. Based on previous assessments concluded by PFI, 324 industrial establishments were directly hit during the war, with 44% of which were totally damaged and 56% were slightly – considerably damaged [44]. The following two tables 2.1 and 2.2 show the amount of damage in industrial sectors in Gaza Strip in terms of dollars and the number of damaged factories respectively.

Table 2.1: The amount of damage in terms of dollars for each industrial sector [41].

Sector	Machine damages (USD)	Construction damages (USD)	Total damage (USD)	Percentage of total (%)
Handicraft	12,800	24,750	37,550	0.04337456
Paper and cartoon	304,500	72,000	376,500	0.43490074
Plastic and rubber	1,921,910	1,632,065	3,553,975	4.10524926
Chemical and cosmetics	1,248,176	506,438	1,754,614	2.02678067
Textiles and garment	1,090,263	398,356	1,488,619	1.7195259
Wood industries	1,961,393	1,619,681	3,581,074	4.13655172
Construction	19,416,402	13,175,423	32,591,825	37.6473007
Food and beverages	19,138,800	7,269,375	26,408,175	30.5044748
Metal and engineering	10,813,207	5,683,100	16,496,307	19.055129
Leather	13,130	3,960	17,090	0.01974091
Pharmaceutical	265,750	0	265,750	0.30697177
Total	55,907,451	30,111,188	86,571,479	100%

Table 2.2: The amount of damage in terms of number of damaged factories for each industrial sector [41].

Sector	Total number of damaged factories	Percentage of total (%)
Handicraft	4	1.2
Paper and cartoon	2	0.6
Plastic and rubber	18	5.6
Chemical and cosmetics	17	5.2
Textiles and garment	11	3.4
Wood and furniture industries	77	23.8
Construction	69	21.3
Food and beverages	11	3.4
Metal and engineering	113	34.9
Leather	1	0.3
Pharmaceutical	1	0.3
Total	324	100

3. Financing needed for reconstruction

As shown in figure 2.2 a percentage of 54% of the damaged establishments need less than US$100’000 to reconstruct their establishments, while 13% need more than US$500’000 to make the reconstruction necessary to resume operation [41].

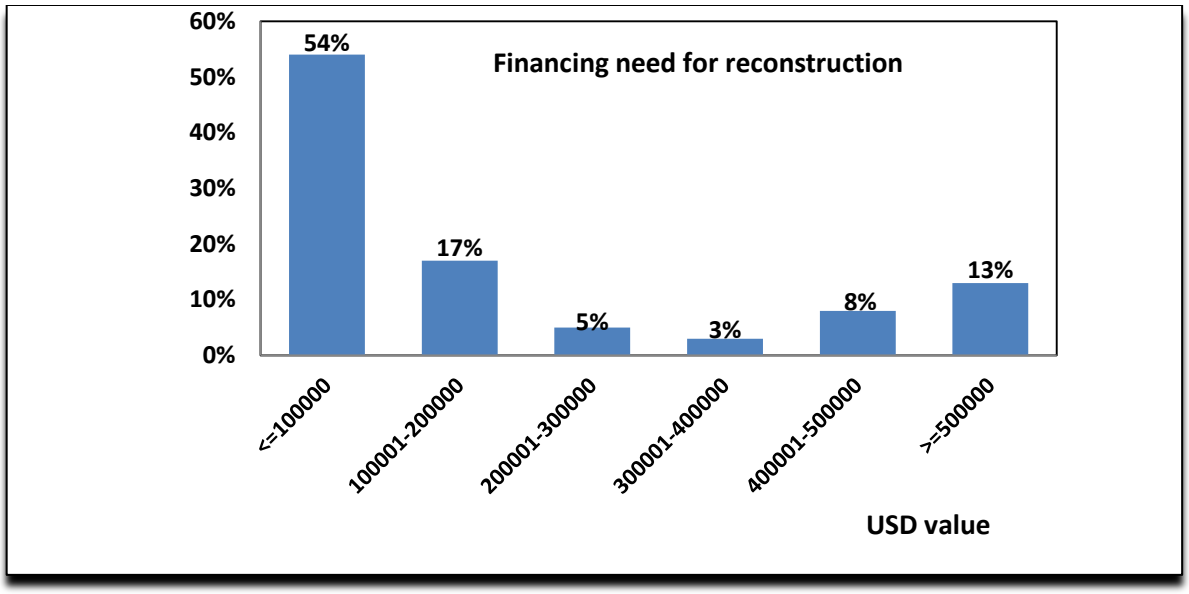

Fig 2.2: Financing needed for reconstruction [41].

4. Availability of raw materials and machinery

Only 10% of the raw materials necessary to resume activities are available in Gaza (either imported and stored previously or bought through "tunnels") while 65% of the raw materials must be imported from Israel and the rest has to be imported from other countries. For the availability of machinery, 21% of the machinery needed to resume production is available in the local market as either new, used or manufactured in Gaza. 44% is from Israel and 35% needs to be imported from other countries[42].

Third: Criteria identification in the previous studies

The first step in MCDM, regardless of the selected method, is the choice of relevant criteria. A lot of studies were conducted in the field of prioritization and ranking by using MCDA. The output of these studies is ranking of different alternatives like projects and locations selection, funding strategies, products comparison and a lot of other applications that cannot be evaluated based on one single criterion.

Previous studies had been surveyed to find out the most important criteria for projects ranking and funding.

The study of AL Hammad et al. (2007)"**A Model to Assist Decision Making of Public Private Partnership in Electricity Projects"** identified six main criteria for ranking infrastructure projects in Saudi Arabia, the study used AHP to prioritize the projects based on six main criteria divided into 23 other sub criteria as shown in table 2.3 [2].

Table 2.3: Criteria and sub criteria for infrastructure projects prioritization [2]

Criteria	Sub criteria
Economic criteria of the project	Total cost
	Payback period
	The market need
	Funding polices
	Project stages
Economic criteria of the country	Inflation rate
	Interest rate
	Economic stability
	Government profit sharing
	Debt problems
Technical criteria	Projects complexity
	Compatibility to standards
	Availability of experiences
Social criteria	Society support
	Jobs security and development
	Environmental concerns
Legal criteria	The percentage of foreign ownership
	Competition laws
	Riskiness
Administrative criteria	Owner experience
	Administrative flexibility and responsibility identification
	Government intervention in the project
	Accreditation and monitoring speed of Abstracts

The study of Dyer and Forman (1992) **"Group decision support with the Analytic Hierarchy Process"** presented a case study to prioritize new product production. It delivered a multi criteria study to evaluate the best product to be manufactured. The researchers suggested five criteria divided into 11 sub criteria as shown in the table 2.4 [21].

Table 2.4: Criteria and sub criteria for new product production [21]

Criteria	Sub criteria
Economic criteria	Net present value
	Risk
	Effect on other products
Technical criteria	Design complexity
	Flexibility to adapt future changes
	Availability of experiences
	Management control
Marketing criteria	Market share
	Market fit
Environmental criteria	Environmental impact
Social criteria	Social impact

The study of Ehie et al. (1990) **"Prioritizing Development Goals in Low-Income Developing Countries"** outlined a systematic approach to prioritizing the multiple and often conflicting development goals and objectives in a typical Low-income Developing Country (LDC). First, a hierarchy of development goals and objectives is developed from an extensive review of the literature. Then, (AHP) is utilized to analyze the judgment elicited from World Bank experts and a priority structure established reflecting the perceived importance of these development goals and objectives. The AHP was based on 3 main criteria divided into 11 sub criteria which also divided into 27 sub sub criteria as shown in table 2.5 [22].

Table 2.5: Criteria and sub criteria for prioritizing development goals [22]

Criteria	Sub criteria	Sub sub criteria
Economic	Increase productivity	Labor productivity
		Capital productivity
		Material productivity
		Energy productivity
	Increase foreign exchange	Foreign exchange earnings
		Foreign exchange expenditure
	Boost economic growth	Productive capacity
		Capital Investment
		Import substitution
	Diversify economy	Agriculture sector
		Industry sector
		Service sector
Social	Improve employment situation	Unemployment
		New employment
	Improve quality of Life	Infant mortality
		Life expectancy
	Control population growth	Migration to urban areas
		Rural settlement
		Birth control
	Improve educational system	Basic Literacy rate
		Vocational job training
	Wealth distribution	Government assistance programs
		Income distribution
Political	Achieve self reliance	External dependence
		Use of Local natural resources
	Maintain political stability	Domestic defense spending
		External military aid

The paper of Huang et al. (2009) **"A multiple criteria evaluation of creative industries for the cultural creativity centre in Taiwan"** built up an evaluation framework for selecting creative industries into the new cultural creativity center in Tainan city, Taiwan. This study made an application of the (AHP) to evaluate the creative industries for the introduction and development in the new cultural creativity center in Taiwan. It determined the critical factors that affected the priority of the alternatives. The alternatives were eleven industrial sectors and they were ranked according to seven criteria listed in table 2.6. The results indicate that the criterion market potential has the highest weight, followed by the regional development and culture improvement criteria. Resource consumption and tourist attraction have the smallest weights, and are comparatively unimportant [32].

Table 2.6: Criteria and sub criteria for evaluating creative industries [32]

Criteria	*resource consumption*
	market potential
	cultural factors
	regional development
	local characteristics
	tourist attraction
	employment opportunity

Augusto et al. (2005) in the study **"An application of a multi-criteria approach to assessing the performance of Portugal's economic sectors Methodology, analysis and implications"** proposed a multi-criteria approach for ranking the performance of the economic sectors of the Portuguese economy and to identify the most attractive sectors. They used criteria to rank the economic sectors which are mainly financial in nature; these criteria are shown in table 2.7. The output of the study is a rank for twenty economic sectors in Portugal, The sector non-metallic mineral products was ranked in first place in relation to all the rankings; the sector wood, cork and furniture was ranked often in second place; the electronic and electrical industry sectors was ranked in third place; the agriculture and fishing sector was ranked in the tail-end of the ranking; the agro-industry

sector and the transportation and distribution sector consistently were ranked in the lowest positions, just before the agriculture and fishing sector [7].

Table 2.7: Criteria and sub criteria for ranking economic sectors [7]

Criteria	Sales growth
	Return on equity
	Profitability of total assets
	Profitability of sales
	Solvency
	Liquidity
	Assets turnover
	Productivity of the work
	Cash flow/sales

Fourth: Criteria identification and definition

After surveying the previous mentioned studies, a conclusion can be made that the main criteria for prioritizing economic projects and industrial sectors are mainly six criteria which are economic, financial, technical, marketing, environmental and social/political criteria. These criteria are adopted by the researcher according to the literature and what is applicable for the situation of Gaza Strip industrial sectors. This study will be mainly based on these six criteria adding other criteria related to the damage volume in industrial sectors in Gaza strip after the war.

The definition of each criterion is discussed in the following:

1. Economic criteria

Economic criteria reflect the effect of the alternative (industrial sector) on the local economy; means that how can the industrial sector presents economic benefits. The economic criteria consist of three sub criteria as shown in table (2.8).

Table (2.8): Economic Sub-criteria Definitions

Economic sub-criteria	Definition
1.1. Employment creation	The ability of the sector to reduce the unemployment rate in society, on other words, the number of needed to operate the sector.
1.2 Contribution to gross domestic product (GDP)	The significant contribution of the sector to GDP, such as export products which bring foreign currency into Gaza Strip.
1.3 Effects on other industrial sectors	How will the rehabilitation of this sector affect the other industrial sectors; whether these effects are positive or negative

2. Financial criteria

Financial criteria search in the project's income and expenditure, sources of finance and financial schedule. The financial criteria consist of four sub criteria as shown in table (2.9).

Table (2.9): Financial Sub-criteria Definitions

Financial sub-criteria	Definition
2.1 Total needed fund	The total minimum amount of fund needed to the sector so it can restart its work and produce the products with production rate as before the war.
2.2 Return on investment	Rate of profit or sometimes just return, is the ratio of money gained or lost on an investment relative to the amount of money invested.
2.3 Net present value	The result of subtracting the total present value costs from the total present value benefits. Also referred to as net benefit or net cost.
2.4 Payback period	The time which taken to recover the initial investment. When the period is small, it is mean that related project has better financial performance

3. Technical criteria

Technical criteria refer to the nature of the sector, complexity of work, ease of access of raw materials and machines. The technical criteria consist of five sub criteria as shown in table (2.10).

Table (2.10): Technical Sub-criteria Definitions

Technical sub-criteria	Definition
3.1 Availability of machines and technology	The availability of the required machines, tools and new technologies in the local market, if not the ease of getting them from abroad.
3.2 Availability and the ease of access of raw materials	The availability of the raw materials in the local market, if not the ease of getting them from outside.
3.3 The nature of infrastructure needed	The Complexity of the rehabilitation process and technologies used, as machines, construction, energy and special preparations.
3.4 - Resources for Development	Resources (particularly experienced staff) available for sector development in the future.
3.5 Product quality	The performance of the sector's products in the hand of the consumer before the war.

4. Marketing criteria

Marketing criteria include the supply and demand analysis, the sector's market share and the loyalty of customers to local sector's products. The marketing criteria consist of four sub criteria as shown in table (2.11).

Table (2.11): Marketing Sub-criteria Definitions

Marketing sub-criteria	Definition
4.1 Quality and reputation of products existed now in the market	How the quality and reputation of existed products in the market will affect the demand of the rehabilitated sector products.
4.2 Market Share at Foreign Markets	Percentage of the total production amount, specified only for foreign markets, when this percentage grow, the exportation probability of the sector will grow.
4.3 Market Share at Local Market	Identify whether same sector's products are local or foreign. Competitions from foreign products often affect the sector's related sales.
4.4 Market Growth	Market growth is the rate of demand increasing. So, it is essential indicator for the sector success or fail. Market growth is often measured by the annual rate of demand increasing.
4.5 Borders and siege overcome	How easy to market the products outside Gaza Strip during siege and closures periods?

5. Environmental criteria

Environmental criteria search in how the rehabilitation of the sector will result in positive or negative effects on the environment. The environmental criteria consist of three sub criteria as shown in table (2.12).

Table (2.12): Environmental Sub-criteria Definitions

Environmental sub-criteria	Definition
5.1 Environmental Impacts	How can the rehabilitated sector affect the environment, whether the effects are positive or negative?
5.2 Rules and regulations regarding environment	Governmental rules and regulations regarding the environment that may obstacle the production of sector's products.

6. Social/Political criteria

Social/Political criteria search in how the rehabilitation of the sector will be supported or opposed from the public and political connections, this may determine type of imported raw materials, exported products and some of products may be prohibited from production in Gaza according to political agreements. The Social/Political criteria consist of three sub criteria as shown in table (2.13).

Table (2.13): Social/Political Sub-criteria Definitions

Social/Political sub-criteria	Definition
6.1 Governmental Support/Opposition	Extent of the local governmental support for or opposition to the sector. In other words, how much the government can fund the sector? Governmental fund depends on the project's accession to the governmental policy
6.2 Public Support/Opposition	Extent of (local) public support for or opposition the sector, according to the society culture and religion, and how much the sector's output suitable for it.
6.3 Donors Support/ Opposition	Extent of donor countries which support the sector. On other words, how much the donor countries can fund the sector.

7. Scale of Damage Criteria

Scale of damage criteria search in the amount of damage in terms of American dollars and the number of damaged facilities in each sector. The scale of damage criteria consist of two sub criteria as shown in table (2.14).

Table (2.14): Scale of Damage Sub-criteria Definitions

Scale of damage sub-criteria	Definition
7.1 Total amount of damage in terms of dollars	The damage in the sector's machines, production lines, construction and any other losses because of the war in terms of Dollars.
7.2 Number of damaged facilities	The number of damaged facilities in the sector that stopped working because of the war.

The structure of evaluation criteria and sub criteria is arranged in figure 2.3.

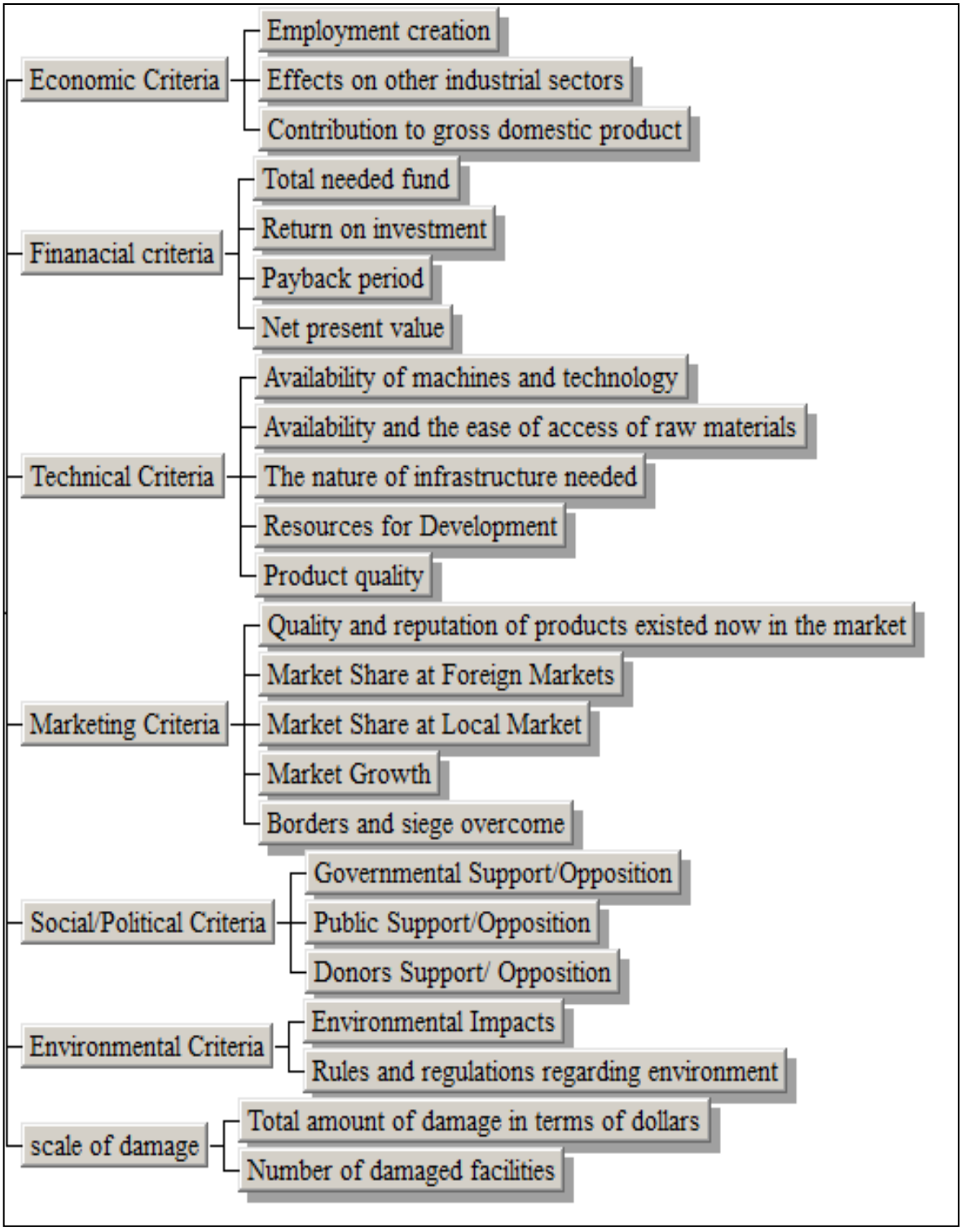

Fig 2.3: Industrial sectors evaluation and ranking criteria (adopted by researcher from literature)

These previous seven criteria with their twenty four sub criteria were arranged in a questionnaire (Appendix A), then the experts opinions will be surveyed by filling this questionnaire. The expert can respond whether the criteria/sub criteria has an effect on the alternative (industrial sector) or not, then opening the area for the expert to modify and add in the criteria/sub criteria. The analysis of the questionnaire was made to identify final set of criteria/sub criteria according to the experts' points of view. The experts' opinions were only concentrated on the importance of stated 7 criteria and 24 sub criteria without any addition of new criteria or sub criteria; their points of view were that the questionnaire includes all needed criteria of evaluation.

After that, these final criteria/sub criteria can be used in the AHP model to compare alternatives (industrial sectors) and get the weight of each criteria/sub criteria for each industrial sector to rank and prioritize funding and rehabilitation.

Fifth: Summary:

The status of the industrial sectors in Gaza Strip is very difficult and it should be rehabilitated and compensated about the damages of the war. The surveying of the previous related studies resulted in considering 7 main criteria with 24 sub criteria to evaluate and rank the industrial sectors in Gaza Strip for the compensation process. These criteria and sub criteria are the basis of ranking the industrial sectors and compensating them by the research AHP and GP models.

Chapter 3: Analytical Hierarchy Process and Goal Programming

First: MCDM

1. **MCDM Steps**
2. **Classification of MCDM techniques**

Second: Analytic Hierarchy Process (AHP)

1. **AHP definition**
2. **AHP principles and axioms**
3. **AHP Methodology**
4. **AHP applications**
5. **AHP strengths and weaknesses**

Third: Goal Programming

1. **GP definition**
2. **History of GP**
3. **GP algorithms**
4. **GP strengths and weaknesses**

Fourth: Combined AHP and GP

1. **Combined AHP and GP in literature**
2. **AHP-GP strengths and weaknesses**

First: MCDM

A decision is a choice out of a number of alternatives, and the choice is made in such a way that the preferred alternative is the "best" among the possible candidates. There are several yardsticks to judge the alternatives and there is no alternative which outranks all the others under each of the performance criteria. Thus, the decision maker does not only have the task to judge the performance of the alternatives in question under each criterion, he/she also has to weigh the relative importance of the criteria in order to arrive at a global judgment. In the beginning of decision making science the operations research presented a single criteria optimization model, which is based on the maximization or minimization of a single objective function, subject to some constraints. Making a decision based solely on a single criterion appears insufficient as soon as the decision-making process deals with complex organizational environments: It is difficult or not impossible to summarize in a single objective the complexity of opinions. Thus it is assumed that decisions most often involve several conflicting objectives. This implies that real world problems have to be solved optimally according to criteria which prohibit an "ideal" solution – optimal for each decision maker under each of the criteria considered. Consequently, one must acknowledge the presence of several criteria which are at least partially contradictory and often non commensurable, leading to the development of MCDM.

(MCDM) is an advanced field of operations research that is devoted to the development and implementation of decision support tools and methodologies to confront complex decision problems involving multiple criteria, goals, or objectives of conflicting nature [18].

Numerous multi-criteria decisions are daily made, both in public and in private life: strategic decisions (in a company the choice of products and markets, for instance, and in private life the choice of a partner and a career), tactical decisions (the choice of a location for production and sales, the choice of a university or a job), and operational decisions (daily or weekly scheduling of activities).

Methods for MCDM have been designed in order to designate a preferred alternative, to classify the alternatives in a small number of categories, and/or to rank the alternatives in a

subjective order of preference; they may sometimes also be used to allocate scarce resources to the alternatives on the basis of the results of the analysis [36].

1. MCDM Steps:

The main steps of MCDM as the following:

1. Establishing system evaluation criteria that relate system capabilities to goals
2. Developing alternative systems for attaining the goals (generating alternatives)
3. Evaluating alternatives in terms of criteria (the values of the criterion functions)
4. Applying a normative multi-criteria analysis method
5. Accepting one alternative as ‘‘optimal’’ (preferred)
6. If the final solution is not accepted, gather new information and go into the next iteration of multi-criteria optimization [39].

2. Classification of MCDM techniques

Several methods have been proposed to deal with MCDM problems, These are:

- **Value function methods:** These methods synthesize assessments of the performance of alternatives against individual criteria, together with inter-criteria information reflecting the relative importance of the different criteria, to give an overall evaluation of each alternative indicative of the decision maker’s preference.
- **Goal and reference point methods:** The decision maker specifies some goals to be achieved; if they are achieved the decision maker is assumed to be satisfied; if not the method seeks to get as close as possible to the goals.
- **Outranking methods:** The outranking methods approach by Roy (1968), are based on a pair wise comparison of alternatives. It provide an ordinal ranking and sometimes only a partial ordering of the alternatives which means that it can only express which alternative is preferred but cannot indicate how much.

  These methods attempt pair-wise or global comparison among alternatives. An alternative (a) is said to outrank another alternative (b) if, taking into account all the available information regarding the problem and the decision maker’s

preferences, there is a strong enough argument to support a conclusion that a is at least as good as b and no strong argument to the contrary [12].

Examples of outranking methods are the PROMETHEE, Brans and Vincke, (1985); ELECTRE Roy, (1973), MACBETH Bana e Costa, (1997) among others [36].

Second: Analytic Hierarchy Process (AHP)

(AHP) is one of MCDM methods; it was originally developed by Thomas L. Saaty in the mid 1970s. It combines tangible and intangible aspects to obtain the priorities associated with the alternatives of the problem.

AHP is a structural framework that allows decision-makers to model a complex problem in a hierarchical structure by breaking it down into smaller parts, then calling for a simple comparison with respect to pairs of judgments to develop priorities within each level of hierarchy. Finally, results are synthesized to obtain overall weights of the alternatives. The input can be obtained from actual measurement such as price, weight etc., or from subjective opinion such as satisfaction feelings and preference. AHP allows some small inconsistency in judgment because human is not always consistent. The ratio scales are derived from the principal Eigen vectors and the consistency index CI is derived from the principal Eigen values.

AHP is based on the experience gained by its developer, Thomas L. Saaty, while directing research projects in the late 1960's in the US Arms Control and Disarmament Agency. It was developed as a reaction to the finding that there is a miserable lack of common, easily understood and easy-to-implement methodology to enable the making of complex decisions. Since then, the simplicity and power of the AHP has led to its widespread use across multiple domains in every part of the world. The AHP has found use in business, government, social studies, R&D and other domains involving decisions in which choice, prioritization or forecasting is needed.

1. AHP Definition

According to Saaty definition "The AHP is a simple, mathematically based MCDM tool to model deal complex, unstructured and multi-attribute problems in a hierarchal structure showing the relationships of goal, criteria, sub criteria, and alternatives". AHP not

only support decision makers by enabling them to structure complexity and exercise judgment, but it allows them to corporate both objective and subjective considerations on the decision problems.

2. AHP Principles and Axioms

AHP is built on a simple theoretical foundation to determine how much the alternatives contribute to the goal. AHP is based on three basic principles; decomposition, comparative judgments and synthesis. The decomposition principle is applied to structure a complex problem into hierarchy of clusters, sub-clusters, sub- sub clusters and so on. The principle of comparative judgments is applied to construct pair wise comparisons of all combinations of elements in a cluster with respect to the parent of the cluster. The principle of synthesis or hierarchal composition is applied to multiply the priorities of elements in a cluster by the priority of the parent element [24].

Axioms provide the foundations for any methodology or technique. Saaty has specified four axioms for AHP and these have been described more simply by Forman and Gass (2001).

The first axiom; the reciprocal axiom, requires that if A is three times better than B, then B is one third as good as A.

The second axiom; the homogeneity axiom, states that the elements to be compared should not differ too much to not have large errors in judgments that lead to a decrease in accuracy and increase in inconsistency.

The third axiom states that the priorities of the elements in a cluster do not depend on lower level elements, that means when comparing elements at each level a decision-maker has just to compare with respect to the contribution of the lower-level elements to the upper-level one. This local concentration of the decision-maker on only part of the whole problem is a powerful feature of the AHP.

The fourth axiom; the expectation axiom, says that individuals who have reasons for their beliefs should make sure that their ideas are adequately represented for the outcomes to

match these expectations. This axiom means that output priorities should not be radically different to any prior knowledge or expectation that a decision maker has [21].

3. AHP Methodology

AHP is based on the assumption that when faced with a complex decision, the natural human reaction is to cluster the decision elements according to their common characteristics. It involves building a hierarchy of decision elements and then making comparisons between each possible pair in each cluster. This gives a weighting for each element within a cluster and also a consistency ratio (CR) which is useful for checking the consistency of the data. The methodology of the AHP is explained in figure 3.1.

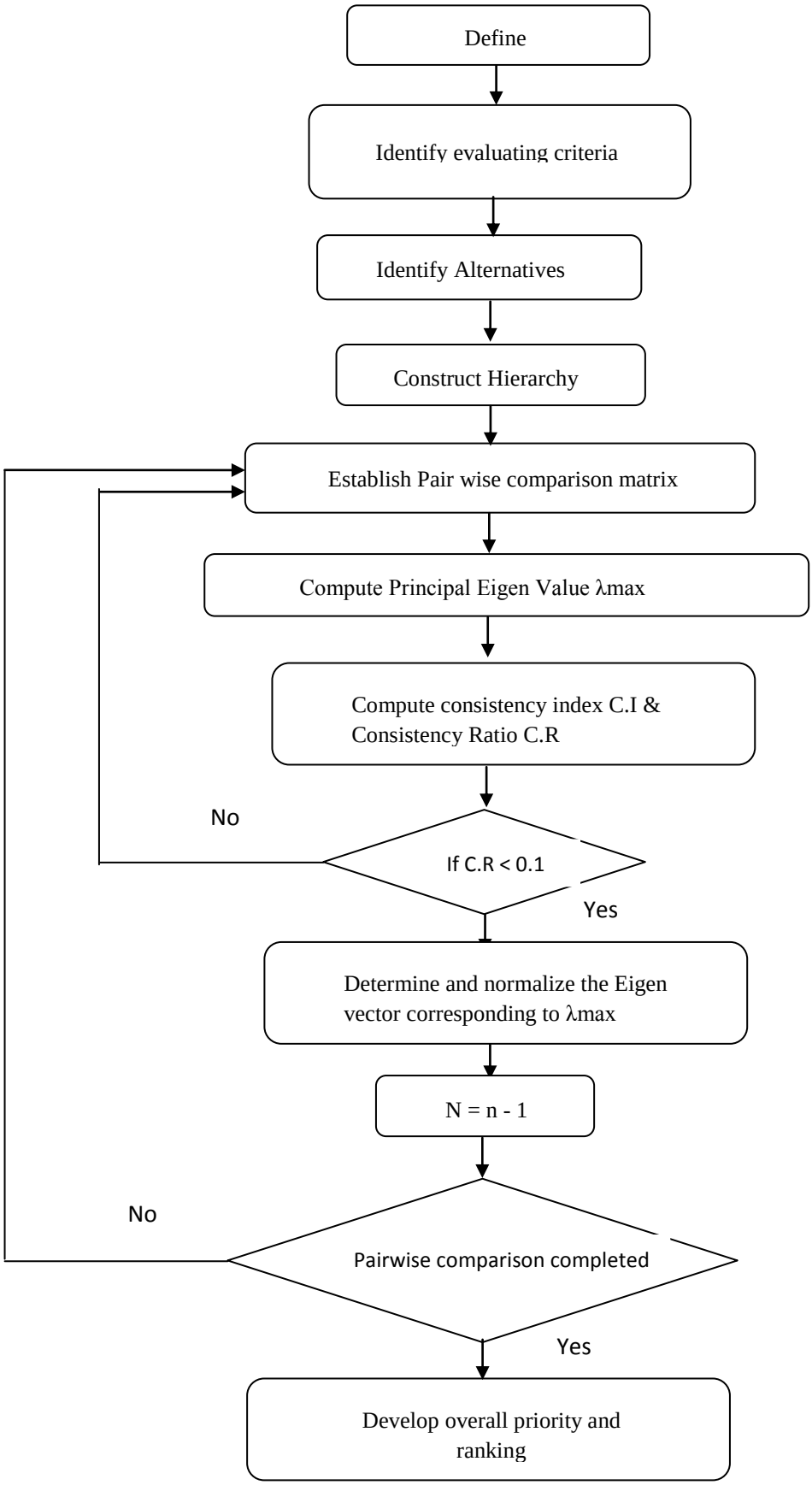

Fig 3.1: AHP methodology (adopted by researcher)

4. Hierarchical Structuring of the Problem

In the first stage, the decision maker defines a hierarchical structure representing the problem at hand. A general form of AHP structure is presented in figure (3.2). In the simplest case, the hierarchy has three levels. The first level represents the goal of the decision problem and is analyzed as resulting from the aggregation of evaluation criteria represented by the second level; the last level of the hierarchy involves the alternatives to be evaluated. In more complex cases, there may be more levels, corresponding to splitting criteria into sub-criteria.

The objective or the overall goal of the decision is represented at the top level of the hierarchy. The criteria and sub-criteria contributing to the decision are represented at the intermediate levels. Finally, the decision alternatives or selection choices are laid down at the last level of the hierarchy. The number of the levels in a hierarchy depends on the complexity of the problem being analyzed and the degree of detail of the problem that an analyst requires to solve.

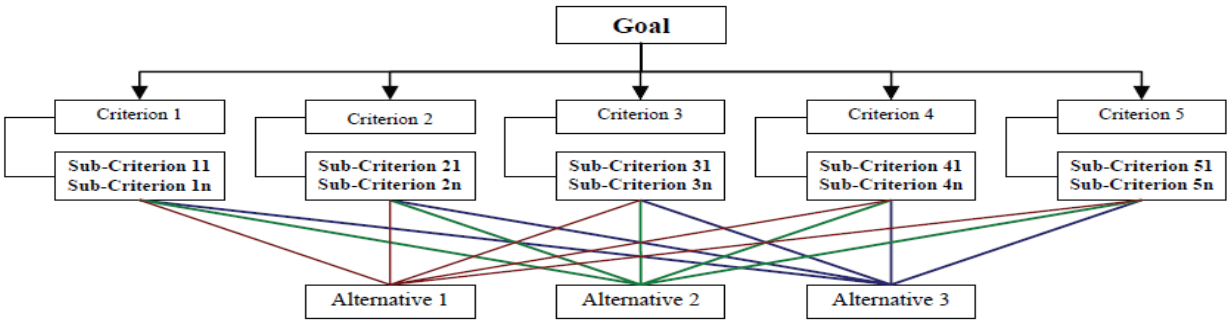

Fig 3.2: AHP Hierarchy (Saaty, 1980)

5. Performing Pairwise Comparisons

Once the hierarchy of the problem is defined, the decision-maker performs a series of pairwise comparisons within the same hierarchical level and then between sections at a higher level in the hierarchy structure to have *n*(n-1)/2* comparisons if there are *n* criteria. In comparisons, a ratio scale of *1-9* is used to compare any two elements. Table (3.1) shows the measurement scale defined by Saaty (1980). The matrix of pair-wise comparisons is:

$$\underline{A} = \begin{bmatrix} w_1/w_1 & w_1/w_2 & w_1/w_3 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & w_2/w_3 & \dots & w_2/w_n \\ w_3/w_1 & w_3/w_2 & w_3/w_3 & \dots & w_3/w_n \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & w_n/w_3 & \dots & w_n/w_n \end{bmatrix}$$

Table (3.1): Saaty's Scale of Importance Intensities [Saaty, 1980].

Intensity of importance	Definition
1	Equal importance
3	Weak importance of one over another
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2,4,6,8	Intermediate values between the two adjacent judgments

The pair wise comparisons of various criteria are organized into a square matrix as shown in matrix A. The diagonal elements of the matrix are *1*. The criterion in the i^{th} row is better than criterion in the j^{th} column if the value of element *(i, j)* is more than 1; otherwise the criterion in the j^{th} column is better than that in the i^{th} row. The *(j, i)* element of the matrix is the reciprocal of the *(i, j)* element.

The pair wise comparisons depend on subjective judgment without any scientific measurements, so it has been verified that a number of these pair wise comparisons taken together forms a sort of average. This average is calculated through a complex mathematical process using eigen values and eigen vectors. The principal eigen value and the corresponding normalized right eigen vector of the comparison matrix give the relative

importance of the various criteria being compared. The elements of the normalized eigen vector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives. (Saaty, 1980)

The procedure of pair wise comparison is to evaluate the importance of the criteria and then the preference for the alternatives with respect to each criterion.

The final solution results in the assignment of weights to the alternatives located at the lowest hierarchical level.

6. Synthesis

Once judgments have been entered for each part of the model, the rating of alternative is multiplied by the weights of the sub-criteria and aggregated to get local ratings with respect to each criterion. The local ratings are then multiplied by the weights of the criteria and aggregated to get global ratings. The AHP produces weight values for each alternative based on the judged importance of one alternative over another with respect to a common criterion. The results are then synthesized to obtain rank of the alternatives in relation to the overall goal.

7. Consistency Evaluation

Comparisons made are subjective and AHP tolerates inconsistency through the amount of redundancy in the approach. If this CI fails to reach a required level, then answers to comparisons may be re-examined. The eigen value technique enables the computation of a consistency measure which is an approximate mathematical indicator of the inconsistencies or intransitivity in a set of pairwise ratings. This consistency measure is called the *CI* which is calculated as:

$$CI = (\lambda_{max} - n)/(n-1)$$

Where λ_{max} is the maximum eigen value of the judgment matrix. This *CI* can be compared with that of Random Consistency Index, (*RI)*. RI can take a value between 0 to *1.49* as shown in table (3.2). The ratio derived, *CI/RI*, is termed the CR, Saaty suggests the value of *CR* should be less than 0.1, if it is greater than 0.1 *(or 10%)*, the level of inconsistency in

the set of ratings is considered to be unacceptable. In this situation, the evaluation procedure has to be repeated to improve consistency. Sensitivity analysis can be performed to see how well the alternatives performed with respect to each of the objectives as well as how the alternatives are sensitive to changes of the objectives. (Saaty, 1980)

Table (3.2): Random Consistency Index (RI) [Saaty, 1980].

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

8. AHP Applications

Broad areas where AHP has been successfully employed include: selection of one alternative from many; resource allocation; forecasting; total quality management; business process re-engineering; quality function deployment, and the balanced scorecard (Saaty and Vargas, 1991). By scanning the literature different uses of AHP can be found these include:

- Serkan et al. (2009) used AHP and TOPSIS methods under fuzzy environment for weapon selection [51].
- Hambali et al. (2009) applied AHP for composite manufacturing process selection [30].
- Steven (2008) used AHP for asset allocation [52].
- Agha (2008) used AHP for evaluating and benchmarking non-governmental training programs [1].
- Ahmet and Bozbura (2007) used AHP for prioritization of organizational capital measurement indicators [15].
- Forman and Gass (2001) constructed AHP model for assessing risk in operating cross-country petroleum pipelines [24].
- Babic and Palzibat (1998) used AHP for ranking of enterprises according to the achieved level of business efficiency [8].

- Berrittella, (2007) used AHP in deciding how best to reduce the impact of global climate change [13].
- McCaffrey, (2005) used AHP in quantifying the overall quality of software systems in Microsoft Corporation [37].
- Grandzol, (2005) used AHP in selecting university faculty in Bloomsburg University of Pennsylvania [28].
- Dey, (2003) used AHP in assessing risk in operating cross-country petroleum pipelines for American Society of Civil Engineers [20].

9. AHP Strengths and Weaknesses

Several researchers, including Triantaphyllou and Mann, (1990) have pointed out the weakness of AHP as follows

a. Weaknesses of AHP

- **High inconsistency Ratio (CR) Between the Stakeholders**

The weakness of AHP in assessing the relative importance weights of various criteria, in addition to that the ability of humans to accurately express their knowledge decreases with increasing problem complexity, are considered the two main sources of the high inc consistency ratio (CR). The weakness in assessing the relative importance weights of various criteria results primarily from two limitations, the difficulty of using Saaty's discrete 9-value scale to reflect the belief of decision makers in the relative importance relationship among the various criteria, and the difficulty of identifying the in-between numbers of fuzzy sets. Saaty's discrete 9-value scale method forces decision makers to select numbers from the finite set {1/9, 1/8, 1/ 7… 1, 2, 3… 7, 8, 9}, contradicting the real world fuzzy memberships of elements in a fuzzy set. In most real world problems, the membership values in a fuzzy set take on continuous values (namely real numbers) rather than discrete numbers. Triantaphyllou and Mann, (1990), found that this limitation can cause extremely high failure rates for AHP.

- **Rank Reversal**

Other drawback sometimes arises with AHP known as ‘rank reversal’, which is associated with the relative nature of the judgments involved. Here, changing the set of alternatives changes the ranking of all alternatives. If new alternatives are likely to be added to the model after initial analysis, and alternatives are amenable to a direct rating approach (i.e. not so qualitative as to require pair wise comparison), then an approach in which ratings of alternatives are assigned directly (such as the Simple Multi-Attribute Rating Technique or SMART) could be a better choice.

- **Complexity**

AHP is by nature a multi-stakeholder and multi criteria approach to decision- support. Such feature may make using AHP especially for strategic decision making. The fist obstacle faced while dealing with such case is lack of agreement on how to identify stakeholder groups, and how to select samples or representatives from them. Stakeholders' interviews sometimes are long. So, a well trained stuff is needed to prepare a valid questionnaire as well as explain the questions briefly and obviously. In short, AHP may appear invalid approach in situations where time is crucial [56].

On the contrary, a number of benefits have been noted with the AHP process in general as a (MCDM) technique.

b. AHP Strengths

AHP has been applied in a wide variety of decision areas including those related to economy, planning, energy policy, health, conflict resolution, project selection, budget allocation, operations management, benchmarking , total quality management, win-win management, site selection, and education. In addition to being used alone, the AHP has been combined with a number of quantitative analysis techniques such as LP, goal programming, Data Envelopment Analysis, game theory, conjoint analysis and SWOT analysis.

The benefits of using AHP as follows:

- It formalizes and makes systematic what is largely a subjective decision process and thereby facilitates "accurate" judgments.
- As a by-product of the method, management receives information about the evaluation criteria's implicit weights.
- The use of computers makes it possible to conduct sensitivity analysis of the results.

The benefits of AHP technique are as follows:

- AHP is an effective management tool. It can handle many alternatives at one time and so permit comparisons to be made. Other popular techniques, such as the Relative Merit Method or Dimensional Analysis, can only handle two alternatives at a time.
- The AHP can handle complex situations where different weights are assigned to the same attributes. Judges' opinions may vary when determining how important an attribute is. Also, a weight could be assigned to the Judges' authority in the decision-making process. For instances, the President of a firm may have more say than the Vice President. Therefore, his opinion can be weighted at 0.65 and the Vice President's at 0.35. This rationale could also be applied to several stockholders.

- **Inclusiveness**

A mixture of quantitative and qualitative information and taking into account multiple stakeholders with conflicted objectives makes AHP to go beyond the evaluation of purely economic consequences and allows non-economic criteria to be assessed on an equal basis, which enhance the results confidence.

- **Flexibility**

The hierarchal nature of AHP makes priority of each element depend on the higher level elements. So, if the surrounded conditions lead to change the judgment of any criteria the final rank of the alternatives will change according to the changes in the ground. So, managers can automatically allocate their resources to accommodate the new circumstances

- **Easiness**

AHP methodology does not depend on cumbersome mathematical concepts. So, it is easy to understand and applied by the majority of people. AHP easiness makes it one of the most decision making widely used tools. In addition to all AHP benefits and drawbacks were mentioned above, the following table, Table (3.3), summarizes other pros/ cons related to it [61].

Table 3.3: Pros and cons of AHP [11]

Pros	Cons
• It allows MCDM. • It is applicable when it is difficult to formulate criteria evaluations, i.e., it allows qualitative evaluation as well as quantitative evaluation. • It is applicable for group decision making environments • The inclusion of the managers at every step of the decision analysis in the AHP method gave them a feeling of ownership that nearly insured the implementation of the findings. • Inconsistency measure helps users to know when they make inconsistent judgments, especially if they are working as a group. People want to be logically consistent in making decisions. • Using AHP in group setting results in better communication, leading to clearer understanding and consensus among the members of decision making group, and hence a greater commitment to the chosen alternative.	• There are hidden assumptions like consistency. Repeating evaluations is cumbersome. • Difficult to use when the number of criteria or alternatives is high, i.e., more than 7. • Difficult to add a new criterion or alternative • Difficult to take out an existing criterion or alternative, since the best alternative might differ if the worst one is excluded.

Third: GP

One of the most optimistic techniques for multiple objective decision analysis is (GP). This is a powerful tool which draws upon the highly developed and tested technique of LP but it also provides a simultaneous solution to a complex system of competing objectives. GP can handle decision problems having a single goal with multiple sub-goals.

Generally, many decision problems in organizations involve multiple objectives. Such problems are not simple to analyze by optimization techniques such as LP. (MCDM) or multiple-objective decision making (MODM) has been a popular topic of management science during the past decade. A number of different approaches of MCDM or MODM have been proposed, such as the multi-attribute utility theory, the multiple-objective "LP", "GP", "Compromised Programming" and various heuristics. Among these, "GP" has been the most widely accepted and applied technique [47].

In conventional LP the objective function is one-dimensional, intended either to maximize effectiveness or to minimize sacrifice. GP techniques are capable of handling multiple goals in multiple dimensions and therefore have no dimensional limitation of the objective function. GP techniques offer optimal solutions to the problem of conflicting or incommensurable goals if an ordinal ranking of goals in terms of their contributions or importance to the organization can be provided [48].

1. GP Definition

GP is a branch of multiple objective programming, which in turn is a branch of MCDA, also known as MCDM. It can be thought of as an extension or generalization of linear programming to handle multiple, normally conflicting objective measures. Each of these measures is given a goal or target value to be achieved. Unwanted deviations from this set of target values are then minimized in an achievement function. This can be a vector or a weighted sum dependent on the GP variant used. [58]

Rifai, (1994) defined in GP as "Mathematical model manages a set of conflicting objectives by minimizing deviations between the target values and the realized". An explicit definition of GP was given by Charnes and Cooper (1961) as "a branch of multi

objective optimization that can be thought of as an extension or generalization of LP to handle multiple, normally conflicting objectives." [47]

GP handles the MCDM problems through considering the measures related to the conflicting objectives as a given goal or target value to be achieved. Unwanted deviations from this set of target values are then minimized in an achievement function. This can be a vector or a weighted sum dependent on the GP variant used. As satisfaction of the target is deemed to satisfy the decision-maker(s), an underlying satisfying philosophy is assumed.

GP is a well-known modification and extension of LP. LP deals with only one single objective to be minimized or maximized, and subject to some constraint; therefore, has limitations in solving a problem with multiple objectives. GP, instead, can be used as an effective approach to handle a decision concerning multiple and conflicting goals. Further, the objective function of a GP model may consist of non-homogeneous units of measure [48].

2. History of GP

GP was first used by Charnes, Cooper and Ferguson in 1955, although the actual name first appear in a text by Charnes and Cooper (1961). Seminal works by Lee (1972), Ignizio (1976), Ignizio and Cavalier (1994) and Romero (1991) followed. Scniederjans (1995) gives in a bibliography of a large number of pre 1995 articles relating to GP and Jones and Tamiz give an annotated bibliography of the period (Jones and Tamiz, 1990-2000). The first engineering application of GP, due to Ignizio in 1962, was the design and placement of the antennas employed on the second stage of the Saturn V. This was used to launch the Apollo space capsule which landed the first men on the moon [58].

GP is a branch of MCDA. It was first introduced by Charnes et al. in 1955, more explicitly defined by the same authors in 1961, and further developed by Ijiri during the 1960's. The first books dedicated to GP by Lee and Ignizio appeared during the early to mid 1970's. In the 1970's, GP and its variants were applied to many different subject areas. Questions were raised as to the effectiveness of GP as an application tool by Zeleny and Harrald during the late 1970's and early 1980's, but GP still grew in popularity judging by the increase of papers applying GP during that period [54].

3. GP Algorithms

Three basic methods have been developed to optimize a multi objective model with possibly conflicting goals:

a) The weights method (mini-sum)
b) The Lexicographic method (preemptive)
c) Chebyshev GP (mini-max)

a. Weighted GP (WGP)

The objective is to find a solution that minimizes the weighted sum of the goal deviations. If the decision-maker is more interested in direct comparisons of the objectives then weighted, or non pre-emptive, GP should be used. In this case all the unwanted deviations are multiplied by weights, reflecting their relative importance, and then added together as a single sum in order to minimize the weighted sum of the goal deviations. It is important to recognize that deviations measured in different units cannot be summed directly due to the phenomenon of incommensurability. Hence each unwanted deviation is multiplied by a normalization constant to allow direct comparison. Popular choices for normalization constants are the goal target value of the corresponding objective (hence turning all deviations into percentages) or the range of the corresponding objective between the best and the worst possible values, hence mapping all deviations onto a zero-one range [59].

WGP assumes that the positive and negative deviations of the criterion outcomes are equally undesirable. That is, that decision-maker perceives both overachievement and underachievement of specified goals as equally undesirable outcomes. Chang (2007) defined the WGP structure in the following model:

$$\boldsymbol{Min}\ \mathbf{Z} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} (\boldsymbol{\alpha_i} \mathbf{d_i^+} + \boldsymbol{\beta_i}\ \boldsymbol{d_i^-}) \qquad \textbf{(3.1)}$$

$$\boldsymbol{S.T}$$

$$\mathbf{f_i(x)} - \mathbf{d_i^+} + \mathbf{d_i^-} = \mathbf{g_i} \qquad \mathbf{i = 1, 2, \ldots n,}\ \ \mathbf{i \in h_r} \qquad \textbf{(3.2)}$$

$$\mathbf{d_i^+}, \boldsymbol{d_i^-} \geq \mathbf{0}, \quad \boldsymbol{i = 1, 2, \ldots . n} \qquad \textbf{(3.3)}$$

$$\mathbf{X} \in \mathbf{F}\ (\mathbf{F\ is\ feasible\ set})$$

Where

$\mathbf{f_i(x)}$: is the linear function of the i^{th} goal.

$\mathbf{g_i}$: is the aspiration level of the i^{th} goal.

$\mathbf{h_r}$: represents the index set of goals placed in the r^{th} priority level.

$\boldsymbol{\alpha_i}$ and $\boldsymbol{\beta_i}$: are the respective positive weights attached to these deviations in the achievement function.

$\mathbf{d_i^+ = max\ (0, f_i(x) - gi)}$ and $\mathbf{d_i^- = max\ (0, g_i - f_i(x))}$ respectively, over and under achievements of the i^{th} goal.

b. Lexicographic GP (LGP)

The initial GP formulations ordered the unwanted deviations into a number of priority levels, with the minimization of a deviation in a higher priority level being of infinitely more importance than any deviations in lower priority levels. This is known as lexicographic or pre-emptive GP. Ignizio (1976) gives an algorithm showing how a lexicographic GP can be solved as a series of LP. LGP should be used when a clear priority ordering exists amongst the goals to be achieved. Chang (2007) defined the LGP structure in the following model:

$$\mathbf{Min\ Z} = [\sum_{\mathbf{i \in h1}} (\boldsymbol{\alpha_i} \mathbf{d_i^+} + \boldsymbol{\beta_i}\ \mathbf{d_i^-}), \ldots\ldots\ldots\ldots \sum_{\mathbf{i \in h_r}} (\boldsymbol{\alpha_i}\ \mathbf{d_i^+} + \boldsymbol{\beta_i} \mathbf{d_i^-})] \qquad \mathbf{(3.4)}$$

$$\boldsymbol{S.T}$$

$$\mathbf{f_i(x) - d_i^+ + d_i^- = g_i} \qquad \mathbf{i = 1, 2, \ldots n,}\ \ \mathbf{i \in h_r} \qquad \mathbf{(3.5)}$$

$$\mathbf{d_i^+}, \boldsymbol{d_i^-} \geq \mathbf{0}, \quad \boldsymbol{i} = \mathbf{1, 2, \ldots . n} \qquad \mathbf{(3.6)}$$

$$\mathbf{X} \in \mathbf{F}\ (\mathbf{F\ is\ feasible\ set})$$

Where definitions of variables included in this model (LGP) are the same as the (WGP).

Objective functions are ordered according to their importance. Given the ordering, the most important function is minimized first, then on the set of optimal solutions with respect to the first function the second function is minimized, and so on, until a unique solution is obtained or all the specified functions are minimized. This implies that goals of higher priority must be met before those of lower priority are considered.

c. Chebyshev GP (CGP)

Can be considered a specific form of a WGP approach, it seeks the solution that minimizes the worst unwanted deviation from any single goal. For decision-makers more interested in obtaining a balance between the competing objectives, CGP, which is considered a specific form of a WGP approach, should be used. Introduced by Flavell, (1976), this variant seeks to minimize the maximum unwanted deviation, rather than the sum of deviations. This utilizes the Chebyshev distance metric, which emphasizes justice and balance rather than ruthless optimization. Chang (2007) defined the CGP structure in the following model:

$$\boldsymbol{Min\ Z} \qquad \textbf{(3.7)}$$

S.T

$$\mathbf{Z \geq\ \alpha_i d_i^{+} + \beta_i\ d_i^{-}} \qquad \textbf{(3.8)}$$

$$\mathbf{f_i(x) - d_i^{+} + d_i^{-} = g_i} \qquad \mathbf{i = 1, 2, \dots n,\ \ i \in h_r} \qquad \textbf{(3.9)}$$

$$\mathbf{d_i^{+}, d_i^{-} \geq 0,\ \ i = 1, 2,} \qquad \mathbf{X \in F\ (F\ is\ feasible\ set)} \qquad \textbf{(3.10)}$$

Where

Z: is an extra continuous variable that measures the maximum deviation.

$\mathbf{f_i(x)}$: is the linear function of the i^{th} goal.

$\mathbf{g_i}$: is the aspiration level of the i^{th} goal.

$\mathbf{h_r}$: represents the index set of goals placed in the r^{th} priority level.

$\boldsymbol{\alpha_i}$ and $\boldsymbol{\beta_i}$: are the respective positive weights attached to these deviations in the achievement function.

$\mathbf{d_i^+ = max\ (0,\ f_i(x) - gi)}$ and $\mathbf{d_i^- = max\ (0,\ g_i - f_i(x))}$ respectively, over and under achievements of the i^{th} goal.

Instead of using subjective notions to set the aspiration levels for the objectives, a set of single optimization problems is solved to arrive at the "best" and "worst" possible values of each objective. The best values are then used as aspiration levels for the objectives. The objective then becomes to minimize the deviation from those aspiration levels so that the worst deviation from any single-goal aspiration level is minimized.

4. GP strengths and weaknesses

a. GP weaknesses

In spite of the vital role of GP in handling the problem with multi criteria and multi stakeholders; GP methodology suffers from some limitations that need to be overcome to enhance its ability to give more accurate and confident decisions. The following sections summarize the limitations of GP.

- **Incommensurability**

At the cases where conflicting objectives with different goals of different importance levels might be involved in the decision-making problem, since decision objectives have different units and scales, traditional methods for multiple objective optimization, such as GP, suffer from the problem of incommensurability. Therefore, several approaches have been developed to handle such cases. The first is the fuzzy weights approach; the fuzzy weights represent only the relative importance of the goal values of a certain objective rather than the relative importance among different objectives. Another model is the weighted model, in which objectives are differently weighted to represent their relative importance, and the weighted sum of the deviations from the centers of triangular membership functions is minimized. However, this method uses only isosceles triangular membership functions.

- **Complexity**

Making decisions is part of our daily lives. In fact, the conflicts of resources and the incompleteness of available information make it almost impossible for decision-makers to build a reliable mathematical model for representation of their preferences. In order to overcome the problem of underestimation of the decision, the decision-makers according to the above mentioned, not only must consider the only single aspiration level in the local region, but also develop multiple aspiration levels under given constraints to obtain more confident solution. It is obvious that the complexity of the Multi-Criteria GP (MCGP) problem with ***n*** aspiration levels requires adding ***(ln n /ln 2)*** extra binary variables. The proposed GP model, with membership function, is used to handle the MODM problem with imprecise aspiration levels of the proposed. Multi-Choice Aspiration Levels (MCAL) model is used for solving the MODM problem with more than one aspiration level [38].

- **Sensitivity**

The results obtained by solving the model, the model output, are completely dependent on the importance weights. So, GP requires that the decision-maker specify fairly detailed a priori information about his or her aspiration levels, preemptive priorities, and the importance of goals in the form of weights.

In many complex problems, it is difficult (or even impossible) for the decision maker to provide the precise information required by these methods, these difficulties are aggravated further when the goals are unrelated to each other.

The primary disadvantages of GP in its linear form as follows:

1. The objective function or achievement function, constraints and goal relations must be linear. In fact, true linearity may not exist. GP requires that the measure of goal attainment and resource utilization be proportional to the level of each activity conducted individually.
2. Fractional values of decision variables must be acceptable in the solution because the optimal solution of a linear GP problem often yields non-integer values for the decision variables.

3. GP requires a static rather than a dynamic environment. This due to the fact that the model coefficients must be constants rather than subject to change as conditions change. This disadvantage can be minimized by including in the model coefficients which are based on forecasts of future conditions [38].

b. GP strengths

Despite the existence of some limitations related to the GP model, GP has enough strengths to be considered one of the most important multi objectives mathematical programming models. These strengths are mentioned in the following sections.

- **Simplicity**

A major strength of GP is its simplicity and ease of use. This accounts for the large number of GP applications in many and diverse fields. As weighted and CGP can be solved by widely available LP computer packages, finding a solution tool is not difficult in most cases. LGP can be solved as a series of LP models, as described by Ignizio and Cavalier (1994).

- **Flexibility**

The weights, aspiration levels, preemptive priorities can be changed during the analysis as the decision maker's knowledge of the decision problem changes (Interactive Programming). So, when it is necessary to change the model's input according to the business rapid change nature, no much efforts are needed for modify the model construction to be suitable for the new scenarios.

The primary advantages of GP over traditional decisions processes as follows:

- It helps define the decision environment in ambiguous terms.
- It provides systematic consideration of alternative decision strategies, often involving different levels of management.
- It ensures that all key elements are considered each time a decision strategy is evaluated.
- It creates a documented record of the decision process.

- It provides quantitative solutions to management problems.

On balance, the advantages of GP appear to outweigh the disadvantages for the problems of decision making [38].

Fourth: Combined AHP and GP

GP is a structured decision-making approach used to evaluate and satisfying solution based on the priorities or weighted ranking assigned to each goal. While GP provides no systematic method to prioritize or rank relative importance or weights of the goals, the AHP measures the relative importance of multiple goals with consistency. A systematic approach to rank elements (goals or alternatives) in AHP can be utilized in the replacement of a subjective judgment to prioritize each goal in GP.

Since AHP is most widely accepted remedy to establish a relative importance among goals, the integrated model in the study utilizes AHP to determine the priorities to be used in GP model development to solve the problem.

The use of AHP alone for a strategic selection problem is not sufficient, because it is not able to incorporate the resource constraints, dependencies among the alternatives and multiple conflicting goals, criteria, and sub criteria into their decision structure.

At the same time, GP cannot also be used alone, because it still requires calculation of the weights of various criteria to use in the objective function of the GP model. One of the most suitable solutions of this dilemma is to use a combination of (AHP) with GP in order to gain a final solution that is nearest to the ideal one.

1. Combined AHP–GP approach in literature

Schniederjans and Garvin (1997) applied the combined AHP–GP approach to evaluate and select the best combination of cost drivers. First, the AHP was used to determine the relative importance weightings of alternative cost drivers with respect to four criteria: correlation with cost, reduction of drivers, performance, and cost of measure. The AHP weightings were then utilized as one of the goal constraints besides budgeted cost, analyst hours, and auditing hours.

The problem of allocating higher education institution's resources to IT-based projects was studied. In the approach of the researchers, the AHP was used first to evaluate the relative importance weightings of alternative networking methods (one of the IT-based projects) with respect to four criteria: risk, performance, conversion, and development. The weightings were then incorporated into the objective function of the GP model. The model was to select the optimal combination of projects to be invested. Budget was the only resource limitation considered in the model [35].

The combined AHP–GP approach was used to deal with the location-allocation problem. First, the AHP was adopted to evaluate the alternative locations with respect to several criteria, such as political situation, global competition and survival, government regulations, and economics related factors. After assigning importance weightings to the alternative locations, a GP model was formulated to select the best combination of alternatives based on the resource limitations (e.g., budget and country restriction for air quality), and determine the allocation of products from locations to distribution centers [9].

AHP was applied to evaluate the relative importance weightings of various harvesting measures for improving the grain harvesting and post-harvesting system in China. A GP model was developed to select the best combination of alternative measures according to the AHP weightings. Some resource limitations were considered in the model, such as budgeting, manpower, facility/equipment, and so on [29].

The combined AHP–GP approach was applied to deal with the resource allocation problem in the health-care system. The relative importance weightings of alternative networking methods obtained by the AHP were incorporated into the objective function of the GP model. Budget and human resources were considered in the model [45].

The combined AHP–GP approach was applied to design quality control systems in the service-based organizations. First, the AHP was used to obtain the relative importance weightings of alternative customer data collection methods with respect to several service quality criteria, including responsiveness, assurance, reliability, empathy, and tangibles. Then, a GP model was constructed to select the best combination of alternatives based on the resource limitations (e.g., budget and human resources) [10].

Table 3.4: Combined AHP-GP application from literature [31]

Approach	Authors	Applications	Specific areas
AHP - GP	Schniederjans and Garvin (1997)	Business	Cost driver selection
	Kwak and Lee (1998)	Higher education	IT-based project selection
	Radash and Kwak (1998)	Marketing	Offset proposal selection
	Badri (1999)	Logistics	Facility location selection
	Guo and He (1999)	Agriculture	Harvesting measure selection
	Kim et al. (1990)	Military	Nuclear fuel cycle selection
	Zhou et al. (2000)	Health Care	IT-based project selection
	Badri (2001)	Logistics	Scheduling plan selection
	Kwak and Lee (2002)	Service	Customer data collection method selection
	Radeliffe and schniederjans (2003)	Health care	IT-based project selection
	Wang et al. (2004)	Industry	Trust factor selection
	Yurdakul (2004)	Logistics	Supplier selection
	Kwak et al. (2005)	Manufacturing	Computer-integrated manufacturing technology selection
	Wang et al. (2005)	Marketing	Advertising medium selection
	Bertolini and Bevilacqua (2006)	Logistics	Supplier selection

2. AHP-GP strengths and weakness

The combination of AHP and GP model has many advantages, one of these advantages is that it forms separate models to reach the most suitable outcome from the viewpoint of each individual stakeholder, as well as the extending of the use of AHP approach alone to consider multiple conflicting goals along with resource limitations and dependencies among the alternatives.

Such combination enables the decision-makers to see different facets of the problem and keep track of the affects of their decisions made in various stages of their solution process on the solution sets. The combined GP-AHP model possesses the flexibility of adding new constraints, aspiration levels, improvement objectives or alternative and modifying them when necessary. However, the Integrated GP-AHP model does not have obvious direct disadvantages. The decision-maker must be aware that the correct usage of the developed GP-AHP approach depends strongly on the following issues;

a. The solution is very sensitive to the variations in the weighting procedure. If, the pair wise comparison phase of the AHP is not made correctly, then the weights will be generated incorrectly, which directly affect the outcome of the AHP-GP approach.

b. The total contribution of a selected alternative is proportional to the total number of alternatives. If the linearity assumption is not valid (i.e. as the total number of alternatives increases, the expected contribution from that alternatives does not increase proportionally), new alternatives must be developed instead. Although the number of alternatives will increase in such a situation, the AHP-GP approach can still be applicable.

c. The constraints in the GP have a great importance in the selection process. Mistakes in the constraints will result in recommendation of an incorrect solution set. In developing the constraints a question list may be prepared to make sure that the decision-maker considers all relevant issues

Fifth: Summary:

The scientific basis of the research models is studied in this chapter by starting with MCDM and its steps applications, AHP methodology is studied as a tool of MCDM. The major strengths of the AHP are examined like the consistency test and the ability of considering quantitative and qualitative criteria, these strengths were a motivation to use AHP in ranking and prioritizing of industrial sectors. Combining AHP with GP is a widely used methodology as explained in the literature in this chapter; it has been applied in different applications from the real situation like business, higher education, marketing, logistics, agriculture, military, health care, service, industry, manufacturing. These wide applications represent a motivation to apply combined AHP-GP model in this research.

Chapter 4: Methodology

First: Introduction:

Second: Data Collection

1. **Criteria Definition**
2. **Alternatives Definition**

Third: AHP Model Application

1. **Hierarchical structure of the problem**
2. **Pair Wise Comparison Conducting**
    a. **Main criteria pair wise comparison**
    b. **Sub criteria pair wise comparison**
    c. **Alternatives pair wise comparison**

Fourth: GP Model Application

1. **Introduction**
2. **GP model**
    a. **GP model Objective function**
    b. **GP model constraints**

Fifth: Summary

First: Introduction

The main objective of this study is to identify the major important criteria for evaluating the industrial sectors in Gaza Strip to reach a ranking for them to help the decision makers in assigning funds to the high ranked sectors in any rehabilitation program that will compensate the losses caused by the war on Gaza strip 2008/2009.

This chapter describes the methodology used in this study to achieve that main objective, starting with data collection, in which criteria and alternatives are identified, followed by the application of AHP model to rank the industrial sectors' priorities for compensation, finishing with the application of GP model to assign each sector's compensating fund for the reconstruction and restarting during the rehabilitation process of Gaza Strip.

Second: Data Collection

The main sources of the required data for this research are shown in table 4.1:

Table4.1: Required data and their sources

Types of data	**Required Data**	**Source**
Secondary data: it is Data that have been collected for previous studies and have already been published about the industrial sectors and the effects of war on Gaza Strip	Required alternatives (industrial sectors) Data about the war effects on the industrial sectors including volume of damage, types of damage, availability of machinery and raw materials and other data and statistics.	(PFI)
	Criteria needed for ranking industrial sectors according to previous studies conducted.	Previous related studies
Primary data: it is collected using two questionnaires for eight experts in the industrial field in Gaza Strip	Criteria identification; Criteria weights; Performance of each alternative against qualitative criteria.	Experts and Decision Makers

1. Criteria Definition

The process of surveying the previous related studies which was explained in section chapter two resulted in an identification and definition of seven main criteria with 24 sub criteria as shown in figure 2.3 These criteria were arranged in a questionnaire to experts (Appendix A) to get a final hierarchy of criteria and sub criteria as shown in figure 4.1. (Appendix E) shows the names and positions of experts.

2. Alternatives Definition

The classification of industrial sectors in Gaza Strip and West Bank is made by the sectors' representative PFI. Industrial sectors represented by PFI include *food and beverage, construction, pharmaceuticals, chemicals, metal and engineering, textiles and garments, leather, paper, handicrafts, plastic and rubber and wood and furniture*. The process of rehabilitation of Gaza strip will compensate the industrial sectors so they can restart their work and production. The amount of fund for each industrial sector should not be lower than the minimum requirements for each sector. These minimum requirements of funds in this study are assumed to be the total amount of damage in terms of dollars for each sector as shown in table 2.1

Third: AHP Model Applying

As the basic requirements for AHP including the goal, criteria, sub criteria and alternatives are identified, the application of the process is as explained in the following steps:

1. Hierarchical structure of the problem:

The final structure of the problem including the goal, criteria, sub criteria and alternatives is now ready to be evaluated to achieve a final ranking of industrial sectors. The hierarchical structure is shown in figure 4.1.

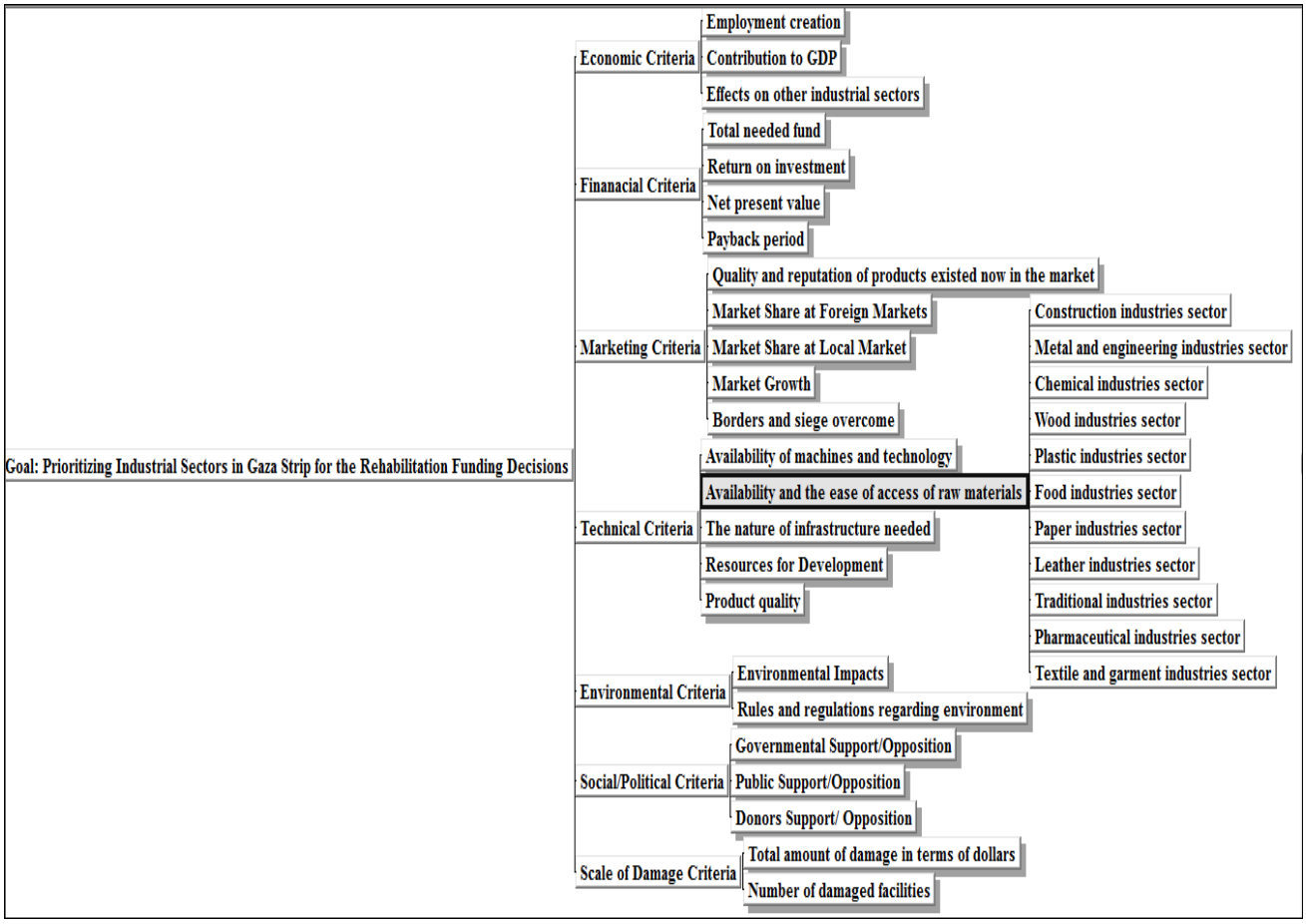

Fig 4.1: Hierarchal structure of AHP model

2. Pair Wise Comparison Conducting:

The AHP process makes it possible to incorporate judgments on intangible qualitative criteria alongside tangible quantitative criteria. The method utilizes pair wise comparisons of alternatives (industrial sectors in the Gaza Strip) as well as pair wise comparisons of the multiple criteria, and sub criteria. The use of such pair wise comparisons allows the decision-maker to focus on the comparison of just two objects, which makes the observation as free as possible from extraneous influences. Additionally, pair wise comparisons generate meaningful information about the decision problem, improving consistency in the decision-making process, especially if the process involves group decision-making.

To conduct pair wise comparison, different questionnaires were designed and distributed among the experts. (Appendix B). Pair wise comparison results obtained from each questionnaire was entered into (E.C 11.5), and then (CR) and the relative weights vector of alternatives, sub criteria, and criteria with respect to main goal were calculated.

The CR for each pair wise comparison must be less than 0.1 to be consistent. In the case of CR is greater than 0.1, then pair wise comparison was modified and relative weights vector were recalculated.

EC program helps a decision-maker to examine and resolve problems involving multiple evaluation criteria. The software uses the AHP methodology to model a decision problem and evaluate the relative desirability of alternatives [27].

a. Main criteria pair wise comparison:

After constructing the general model and entering the experts' judgments of main criteria pair wise comparison to the EC, the results shown in figure 4.2 are obtained.

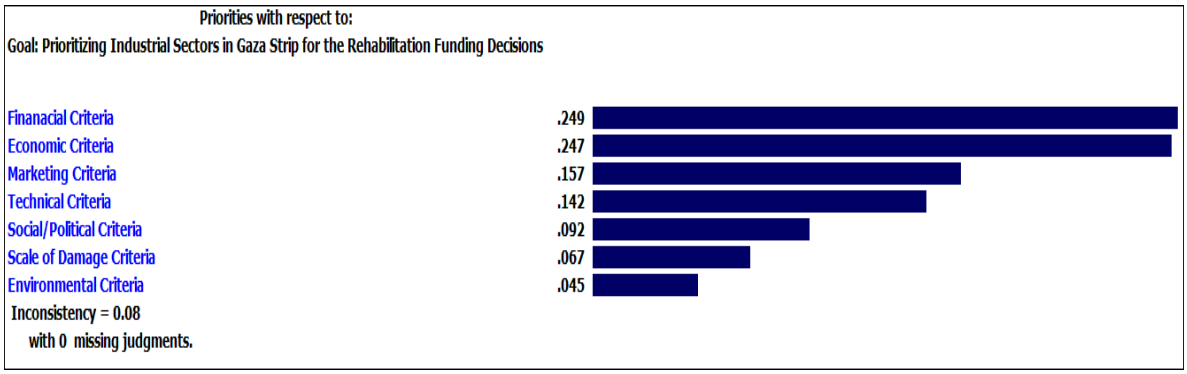

Fig 4.2: EC results of main criteria pair wise comparisons

From figure 4.2, the financial criteria has the highest priority with respect to the goal with a percentage of 24.9%, not far away from it; the economic criteria which is the 2nd one in priority with a percentage of 24.7%. Both scale of damage and environmental criteria are ranked the last two criteria with a percentage 6.7% and 4.5% respectively. These results ensure the experts' opinions that the sectors prioritized should be financially the strongest ones in order to make the highest contribution to the general economy.

b. Sub criteria pair wise comparison:

1. *Economic sub criteria pair wise comparison*:

The experts' judgments of economic sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.3.

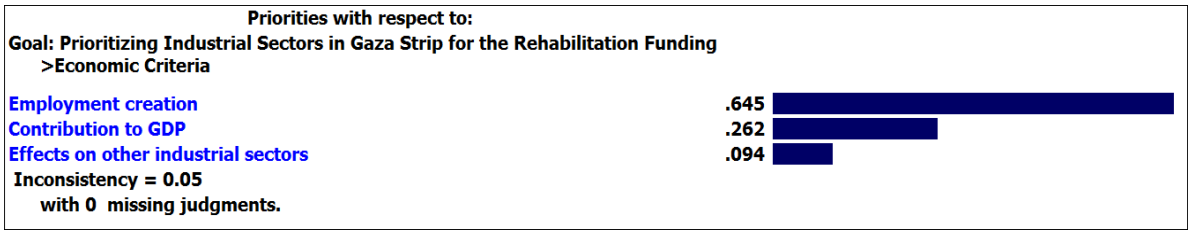

Fig 4.3: EC results of economic sub criteria pair wise comparisons

From figure 4.3, the employment generation sub criterion has the highest priority with a percentage of 64.5% from the economic criteria. The total contribution of this sub criteria is identified by multiplying the local weight of it which is (0.645) by the weight of its main criteria identified in the previous pair wise comparison of main criteria which is (0.247), the result is 15.93%; this number represents the contribution of the "employment generation" sub criteria to the model goal. The same procedure is applied to all other sub criteria and shown in table 4.2. This result reflects the real problem of large percentage of unemployment in Gaza Strip especially after the war 2008/2009.

2. *Financial sub criteria pair wise comparison*:

The experts' judgments of financial sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.4

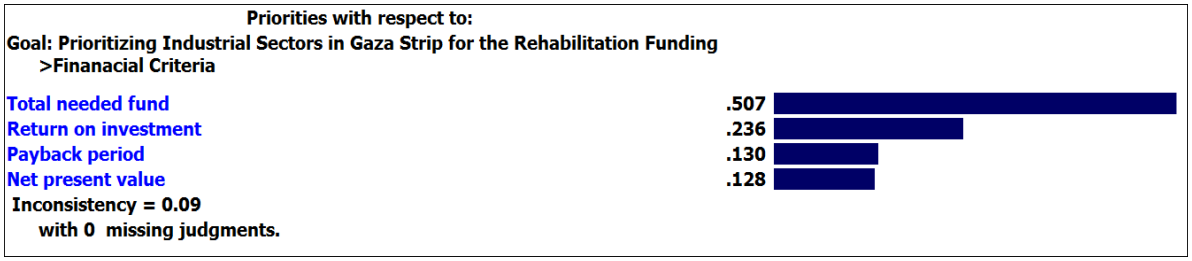

Fig 4.4: EC results of financial sub criteria pair wise comparisons

3. *Technical sub criteria pair wise comparison*:

The experts' judgments of technical sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.5

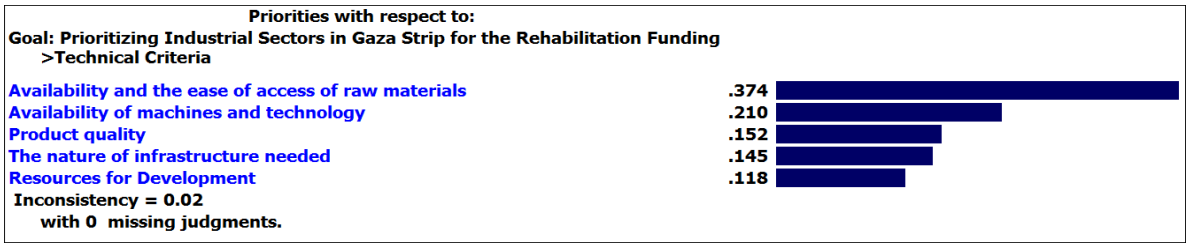

Fig 4.5: EC results of technical sub criteria pair wise comparisons

From figure 4.5, the availability and the ease of the access of raw materials sub criterion has the highest priority among technical sub criteria with a percentage of 37.4%. This percentage is high even when the most of raw materials are entered by tunnels, this because of the very high risk of entering such materials from tunnels. Although the machines were the highly damaged during the war, the availability of machines is ranked 2nd with a percentage of 21%, this result is because a lot of these machines can be repaired or have a substitute locally.

4. *Marketing sub criteria pair wise comparison*:

The experts' judgments of marketing sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.6

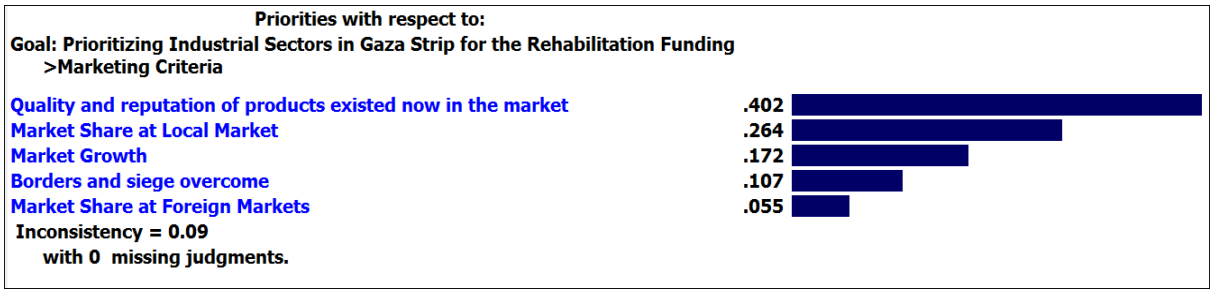

Fig 4.6: EC results of marketing sub criteria pair wise comparisons

Figure 4.6 shows that the sub criterion quality and reputation of products existed in the market has the highest priority with a percentage of 40.2%. This sub criterion is ranked 1st

because of the real problem created from the tunnels' products which filled the local market, the rehabilitated sector's products should have a higher quality than these products to compete in the local market and then highly prioritized. The sub criterion market share at the local market is ranked 2nd with a percentage of 26.4%. The high percentage of this sub criterion is because any rehabilitation process should firstly solve the problem of the lack of products in the local market, and contribution to overcome the siege.

5. *Environmental sub criteria pair wise comparison*:

The experts' judgments of environmental sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.7

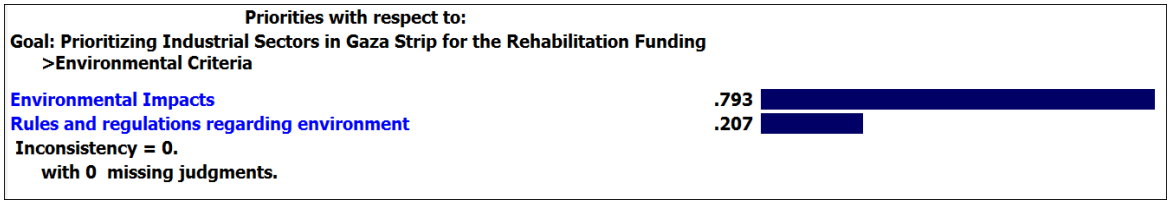

Fig 4.7: EC results of environmental sub criteria pair wise comparisons

The sub criterion "environmental impacts" has the highest priority with a percentage of 79.3%, the reason for that as the experts think is the rules and regulations regarding environment will help the sector which has a better environmental impacts.

6. *Social/Political sub criteria pair wise comparison*:

The experts' judgments of social/political sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.8

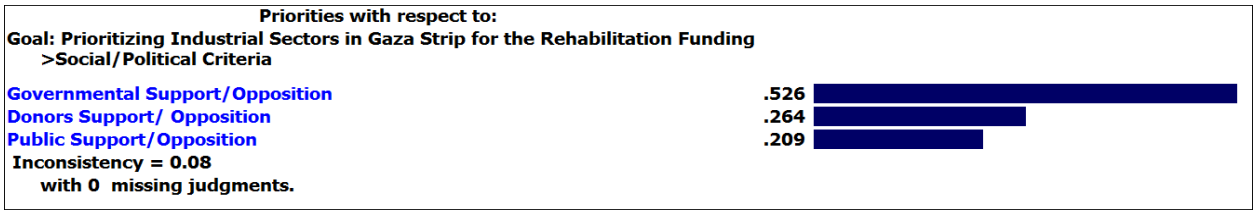

Fig 4.8: EC results of social/political sub criteria pair wise comparisons

7. *Scale of damage sub criteria pair wise comparison*:

The experts' judgments of "scale of damage" sub criteria pair wise comparison which were entered to the EC resulted in the priorities of each sub criteria with respect to the goal as shown in figure 4.9

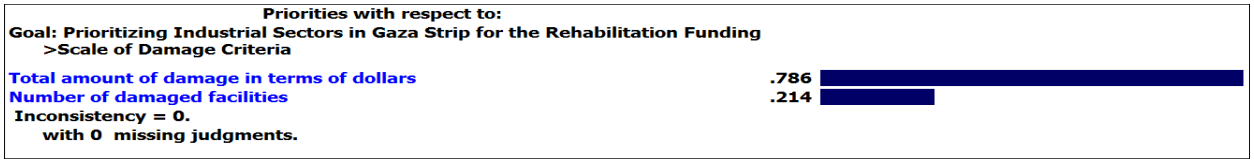

Fig 4.9: EC results of scale of damage sub criteria pair wise comparisons

The sub criterion "total amount of damage in terms of dollars" has aggregated a percentage of 78.6% which is higher than the sub criterion "number of damaged factories" 21.4%. The reason for that is the amount of damage in some sectors is very high and at the same time the damaged factories number is small; these factories were big and employed large number of workers. In other words, the total amount of damage in some sectors with small number of damaged factories is higher than the amount of damage in other sectors with large number of damaged factories.

After making the pair wise comparison of main criteria and sub criteria, the global weight of the sub criteria is identified by multiplying the local weight of sub criteria by the weight of its main criteria. From this global weight, a conclusion can be made about the rank of the importance of sub criteria according to the opinions of decision makers. The global weight of all sub criteria is shown in table 4.3

Table 4.2: Local and global weights of main criteria and sub criteria

Main criteria	Weight [1]	Sub criteria	Local weight [2]	Global weight [1]*[2]
Economic	0.247	Employment creation	0.645	0.159315
		Contribution to GDP	0.262	0.064714
		Effects on other industrial sectors	0.094	0.023218
Sum			**1**	**0.247**
Financial	0.249	Total needed fund	0.507	0.126243
		Return on investment	0.236	0.058764
		Net present value	0.128	0.031872
		Payback period	0.13	0.03237
Sum			**1**	**0.249**
Technical	0.142	Availability of machines and technology	0.21	0.02982
		Availability and the ease of access of raw materials	0.374	0.053108
		The nature of infrastructure needed	0.145	0.02059
		Resources for Development	0.118	0.016756
		Product quality	0.152	0.021584
Sum			**1**	**0.142**
Marketing	0.157	Quality and reputation of products existed now in the market	0.402	0.063114
		Market Share at Foreign Markets	0.055	0.008635
		Market Share at Local Market	0.264	0.041448
		Market Growth	0.172	0.027004
		Borders and siege overcome	0.107	0.016799
Sum			**1**	**0.157**
Environmental	0.045	Environmental Impacts	0.793	0.035685
		Rules and regulations regarding environment	0.207	0.009315
Sum			**1**	**0.045**
Social/political	0.092	Governmental Support/Opposition	0.526	0.048392
		Public Support/Opposition	0.209	0.019228
		Donors Support/ Opposition	0.264	0.024288
Sum			**1**	**0.092**
Scale of damage	0.067	Total amount of damage in terms of dollars	0.786	0.052662
		Number of damaged facilities	0.214	0.014338
Sum			**1**	**0.067**

Table 4.2 shows that:

- The most important criteria is the "financial" with a percentage of 24.9% and the "economic" criteria is the second with a percentage of 24.7%; the two criteria are very closed; this assures the rehabilitation of financially and economically strong sectors that can make good impacts on the economy of Gaza Strip.
- The "marketing" and "technical" criteria are ranked 3rd and 4th with a percentage of 15.7% and 14.2% respectively; this assures that the rehabilitated sectors should be technically strong to serve the big needs of local markets especially of the industrial products.
- The "scale of damage" criteria is ranked before the last; this assures the experts' opinions to consider not only one single criteria in the compensation which is the "scale of damage" as executed in the last stages, but also the other mentioned important criteria which have positive impacts on the general economy and situation in Gaza Strip.
- The "employment creation" sub criterion has the highest weight of all 24 sub criteria with a contribution of 15.93% to the goal; this value reflects the real need to overcome the high problem of unemployment in Gaza Strip.
- The "contribution to GDP", "return on investment", "market share at local market", "total needed funds" and "availability and the ease of access of raw materials" sub criteria are in the top rank of all 24 sub criteria; these sub criteria represent a basis for the development of strong sectors to serve strong market.

c. Alternatives pair wise comparison:

The results of conducting pair wise comparison to the alternatives which are the 11 industrial sectors in Gaza Strip against each sub criteria are as the following:

1. Industrial sectors' pair wise comparison according to "employment creation":

The employment creation criteria is a quantitative one and was computed to be the difference between the total number of workers before the war and total number of workers

after the war as in equation 4.1; meaning that the rehabilitation process will create new employment chances equal to the number of workers who lost their jobs because of the war.

Employment creation = the total number of workers before the war - the total number of workers after the war…… (4.1)

The total number of workers in each in industrial sector before and after the war 2008/2009 and the difference between them is shown in table 4.2.

Table 4.3: Number of workers before and after the war for each sector (PFI, 2009)

Industrial sector	Number of workers before the war	Number of workers before the war	Employment creation	Percentage of employment creation
Construction industries	545	217	328	22.8%
Food industries	524	235	289	20.1%
Paper industries	38	17	21	1.5%
Textiles industries	143	68	75	5.2%
Leather industries	3	0	3	0.2%
Metal and engineering industries	592	227	365	25.4%
Wood industries	364	133	231	16.1%
Chemical industries	80	40	40	2.8%
Plastic industries	174	97	77	5.4%
Traditional industries	8	14	0	0.000
Pharmaceutical industries	43	35	8	0.6%
Total	2514	1083	1437	100%

The pair wise comparison between the industrial sectors was entered to the EC and the result is shown in figure 4.10.

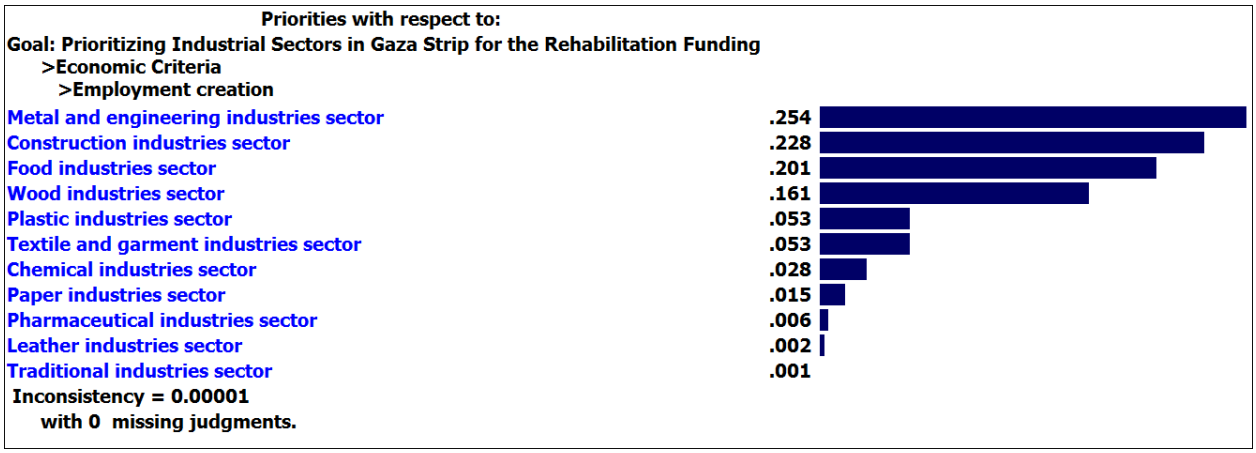

Fig 4.10: EC results of industrial sectors pair wise comparisons with respect to "employment creation" sub criteria.

The industrial sectors are ranked according to the "employment creation" sub criteria in figure 4.10 in descending order such that the first one has the highest priority with a percentage of 25.4% which is the "metal and engineering industries", the last one is the "traditional industries" sector with a percentage of 0.1%.

2. Industrial sectors' pair wise comparison according to "contribution to GDP":

The experts' judgments of industrial sectors pair wise comparison with respect to the "contribution to GDP" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.11.

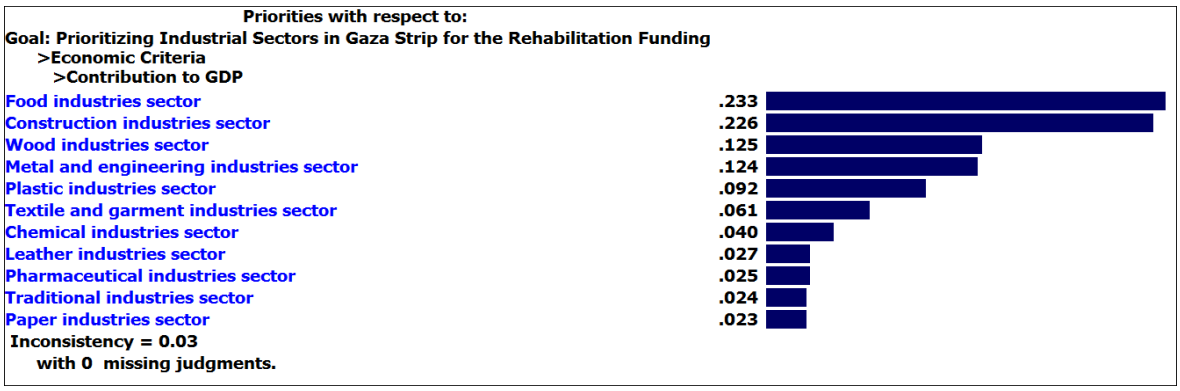

Fig 4.11: EC results of industrial sectors pair wise comparisons with respect to "contribution to GDP" sub criteria.

The industrial sectors are ranked according to the "contribution to GDP" sub criteria in figure 4.11 in descending order such that the first one has the highest priority with a percentage of 23.3% which is the "food industries", the last one is the "paper industries" sector with a percentage of 2.3%.

3. Industrial sectors' pair wise comparison according to "effect on other industrial sectors":

The experts' judgments of industrial sectors pair wise comparison with respect to the "effects on the other industrial sectors" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.12.

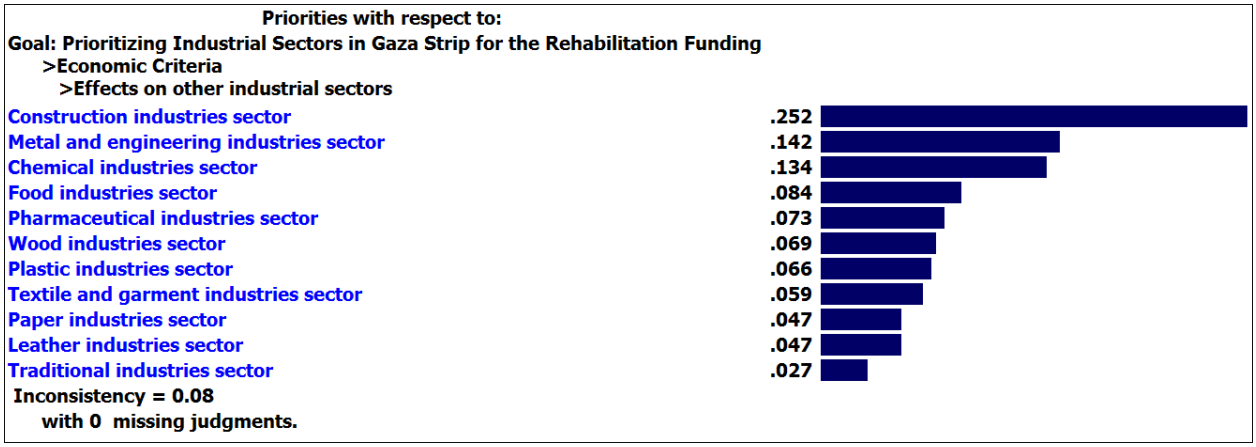

Fig 4.12: EC results of industrial sectors pair wise comparisons with respect to "effects on the other industrial sectors" sub criteria.

The industrial sectors are ranked according to the "effects on the other industrial sectors" sub criteria in figure 4.12 in descending order such that the first one has the highest priority with a percentage of 25.2% which is the "construction industries", the last one is the "traditional industries" sector with a percentage of 2.7%.

4. **Industrial sectors' pair wise comparison according to "total needed fund":**

The experts' judgments of industrial sectors pair wise comparison with respect to the "total needed fund" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.13

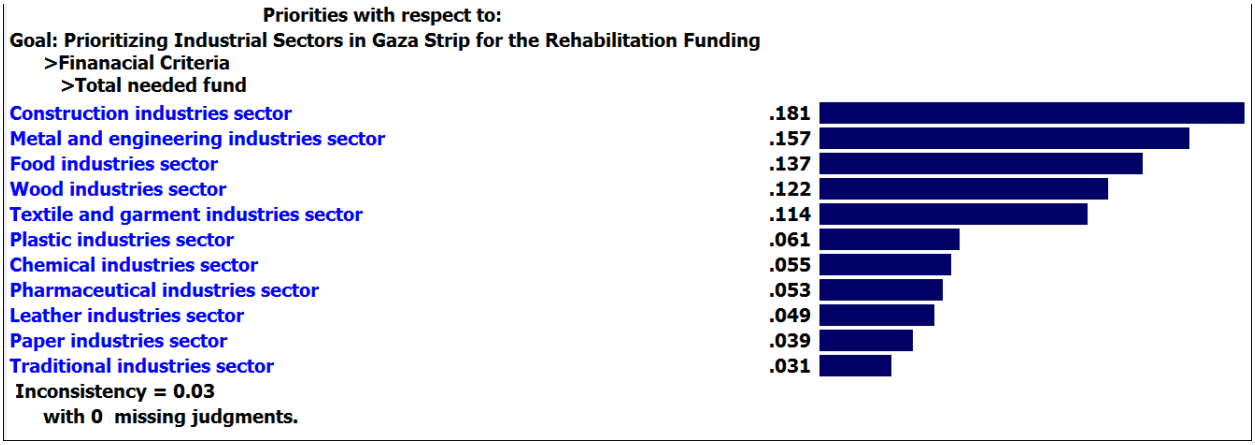

Fig 4.13: EC results of industrial sectors pair wise comparisons with respect to "total needed fund" sub criteria.

The industrial sectors are ranked according to the "total needed fund" sub criteria in figure 4.13 in descending order such that the first one has the highest priority with a percentage of 18.1% which is the "construction industries"; the last one is the "traditional industries" sector with a percentage of 3.1%.

5. **Industrial sectors' pair wise comparison according to "return on investment":**

The experts' judgments of industrial sectors pair wise comparison with respect to the "return on investment" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.14

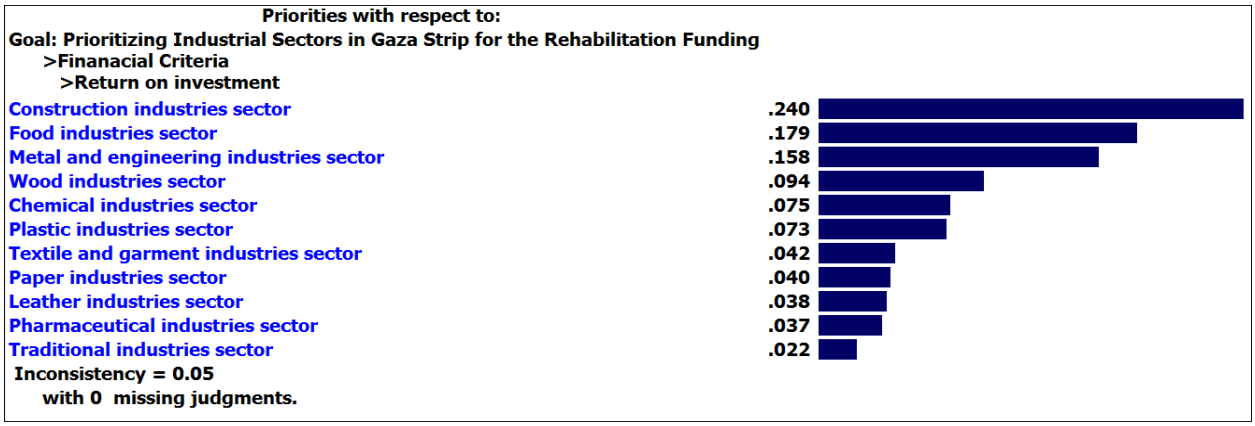

Fig 4.14: EC results of industrial sectors pair wise comparisons with respect to "return on investment" sub criteria.

The industrial sectors are ranked according to the "return on investment" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 24% which is the "construction industries"; the last one is the "traditional industries" sector with a percentage of 2.2%.

6. Industrial sectors' pair wise comparison according to "net present value":

The experts' judgments of industrial sectors pair wise comparison with respect to the "net present value" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.15

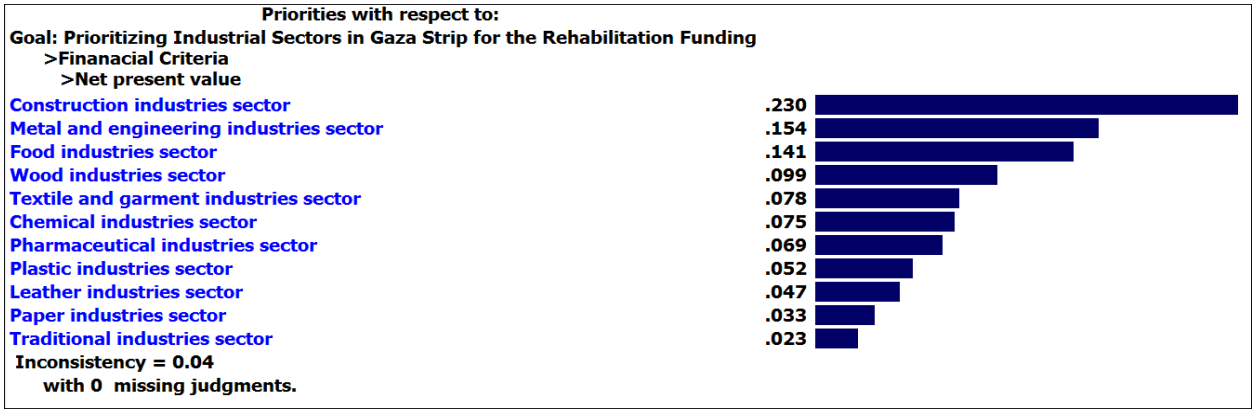

Fig 4.15: EC results of industrial sectors pair wise comparisons with respect to "net present value" sub criteria.

The industrial sectors are ranked according to the "net present value" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 23% which is the "construction industries"; the last one is the "traditional industries" sector with a percentage of 2.3%.

7. Industrial sectors' pair wise comparison according to "payback period":

The experts' judgments of industrial sectors pair wise comparison with respect to the "payback period" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.16

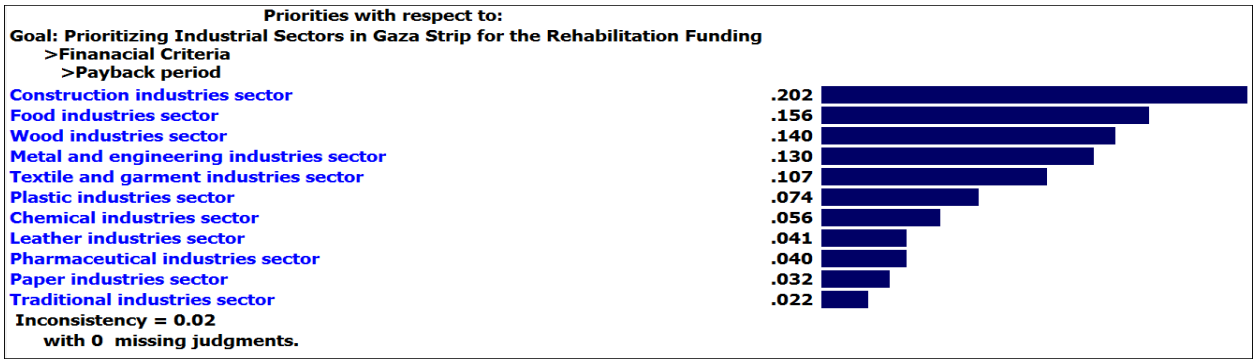

Fig 4.16: EC results of industrial sectors pair wise comparisons with respect to "payback period" sub criteria.

The industrial sectors are ranked according to the "payback period" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 20.2% which is the "construction industries"; the last one is the "traditional industries" sector with a percentage of 2.2%.

8. Industrial sectors' pair wise comparison according to "availability of machines and technology":

The experts' judgments of industrial sectors pair wise comparison with respect to the "availability of machines and technology" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.17

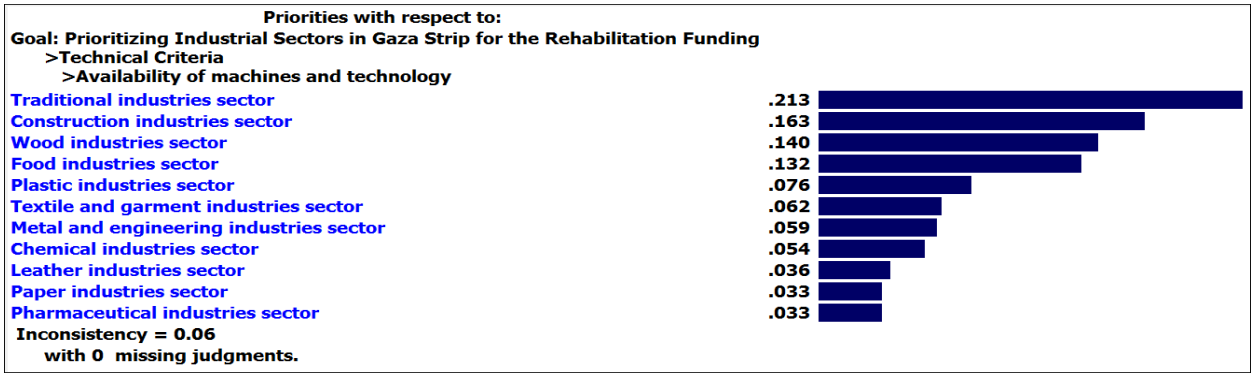

Fig 4.17: EC results of industrial sectors pair wise comparisons with respect to "availability of machines and technology" sub criteria.

The industrial sectors are ranked according to the "availability of machines and technology" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 22.3% which is the "traditional industries"; the last one is the "pharmaceutical industries" sector with a percentage of 3.3%.

9. Industrial sectors' pair wise comparison according to "Availability and the ease of the access of raw materials":

The experts' judgments of industrial sectors pair wise comparison with respect to the "availability and the ease of the access of raw materials" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.18

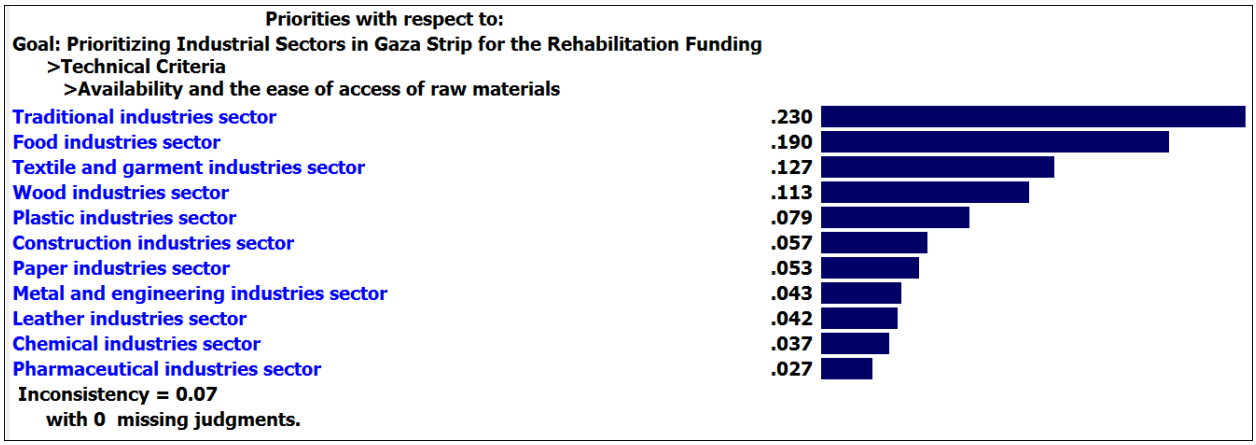

Fig 4.18: EC results of industrial sectors pair wise comparisons with respect to "availability and the ease of the access of raw materials" sub criteria.

The industrial sectors are ranked according to the "availability and the ease of the access of raw materials" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 22.3% which is the "traditional industries"; the last one is the "pharmaceutical industries" sector with a percentage of 3.3%.

10. Industrial sectors' pair wise comparison according to "The nature of infrastructure needed":

The experts' judgments of industrial sectors pair wise comparison with respect to the "the nature of infrastructure needed" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.19

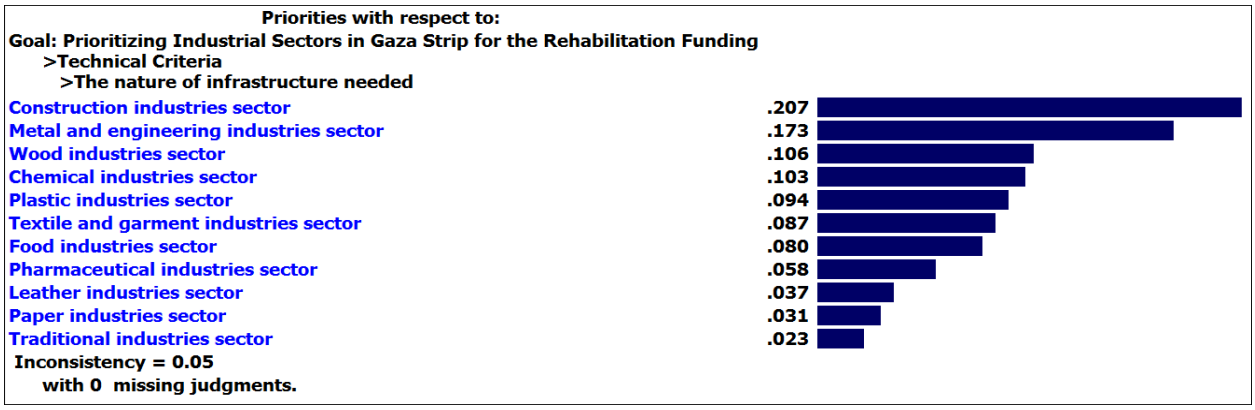

Fig 4.19: EC results of industrial sectors pair wise comparisons with respect to "the nature of infrastructure needed" sub criteria.

The industrial sectors are ranked according to the "the nature of infrastructure needed" sub criteria in figure 4.14 in descending order such that the first one has the highest priority with a percentage of 20.7% which is the "construction industries"; the last one is the "traditional industries" sector with a percentage of 2.3%.

11. Industrial sectors' pair wise comparison according to "Resources for development":

The experts' judgments of industrial sectors pair wise comparison with respect to the "resources for development" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.20

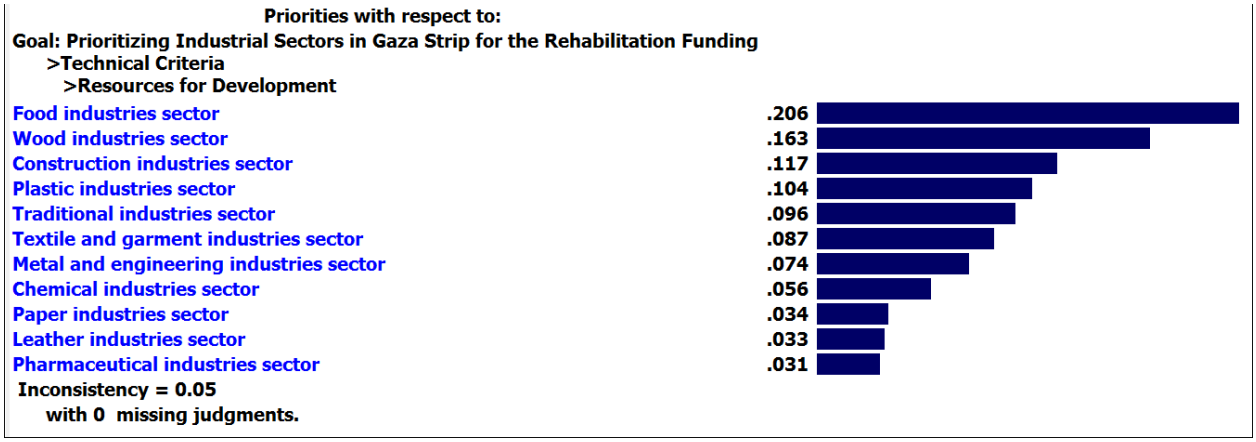

Fig 4.20: EC results of industrial sectors pair wise comparisons with respect to "resources for development" sub criteria.

The industrial sectors are ranked according to the "resources for development" sub criteria in figure 4.20 in descending order such that the first one has the highest priority with a percentage of 20.6% which is the "food industries"; the last one is the "pharmaceutical industries" sector with a percentage of 3.1%.

12. Industrial sectors' pair wise comparison according to "Product quality":

The experts' judgments of industrial sectors pair wise comparison with respect to the "product quality" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.21

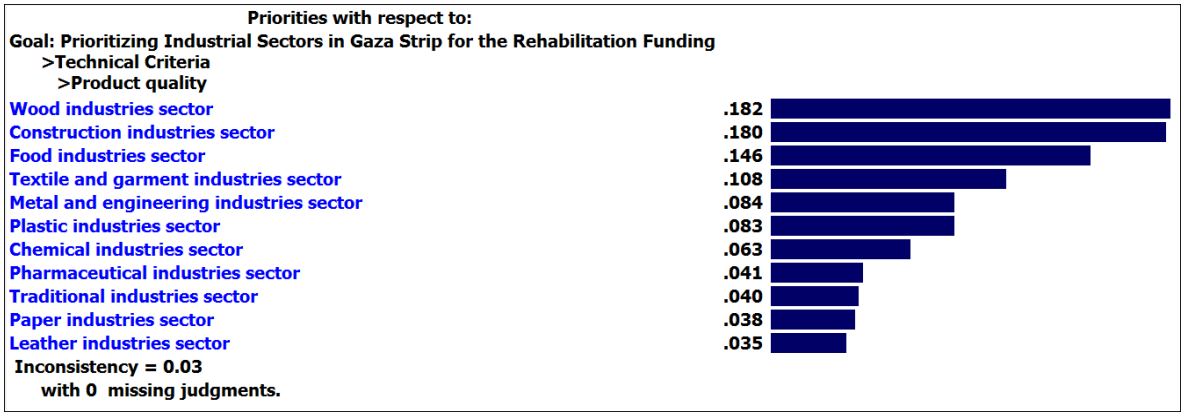

Fig 4.21: EC results of industrial sectors pair wise comparisons with respect to "product quality" sub criteria.

The industrial sectors are ranked according to the "product quality" sub criteria in figure 4.21 in descending order such that the first one has the highest priority with a percentage of 18.2% which is the "wood industries"; the last one is the "leather industries" sector with a percentage of 3.5%.

13. Industrial sectors' pair wise comparison according to "Quality and reputation of products existed now in the market":

The experts' judgments of industrial sectors pair wise comparison with respect to the "quality and reputation of products existed now in the market" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.22

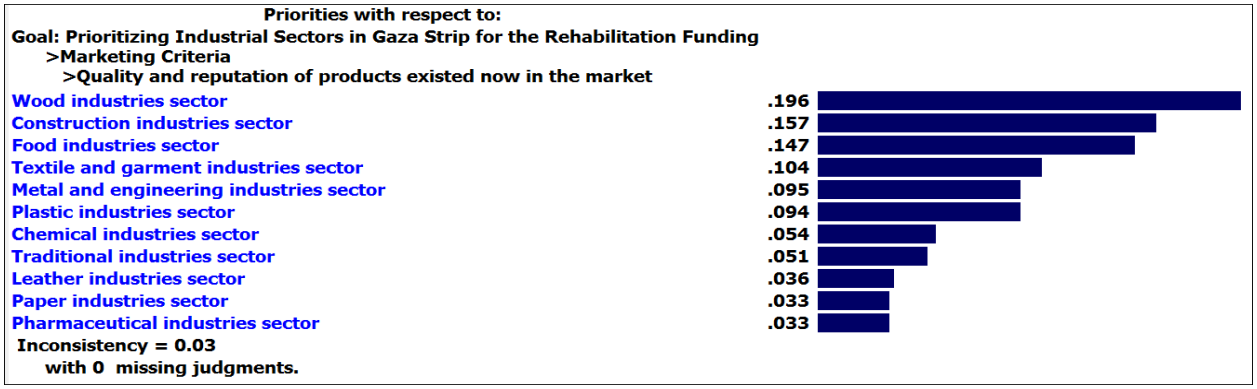

Fig 4.22: EC results of industrial sectors pair wise comparisons with respect to "quality and reputation of products existed now in the market" sub criteria.

The industrial sectors are ranked according to the "quality and reputation of products existed now in the market" sub criteria in figure 4.22 in descending order such that the first one has the highest priority with a percentage of 19.6% which is the "wood industries"; the last one is the "pharmaceutical industries" sector with a percentage of 3.3%.

14. Industrial sectors' pair wise comparison according to "Market share at Foreign markets":

The experts' judgments of industrial sectors pair wise comparison with respect to the "market share at foreign markets" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.23

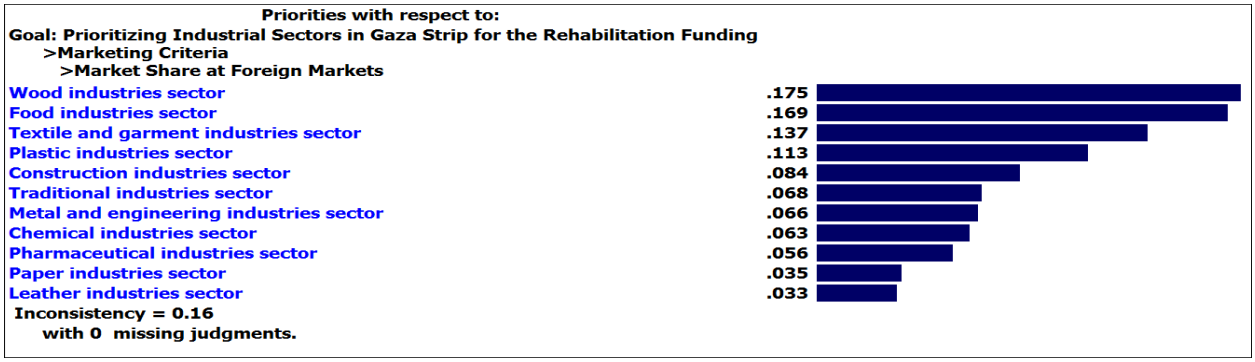

Fig 4.23: EC results of industrial sectors pair wise comparisons with respect to "market share at foreign markets" sub criteria.

The industrial sectors are ranked according to the "market share at foreign markets" sub criteria in figure 4.23 in descending order such that the first one has the highest priority with a percentage of 17.5% which is the "wood industries"; the last one is the "leather industries" sector with a percentage of 3.3%.

15. Industrial sectors' pair wise comparison according to "Market share at local market":

The experts' judgments of industrial sectors pair wise comparison with respect to the "market share at local markets" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.24

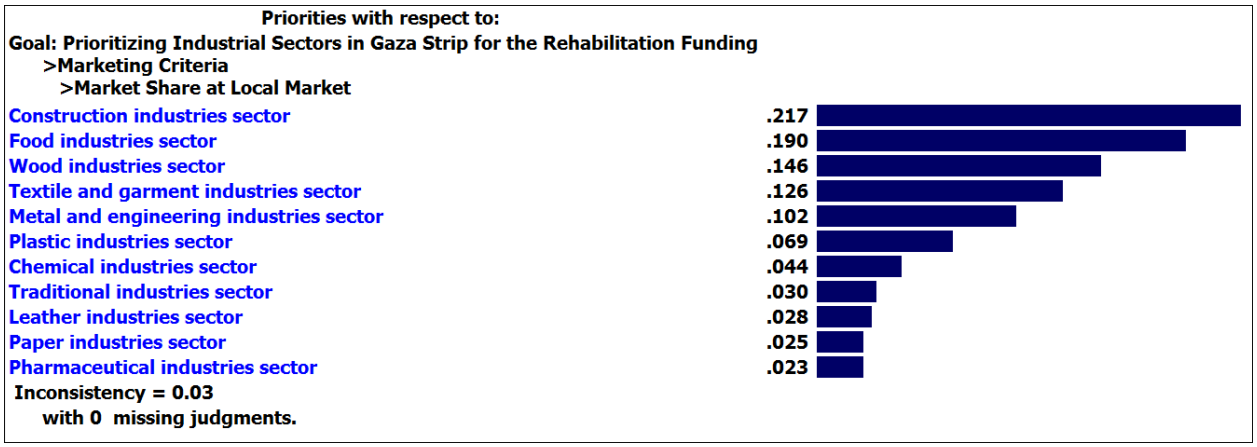

Fig 4.24: EC results of industrial sectors pair wise comparisons with respect to "market share at foreign markets" sub criteria.

The industrial sectors are ranked according to the "market share at local markets" sub criteria in figure 4.24 in descending order such that the first one has the highest priority with a percentage of 21.7% which is the "construction industries"; the last one is the "pharmaceutical industries" sector with a percentage of 2.3%.

16. Industrial sectors' pair wise comparison according to "Market growth":

The experts' judgments of industrial sectors pair wise comparison with respect to the "market growth" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.25

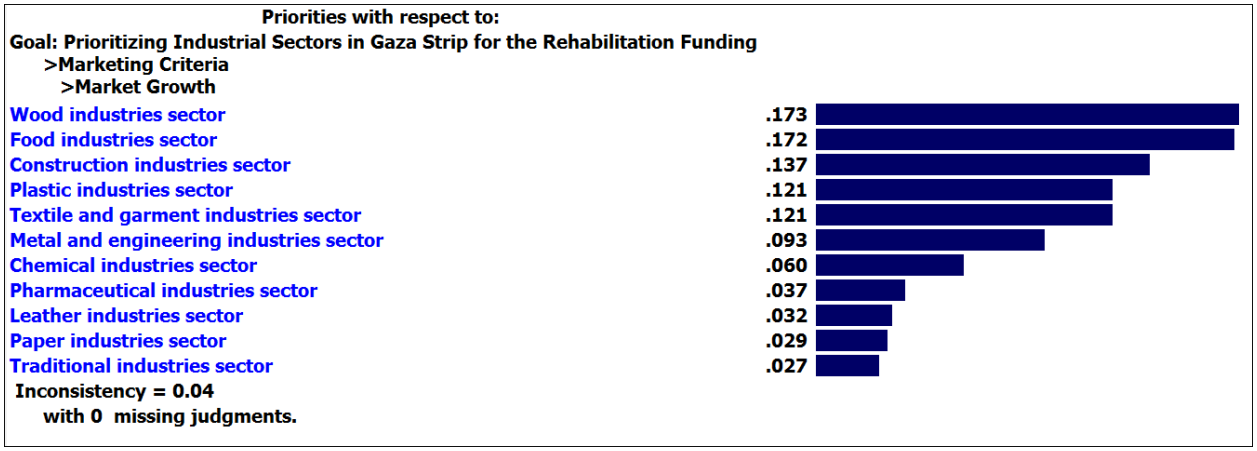

Fig 4.25: EC results of industrial sectors pair wise comparisons with respect to "market growth" sub criteria.

The industrial sectors are ranked according to the "market growth" sub criteria in figure 4.25 in descending order such that the first one has the highest priority with a percentage of 17.3% which is the "wood industries"; the last one is the "traditional industries" sector with a percentage of 2.7%.

17. Industrial sectors' pair wise comparison according to "Ease of export and closures overcome":

The experts' judgments of industrial sectors pair wise comparison with respect to the "Ease of export and closures overcome" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.26

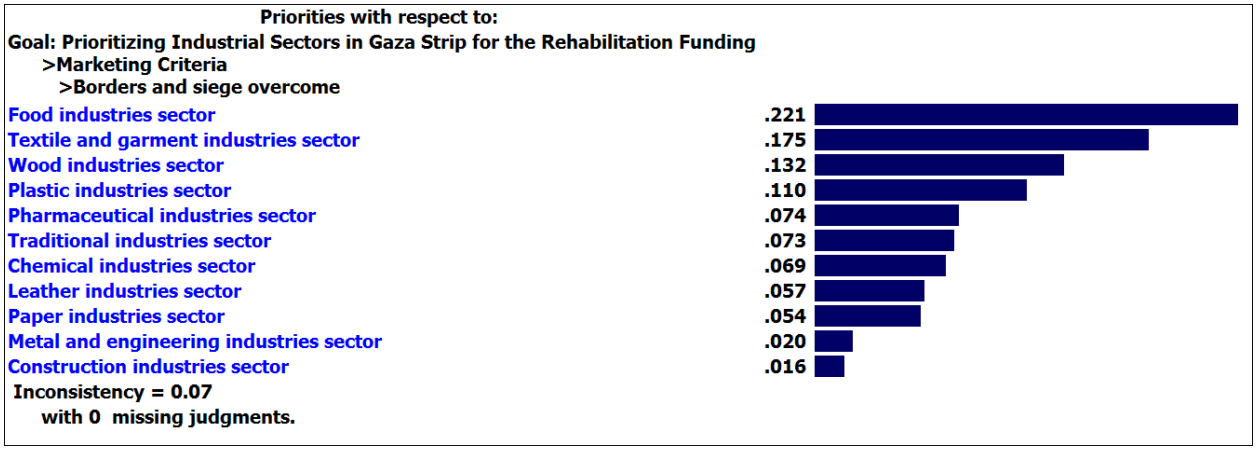

Fig 4.26: EC results of industrial sectors pair wise comparisons with respect to "Ease of export and closures overcome" sub criteria.

The industrial sectors are ranked according to the "Ease of export and closures overcome" sub criteria in figure 4.26 in descending order such that the first one has the highest priority with a percentage of 22.1% which is the "food industries"; the last one is the "construction industries" sector with a percentage of 1.6%.

18. Industrial sectors' pair wise comparison according to "Environmental impacts":

The experts' judgments of industrial sectors pair wise comparison with respect to the "environmental impacts" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.27

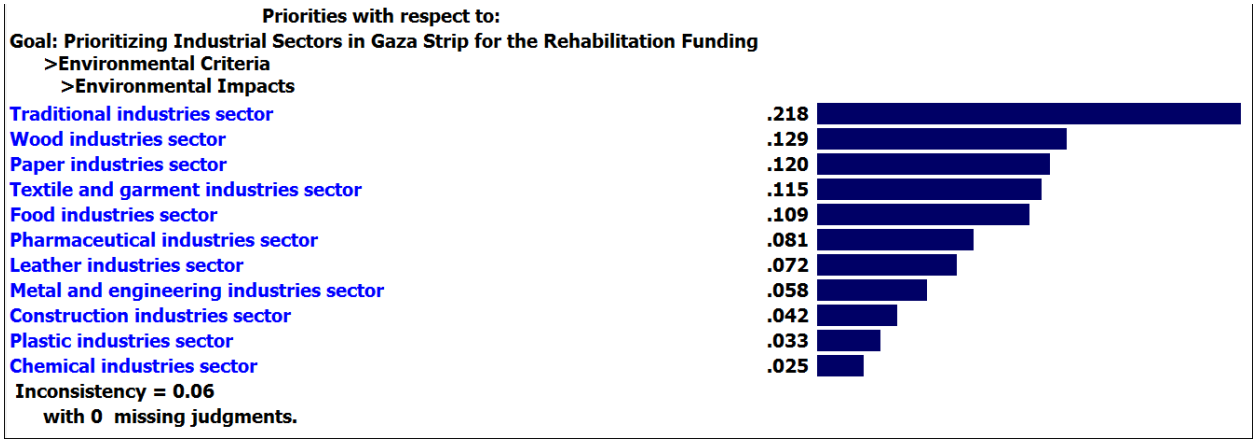

Fig 4.27: EC results of industrial sectors pair wise comparisons with respect to "Environmental impacts" sub criteria.

The industrial sectors are ranked according to the "Environmental impacts" sub criteria in figure 4.27 in descending order such that the first one has the highest priority with a percentage of 21.8% which is the "traditional industries"; the last one is the "chemical industries" sector with a percentage of 2.5%.

19. Industrial sectors' pair wise comparison according to "Rules and regulations regarding environment":

The experts' judgments of industrial sectors pair wise comparison with respect to the "rules and regulations regarding environment" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.28

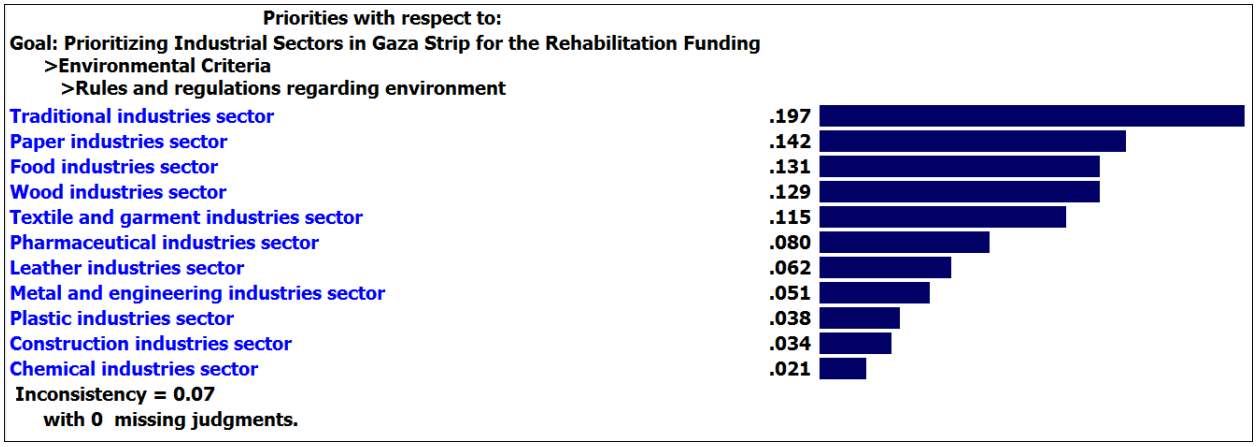

Fig 4.28: EC results of industrial sectors pair wise comparisons with respect to "rules and regulations regarding environment" sub criteria.

The industrial sectors are ranked according to the "rules and regulations regarding environment" sub criteria in figure 4.28 in descending order such that the first one has the highest priority with a percentage of 19.7% which is the "traditional industries"; the last one is the "chemical industries" sector with a percentage of 2.1%.

20. Industrial sectors' pair wise comparison according to "Governmental Support/Opposition":

The experts' judgments of industrial sectors pair wise comparison with respect to the "Governmental Support/Opposition" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.29

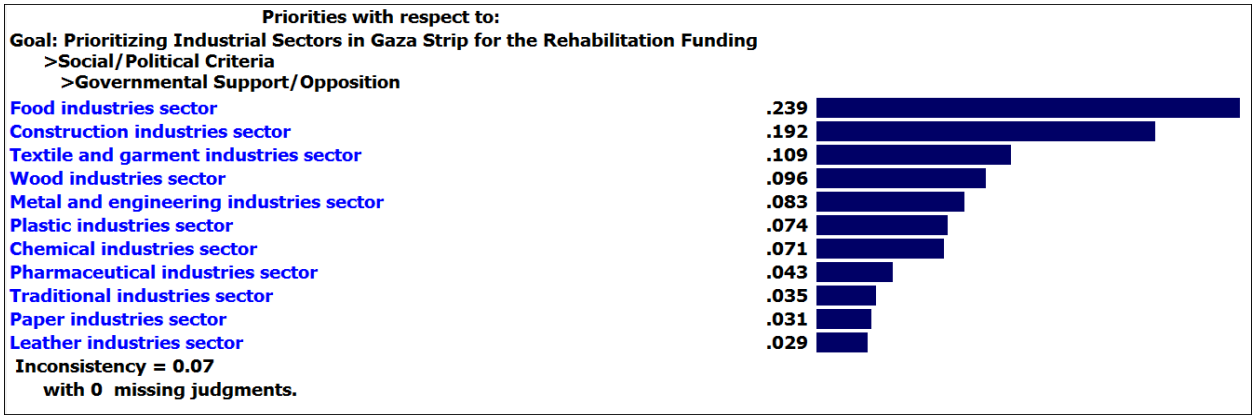

Fig 4.29: EC results of industrial sectors pair wise comparisons with respect to "governmental Support/Opposition" sub criteria.

The industrial sectors are ranked according to the "governmental Support/Opposition" sub criteria in figure 4.29 in descending order such that the first one has the highest priority with a percentage of 23.9% which is the "food industries"; the last one is the "leather industries" sector with a percentage of 2.9%.

21. Industrial sectors' pair wise comparison according to "Public Support/Opposition":

The experts' judgments of industrial sectors pair wise comparison with respect to the "public Support/Opposition" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.30

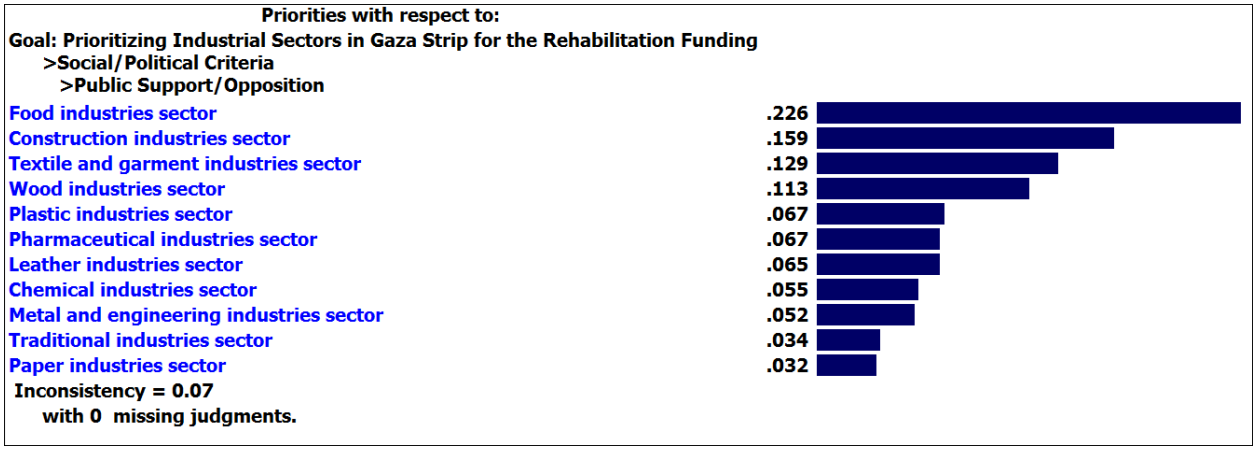

Fig 4.30: EC results of industrial sectors pair wise comparisons with respect to "public Support/Opposition" sub criteria.

The industrial sectors are ranked according to the "public Support/Opposition" sub criteria in figure 4.30 in descending order such that the first one has the highest priority with a percentage of 22.6% which is the "food industries"; the last one is the "paper industries" sector with a percentage of 3.2%.

22. Industrial sectors' pair wise comparison according to "Donors support/Opposition":

The experts' judgments of industrial sectors pair wise comparison with respect to the "donors Support/Opposition" sub criteria which were entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.31

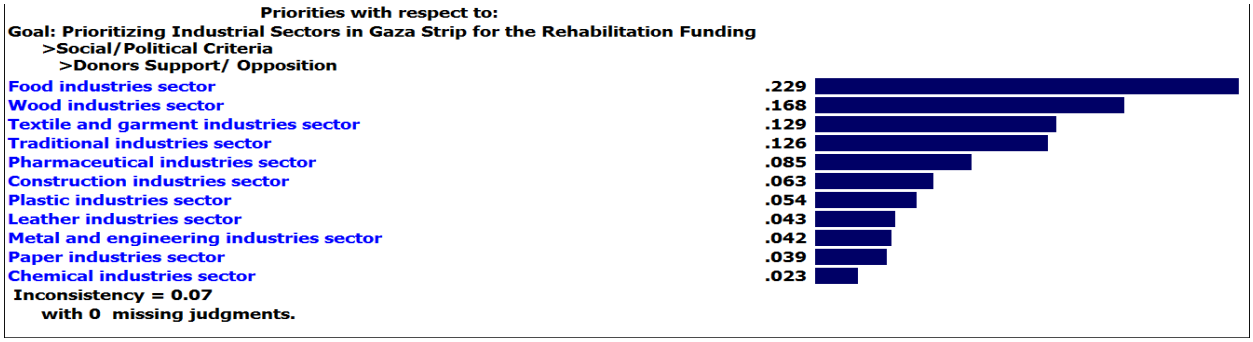

Fig 4.31: EC results of industrial sectors pair wise comparisons with respect to "donors Support/Opposition" sub criteria.

The industrial sectors are ranked according to the "donors Support/Opposition" sub criteria in figure 4.30 in descending order such that the first one has the highest priority with a percentage of 22.9% which is the "food industries"; the last one is the "chemical industries" sector with a percentage of 2.3%.

23. Industrial sectors' pair wise comparison according to "Total amount of damage in terms of Dollars":

The "total amount of damage in terms of Dollars" sub criterion is a quantitative one which was explained in table 2.1. The pair wise comparison was entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.32

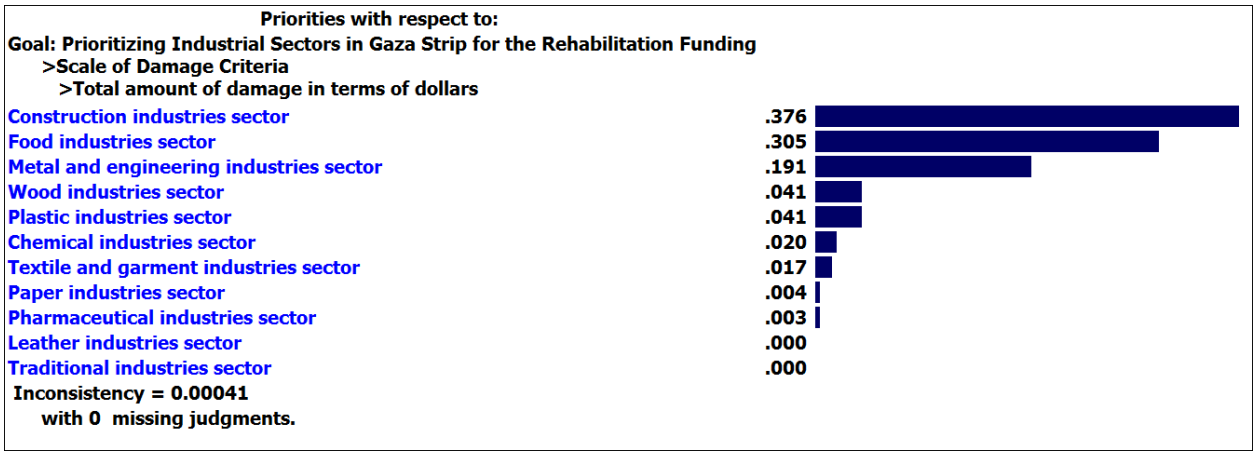

Fig 4.32: EC results of industrial sectors pair wise comparisons with respect to "total amount of damage in terms of Dollars" sub criteria.

The industrial sectors are ranked according to the "total amount of damage in terms of Dollars" sub criteria in figure 4.32 in descending order such that the first one has the highest priority with a percentage of 37.6% which is the "construction industries"; the last one is the "chemical industries" sector with a percentage of 0%.

24. Industrial sectors' pair wise comparison according to "Number of damaged facilities":

The "number of damaged factories" sub criterion is a quantitative one which was explained in table 2.2. The pair wise comparison was entered to the EC resulted in the priorities of each industrial sector with respect to the sub criteria as shown in figure 4.32

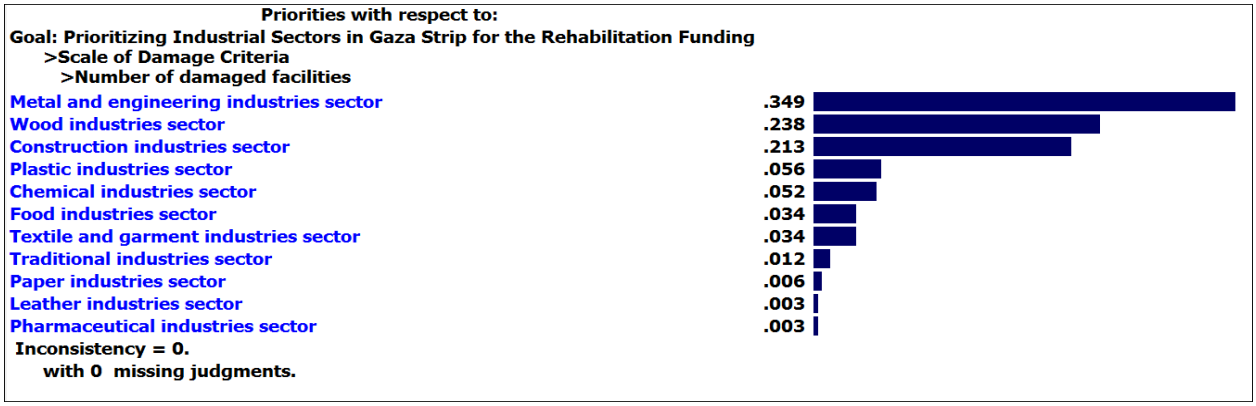

Fig 4.33: EC results of industrial sectors pair wise comparisons with respect to "number of damaged factories" sub criteria.

The industrial sectors are ranked according to the "number of damaged factories" sub criteria in figure 4.33 in descending order such that the first one has the highest priority with a percentage of 34.9% which is the "metal and engineering industries"; the last one is the "chemical industries" sector with a percentage of 0.3%.

d. Overall Ranking:

The entire results of all pair wise comparison and their computations are explained in appendix (C).

The overall ranking of industrial sectors based on AHP model is shown in figure 4.34 as resulted from EC software.

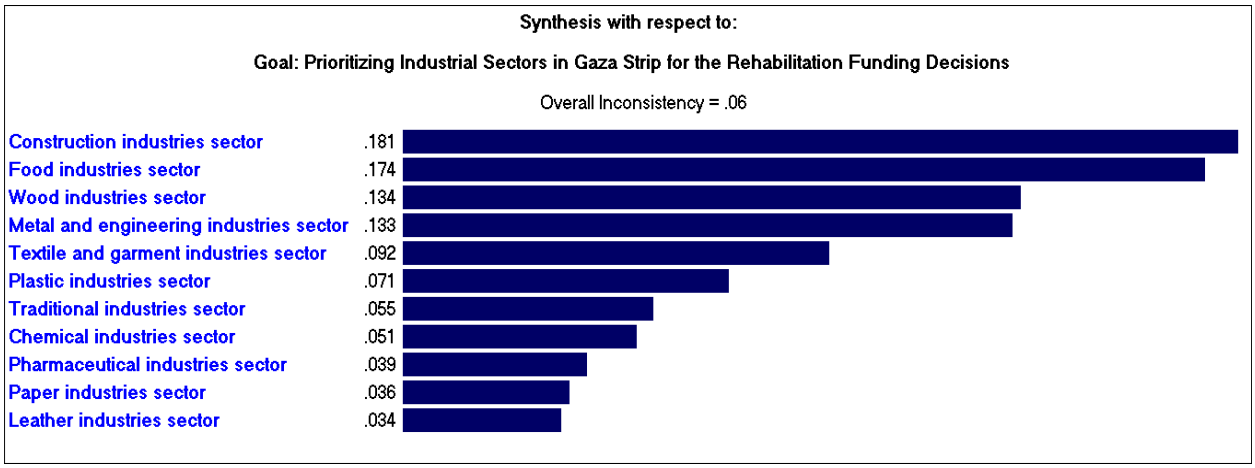

Fig 4.34: EC results of industrial sectors overall ranking according to all criteria and sub criteria.

From figure 4.34, the "construction industries sectors" is ranked first in the pair wise comparison of all criteria and sub criteria of the AHP model with a percentage of 18.1%; the second sector is "food industries" with a percentage of 17.4% and the third is "wood industries sector" with a percentage of 13.4%, while the last one is "leather industries" with a percentage of 3.4%.

Fourth: GP Model Application:

1. Introduction

The application of AHP presented in the previous section resulted in a general ranking for the industrial sectors in Gaza Strip for the rehabilitation process. The industrial sector which obtained the highest weight was ranked first and the one which obtained the least weight was ranked last. GP model has been developed to allocate funds to industrial sectors according to each sector's priority obtained from AHP.

From table 2.1, the total amount of damage in the industrial sectors in Gaza Strip because of the war 2008/2009 was 87 million dollars. This number includes the damage in construction, furniture, machines, infrastructure, raw materials and finished products. Two compensation projects were executed last time, the first was GPSR funded from the European Union. This project is intended to compensate all industrial sectors damages except the damage in the raw materials and the finished products which are 17 million

dollars. Until now the GPSR project delivered 13,149,920 dollars divided into 5 stages as shown in table 4.25.

Table 4.5: Stages of fund delivered by GPSR project (PFI, 2011)

Stage	Total amount of funds (USD)
1	5,902,551
2	4,682,164
3	1,619,277
4	946,928
Total	13,149,920

These four stages were executed by PFI in which these amounts of funds were distributed to the affected factories from the war. Another project was executed by PFI and funded by the IDB in which the damage in the machines and production lines has been compensated with a total amount of 5,140,485 dollars. The industrial sector is compensated until now from these two projects with 18,290,405 dollars (PFI, 2011).

There is no time table shows the rest stages of compensation in the future (PFI, 2011). The rest stages are assumed to be another equal 5 stages with a total amount of funds equals to the reached 5 stages amount of funds (18.29) million dollars subtracted from the total needed amount of funds for all sectors (87.03) million dollars. This means that the rest 5 stages will be 68.75 million dollars; each stage will be 13.75 million dollars.

2. GP model

The GP model will identify the amount that should be allocated to each industrial sector in each stage of compensation. The goals guarantee that each sector should be compensated with an amount that exceeds the minimum requirements of it; which is assumed to be the amount of damage for the sector shown in table 2.1.

a. GP model Objective function:

The objective function of the GP model is to minimize the negative deviations from the goals. These goals are arranged as the constraints of the model which are the minimum requirement of fund for each sector to restart its work and deliver products to the markets. The GP formulation ordered the unwanted deviations into a number of priority levels, with the minimization of a deviation in a higher priority level being more importance than any deviations in lower priority levels. These priorities are the weights of industrial sectors obtained from AHP. This implies that goals of higher priority are met before those of lower priority. The objective function is shown in equation 4.2

Minimize $\sum_{i=1}^{11} W_i D_{in}$ …… (4.2)

Where:

W_i: is the weight of the industrial sector (i) as ranked from AHP model.

Din: is the negative deviation from the goal (i)

The industrial sectors are 11, so i = 1 to 11.

b. GP model constraints:

The GP model includes two types of constraints, the first type represents the goals of the model which are the minimum requirement of fund for the industrial sector, and the second type represents the amount of funds delivered at each stage of compensation.

1. Minimum requirement of funds for the industrial sector constraints (goals)*:*

$$\sum_{j=1}^{10} X_{ij} + d_{in} - d_{ip} = total\ amount\ of\ damage\ of\ industrial\ sector\ "i" \ldots\ldots\ldots (4.3)$$

For all i= 1 to 11 (industrial sectors)

2. The amount of funds delivered at each stage of compensation

$$\sum_{i=1}^{11} X_{ij} = total\ amount\ of\ funds\ at\ stage\ (j) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.14)$$

For all j= 1 to 10 (stages of compensation)

Where:

X_{ij}: is the amount of fund that should be allocated to industrial sector (i) at stage (j)

$_{din}$: the negative deviation from the minimum requirement of industrial sector (i)

$_{dip}$: the positive deviation from the minimum requirement of industrial sector (i)

For the previous executed 5 stages, the funds were distributed separately at each stage. The distribution was based on only one criterion which was the amount of damage, such that the factories with total damage less than 25000 dollars were compensated first and at the same time the factories with damages more than 25000 dollars were compensated with only 25000 dollars at first stage and the rest in the later stages (PFI, 2011).

The model is formulated and solved by LINDO software and the results are shown in table 4.26.

The LINDO API software can easily create **optimization applications**. The model was solved by using a free trial version of LINDO API 6.1.

The limitations on this trial version include the solution of only 150 constraints, 300 variables, 50 integer variables and 2000000 non-zeros.

The research GP model includes 132 variables; 110 variables from them are decision variables and the rest 22 variables positive and negative deviations from the goals variables. The constraints of the research GP model are 21 constraints; 11 from them represent the minimum requirement of each industrial sector and the rest 10 constraints represent the maximum amount of fund allocated at each stage.

(Appendix (D) shows the GP model).

Fifth: Summary:

The methodology used in this study was described in this chapter, required data was collected, in which criteria and alternatives are identified, followed by the application of AHP model to rank the industrial sectors' priorities for compensation, from the AHP rank "construction industries sectors" is ranked first with a percentage of 18.1%; the second sector is "food industries" with a percentage of 17.4% and the third is "wood industries sector" with a percentage of 13.4%, while the last one is "leather industries" with a percentage of 3.4%.

The chapter was finished with the application of GP model to assign each sector's compensating fund for the reconstruction and restarting during the rehabilitation process of Gaza Strip.

Chapter 5: Results and Analysis

First: Introduction

Second: AHP model results and analysis

1. AHP Sensitivity Analysis:

- **a. performance sensitivity analysis**
- **b. Gradient sensitivity analysis**
- **c. Dynamic sensitivity analysis**

Third: The combined AHP-GP model results and analysis

Fourth: Comparison between research results and executed compensations

Fifth: Summary

First: Introduction:

This chapter describes the results of the study starting with AHP model results; analysis of AHP model results is made by the two types of AHP sensitivity analysis performance and gradient. Then the results of the combined AHP-GP model are presented and analyzed. Finishing with a comparison between the research results and the actually executed stages of compensation.

Second: The AHP model results and analysis:

The application of AHP in this research resulted in an overall ranking for the industrial sectors in Gaza strip. The resulted rank is shown in table 4.4 and figure 4.34. The rank is according to the total weight of the sector in the AHP model in all criteria and sub-criteria. Analyzing the results of the AHP model can be made by conducting the sensitivity analysis which can be made by the EC software as shown in the following section.

1. AHP Sensitivity Analysis:

AHP sensitivity analysis is to investigate how sensitive the rankings of the alternatives are to changes in the importance of the criteria. EC offers five modes for graphical sensitivity analysis which are:

- Performance
- Dynamic
- Gradient
- Head to head or called (difference graph)
- Two-dimensional

a. Performance sensitivity analysis:

This type of analysis shows how the alternatives are prioritized relative to other alternatives with respect to each criterion as well as overall. Figure 5.1 shows the performance sensitivity analysis graph.

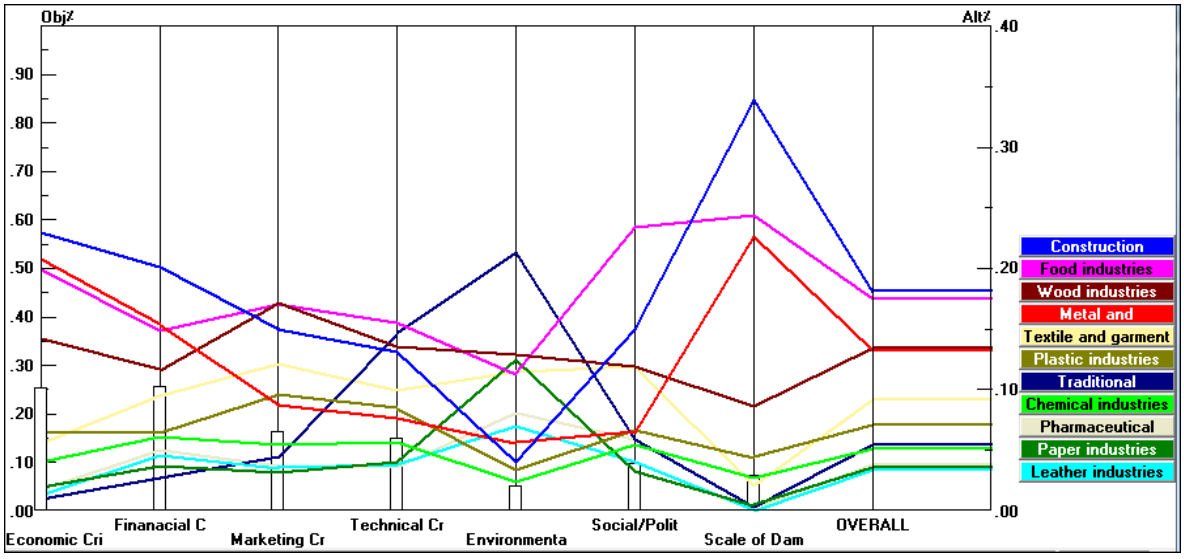

Fig 5.1: Performance sensitivity analysis

The criteria are represented by vertical bars, and the alternatives are displayed as horizontal line graphs. The intersection of the alternative line graphs with the vertical criterion lines shows the priority of the alternative for the given criterion, as read from the right axis labeled Alt%. The criterion's priority is represented by the height of its bar as read from the left axis labeled obj%. The overall priority of each alternative is represented on the overall line, as read from the right axis.

Figure 5.1 shows that:

Construction industries sector is ranked first in the overall ranking of all alternatives; the major reasons for that are:

- The "financial" criterion is the most important one with a percentage of 24.9%; and this sector has the highest performance in this criterion (51%).
- The "economic" criterion is the second important one with a percentage of 24.7%; and this sector has the highest performance in this criterion (56.8%).
- The performance of this sector is the highest in both the "environmental" and "scale of damage" criteria.
- The performance of this sector is the second in the "social/political" criterion and the third in the both "marketing" and "technical" criteria.

Food industries sector is ranked second in the overall ranking of all alternatives; the major reasons for that are:

- The “financial” criterion is the most important one with a percentage of 24.9%; and the performance of this sector in this criterion is the third (37.4%).
- The “economic” criterion is the second most important one with a percentage of 24.7%; and the performance of this sector in this criterion is the third 49%.
- The performance of this sector is the highest in the “marketing”, “technical” and “social/political” criteria.
- The performance of this sector is the second in the “scale of damage” criterion and third in the “environmental” criterion.

Although the performance of metal and engineering industries sector is more than the fourth one in most criteria, its overall performance is fourth; this because of the highest performance of this sector in the most important three criteria (financial, economic and marketing).

b. Gradient sensitivity analysis:

This graph shows the alternatives' priorities with respect to one criterion at a time. Changes in the weight or the judgments may lead to changes in the outcome of the decision. The gradient sensitivity analysis assigns each criterion a separate gradient graph. The vertical line represents the current priority of the selected criterion. The slanted lines represent the alternatives. The current priority of an alternative is where the alternative line intersects the vertical criterion line.

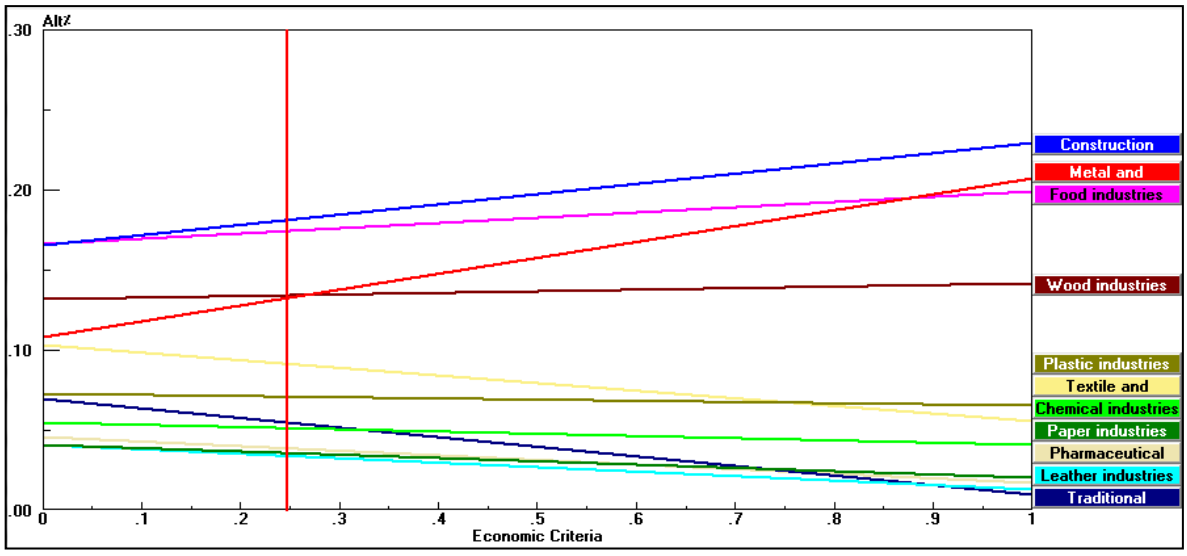

Fig 5.2: Gradient sensitivity analysis for economic criteria

Figure 5.2 shows that, under the current weight of the economic criterion, which is 24.7% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector regardless of the weight of the economic criteria. The overall performance of "construction", "metal and engineering" and "food" sectors increase if the weight of the economic criteria increases. If the weight of the economic criteria is 90% and higher, the "metal industries" becomes second and the "food industries" becomes third. The rest sectors performance decrease if the weight of the economic criteria increases.

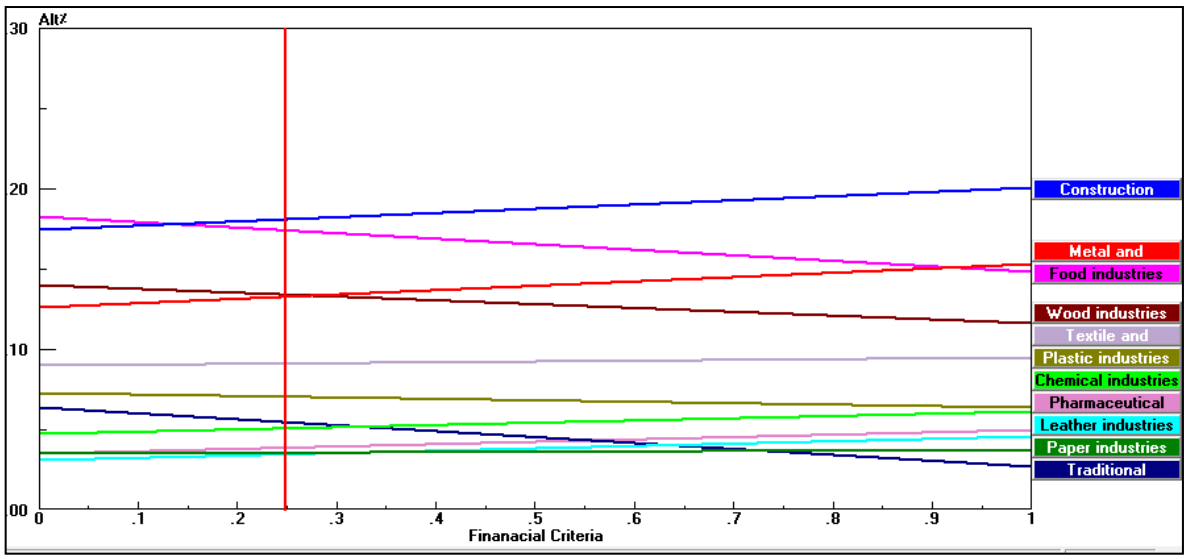

Fig 5.3: Gradient sensitivity analysis for financial criteria

Figure 5.3 shows that, under the current weight of the financial criterion, which is 24.9% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights larger than 15% of the financial criteria. If the weight of the financial criteria is lower than 15%, the food sector becomes the top ranked. The overall performance of "construction" and "metal and engineering" sectors increase if the weight of the financial criteria increases. The rest sectors' performance decreases if the weight of the financial criteria increases.

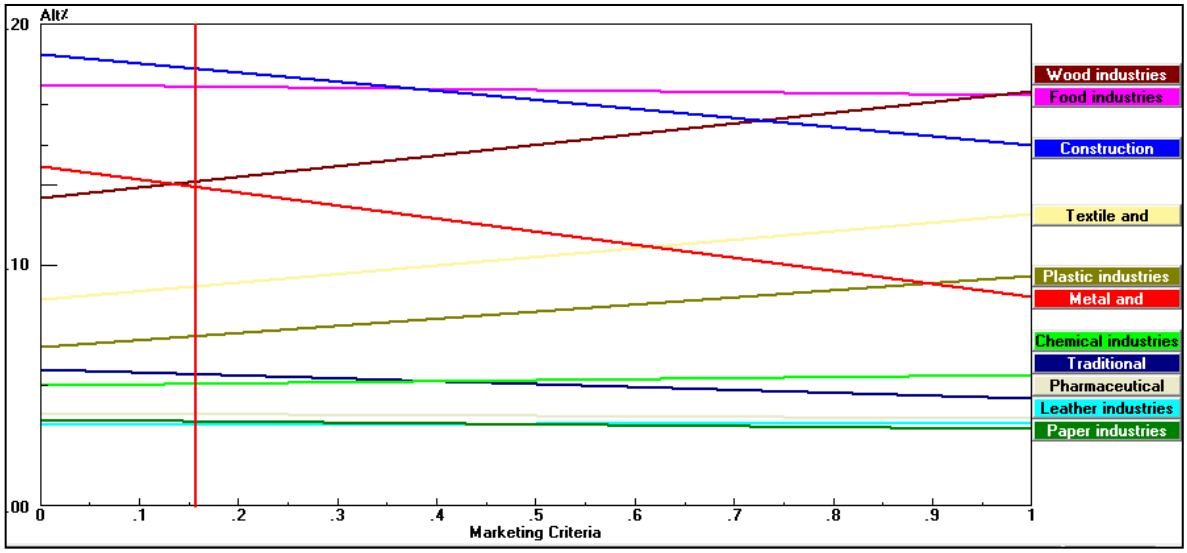

Fig 5.4: Gradient sensitivity analysis for marketing criteria

Figure 5.4 shows that, under the current weight of the marketing criterion, which is 15.7% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights lower than 40% of the marketing criteria. If the weight of the marketing criteria is larger than 40%, the food sector becomes the top ranked. The overall performance of "wood", "textiles" and "plastic" sectors increase if the weight of the marketing criteria increases. The rest sectors' performance decreases if the weight of the marketing criteria increases.

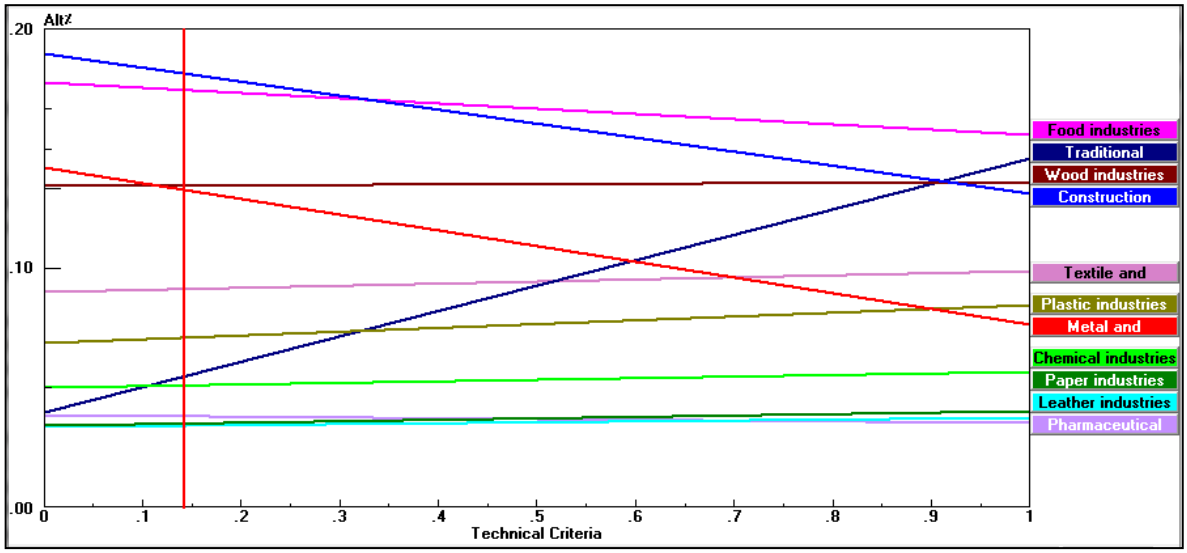

Fig 5.5: Gradient sensitivity analysis for technical criteria

Figure 5.5 shows that, under the current weight of the technical criterion, which is 14.2% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights lower than 33% of the technical criteria. If the weight of the technical criteria is larger than 40%, the food sector becomes the top ranked. The overall performance of "wood", "textiles" and "plastic" sectors increase if the weight of the marketing criteria increases. The rest sectors' performance decreases if the weight of the marketing criteria increases.

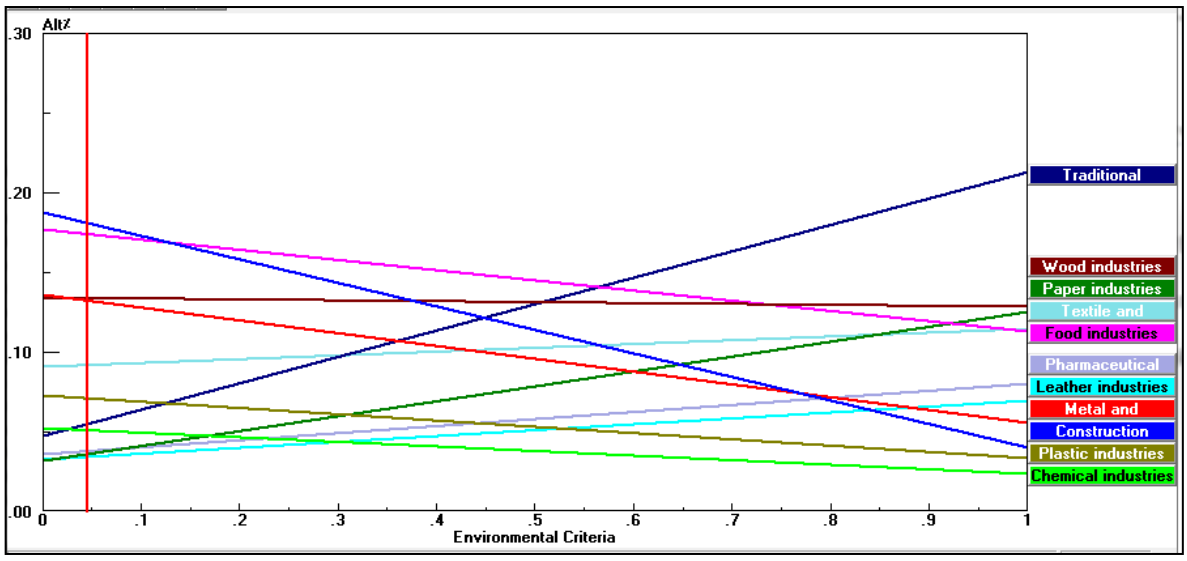

Fig 5.6: Gradient sensitivity analysis for environmental criteria

Figure 5.6 shows that, under the current weight of the environmental criterion, which is 4.5% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights lower than 12% of the environmental criteria. If the weight of the environmental criteria is between 12% and 57%, the food sector becomes the top ranked. For all weights larger than 57% of the environmental criteria, the traditional industries sector is the top ranked. The overall performance of "traditional", "paper" and "leather" sectors increase if the weight of the environmental criteria increases. The other sectors' performance will sharply decrease if the weight of the environmental criteria increases.

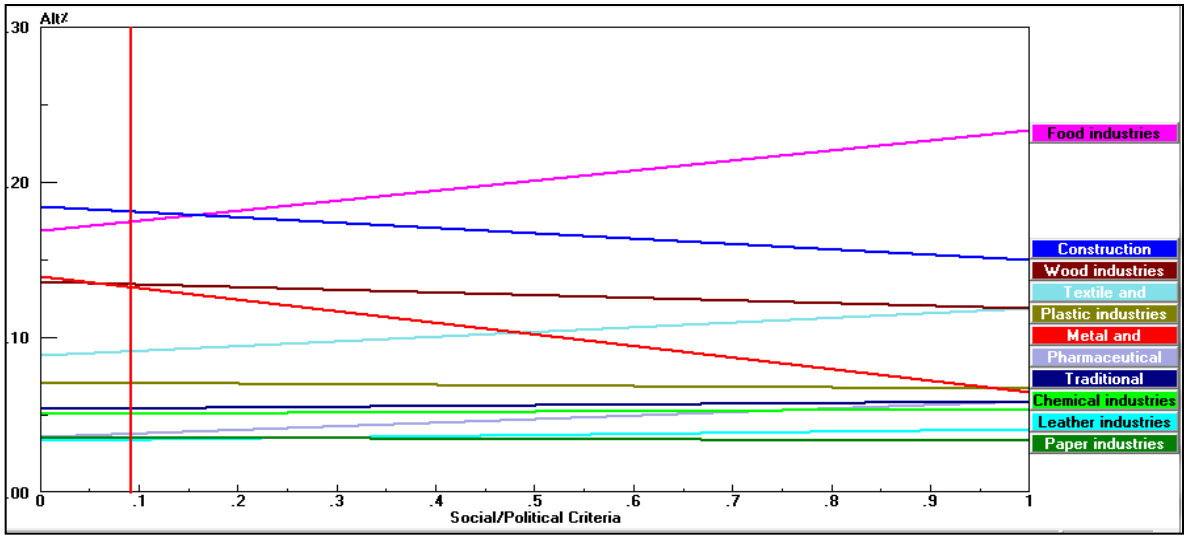

Fig 5.7: Gradient sensitivity analysis for social/political criteria

Figure 5.6 shows that, under the current weight of the social/political criterion, which is 9.2% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights lower than 16% of the social/political criteria. If the weight of the social/political criteria is larger than 16%, the food sector becomes the top ranked. The overall performance of "food" and "textiles" sectors will sharply increase if the weight of the social/political criteria increases. The "construction", "wood" and "metal and engineering" sectors' performance will sharply decrease if the weight of the social/political criteria increases.

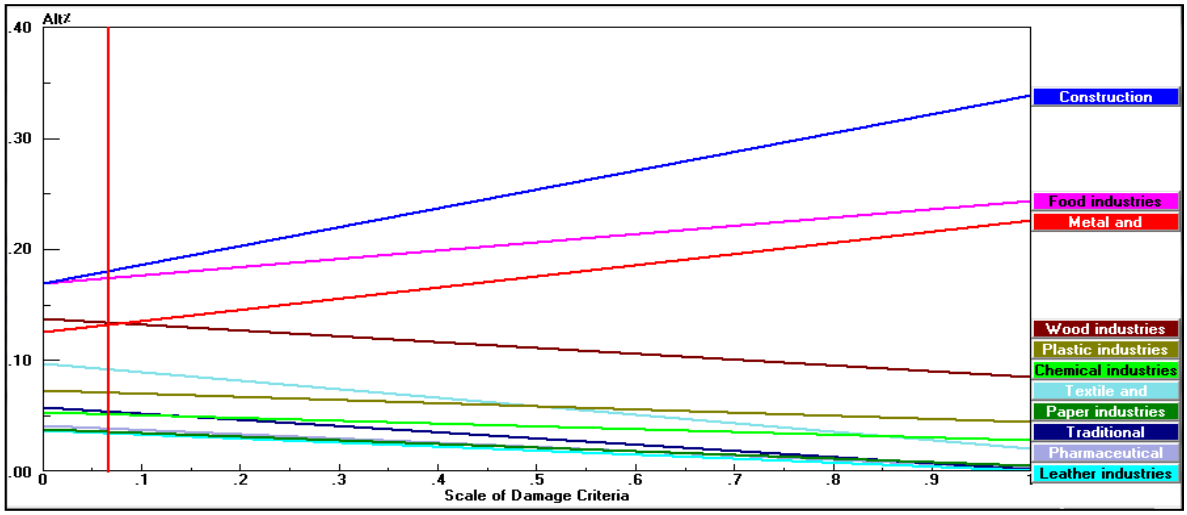

Fig 5.8: Gradient sensitivity analysis for scale of damage criteria

Figure 5.6 shows that, under the current weight of the scale of damage criterion, which is 6.7% of the relative weight; construction industries sector gets the highest overall performance. It remains the top-ranked sector for all weights of the scale of damage criteria. The overall performance of "construction, "food" and "metals and engineering" sectors will sharply increase if the weight of the scale of damage criteria increases. The rest sectors' performance will sharply decrease if the weight of the scale of damage criteria increases.

c. Dynamic sensitivity analysis:

The dynamic sensitivity analysis is a horizontal bar graph that can be used to increase or decrease the priority of any criterion and see the change in the priorities of the alternatives. As any criterion is increased, the priorities of the remaining criteria decrease in proportion to their original priorities. The program recalculates the priorities of the alternatives based on their new relationship. The application of the dynamic sensitivity should be used when there is a forecast to the situation of criteria in the future; this forecast includes different scenarios for the weights of the criteria and the priorities of alternatives are examined at each scenario.

In this research, the performance and gradient sensitivity analysis is applied. The dynamic sensitivity analysis is not applied, and the scenarios of future changes of criteria will be concluded from the gradient sensitivity analysis.

Third: The combined AHP-GP model results and analysis:

The process of compensation is executed in ten stages to aggregate the total need of funds for all industrial sectors in Gaza strip. The top ranked industrial sectors in the AHP model which have the highest weights should be compensated in the first stages. The GP model guarantees this condition by setting the weights of the industrial sectors of the AHP model as the coefficients of the objective function. The model includes one objective (minimize deviations) with 11 goals (minimum industrial sectors' needs from fund), so here there is one priority referred to the objective with different weights (AHP model weights) referred to the industrial sectors. The priority of each industrial sector is identified by its weight which got from the AHP model. So the word weight will express priority when used with industrial sectors.

The results of using GP model to allocate the compensating funds to the 11 industrial sectors in Gaza Strip by incorporating the importance weights of them resulted from the economical expert's points of view which were considered in the AHP model are shown in tables 5.1 and 5.2.

Table 5.1 shows the amount of funds in terms of dollars that should be allocated to each industrial sector at each stage. Table 5.2 shows the percentage of allocated funds at each stage from the total industrial sector need of funds.

Table: 5.1: The results of LINDO software for the AHP-GP model

	Amounts of funds allocated to											
Stage	Construction	Food	Wood	Metal	Textiles	Plastic	handicraft	Chemical	Pharmaceutical	Paper	Leather	Allocated fund (million dollars)
1	-	4.702	1.198	0	0	0	0	0	0	0	0	5.9
2	0.098	0	0	4.579	0	0	0	0	0	0	0	4.677
3		0	0	1.619	0	0	0	0	0	0	0	1.619
4		0	0.95	0	0	0	0	0	0	0	0	0.95
5	5.14	0	0	0	0	0	0	0	0	0	0	5.14
6	13.75	0	0	0	0	0	0	0	0	0	0	13.75
7		0	1.432	10.302	0	0	0	1.75	0.266	0	0	13.75
8	13.602		0	0	0	0	0	0	0	0	0.148	13.75
9	0	13.75			0	0	0	0	0	0	0	13.75
10	0	7.958	0		1.49	3.55	0.376			0.376		13.75
Total	32.59	26.41	3.58	16.5	1.49	3.55	0.376	1.75	0.266	0.376	0.148	87.03

Table: 5.2: The results of LINDO software for the AHP-GP model as percentages from total each industrial sector needs

	Percentage of funds from total IS needs allocated to											
Stage	Construction	Food	Wood	Metal	Textiles	Plastic	handicraft	Chemical	Pharmaceutical	Paper	Leather	Allocated fund (million dollars)
1	-	17.8	33.46	0	0	0	0	0	0	0	0	5.9
2	0.3	0	0	27.75	0	0	0	0	0	0	0	4.677
3		0	0	9.81	0	0	0	0	0	0	0	1.619
4		0	26.54	0	0	0	0	0	0	0	0	0.95
5	15.77	0	0	0	0	0	0	0	0	0	0	5.14
6	42.19	0	0	0	0	0	0	0	0	0	0	13.75
7		0	40	62.43	0	0	0	100	100	0	0	13.75
8	41.73		0	0	0	0	0	0	0	0	100	13.75
9	0	52.07			0	0	0	0	0	0	0	13.75
10	0	30.13	0		100	100	100			100		13.75
Total	100	100	100	100	100	100	100	100	100	100	100	87.03

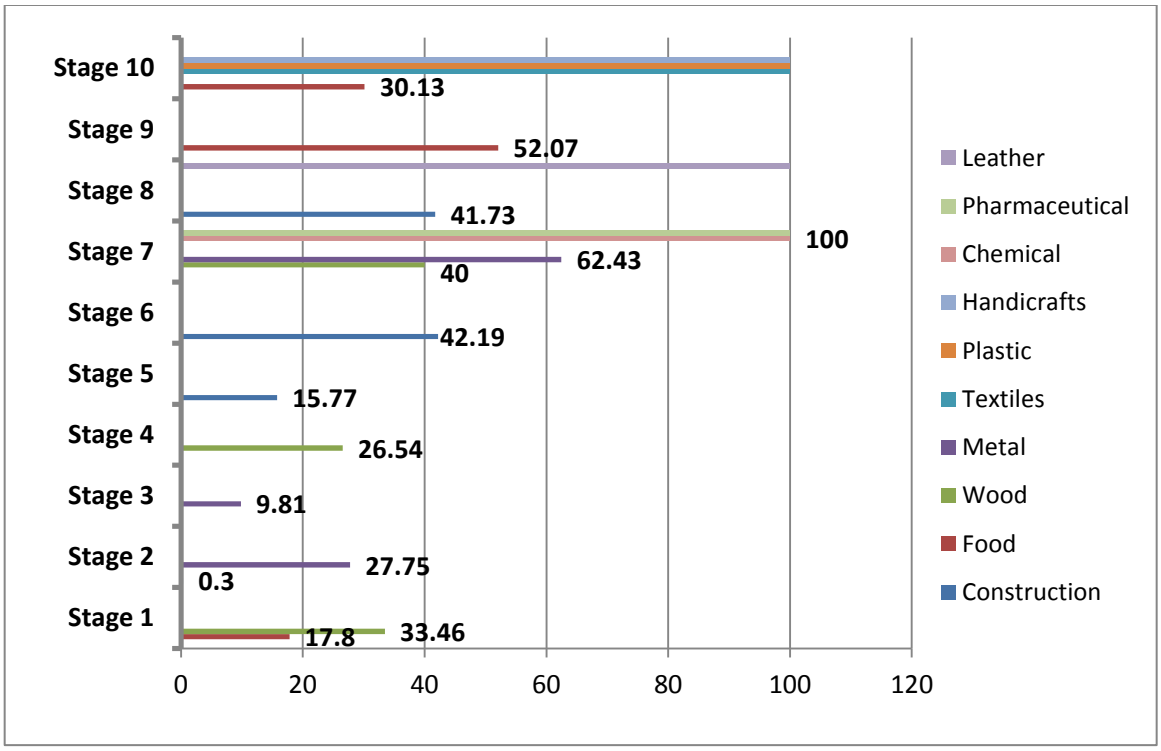

Fig 5.9: Percentages of industrial sectors compensation at each stage.

1. Stage 1 funds allocation

Figure 5.9 shows how stage 1 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that, from the total amount of funds in stage 1 which is 5.9 million dollars:

- 79.7% should be allocated to compensate 17.8% of the "food industries sector" needs which was ranked 2nd in AHP model.
- 20.3% should be allocated to compensate 33.46% of the "wood industries sector" needs which was ranked 3rd in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 1 funds to the 2nd and the 3rd ranked industrial sectors.
- The results of GP model don't include the any amount of funds for the 1st ranked industrial sector which is "construction industries", the reason for that is to compensate two other top ranked sectors which are the 2nd and 3rd especially when the 2nd sector's weight (17.4%) is very close to the 1st sector's weight (18.1%); another reason for that is the objective function value (deviations from the goals) will be minimum at these values.

2. Stage 2 funds allocation

Figure 5.9 shows how stage 2 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that, from the total amount of funds in stage 2 which is 4.677 million dollars:

- 2.1% should be allocated to compensate 0.3% of the "construction industries sector" needs which was ranked 1st in AHP model.
- 97.9% should be allocated to compensate 27.75% of the "metal industries sector" needs which was ranked 4th in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 2 to the 1st and the 4th ranked sectors.

The reason of compensating the 4th ranked industrial sector in this early 2nd stage is the very small difference between the AHP weight of it and of the 3rd industrial sector which 0.1% (13.4-13.3) %.

3. Stage 3 funds allocation

Figure 5.9 shows how stage 3 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that:

- The total amount of funds in stage 3 which is 1.619 million dollars should be allocated to compensate 9.8% of the "metal industries sector" needs which was ranked 4th in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 3 to the 4th ranked one.
- The total amount of funds in stage 3 is allocated to one industrial sector, because it is small amount (1.619 million dollars), which is only 9.8% of 4th sector needs of funds.
- The 4th industrial sector should be compensated in this early stage because of its high AHP weight (13.3%) which is very close to the AHP weight of the 3rd one (13.4%).

4. Stage 4 funds allocation

Figure 5.9 shows how stage 4 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that:

- The total amount of funds in stage 4 which is 0.95 million dollars should be allocated to compensate 26.5% of the "wood industries sector" needs which was ranked 3rd in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 4 to the 3rd ranked one.
- The total amount of funds in stage 4 should be allocated to one sector; because it is small amount (0.95 million dollars), which is 26.5% of 3rd sector needs of funds.

5. Stage 5 funds allocation:

Figure 5.9 shows how stage 5 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that:

- The total amount of funds in stage 5 which is 5.14 million dollars should be allocated to compensate 15.8% of the "construction industries sector" needs which was ranked 1st in the AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 5 to the 1st ranked one.

6. Stage 6 funds allocation:

Figure 5.9 shows how stage 6 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that:

- The total amount of funds in stage 6 should be allocated to compensate 42.2% of the "construction industries sector" needs which was ranked 1st in the AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 6 to the 1st ranked one.

7. Stage 7 funds allocation:

Figure 5.9 shows how stage 7 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that, from the total amount of funds in stage 7 which is 13.75 million dollars:

- 10.41% should be allocated to compensate 40% of the "wood industries sector" needs which was ranked 3rd in AHP model.
- 74.92% should be allocated to compensate 62.44% of the "metal industries sector" needs which was ranked 4th in AHP model.
- 12.73% should be allocated to compensate the total needs of the "chemical industries sector" which was ranked 8th in AHP model.
- 1.93% should be allocated to compensate the total needs of the "pharmaceutical industries sector" which was ranked 9th in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 7 to complete the rest needs of the 3rd and the 4th ranked industrial sectors and to compensate the total amount of funds needed for both 8th and 9th sectors.

8. Stage 8 funds allocation:

Figure 5.9 shows how stage 8 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that, from the total amount of funds in stage 8 which is 13.75 million dollars:

- 98.92% should be allocated to compensate 41.74% of the "construction industries sector" needs which was ranked 1st in AHP model.
- 1.1% should be allocated to compensate the total amount of funds needed for the "leather industries sector" which was ranked last in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 8 to complete the rest needs of the 1st ranked sector and to compensate the total amount of funds needed for the last one.

9. Stage 9 funds allocation:

Figure 5.9 shows how stage 9 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that:

- The total amount of funds of the stage 9 should be allocated to compensate 52.1% of the "food industries sector" needs which was ranked 2nd in AHP model.

- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 9 to complete 52.1% of the needs of the 2nd ranked industrial sector.

10. Stage 10 funds allocation:

Figure 5.9 shows how stage 10 should be allocated according to the results of the combined AHP-GP model shown it table 5.2. It shows that, from the total amount of funds in stage 10 which is 13.75 million dollars:

- 57.9% should be allocated to compensate 30.1% of the "food industries sector" needs which was ranked 2nd in AHP model.
- 10.84% should be allocated to compensate the "textiles industries sector" total needs which was ranked 5th in AHP model.
- 25.82% should be allocated to compensate the "plastic industries sector" total needs which was ranked 6th in AHP model.
- 2.73% should be allocated to compensate the "handicraft industries sector" total needs which was ranked 7th in AHP model.
- 2.73% should be allocated to compensate the "paper industries sector" total needs which was ranked 10th in AHP model.
- The GP model took into consideration each industrial sector priority derived from the AHP model by allocating stage 10 to complete the rest needs of the 2nd ranked industrial sector and to compensate the total amount of funds needed for the 5th, 6th, 7th and 10th sectors.

The reasons of compensating the 1st industrial sector in the nearly late stages are:

- The very convergent AHP weights of both 1st (18.1%) and 2nd (17.4%) industrial sectors and also both the 3rd (13.4%) and 4th (13.3%) ones. This convergent importance between the four sectors and the big amount of funds needed for these sectors caused the delay of compensating the 1st one to the later stages to compensate more than on sector (2nd, 3rd and 4th) in first 5 stages.

- The 1st industrial sector which is construction has the highest need of funds which is 32.59 million dollars; this need is higher than the total amount of funds for the first five stages.
- Compensating the 1st industrial sector starts directly in the following 6th stage which should be totally allocated to compensate 42.2% of its needs of funds.
- Stage 7 should be totally allocated to the 2nd and 3rd industrial sectors, then stage 8 to the 1st one.

Fourth: Comparison between research results and executed compensations:

The distributed funds are executed by the first 5 stages. The other stages from 6 to 10 are not executed until now. For the executed 5 stages, the data is available only for the first stage of compensation (PFI, 2011). This data for the first stage data is classified according to the name of the factory; this situation has forced a hard work from the researcher to classify each factory to its industrial sector.

Table 5.3 shows the after classification distributed funds to each industrial sector for executed stage 1. The data for the rest executed 4 stages from 2 to 5 is not available (PFI, 2011).

The comparison between the research results and the real executed compensation will be made only for stage 1.

Table 5.3: Executed stage 1 distributed funds for each industrial sector (PFI, 2011)

Industrial sector	Amount Distributed funds (million dollars)	Total need (million dollars)	Percentage from total need (%)
Construction	1.95	32.59	5.98
Food	0.79	26.41	2.99
Wood	0.83	3.58	23.18
Metal	1.4	16.5	8.48
Textiles	0.5	1.49	33.56
Plastic	0.135	3.55	3.8
Handicraft	0.0042	0.376	1.12
Chemical	0.27	1.75	15.43
Pharmaceutical	0	0.266	0
Paper	0.0521	0.376	13.86
Leather	0.01	0.376	2.66
Total	5.9	87.26	6.76

The percentage of distributed funds to each industrial sector needs in stage 1 to the total needs of it is shown in figure 5.10, while figure 5.11 shows stage 1 allocation as resulted from applying the AHP-GP model in this research.

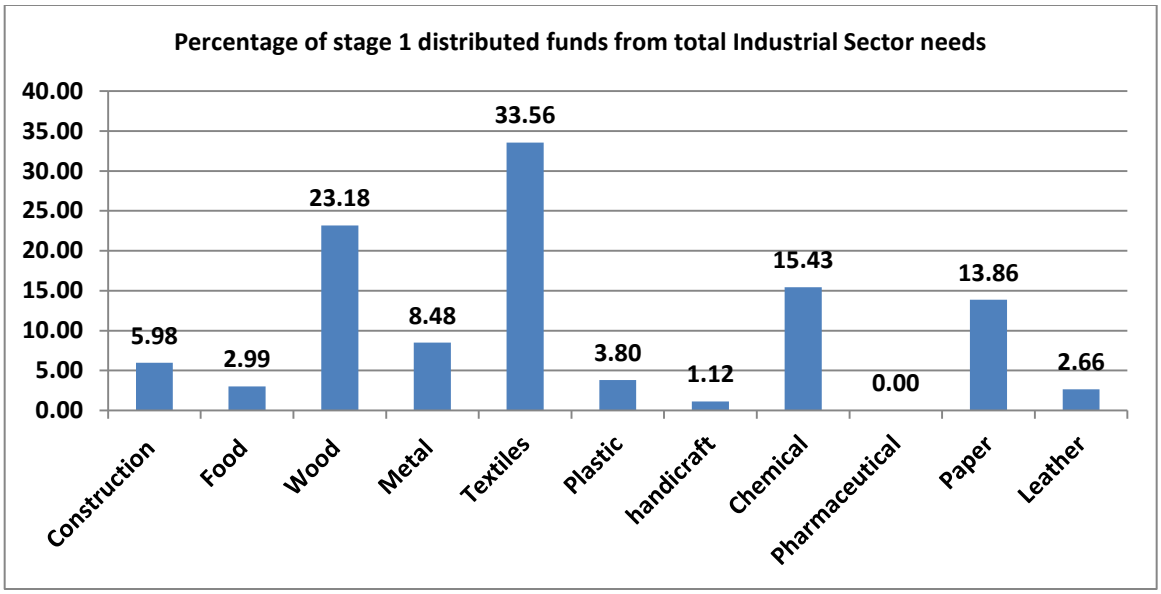

Fig 5.10: Percentage of distributed funds executed in stage 1 (PFI, 2001)

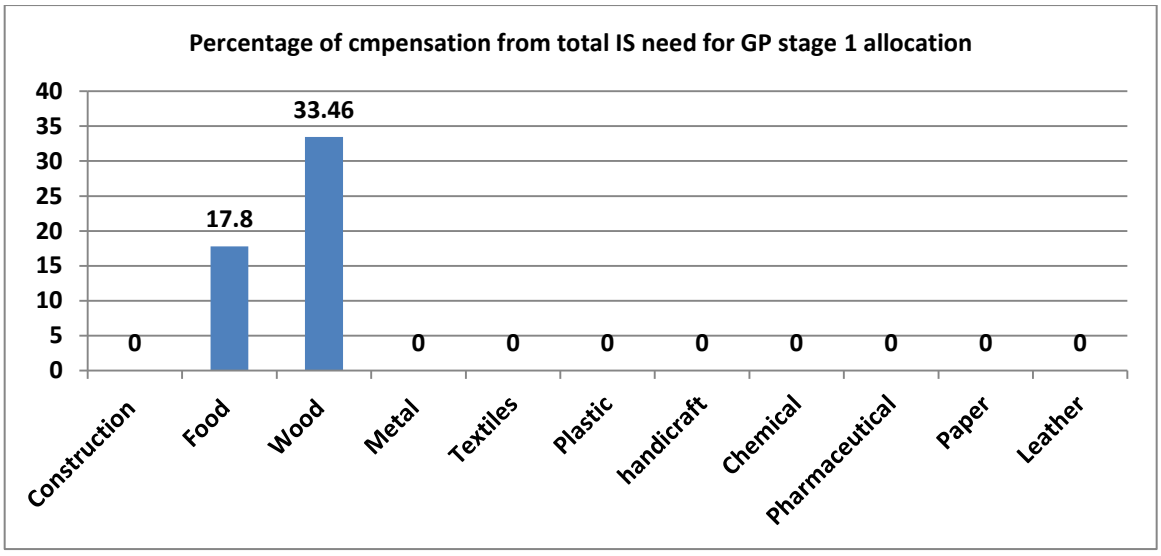

Fig 5.11: Stage 1 allocation as resulted from applying the AHP-GP model

Figure 5.10 represents the real situation of stage 1 executed by PFI and figure 5.11 represents the research results after applying the research combined AHP-GP model. The comparison between two figures results in the following conclusions:

- According to the research model, stage 1 should be allocated to 2nd "food" and 3rd "wood" ranked industrial sectors, while the executed allocation was to all 11 sectors except the 10th one which is "pharmaceutical".

- According to the research model, stage 1 should compensate 17.8% of the needs of 2nd "food industries sector", while the executed allocation was only 2.99% of its needs.
- According to the research model, stage 1 should compensate 33.46% of the needs of 3rd "wood industries sector", while the executed allocation was only 23.18% of its needs.
- In the executed stage 1, there is no obvious prioritization of one sector to others; the compensation process tried to compensate all sectors at the same time.
- The differences between the allocated funds in the executed stage 1 is because the criterion was to compensate the factories with damages less than or equal to 25000 dollars, so the sector that has higher number of factories with damage less than or equal to 25000 dollars will take the highest amount of funds.
- In the executed stage 1, the last ranked sectors like the 10th "paper" and 11th "leather" are compensated; the funds allocated to these late sectors are deducted from the share of the first ranked ones which have higher priorities to be compensated in this early stage.

Fifth: Summary:

The analysis of the research results was presented in this chapter. AHP performance sensitivity analysis showed that the performance of the top ranked sectors "construction", "food", "wood" and "metals" is the best in the first ranked criteria "financial", "economic", "marketing" and "technical"; this assures the overall ranking of industrial sectors for the compensation decisions. From the dynamic sensitivity analysis, a conclusion was made about the performance of each sector against any change in the main criteria; the weight of each main criteria s changed and the effect of this changed on the overall ranking of industrial sectors is examined. The combined AHP-GP model is applied to present a detailed fund allocation for industrial sectors in the ten stages of compensation.

Chapter 6: Conclusions and Recommendations

First: Conclusions

Second: Recommendations

First: Conclusions:

- There is an absolute necessity to prioritize the industrial sectors in Gaza Strip before any compensation process for the damages of war.
- Industrial sectors prioritization in this study is constructed as a multi criteria problem in order to rank them by AHP and to allocate the optimal amounts of funds to each one by GP.
- There are many criteria and variables that affect industrial sectors' prioritization and these should be considered in the evaluation process. This research shows that the consideration of all these criteria could help produce better decisions.
- AHP model is capable of handling multiple criteria and enabled us to incorporate 24 both qualitative and quantitative factors, when assessing the industrial sectors in Gaza strip.
- A powerful tool based on systematic scientific approach is presented in this research for the decision makers; the use of this tool guarantees an effective way to allocate funds in any rehabilitation process for the industrial sectors in Gaza Strip.
- Pair-wise comparison used in this work reduces the dependency of the model on human judgment. The consistency test of the AHP model guarantees an accurate evaluation process; if there is a problem in the consistency the decision makers can know where the problem is and revise their judgments.
- The construction industries sector is the top ranked sector as resulted from the AHP model; this reflects the real situation of the big suffering of other industrial sectors and most projects in Gaza Strip because of the damages and stoppage of this sector.
- From the combined model of AHP-GP, an allocation plan of funds is presented that firstly compensate the highest prioritized industrial sectors which have the most important impacts in Gaza Strip economy.

Second: Recommendations

Based on the results of this research the following points are recommended:

- Decision makers in Gaza Strip especially PFI and the donors organizations are recommended to use the results of this research in any future rehabilitation process for the industrial sectors.
- The research models can be used in the evaluation and ranking of the most important industrial sectors to improve the general economy.
- It is recommended to use the basis of this study in prioritizing and evaluating other economic sectors in Gaza Strip and Palestine.
- It is recommended for the future researchers to use other MCDM techniques like (TODIM), Preference Ranking Organization Method for Enrichment Evaluations (PRMOTHEE) and Elimination and Choice Expressing the Reality (ELECTRE) in prioritizing and ranking the industrial sectors and compare their results to this research results.

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Appendices

Appendix A: Evaluation criteria Questionnaire

Islamic University of Gaza

Deanery of Higher Studies

Faculty of Commerce

Department of Management

Dear Sir;

The aim of this questionnaire is to identify the major criteria needed to identify the compensation priorities of the industrial sectors in Gaza strip about their damages resulted from the war 2008/2009.

This questionnaire is the first step in constructing a model for identifying the optimal compensating fund for each industrial sector in Gaza Strip using the Analytic Hierarchy Process and Goal Programming.

In order to achieve this aim, we hope from you, please to fill the questionnaire by giving your own opinions of the importance of each criterion and remembering that you can add other important criteria and sub criteria in your opinion.

The research will help toward improved evaluation process to arrive to successful final compensation process.

All of data collected from you will be used only for scientific purpose which the researcher needs for his MBA degree thesis.

All thanks and appreciation for contribution in enhancement of scientific research process.

Researcher

Ahmed S. Al Afeefy

Supervisor

Prof. Dr. Yousif H. Ashour

Part I

General Information

Put the sign (X) in the suitable selection:

- **Place of work**

☐ Public sector
☐ Donors
☐ Private sector
☐ Non Governmental Organizations NGO's
☐ UNRWA
☐ Other, determine……

- **Experience**

☐ 1 – 4 years
☐ 5-10 years
☐ More than 10 years

- **Education**

☐ Bachelor B.Sc.
☐ Master M.Sc.
☐ Doctorate (Ph.D.)

Part II

Criteria and sub criteria importance table

Main criteria	Sub criteria	Very important	Important	Moderately important	Little important	Not important
Economic criteria	Employment creation					
	Contribution to GDP					
	Effects on other industrial sectors					
Financial	Total needed fund					
	Return on investment					
	Net present value					
	Payback period					
Technical	Availability of machines and technology					
	Availability and the ease of access of raw materials					
	The nature of infrastructure needed					
	Resources for Development					
	Product quality					
Marketing	Quality and reputation of products existed now in the market					
	Market Share at Foreign Markets					
	Market Share at Local Market					
	Market Growth					
	Borders and siege overcome					
Environmental	Environmental					

	Impacts					
	Rules and regulations regarding environment					
Social/Political	Governmental Support/Opposition					
	Public Support/Opposition					
	Donors Support/ Opposition					
Scale of damage	Total amount of damage in terms of dollars					
	Number of damaged facilities					

Other important criteria or sub criteria:

1)

2)

3)

4)

Appendix B: Pair Wise Comparisons

Dear Sir;

The aim of this questionnaire is to make the pair wise comparisons of major criteria and sub criteria identified in questionnaire 1 and their importance in the process of prioritizing industrial sectors using Analytic Hierarchy Process.

This questionnaire is the first step in constructing a model for identifying the optimal compensating fund for each industrial sector in Gaza Strip using the Analytic Hierarchy Process and Goal Programming.

The questionnaire includes three types of pair wise comparison:

First: Main criteria pair wise comparison and their importance in prioritizing industrial sectors.

Second: Sub criteria pair wise comparison

Third: Alternatives (industrial sectors) pair wise comparison with respect to sub criteria.

The research will help toward improved evaluation process to arrive to successful final compensation process.

All data collected from you will be used only for scientific purpose which the researcher needs for his MBA degree thesis. All thanks and appreciation for contribution in enhancement of scientific research process.

Researcher

Ahmed S. Al Afeefy

Supervisor

Prof. Dr. Yousif H. Ashour

The numbers from (1 – 9) are used for showing the preference or the importance in the comparison as shown in the following table:

Number	Description
1	The criterion (x) is of the same importance of criterion (y)
3	The important of criterion (x) is 3 times the important of criterion (y)
5	The important of criterion (x) is 5 times the important of criterion (y)
7	The important of criterion (x) is 7 times the important of criterion (y)
9	The important of criterion (x) is 9 times the important of criterion (y)
2, 4, 6, 8	The important of criterion (x) is 2, 4, 6, 8 times the important of criterion (y)

Illustrative example:

Economic sub criteria	Employment creation	Contribution to GDP	Effects on other industrial sectors
Employment creation		3	1
Contribution to GDP			1/5
Effects on other industrial sectors			

3: means that the importance of "employment creation" is 3 times the importance of "contribution to GDP"

1: means that the importance of "employment creation" is the same as the importance of "contribution to GDP

1/5: means that the importance of "Effects on other industrial sectors" is 5 times the importance of "contribution to GDP"

b. Main criteria pair wise comparison:

Criteria	Economic	Financial	Technical	Marketing	Environmental	Socio/Cultural	Scale of damage
Economic							
Financial							
Technical							
Marketing							
Environmental							
Socio/Cultural							
Scale of damage							

c. Sub criteria pair wise comparison:

1. Economic sub criteria pair wise comparison:

Economic sub criteria	Employment creation	Contribution to GDP	Effects on other industrial sectors
Employment creation			
Contribution to GDP			
Effects on other industrial sectors			

2. Financial sub criteria pair wise comparison:

Financial sub criteria	Total needed fund	Return on investment	Net present value	Payback period
Total needed fund				
Return on investment				
Net present value				
Payback period				

3. Technical sub criteria pair wise comparison:

Technical sub criteria	Availability of machines and technology	Availability and the ease of the access of raw materials	The nature of infrastructure needed	Resources for development	Product quality
Availability of machines and technology					
Availability and the ease of the access of raw materials					
The nature of infrastructure needed					
Resources for development					
Product quality					

4. Environmental sub criteria pair wise comparison:

Environmental sub criteria	Environmental impact	Rules and regulations regarding environmental
Environmental impact		
Rules and regulations regarding environmental		

5. Social/Political sub criteria pair wise comparison:

Social/Political sub criteria	Governmental support/opposition	Public support/opposition	Donors support/opposition
Governmental support/opposition			
Public support/opposition			
Donors support/opposition			

6. Scale of damage sub criteria pair wise comparison

Scale of damage sub criteria	Total amount of damage in terms of dollars	Number of damaged factories
Total amount of damage in terms of dollars		
Number of damaged factories		

d. Alternative (industrial sectors) pair wise comparison with respect to sub criteria

1. Industrial sectors' pair wise comparison according to "contribution to GDP"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Leather											
Traditional											
Pharmaceutical											
Textiles											

2. Industrial sectors' pair wise comparison according to "effect on other industrial sectors"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

3. Industrial sectors' pair wise comparison according to "total needed fund"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

4. Industrial sectors' pair wise comparison according to "return on investment"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

5. Industrial sectors' pair wise comparison according to "net present value"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

6. Industrial sectors' pair wise comparison according to "payback period"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

7. Industrial sectors' pair wise comparison according to "availability of machines and technology"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

8. Industrial sectors' pair wise comparison according to "Availability and the ease of the access of raw materials"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Textiles											

9. Industrial sectors' pair wise comparison according to "The nature of infrastructure needed"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

10. Industrial sectors' pair wise comparison according to "Resources for development"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Leather											
Traditional											
Pharmaceutical											
Textiles											

11. Industrial sectors' pair wise comparison according to "Product quality"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

12. Industrial sectors' pair wise comparison according to "Quality and reputation of products existed now in the market"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

13. Industrial sectors' pair wise comparison according to "Market share at Foreign markets"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

14. Industrial sectors' pair wise comparison according to "Market share at local market"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

15. Industrial sectors' pair wise comparison according to "Market growth"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

16. Industrial sectors' pair wise comparison according to "Ease of export and closures overcome"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

17. Industrial sectors' pair wise comparison according to "Environmental impacts"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Textiles											

18. Industrial sectors' pair wise comparison according to "Rules and regulations regarding environment"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

19. Industrial sectors' pair wise comparison according to "Governmental Support/Opposition"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
Leather											
Traditional											
Pharmaceutical											
Textiles											

20. Industrial sectors' pair wise comparison according to "Public Support/Opposition"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											
Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

21. Industrial sectors' pair wise comparison according to "Donors support/Opposition"

	construction	Metal	Chemical	Wood	Plastic	Food	Paper	Leather	Traditional	Pharmaceutical	Textiles
construction											
Metal											
Chemical											

Wood											
Plastic											
Food											
Paper											
Leather											
Traditional											
Pharmaceutical											
Textiles											

Appendix C: Entire AHP computations and industrial sectors ranking

Entire EC results of all pair wise comparisons of main criteria and sub criteria and alternatives local weights

					Alternatives local weights [3]										
Main Criteria	**Weight of main criteria [1]**	**Sub criteria**	**Local Weight of SC [2]**	**Global weight of SC [1]*[2]**	**handicraft**	**Paper**	**Plastic**	**Chemical**	**Textiles**	**Wood**	**Construction**	**Food**	**Metal**	**Leather**	**Pharmaceutical**
Economic	0.247	Employment creation	0.645	0.159315	0	0.015	0.054	0.028	0.052	0.161	0.228	0.201	0.254	0.002	0.005
		Contribution to GDP	0.262	0.064714	0.024	0.023	0.092	0.04	0.061	0.125	0.226	0.233	0.124	0.027	0.025
		Effects on other industrial sectors	0.094	0.023218	0.027	0.047	0.066	0.134	0.059	0.069	0.252	0.084	0.142	0.047	0.073
		Sum	1	**0.247**											
Financial	0.249	Total needed fund	0.507	0.126243	0.031	0.039	0.061	0.055	0.114	0.122	0.181	0.137	0.157	0.049	0.053
		Return on investment	0.236	0.058764	0.022	0.04	0.073	0.075	0.042	0.094	0.24	0.179	0.158	0.038	0.037
		Net present value	0.128	0.031872	0.023	0.033	0.052	0.075	0.078	0.099	0.23	0.141	0.154	0.047	0.069
		Payback period	0.13	0.03237	0.022	0.032	0.074	0.056	0.107	0.14	0.202	0.156	0.13	0.041	0.04
		Sum	1	**0.249**											
Technical	0.142	Availability of machines and technology	0.21	0.02982	0.213	0.033	0.076	0.054	0.062	0.14	0.163	0.132	0.059	0.036	0.033
		Availability and the ease of access of raw materials	0.374	0.053108	0.23	0.053	0.079	0.037	0.127	0.113	0.057	0.19	0.043	0.042	0.027
		The nature of infrastructure needed	0.145	0.02059	0.023	0.031	0.094	0.103	0.087	0.106	0.207	0.08	0.173	0.037	0.058
		Resources for Development	0.118	0.016756	0.096	0.034	0.104	0.056	0.087	0.163	0.117	0.206	0.074	0.033	0.031
		Product quality	0.152	0.021584	0.04	0.038	0.083	0.063	0.108	0.182	0.18	0.146	0.084	0.035	0.041

Entire EC results of all pair wise comparisons of main criteria and sub criteria and alternatives local weights

					Alternatives local weights [3]										
Main Criteria	**Weight of main criteria [1]**	**Sub criteria**	**Local Weight of SC [2]**	**Global weight of SC [1]*[2]**	**handicraft**	**Paper**	**Plastic**	**Chemical**	**Textiles**	**Wood**	**Construction**	**Food**	**Metal**	**Leather**	**Pharmaceutical**
		Sum	1	**0.142**											
Marketing	0.157	Quality and reputation of products existed now in the market	0.402	0.063114	0.051	0.033	0.094	0.054	0.104	0.196	0.157	0.147	0.095	0.036	0.033
		Market Share at Foreign Markets	0.055	0.008635	0.068	0.035	0.113	0.063	0.137	0.175	0.084	0.169	0.066	0.033	0.056
		Market Share at Local Market	0.264	0.041448	0.03	0.025	0.069	0.044	0.126	0.146	0.217	0.19	0.102	0.028	0.023
		Market Growth	0.172	0.027004	0.027	0.029	0.121	0.06	0.121	0.173	0.137	0.172	0.093	0.032	0.037
		Borders and siege overcome	0.107	0.016799	0.073	0.054	0.11	0.069	0.175	0.132	0.016	0.221	0.02	0.057	0.074
		Sum	1	**0.157**											
Environmental	0.045	Environmental Impacts	0.793	0.035685	0.218	0.12	0.033	0.025	0.115	0.129	0.042	0.109	0.058	0.072	0.081
		Rules and regulations regarding environment	0.207	0.009315	0.197	0.142	0.038	0.021	0.115	0.129	0.034	0.131	0.051	0.062	0.08
		Sum	1	**0.045**											
Social/Political	0.092	Governmental Support/Opposition	0.526	0.048392	0.035	0.031	0.074	0.071	0.109	0.096	0.192	0.239	0.083	0.029	0.043
		Public Support/Opposition	0.209	0.019228	0.034	0.032	0.067	0.055	0.129	0.113	0.159	0.226	0.052	0.065	0.067
		Donors Support/ Opposition	0.264	0.024288	0.126	0.039	0.054	0.023	0.129	0.168	0.063	0.229	0.042	0.043	0.085
		Sum	1	**0.092**											

Entire EC results of all pair wise comparisons of main criteria and sub criteria and alternatives local weights

					Alternatives local weights [3]										
Main Criteria	**Weight of main criteria [1]**	**Sub criteria**	**Local Weight of SC [2]**	**Global weight of SC [1]*[2]**	**handicraft**	**Paper**	**Plastic**	**Chemical**	**Textiles**	**Wood**	**Construction**	**Food**	**Metal**	**Leather**	**Pharmaceutical**
Scale of damage	0.067	Total amount of damage in terms of dollars	0.786	0.052662	0	0.004	0.041	0.02	0.017	0.041	0.376	0.305	0.191	0	0.003
		Number of damaged facilities	0.214	0.014338	0.012	0.006	0.056	0.052	0.034	0.238	0.213	0.034	0.349	0.003	0.003
		Sum	1	**0.067**											

Entire EC results of all pair wise comparisons of main criteria and sub criteria and alternatives global weights and ranking

		Alternatives global weights [1] * [2] * [3]										
Main Criteria	**Sub criteria**	**handicraft**	**Paper**	**Plastic**	**Chemical**	**Textiles**	**Wood**	**Construction**	**Food**	**Metal**	**Leather**	**Pharmaceutical**
Economic	Employment creation	0	0.0023897	0.008603	0.0044608	0.0082844	0.0256497	0.0363238	0.0320223	0.040466	0.0003186	0.0007966
	Contribution to GDP	0.0015531	0.0014884	0.0059537	0.0025886	0.0039476	0.0080893	0.0146254	0.0150784	0.0080245	0.0017473	0.0016179
	Effects on other industrial sectors	0.0006269	0.0010912	0.0015324	0.0031112	0.0013699	0.001602	0.0058509	0.0019503	0.003297	0.0010912	0.0016949
Financial	Total needed fund	0.0039135	0.0049235	0.0077008	0.0069434	0.0143917	0.0154016	0.02285	0.0172953	0.0198202	0.0061859	0.0066909
	Return on investment	0.0012928	0.0023506	0.0042898	0.0044073	0.0024681	0.0055238	0.0141034	0.0105188	0.0092847	0.002233	0.0021743
	Net present value	0.0007331	0.0010518	0.0016573	0.0023904	0.002486	0.0031553	0.0073306	0.004494	0.0049083	0.001498	0.0021992
	Payback period	0.0007121	0.0010358	0.0023954	0.0018127	0.0034636	0.0045318	0.0065387	0.0050497	0.0042081	0.0013272	0.0012948
Technical	Availability of machines and technology	0.0063517	0.0009841	0.0022663	0.0016103	0.0018488	0.0041748	0.0048607	0.0039362	0.0017594	0.0010735	0.0009841
	Availability and the ease of access of raw materials	0.0122148	0.0028147	0.0041955	0.001965	0.0067447	0.0060012	0.0030272	0.0100905	0.0022836	0.0022305	0.0014339
	The nature of infrastructure needed	0.0004736	0.0006383	0.0019355	0.0021208	0.0017913	0.0021825	0.0042621	0.0016472	0.0035621	0.0007618	0.0011942
	Resources for Development	0.0016086	0.0005697	0.0017426	0.0009383	0.0014578	0.0027312	0.0019605	0.0034517	0.0012399	0.0005529	0.0005194
	Product quality	0.0008634	0.0008202	0.0017915	0.0013598	0.0023311	0.0039283	0.0038851	0.0031513	0.0018131	0.0007554	0.0008849
Marketing	Quality and reputation of products existed now in the market	0.0032188	0.0020828	0.0059327	0.0034082	0.0065639	0.0123703	0.0099089	0.0092778	0.0059958	0.0022721	0.0020828
	Market Share at Foreign Markets	0.0005872	0.0003022	0.0009758	0.000544	0.001183	0.0015111	0.0007253	0.0014593	0.0005699	0.000285	0.0004836
	Market Share at Local Market	0.0012434	0.0010362	0.0028599	0.0018237	0.0052224	0.0060514	0.0089942	0.0078751	0.0042277	0.0011605	0.0009533

Entire EC results of all pair wise comparisons of main criteria and sub criteria and alternatives global weights and ranking

		Alternatives global weights [1] * [2] * [3]										
Main Criteria	**Sub criteria**	**handicraft**	**Paper**	**Plastic**	**Chemical**	**Textiles**	**Wood**	**Construction**	**Food**	**Metal**	**Leather**	**Pharmaceutical**
	Market Growth	0.0007291	0.0007831	0.0032675	0.0016202	0.0032675	0.0046717	0.0036995	0.0046447	0.0025114	0.0008641	0.0009991
	Borders and siege overcome	0.0012263	0.0009071	0.0018479	0.0011591	0.0029398	0.0022175	0.0002688	0.0037126	0.000336	0.0009575	0.0012431
Environmental	Environmental Impacts	0.0077793	0.0042822	0.0011776	0.0008921	0.0041038	0.0046034	0.0014988	0.0038897	0.0020697	0.0025693	0.0028905
	Rules and regulations regarding environment	0.0018351	0.0013227	0.000354	0.0001956	0.0010712	0.0012016	0.0003167	0.0012203	0.0004751	0.0005775	0.0007452
Social/Political	Governmental Support/Opposition	0.0016937	0.0015002	0.003581	0.0034358	0.0052747	0.0046456	0.0092913	0.0115657	0.0040165	0.0014034	0.0020809
	Public Support/Opposition	0.0006538	0.0006153	0.0012883	0.0010575	0.0024804	0.0021728	0.0030573	0.0043455	0.0009999	0.0012498	0.0012883
	Donors Support/ Opposition	0.0030603	0.0009472	0.0013116	0.0005586	0.0031332	0.0040804	0.0015301	0.005562	0.0010201	0.0010444	0.0020645
Scale of damage	Total amount of damage in terms of dollars	0	0.0002106	0.0021591	0.0010532	0.0008953	0.0021591	0.0198009	0.0160619	0.0100584	0	0.000158
	Number of damaged facilities	0.0001721	0.0000860	0.0008029	0.0007456	0.0004875	0.0034124	0.003054	0.0004875	0.005004	0.000043	0.00004.3
Sum		**0.055**	**0.036**	**0.071**	**0.051**	**0.092**	**0.134**	**0.181**	**0.174**	**0.133**	**0.034**	**0.039**
Rank		**7th**	**10th**	**6th**	**8th**	**5th**	**3rd**	**1st**	**2nd**	**4th**	**11th**	**9th**

Appendix D: Goal Programming Model

Min
0.181d1n+0.174d2n+0.134d3n+0.133d4n+0.092d5n+0.071d6n+0.055d7n+0.051d8n+0.039d9n+0.036d10n+0.034d11n

subject to

X11+x12+x13+x14+x15+x16+x17+x18+x19+x110+d1n-d1p=32.59

X21+x22+x23+x24+x25+x26+x27+x28+x29+x210+d2n-d2p=26.41

X31+x32+x33+x34+x35+x36+x37+x38+x39+x310+d3n-d3p=3.58

X41+x42+x43+x44+x45+x46+x47+x48+x49+x410+d4n-d4p=16.5

X51+x52+x53+x54+x55+x56+x57+x58+x59+x510+d5n-d5p=1.49

X61+x62+x63+x64+x65+x66+x67+x68+x69+x610+d6n-d6p=3.55

X71+x72+x73+x74+x75+x76+x77+x78+x79+x710+d7n-d7p=0.376

X81+x82+x83+x84+x85+x86+x87+x88+x89+x810+d8n-d8p=1.75

X91+x92+x93+x94+x95+x96+x97+x98+x99+x910+d9n-d9p=0.266

X101+x102+x103+x104+x105+x106+x107+x108+x109+x1010+d10n-d10p=0.376

X111+x112+x113+x114+x115+x116+x117+x118+x119+x1110+d11n-d11p=0.171

X11+x21+x31+x41+x51+x61+x71+x81+x91+x101+x111=5.9

X12+x22+x32+x42+x52+x62+x72+x82+x92+x102+x112=4.677

X13+x23+x33+x43+x53+x63+x73+x83+x93+x103+x113=1.619

X14+x24+x34+x44+x54+x64+x74+x84+x94+x104+x114=0.95

X15+x25+x35+x45+x55+x65+x75+x85+x95+x105+x115=5.14

X16+x26+x36+x46+x56+x66+x76+x86+x96+x106+x116=13.75

X17+x27+x37+x47+x57+x67+x77+x87+x97+x107+x117=13.75

X18+x28+x38+x48+x58+x68+x78+x88+x98+x108+x118=13.75

X19+x29+x39+x49+x59+x69+x79+x89+x99+x109+x119=13.75

X110+x210+x310+x410+x510+x610+x710+x810+x910+x1010+x1110=13.75

Appendix E: Experts Names and Their Positions

1. Dr. Mohammed Abu Haiba. Head of Industrial and Mechanical Engineering Departments, Islamic University of Gaza
2. Ghayda' Al Ameer. Previous Manager in Paltrade; now a manager in GIZ (German Society for International Cooperation)
3. Haytham Abu Sha'ban. Business Development Advisor (Al Watanya Telecommunications- Gaza Strip Manager)
4. Eng. Abdallah Al Barassi. Development Alternatives Inc. (DAI), Account Manager, Facility for New Market Development (FNMD) Project
5. Eng. Basel Qandeel. Palestinian Federation of Industries (PFI) Industrial Medernization Center (IMC) Manager, Now Projects Coordinator at Islamic University of Gaza
6. Eng. Ahmed Al Nabrees. Palestinian Federation of Industries (PFI) Industrial Medernization Center (IMC) Manager
7. Horse Power Engineering Company for Industrial and Management Consultancy
8. Badr Abu Sha'ban. Business Development Advisor (Tatweer company for Business Services)