نموذج رقم (1)

إقــــرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Designing a Mathematical Model for Optimal Assets and
Liabilities Management Using Goal programming Model
(Case study: the bank of palestine 2013 - 2014)

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DECLARATION

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification

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The Islamic University
Deanship of Higher Education
Faculty of Commerce
Department of Business Administration

**Designing a Mathematical Model for Optimal Assets and Liabilities
Management Using Goal Programming Model
(Case study: the bank of Palestine 2013 -2014)**

تصميم نموذج رياضي من أجل إدارة مثلى للأصول (الموجودات) و الخصوم (المطلوبات)
باستخدام البرمجة بالأهداف دراسة حالة على بنك فلسطين لعامي 2013 و 2014 .

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحثة/ افنان غسان محمد حسن لنيل درجة الماجستير في كلية *التجارة/* قسم إدارة الأعمال وموضوعها:

تصميم نموذج رياضي من أجل إدارة مثلى للأصول (الموجودات) و الخصوم (المطلوبيات) باستخدام البرمجة بالأهداف دراسة حالة على بنك فلسطين لعامي 2013 و 2014

Designing a Mathematical Model for Optimal Assets and Liabilities Management Using Goal Programming Model
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وبعد المناقشة العلنية التي تمت اليوم السبت 23 شوال 1436هـ، الموافق 2015/08/08م الساعة الواحدة ظهراً، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

أ.د. يوسـف حسـين عاشـور   مشرفاً و رئيساً   ....

أ.د. فارس محمـود أبو معمـر   مناقشـاً داخليـاً   ....

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وبعد المداولة أوصت اللجنة بمنح الباحثة درجة الماجستير في كلية *التجارة/*قسم إدارة الأعمال.

واللجنة إذ تمنحها هذه الدرجة فإنها توصيها بتقوى الله ولزوم طاعته وأن تسخر علمها في خدمة دينها ووطنها.

والله ولي التوفيق ،،،

مساعد نائب الرئيس للبحث العلمي والدراسات العليا

أ.د. فؤاد علي العاجز

Dedication

To the best parents in the world, "Thank you" is a small phrase that will never describe my love and appreciation for all what you have done.

To my beloved husband, I will never forget your care, love, encouragement, and support through the preparation of my thesis. I am blessed by Allah to have you in my life.

To my hope and smile in my life, my son: Anas, I will never be able to express my feelings for having you in my life.

To my brothers and sisters, who shared with me my mother's bosom and I am having a great life with them.

To my aunts and uncles who, I am having a good life with them.

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Abstract

This research with using data from the years 2013 and 2014 to design a mathematical model in order to manage the optimal assets and liabilities in the bank of Palestine . Therefore, management of this process is regarded as the most important topic at strategic planning of bank. Therefore, it is required to obtain quantitative techniques for optimum management of assets and liabilities. One of the quantitative models for management of asset and liability in bank is Goal Programming model. A general surveying of previous related literature and interviews with some heads of the commercial national banks (bank of Palestine, Quds bank, Palestinian commercial bank, and Palestinian investment bank) identify the evaluation goals of managers and priorities. The six main goals are market share of credit, market share of deposits, return on assets, return on equity, liquidity risk and capital adequacy ratio. Analytic Hierarchy Process (AHP) standard questionnaire has been used in order to prioritizing and determining the importance degree of goals and this questionnaire has been solved with using of Expert Choice software so the findings are placed in objective function of Goal Programming model and have been solved by lingo 13.0 software. Finding of this study showed that it was possible to design model of optimum management of assets and liabilities at this bank and it is possible to determine suitable structure for items of sheet balance.

Abstract in Arabic

ملخص الدراسة

هذه الدراسة إذ تستخدم البيانات المتوفرة لعامي 2013 و2014 من أجل تصميم نموذج رياضي لكي تدير بشكل امثل الأصول (الموجودات) والخصوم (الالتزامات) في بنك فلسطين المحدود. تعتبر إدارة الأصول والخصوم الموضوع الأكثر أهمية في التخطيط الاستراتيجي في البنك. لذا فهي بحاجة إلى تقنية كمية لإدارة مثلى للأصول والالتزامات واحدة من تلك النماذج الكمية هي البرمجة الهدفية . تم إجراء مسح شامل للدراسات السابقة المرتبطة بالدراسة، كما أجريت مقابلات مع بعض مدراء البنوك التجارية الوطنية العاملة في قطاع غزة (بنك فلسطين المحدود وبنك القدس والبنك التجاري الفلسطيني وبنك الاستثمار الفلسطيني) من اجل تحديد أهداف المدراء وأولوياتهم. وتناولت الدراسة الأهداف الستة الرئيسة التالية الحصة السوقية من التسهيلات الائتمانية والحصة السوقية من الودائع و العائد على الأصول والعائد على الملكية وكفاية رأس المال ومخاطر السيولة. حيث تم استخدام طريقة التحليل الهرمي لتحديد درجة أهمية وأولوية كل هدف من الأهداف الستة من خلال إجراء مقارنات ثنائية وتم إدخال هذه المقارنات إلى برنامج"Expert Choice" وهو البرنامج المحوسب المبني على أساس نظرية التحليل الهرمي، حيث استخدمت الأوزان الناتجة في دالة الهدف في نموذج البرمجة بالأهداف.

أشارت تلك الدراسة انه من الممكن تصميم نموذج لإدارة مثلى للأصول والالتزامات في بنك فلسطين، و من الممكن تحديد إجراء مناسب لبنود الميزانية .

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Abbreviation

AFS	Available For Sale
AHP	Analytic Hierarchy Process
ALCO	Asset Lability Committee
ALM	Asset Liability Management
BOP	Bank Of Palestine
CI	Consistency Index
CR	Consistency Ratio
FTP	Fund Transfer Pricing
GP	Goal Programming
HTM	Held To Maturity
LGP	Lexicographic Goal Programming
MCDM	Multi-Criteria Decision Making
P&L	Profit and Loss
PMA	Palestine Monetary Authority
RM	Risk Management
VaR	Value at Risk
WGP	Weighted Goal Programming

Glossary

- **Analytic hierarchy process:** A structured technique for organizing and analyzing complex decisions.

- **Asset- Liability Management**: A comprehensive and dynamic framework for measuring, monitoring and managing the market risk of a bank. It is the management of structure of balance sheet (liabilities and assets) in such a way that the net earnings from interest are maximized within the overall risk-preference (present and future) of the institutions.

- **Decision variable:** A variable that is both under the control of the decision marker and one that can have an impact on the problem solution. All decision variable will be assumed nonnegative unless otherwise.

- **Deviational variable:** An auxiliary variable in a goal constraint equation that measure the underachievement or overachievement of the specified aspiration level. A negative deviation variable($d^-_i \geq 0$) reflects the amount by which aspiration level I is underachieved, which a positive deviational variable ($d^+_i \geq 0$) indicates that amount by which aspiration level I is exceeded, where $d^-_i \times d^+_i = 0$.

- **Goal constraint:** A set of constraints that corresponds to the goals expressed by the decision maker.

- **Goal programming (GP):** A mathematical model manages a set of conflicting objectives by minimizing deviations between the target values and the realized.

- **Linear programing**: A specific case of mathematical optimization. It is a mathematical method for determining a way to achieve the best outcome in a given mathematical model for some list of requirements represented as linear relationships.

- **Multi Criteria Decision Making**: A sub-discipline of operations research that explicitly considers multiple criteria in decision-making environments.

- **Operation Research**: An analytical method of problem-solving and decision-making. It can also be defined as the Application of mathematical technique of decision making.

- **Optimal solution**: The specific decision-variable value or values that provide the "best" output for the model.

Chapter 1: General Introduction

1.1   **Introduction**

1.2   **Research Problem**

1.3   **Research objectives**

1.4   **Population of the research**

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1.1 Introduction

Financial institutions face several risks such as the liquidity risk, interest rate risk, credit risk and operational risk. Financial institution manages the risks of asset liability mismatch by matching the assets and liabilities according to the maturity pattern or the matching the duration, by hedging and securitization (Jain, et al., 2011).

The determination of the size and composition of the sources from which bank funds are to be collected and how they should be distributed to the various uses is termed Bank – Balance sheet or Bank Asset and Liability Management (Persentili and Guven,1997).

Asset and Liability Management (ALM) is a strategic management instrument to manage interest rate risk and liquidity risk faced by financial institution, other financial services companies and corporations. ALM is the practice of managing risks that arise due to uncertainty happened between the assets and liabilities of financial institution (Jain, et al., 2011).

ALM is relevant to and critical for the sound management of the finances of any organization that invests to meet its future cash flow needs and capital requirements. An efficient ALM requires maximizing firms profit as well as controlling and lowering various risks .This multi-objective decision problem aims at reaching goals such as maximization of liquidity, revenue, capital adequacy, and market subject to strategic financial management, legal requirements and institutional policies in order to progress the profitability of banks (Samuel, 2011).

The techniques of ALM occurred for strategic programming, revenues, income and modeling prediction based on balance sheet which is the display of bank's sources and uses. According to the definition the techniques of asset and liability management are targeted the volume, composition, date, sensitivity's rate, quality and liquidity of assets and liabilities for achieving the proportion of risk to predetermined return (Naderi et .al, 2013).

The purpose of ALM is supporting the quality and quantity of assets with considering the risky of assets and liabilities for future management. In fact, ALM designs an appropriate strategy's management of investment in various assets with considering the liabilities of financial institution and output flows related to it with using the available financial resources in institution. (Naderi et.al, 2013)

In this research, Analytical Hierarchy Process (AHP) is used in order to prioritize and determine the importance degree of goals to place in objective function of Goal programming (GP).

The used quantitative model is Goal programming (GP) which is defined as ultimate goal of minimizing the deviations and determined necessities. Different necessities with goals are as form of constraints, the main variables of model, assets and liabilities items of balance sheet also deviations all are defined as goals (Naderi, et al., 2013).

Therefore, this research depends on Naderi et .al , (2013) research which was titled "Asset and Liability Optimal Management Mathematical Modeling for Bank "designed a mathematical model in order to select the optimum

management of assets and liabilities of one of the banks in Mellat. Their results showed that it was possible to design model of optimum management of assets and liabilities of the selected bank so as to determine suitable structure for items of its balance sheet and extend the outcomes to the management of balance sheet items of other banks.

However, in this research mathematical model designed in order to select the optimum management of assets and liabilities of the bank of Palestine in Gaza strip.

1.2   Research Problem

ALM has especial place for all institutions, especially, financial institutions and among them, especially banks. However, bank management typically involves several conflicting goals, such as the maximization of returns, minimization of risk, expansion of deposit and loans, etc. Because of the rapidly increasing complexity of problems facing the management of commercial banks in today's competitive environment managers constantly seek to know what technique can maximize the return and control the risk also totally can maximize the shareholder wealth. In this regard, more attention should be given to using management science techniques to structure and simplify the problems, try to propose the techniques and models until identify the best solutions and possible answers and help the manager in the decision process.

Several attempts have been made and continue to be in the area of exploring up-to –date risk measurement, management and control in financial

institutions and how the credit process integrates with the overall strategy of the firm in order to increase its profitability. The complexity of this problem can be captured more adequately by multiobjective mathematical programming.

Therefore, this research sought to design a mathematical model in order to manage the optimal assets and liabilities in bank of Palestine, using goal programming model.

1.3 Research objectives

The main objective of the research is to design a mathematical model in order to manage assets and liabilities in bank of Palestine using (GP) and identifying the main goals of the commercial national banks in Gaza strip, prioritizing and determining the importance degree of goals using (AHP).

Other objectives of the research can be summarized as follows:

- To propose a multi-objective decision model to reach an optimal ALM strategy.
- To propose a scientific results that can be a basis to determine suitable structure for items of balance sheet.
- To use the science of Multi Criteria Decision Making (MCDM) techniques which are (AHP) and (GP) .

1.4 Population of the research

This research targets commercial national banks in Gaza Strip (bank of Palestine, Quds bank, Palestinian commercial bank, and Palestinian investment bank) in the process of data collection and filling AHP standard questionnaire. However, it will focus on the bank of Palestine in Gaza strip through the process of applying GP model.

1.5 Limitation of the research

This research targets commercial national banks and excludes Islamic Palestinian banks in Gaza Strip because the differences in the balance sheet between them. Also the researcher chooses the bank of Palestine in Gaza strip among the other commercial banks through the process of applying GP model because the bank of Palestine (BOP) helped the researcher to take the data who needed such as the percentage of each goals the bank planned to reach and the main goals of the bank but the other commercial banks refuse to give the researcher these data because they are branches in Gaza Strip and the general (public) administration in the West Bank so they have not these data .

1.6 Research importance

The importance of this research lies in selecting a vital subject that is very important to the banks in Gaza Strip

The importance of the research can be summarized as follows:

- The real need for a quantitative model for the optimal management of asset and liabilities in banks

- The necessity for comprehensive strategic management and investment in view of liabilities.

- This research is considered as one of the new studies in Palestine that use the science of operations in this field .

- Supporting the quality and quantity of assets with considering the risky of assets and liabilities for future management.

- Effective technique for planning future investments.

- The model gives the bank management a way of testing and quantifying the effects of policy decision.

1.7 Research methodology

The research methodology explains the road map needed to reach the research goal. Starting of the goal definition, then data collection and finishing with the application. Figure 1.1 explains the research methodology.

Goal Definition (managing optimal asset and liability management of the Bank Of Palestine)

Data collection

interview with some heads of banks (Determining the most important goals)

Bank's manager AHP standard questionnaire (prioritizing goals and criteria pairwise comparison)

Assistant head of Financial Planning division of Bank Of Palestine (ratio of planning Goals)

AHP Model Application (degree of priority and adaptation rate for different goals)

Goal Programming Model Application (asset and liability management)

Results and Analysis

Conclusions and Recommendations

Figure 1.1 Research Methodology

Research methodology

1. Goal Definition

The goal of this research is to design a mathematical model to manage optimal ALM for the BOP using GP. AHP will be used to obtain the degree of priority of each criterion , and GP will be used to determine suitable structure for items of balance sheet .

Data Collection

The data needed for the research are: the planned goals, ratio of planned assets , and the amount of liabilities . The required data can be collected from: (I) Bank of Palestine. (II) Some commercial banks (III) Interviews with experts and head of banks (V) annual report of BOP.

2. AHP application

One of AHP strengths is the possibility to evaluate quantitative as well as qualitative criteria. These pair wise comparisons are substituted in the Expert Choice 11 (the software of AHP), the software output makes the final weight of each criterion gaining the result of AHP model rank. Now the priorities and weights for each goals resulted from the AHP model can be inserted in the GP model to satisfy the priority of goals and manage the asset items according to each priority.

3. 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 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 research there are different constraints that divided into two groups structural and goal constraints , these constraints with the objective function will be arranged as a GP model and solved using one of the software of the GP to get the final suitable structure for items of balance sheet and extend it to management of asset items in the bank .

1.8 Previous studies

Foreign studies

There are a lot of related studies .These studies are as discussed below and ranked according to the degree of nearness, relationship to this research.

The study of Hibiki and Fukukawa, (1992) titled **"Goal Programming Model Approach for Risk Manaement on Banking based on asset liability management (ALM)"**

The recent financial deregulation and internationalization have caused a great. deal of financial risk to banking in Japan. Therefore financial risk management becomes very important, and banks need to manage not only profit, but also risk. Several models relating to the bank management have been studied as mathematical programming problems in finance literatures. Risk measures are variously defined, however there are no models based on the idea of risk management (ALM). Therefore they propose the risk measures based on ALM, and the mathematical programming model approach with them. Then goal programming, which is one of the mathematical programming, is applied to the model, in order to manage profit and risk by setting their aspiration levels and required levels, and to represent the trade-off relation between profit. and risk. In this model, the management. is assumed to have three kinds of conflicting goals, which are the goals of (i) interest rate risk exposure, (ii) profit, and (iii) maturity gap for active risk management (which means taking actively the risk based on expecting the trend of the interest rate). In addition to these specific goals, regulations, policy on

banking and market conditions have to be considered. The four kinds of constraints are formulated, which are the constraints of (i) the upper limit of liquidity risk exposure, (ii) the lower limit of risk asset ratio, (iii) the lower limit of the ratio of cash to deposit. And (iv) the upper and/or the lower bounds of feasible funding, investment, and so on. Finally, several numerical examples are analyzed in order to investigate the performance of the approach. Due to space restriction, they describe two examples, which are (i) solved in various kinds of goal levels, and (ii) solved in different expectation to the trend of interest rate, in this paper. The results presented are so remarkably good that the model provides a very real advance over previously reported models.

The study of Giokas and Vassiloglou ,(2003) titled **"A goal programming model for bank assets and liabilities management"**

Assets and liabilities management is one of the most important issues in bank strategic planning. In the past, this problem has often been addressed through conventional mathematical programming, i.e. linear programming. However, bank management typically involves several conflicting goals, such as the maximization of returns, minimization of risk, expansion of deposits and loans, etc. The complexity of this problem can be captured more adequately by multiobjective mathematical programming. This paper discusses the construction and application at the Commercial Bank of Greece of a goal programming model that takes into account the essential institutional, financial, legal and bank policy considerations.

The study of Kosmidou and Zopounidis ,(2004) titled **" A multicriteria methodology for bank asset liability management "**

The aim of this paper is to present an Asset Liability Management (ALM) technique, which combines a goal programming model with a simulation analysis to determine the balance sheet of a bank for the year 2000. To attain this goal, they analyzed the 1999 balance sheet of a Greek commercial bank facing conflicting goals such as returns, liquidity, solvency, and expansion of deposits and loans under uncertainty. An optimizer was embedded in a simulation model to obtain different optimal solutions for a set of interest rate scenarios, while a sensitivity analysis explored the effects of alterations in the order of goal priorities.

The study of Tektas et.al , (2005) titled **"Asset and liability management in financial crisis"**

An efficient asset-liability management requires maximizing banks' profit as well as controlling and lowering various risks. This multi-objective decision problem aims to reach goals such as maximization of liquidity, revenue, capital adequacy, and market share subject to financial, legal requirements and institutional policies. This paper models asset and liability management (ALM) in order to show how different managerial strategies affect the financial wellbeing of banks during crisis. A goal programming model is developed and applied to two medium-scale Turkish commercial banks with distinct risk-taking behavior. This article brings new evidence on the performance of emerging market banks with different managerial philosophies by comparing asset-liability management in crisis. The study has shown how

shifts in market perceptions can create trouble during crisis, even if objective conditions have not changed. The proposed model can provide optimal forecasts of asset-liability components and banks' financial standing for different risk-taking strategies under various economic scenarios. This may facilitate the preparation of contingency plans and create a competitive advantage for bank decision makers.

The study of Samuel ,(2011) titled **The Effects Of Asset Liability Management On Profitability Of National Investment Bank In The New Juabeng Municipality"**

ALM is relevant to and critical for the sound management of the finances of any organization that invest to meet its future cash flow needs and capital requirements. An efficient asset liability management requires maximizing firms profit as well as controlling and lowering various risks. This multi-objective decision problem aims at reaching goals such as maximization of liquidity, revenue, capital adequacy, and market subject to strategic financial management, legal requirements and institutional policies in order to progress the profitability of banks. This study used a goal programming model to examine the assets and liability management in relation to profitability by financial institution taking into account the specific characteristics of Ghanaian Financial Environment. The ultimate aim is to identify the best possible strategy to manage the composition of financial institution's assets and liability by controlling the various types of business strategies to maximize profitability. The model contribute to the model contributes to the specific goals and constrains. It also tests the sensitivity of financial institution

performance for different risk taking strategies in environment. To be able to achieve the objectives of this research, a study target of all the 27 NIB branches in the country were considered by randomly interviewing functional managers from 7 branches in the country from Eastern Region and Greater Accra and five years financial reports from the headquarters were fully analyzed to draw conclusion about the subject. It is recommended that in view of the importance of asset-liability management, banks should adopt formalized ALM techniques that should be subjected to periodic update and with the view to meeting the goals and objectives of portfolio management. OECD (2005), "Advances in Risk Management of Government Debt", Financial Market Trends, No.88.D. e.tal.Mason R. 11.

The study of Sedzro et . al ,(2012) titled **"Analytical Hierarchy Process and Goal Programming Approach for Asset Allocation"**

Asset allocation in portfolio construction must simultaneously consider market conditions and investors' specific preferences. Therefore, it is a multi-criteria decision that goes beyond the scope of the two-criteria, mean and variance of the portfolio returns, optimization method that traditionally prevails in the financial literature. This article suggests a procedure that makes integrated asset management possible, based on the Analytic Hierarchy Process combined with a mean variance and goal programming model. They illustrate this procedure with data from Canadian mutual funds over a total period of five years and three months, from September 2002 to November 2007. The results obtained are encouraging, as the portfolios constructed in this manner

perform better than the S&P/TSX 60 index, which is the reference portfolio for the Canadian market.

The study of Arewa et.al ,(2013) titled **" Financial Statement Management, Liability Reduction and Asset Accumulation: An Application of Goal Programming Model to a Nigerian Bank"**

This paper examines the management of the financial statement of UBA using goal programming (GP) technique. The data are collected from the annual financial statement of the bank to cover a period of 2007 to 2011. Six goals are identified in the bank: goal (1) (asset accumulation); goal 2 (liability reduction); goal 3 (shareholders' wealth); goal 4 (earning); goal 5 (profitability); and goal 6 (optimum management of the items in the financial statement). Applying POM-QM Version 3 software, the solution generated reveals that besides goal 2, all other goals are attainable by the bank. It is not therefore possible for the bank to reduce its liabilities, for the sake of reducing or increasing the other items of its financial statement. Based on this, it is concluded that the bank should convert its liabilities to earning assets quickly or as much as possible.

The study of Naderi et. al ,(2013) titled **" Asset and Liability Optimal Management Mathematical Modeling for Bank"**

This research with using data from the years 2010 and 2011to design a mathematical model in order to manage the optimal assets and liabilities in Bank Mellat. Therefore, management of this process is regarded as the most important topic at strategic planning of bank. Therefore, it is required to obtain

quantitative techniques for optimum management of assets and liabilities. One of the quantitative models for management of asset and liability in bank is Goal Programming model. While modeling all legal and operational considerations, compulsory limitations and considerations related to goals of managers and priorities are observed. This model has structural and ideal limitation and decision making variable divides into two groups including: principal variable and diversion variable. Result of this study showed that it was possible to design model of optimum management of assets and liabilities at this bank and it is possible to determine suitable structure for items of balance sheet and extend it to management of asset items in all banks and also it is possible to extend it to all banks.

The study of Mehri and Jamshidinavid , (2015) titled **" Designing a Mathematical Model of Asset and Liability Management Using Goal Programming (Case study : Eghtesad-e- Novin Bank)"**

A weakness in the banking system is to equip the resources and optimized allocation of those resources. In that way, the balance sheet management is specifically important. But the management policies and legal whose limitation purpose is to create a balance among the conflicting objectives of profitability, liquidity and risk in banks would make the bank's balance sheet management a kind of complicated program. The best way to fix this problem is using the multi-objective decision-making models . The objective of the present study is to design a mathematical model of asset-liability management using goal programming in Eghtesad-e-Novin Bank.Using the Analytic Hierarchy Process technique, the financial statements information

relevant to the fiscal year 2005-2014 the goal programming model was designed according to the structural restrictions and the legal requirements for that aim,, goal restrictions and the objective function for the optimal allocation of resources to consumptions, and it was solved using LINGO software. The results suggest that the importance degree of objectives was determined by using the Analytic Hierarchy Process technique, the conflicting objective requirements and policies were combined and satisfied, and the optimal combination of balance sheet items was specified.

Arabic studies

The study of Chakroun and Abid (2014), titled **" A Multiobjective Model for Bank Asset Liability Management: The Case of a Tunisian Bank "**

This paper presents the application of a Goal Programming (GP) model to develop an Asset Liability Management (ALM) strategy from a balance sheet of a Tunisian commercial bank. The model determines the optimal structure of the balance sheet for the year 2007. To reach the objective, the paper analyzes the bank's balance sheet for 2006 facing several conflicting goals such as solvency, liquidity, maximizing of net interest margin and increasing deposits and loans under the structural, political, and regulatory constraints. The solution of this model involves minimization of the sum deviations from the target values of goals. The results differ significantly from the current values of the bank's balance sheet, which shows the relevance of the model and its use as a strategic planning and decision support tool. Then, a post-optimality analysis is performed to check the validity and stability of the optimal

solution. Finally, forecasts of asset and liability accounts are made to maintain a long-term ALM strategy for the bank.

Local studies

There are some local studies using combined AHP – GP .

The study of Al Afeefy (2011) titled **" Optimal Compensating Fund Allocation for Industrial Sectors in Gaza Strip Using AHP and Goal Programming"**

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

The study of Abu Libda , (2013) titled **" An Optimization-Based Decision Support System For Higher Education Student Preferences-Based Scheduling (DSSPS)"**

With the rapid evolution of the computer and the increasing human dependence on it, new and innovative decision support systems are being designed continually to support and optimize decision making activities. The objective of this study is to develop a decision support system based on zero-one goal programming and the analytic hierarchy process to aid the process of academic preferences-based scheduling in universities that adopt the credit hours system. Usually, a high education student cares about making a satisfactory progress toward graduation; however, students usually have their own financial, timing or other personal issues regarding their study load. The objective of this system is to provide the student with a schedule that

optimizes achievement of his/her semester registration preferences, considering each one importance. These preferences are represented by the commonly considered ones, such as the desired number of credit hours, the desired empty days between final exam, the desired and the undesired group of courses, the proffered and the non-proffered lecturers and the desired empty days or periods throughout the week. Trying to reach these preferences, the system will also avoid all kinds of timing conflicts or breaching any of the commonly known registration regulations. Thus, the outcome of this system is a rapid, optimum and ready schedule. The main component of this system is a computer software that serves as a linear programming models generator. This software – with the help of a backend database - generates different goal programming models for different cases, solve it and present the results in a readable way.

Comments on the previous studies:

There is large number of foreign studies regarding to the ALM 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 large motivation to use AHP and GP to design a mathematical model of ALM . The Arabic studies are little in ALM based on quantitative models and Some of local studies addressed using AHP and GP in industrial sector and technical sector for university and student . This study gets the benefit from the foreign studies and some of local studies by applying a scientific approach to design a mathematical model of ALM to get benefit to banking sector.

This study gets the benefit from the foreign studies such as Naderi et .al (2013) and Mehri and Jamshidinavid ,(2015) articles to design a mathematical model of ALM . They implement their studies in Iran but the researcher want to implement this mathematical model of ALM in Palestine to be a new study in this field in Gaza and the main differences between this study and foreign studies the main goals selected and some of items of balance sheet according to the banks here in Gaza. Also get a benefit from local studies but in other sector and with using the preemptive and weighted goal programming this is the main differences between the local studies and this study .

Chapter 2: Related Background

2.1 Foundation of asset and liability management (ALM)

The general term asset and liability management entered common usage from the mid- 1970 s on wards under a changing – interest – rate environment, it became imperative for banks to manage both assets and liabilities simultaneously, in order to minimize interest rate and liquidity risk and maximize interest income. ALM is a key component of any financial institution's overall operating strategy (Choudly, 2011).

ALM is defined in terms of four key concepts, which are described below (Choudly, 2011).

The first is **liquidity**, which in an ALM content does not refer to the ease with which an asset can be bought or sold in the secondary market, but the ease with which assets can be converted into cash. (The marketability definition of liquidity is also important in ALM. Less liquid financial instruments must offer a yield premium that can be compared with liquid instruments). Liquidity is very important to meet customer demand for instant access funds .

The second key concept is the money market **term structure** of interest rates. The shape of the yield curve at any one time, and expectation as to its shape in the short term and medium term, significantly impact the ALM strategy employed by a bank. Market risk in the form of **interest rate sensitivity**, in the form of the present value sensitivity of specific instruments to changes in the level of interest rates, and in the form of the sensitivity of floating rate assets and liabilities to changes in rate are all significant .

The third key factor is the **maturity profile** of the book.

The maturities of assets and liabilities can be matched or unmatched; although the latter common the former is not uncommon depending on the specific strategies that are being employed. Matched asset and liabilities lock in return in the form of the spread between the funding rate and the return on assets. The maturity profile, the absence to of locked-in spread and the yield curve combine to determine the total interest rate risk of the banking book.

The fourth key concept is **default risk**: the risk of exposure that borrowers will default on interest or principle payments that are due to banking institution.

2.2 ALM and the Banking Industry

2.2.1 Banking Book and Trading Book

The bank balance sheet is divided in two parts:

The Banking Book and the Trading Book (Adam , 2008)

The Trading Book is made up of all the operations accounted for in marked-to-market coming from "trading room" businesses: Fixed Income Department, Equity Derivatives Department, Credit derivatives, Commodity Trading. It includes derivatives sold to customers, hedging strategy developed in front of these derivatives, Bonds accounted as trading.

The Banking Book is the sum of all the operations recorded by the accountants on an "accrued" basis (including of course the retail banking

operations): loans to individual, to corporations, deposits, investment and debt accounted as available for sale (AFS) or Held to Maturity (HTM).

Traditionally, ALM has been concerned with the banking book. The conventional techniques of ALM were developed for application to a bank's banking book – that is, it's lending and deposit – taking transactions. The core banking activity will generate either an excess of funds (where the receipt of deposits outweighs the volume of lending the bank has under take) or a shortage of funds (when the reverse occurs). The mismatch is balanced via financial transactions both interest rate and liquidity risks, which are then monitored and manages by the ALM desk. Interest rate risk is the risk that the bank suffers losses due to adverse movements in market interest rate. Liquidity risk is the risk that the bank cannot generate sufficient funds when required; the most extreme version of this is when there is a run on the bank and the bank cannot raise the funds required when depositors with draw their cash.The asset side of the banking book- that is, the loan portfolio- also generate credit risk.(Choudly, 2011)

2.2.2 Bank organization

In banks, the organization makes a distinction between risk management (RM), treasury and financial direction. The ALM position in the bank organization at the beginning of the 90s is often inside the risk management, sometimes inside the treasury department and sometimes inside the budget department. Risk management looks after the risk and historically after the credit risk and the market risk included in trading books. The treasury's objective is often to monitor very short-term liquidity risk and to reduce bid/

ask on interbank loans and the cost of deposits. The treasury has a monopolistic access to financial markets with the objective of better volume/cost arbitrage. The treasury pilots the overall liquidity position financial direction looks after accounting and budgeting (Adam,2008).

The implementation of ALM in the banking book introduces a set of organizational questions(Adam , 2008):

- Taking of responsibility for AFS and HTM investments;
- Differentiation between financial risk taking and commercial risk talking: the objective is to guarantee the businesses their commercial margins through transfer price;
- Refinancing assets and replacing liabilities;
- Taking the financial risk related to the refinanced assets and liabilities;
- Bank's equity piloting;
- Currency risk, interest rate risk and liquidity risk piloting;
- Looking after "added value" when working with the interest rate and liquidity markets;
- Transmitting to businesses the financial engineering competences when marketing a new product, implementing a new business strategy .

The position of ALM in the organization depends on the orientation decided upon by the bank's executive management: either more risk oriented, or more investment oriented. In the primitive organizations, ALM is a part of RM and treasury has the responsibility for investment. In advanced organizations,

ALM acts as a long-term treasury responsible for long-term investments and for associated risk. In such a case, there is a need for an independent term to monitor the accuracy between reports and the position in reality. So that now a days, ALM teams tend to be independent from finance departments and risk management teams. (Adam, 2008)

2.3   Traditional ALM

Generally, in the past a bank's ALM function has been concerned with managing the risk associated with the banking book. This does not mean that this function is now obsolete, rather that additional functions have now been added to the ALM role. There are a large number of financial in situations that adopt the traditional approach; indeed, the nature of their operations would not lend themselves to anything more (Choudly, 2011).

The role of the traditional ALM (Choudly, 2011)**:**

· **Interest rate risk management**. This is the interest rate risk arising from operation of the banking book. It includes net interest income sensitivity analysis typifies by maturity gap and duration gab analysis and sensitivity of the book to parallel changes in the yield curve. The ALM desk will monitor the exposure the position the bank in accordance with its limits as well as its market view. Smaller banks, or subsidiaries of banks that are based overseas, often run no interest rate risk- that is, there is no short gap in their book. Apart from this the ALM desk is responsible for hedging interest rate risk or positioning the book in accordance with its view .

- **Liquidity and funding management**. There are regulatory requirements that dictate the proportion of banking assets that must be held as a short-term instruments. The liquidity book in a bank is responsible for running the portfolio of short-term instruments. The exact makeup of the book is, however, the responsibility of the ALM desk and will be a function of the desk's view of market interest rates, as well as its opinion on the relative value of one asset over another.

- **Reporting on hedging of risks**. The ALM fulfils a senior management information function by regularly reporting on the extent of the bank's risk exposure this may be in the form of a weekly hardcopy report or via some other medium.

- **Setting up risk limits**. The ALM unit will set limits, implement them and enforce them, although it is common for an independent 'middle office' risk function to monitor compliance with limits .

- **Capital requirement reporting**. This function is involves the compilation of reports on capital usage and position limits as a percentage of capital allowed, as well as reporting to regulatory authorities.

2.4 Developments in ALM

An increasing number of financial institutions have been enhancing their risk management function by adding to the responsibilities of the ALM function. These have included enhancing the role of the head of treasury and ALCO- by using such other risk exposure measures as option- adjusted spread and value at- risk (VaR) – and integrating traditional interest rate risk management with

credit risk and operational risk. The increasing use of credit derivatives has facilitated this integrated approach to risk management(Choudly, 2011).

Additional roles played by the ALM desk may include(Choudly, 2011).

- Using the VaR tool to asses risk exposure;
- Integrating market risk and credit risk;
- Using new risk- adjusted measure of return;
- Optimizing portfolio return;
- Proactively managing the balance sheet- this includes giving direction on the securitization of assets (removing them from the balance sheet), hedging credit exposure using credit derivatives and actively enhancing returns from the liquidity book, such as entering into stock lending and repo.

An enhanced ALM function will be definition expand the role of the treasury function and the ALCO. (ALM committee). This may see the treasury function becoming active portfolio managers of the bank's book.

The ALCO - traditionally composed of risk managers from a cross the bank as well as the senior member of the ALM desk or liquidity desk- is responsible for assisting the head of treasury and the finance director on the risk management process. In order to fulfil the new enhanced function the treasure will require a more strategic approach to this function, as many of the decisions about running the bank's entire portfolio will be closely connected with the overall direction that the bank wishes to take- these are board- level decisions. (Choudly , 2011).

2.5 The Objective of ALM

ALM teams now have a set of responsibilities.

The ALCO (the ALM committee) pays attention to these responsibilities (Adam,2008):

- Responsibility for short- term and long-term treasury activities (liquidity risk management);
- Other ALM risks management: interest rate risk, optional risks, exchange rate risk, etc;
- FTP (fund Transfer Pricing) modeling and ALM in come computation;
- Conformity with local regulation and statutory obligations;
- Optimization of risk return and capital management. And is essential and strategic for company a growth development.

2.6 Risk management for asset and liability mangers.

The risk management Department is usually a key department in banks. In some banks at the beginning of the 90s, the A/L management Departments used to be parts of the Risk Management Departments.

Risk management has many objectives(Adam, 2008) :

- Stopping bad things happening;
- Keeping regulators happy;
- Risk reporting;
- New products risk analysis;

- Risk policy and risk appetite definition in connection with the operational teams and sometimes the presentation of risk taking opportunities;

    All main kinds of the risk are described as;

- Financial market risks (interest rate risk, currency risk liquidity risk, credit risk, etc);

- Business and model risk;

- Operational risk;

- Accounting risk.

2.6.1 Financial risks

2.6.1.1 Liquidity risk

Liquidity risk is a difficult issue in risk management many definitions may be provided for this risk.

"liquidity risk is a risk arising from a bank's inability to meet its obligation when they come due without incurring unacceptable losses" (comptroller of the currery, 2001). Liquidity risk can be defined as the risk of being unable to liquidate a position timely a reasonable price (Muranaga and Ohsawa, 2002).

This risk affects both bank's earnings and capital. Therefore, it becomes the top priority of a bank's management to ensure the availability of sufficient funds to meet future demands of providers and borrowers, at reasonable costs.

2.6.1.2 Credit Risk

Credit risk is the potential loss to the nonperformance of a financial contract, or financial aspects of nonperformance in any contract.(Dermine,2007)

Credit risk is the risk that the borrower defaults and does not honor its obligation to service debt. (Gestel and Baesens, 2009)

Credit risk consists of pre-settlement and settlement risk:

- Per-settlement risk is the potential loss due to the counterparts default during the life of the transaction (loan, bond, derivative product). This risk can exist over long periods, often years, settlement risk happens because the payment or the exchange of cash flows is not made directly to the counterpart but via one or multiple banks that may also default at the moment of the exchange and as soon as an institution makes the required payment until the offsetting payment is received (Gestel and Baesens, 2009).

2.6.1.3 Interest rate risk

Interest rate risk is the risk to earning or capital arising from movement of interest rate. It arises from differences between the timing of rate charges and the liming of cash flow (reprising risk) from charging rate relationship among yield curves that affect bank activities (basis risk); from changing rate relationship across the spectrum of maturities (yield curve risk); and from interest-rate-related option embedded in bank products (option risk).

2.6.1.4 Inflation Risk

Inflation risk is also known as purchasing power risk, this risk rises from the decline in value of securities cash flow due to inflation, which is measured in terms of purchasing power (Adam ,2008)

2.6.1.5   Currency Risk

Currency risk a rises from price changes of one currency against another. It occurs when making investments in different currencies, especially when making cross-border and commitments in a foreign currency. (Gestel and Baesens, 2009)

2.6.1.6   Equity Risk

The equity risk on the portfolio denotes the possible down ward price movements of the equity on portfolio. The main products subject to equity risk are common stocks (voting and non-voting), convertible securities, commitments to buy or sell equities and derivative products. This risk come from volatility and exhibit significant fluctuations over time of stock prices (Gestel and Baesens, 2009)

2.6.1.7   Commodity Risk

Commodity risk arises from uncertain future market price changes of commodities. A commodity is physical product that can be traded on the secondary market. Such as agricultural products, precious metals and minerals. (Gestel and Baesens, 2009).

2.6.2   Non- Financial Risks

Companies are not only exposed to financial risk but also too many other kinds of risk.

2.6.2.1 Operational Risk

The Basel committee defines operational risk "as the risk of loss resulting from inadequate or failed interval processes, people and systems or from external events". This definition includes legal risk but excludes strategic and reputation risk.

2.6.2.2 Model Risk

Model risk is one of the most important risks in the banking book. This risk comes from a lack of data, the exploitation of inconsequential data in the modelling and an inadequate treatment of the available information.

- In trading activities, model risk included in pricing models.
- In non- trading book, the model risk will be present in customer behavior modelling and financial market modelling. (Adam,2008)

2.6.2.3 Business Risk

Business risk or entrepreneurial risk may occur from reckless entrepreneurship with high resulting fixed costs exceeding income. (Gestel and Baesens, 2009).

Adam (2008) said Business risk represents the risk of the variation of the economic value due to a variation of business parameters. (the number of existing customers or contracts).

Chapter3: Goal Programming and Analytical Hierarchy Process

3.1 Goal Programming (GP)

3.1.1 Introduction

3.1.2 GP Definition

3.1.3 Types of Goals

3.1.4 History of Goal Programming

3.1.5 Goal programming formulation

3.1.6 Advantages and Disadvantages of the Goal programming

3.2 Analytic Hierarchy Process (AHP).

3.2.1 Introduction

3.2.2 AHP Definition

3.2.3 AHP steps

3.2.4 AHP strengths

3.2.5 Weaknesses

3.3 Combined AHP and GP

3.4   Combined AHP–GP approach in literature

3.1 Goal Programming (GP)

3.1.1 Introduction

In real life, virtually all problems have several objectives not just one. Goal programming (GP) is one of the models which have been developed to deal with the multiple objectives decision – making problems. This model allows taking into account simultaneously many objectives while the decision making is seeking the best solution from a many set of feasible solution.

GP techniques have become widely used approach in operation research. GP model and its variants have been applied to solve large-scale multi criteria decision making problems. (Sen and Nandi, 2012).

In GP techniques all management goals where one or many, are incorporated into the objective function and the environmental conditions those outside the management's control are treated as constraints.

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. (Romero, 1991).

3.1.2 GP Definition

Goal programming (GP) is an extension of linear programming (LP) which is a mathematical tool to handle multiple, normally conflicting objectives. (Dan and Desmond, 2013).

According to Ignizio (1978) Goal programming "is a tool that has been proposed as a model and approach for analysis of problems involving multiple conflicting objectives".

The goal programming technique is an analytical framework that decision maker can use to provide optimal solutions of multiple and conflicting objectives.

Rifai (1994) defined in GP as "mathematical model manages a set of conflicting objectives by minimizing deviations between the target value and the realized".

3.1.3 Types of Goals

There are three possible types of goals:

- A lower. One-sided goal:- This goal sets a lower ,limit that we do not want to fall under (but exceeding the limit is a acceptable).
- An upper, one-sided goal:- this goal sets an upper limit that we do not want to exceed (but falling under the limit is acceptable).
- A two-side goal:- this goal sets specific targets that we do not want to miss on either side.

3.1.4 History of Goal Programming

Goal programming was extended from linear programming.

It was first developed and introduced by A. charnes and w.w.Cooper in 1961. This solution approach has been extended by Ijiri (1965). In 1968 B. contini considered goal programming under conditions of uncertainty. Major

applications were developed by V. Jaakelainen, S. Lee and Romero (1991) followed. Goal programming has become widely accepted and applied technique in various functional areas.

3.1.5 Goal programming formulation

Goal programming model is a simple extension and modification of the linear programming technique that provides a simultaneous solution of a system of complex objectives rather than a single one (Munhoz & Morabito, 2002).

One significant difference between goal programming and other types of modeling is the use of goal constraints in addition to real constraints.

A goal constraint is different from a real constraint in that the former is set equal to a target level that does not have to be achieved (Nichols & Ravindran, 2004).

To formulate goal programming model (Ignizio, 1986), the following steps should be followed.

    a. Define the decision variables.
    b. State the system constraints and goal constraints.
    c. Determine the preemptive priority factor and relative weight (if need be).
    d. Develop the objective function.
    e. State the nonnegative requirement.

In the formulation, two types of variables are used decision variables.

Two categories of constraints are used system or structural constraints and goal constraints, which are expressions of the original functions with target goals set a priority and positive and negative deviational variables.

The objective function in GP is always minimized and must be composed deviational variables only.

The general goal programming model can be expressed as follows.

Minimize

$$Z = \sum_{i=1}^{m}(d_i^- + d_i^+).$$

Subject to the linear constraints.

Goal constraints:

$$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = b_i \quad , \quad i = 1,2,...,m$$

System constraints:

$$\sum_{j=1}^{n} a_{ij}x_j \begin{bmatrix} \leq \\ = \\ \geq \end{bmatrix} b_i \quad , \quad i = m+1,...,m+p$$

With

$$x_j, \quad d_i^-, \quad d_i^+, \quad \geq 0$$

for

$$i = 1,2,...,m$$

and

$$j = 1,2,...,n$$

Where there are m goals, p system constraints and n decision variables.

Z = Objective function.

aij = The coefficient associated with variable j in the i th goal .

x_j = The j th decision variable.

b_i = The associated right hand side value .

d_i^- = Negative deviational variable from the i th goal.(underachievement)

d_i^+ = Positive deviational variable from the j th goal. (Overachievement)

3.1.5.1 Preemptive Goal Programming (Lexicographic)

Preemptive goal programming is also called non-Archimedean or lexicographic goal programming (Ignizio, 1986), there is a hierarchy of priority level for the goals before solving a goal programming problem, the goals needed to be ranked. In priority goals programming the objectives can be divided into different priority classes. The goals are given ordinal rankings are called preemptive priority factors. The goals of primary importance receive first-priority attention; those of secondary importance receive second-priority attention, and so forth.

Lexicographic Goal programming (LGP) formulation ordered the unwanted deviations into a number of priority levels, with the minimization of deviation in a higher priority level begin of infinitely more importance than any deviation in lower priority levels.

The lexicographic goal programming model can be presented as

Minimize

$$Z = \sum_{i=1}^{m} P_k (d_i^- + d_i^+)$$

Subject to the linear constraints:

Goal constraints:

$$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = b_i \quad , \quad i = 1,2,...,m$$

  System constraints

$$\sum_{j=1}^{n} a_{ij} x_j \begin{bmatrix} \leq \\ = \\ \geq \end{bmatrix} b_i \quad , \quad i = m+1,...,m+p$$

With

$$x_j, d_i^-, d_i^+ \geq 0 \quad , \quad i = 1,2,...,m$$

and

$$j = 1,2,...,n$$

Where there are m goals, p system constraints, k priority levels and n decision variables.

P_k =the p priority factor of the k the goal

.

Steps for the Preemptive Goal Programming algorithm are provided in table 3.1 . Figure 3.1 depicts the flow chart of the overall algorithm.

Table 3.1 Preemptive Goal Programming Algorithm

| Step	Action
1	Embed the relevant data set. Set the first goal set as the current goal set.
2	Obtain a linear programming (LP) solution defining the current goal set as the objective function.
3	If the current goal set is the final goal set, **a**. set it equal to the LP objective function value obtained in step 2, and STOP. Otherwise, go to step4.
4	If the current goal set is achieved or overachieved **a.** set it equal to its aspiration level and add the constraint to the constraint set , Go to step 5.**b**. Otherwise, if the value of the current goal set is underachieved , set the aspiration level of the current goal equal to the LP objective function value obtained in step 2. Add this equation to the constraint set. Go to step 5.
5	Set the next goal set of importance as the current goal set. Go to step 2.
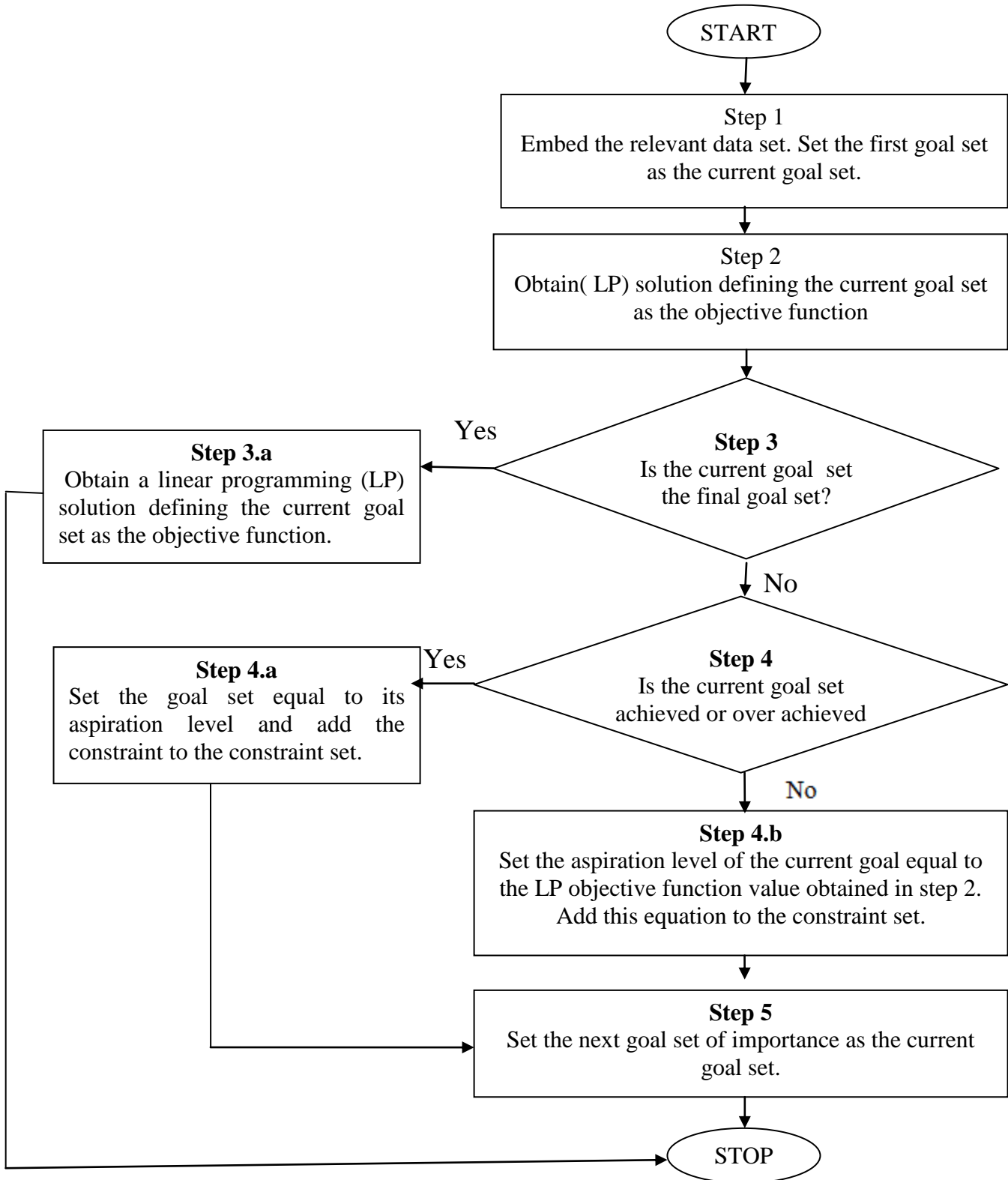
Figure 3.1 Flowchart of the Preemptive Goal Programming Algorithm (Kongar and Sobh , 2006)

3.1.5.2 Weighted Goal Programming (WGP)

Weighted Goal Programming is also called non-preemptive goal programming; all goals are of roughly comparable importance. The weighting of deviational variables at the same priority level should be considered in the goal programming.

The objective is to find a solution that minimizes the weighted sum of the goal deviation. In this case all unwanted deviation are multiplied by weights, reflecting their relative importance, and then added together as a single sum WGP assumes that positive and negative deviations ot the criterion outcomes are equally undesirable.

Charnes and Cooper (1977) stated the WGP model as follows.

Minimize

$$z = \sum_{i=1}^{m} (w_i^- d_i^- + w_i^+ d_i^+)$$

Subject to the linear constraints.

Goal constraints:

$$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = b_i \quad , \quad i = 1,2,...,m$$

System constraints

$$\sum_{j=1}^{n} a_{ij}x_j \begin{bmatrix} \leq \\ = \\ \geq \end{bmatrix} b_i \quad , \quad i = m+1, \dots, m+p$$

With

$$x_j, d_i^-, d_i^+ \geq 0 \quad , \quad i = 1,2, \dots, m \quad , \quad j = 1,2, \dots, n$$

Where there are m goals, p system constraints and n decision variable.

$w_i^- = $ positive numerical weight assigned to the negative deviational variable, $d_i^- = $ of the i th constraints

$w_i^+ = $ positive numerical weight assigned to the positive deviational variable, $w_i^- = $ of the i th constraint

while Ijiri (1965) has introduce the idea of combing preemptive priorities and weighting charnes and cooper (1977) suggested the goal programming model as

Minimize

$$z = \sum_{i=1}^{m} \sum_{k=1}^{n} p_k \left(w_{i,k}^- d_i^- + w_{i,k}^+ d_i^+ \right)$$

Subject to the liner constraints

Goal constraints

$$\sum_{j=1}^{n} a_{ij} \, x_j + d_i^- - d_i^+ = b_i \quad , \quad i = 1,2,\dots,m$$

System constraints

$$\sum_{j=1}^{n} a_{ij} \, x_j \begin{bmatrix} \leq \\ = \\ \geq \end{bmatrix} b_i \quad , \quad i = m+1,\dots,m+p$$

With

$$x_j \, , d_i^- \, , d_i^+ \geq 0 \qquad i = 1,2,\dots,m$$

and

$$j = 1,2,\dots,n$$

Where there are m goals, p system constraints, k priority levels and n decision variable.

$z = $ objective function

$p_k = $ the priority factor of the k th goal.

$w_i^- = $ positive numerical weight a assigned to the negative deviational variable, d_i^- of the i th constraint.

$w_i^+ = $ positive numerical weight a ssigned to the positive deviational variable d_i^+ of the i th constraint.

$d_i^- = $ negative deviational variable from the i th goal (underachievement).

d_i^+ = positive deviational variable from the i th goal (overachievement).

a_{ij} = the coefficient associated with variable j in the i th goal.

x_j = the j th decision variable.

b_i = the a associated right hand side value.

3.1.6 Advantages and Disadvantages of the Goal programming

Goal programming is one of the most optimistic techniques for multiple objective decision analysis.

The following one some advantages of goal programming (Wang et.al, 2008)

1) Simplicity and ease of use by simultaneously handling a large number of variables, constraints and objectives.
2) Applied to a large variety of uses from almost any industry and also for global applications and files include agriculture, engineering, financial investment planning production, natural resources.
3) Allow for an ordinal ranking of goal, where low priority goals are considered only after higher-priority goals have been satisfied to the fullest extent possible.
4) Useful in situations where the multiple goals are conflicting and cannot all be fully achieved.

5) Appropriate to find a satisfactory solution where many objectives or goals are to be considered.

6) Used to "satisfice" rather than to "optimize" the problem.

With all the clear benefits and efficiencies that GP brings, it does not come without some surrounding criticism

However there are some **disadvantages** of goal programming. These include the following (Wang et.al, 2008).

1. The tendency for the solution obtained to be parents inefficient which occur when the achieved level of any one objective can be improved without negatively impacting the achieved level of any other objective. However, this is only problem if alternative optimum solutions are presented
2. Challenge of assigning appropriate weights to the objectives
3. More time and thought, is required in the construction of the model.
4. More decision –maker involvement is required, that is in the establishment of aspiration levels and weightings.

3.2 Analytic Hierarchy Process (AHP).

3.2.1 Introduction

Multi-criteria decision making (MCDM) play a critical role in many real life. The analytic hierarchy Process (AHP) is a multi-criteria decision making approach and was introduced by saaty (1977 and 1994). The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain.(Triantaphyllou and Mann , 1995) .

The AHP is a decision support tool which can be used to solve complex decision problems. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives. The pertinent data are derived by using a set of pairwise comparisons. These comparisons are used to obtain the weight of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency.

3.2.2 AHP Definition

AHP is "a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales" (saaty, 2008). It is one of the more popular method of MCDM.

3.2.3 AHP steps

Saaty developed the following steps for applying the AHP.

1) Define the problem and determine its goal.

2) Structure the hierarchy from the top (the objectives from a decision-maker's view point) through the intermediate levels (criteria on which sub-sequent level depend) to the lowest level which usually contains the list of alternatives.

3) Construct a set of pairwise comparison matrices (size n X n) for each of the lower levels with on matrix for each element in the level immediately above by using the relative scale measurement shown in Table 3.2. The pair-wise comparisons are done in terms of which element dominates the other.

4) There are $\frac{n(n-1)}{2}$ judgments required to develop the set of matrices step 3. Reciprocals are automatically assigned in each pair-wise comparison.

5) Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken overall weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

6) Having made all the pairwise comparisons, the consistency is determined by using eigenvalue, λ_{max} , to calculate the consistency index, CI is follows: $CI = \frac{\lambda_{max-n}}{n-1}$, where n is the matrix size, judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in table 3. 3.

The CR is acceptable if it does not exceed 0.10 if it is more, the judgement matrix is inconsistent to obtain a consistent matrix, judgments should be reviewed and improved.(Vaidya and Kumar, 2004)

Develop hierarchy of problem in graphical representation.	Overall goal, criteria, and attributes are in different level of hierarchy.
Construct a pair wise comparison matrix.	Two criteria are compared at each time to find out which one is more important.
Synthesization	To calculate priority of each criterion.
Undergo consistency test.	To check whether judgment of decision makers is consistent.
No All judgments are consistent?	Consistency of all judgments in each level must be tested.
Yes
No All levels are compared?	All criteria and attributes in each criterion must be compared.
Yes
Develop overall priority ranking.	Based on each attributes priority and its corresponding criterion priority.

Fig 3.2 The flowchart of the analytic hierarchy process (saaty, 2008)

Table 3.2: Pair-wise comparison scale for AHP preferences

Numerical	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Table 3.3: Average random consistency CI

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

3.2.4 AHP strengths

- The advantages of AHP over multi criteria methods are its flexibility, intuitive a appeal to the decision makers and its ability to check inconsistencies (Ramanathan, 2001).

- Additionally, the AHP method has distinct advantage that it decomposes a decision problem into its constituent parts and builds hierarchies of criteria. Here, the importance of each criterion becomes clear. (Macharis et.al, 2004).

- AHP helps to capture both subjective and objective evaluation measures. While providing a useful mechanism for checking the consistency of the evaluation measures and alternative, AHP reduce bias in decision making.

- The AHP method supports group decision-making through consensus by calculating the geometric mean of the individual pairwise comparisons. (Zahir, 1999).

- AHP is uniquely positioned to help model situations of uncertainty and risk since it is capable of deriving scales where measures ordinarily do not exist. (Millet & Wedley, 2002).

3.2.5 Weaknesses

Despite the popularity of the AHP, many authors have expressed concern over certain issues in the AHP methodology.

- Many researching have long observed some cases in which ranking irregularities can occur when the AHP or some of variants are used. This rank reversal is likely to occur when a copy or a near copy of an existing option is added to the set of alternatives that are being evaluated.

- The AHP, method can be considered as a complete aggregation method of the additive type. The problem which such aggregation is that compensation between good scours on some criteria and bad scores on the other criteria can occur. Detailed, and often important, information can be lost by such aggregation.

- With AHP the decision problem is decomposed into a number of sub system, within and between which a substantial number of pairwise comparisons need to be completes. This approach has the disadvantage that the number of pairwise comparisons to be made, may become very large $\frac{n(n-1)}{2}$, and thus become a lengthy task. (Macharis et .al., 2004).

- Another important disadvantage of the AHP method is the artificial limitation of the use of the a-point scale. Sometime, the decision-maker might find difficult to distinguish among them and tell for example whether one alternative is 60r 7 times more important than another. Also, the AHP method cannot cope with the fact that alternative A is 25 times more important than alternative C

Due to the discussion on the scale's restrictions(Hajkowicz, et.al,2000) modified the procedure in their research by using a z-point-scale, due to time constraints placed on decision makers, so the decision makers only indicated whether a criterion was more or less important or equally important to its partner .

3.3 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. Khorramshagol and Ignition (1984) originally discussed an integration of GP and AHP concepts in the study of single and multiple decision- making in a multiple objective environment .

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.

3.4 Combined AHP–GP approach in literature

Al Afeefy (2011) used the combined AHP–GP approach to rank the compensating priorities of industrial sectors in Gaza strip using (AHP), and then identifying the optimal fund for each sector using GP. First, the AHP was adopted to get a final rank of industrial sectors by making 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 .After assigning importance weightings to the alternative locations, a GP model was formulated to allocate funds to the top ranked sectors.

Sedzro and others (2012) applied the combined AHP–GP approach to make an analogy with the integrated asset allocation approach; 1) the AHP method makes it possible to consider both market conditions and investor

preferences; 2) goal programming serves as an optimizer when building a portfolio that fits the invertor's goals. First they apply the AHP method to determine the percentage of the portfolio to invest in each asset class based on economic scenarios and the investor's risk profile. The AHP model's outputs correspond to the pro portions to invest in each asset class under consideration :stocks, bonds and liquid assets, based on analysts' economic forecasts .Second, we use a two-steps optimization procedure: 1 (mean variance optimization to determine maximum return for the various levels of return variance; 2) The ratios obtained by running the AHP model are taken as goals for the goal optimization exercise, with constraints including the optimal returns and variances obtained during the first step.

Abu Libda (2013) applied the combined AHP–GP approach .The objective of the study to develop a decision support system based on zero-one goal programming and the analytic hierarchy process to aid the process of academic preferences-based scheduling in universities that adopt the credit hours system. The AHP was used to derive weights or priorities that will be assigned to the various goals involved in the model. These weights will be derived from a set of pairwise comparisons established between the goals involved. The AHP weightings were then incorporated into the GP model.

Naderi et.al (2013) design a mathematical model in order to manage the optimal assets and liabilities in Bank .In their research, the AHP was used first to prioritizing and determining the importance degree of goals. The AHP weightings were placed in objective function of Goal Programming model and have been solved by lingo10 software.

 Mehri and Jamshidinavid (2015) applied the combined AHP–GP approach. The objective of the present study is to design a mathematical model of

asset-liability management. The AHP was used first to determine the importance degree of objectives .The AHP weightings were then incorporated into the GP model.

Chapter 4: Methodology

4.1 Introduction

4.2 Data collection

4.3 AHP Model Applying

4.4 GP Model Applications

4.1 Introduction

The main objective of this research is to design a mathematical model in order to manage assets and liabilities in bank of Palestine using (GP) model and to identify the main goals of the commercial Palestinian banks in Gaza strip, prioritize and determine the importance degree of goals using AHP.

This chapter describes the methodology used in this research to achieve that main objective starting with data collection, in which criteria are identified, followed by application of AHP to rank the goals of the bank's priorities, finishing with the application of GP model to determine suitable structure for items of balance sheet.

4.2 Data Collection

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

Table 4.1: Required data and their sources

Types of data	Required Data	Source
Secondary data :it is data that collected for previous studies and have been already published about banking sector and bank of Palestine	total assets , deposits and credit facilities and other data of banking sector and BOP in 2013 and 2014	Annual report and financial statements of BOP
Primary data: it is collected using interviews and two questionnaires for heads of banks	Identification; Criteria Criteria Weights; Planning goals and their percentage	Heads of the banks And expert and decision makers

4.2.1 Criteria Definition:

The process of surveying the previous related studies and many interviews more than 5 times with some heads of the Palestinian commercial banks to determine the main goals of the Palestinian bank in Gaza strip resulted in an identification and definition of six main criteria (goals) .These criteria were arranged in a questionnaire to the heads of the four national commercial banks targets (Appendix A) to get a priority level of criteria (Appendix D) shows the names and positions of the experts.

4.3 AHP Model Applying

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

4.3.1 Level priority of the defined goals:

Because the importance level of defined goals is different the goals were divided into three groups:

The very important group

Return on Assets, Return on equity, Capital adequacy ratio

The important group

Market share of credit , Market share of deposits

The moderate important group

Liquidity risk

4.3.2 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 (the determined goals of the banks). 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, the questionnaire was designed and distributed among the experts (Appendix B). Pair wise comparison results obtained from each questionnaire was entered into Expert Choice (E.C 11.5), and then Consistency Ratio (CR) and the relative weights vector of 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 the 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.

4.3.3 Main criteria pair wise comparison

Table 4.2: The definition of the main criteria(goals)

Goals	Defenition
Return on Assets	This ratio measure for the operating efficiency for the company based on the firm's generated profits from its total assets. This ratio is calculated as net profit after tax divided by the total assets.
Return on Equity	This ratio measures the shareholders rate of return on their investment in the company. This ratio calculated as net profit after tax divided by the total shareholders' equity
Capital adequacy Ratio	The main function of this ratio is protecting the banks against unexpected losses and also supporting the depositors and creditors . This ratio is result of bank's capital base division to weighted assets based on the risk.
Market share of Credit	This ratio is calculated as credit facilities to the bank divided by credit facilities to the bank sector .
Market share of Deposits	This ratio is calculated as customer deposits to the bank divided by customer deposits to the bank sector.
Liquidity Risk	Is a bank's inability to fulfill its obligations to others in due time .

After constructing the general model and entering the experts' judgments of pair wise comparison to the EC, the results shown in figure 4.1 are obtained

Goal: Degree of importance

retun on Assets	.264
Return on Equity	.237
Capital adequacy ratio	.236
Market share of credit	.090
Market share of deposits	.090
liquidity risk	.083

Inconsistency = 0.02
with 0 missing judgments.

Fig 4.1: EC results of main criteria pair wise comparisons

As shown in 4.1, the return on assets criteria has the highest priority with respect to the goal with a percentage of 26.4%, the return on equity the 2nd one in priority with a percentage of 23.7%, not far away from it; the capital adequacy ratio which is the 3 rd one in priority with a percentage of 23.6%   .Both scale of market share of credit and market share of deposits criteria are ranked the fourth two criteria with a percentage 9% .the liquidity risk ranked the last criteria with a percentage of 8.3 %.

4.4 GP Model Applications

The GP model will identify the amount that should be allocated to each asset's element in the balance sheet for the BOP .

4.4.1 Decision variable

The decision variable are divided into two groups, the main and deviation variables. Model has 25 decision variables which 13 variables are main variables (Relating to the balance sheet elements and 12 variables are deviation variables (6 positive deviation variables and 6 negative deviation variables).

The first group of decision variables: According to balance sheet structure as shown in table 4.3 The definitions are provided for decision variable

Table 4.3: balance sheet structure of BOP

Assets		Liabilities and Equity	
Cash and balances with Palestine Monetary Authority	x_1	Palestine Monetary Authority's deposits	y_1
Balances at banks and financial institutions	x_2	Banks and financial institution's' deposits	y_2
Financial assets at fair value through income statement	x_3	Customers' deposits	y_3
Direct Credit Facilities	x_4	Cash margins	y_4
Financial assets at fair value through other comprehensive income	x_5	Sundry provisions	y_5
Financial assets at amortized cost	x_6	Tax provisions	y_6
Investment in an associate	x_7	Other liabilities	y_7
Property, plant and equipment	x_8	Equity	y_8
Projects in progress	x_9		
Other assets	x_{10}		

Second group of decision variables: the deviations amount in goal programming model is expressed the level of achievement to goals in table 4.4

Table 4.4: the deviation variable of goal

Goals	The creation of positive deviation from goals	The creation of negative deviation from goals
market share of credit	d_1^+	d_1^-
market share of deposits	d_2^+	d_2^-
Return on equity	d_3^+	d_3^-
Return on assets	d_4^+	d_4^-
Capital adequacy ratio	d_5^+	d_5^-
Liquidity risk	d_6^+	d_6^-

4.4.2 Constraints

Constraints are divided into two groups structural and goal constraints .The presented model has 18 constraints that 12 of them are structural constraints and 6 are goal constraints. From 12 structural constraints three constraints are considered as constant form in two periods.

The percentages that the researcher obtained from the Bank Of Palestine is constructed in table 4.5

Table 4.5: The percentages obtained from the Bank Of Palestine (BOP) for 2013 and 2014

Items	The amount of 2013	The amount of 2014
Cash and balances with Palestine Monetary Authority	30% - 40% of customer deposits	15% -20% of customer deposits
Balances at banks and financial institutions	20% -25% of customer deposits	25% -30% of customer deposits
Financial assets at fair value through income statement	1% - 2% of customer deposits	1% -2% of customer deposits
Financial assets at fair value through other comprehensive income	1% - 2% of customer deposits	1% - 2% of customer deposits
Financial assets at amortized cost	8% -10% of customer deposits	10% -12% of customer deposits
Investment in an associate	Up to 1% of customer deposits	Up to 1% of customer deposits
Property, plant and equipment	2% -4% of customer deposits	2%-4% of customer deposits
Projects in progress	0.5% of customer deposits	0.1% of customer deposits
Other assets	1% - 2% of customer deposits	1% - 2% of customer deposits
market share of credit	25% of credit facilities of banking sector	26% of credit facilities of banking sector
market share of deposits	21% of deposits of banking sector	23% of deposits of banking sector
Return on equity	15% of shareholders' equity	15% of shareholders' equity
Return on assets	2% of total assets	2% of total assets
Capital adequacy ratio	12%	12%
Liquidity risk	25%	25%
Customer deposits	1,668,535,234	1,908,480,620
Cash margins	77,028,031	154,043,455
Total equity	252,018,974	280,106,578

4.4.2.1 Structural Constraints

- **Cash and Balances with Palestinian Monetary Authority (PMA)**

The optimal amount of cash should be such that in case of customer deposits possible exit the banks does not face with major problems and does not make liquidity risk for bank. The optimal amount of stored cash on hand at least should be between 30% to 40% of customer deposits in 2013 and between %15 to %20 in 2014 .

$$2013 : x_1 \geq 30\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_1 \leq 40\% \sum_{i=3}^{4} yi$$

$$2014 :: x_1 \geq 15\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_1 \leq 20\% \sum_{i=3}^{4} yi$$

- **Balances at banks and finincial institutions**

According to needing for exchange also interbank needs approximitely aconstant value of assets is in other banks and finincial institutions that generally this number is between 20 %to 25 % of customer deposits in 2013 and between 25 % to 30 % Of customer deposits in 2014.

$$2013 : x_2 \geq 20\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_2 \leq 25\% \sum_{i=3}^{4} yi$$

$$2014 : x_2 \geq 25\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_2 \leq 30\% \sum_{i=3}^{4} yi$$

- **Financial assets at fair value through income statement**

Financial assets at fair value through income statement are including investment in quoted shares at Palestinian securities exchange , this amount should be between 1% to 2 % of customer deposits for years 2013 and 2014 .

$$x_3 \geq 1\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_3 \leq 2\% \sum_{i=3}^{4} yi$$

- **Financial assets at fair value through other comprehensive income**

 Financial assets at fair value through other comprehensive income are including investment foreign and local quoted shares, foreign and local investment portfolios, local unquoted shares .From the manager and exprerts's opinion of bank of palestine the minimum amount of this variable is between 1% to 2 % of customer deposit for years 2013 and 2014 .

$$x_5 \geq 1\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_5 \leq 2\% \ \sum_{i=3}^{4} yi$$

 - **Financial assets at amortized cost**

Financial assets at amortized cost are including investment in foreign quoted bonds, foreign treasury bills and local unquoted bonds .From the manager and exprerts's opinion of bank of palestine the minimum amount of this variable is between 8% to 10% of customer deposit in 2013 and between 10 % to 12% in 2014

$$2013: \ x_6 \geq 8\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_6 \leq 10\% \sum_{i=3}^{4} yi$$

$$2014: \ x_6 \geq 10\% \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_6 \leq 12\% \sum_{i=3}^{4} yi$$

 - **Investment in an associate**

Investment in Arab Islamic Bank (AIB) and AMAN and ABRAJ should be up to a percentage Of customer deposits for years 2013 and 2014.

$$x_7 \leq 1\% \sum_{i=3}^{4} yi$$

- **Property, Plant and Equipment**

This group of assets include real estate proprieties , furniture and equipment ,computers , leasehold improvments and vehicles . this amount is between 2% to 4 % Of customer deposit is allocated to this group of assetsfor years 2013 and 2014.

$$x_8 \geq 2 \text{ \% } \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_8 \leq 4 \text{ \% } \sum_{i=3}^{4} yi$$

- **Projects in progress**

This item includes the cost of new branches expansion , renovation and leasehold improvements.this amount should be 0.5% in 2013 and 0.1% in 2014.

In 2013: $x_9 = 0.5 \text{ \% } \sum_{i=3}^{4} yi$

In 2014 : $x_9 = 0.1 \text{ \% } \sum_{i=3}^{4} yi$

- **Other assets**

The item includes the cost of new branches ,renovation and leasehold improvements, accrued interest and commissions , stationery and printings stock , intangible assets , prepayments ,trade receivables of subsidiaries and others and the amount should be up 1% to 2 % Of customer deposite .

$$x_{10} \geq 1 \text{ \% } \sum_{i=3}^{4} yi \qquad \text{and} \qquad x_{10} \leq 2 \text{ \% } \sum_{i=3}^{4} yi$$

Customer deposit

Customer deposit are formed the commercial bank's major part of financial resources and this item include current and demand deposite ,saving deposits, time deposits and debit balances – temorarily credit .

The real amount in 2013 (doller): $y_3 = 1,668,535,234$

The real amount in 2014 (doller): $y_3 = 1,908,480,620$

Cash margins

This item includes direct credit facilities and indirect credit facilities

The real amount in 2013 (doller): $y_4 = 77,028,031$

The real amount in 2014 (doller): $y_4 = 154,043,455$

Total equity

This item includes paid-in share capital , additional paid –in capital ,statutory reserve , voluntarily reserve, general banking risk reserve, pro-cyclicality reserve , avaliable –for-sale investment reserve , retained earnings and non-controlling interest .

The real amount in 2013 (doller): $y_8 = 252,018,974$

The real amount in 2014 (doller): $y_8 = 280,106,578$

4.4.2.2 Goal constraints

Market share of credit

According to Nature of banking which is attracting the deposit and facility's granting, facility is formed the most important number of banks' assets. The credit limit of resources that is calculated in each year also is presented it to bank network in order to awareness of facilities granting limit is indicated the allocating in 2013 is 25% of credit facilities of banking sector and in 2014 is 26% of credit facilities of banking sector.

The credit facilities of banking sector in 2013 are 4,480,286,185 and in 2014 is 4,895,882,595.

$2013: x_4 + d_1^- - d_1^+ = 25\%(4,480,286,185) = 1,120,071,546$

$2014: x_4 + d_1^- - d_1^+ = 26\%(4,895,882,595) = 1272929475$

Market share of deposits

Customers deposits are formed the commercial bank's major part of financial resources so the customer deposit should be 21 % of deposits of banking sector in 2013 and 23 % of total deposits of banking sector in 2014 .

Total deposits of banking sector in 2013 is 8,306,247,172 and in 2014 is 8,935,342,947

$2013: y_3 + y_4 + d_2^- - d_2^+ = 21\%(8,306,247,172) = 1,744,311,906$

$2014: y_3 + y_4 + d_2^- - d_2^+ = 23\%(8,935,342,947) = 2,055,128,878$

Return on equity

This ratio is calculated as net profit after tax divided by the total shareholders' equity. This ratio measures the shareholders rate of return on their investment in the company so the return on equity is for year 2013 and 2014 is %15of total shareholders' equity.

The net profit after tax in 2013 is 40,438,831 and in 2014 is 40,222,506.

$2013: 15\% \; y_8 + d_3^- - d_3^+ = 40,438,831$

$2014 : 15\% \; y_8 + d_3^- - d_3^+ = 40{,}222{,}506$

Return on assets

This ratio is calculated as net profit after tax divided by the total assets. This ratio measure for the operating efficiency for the company based on the firm's generated profits from its total assets. The return on asset is for the years 2013 and 2014 is 2% of total assets.

The net profit after tax in 2013 is 40,438,831 and in 2014 is 40,222,506.

$2013 : 2\% \; \sum_{i=1}^{10} x_i + d_4^- - d_4^+ = 40{,}438{,}831$

$2014 : 2\% \; \sum_{i=1}^{10} x_i + d_4^- - d_4^+ = 40{,}222{,}506$

Capital adequacy ratio

Capital adequacy ratio is result of bank's capital base division to weighted assets based on the risk that according to the approved of Basel committee I about banks this ratio should be at least 8% but PMA this ratio should be at least 12 %.The mentioned ratio is as the most important analysis ratios of bank's financial statements which represents the bank's power in front of unpredictable losses, so for each item of asset is defined a risk coefficient.

The regulatory capital in 2013 is 166,318,565 and in 2014 is 186,827,481

In 2013

$12\%(0\% x_1 + 0\% x_2 + 100\% x_3 + 100\% x_4 + 100\% x_5 + 0\% x_6 + 100\% x_7 + 100\% x_8 + 100\% x_9 + 100\% x_{10}) + d_5^- - d_5^+ = 166{,}318{,}565$

In 2014

$12\% (0\% x_1 + 0\% x_2 + 100\% x_3 + 100\% x_4 + 100\% x_5 + 0\% x_6 + 100\% x_7 + 100\% x_8 + 100\% x_9 + 100\% x_{10}) + d5^- - d5^+ = 186,827,481$

Liquidity Risk

Liquidity risk is occurring because of a bank's inability to reduce the liabilities or providing resources for increasing the assets. One of the most important goals of banks' managers is controlling the liquidity risk which in national banks for controlling the liquidity risk 25% of customer deposits to assets is allocated with high degree of liquidity in 2013 and 2014 .

$$x_1 + x_2 - 25\% \sum_{i=3}^{4} y_i + d_6^- - d_6^+ = 0$$

4.4.2.3   The objective function:

The objective function according to goal constraints and priority coefficient of each goal is as follows in goal groups:

Min Z= P_1 (0.264 d_4^- + 0.237 d_3^- + 0.236 d_5^-) + p2 (0.090 d_1^- + 0.090 d_2^-) + p3 (0.083 d_6^-)

The model is formulated and solved by LINGO 13.0 software and the results are shown in table 5.1 and table 5.2

The LINGO 13.0 software can easily create optimization applications. The model was solved by using a free trial version of LINGO 13.0

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

Chapter 5: Results and Analysis

5.1 Results

5.2 Analysis

5.3 Sensitivity analysis

5.1 The findings of goal programming model

The findings of using GP model to allocate amount for each asset's element of BOP by incorporating the importance weights of goals resulted from the head of banks points of view which were considered the AHP model are shown in tables 5.1 and 5.2.

Table 5.1 The finding of goal programming model and its comparison with bank's real balance sheet in year 2013 (Amounts: dollar)

Assets	Variable	Model	Real	Deviation
Cash and balances with Palestine Monetary Authority	x_1	523,669,006	638,406,726	- 114,737,720
Balances at banks and financial institutions	x_2	349,112,671	350,748,099	- 2,635,428
Financial assets at fair value through income statement	x_3	17,455,633	7,085,308	+ 10,370,325
Direct Credit Facilities	x_4	1,120,071,546	1,103,641,018	+ 16,430,528
Financial assets at fair value through other comprehensive income	x_5	17,455,633	22,313,964	- 4,858,331
Financial assets at amortized cost	x_6	139,465,056	146,594,774	- 6,949,709
Investment in an associate	x_7	17,455,633	17,070,699	+ 384,934
Property, plant and equipment	x_8	34,911,266	39,587,275	- 4,676,009
Projects in progress	x_9	8,727,817	8,291,148	+436,669
Other assets	x_{10}	17,455,633	14,306,932	+ 3,148,701
Total		2,245,779,894	1,358,045,943	-(887,733,951)

Table 5.2 The finding of goal programming model and its comparison with bank's real balance sheet in year 2014

Amount s: dollar

Assets	Variable	Model	Real	Deviation
Cash and balances with Palestine Monetary Authority	x_1	309,377,258	364,222,324	- 54,845,066
Balances at banks and financial institutions	x_2	515628784	581,758,608	- 66,129,820
Financial assets at fair value through income statement	x_3	20,625,151	7,367,695	+ 13,257,456
Direct Credit Facilities	x_4	1,272,929,475	1,151,825,644	+ 121,103,831
Financial assets at fair value through other comprehensive income	x_5	20,625,151	22,671,491	- 2,046,340
Financial assets at amortized cost	x_6	206,251,511	226,643,035	- 20,391,524
Investment in an associate	x_7	20,625,151	18,692,906	+ 1,932,245
Property, plant and equipment	x_8	41,250,301	47,981,522	- 6,731,221
Projects in progress	x_9	2,062,515	2,272,393	-209,878
Other assets	x_{10}	20,625,151	19,337,893	+1,287,258
Total		2,430,000,448	2,442,773,551	+(12,773,063)

5.2 Analysis

1. According to table 5.1 and table 5.2 the allocated amount to the cash and balances with Palestine Monetary Authority variable in this model for year 2013 is 114,737,720 dollar less than its real amount. This difference was 54,845,066 dollar in year 2014.The dedicated amount difference by model to Balances variable at banks and financial institutions and the real amount of the balance sheet in 2013 and 2014 is respectively 2,635,428 dollar and 66,129,820 dollar. Being upper of mentioned current assets in balance sheet in proportion to model's dedicated amount is indicating that bank managers are followed of a bold policy in management of their current assets, it means that managers are always trying to reach the cash to the possible maximum. In other words, they will decrease the assets operating working.

2. According to table 5.1 and table 5.2 the presented model suggests the increasing in the allocated amount to Financial assets at fair value through income statement of years 2013 and 2014 respectively 10,370,325 dollar and 13,257,456 dollar and the decreasing in the allocated amount to Financial assets at fair value through other comprehensive income of years 2103 and 2014 respectively 4,858,331dollar and 2,046,340 dollar and also decreasing in the allocated amount to Financial assets at amortized cost of years 2013 and 2014 respectively 6,949,709 dollar and 20,391,524 dollar.

3. According to table 5.1 and table 5.2 the studying on the model's findings show that allocated amount by model to direct credit facilities group for years 2013 and 2014 is respectively 16,430,528 dollar and 121,103,831 dollar is more than of balance sheet's real amount. Also the presented model suggests

the increasing in investments in an associate for years 2013 and 2014 is respectively 384,934 dollar and 1,932,245 dollar. Mentioned differences indicate that the policy of resource allocation to investments and facilities which has acceptable return in such way that is lower than the amount of model's allocation that this matter reduced the return and obtained profit by bank.

4. Since the constant assets are as assets with low return, so it is better that Property, plant and equipment amount decreases about   4,676,009 dollar in 2013 and 6,731,221 dollar in 2014 as shown in table 5.1 and table 5.2 .

5. According to table 5.1 and table 5.2 the allocated amount to Projects in progress by model about 436,669 dollar is more than its real amount in 2013 and about 209,878 dollar is less than its real amount .The allocated amount to other assets by model for years 2013 and 2014 is respectively about 3,148,701 dollar and 1,287,258 dollar is more than its real amount.

6. The amount of objective function is zero for model in two studied section which shows the fulfillment of the desired values of all the objectives. This matter is indicated the complete realization of the objectives in identified priorities levels.

8. Capital adequacy which shows the bank's ability to perform its obligations is as the most important measures of bank in international level also are measure for rating the banks. D5p about 2,539,307 dollar for year 2013 and 2,868,449 dollar for year 2014 which means that based on the assets allocation

by model this ratio has been improved about mentioned amount for each section.

9. Risk management is one of the main goals of assets and liabilities management's process. Assets with a high degree of liquidity (Cash, Balances at banks and financial institutions) should be at least 25% of customer deposits. Observance of this subject protects the bank from liquidity and insolvency risk. D6P about 436,390,839 dollar for year 2013 and 309,377,258 dollar for year 2014 which means that assets allocation between different groups by model is in such way that about mentioned amount is reduced the liquidity risk which is as model's advantage.

10 . Return on asset ratio measure for the operating efficiency for the company based on the firm's generated profits from its total assets should be 2% . D4p about 7,529,463 dollar for the year 2013 and about 2,435,352 dollar for the year 2014 .

11. Return on equity ratio measures the shareholders rate of return on their investment in the company so the return on equity 15%. D3p about 3,375,896 dollar for the year 2013 and about 3,799,374 dollar for the year 2014.

12**.** Customers deposits are formed the commercial bank's major part of financial resources so the customer deposit should be 21 % in 2013 and 23 % in 2014. the amount of customer deposit about 1,745,563,308 dollar in 2013 and 3,448,826 dollar in 2014 and D2p about 1,251,419 dollar for the year 2013 and about 1,251,359dollar for the year 2014 .

5.3 Sensitivity analysis

One advantage of linear GP model is that slandered LP procedures can be employed to solve the problem. This implies that the array of Sensitivity analysis which is an integral part of the solution of linear programs can be applied to the GP model as well. In particular, shadow prices and range analysis can be used to evaluate the Sensitivity of the optimal solution to changes in goal aspiration levels. Range analysis can be used to investigate the effect on the optimal solution of changes in the weights in the objective function. The usual LP Sensitivity analysis is applied to one parameter at a time assuming that all other parameters are held constant. This assumption may not be appropriate when analyzing the weights in the GP objective function. Here the changes in one weight will likely impact the other weights since they are relative weights and because they are frequently standardized.

 (Ringuest , 2012).

An analysis of the effect of parameter changes after determining the optimal solution is very important part of any solution process. This procedure is broadly defined as the post optimal Sensitivity analysis. Because there usually exist, some degree of uncertainty in real – world problems concerning the model parameters i.e., priority factor, technological coefficient, and goal levels or available resources. Sensitivity analysis should be an important part of the GP solution. If the optimal solution is relatively sensitive to changes in certain parameters, special efforts should be directed to forecasting the future value of these parameters. By the same token , if the optimal solution has very little sensitivity to changes in certain parameters , it might be a waste of time and effort to try to estimate the values of parameters more accurately . (Holzman , 1981).

Most commercial LP solver return at least the following information :

- The objective function coefficients for the original variables at optimum, called the reduced cost
- The objective function coefficients for slack or surplus variables at optimum, called the shadow price or dual price .
- The ranges of original objective function coefficients for the original variables for which the current basis remains optimal.
- The ranges of right-hand- side constant for the constraints for which the current basis remains optimal.

Table 5.3 : The solution output returned by LINGO 13.0 solver for the year 2013.

```
Variable            Value         Reduced Cost
    D4N          0.000000           0.2640000
    D3N          0.000000           0.2370000
    D5N          0.000000           0.2360000
    D1N          0.000000           0.9000000E-01
    D2N          0.000000           0.9000000E-01
    D6N          0.000000           0.8300000E-01
     X1       0.5236690E+10         0.000000
     Y3       0.1668535E+10         0.000000
     Y4       0.7702803E+08         0.000000
     X2       0.3491127E+10         0.000000
     X3       0.1745563E+09         0.000000
     X5       0.1745563E+09         0.000000
     X6       0.1396451E+10         0.000000
     X7       0.1745563E+09         0.000000
     X8       0.3491127E+09         0.000000
     X9       0.8727816E+08         0.000000
    X10       0.1745563E+09         0.000000
     Y8       0.2520190E+09         0.000000
     X4       0.1120072E+10         0.000000
    D1P        0.000000             0.000000
    D2P        1251359.             0.000000
    D3P       0.3375896E+09         0.000000
    D4P       0.2435352E+10         0.000000
    D5P       0.2539307E+10         0.000000
    D6P       0.4363908E+10         0.000000
```

Table 5.4 : The objective function and constraint slack or surplus and dual price

```
Row     Slack or Surplus      Dual Price
 1          0.000000          -1.000000
 2          0.000000           0.000000
 3          0.1745563E+10      0.000000
 4          0.000000           0.000000
 5          0.8727816E+09      0.000000
 6          0.000000           0.000000
 7          0.1745563E+09      0.000000
 8          0.000000           0.000000
 9          0.1745563E+09      0.000000
10          0.000000           0.000000
11          0.3491127E+09      0.000000
12          0.000000           0.000000
13          0.000000           0.000000
14          0.3491127E+09      0.000000
15         -0.3259629E-08      0.000000
16          0.000000           0.000000
17          0.1745563E+09      0.000000
18          0.000000           0.000000
19          0.000000           0.000000
20          0.000000           0.000000
21          0.000000           0.000000
22          0.000000           0.000000
23          0.000000           0.000000
24          0.000000           0.000000
25          0.000000           0.000000
26          0.000000           0.000000
```

Note that LINGO refers to the objective function as "row (1)" and the constraint as rows (2)-(26) .

LINGO also provides the simple ranges information that can be used for sensitivity analysis:

Table 5.5: Objective coefficient ranges

```
Ranges in which the basis is unchanged:

                        Objective Coefficient Ranges:

                    Current        Allowable      Allowable
      Variable     Coefficient     Increase        Decrease
          D4N       0.2640000      INFINITY       0.2640000
          D3N       0.2370000      INFINITY       0.2370000
          D5N       0.2360000      INFINITY       0.2360000
          D1N     0.9000000E-01    INFINITY     0.9000000E-01
          D2N     0.9000000E-01    INFINITY     0.9000000E-01
          D6N     0.8300000E-01    INFINITY     0.8300000E-01
           X1       0.000000       INFINITY       0.000000
           X2       0.000000       INFINITY       0.000000
           X3       0.000000       INFINITY       0.000000
           X5       0.000000       INFINITY       0.000000
           X6       0.000000       INFINITY       0.000000
           X7       0.000000       INFINITY       0.000000
           X8       0.000000       INFINITY       0.000000
          X10       0.000000       INFINITY       0.000000
           X4       0.000000     0.9000000E-01    0.000000
          D1P       0.000000       INFINITY       0.000000
          D2P       0.000000       INFINITY     0.9000000E-01
          D3P       0.000000       INFINITY       0.2370000
          D4P       0.000000      0.4500000       0.000000
          D5P       0.000000     0.7500000E-01    0.000000
          D6P       0.000000       INFINITY       0.000000
```

Table 5.6 : Right hand Side Ranges

```
                Righthand Side Ranges:


              Current          Allowable          Allowable
    Row         RHS            Increase           Decrease
     2      0.5236690E+10    0.1745563E+10      0.4363908E+10
     3      0.6982253E+10      INFINITY         0.1745563E+10
     4      0.3491127E+10    0.8727816E+09      0.3491127E+10
     5      0.4363908E+10      INFINITY         0.8727816E+09
     6      0.1745563E+09    0.1745563E+09      0.1745563E+09
     7      0.3491127E+09      INFINITY         0.1745563E+09
     8      0.1745563E+09    0.1745563E+09      0.1745563E+09
     9      0.3491127E+09      INFINITY         0.1745563E+09
    10      0.1396451E+10    0.3491127E+09      0.1396451E+10
    11      0.1745563E+10      INFINITY         0.3491127E+09
    12      0.1745563E+09      INFINITY         0.1745563E+09
    13      0.3491127E+09    0.3491127E+09      0.3491127E+09
    14      0.6982253E+09      INFINITY         0.3491127E+09
    16      0.1745563E+09    0.1745563E+09      0.1745563E+09
    17      0.3491127E+09      INFINITY         0.1745563E+09
    21      0.1120072E+10      INFINITY         0.1120072E+10
    22      -1251359.          1251359.          INFINITY
    23      -0.3375896E+09    0.3375896E+09      INFINITY
    24      0.2298320E+08    0.2435352E+10       INFINITY
    25      0.6158477E+08    0.2539307E+10       INFINITY
    26      0.4363908E+10    0.4363908E+10       INFINITY
```

Table 5.7 :The solution output returned by LINGO 13.0 solver for the year 2014.

Variable	Value	Reduced Cost
D4N	0.000000	0.2640000
D3N	0.000000	0.2370000
D5N	0.000000	0.2360000
D1N	0.000000	0.9000000E-01
D2N	0.000000	0.9000000E-01
D6N	0.000000	0.8300000E-01
X1	0.3093773E+10	0.000000
Y3	0.1908481E+10	0.000000
Y4	0.1540345E+09	0.000000
X2	0.5156288E+10	0.000000
X3	0.2062515E+09	0.000000
X5	0.2062515E+09	0.000000
X6	0.2062515E+10	0.000000
X7	0.2062515E+09	0.000000
X8	0.4125030E+09	0.000000
X9	0.2062515E+08	0.000000
X10	0.2062515E+09	0.000000
Y8	0.2801066E+09	0.000000
X4	0.1272929E+10	0.000000
D1P	0.000000	0.000000
D2P	7386197.	0.000000
D3P	0.3799374E+09	0.000000
D4P	0.2528505E+10	0.000000
D5P	0.2868449E+10	0.000000
D6P	0.3093773E+10	0.000000

Table 5.8 :The slack or surplus and dual price for objective function and the constraints

```
Row     Slack or Surplus        Dual Price
  1          0.000000           -1.000000
  2          0.000000            0.000000
  3        0.1031258E+10         0.000000
  4          0.000000            0.000000
  5        0.1031258E+10         0.000000
  6          0.000000            0.000000
  7        0.2062515E+09         0.000000
  8          0.000000            0.000000
  9        0.2062515E+09         0.000000
 10          0.000000            0.000000
 11        0.4125030E+09         0.000000
 12          0.000000            0.000000
 13          0.000000            0.000000
 14        0.4125030E+09         0.000000
 15          0.000000            0.000000
 16          0.000000            0.000000
 17        0.2062515E+09         0.000000
 18          0.000000            0.000000
 19          0.000000            0.000000
 20          0.000000            0.000000
 21          0.000000            0.000000
 22          0.000000            0.000000
 23          0.000000            0.000000
 24          0.000000            0.000000
 25          0.000000            0.000000
 26          0.000000            0.000000
```

Note that LINGO refers to the objective function as "row (1)" and the constraint as rows (2)-(26).

LINGO also provides the simple ranges information that can be used for sensitivity analysis:

Table 5.9 : Objective Coefficient Ranges :

```
Ranges in which the basis is unchanged:

                         Objective Coefficient Ranges:

                      Current          Allowable        Allowable
       Variable     Coefficient         Increase         Decrease
            D4N      0.2640000          INFINITY        0.2640000
            D3N      0.2370000          INFINITY        0.2370000
            D5N      0.2360000          INFINITY        0.2360000
            D1N      0.9000000E-01      INFINITY        0.9000000E-01
            D2N      0.9000000E-01      INFINITY        0.9000000E-01
            D6N      0.8300000E-01      INFINITY        0.8300000E-01
             X1      0.000000           INFINITY        0.000000
             X2      0.000000           INFINITY        0.000000
             X3      0.000000           INFINITY        0.000000
             X5      0.000000           INFINITY        0.000000
             X6      0.000000           INFINITY        0.000000
             X7      0.000000           INFINITY        0.000000
             X8      0.000000           INFINITY        0.000000
            X10      0.000000           INFINITY        0.000000
             X4      0.000000           0.9000000E-01   0.000000
            D1P      0.000000           INFINITY        0.000000
            D2P      0.000000           INFINITY        0.9000000E-01
            D3P      0.000000           INFINITY        0.2370000
            D4P      0.000000           0.4500000       0.000000
            D5P      0.000000           0.7500000E-01   0.000000
            D6P      0.000000           INFINITY        0.000000
```

Table 5.10 : Right hand side Ranges

```
                   Righthand Side Ranges:


              Current         Allowable         Allowable
     Row        RHS           Increase          Decrease
      2      0.3093773E+10    0.1031258E+10    0.3093773E+10
      3      0.4125030E+10      INFINITY       0.1031258E+10
      4      0.5156288E+10    0.1031258E+10    0.3093773E+10
      5      0.6187545E+10      INFINITY       0.1031258E+10
      6      0.2062515E+09    0.2062515E+09    0.2062515E+09
      7      0.4125030E+09      INFINITY       0.2062515E+09
      8      0.2062515E+09    0.2062515E+09    0.2062515E+09
      9      0.4125030E+09      INFINITY       0.2062515E+09
     10      0.2062515E+10    0.4125030E+09    0.2062515E+10
     11      0.2475018E+10      INFINITY       0.4125030E+09
     12      0.2062515E+09      INFINITY       0.2062515E+09
     13      0.4125030E+09    0.4125030E+09    0.4125030E+09
     14      0.8250060E+09      INFINITY       0.4125030E+09
     16      0.2062515E+09    0.2062515E+09    0.2062515E+09
     17      0.4125030E+09      INFINITY       0.2062515E+09
     21      0.1272929E+10      INFINITY       0.1272929E+10
     22      -7386197.          7386197.         INFINITY
     23     -0.3799374E+09    0.3799374E+09      INFINITY
     24      0.3609748E+08    0.2528505E+10      INFINITY
     25      0.1440773E+09    0.2868449E+10      INFINITY
     26      0.5156288E+10    0.3093773E+10      INFINITY
```

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

6.2 Recommendations

6.1 Conclusion

one of the most important duties of the financial management is the asset and liability management. Existence of various and sometimes conflicting objectives in this field would support the necessity of using the multi-objective decision making models. The study designs the goal programming model for the optimal management of assets and liabilities in BOP. The findings of the study are as follows:

1. Design a quantitative model for the optimal management of assets and liabilities is possible in studied bank.

2. Using the GP model as a decision making tool in ALM, while risk is under control, you can increase return.

3. Using the Analytic Hierarchy Process, the importance degree of the most important objectives in the field of ALM can be quantitatively measure

4. 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.

6.2 Recommendations

1. Using of other quantitative models and comparison of its findings with used model and also using of statistical models and econometric for predicting the model's inputs.

2. Using of presented model in public and private banks, Comparison and analysis of obtained finding.

3. Entrance of balance sheet's off items and affective on balance sheet to model.

4. Entrance of other financial concepts in model for example liquidity gap and other risks.

5. Presentation and analysis of quantitative models in shorter time for example Six month or monthly

6. Other type's definition of necessities, new goals and a test about its effect on model finding.

7. Decision makers in banks especially BOP are recommended to use the findings of this research in any future strategic management.

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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 goals of assets and liabilities management in the bank sectors in Gaza strip in 2013-2014.

This questionnaire is the first step in constructing a model in order to manage the optimal assets and liabilities using the Goal Programming model.

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 in your opinion.

The research will help toward improved evaluation process to arrive to successful final management of assets and liabilities.

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:

Afnan .Gh.Hassan

Supervisor:

Prof. Dr. Yousif H. Ashour

Part I

General Information

Put the sign (X) in the suitable selection:

- **Place of work**

☐ Bank of Palestine

☐ Quds Bank

☐ Palestine commercial Bank

☐ palestine investement Bank

- **Experiences**

☐ 1 – 4 years

☐ 5 - 10 years

☐ More than 10 years

- **Education**

☐ Bachelor (B.Sc.)

☐ Master (M.Sc.)

☐ Doctorate (Ph.D.)

Part II

Main criteria	Very important	Important	Moderately important	Little important	Not important
Market share of credit					
Market share of deposits					
Return on assets					
Return on equity					
Capital adequacy ratio					
Liquidity risk					

Other important 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 identified in questionnaire 1 and their importance in the process of prioritizing and determining the importance degree of goals using Analytic Hierarchy Process.

This questionnaire is the first step in constructing a model in order to manage the optimal assets and liabilities in banks in Gaza Strip using the Analytic Hierarchy Process and Goal programming.

The research will help toward improved evaluation process to arrive to successful final Manage of assets and liabilities.

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

Afnan .Gh.Hassan

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:

Goals	Capital adequacy	Liquidity risk	The growth of total assets
Capital adequacy		3	1
Liquidity risk			1/5
The growth of total assets			

3: means that the importance of "Capital adequacy" is 3 times the importance of "Liquidity risk"

1: means that the importance of "Capital adequacy" is the same as the importance of "The growth of total assets"

1/5: means that the importance of "The growth of total assets" is 5 times the importance of "Liquidity risk"

Criteria pair wise comparison

Criteria	Market share of credit	Market share of deposit	Return on assets	Return on equity	Capital adequacy	Liquidity risk
Market share of credit						
Market share of deposit						
Return on assets						
Return on equity						
Capital adequacy						
Liquidity risk						

Appendix C: Balance sheet of bank of Palestine

Bank of Palestine		
Consolidated Financial Position Statement		
	12/31/2014	12/31/2013
	USD	USD
Assets		
Cash and balances with Palestine Monetary Authority	346,222,324	638,406,726
Balances at banks and financial institutions	581,758,608	350,748,099
Financial assets at fair value through income statement	7,367,695	7,085,308
Direct Credit Facilities	1,151,825,644	1,103,641,018
Financial assets at fair value through other comprehensive income	22,671,941	22,313,964
Financial assets at amortized cost	226,643,035	146,594,774
Investment in an associate	18,692,906	17,070,699
Property, plant and equipment	47,981,522	39,587,275
Projects in progress	2,272,393	8,291,148
Other assets	19,337,893	14,306,932
Total Assets	**2,424,773,961**	**2,348,045,943**
Liabilities and Equity		
Liabilities		
Palestine Monetary Authority's deposits	24,086,209	90,206,966
Banks and financial instiutions' deposits	753,769	142,399,691
Customers' deposits	1,908,480,620	1,668,535,234
Cash margins	154,043,455	77,028,031
Sundry provisions	18,320,233	16,373,477
Tax provisions	1,027,063	57,909,375
Other liabilites	37,956,034	43,574,195
Total Liabilities	**2,144,667,383**	**2,096,026,969**
Equity		
Paid in share capital	160,000,000	150,000,000
Additional paid in capital	9,034,692	9,034,692
Statutory reserve	32,023,745	28,006,564
Voluntarily reserve	147,932	95,845
General banking risks reserve	19,249,207	23,565,172
Pro-cyclicality reserve	27,849,613	22,005,031
Change in fair value	(4,797,893)	(5,159,800)
Retained earnings	35,916,850	23,839,731
	279,424,146	**251,387,235**
Non-controlling interests	682,432	631,739
Total Equity	**280,106,578**	**252,018,974**
Total Liabilities and Equity	**2,424,773,961**	**2,348,045,943**

Appendix D: Expert names and position

- Said Meqdad, assistant head of financial planning division of bank of Palestine.
- Sai'd El Khatib, manager of Palestinian commercial bank.
- Shokri kurraz, manager of Quds bank.
- Maher El Daloo, assistant of head manager of Palestinian investment bank.

Appendix E: Goal programming model 2013

Min
 0.264 d4n +0.237 d3n + 0.236 d5n + 0.09 d1n+ .09 d2n+ .083 d6n
St
X1-3y3-3y4>=0
 X1-4y3-4y4<=0
X2-2y3-2y4>=0
X2-2.5y3-2.5y4<=0
X3-.1y3-.1y4>=0
X3-.2y3-.2y4<=0
X5-.1y3-.1y4>=0
X5-.2y3-.2y4<=0
X6-.8y3-.8y4>=0
X6-1y3-1y4<=0
X7-0.1y3-0.1y4>=0
X8-.2y3-.2y4>=0
X8-.4y3-.4y4<=0
X9 -0.05y3-.05y4=0
X10 -.1y3-.1y4>=0
X10 -.2y3-.2y4<=0
Y3=1668535234
Y4=77028031
y8=252018974
X4+d1n-d1p=1120071546
y3+y4+d2n-d2p=1744311906
1.5y8+d3n-d3p=40438831
.2 X1+.2 X2+.2 X3+.2 X4+.2 X5+.2 X6+.2 X7+.2 X8+.2 X9+.2 X10 +d4n-d4p=40438831
1.2X3+1.2X4+1.2X5+1.2X7+1.2X8+1.2X9+1.2X10+d5n-d5p=166318565
X1+X2 -2.5 y3-2.5 y4+d6n-d6p=0
end

Appendix F: Goal programming model 2014

Min
 0.264 d4n +0.237 d3n + 0.236 d5n + 0.09 d1n+ .09 d2n+ .083 d6n
St
X1-1.5y3-1.5y4>=0
 X1-2y3-2y4<=0
X2-2.5y3-2.5y4>=0
X2-3y3-3y4<=0
X3-.1y3-.1y4>=0
X3-.2y3-.2y4<=0
X5-.1y3-.1y4>=0
X5-.2y3-.2y4<=0
X6-1y3-1y4>=0
X6-1.2y3-1.2y4<=0
X7-0.1y3-0.1y4>=0
X8-.2y3-.2y4>=0
X8-.4y3-.4y4<=0
X9 -0.01y3-.01y4=0
X10 -.1y3-.1y4>=0
X10 -.2y3-.2y4<=0
Y3=1908480620
Y4=154034455
y8=280106578
X4+d1n-d1p=1272929475
y3+y4+d2n-d2p=2055128878
1.5y8+d3n-d3p=40222506
.2 X1+.2 X2+.2 X3+.2 X4+.2 X5+.2 X6+.2 X7+.2 X8+.2 X9+.2 X10 +d4n-d4p=40222506
1.2X3+1.2X4+1.2X5+1.2X7+1.2X8+1.2X9+1.2X10+d5n-d5p=168827481
X1+X2 -2.5 y3-2.5 y4+d6n-d6p=0
end