THE DETERMINATION OF OPTIMAL TIME-IN-GRADE FOR PROMOTION AT EACH RANK IN THE TURKISH ARMY

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Barbaros Hayrettin ŞENERDEM

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

Assistant Professor Yavuz GÜNALAY

Supervisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

Assistant Professor Oya Ekin KARAŞAN

Examining Committee Member

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

Associate Professor Erdal EREL

Examining Committee Member

Approval of the Institute of Economics and Social Sciences.

Professor Kürşat Aydoğan

Director Of Institute Of Economics And Social Sciences

ABSTRACT

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ŞENERDEM, Barbaros Hayrettin

M.B.A. Thesis

Supervisor: Assist. Prof. Yavuz GÜNALAY

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The increasing pace of development in Human Resource Management makes an objective promotion system more valid than a system on subjective criteria in the Turkish Army. Therefore, the Army Headquarters tries to adapt an appropriate promotion system and criteria to The Turkish Army's big hierarchical structure. Thus, the gap between the current and required officer inventory in the promotion system is thought to be minimized.

In this study, the validity of a new promotion system, which is still under consideration in Human Resource Department of The Turkish Army, is evaluated against the current promotion system in The Turkish Army to establish a base for further quantitative research. The core of the study focuses on a non-linear optimization problem. The optimization is to obtain optimal values for time to wait at a rank until promotion. Optimal values of the selected promotion criteria, time – in-grade, are thought to make great contribution to further personnel decisions in The Turkish Army's promotion system. The constructed model also supports the manpower planning requirements of the Army in determining the impact of existing policies on given promotion criteria over the long term.

Keywords: Human Resource Planning, The Turkish Army Manpower Planning, Non-linear Programming, Promotion, and Time-in-Grade.

ÖZET

TÜRK SİLAHLI KUVVETLERİ'NDE TERFİ İÇİN OPTİMAL RÜTBE BEKLEME SÜRELERİNİN BELİRLENMESİ

ŞENERDEM, Barbaros Hayrettin

M.B.A. Tezi

Tez Yöneticisi: Yard. Doç. Dr. Yavuz GÜNALAY

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Günümüzde İnsan Kaynakları Yönetimindeki gelişmeler, Türk Kara Kuvvetleri'nde objektif terfi sistemlerinin subjektif olanlardan daha fazla değer görmesine sebep olmuştur. Bu yüzden, Kara Kuvvetleri Karargahı en uygun terfi sistem ve kriterlerini kendi hiyerarşik yapısına katma çabasındadır. Böylelikle mevcut ile ihtiyaç duyulan subay miktarı arasındaki fark en aza indirgenmiş olacaktır.

Bu çalışmada, öncelikle kantitatif araştırmaya temel teşkil etmesi açısından, teklif edilen terfi sisteminin geçerliliği mevcut sistem karşısında değerlendirilmiştir.

Çalışmanın asıl bölümü ise doğrusal olmayan programlamayı içeren en iyileme modeli üzerine yoğunlaşmıştır. Burada optimizasyon, bir rütbedeki terfiye esas rütbe bekleme sürelerinin optimal değerlerini bulmak için yapılmıştır. Optimal rütbe bekleme sürelerinin, ileride terfiyi ilgilendiren kararlarda büyük katkı sağlayacağı düşünülmektedir. Ayrıca, oluşturulan model Kara Kuvvetleri insan gücü ihtiyaç planlamasını desteklemektedir. Bu destek terfi kriterleri üzerindeki mevcut politikaların etkilerini uzun dönem için belirlememizi sağlar.

Anahtar Kelimeler: İnsan Kaynakları Planlaması, Türk Kara Kuvvetleri İnsan Gücü Planlaması, Doğrusal Olmayan En İyileme Modelleri, Terfi ve Rütbe Bekleme Süreleri.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

1. INTRODUCTION

As the understanding of management changes very fast, the human factor gets its place in this new occurrence, since the mutual interests of both an individual and organization shape the integrated vision of organizations. Therefore, with a picture of rapidly changing future, it must be pointed to call for a rethinking of many of principles that govern the management of personnel in the organizations. In other words, the Human Resource Management (HRM) function became a key-supporting element in the management of organizations. From the perspective of corporate objectives, HRM is responsible for ensuring that the right people are available at the right places and at the right times to execute corporate plans with the highest level of quality. Such a role is also often referred to as manpower planning. Process and system improvements to manpower planning offer benefits to the HRM function and to the organization as a whole. The central concern in manpower planning is in matching staff availability with staff requirements, which is essentially an optimization problem.

The optimization is particularly interested in manpower movements. They are the results of recruitment, promotions, continuations, attritions, and retirements over multiple periods of time. The optimal manpower flow with some management policies paves the way for personnel strength targets. In this perspective, I suppose that this thesis is going to propose some criteria in the methodology of manpower planning in hierarchical organizations, in which a promotion system is used as a backbone.

Since the Turkish Army reserves much of its efforts for development of the current promotion system, the focus of my thesis is a contribution to what the project groups in the Turkish Army Headquarters have had so far on this subject. Thus, the focus is on the determination of a promotion eligibility criterion value through the draft system. The optimal value serves the perfect personnel flow in the system by constructing the required hierarchical structure of the Turkish Army.

Major objectives of the thesis can be listed as follows:

a. To examine the Turkish Army's organizational structure for promotion
b. To demonstrate the justifiability of the proposed draft promotion system
c. To construct a manpower planning model for promotion
d. To show the contribution of the model's major determinants to the output

In the study, after reviewing the literature about promotion, manpower planning, and relevant mathematical models in Chapter 2, brief background

information about the Turkish Army promotion system is presented in Chapter 3 along with some evaluations on revision in the system. Chapter 4 explains construction of the promotion model in discussion of the methodology used. Chapter 5 contains discussion of the optimization model's results. Finally, conclusion and recommendations take place in Chapter 6. The appendices are supportive of the application aspect of the thesis. Included are GAMS codes of relevant models.

CHAPTER 2

2. LITERATURE REVIEW

2.1. HUMAN RESOURCE MANAGEMENT AND PLANNING

In today's world, differentiation from other forms of management essentially gets shape around people. It is people who make the difference. Therefore, effective HRM became a key issue for all organizations. The efforts in HRM are to build and maintain an ideal work environment and work atmosphere through performance excellence, full participation, and personal and organizational growth.

HRM deals with: (Schuler, 1995)

a. Staffing (recruitment, promotion, selection, and placement),
b. Appraising (performance appraisal),
c. Compensating (total compensating, performance-based pay, and indirect compensation),
d. Training and organization development.

In general terms, HRM is responsible for identifying, prioritizing, and strategically planning for emerging HR issues, trends, and opportunities which will impact organizations. It establishes a process for looking ahead and addressing long term HR issues and problems before it is too late.

The efforts in all of these focuses aggregate the whole personnel policy of the organization. The way to follow this policy is constructed upon HR planning or manpower planning. Manpower planning can be said to be the core of HRM, supported by other aspects of HRM. In other words, HR planning gives an approach to HRM system considering manpower in an aggregate sense. Process and system improvements to HR planning also imply benefits both to the HRM function and to the organization as a whole. To Schuler (1995), the HR planning function is responsible for:

a. Reducing cost by anticipating and correcting labor shortages and surpluses before they become unmanageable and expensive,
b. Making optimum use of workers' aptitudes and skills,
c. Improving the overall business planning process,
d. Providing more opportunities for women, minority groups, and disabled individuals in future growth plans,
e. Identifying the specific skills available and needed,
f. Promoting sound HRM throughout all levels of the organization,
g. Evaluating the effect of alternative HR actions and policies.

Grinold *et al.* (1977), and Khoong (1999) say that HR planning within an organization ideally has the basic purpose of producing the correct numbers of the correct types of people in the correct jobs at the appropriate times.

People, jobs, money, time are especially the basic components of HR system (Grinold *et al.*, 1977). A decision maker should know the interactions among these components to formulate and evaluate an HR system, because they are important determinants of employee satisfaction and performance for efficiency of an organization. In accordance with the purpose of the HR planning, a correct match among these four components of the HR system provides more effective implementation through planning. Therefore, HR planning realistically prevents having too many wrong types of matches too frequently. Without it, destructive problems are bound to occur.

The successful implementation of manpower plans depends on how much they are consistent with the total organization's long run needs. The success in plans requires: (Sayles *et al.*, 1981)

a. An understanding of the existing interdependencies among personnel systems and personnel flows,
b. The establishment of guideline and policies based on this understanding, within which managers will make their personnel decisions,
c. Some mechanisms to detect when these policies either need change or are being violated.

The successful pursuit of these requirements put decision makers into a better position to catch the answers to potential questions related to HRM.

Ideally, an organization predicts the number of each kind of skill it will require and recruit people for those positions. Designing that kind of HRM system through planning requires the organization both to predict its future needs and to develop systematic job analyses that allow the development of learning leader (Sayles *et al.*, 1981). The content of each job as an output of job analysis plays an important role in determination of personnel needs, satisfaction levels, and coordination. Furthermore, these aspects of HRM shape the promotion policy in terms of the organization's broader personnel philosophy. Thus, career path or promotion ladders differ in length, breadth, and permeability from one organization to another (Sayles *et al.*, 1981).

2.2. THE PROMOTION CONCEPT

In an organization structure, authority and responsibility belonging to a position should be clearly identified. To an employee, a position may imply somewhere to fill on a career ladder. However, to an employer, a position may imply a branch in a hierarchical pyramid for a smooth workflow. From this context, the different definitions of promotion have slight differences in meaning.

In general terms, the promotion can be simply defined as having more authority and responsibility in an organization structure. In the dictionary definition, promotion implies raising a person to a higher or better position with greater privileges and salary, especially when done according to a fixed and normal gradation or after tests evaluating professional competence (Macmillan Dictionary). Scheer (1985) defined promotion as an upgrading of a worker's job from one level to a higher one with a correspondingly higher rate of pay. Although many pay increases are characterized by promotion, the key factors in upgrading are authority and responsibility increase (Tortop, 1992 and Ivancevich *et al.*, 1983).

Whatever the definition of promotion is, major concern leads us to employee needs and aspirations. It would be naïve to assume that all employees' motivational factors are the same or that their aspirations remain constant over a career. On one hand, some achievement-oriented people always seek much more than ever. Career path is a way to satisfy their desires through promotion. To this kind of people, promotion is a move up the career ladder (Encina, 2000). On the other hand, isolation from a hard and a demanding work with a lower-paid and easier job may be accepted as promotion. These are the different perceptions of the meaning of advancement among people (Sayles *et al.*, 1981, and Nelson *et al.*, 1997).

In practice of filling any job vacancy, it is a way to select the best-qualified person whether he/she is outside from the organization or he/she is inside the organization. If this need for this job vacancy meets with anyone within the organization, the practice is named promotion.

From a different perspective, a systematic promotion can be seen as one step in a consequence of jobs for employees to enlarge or broaden their understanding of overall operations in accordance with more company convenience, not only with employee's interest (Scheer, 1985).

2.3. THE PURPOSE OF PROMOTION

Promotion is a result of contribution to skills and creativity through motivation for employees. Thus, the degree of how much employees are qualified can be differentiated in peers by promotion. The execution of promotion gives them a chance of self-realization towards new steps in career path. If their expectations and objectives in career formation come parallel to that of the organization, promotion can be accepted as a strategic tool providing benefits toward organizational goals. As it is seen, the purpose of promotion can be evaluated from two different perspectives including employee side and organization side (Yücel, 1997). These are:

a. To create personnel source for upper levels in hierarchical pyramid with regard to organizational needs: One value of promotion from within lies in its chain reaction. To fill one higher job, which in turn creates a vacancy lower down (Scheer, 1985). And it goes down right to the positions that belongs to junior staff for recruitment. The promotion system works with a personnel pull policy from lower levels in accordance with job vacancies.

b. *To provide satisfaction for employees:* When a system involves human factor, psychology plays an important role in shaping the structure of process. To talk about satisfaction, we must go down into motivation in psychology. The strength of a tendency to get promotion depends on how much an employee places importance on a higher grade as a reward. This is the motivation that makes an employee competitive, creative, and courageous to nurture his/her talent toward promotion. Thus, the more motivation is, the more satisfaction one gets.

Baker *et al.* (1988) point out that promotions in organizations serve two important and distinct purposes. First, individuals differ in their skills and abilities, jobs differ in the demands they place on individuals, and promotions are a way to match individuals to the jobs for which they're best suited. This matching process occurs over time through promotions as employees accumulate human capital and as more information is generated and collected about the employee's talents and capabilities. A second role of promotions is to provide incentives for lower level employees who value the pay and prestige associated with a higher rank in the organization.

2.4. THE MOTIVATION THEORIES RELATED TO PROMOTION

The motivation theories directly related to promotion are Herzberg's two-factor theory, McChelland's need theory, and expectancy theory.

2.4.1. Herzberg's Two Factor Theory

Herzberg's two-factor theory is interested in people's satisfied and dissatisfied needs at work. Work conditions related to satisfaction of the need for psychological growth are named motivation factors. Work conditions related to dissatisfaction caused by discomfort or pains are named hygiene factors (Nelson *et al.*, 1997).

The hygiene factors are not the main focus for psychological growth or individual development. However, the motivation factors are considered as tools to lead a person to contribute to the work and themselves in the organization. They directly affect a person's motivational drive to do a good job. When we examine motivators for job satisfaction below, it is seen that they all are the elements that constitute promotion. The motivation factors are: (Herzberg, 1982)

a. Achievement,
b. Recognition of achievement,
c. Work itself,
d. Responsibility,
e. Advancement,
f. Growth,
g. Salary.

In a chain reaction, the satisfaction of one or more of these factors above naturally leads anyone at work toward promotion. Only the result varies according to how promotion is perceived in terms of types.

2.4.2. McChelland's Need Theory

McChelland's Need Theory focuses on personality rather than satisfaction and dissatisfaction. In the theory, the three basic points, which shows variation depending on personality, are accepted as achievement, power, and affiliation.

The need for achievement deals with the issues of excellence, competition, challenging goals, persistence, and overcoming difficulties (Nelson *et al.*, 1997). A person with a high need for achievement always seeks for a position one-step ahead that satisfies his/her need.

The need for power deals with making an impact on others and events. A person with a high need for power tries to catch an opportunity to control other people. If promotion gives this power, the person will have an urge to get promoted at whatever he/she pays for it.

However, the need for affiliation is concerned with close interpersonal relationships including mutual understanding. This fundamental point is seen away from what urges people for promotion.

2.4.3. Vroom's Expectancy Theory

Vroom's Expectancy theory offers a model of how rewards for performance affect behavior. A person's motivation increases as long as he/she believes that effort is for performance and that performance is for rewards, assuming the person wants the rewards (Nelson *et al.*, 1997). In the same context, Whetten *et al.* (1998) wrote that:

> "Motivation is manifested as work effort and that effort consists of desire and commitment. Motivated employees have the desire to initiate a task and the commitment to do their best. Whether their motivation is sustained over time depends on the remaining elements of the model, which are organized into two major segments: (1) the effort → performance link and (2) the outcomes (rewards) → satisfaction link. These crucial links in the motivational process can be best summarized as questions pondered by individuals asked to work harder, change their work routine, or strive for a higher level of quality."

All people place different value on each reward, but promotion is a combination of many rewards such as higher salary, power, authority, and responsibility. That is why people prefer promotion in common to satisfy their needs. In general, promotions are good for the motivation of all the staff as they see their peers being rewarded for good performance and it gives employees the feeling that they can grow in the organization.

According to Baker *et al.* (1988), in order to provide incentives, this model predicts the existence of reward systems so that a worker's expected utility increases with observed productivity. These rewards can take many different forms, including praise from superiors and co-workers, implicit promises of future promotion

opportunities, feelings of self-esteem that come from superior achievement and recognition, and current and future cash rewards related to performance.

Unfortunately, promotion incentives are reduced for employees who have been passed up for promotion previously and whose future promotion potential is doubtful, and incentives will be absent for employees who clearly fall short of the promotion standard or who cannot conceivably win a promotion tournament. In addition, promotion possibilities provide no incentives for anyone to exceed the standard or to substantially outperform his or her coworkers (Baker *et al.*, 1988).

2.5. PROMOTION STRUCTURE

2.5.1 Promotional Career Paths

Every organization must determine how employees should normally progress from one position in grade to another. The answer to this question lies in promotional career paths. Before we go any further we need a definition of "career", Addison, (2000) gives five distinct meanings of career.

a. Career as advancement through vertical movements upwards – the traditional definition,
b. Career as profession – associates vertical movement through a profession,
c. Career as a life long sequence of jobs,

d. Career as a sequence of role related experiences,
e. Career as a life long sequence of work attitudes and behaviors – emphasis on the pattern of movement between work roles and subjective experiences of the individual.

The meanings show that promotion shapes its frame around career. Therefore, the progress at work knits both of them together. Promotion is a transition between one stage of career and another. It has to follow the career path constructed upon organizational structure in order to grow in the organization. In other words, development of individuals enables them to move through promotional career path.

A well-designed career path offers many advantages to an organization: (Sayles *et al.*, 1981)

a. It creates increasing challenge, employee growth, and on the job learning. It offers the individual an opportunity to grow to his or her full potential,
b. It plays a complementary role for the organization's qualified employees toward ideal,
c. It is an important source of motivation through promotion, because promotion is one of the most highly visible rewards for the fine performance,
d. It allows the organization to appraise people on the basis of their actual performance rather than their potential,

e. Promotion through a career ladder is often cheaper than hiring fully qualified candidates from outside the organization,

f. Promotional programs provide the best means for most organizations to meet affirmative action goals.

However, rather than encouraging the opening-up career paths for everyone, management in some areas has to close off career access, because of the problem of career bottlenecks (Junor, 1997). Non commissioned officer advancement after transition to officer career path faces with somewhat similar limitation in Turkish Army.

2.5.2 Types of Promotion within Organizations

The change in the complexity of the organizational structure offers three different promotion types within organizations; vertical promotion, horizontal promotion, and cross promotion (Yücel, 1997). Experience, skills, training, and managerial qualifications are detrimental factors for all promotion types. Although there is a wider range of career paths in definition, only some of them are related to promotions within organizations.

a. *Vertical Promotion:* Vertical promotion can be defined as movement up to a higher position in the pyramidal design of organizations. The transition in the hierarchy of the organization is vertical. It means more authority and responsibility together with rise in salary. It is conducted through vertical career path.

b. *Horizontal Promotion:* It refers to sideway moves into different jobs at the same level. On contrary to vertical promotion, the transition in this type of promotion is horizontal. It is very simple way of promotion following horizontal career path. Although it does not provide any employee a rise in authority, responsibility, and salary, it can give prestige, privilege, and comfort according to position. The horizontal promotion can be justified in terms of a need for variety and interest, and may broaden a person's skills if pursued systematically.

c. *Cross Promotion:* Cross promotion involves a combination of the horizontal and vertical models. According to the need of organizations, both promotion processes are conducted across from one department to another within organization. It has the highest responsibility in the promotion types.

Other than formal promotional types, the informal promotion refers to the need of self-actualization, but it occurs rarely (Yücel, 1997).

2.6. PROMOTION CRITERIA

The criteria principles of promotion are affected from many variables such as environment, organizational culture, economic and legal frame, and managerial policy.

The promotion criteria can be first divided into two groups as direct criteria and indirect criteria. The direct promotion criteria include seniority, merit, ability, exams, training, and on-job evaluation. However, indirect criteria include nepotism, political nepotism, favoritizm, ethnic, and religious factors. (Yücel, 1997, and Sayles *et al.*, 1981).

2.6.1. Direct Promotion Criteria

2.6.1.1. Merit

What emerges consistently is an image of a world in which competition has squeezed every organization to promote only the most productive individuals, in which all slack has been eliminated. If good performance deserves promotion, the best performers should be advanced. Good performance may lie in the quality of job, skills, proficiency, persistence, motivation, initiative, adaptability, the ability to learn new tasks and interpersonal skills. Differences in merit may not be easily measured. Performance on some jobs reflects the impacts of many different people chance factors, so individual merit can be hard to measure. Therefore, effective performance appraisal helps build trust in the system.

For the sake of efficiency, the proper and rational use of personnel sources is very important for organizations. The merit-based promotion system attracts ambitious professionals impatient with the seniority-based promotion system,

because promotions based on merit advance employees who are best qualified for the position, rather than those with the greatest seniority. Therefore, those, who are able to contribute more to the outcome of the organization, should be considered for promotion on the merit base. Otherwise, corrupted system makes efficiency go down in the whole organization.

In short, the benefits and disadvantages of merit systems are outlined below: (Encina, 2000)

Advantages:

a. Employee job-related abilities can be better matched with jobs to be filled,
b. Motivated and ambitious employees can be rewarded for outstanding performance,
c. Performance is fostered,
d. People can be hired for a specific job, rather than for ability to be promotable.

Disadvantages:

a. Merit and ability are difficult to measure in an objective, impartial way,
b. Supervisors may reward their favorites, rather than the best employees, with high merit ratings,

c. Disruptive conflict may result from worker competition for merit ratings,
d. Unlawful discrimination may enter into merit evaluations.

2.6.1.2. Seniority

The use of subjective criteria such as merit and ability leads many employees to feel that promotions are not made fairly. To come closer to objectivity, seniority takes its place among the decision criteria. This obvious criterion, seniority, means length of continuous service in a grade. In other words, seniority is computed in years and days of employment based on elapsed time from the date of entrance to employment. The amount of accumulation of seniorities during the period of employment is prime determinant in promotion. In a straight seniority system, an employee would enter the organization at the lowest possible level and advance to higher positions as vacancies occur. With this criterion, employee is deemed to have greater relevant seniority than any other employee for such a position. It is the oldest criteria for promotion to depend on. In addition to this, why seniority is accepted more than other criteria, is that rewarding seniority encourages loyalty and commitment and promotes cooperation (Ivancevich *et al.*, 1983 and Encina, 2000).

The ease of measurement of this criterion makes it close to objectivity. Therefore, the general acceptance of promotion based on seniority is more common than that of others.

However, promotions primarily on the basis of qualifications, demonstrated skills and abilities, and past performance of duty can be governed by seniority when two or more employees have equal qualifications and have demonstrated equal ability and skill through past performance of duty (SLU Promotion Policy, 1998).

Length of service is thought to be correlated with ability. Over time, an employee learns more about job and its requirements. Also with age grading, older people are assumed to deserve more privileges (Sayles *et al.*, 1981).

Apart from all, employees can be promoted only as fast as length of service permits. While the seniors may be set in their ways, the juniors may be highly ambitious. If good performers are not promoted relatively rapidly, they will leave or reduce their efficiency. Therefore, it gives no way for competition and prevents motivation. Thus, creativity gets lost under the burden of seniority-based promotion. In Turkey, some current government systems working with seniority-based promotion are away from responsibility, sensibility, and efficiency (Tutum, 1994).

Excess capacity in cadre leads the system to inefficiency in seniority-based promotion. It is also a loophole in this system that unqualified personnel may fill the vacancies (Yücel, 1997). It serves only as an incentive or reward for people who are not capable of being promoted along with their peers. These people compete for promotion against individuals who have not been in the system as long and take

up the slots of those who are younger, more ambitious and perhaps better future leaders.

In addition to all, many organizations have at least two scales for describing the seniority of staff. One scale is related to the organizational appointment hierarchy (which resemble a managerial career path hierarchy). Another is related to the salary grade of the staff (which is often the scale used to define a technical career path). The salary is more stable than the appointment hierarchy scale (which may change each time the organization is restructured). It is generally accepted that appointment levels is tied to each salary grade (Khoong, 1996).

In summary, the benefits and disadvantages of using seniority in promotion decisions follow as: (Encina, 2000)

Advantages:

a. Employees get to experience many jobs on the way up the promotional ladder, provided that they stay long enough and openings develop. Jobs can be grouped into different ladders such that experience on one job constitutes good training for the next,
b. Cooperation between employees is generally beyond competition,
c. Employees need not seek to gain favor with supervisors for promotion. If, for example, a supervisor's direction violates the

interests or policy of the ranch, employees might have less hesitation not to follow it.

Disadvantages:

a. Some employees may not be able or want to do certain jobs into which a strict seniority system would propel them. Employees should be able to opt not to accept an opportunity for promotion,
b. Ambitious workers may not be willing to "wait their turn" for higher-level jobs that they want,
c. Employee motivation to work as well as possible is not reinforced,
d. Employers would tend to hire over skilled people at entry level, so they have the capacity for promotion.

It is also impossible under the pyramidal structure of any organization to get and keep school graduates until a fixed retirement age and offer the majority of them pay raises and promotions on the basis of length of service (Imada, 1995)

2.6.1.3. Seniority & Merit Together

Seniority and merit combination in the promotion process may obtain a different mix of benefits (Encina, 2000). In doing so, there are many possible

variations leading to different results. For example, you could promote the most senior person minimally qualified for a job, or you could choose the most senior of the three best-qualified workers. An effective blend may combine good points from each.

Multi step-wise promotion system is also an adjustment to seniority based promotion (Imada, 1995). The rules of promotion change from the uniform seniority-based system to speed race-oriented scheme to the tournament race-oriented system according to the initial stage, the middle stage and the latter stage of a person's career. At the initial stage of a person's career, the system is strongly colored by seniority and is gradually becoming race-oriented to get quick or slow promotion. As the stages of career advance, the principles of competition appear and finally separate the winner from the loser.

2.6.1.4. Ability

It refers to potential performance. An employee may be doing fine on his current assignment, but he/she may lack the ability to take on more responsibility. Individuals differ in characters, ability, and attitudes. There is not any rule that a good teacher should always be a good principal in a school.

Long-term factors are also relevant. The individual best suited for an immediate promotion may not have the greatest long-term potential. The best

candidate in the short-run may be a senior employee who has the ability to move only one more step up the promotional ladder. Under the circumstances, it may be better to promote a younger person who will eventually advance into higher management (Sayles *et al.*, 1981).

2.6.1.5. Promotion Exams

Whatever the criteria are, promotion exams can be integrated with each selected criterion due to its positive effect toward objectivity. It cerates competition in the pursuit of evaluation of acquired skills, information, experience. Although promotion exams are seen as an objectivity factor in promotion, they sometimes are not preferred owing to being time consuming and need of proficiency in execution.

2.6.1.6. In - Service Trial

The evaluation of this criterion consists of a period before consideration of promotion. The cost of promotion decisions lead organizations this kind of rational evaluation. Instead of carrying the burden of wrong promotional decisions, this evaluation period is helpful to understand employees' eligibility. After completion of this period, if the employee fails to succeed, the employee may return to the former classification without loss of seniority. If the former job has not

been posted, the employee may return to the former job. The process's inclination to objectivity can be the reason of preference among promotion criteria.

2.6.1.7. Training

In promotion, training is required to gain relevant skills for a higher grade. Therefore, everyone is evaluated with level of her/his training for promotional consideration. In spite of efficiency and productivity after training, it is a force that has the promotion cost go up. A consistent training is a must for a permanent improvement toward promotion. From this context, the qualification of training should be determined according to requirements of positions. Every step in training makes you closer to be promoted.

2.6.2. Indirect Promotion Criteria

In general, these criteria are not a determinant for an objective promotion selection. What you belong must not be higher in degree than what you have in terms of skills, ability, experience, and performance among promotion preferences. They are nothing more than the things that make promotion system deviate from objectivity.

2.7. THE FACTORS AFFECTING AN EFFICIENT PROMOTION SYSTEM

Before planning promotion, it is a must to make clear the factors that affecting promotion system. Yucel, (1997) stated relevant fundamental factors as personnel policies, promotion policies, environmental changes, and psychological factors. Since our approach to the promotion model consists of mostly quantitative variables, we prefer to focus on the first two ones, which include more quantitative variables rather than the last two ones.

2.7.1. Personnel Policies

Personnel policies, the core of HRM, consist of everything right from general to detail in terms of planning or implementation. They are the initial steps toward consistent and efficient operations in organizations. Personnel policies get detail in recruitment, selection, training, retention, separations, retirement, transfers, promotions, staffing, and personnel need analysis. Promotion especially gets its shape over all those.

In addition to this, job analysis, cadre planning, and career planning in personnel need analysis serve promotion planning very much as well (Yucel, 1997). Only one of them means nothing without others.

Job analysis, the first step before personnel planning, determines the job qualifications for employees. It is also the core of personnel appraisal system. Thus, it creates considerable standards applied to promotion, which is thought to be last step in planning process (Uyargil, 1989).

Cadre is defined in Macmillan Dictionary as personnel forming the nucleus of a larger group or organization. On the other hand, it simply refers to each post forming the organization. Therefore the available employee inventory should be compatible with cadre capacity. Employee inventory never exceeds cadre capacity, which is a limitation in promotions. Cadre planning determines, for each individual, the list of posts that he/she can possibly move to which. So it is obvious that cadre and career planning are knitted each other to give way to promotions.

2.7.2. Promotion Policies

The qualified personnel in every level of organizations are very important for future operations. This expectancy is fulfilled only with promotion policies supported by powerful personnel policies.

In practice, promotion policies may affect employees' hopes for advancement and the productivity of workforce. For example, policies that all but guarantee promotions to present employees may discourage worker development.

Methods to follow, eligibility criteria for promotion, an objective appraisal system and authorized people to consider for promotion must be determined clearly in promotion policies. For example, suitability of posts, suitability of individuals and, expected time needed before movement to each post can determinant in policy-making. Organizational needs give a formation to the plans of promotion polices. If we think that the organization is in a continuous change, these plans must be reviewed periodically for commitment to the policies.

2.8. ANALYTICAL APPROACH TO PROMOTION

2.8.1. Mathematical Promotion Models in Manpower Planning

The mathematical models in promotion can be used to analyze manpower policy, assist in promotion planning, and grasp the fundamentals of manpower flow process. More about what we can do with models follows as: (Grinold *et al.*, 1977)

a. Forecast the future manpower requirements that will be satisfied by the current inventory of personnel,
b. Analyze the impact of proposed changes in policy, such as changes in promotion or retirement rules, changes in salary and benefits, and changes in the organization's rate of growth,
c. Explore regions of possible policy changes and allow a planner to experiment with and perhaps discover new policies,

d. Test the rationale of historical policy for consistency, and establish the relations among operating rules of thumb,
e. Understand the basic flow process, and thus aid in assessing the relative operational problems,
f. Designs systems that balance the flows of manpower, requirements, and costs,
g. Structure the manpower information system in a manner suitable for policy analysis and planning.

The models are constructed to relate organization or system performance to manpower policy. The effects of changes in policy, both in short and long term, can be predicted and quantified with the mathematical models.

It must be known that it is out of reach to model every aspect of real world system. Therefore, every model necessarily contains a number of assumptions. As long as we know the system constraints and understand the model's logic, our interpretations will be more valuable within these limitations and lead us to alternative polices for the manpower systems.

Since armed forces are manpower incentive, the use of proper mathematical models in promotion is obviously of central importance in planning for armed forces. It is the unique difference from the usual organizations that military manpower planning problems deals with a relatively stable labor force (the military career).

2.8.2. Promotion Model Development Studies in the Army

Related manpower planning studies about armed forces has been put forth in many models so far. Bres *et al.* (1980) developed a gal programming model to determine the allocation of officer sources for the present and future requirements in different specialty areas of the Navy. The importance of this model lies in that it includes many sources supplying officers for a variety of specialty areas, called warfare community, instead of single source and community. When we consider promotion, we will see that it covers the organization's manpower stocks as a whole, described in grade-stream-age combinations. To get a more detailed and consistent work, we should look at subsets of population, e.g. specific divisions or special pools (Khoong, 1996). Therefore the system frame is placed on various warfare communities dependent on commissioning programs and time-in-service. In this model, officer inventory requirements are specified within each community by the number needed at any time–in-grade (TIG)'s. Then, the main objective is the allocation of sources to the requirements of the Navy communities with possible least deviations, because officers shows a different career behavior that differs according to their sources. While achieving objectives, the model minimizes the difference between requirements and officer inventory in either positive or negative way. What makes the model explicitly recognized is also its unique time based characteristics with time-in-grade.

Rates used in the model were obtained from historical or other estimation procedures, because they were thought to be uncontrollable. It is important to know

in the models whether parameters are controllable in short or long terms. Khoong (1996) clears this point by saying that promotion rates are moderately controllable in the shot term but highly controllable in the long term through the career prospectuses. According to him, historical data can give good indicators on expected future behaviors of highly uncontrollable parameters, but give good indicators on expected future behaviors of highly controllable parameters.

Whereas the model deals with only one community, the effective use of the model for further use can be managed by trade-offs between requirements in various officer communities.

Apart from previous model, Gass *et al.* (1988) developed a model to project the strength of the active U.S. Army for 20 years in a way that it serves long-range manpower plans. The model involves the interaction of gains, losses, promotions, and reclassifications to determine the impact of existing policies over the long term and to determine changes that might be required to reach a desired force. Grades, skill, TIG are determinants of officer inventory and requirements where the number of officers is major changing variable for classifications.

This personnel goal-programming model is analyzed in two forms; that are the manpower planning model and the manpower requirement model. The models are constructed upon current system to adjust it to future requirements. Therefore initial officer inventories for each grade in the model are given. Accessions and separations serve as gains and losses respectively. The core of the process generally

depends on promotions, transfers to other skills, and costs of the force in terms of weights. Work on current system enable analyst to use fixed rates of separation and promotion. Also possible accessions by grade and TIG were given and added, as required, to form part of the officer inventory.

To reach the desired force within the Army, the objective function, which was controlled by grade target and total force target, was designed to minimize all deviations in separations, promotions, grade targets, and total force target. The importance of deviations in the function is given with weights attained to them. Gass's two models' constructions differ in the implementation of skill and TIG indices, which means that either one of the indices is variable while the other one is stable.

In a similar study, Candar (2000), in his master thesis, analyzed feasibility of a new promotion system and capability of balancing the number of officers related with their ranks in The Turkish Army. In his thesis, he developed an optimization model to find optimum promotion rates per rank, per year for the only warfare community of armor.

Another model is developed by Collins *et al.* (1983). This goal-programming model allows military manpower analysts to simulate and analyze the effects of manpower policy and program changes or the size and composition of the active duty forces. This "Accession Supply Costing and Requirements" model was designed to optimize the input of manpower accessions with supply, end strength, and man-year

constraints, and to determine the cost of the resultant force. Only length of service is a determinant factor in the model rather than both length of service and grades / ranks.

Also a model by Reeves *et al.* (1999) is related to a military reserve manpower-planning model. It is a multi objective model for manpower planning in a company-sized military unit. It includes five different objectives as minimizing the staff without special schooling, maximizing military education, maximizing mutual support missions, minimizing underachievement of skill training, and, minimizing underachievement of required training. The determinants in the model are grades, activities as objectives, time period, skill level and, education level.

2.8.3. Markov Chains

Many systems, which consist of a number of states, can have the property that given the present state, the past states have no influence on the future. This property is called the Markov property, and systems having this property are called Markov chains (Stone *et al.*, 1972).

In the definition of Markov chains, Freedman, (1983) propose a stochastic process, which moves through a countable set of states. At any stage, the process decides where to go next by a random mechanism which depends only on the current

state, and not on the previous history or even on any time. Then he defines these processes as Markov chains with stationary transitions and many states.

Markov chain refers to the behavior of an informationally closed and generative system that is specified by transition probabilities between that system's states. The states can be general as to ranks, categories, and pay levels. The probabilities of a Markov chain are usually entered into a transition matrix indicating which state follows which other state. The order of a Markov chain corresponds to the number of states from which probabilities are defined to a successor.

The key property of a Markov chain is that the ``future'' depends only on the ``present'', and not on the ``past''. A Markov chain is a stochastic process such that:

a. It has states,

b. It has Markovian transitions,

c. It has stationary transition probabilities,

d. It has a set of initial probabilities.

Although our model consists of a flow model similar to markov chain, in determination of optimal TIG's, the result is dependent on cadre rather than transition probabilities. Therefore the model avoids any reference to probabilities. However, the ideal transition probabilities, which should be obtained for a perfect

flow, will be side products of our model at each rank. To some extend, the development is the inverse of what markov process follows initially to the result as a forecast.

CHAPTER 3

3. A BRIEF REVIEW OF THE TURKISH ARMY PROMOTION SYSTEM

3.1. GENERAL

The Turkish Army as a big and hierarchical organization has a degree of vertical differentiation among levels of management. In promotion system context, this differentiation is obviously seen in a series of ranks. The size of the Army does not permit any Army officer to have large span of control. Therefore, a hierarchical rank system is an inevitable consequence of this hierarchical structure. In career ladder, the ranks for the Turkish Army are listed in Table 3.1 according to seniority.

Organizational assignments of officers to different units are made according to their ranks. These Army units are compatible with a hierarchical structure as ranks are. In an organizational tree structure, larger units consist of all smaller units in size as successive branches of the tree. All basic units in the Turkish Army are listed below in an order of size from large to small:

a. Army

b. Army Corps

c. Brigade

d. Regiment = 3 Battalion + Headquarter (Exceptional unit in the current system)

e. Battalion = 3 Company + Headquarters

f. Company = 3 Team

g. Team / Platoon

Title	Abbreviation		
1. Third Lieutenant	3RD LT.	Lower-ranking officer	Reserve Officer
2. Second Lieutenant	2ND LT.		
3. First Lieutenant	1ST LT.		
4. Captain	CPT.		
5. Major	MAJ.	Higher-ranking officers	Regular Officer
6. Lieutenant Colonel	LTC.		
7. Colonel	COL.		
8. Brigadier General	BG.	Generals	
9. Major General	MG.		
10. Lieutenant General	LTG.		
11. Full General	GEN.		

Table 3. 1. Ranks in an Order of Seniority

The relevant assignments for regular officers according to their ranks are;

2nd Lt.- (one star) He is the youngest officer who is fresh out of training school. He can be an executive officer for a captain and would be given command of a team, platoon or large squad.

1st Lt.- (two stars) He is an executive officer for Captain. He would be given command of a team, platoon or large squad and he does mostly administrative duties.

Captain- (three stars) He commands COMPANIES, or can be assigned to administrative duties.

Major- (bay leaf and one star) He is usually executive officer for Lt. Colonel or in command of very small units or battalions. He can also be assigned to administrative jobs.

Lieutenant (Lt.) Colonel- (bay leaf and two stars) He is in charge of BATTALIONS or for administrative duties.

Colonel- (bay leaf and three stars) He is usually for administrative duties or in command of REGIMENTS.

Generals have a different promotion process in the system so that the focus of our study will be just on the ranks of COL. and below for regular officers. Therefore, there is no need to provide details about generals in the study.

3.2. CURRENT PROMOTION SYSTEM

The initial sources of regular officers are;

a. The Army Academy
b. Universities and Colleges
    (1) Include any cadet who studies at universities as an undergraduate for the Army
    (2) Include any civilian university-graduate candidate who applies to be an officer
    (3) Include any reserve officer (3rd LT.) who wants to be a regular officer
c. Eligible Non-commissioned officers
d. Officers with a contractual agreement

As a criterion, every officer in the current traditional promotion system has to be eligible for promotion as long as the personnel completes a predesignated period for each rank's TIG requirement. TIG requirements for each rank are listed in Table 3.2. Another criterion for eligibility to promote is average performance appraisal score in the same rank.

The education period in the Army Academy is 4 years. If this period exceeds 4 years for the officers whose source is different from the Army Academy, this excess amount of education is subtracted from the officer's (2nd LT.) TIG. For example, doctors study 6 years at the Army Medical School – 2 years more than an

Army Academy graduate. Thus, they spend only 1 year, instead of 3 years, to be promoted to 1st LT. This implementation helps them to fill the gap between themselves and their peers.

Rank	TIG
2LT	3 years
1LT	6 years
CPT	6 years
MAJ	5 years
LTC	3 years
COL	5 years

Table 3. 2. TIG Requirements in the Current Promotion System in Peace

Due to the need of permanent officer positions at higher ranks, the eligible officers are considered for promotion according to their relative performance appraisal score. The only difference is that eligible COL.'s personal files are sent to Supreme Military Council instead of the relevant department in the Turkish Army Headquarters. In the Council, COL. is considered for promotion to BG according to his/her personal file.

In addition to standard TIG requirements, there are some opportunities that offer an early promotion to officers. The first of which is the graduation from the Turkish Military Academy (Harp Akademileri), which gives 2 years seniority for promotion. The second is the graduation of the Turkish Armed Forces Academy

(Türk Silahlı Kuvvetler Akademisi), which gives 1-year seniority for promotion to only staff officers. The opportunities related to education are;

a. 1-year seniority for Master Degree
b. 1-year seniority for PhD
c. 1-year seniority after being an associate professor
d. 1 more year for a second master or PhD degree

The seniority gained by education cannot exceed 4 years in total. Also, some merit criteria are reasons for a 1-year early promotion. 8% of each combat category or 4% of each support category is exactly promoted to Captain and Major in this process. The selected officers for early promotion should be first comers in performance evaluation.

The promotion decisions for all personnel in the Turkish Army are put into practice on August 30 of every year, but for some exceptions reserved in provisions of law.

The need for target positions for a higher rank is determined as a total sum of the need of different warfare communities / categories. See Table 3.3 for categories. Although staff officers are accepted in a category in the career ladder, their promotion evaluation is handled in a different perspective than the systematic approach. Therefore, staff officers are excluded from Table 3.3. In this context, the

promotion selection process in each warfare category is unique to itself. The outcome of total promotion system is an integrated result of each category.

The officers who fail to be promoted to a higher rank due to lack of positions will wait until the positions are available. Their performance will be appraised every year, in case of promotion. Subject to the needs of the Army, officers pending a chance for promotion may selectively continue on active duty at a higher rank. Maximum time constraints for each rank to wait are shown in Table 3.4.

If officers were not promoted until the upper bound of either time constraint, they would be retired. However, the number of MAJ. and LTC. pending a chance for promotion must not exceed 30% of their own rank's cadre and they are retired under provisions of law. All in all, the factors affecting current officer inventory aside from mentioned above are;

a. Transfers between personnel career categories,
b. Casualties due to;
    (1) Voluntary retirement
    (2) Compulsory retirement
    (3) Separation (Due to disciplinary sanctions and health)
    (4) Deaths and Resignations

Title

1. Infantry (Combat)
2. Armor (Combat)
3. Field Artillery (Combat)
4. Aviation (Combat)
5. Air Defense (Combat)
6. Military Intelligence (Combat)
7. Engineering (Combat)
8. Signal (Combat)
9. Transportation (Support)
10. Quartermaster (Support)
11. Ordnance (Support)
12. Personnel Affairs (Support)
13. Finance (Support)
14. Engineer (Support)
15. Army Medical Specialist – Doctor (Support)
16. Dental Specialist – Dentist (Support)
17. Medical Service (Support)
18. Pharmacist (Support)
19. Veterinary (Support)
20. Chemist (Support)
21. Law (Support)
22. Army Band (Support)
23. Technician (Support)
24. Instructor/Teacher (Support)
25. Cartographer (Support)

Table 3. 3. Army Warfare Communities / Categories

Rank	Time Constraints
2nd LT.	Maximum age determined by law (42)
1st LT.	Maximum age determined by law (46)
CPT.	After the completion of the 21st year active duty of service **OR** Maximum age determined by law (50)
MAJ.	After the completion of the 22nd year active duty of service **OR** Maximum age determined by law (55)
LTC.	After the completion of the 25th year active duty of service **OR** Maximum age determined by law (58)

Table 3. 4. Maximum Time Constraints to Wait for Promotion at the Same Rank

More details about the Turkish Army Promotion System can be examined in Turkish Republic Ministry of Defense, Code 926 Turkish Armed Forces' Personnel Law of 1967.

3.3. EVALUATION OF THE CURRENT PROMOTION SYSTEM

If fullness ratio of target positions for a higher rank is low, the current system is nothing more than an automatic promotion system. In automatic promotion system, usually nothing works in accordance with regulations other than TIG. On the other hand, every officer is promoted to a higher rank as long as officer is eligible for required TIG regardless of performance appraisal. Therefore, more available positions than present officer inventory cannot prevent any officer from promotion to a higher rank. This is an inevitable result of imbalance in the system between need and inventory.

Personnel recruitment is a long-term plan to meet promotion expectations in the current system. In spite of this, this plan can give positive outcomes with a loyalty, but there are a lot of reasons for the implementation to deviate from the plan. In practice, one of the reasons is that the internal primary military sources, Army Military Academy and Military Medical School, are limited with their capacity. Furthermore, it seems very difficult to increase the capacities because of cost. Outsourcing for officers is also another alternative for personnel recruitment to get rid of most of the education cost. Although it seems feasible, it is still at the initial stage. Even if it were a part of the solution to the problem, the reflection of the result would not be adequate for a long period of time. Thus, the implementation will continue to give way to automatic promotion, which has been involuntarily followed since 1967. Therefore, the system should be handled as a whole. The primary policy for the system must be to get rid of temporary treatments with instant remedies.

The current promotion system with its emphasis on time in service and time in grade complacency, gives people respect for their experience, but not for their performance. The officers who have been in so long at a rank according to fixed TIG's do not need to study to get promoted. All they have to do is to show up. This makes the system unfair for the hard-working young service members in terms of TIG. Rewarding people primarily for the time spent either in service or in grade does not encourage nor nurture the talent of employees. Therefore, when motivation goes down, competence and creativity will vanish through low performance. It is completely opposite to the spirit of promotion. The presence of seniority based promotion system can, of course, lead the organization to loyalty but reduce

motivation. Therefore, the efficiency of the system cannot be sacrificed for the sake of objectivity as in seniority criterion. It is a question why we do not follow a rational merit-based promotion system.

When we consider promotion as a reward in the working environment, the merit criterion seems to be compatible with the relevant motivation theories. However, it is more subjective due to measurement difficulties. It is possible that the insistence in the objectivity can make the HRM department in The Turkish Army Headquarters construct a new system including a well-balanced mixture of merit and seniority criteria.

3.4. THE NEW PROMOTION SYSTEM FOR THE TURKISH ARMY UNDER CONSIDERATION BY THE HRM DEPARTMENT OF TURKISH ARMY

The requirements of the millennium in the Human Resource Management urge The Turkish Army to do some revisions in the promotion system. Therefore, the relevant HRM department in the Turkish Army Headquarters proposed a new promotion system as a draft, but it still needs to be developed in a scientific perspective to get an acceptance all over the Turkish Armed Forces.

Here, we presented only differences between the current and the draft promotion system. The draft promotion system is thought to overcome many disadvantages of the previous system. The contour of those is drawn in the previous

section, which consists of an improper balance between officer need and present officer inventory, and an unfair promotion process to distinguish low and high performer.

A proper performance appraisal system is going to be a backbone of this draft system along with flexible TIG requirements including minimum and maximum points in years to promote. See Table 3.5 for TIG requirements in the draft system. Because of complete integration of performance appraisal and TIG ranges, the draft system is called flexible promotion system. If one fails to be selected for regular promotion in any range of TIG, this person will be subject to further military regulations in officer promotion.

Rank	**Range for TIG to Promote**
2LT	3 years (fixed)
1LT	4-7 years
CPT	4-7 years
MAJ	4-7 years
LTC	3-7 years
COL	4-13 years

Table 3. 5. TIG Requirements for the Regular Promotion in the Draft System

The flexible promotion system gives way to competition and professional development for officers. Also, it gives an opportunity to young officers to promote to higher ranks in younger ages. For example, according to the draft system with flexible TIG's, an officer is expected to be a COL in 18 years and a General in 22 years at least. However, in the current system, an officer can promote to COL in 20-23 years and to General in 25-28 years with possible exceptional early promotions.

3.4.1. The Principles of the Draft Promotion System

The flexible promotion system is based on overall demonstrated performance and potential abilities. Therefore, performance appraisal system will be reviewed for objective criteria. There will be no promotion owing to education and academic training.

Total service period is 31 years as it is in the present promotion system.
In case of failure, to be selected for promotion out of TIG range;

a. 1 LT and 2LT will be continuously considered for promotion to the next higher rank for 41 years (age limitation), if there is any available position,

b. CPT will be continuously considered for promotion to MAJ until the end of 21-year active duty service, if there is any available position,

c. MAJ will be considered for promotion to LTC until the end of 24-year active duty service, if there is any available position,

d. LTC will be considered for promotion to COL until the end of 28-year active duty service, if there is any available position,

The total number of MAJ or LTC waiting for reconsideration for promotion after failure to be selected promotion cannot exceed 30% of the cadre in the belonged rank. In case of violation, those officers, who come last in evaluation according to their demonstrated performance, potential abilities, and the first date of rank regardless of seniority and precedence, will be retired.

For COL, in case of failure to be selected for promotion after 13 years in the same rank, retirement is inevitable.

All regular officer ranks including MAJ, CPT and 2nd LT are considered in 4 different groups for promotion to the next higher grade. LTC is considered in 5 different groups for promotion to the next higher grade. There isn't any group requirement for COL in consideration for promotion to the next higher grade. According to position vacancies and requirements, the percentage to be promoted is accepted as a guideline every year. These percentages for each rank are determined for each group in this rank. The reason for grouping is to conduct a fair and equitable promotion selection. Thus, the balance in consideration for promotion is gotten among officers in the same rank with different TIG's in the accepted ranges.

The promotion principles for each rank in detail are:

Second Lieutenant: After the training school, the fresh officers who complete 3-year TIG requirement are promoted to 1st LT as it is in the current system.

First Lieutenant: Officers in this rank are considered in 4 different groups for promotion to CPT. The promotion percentages to be applied to each group is different from each other. These percentages determine the number of people to promote to CPT in each group. These groups are not necessarily disjoint; can overlap each other. The groups are evaluated in a successive order instead of simultaneous evaluation.

***Group 1*:** The officers in this rank, who complete 4, 5 and 6 years in service of the same rank, are considered for promotion to CPT in this group.

Group 2: The officers in this rank, who fail to promote to CPT in the same promotion term after being considered for promotion in the first group, are considered for promotion to CPT in this group.

Group 3: The officers in this rank who, fail to promote to CPT in the same promotion term after being considered for promotion in the first and second group, are considered for promotion to CPT in this group.

Group 4: The officers in this rank who; fail to be promoted to CPT in previous years and complete 7 and more years in service of the same rank are considered for promotion to CPT in this group, if there is room in CPT for promotion. Otherwise, they will continue to wait for promotion under provisions of law. This reconsideration for CPT can continue up to the end of the 21-year active duty service.

Details in each group for different ranks up to MAJ are the same except maximum service year at each rank. The only difference for the groups at the rank of LTC is that this rank includes 5 groups depending on TIG range, so these group partitions are different from those of other ranks. The partition at the rank of LTC is done with the same logic as it is at the other ranks.

However, the configuration of all groups at each rank and their respective evaluation shade upon validity and fairness of the groups in promotion. It seems that the group process is unfortunately nothing more than that of the whole evaluation of any rank for promotion, because successive evaluation left no room for weak officers to promote fairly. If groups covered different segments of the inventory of any rank, the fairness in the process would be achieved.

CHAPTER 4

4. DESCRIPTION OF THE PROBLEM AND PROPOSED MODEL

4.1. PROBLEM STATEMENT

The drawbacks of the current promotion system – those explained in Chapter 2 - are mostly avoided in the draft promotion system. Although the draft system seems to stand on a rational base, the validity of manpower-planning model in the system is open to be tested. One of the determinants in the model to be tested is TIG range requirements at each rank.

The test criterion is the optimization results of TIG ranges in the draft promotion system. In this test process, the compatibility of TIG with cadre and yearly inflow inventory at each rank is a criterion for optimization. The yearly inflow inventory means the number of officers who begin service at any rank every year. In addition, the system flow in the determination of TIG ranges is compared to that of the draft system.

The current approaches mentioned in the previous chapter deal with expected personnel requirements, projected personnel strength, and personnel supply forecasting rather than TIG optimization. It is seen that TIG is used as only a determinant index in some models. However, in our model, it is a decision variable to find a common value for all warfare categories at each rank.

Apart from this, Gass *et al.* (1988) and Bres *et al.* (1980) lean their models on Markov flows. As stated in the literature review, to be truly Markovian it must be true that, given you have been in some grade t years, the probability of being promoted to the next grade is always the same, independent of t. Therefore, it is certainly not true in any military system and have very little practical use. Instead, we did not construct our model upon promotion probabilities and we used a descriptive process toward the optimization.

All models except the one by Bres *et al.* (1980) do not need to analyze the system in terms of each warfare categories, because their model's general form could be applicable to different warfare categories separately. If the model needed any consistency among the warfare categories, it would be necessary to handle all categories together in one model as done in this study.

The answer to this problem makes the system stand on considerable foundations. In an analogy, the determination of the base length of hierarchical pyramid with a constant height can help The Turkish Army to see ahead in further manpower planning. Especially, the value of inflow inventory for each category at

the rank of lieutenant can shape the internal military source capacities. Also the proper TIG ranges prevent any extreme cadre violations in the system so that the explicit structure of the hierarchical organization can be kept intact.

4.2. DESCRIPTION OF THE RESEARCH

The research is designed to construct a manpower-planning model to obtain a considerable criterion in The Turkish Army promotion system. Mostly quantitative research methods are used rather than qualitative research methods. Therefore, the optimization model should require mostly computational variables rather than variables including experiences, perceptions, words, thoughts, feelings, behaviors. Although qualitative variables in real world settings of military environment are other inevitable components of the model through a successful result of TIG requirements for each rank, it is assumed that personnel strength targets, personnel resource capacity, retirement ratios, and other computational variables play more crucial role in the construction of the optimization model than qualitative variables. Moreover, the difficulty in converting qualitative variables into quantitative variables is another factor that makes us use quantitative research in our study.

4.2.1. General Resource Framework

The considerable studies and efforts parallel to the shaping future in The Turkish Army make the human resource management system close to modern

concepts. From this context, the proposed draft plan, by The Turkish Army HRM Department, about promotion system gives a prior direction to my study. The criteria proposed in the draft plan are examined to construct an effective manpower model. The objective of the manpower-planning model in my dissertation is the determination of time–in-grade, almost the same for all warfare categories, for promotion at each rank.

4.2.2. Research Methods

Literature survey including books, articles and papers about promotion and manpower planning / models are used for data collection along with Internet survey. They help me to draw the contour of the study with some descriptions, real world applications, and processes.

To analyze data, I used parametric techniques in statistics. The data from The Turkish Army Headquarters are first investigated with descriptive analysis to obtain workable data by the help of some Plug-ins in Windows Excel. Then, software named GAMS is used for optimization of data through the constructed model. The General Algebraic Modeling System (GAMS), a decision support tool, is specifically designed for modeling linear, nonlinear and mixed integer optimization problems.

4.3. THE CONSTRUCTION OF THE MODEL

My manpower model consists of 6 different major classes of manpower. As an exact portioning rule related to the eventual purpose of the Turkish Army, officers are classified by ranks (second lieutenant, first lieutenant, captain, major, lieutenant colonel, and colonel). Due to automatic promotion from second lieutenant to first lieutenant, those two ranks are considered as a single rank named lieutenant in our model. In other words, the mentioned automatic promotion, which makes us modify the model, refers that the probability of promotion for the officers at the rank of second lieutenant is 1, which is fixed. The given three-year fixed TIG at the rank of second lieutenant enables the model to handle these two ranks together as a unique rank. Another reason behind the consideration is that the ranks of second lieutenant and first lieutenant cover the same positions to be assigned such as platoon commander, team commander. There is nothing to differentiate these two ranks for any assignment.

Furthermore, there are 25 career specialty areas as warfare communities within each rank such as infantry, artillery, and aviation. See Table 3.3 for a complete warfare category list except staff officers. Each officer in the organization is identified as a member of one and only one rank and one warfare community. In addition, approximate values are used for the data in the model instead of real ones in the system due to security requirements of the Turkish Army.

The evaluation over time in this manpower system necessitates an interaction between different ranks through time. New officers join the system and officers in the system remain at one rank for a time, then either move to a higher rank or leave the system. In this process an officer can serve maximum 31 years right from the beginning of the rank of Second Lieutenant to the end of the rank of Colonel. The transitions for promotions between ranks are determined by TIG as a major eligibility factor. The second determinant factor here in the model for promotions is individual performance of officers. It helps us to shape the hierarchical pyramid in the organization through promotions. In spite of the fact that the model is based upon ideal personnel flow, the unexpected variations in the system flow are thought to be compensated with personnel reserves at each rank. What I mean with reserves is the number of officers pending for promotion to a higher rank after maximum TIG. These reserves occupy a percentage of target positions at each rank. In addition, the reserves are the compulsory accumulations based on the difference between inflow inventory and outflow inventory at each rank. The outflow inventory means the number of officers who promote to a higher rank. What makes the accumulation in reserves compulsory and doesn't let anyone to be put out of the system for a while is the law. Age and total service time limitations in the law are other determinants to set the reserves at each rank, because anyone in The Turkish Army has the rights guaranteed by law to stay in service until he/she faces with either of these limitations. See Table 4.1 for maximum calculated waiting time at each rank on the basis of age and service limitations set by the law. Therefore, the total accumulation toward the calculated limitations at each rank gives the total reserves. That the reserves are not held apart from cadre makes the system vulnerable to big variations in the rate of

promotions. It means that the higher the promotion needs get, the bigger the gaps between the cadres and current inventories after promotion are. However, this drawback is got rid of by successive completion of cadre from each previous rank's reserve until the aggregate need is compensated with recruitments at the rank of lieutenant. As it is seen, for the sake of a flawless flow in the system, we have to bear this accumulation in each rank toward the limitations stated in the personnel law. In spite of this, it is required to carry a reserve of 35% of each rank's cadre to provide every officer a broad and fair opportunity for promotion.

	Colonel	**Lieutenant Colonel**	**Major**	**Captain**	**Lieutenant**
FORMULATION **Given Limit – Min. Time in Service**[1]	-	28–(3+1+1+1)	24–(3+1+1)	21–(3+1)	18 - 0[2]
RESULT **Max. Waiting Time at Each Rank**	-	22	19	17	18

Table 4. 1. Maximum Calculated Waiting Time at Each Rank on the Basis of Age and Service Limitations Set by the Law

In practice, the amount of these reserves can be increased according to further need forecasts but not to be decreased owing to the law. These accumulations or reserves for each rank decrease also the circulation area of officers for promotion in a steady state system. It means a decrease in either TIG's or yearly inflow inventory.

[1] The detailed minimum times in services for all ranks are demonstrated in Table 4.5.

[2] The limitation for the rank of Lieutenant set by the law is on the basis of age. When we assume that the initial age is 23 at the beginning of service period at work, an officer at the rank of lieutenant can serve maximum 41-23=18 years to the Army.

Of course, as model requires, the excess amount of personnel leaves the system in consideration of all constraints.

In the model, it is assumed that the promotion rates are proportional with personnel needs, and personnel needs are proportional with individual performance and cadre. However, there is an inverse proportion between personnel needs and TIG's. In the retrospective assessment of US Defense Officer Personnel Management Act of 1980 by Rostker *et al.* (1993), it is supported that a decline in officer cadre causes an increase in TIG. Therefore, the model is placed on TIG's and cadre. Then, the formulation of TIG is:

$$TIG = \frac{\text{Cadre}}{\text{Yearly Inflow Inventory}}$$

The performance effect on personnel needs is solved with a flexible personnel reserve in the system as mentioned above.

We assume that the total number of target positions, cadre, in the system remained constant. The system is accepted where no demotions can occur and where a person cannot advance more than one rank per year. For a perfect flow of replacements to fill the vacated positions, all these vacancies are filled by appointing new individuals into the higher rank. There are no vacancies left unfilled.

The current officer sources are The Army Academy, military and civilian colleges and universities, eligible Non-Commissioned officers, and officers with a contractual agreement for The Army. Although there is a capacity limitation for The Army Academy and Military Colleges and Universities, it is relaxed as a constraint to learn the exact capacity need for a revision. Therefore, the variations in the officer supply depend only on the amount of need. The need-dependant supply doesn't restrict the model in terms of capacity for all personnel sources.

Given casualties are also evaluated according to warfare communities, which they belong, in an aggregate sense. Consequently, they are reflected to the model in order to project the yearly inflow inventory. The casualty rates for each rank and category are shown in Table 4.2.

		Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
1	**INFANTRY**	0.157	0.056	0.073	0.052	0.035
2	**ARMOR**	0.157	0.056	0.073	0.052	0.035
3	**ARTILLERY**	0.157	0.056	0.073	0.052	0.035
4	**AVIATION**	0.157	0.056	0.081	0.056	0.019
5	**AIR DEFENCE**	0.157	0.055	0.069	0.049	0.035
6	**MILITARY INTEELIGENCE**	0.157	0.054	0.070	0.041	0.032
7	**ENGINEERING**	0.158	0.057	0.078	0.052	0.035
8	**SIGNAL**	0.157	0.056	0.072	0.052	0.035
9	**TRANSPORTATION**	0.156	0.056	0.070	0.050	0.035
10	**QUARTERMASTER**	0.157	0.059	0.087	0.044	0.035
11	**ORDNANCE**	0.157	0.056	0.072	0.051	0.035
12	**PERSONNEL**	0.155	0.051	0.057	0.038	0.021
13	**FINANCE**	0.156	0.055	0.069	0.031	0.020
14	**ENGINEER**	0.154	0.054	0.077	0.028	0.025
15	**ARMY MEDICAL SPECIALIST**	0.009	0.026	0.061	0.022	0.011
16	**DENTAL SPECIALIST MEDICAL SERVICE PHARMACIST& VETERINARY**	0.155	0.055	0.063	0.021	0.021
17	**LAW**	0.153	0.049	0.054	0.035	0.015
18	**INSTRUCTOR/TEACHER**	0.154	0.049	0.057	0.021	0.012

Table 4. 2. The Casualty Rates (%) for Each Rank and Category on Cadre

The flow of inventories, separations, and promotions can be visualized as a flow through a network as shown in Figure 4.1. The figure represents a reduced dimension and thus does not represent the complete and true problem. In other words, it represents only one warfare community and three levels of rank to understand the flow in the system.

If we think that there are different cadres for each warfare community, the differentiation in their TIG's is inevitable with regard to the formula of TIG. However, it is possible to reduce the difference among their TIG's by adjusting yearly personnel transitions. In other words, these adjustments are done in order to have a fair TIG distribution among the warfare categories. For this reason, the goal of the model is to minimize the deviations in TIG's of different warfare communities. So we expect to obtain a common TIG in a fair manner to apply throughout The Army for determination of each rank's yearly personnel needs. In this context, non-linear programming gives us way for optimization of the model.

All in all, we will follow the assumptions below, which were mentioned so far, in this construction of the model:

a. Second lieutenant and first lieutenant are assumed as a single rank named lieutenant.
b. Each officer in the Army is assumed to be identified as a member of one and only one rank and one warfare community.

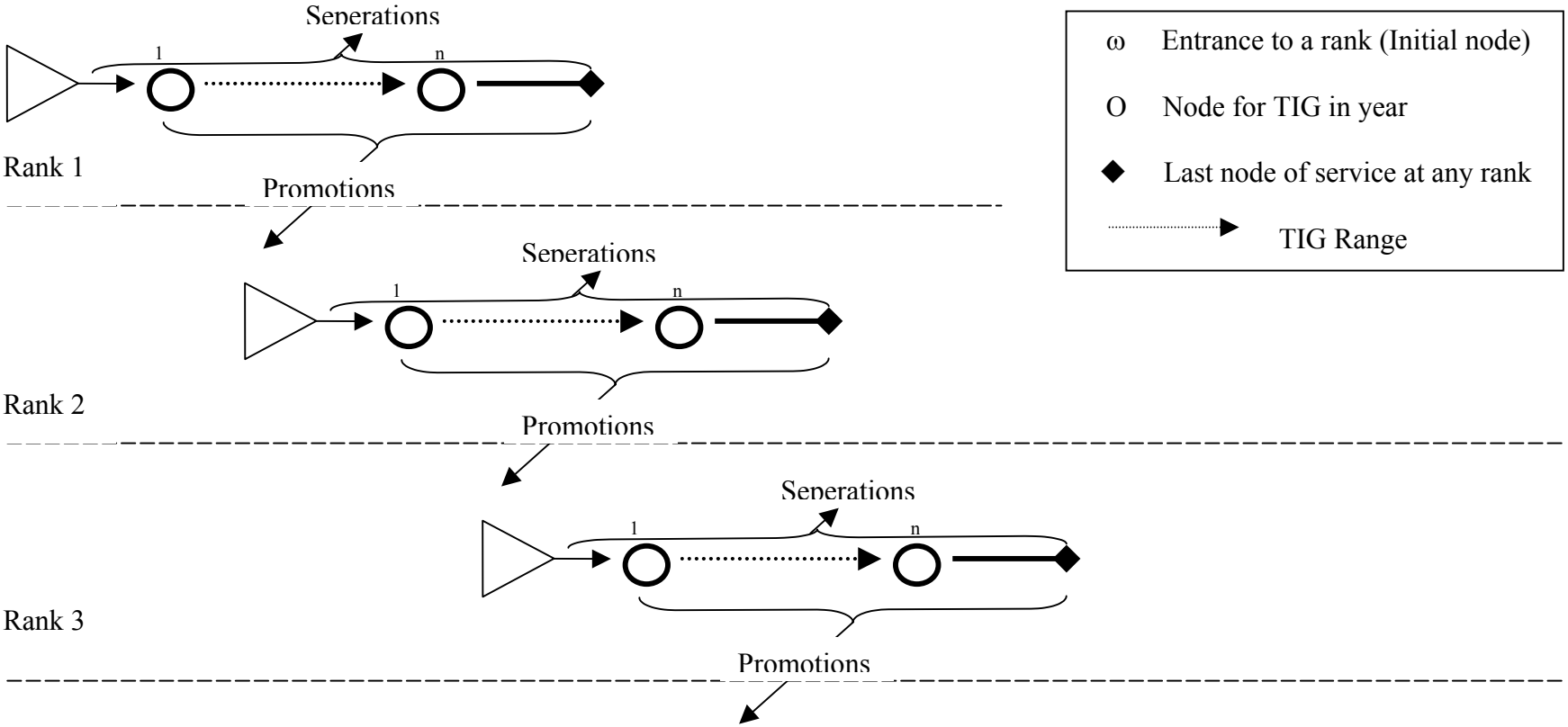

Figure 4. 1. A Reduced Size Network Flow Diagram of the Turkish Army Promotion System

c. In the personnel flow system of the Army, it is simply assumed that new officers join the system. An officer who has already entered the system either remain at the same rank or promotes to a higher rank or leaves the system at the decision epochs (i.e. August 30th of each year)
d. It is assumed that the model is based on ideal personnel flow.
e. It is assumed that the promotion rates are proportional with the cadre.
f. It is assumed that the total number of target positions, cadre in the system remained constant for each rank and warfare community.
g. It is assumed that there exist no demotions nor multiple rank advancements at one time occur in the system.
h. It is assumed that all vacancies of higher ranks are filled by appointing new individuals from lower ranks. There are no vacancies left unfilled.

4.3.1. Elimination and Grouping the Data

According to the objective function of the model, the optimal result forms a bell shape around the TIG averages of each rank. Therefore, where μ_i is average cadre and σ_i is its standard deviation for *i= lieutenant, captain, major, etc.,* whatever the number of categories / warfare communities is, any cadre/s extremely away from their own average ($\pm$ 3 σ) force the time-in-grade's average shape around on the side of surplus with regard to TIG formulation. The formula shows the direct proportion between TIG and Cadre so that the variation in the cadre average can be observed in the TIG average in the same way. This is an unwanted consequence of cadres which are out of acceptable limitations representing the $\mu \pm 3\ \sigma$. For this reason, we use

grouping and elimination among warfare communities to prevent constructing an unintentional constraint. The grouping depends on the similarity in expertise area, and elimination is dependent on requirements of personnel regulations. The hierarchical pyramid structure and $\mu \pm 3\ \sigma$ are determinants of elimination and grouping. Especially in the latter process, the selection of categories is firstly done by a priority classification among the categories.

The implementation of the model depends on the original cadre data for each rank and warfare category. See Table 4.3 for the original data of the model.

First, as it is seen from Table 4.3, the cadre numbers for each warfare community form a hierarchical pyramid all along the career path right from the rank of lieutenant to that of colonel. The pyramid structure is similar for all warfare communities. The hierarchical pyramid structure forms in a way that cadres are inversely proportional with the level of ranks. In other words, although cadres are high in number at low ranks, they are low in number at higher ranks. However, the categories of Cartographer, Technician, and Chemist violate the rule of pyramid structure. Therefore, the irregularity weed out with the agreement of Turkish Army Headquarters by eliminating the category of Technician for further planning and grouping the categories of Cartographer, Chemist, and Engineer together as the category of Engineer. The revised table after process is shown in Table 4.4.

		Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
1	**INFANTRY**	227	396	707	1359	2236
2	**ARMOR**	130	195	373	586	1091
3	**ARTILLERY**	193	317	643	914	1475
4	**AVIATION**	45	76	251	405	706
5	**AIR DEFENCE**	46	56	127	180	416
6	**MILITARY INTEELIGENCE**	75	101	223	277	444
7	**ENGINEERING**	91	113	225	366	625
8	**SIGNAL**	69	103	265	504	792
9	**TRANSPORTATION**	45	78	164	224	390
10	**QUARTERMASTER**	60	109	227	354	420
11	**ORDNANCE**	100	141	260	535	628
12	**PERSONNEL**	83	171	297	408	491
13	**FINANCE**	27	35	55	62	65
14	**ENGINEER**	57	101	165	184	300
15	**ARMY MEDICAL SPECIALIST**	142	223	530	730	1002
16	**DENTAL SPECIALIST**	17	24	47	76	150
17	**MEDICAL SERVICE**	7	16	46	108	130
18	**PHARMACIST**	4	9	18	35	46
19	**VETERINARY**	10	21	54	63	83
20	**CHEMIST**	1	0	1	0	0
21	**LAW**	21	36	73	84	105
22	**ARMY BAND**	7	11	28	34	38
23	**TECHNICIAN**	0	0	0	25	4
24	**INSTRUCTOR/TEACHER**	72	115	272	370	374
25	**CARTOGRAPHER**	0	0	2	1	8

Table 4. 3. The Original Data for the Model

		Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
1	**INFANTRY**	227	396	707	1359	2236
2	**ARMOR**	130	195	373	586	1091
3	**ARTILLERY**	193	317	643	914	1475
4	**AVIATION**	45	76	251	405	706
5	**AIR DEFENCE**	46	56	127	180	416
6	**MILITARY INTEELIGENCE**	75	101	223	277	444
7	**ENGINEERING**	91	113	225	366	625
8	**SIGNAL**	69	103	265	504	792
9	**TRANSPORTATION**	45	78	164	224	390
10	**QUARTERMASTER**	60	109	227	354	420
11	**ORDNANCE**	100	141	260	535	628
12	**PERSONNEL**	83	171	297	408	491
13	**FINANCE**	27	35	55	62	65
14	**ENGINEER**	58	101	168	185	308
15	**ARMY MEDICAL SPECIALIST**	142	223	530	730	1002
16	**DENTAL SPECIALIST**	17	24	47	76	150
17	**MEDICAL SERVICE**	7	16	46	108	130
18	**PHARMACIST**	4	9	18	35	46
19	**VETERINARY**	10	21	54	63	83
20	**LAW**	21	36	73	84	105
21	**ARMY BAND**	7	11	28	34	38
22	**INSTRUCTOR/TEACHER**	72	115	272	370	374

Table 4. 4. The Revised Formation After Eliminating the Category of Technician and Grouping the Categories of Cartographer, Chemist, and Engineer Together as the Category of Engineer.

Table 4.4 shows a complete pyramid structure for all categories throughout all ranks without any exception after correction.

Second, the priority in grouping and elimination of data is determined by the degree of consistency among the data in the model. When we assume that every officer in the system waits at least one year at each rank throughout 31-year service period, the allocation of TIG's for each rank in the model will be in the ranges in Table 4.5. The possible minimum lower bounds are determined to give the model maximum relaxation through solution.

	Lower Bound	Upper Bound
Lieutenant	3+1= **4**[3]	31- 4 = **27**
Captain	**1**	31-7 [4] = **24**
Major	**1**	31-7 = **24**
Lieutenant Colonel	**1**	31-7 = **24**
Colonel	**1**	31-7 = **24**

Table 4. 5. Possible TIG Ranges for Each Rank in the Model

[3] The unification of the ranks of second lieutenant and first lieutenant into the rank of lieutenant force the TIG lower bound to be 3+1=4 for this rank. The given 3-year fixed TIG for second lieutenant and minimum TIG requirement for first lieutenant equals 4. Although TIG for the category of doctor at the rank of second lieutenant is 1 at most, TIG for it is considered 3 as well on the base of having a 6-year education period among peers.

[4] The sum of all minimum TIG requirements at each rank other than the specified rank.

The cadres for each rank should be compatible with these ranges to get the optimal solution. In consideration of TIG formula, we also assume that yearly inflow inventory is at least 1 and has no upper bound. Therefore, the upper bounds for cadres of each rank are determined as +INF. The lower bounds for cadres of each rank are determined to be equal to the upper bounds of TIG's as well. To prevent constructing an unintentional constraint by data, which is mentioned above, we chose the cadre data out of expected ranges for further consideration. Those from the original data in Table 4.3, which violate the ranges, are in Table 4.6 in terms of categories.

Lieutenant	*Captain*	*Major*	*Lieutenant Colonel*	*Colonel*
Chemist	Chemist	Chemist	Chemist	Chemist
Technician	Cartographer	Technician	Technician	Technician
Cartographer		Cartographer	Cartographer	Cartographer
		Pharmacist	Pharmacist	Pharmacist
			Med-Service	Med-Service
			Dental Specialist	Dental Specialist
			Veterinary	Veterinary
			Army Band	Army Band
				Law

Table 4. 6. The Categories out of Minimum – Maximum Cadre Range

From this context, the priority of categories for grouping and elimination is decided upon the repetition number at each rank in Table 4.6. The priority order is shown in Table 4.7. Thus, Table 4.7 with its first three choices justifies the hierarchical pyramid structure formation done above.

1. Chemist	6. Dental Specialist
2. Cartographer	7. Veterinary
3. Technician	8. Army Band
4. Pharmacist	9. Law
5. Medical Service	

Table 4. 7. Priority List for Further Consideration of Elimination and Grouping

Third, to determine the extreme values of cadres belonging to each category, I found the acceptable range between $\mu+3\sigma$ and $\mu-3\sigma$ for each rank. Those of which are out of the range cause any consideration of all categories for elimination and grouping. After the gradual elimination and grouping of some categories, which are in the priority list, the similar process continues until the all values of cadres are completely in the range. The iteration results for the given data are shown below:

First Iteration: In this operation, Table 4.8 is created by using the data in Table 4.4.

	Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
Average	70	111	230	357	546
Std. Dev.	59,81	99,97	192,18	327,05	532,65
3 x (Std. Dev.)	179,43	299,92	576,54	981,16	1597,96
$\mu+3\sigma$	249	411	806	1338	2144
$\mu-3\sigma$	-110	-189	-347	-624	-1052

Table 4. 8. Descriptive Analysis Results of the Data in Table 4.4.

According to Table 4.8, the category of Infantry is seen out of range at the rank of Captain and Lieutenant in terms of cadre. Thus, I group three categories including Dental Specialist, Medical Service, Pharmacist, and Veterinary together to keep the variation in acceptable limits with regard to priority list. Why I chose these three categories is that they represent the same expertise area. The revised table is shown in Table 4.9.

Second Iteration: In this operation, Table 4.10 is created by using the data in Table 4.9. In Table 4.10, although the category of Infantry is pulled into the range at the rank of Captain in terms of cadre, it is still out of range at the rank of Lieutenant. Therefore, I ignore the category of Army Band as a necessity of priority list. Then, the revised table is formed in Table 4.11.

		Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
1	**INFANTRY**	227	396	707	1359	2236
2	**ARMOR**	130	195	373	586	1091
3	**ARTILLERY**	193	317	643	914	1475
4	**AVIATION**	45	76	251	405	706
5	**AIR DEFENCE**	46	56	127	180	416
6	**MILITARY INTEELIGENCE**	75	101	223	277	444
7	**ENGINEERING**	91	113	225	366	625
8	**SIGNAL**	69	103	265	504	792
9	**TRANSPORTATION**	45	78	164	224	390
10	**QUARTERMASTER**	60	109	227	354	420
11	**ORDNANCE**	100	141	260	535	628
12	**PERSONNEL**	83	171	297	408	491
13	**FINANCE**	27	35	55	62	65
14	**ENGINEER**	58	101	168	185	308
15	**ARMY MEDICAL SPECIALIST**	142	223	530	730	1002
16	**DENTAL SPECIALIST MEDICAL SERVICE PHARMACIST VETERINARY**	38	70	165	282	409
17	**LAW**	21	36	73	84	105
18	**ARMY BAND**	7	11	28	34	38
19	**INSTRUCTOR/TEACHER**	72	115	272	370	374

Table 4. 9. The Revised Formation After Grouping the Categories of Dental Specialist, Medical Service, Pharmacist, and Veterinary Together.

	Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
Average	80	129	266	414	632
Std. Dev.	57,41	97,31	184,39	321,44	529,20
3 x (Std. Dev.)	172,24	291,94	553,18	964,33	1587,59
$\mu+3\sigma$	253	421	819	1378	2220
$\mu-3\sigma$	-92	-163	-287	-551	-955

Table 4. 10. Descriptive Analysis Results of the Data in Table 4.9.

		Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
1	**INFANTRY**	227	396	707	1359	2236
2	**ARMOR**	130	195	373	586	1091
3	**ARTILLERY**	193	317	643	914	1475
4	**AVIATION**	45	76	251	405	706
5	**AIR DEFENCE**	46	56	127	180	416
6	**MILITARY INTEELIGENCE**	75	101	223	277	444
7	**ENGINEERING**	91	113	225	366	625
8	**SIGNAL**	69	103	265	504	792
9	**TRANSPORTATION**	45	78	164	224	390
10	**QUARTERMASTER**	60	109	227	354	420
11	**ORDNANCE**	100	141	260	535	628
12	**PERSONNEL**	83	171	297	408	491
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14	**ENGINEER**	58	101	168	185	308
15	**ARMY MEDICAL SPECIALIST**	142	223	530	730	1002
16	**DENTAL SPECIALIST MEDICAL SERVICE PHARMACIST VETERINARY**	38	70	165	282	409
17	**LAW**	21	36	73	84	105
18	**INSTRUCTOR/TEACHER**	72	115	272	370	374

Table 4. 11. The Revised Formation After Ignoring the Category of Army Band

According to Table 4.12, all data in Table 4.11 seem to satisfy the range limitations to keep variation at an acceptable level and could be used in the model.

	Colonel	Lieutenant Colonel	Major	Captain	Lieutenant
Average	85	135	279	435	665
Std. Dev.	56,17	95,74	180,24	316,95	524,01
3 x (Std. Dev.)	168,51	287,22	540,72	950,85	1572,03
$\mu+3\sigma$	253	423	820	1386	2237
$\mu-3\sigma$	-84	-152	-262	-516	-907

Table 4. 12. Descriptive Analysis Results of the Data in Table 4.11.

4.3.2. The Algebraic Representation of The Problem

1.Indices:

i = ranks $\quad\quad$ $i = 1, \ldots, m$;

where m is the number of all ranks, which are:

1. Lieutenant
2. Captain
3. Major
4. Lieutenant Colonel
5. Colonel

j = warfare communities / categories $\quad\quad$ $j = 1, \ldots, n$;

where n is the number of all warfare categories, which are:

1. Infantry (Combat)
2. Armor (Combat)
3. Field Artillery (Combat)
4. Aviation (Combat)
5. Air Defense (Combat)
6. Military Intelligence (Combat)
7. Engineering (Combat)

8. Signal (Combat)
9. Transportation (Support)
10. Quartermaster (Support)
11. Ordnance (Support)
12. Personnel Affairs (Support)
13. Finance (Support)
14. Engineer (Support)
15. Army Medical Specialist – Doctor (Support)
16. Dental Specialist /Medical Service/Pharmacist/Veterinary (Support)
17. Law (Support)
18. Instructor/Teacher (Support)

2.Given Data and Parameters:

a_{ij} = target officer need for rank i and category j
(person, constant over years)

s_{ij} = yearly average percentage of cadre in casualty for rank i and category j (percent, constant over years)

r_i = maximum waiting time to put an officer out of the system at the rank *i* (year)

3.Decision Variables:

x_{ij} = the average inflow officer inventory to meet the target need excluding casualty need (person per year),

where $x_{ij} \geq 0$, for all i,j

h_{ij} = the average revised cadre after excluding reserves for rank i and category j (person)

$reserve_{ij}$ = the accumulation in reserves for rank i and category j (person)

$\overline{TIG}_i$ = the average TIG for rank i (year)

z = the value of objective function as a total variance of TIG's for each rank i

4.Constraints:

Define reserve for rank i , $i=1,..,m-1,$ and category j, j=1,..,n:

$$reserve_{ij} = [x_{ij} - x_{i+1,j} - (s_{i+1,j} * a_{i+1,j})] * r_i$$

Observe reserve for rank i and category j:

$$reserve_{ij} \leq a_{ij} * 0.35$$

Define the revised cadre after excluding reserves for rank i and category j:

$$h_{ij} = a_{ij} - reserve_{ij}$$

Define average TIG for rank i:

$$\overline{TIG_i} = \frac{\sum_{j=1}^{n} h_{ij} / x_{ij}}{n}$$

Observe the total TIG in the whole system:

$$\sum_{i=1}^{m} \left[\frac{\sum_{j=1}^{n} h_{ij} / x_{ij}}{n} \right] = 31$$

Observe the minimum required inflow officer inventory per year for rank i and category j:

$$x_{ij} \geq 1$$

Observe the minimum required TIG for rank *i*, *i*=2,..,m, and category *j*:

$$h_{ij} / x_{ij} \geq 1$$

Observe the minimum required TIG for the rank of lieutenant and category *j*:

$$h_{1j} / x_{1j} \geq 4$$

Observe hierarchy structure between rank *i* and rank *i+1* for *i*=1,..*m*-1 and *j*=1,..*n*:

$$[x_{i+1,j} + (s_{i+1,j} * a_{i+1,j})] \leq x_{ij}$$

5.Objective Function:

$$\text{Minimize} \quad z = \sum_{i=1}^{m} \frac{\sum_{j=1}^{n} \left[h_{ij} / x_{ij} - \overline{TIG}_i \right]^2}{n-1}$$

The problem is formulated as a non-linear programming model. Although the decision variables are integer in nature, they are relaxed to be real numbers in the model. The reason to choose real numbers is that they are thought to belong to average values of decision variables over years. Therefore, the average values of decision variables justify the continuous values in results of the model.

CHAPTER 5

5. DISCUSSIONS OF THE RESULTS

5.1. RESERVE RATES

Reserve rates influence the model and its optimal solutions. They are also decision variables and cannot be calculated or estimated easily. Therefore, we solve the model for several reserve rates and observe the system behavior, first. GAMS code of the model was run for reserve rates of 5%, 10%, 15%, 20%, 25%, … , 100%. The GAMS code of the non-linear model with equal weights for each rank is given in Appendix-A. Then, the results were analyzed for each run in terms of all TIG's and objective function. See Table 5.1 for the results with constant reserve rates for all ranks. Also, by using these results, Figure 5.1 displays the trend for TIG of each rank over given reserve rates together with objective values.

As it is seen from the Figure 5.1, it is observed that all trends of TIG's show less marginal change in common between the reserve rates of 5% and 45%. However, the objective values for all reserve rates are observed very close to zero

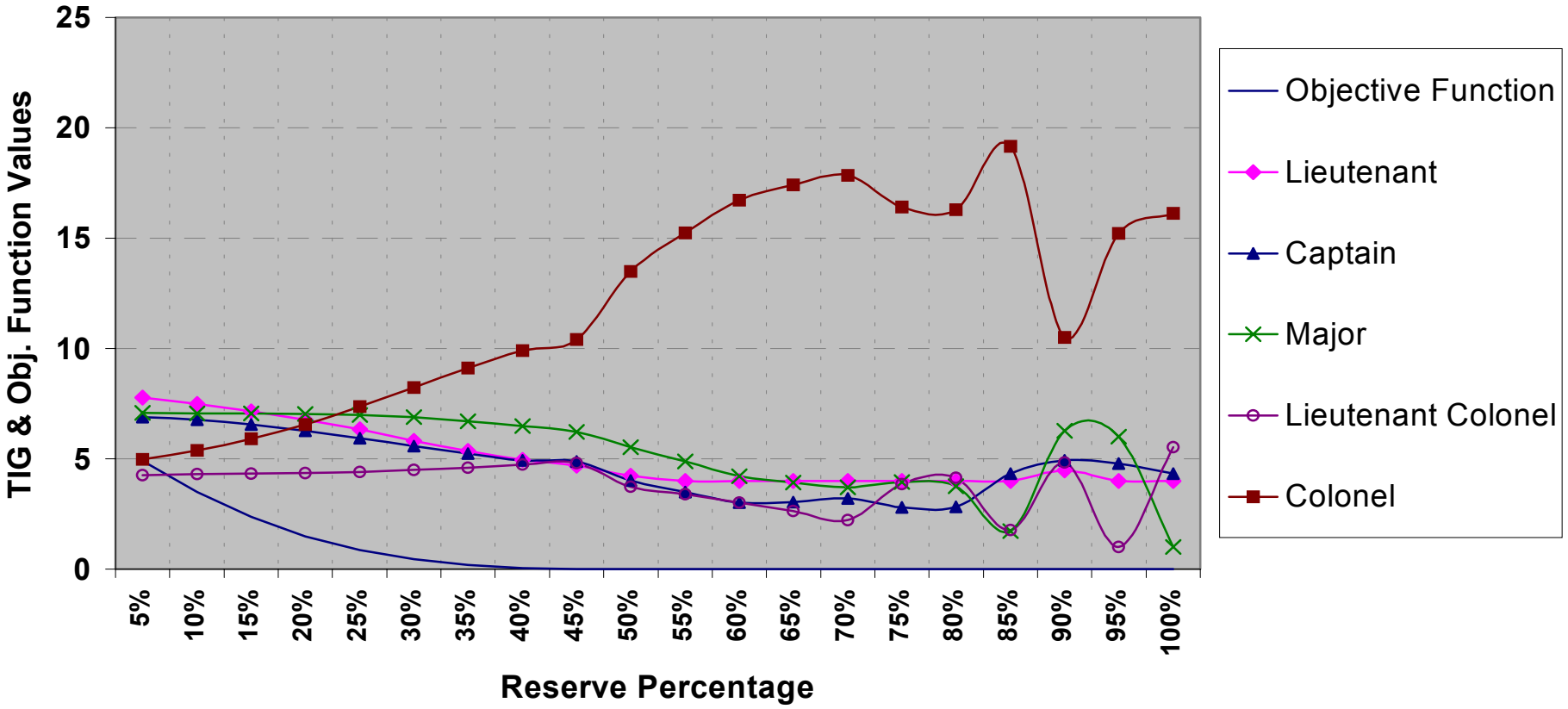

Figure 5. 1. The trends for TIG of each rank over given reserve rates together with objective values.

after the value of 35% and above. Therefore, these two acceptable areas overlap between the reserve rates of 35% and 45%.

All in all, the last determined range for reserve rates, which is between 35% and 45%, could give some flexibility to The Turkish Army in execution of the plan through needs. What makes critical this range is that it never causes to change predetermined TIG's more than expected in the manpower-planning model.

	Reserve Rates							
	5%	***10%***	***15%***	***20%***	***25%***	***30%***	***35%***	***40%***
Objective Function	4,904	3,495	2,361	1,484	0,866	0,444	0,18	0,0471
TIG for Each Rank								
Lieutenant	7,785	7,479	7,143	6,775	6,333	5,815	5,356	4,956
Captain	6,901	6,773	6,558	6,278	5,925	5,577	5,243	4,935
Major	7,074	7,065	7,067	7,022	6,981	6,893	6,699	6,482
Lt. Colonel	4,262	4,307	4,329	4,359	4,398	4,497	4,588	4,733
Colonel	4,978	5,376	5,902	6,566	7,363	8,218	9,114	9,894

	Reserve Rates					
	45%	***50%***	***55%***	***60%***	***65%***	***70%***
Objective Function	0,00516	6,006E-17	4,927E-17	5,865E-17	4,579E-12	3,057E-10
TIG for Each Rank						
Lieutenant	4,678	4,227	4	4	4	4
Captain	4,886	4,011	3,495	3,004	3,031	3,212
Major	6,226	5,528	4,871	4,221	3,915	3,699
Lt. Colonel	4,814	3,734	3,406	3,004	2,639	2,235
Colonel	10,395	13,501	15,228	16,734	17,416	17,855

	Reserve Rates					
	75%	***80%***	***85%***	***90%***	***95%***	***100%***
Objective Function	3,134E-10	2,163E-09	4,789E-10	3,332E-17	2,439E-18	3,491E-09
TIG for Each Rank						
Lieutenant	4	4	4	4,48	4	4
Captain	2,79	2,831	4,327	4,926	4,781	4,342
Major	3,952	3,745	1,731	6,257	5,996	1
Lt. Colonel	3,852	4,139	1,777	4,828	1	5,537
Colonel	16,407	16,285	19,165	10,509	15,222	16,12

Table 5. 1. The Results with Constant Reserve Rates for All Ranks

From this context, on one hand, the original model gives the smallest objective value on the reserve rate of 61% with a little modification in GAMS code. See Table 5.2 for detailed TIG and objective function values, and Appendix-B for the GAMS code of the original model with some modification to obtain an optimal constant reserve rate for all ranks. However, the output at this point of reserve rate is not acceptable due to being out of the determined range. Therefore, the closer values to 61%, we choose for reserve rates in the model, the closer the results will be to optimal. Although the change in objective function is too small, the tendency of some TIG values to have a big marginal change makes us stick to the determined range of reserve rates. On the other hand, if I apply different reserve rates to each rank other than apply a constant reserve rate for all ranks throughout the model as in the original formation of the model, the results shape as in Table 5.3. See Appendix-C for GAMS code of the revised model for optimal reserve rates of each rank. According to results of the revised model, the reserve rates and TIG's are not exactly compatible with that of original model. This is the evidence of that rates of each rank are dependant of TIG's. If they were independent of each other, it would be expected that TIG's remain the same where optimal reserve rates are applied.

Objective Function	TIG				
	Lieutenant	Captain	Major	Lieutenant Colonel	Colonel
1.479E-15	4	2.897	4.078	2.957	17.068

Table 5. 2. Optimal Values for Reserve Rate of 61%

	Lieutenant	Captain	Major	Lieutenant Colonel	Colonel
Reserve Rates	50.100	78.177	43.543	33.427	0
TIG	4	1.590	6.686	5.263	13.461

Objective Value	5.225E-14

Table 5. 3. The Revised Model Output With Optimal Reserve Rates for Each Rank

In consideration of all discussed so far, I select the reserve rate of 35% from the range where the system is most stable to present the output of some decision variables. According to all given data, the results of the nonlinear model follow in Tables 5.4 – 5.6.

Objective Value (z) = 0.180

RANKS	TIG'S
Lieutenant	5.356
Captain	5.243
Major	6.699
Lieutenant Colonel	4.588
Colonel	9.114

Table 5. 4. Average TIG's for Each Rank [c (*i*)]

Warfare Categories	Lieutenant	Captain	Major	Lieutenant Colonel	Colonel
Infantry	281.883	170.848	91.969	65.001	24.912
Armor	135.548	84.788	49.229	36.03	14.267
Artillery	205.334	136.945	78.462	54.525	21.181
Aviation	86.559	50.407	21.793	12.913	5.008
Air Defense	44.342	27.433	16.335	12.285	5.063
Intelligence	62.912	45.604	27.76	20.354	8.231
Engineering	83.048	53.999	31.568	24.412	9.987
Signal	98.987	58.226	28.77	19.132	7.588
Transport	51.107	33.443	19.097	12.83	4.939
Quartermaster	69.449	51.2	26.412	17.344	6.585
Ordnance	98.741	65.94	36.206	27.381	10.977
Personnel	78.413	58.958	36.206	24.615	9.109
Finance	14.777	12.855	9.06	7.135	2.894
Engineering	44.668	35.665	22.729	16.453	6.363
Doctor	143.988	115.095	59.409	39.967	15.584
Medical	47.485	33.61	17.41	10.973	4.179
Law	17.015	13.304	8.522	5.92	2.305
Teacher	61.376	51.087	29.568	20.039	7.902

Table 5. 5. Yearly Inflow Inventory Excluding Casualties [x (*i,j*)]

Warfare Categories	Lieutenant	Captain	Major	Lieutenant Colonel	Colonel
Infantry	726.598	463.557	91.058	97.891	.
Armor	365.181	141.613	43.303	29.76	.
Artillery	375.496	196.25	117.521	66.938	.
Aviation	242.502	140.811	87.85	18.487	.
Air Defense	145.6	39.699	18.421	.	.
Intelligence	107.123	37.983	37.086	7.653	.
Engineering	180.302	82.982	13.582	1.04	.
Signal	261.953	176.4	73.523	15.636	.
Transport	116.339	48.719	36.099	19.161	.
Quartermaster	48.121	85.655	50.111	29.458	.
Ordnance	99.273	187.25	17.654	15.481	.
Personnel	71.121	98.993	54.521	58.109	.
Finance	.	.	.	0.643	.
Engineering	68.814	.	15.619	25.483	.
Doctor	230.986	126.767	132.126	39.704	.
Medical	143.15	98.7	49.151	19.889	.
Law	13.888	14.273	15.925	8.85	.
Teacher	45.35	102.248	73.976	23.094	.

Table 5. 6. Total Accumulation in Reserves [reserve (*i,j*)][5]

[5] The symbol ". " for reserve (*i,j*) in the Table 5.7. means a value very close to zero.

5.2. COMPARISON OF WEIGHTS OF THE MODEL

I have used equal weights as a multiplier for each rank's total TIG variance in the objective function so far. However, I provide weights to support the analysis of the results. In determination of weights, I make use of hierarchical structure of the Turkish Army in terms of ranks. Thus, the weight of a rank is formed according to number of the previous rank in its span of control. The base unit is lieutenant in this formation. Then, the value of weights for each rank is adjusted in the way that their sum is equal to 5 as it is in equal weighted model. See Table 5.7 for weights of each rank to use in the objective function.

	Lieutenant	***Captain***	***Major***	***Lieutenant Colonel***	***Colonel***
Weights from Hierarchical Structure	1	3	8	9	27
Adjusted Weights	0,1042	0,3125	0,834	0,9375	2,8125

Table 5. 7. Adjusted Weights for each Rank

Comparison of the results including both equal and adjusted weights as determinants is shown in Table 5.8. The results with adjusted weights are obtained after running of GAMS code of the modified original model. See Appendix-D for modifications of GAMS code of the revised model.

From Table 5.8, the difference between the outputs of two models, which base on equal weights and adjusted weights respectively, is small enough to ignore. Although the objective value's change is around 2,8%, the absolute change in value is in thousandths. Therefore, the use of either weight multiplier in objective function of the model doesn't affect the results very much.

		With Equal Weight	With Adjusted Weight	Change in Value	Change in Percentage
TIG's	Lt.	5,356	5,331	-0,025	-0,6%
	Cpt.	5,243	5,256	0,013	0,3%
	Maj.	6,699	6,737	0,038	0,7%
	Lt. Col.	4,588	4,507	-0,081	-1,8%
	Col.	9,114	9,169	0,055	0,6%
Objective Value (With Multiplier of Weight)		0,180	0,0734	-0,1066	-59,22%
Objective Value (Without Multiplier of Weight)		0,180	0,1851	0,0051	2,8%

Table 5. 8. Comparison Table of the Outputs for Equal and Adjusted Weights

CHAPTER 6

6. CONCLUSION AND RECOMMENDATIONS

It is seen that the draft promotion system in the Turkish Army provides many advantages to everyone in the organization such as increased motivation and competition. These validate the statement that HRM necessitates a majority of aspects of reforms in the 21st century to give the deserved value of officers.

From this context, the thesis has described the development of a non-linear model for manpower planning in the Turkish Army. The model provides a computational methodology for analyzing the impact of the Army force structure on TIG's as it makes a transition to meet rank requirements. Furthermore, the model can allow the Turkish Army to evaluate simultaneously changes in the inflow inventories and reserves. It was tested by approximate data from the very system. Several runs of the model by checking the computational results and report forms are to reflect the expected structure of the Turkish Army. A special attention was also given to the construction of the model not to face with a bottleneck related to huge personnel inventory fluctuations in the system. Therefore, the usefulness and

applicability of the model and its solutions seems to be highly positive to implement in the real world.

The formation of TIG's in the draft promotion system of the Turkish Army shows that current cadres in the system give way to a pyramid structure, which bulges out in the head of the pyramid. It happens so, because the increasing trend in both cadre and TIG's toward higher ranks causes the inventory at those ranks increase. However, in our model, a TIG formation is observed from adjusted cadres, which is compatible with ranks. See Table 5.4 for average TIG's of each rank. Therefore, lower cadres at higher ranks mean shorter TIG requirement. However, great number of casualties at the rank of colonel due to retirement forces TIG requirement to be high. In addition to this, the pressure of higher ranks in terms of lower personnel requirement comes out with a longer TIG requirement at the rank of Major. This finding emphasis that the consistency of cadres in the system carries crucial importance due to its effect on TIG formation.

Although I obtain results on basis of given data, the Turkish Army Headquarters doesn't use fixed cadre in its hierarchical structure as I use fixed cadre in my model. Therefore, it is impossible for the Army headquarters to reach such results unless the total cadre for each rank is fixed. The continuously changing cadre every year is also a handicap in the draft promotion system, because it is not compatible with the Constitution (Item 128/2, 128, 10) in terms of providing equality.

The model that was developed and tested provides a basis for further development and implementation of an interactive manpower planning system in the Turkish Army. Such a system could improve both the consistency and quality of the personnel decisions.

The officer resources, which have a capacity problem, can make use of the findings of the optimization in determination of their capacity in advance. Thus, the Turkish Army promotion system can keep itself away from the capacity handicap for recruitment of officers at the rank of lieutenant. Perhaps, the capacity increases, which depends on the determination of required inflow number of officers (x_{1j}, j=1,…, n) in the model, in military schools can shape some expenses of yearly defense budget.

As a further research, the lower bound of each TIG range for each rank can be investigated with qualitative research techniques. Here in the model, although I use minimum acceptable values for each TIG range as a lower bound, a revised model can shape the output in accordance with the new values of lower bound of TIG range, which could be the result of qualitative research. It is for sure that the configuration of our model doesn't show any difficulty for this revision. Thus, the lower bound of each TIG range could be obtained by a qualitative research along with the upper bounds from the original layout of the model. On the other hand, to give an exact range to qualitative study for TIG's of each rank in the model on quantitative base, we can run the model many times by tightening the lower bound of TIG's of each rank by one until the solution is infeasible. If not, the process will end

at the upper bound of TIG's of each rank, which is the first upper integer after the average TIG values of each rank. Therefore, the number of repetition of the runs is finite. Why we chose this point, as an upper bound for TIG's is that the model can't go further than that point with a minimization objective. In the process the points where we find infeasible solutions for the model will shape the lower bounds of TIG's of each rank. Thus, we can obtain a range for all TIG's for variations.

Our model presenting a steady state manpower flow optimization needs also a transition plan to adapt the current promotion system to the findings of the constructed model. Without a transition process, a shock implementation of the results may result in a collapse of the flow in the model.

Modification of the model to include staff officers to the flow of the model can be done in the way that this warfare category shapes itself probabilistically in the range between the rank of senior 1st Lieutenant and senior Captain. Then, the staff officers in flow of the system can be isolated from the other warfare categories rather than integration toward the retirement and promotion to General. The spectacular difference in formation of this category lies in that promotion is subject to special regulations.

The results other than TIG's are in aggregate sense for each rank. The decomposition of all values in terms of promotion groups (See 3.4.1. The principles of the draft promotion system for promotion groups) means nothing to the final value, instead the decomposition increase the complexity of the model. In spite of

this, a further study can be done for determining the promotion percentages and configuration for each promotion group at any rank to provide a fair ladder in promotion, which is compatible with the results of this model.

All in all, a perfect flow in the presented model lies in that the Turkish Army should make a detailed job description, job analysis, cadre analysis, and career planning in its Human Resource Management system to obtain the data to use in the presented model.

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APPENDIX A. GAMS CODE OF THE ORIGINAL MODEL

This model, which is written in GAMS code below, gives equal weight to all ranks, and the variable "r rate" as *reserve rate* in the model is considered to be given for every run as a constant value.

```
Sets

      i      ranks
      /            lieutenant
                   captain
                   major
                   ltcolonel
                   colonel       /
      j     categories
      /            infantry
                   armor
                   artillery
                   aviation
                   airdefence
                   inteligenc
                   enginering
                   signal
                   transport
                   qumaster
                   ordnance
                   personnel
                   finance
                   engineer
                   doctor
                   medical
                   law
                   teacher       /
      w    /       service       /       ;
```

Table r(i,w) maximum waiting time in years for each rank

	service
lieutenant	18
captain	17
major	19
ltcolonel	22
colonel	0 ;

Table s(i,j) percentage of cadre in casualty for rank i and category j

	infantry	armor	artillery	aviation	airdefence
lieutenant	0.035	0.035	0.035	0.019	0.035
captain	0.052	0.052	0.052	0.056	0.049
major	0.073	0.073	0.073	0.081	0.069
ltcolonel	0.056	0.056	0.056	0.056	0.055
colonel	0.157	0.157	0.157	0.157	0.157

+	inteligenc	enginering	signal	transport	qumaster
lieutenant	0.032	0.035	0.035	0.035	0.035
captain	0.041	0.052	0.052	0.050	0.044
major	0.070	0.078	0.072	0.070	0.087
ltcolonel	0.054	0.057	0.056	0.056	0.059
colonel	0.157	0.158	0.157	0.156	0.157

+	ordnance	personnel	finance	engineer	doctor	medical
lieutenant	0.035	0.021	0.020	0.025	0.011	0.021
captain	0.051	0.038	0.031	0.028	0.022	0.021
major	0.072	0.057	0.069	0.077	0.091	0.063
ltcolonel	0.056	0.051	0.055	0.054	0.056	0.055
colonel	0.157	0.155	0.156	0.154	0.159	0.155

+	law	teacher
lieutenant	0.015	0.012
captain	0.035	0.021
major	0.054	0.057
ltcolonel	0.049	0.049
colonel	0.153	0.154 ;

Table a(i,j) target cadre for rank i and category j

	infantry	armor	artillery	aviation	airdefence
lieutenant	2236	1091	1475	706	416
captain	1359	586	914	405	180
major	707	373	643	251	127
ltcolonel	396	195	317	76	56
colonel	227	130	193	45	46

+	inteligenc	enginering	signal	transport	qumaster
lieutenant	444	625	792	390	420
captain	277	366	504	224	354
major	223	225	265	164	227
ltcolonel	101	113	103	78	109
colonel	75	91	69	45	60

+	ordnance	personnel	finance	engineer	doctor	medical
lieutenant	628	491	65	308	1002	409
captain	535	408	62	185	730	282
major	260	297	55	168	530	165
ltcolonel	141	171	35	101	223	70
colonel	100	83	27	58	142	38

+	law	teacher
lieutenant	105	374
captain	84	370
major	73	272
ltcolonel	36	115
colonel	21	72 ;

Variables

x(i,j)	inflow inventory excluding casualties for rank i and category j
c(i)	average TIG for rank i
totalTIG	total TIG
TIG	Time-in-Grade
reserve(i,j)	yearly accumulation in reserves for rank i and category j
h(i,j)	revised cadre after excluding reserves for i and j
z	total variance of all TIG's ;

```
Positive Variable x ;

x.lo(i,j)= 1 ;
x.up(i,j)=inf ;
TIG.lo(i,j)= 1 ;
TIG.lo('lieutenant',j)=4 ;


Equations

        vardef          define total variance in the objective function
        aver(i)         define average TIG for rank i
        hierarchy1(j)   observe hierarchy structure between LT and CPT
        hierarchy2(j)   observe hierarchy structure between CPT and MAJ
        hierarchy3(j)   observe hierarchy structure btw MAJ and LTCOL
        hierarchy4(j)   observe hierarchy structure btw LTCOL and COL
        TIG1            define total TIG
        TIG2(i,j)       define TIG for rank i and category j
        TIGlimit        observe total TIG limit
        rsvr(i,j,w)     define  reserve amount for rank i and category j
        rsvrcont(i,j)   observe reserves
        cadre(i,j)      define revised cadre;


rsvr(i,j,w)..       reserve(i,j)=e=[x(i,j)-x(i+1,j)-(s(i+1,j)*a(i+1,j))]*r(i,w);
rsvrcont(i,j)..     reserve(i,j)=l=(a(i,j)*r rate)/100;
cadre(i,j)..        h(i,j)=e=a(i,j)-reserve(i,j);
hierarchy1(j)..     x('captain',j)+ (s('captain',j)*a('captain',j))=l=x('lieutenant',j);
hierarchy2(j)..     x('major',j)+(s('major',j)*a('major',j))=l=x('captain',j);
hierarchy3(j)..     x('ltcolonel',j)+(s('ltcolonel',j)*a('ltcolonel',j))=l=x('major',j);
hierarchy4(j)..     x('colonel',j)+(s('colonel',j)*a('colonel',j))=l=x('ltcolonel',j);
aver(i)..           c(i)=e=(sum(j,(h(i,j)/x(i,j))))/18 ;
TIG1..              totalTIG=e=sum(i,c(i));
TIG2(i,j)..         TIG(i,j)=e=h(i,j)/x(i,j);
TIGlimit..          totalTIG=e=31;
vardef..            z=e=sum(i,([sum(j,sqr[(h(i,j)/x(i,j))-c(i)])]/17))  ;


option iterlim=40000 ;
Model manpower /all/  ;
6manpower.optFile=1;
option NLP=minos5 ;
Solve manpower using NLP minimizing z  ;
```

APPENDIX B. GAMS CODE OF THE REVISED MODEL FOR AN OPTIMAL CONSTANT RESERVE RATE

The only difference of the revised model from the original model (see Appendix-A) is to give the model responsibility to determine an optimal constant reserve rate for all ranks along with TIG's and inflow inventory. Therefore, the variable "rrate" in equation sections of the original model is also defined as a decision variable in the revised model. The GAMS code of these definition lines in the variable section of the revised model follows as:

```
rrate        number of cadre for reserves in every 100, constant for all ranks

Positive variable rrate;
rrate.up=100;
```

[6] This line requires creation of another file named "minos5.opt" consisting of a code of "major iterations 10000".

APPENDIX C. GAMS CODE OF THE REVISED MODEL FOR OPTIMAL RESERVE RATES OF EACH RANK

The only difference of the revised model from the original model (see Appendix-A) is that the revised model determines each optimal reserve rate for all ranks separately along with TIG's and inflow inventory. Therefore, the variable "rrate" in equation sections of the original model is defined as a decision variable named rrate(i) for each rank in the revised model, and the GAMS code of these definition lines in the variable section and code of line revision in equation section of the revised model follows as:

a. In "VARIABLES" section:

```
rrate(i)          number of cadre for reserves of each rank in every 100
Positive variable rrate;
rrate.lo(i)=1;  rrate.up(i)=100;  rrate.lo('colonel')=0;
```

b. In "EQUATIONS" section:

```
rsvrcont(i,j)..     reserve(i,j)=l=(a(i,j)*rrate(i))/100;
```

APPENDIX D. GAMS CODE OF THE REVISED MODEL WITH ADJUSTED WEIGHTS

The only difference of the revised model from the original model (see Appendix-A) is that the revised model bases on adjusted weights rather than equal weights as in the original model. The relevant modifications in the GAMS code of the original model to get the revised model code follow as:

a. In "SETS" section: Define the dimension of indices '*w*'

```
w    / service
       weight /      ;
```

Table r (i,w) maximum waiting years in service and adjusted weights for all i

	service	weight
lieutenant	18	0.1042
captain	17	0.3125
major	19	0.834
ltcolonel	22	0.9375
colonel	0	2.8125 ;

b. In "EQUATIONS" section:

```
rsvr(i,j,w)..      reserve(i,j)=e=[x(i,j)-x(i+1,j)-(s(i+1,j)*a(i+1,j))]*r(i,'service');
rsvrcont(i,j)..    reserve(i,j)=l=(a(i,j)*35)/100;
vardef..           z=e=sum(i,r(i,'weight')*([sum(j,sqr[(h(i,j)/x(i,j))-c(i)])]/17));
```