USING ARTIFICIAL NEURAL NETWORKS TO PREDICT ISSUANCE DURATIONS OF OCCUPANCY PERMIT APPLICATIONS

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ABSTRACT

USING ARTIFICIAL NEURAL NETWORKS TO PREDICT ISSUANCE DURATIONS OF OCCUPANCY PERMIT APPLICATIONS

This study aims to predict the issuance durations of occupancy permit applications using the delay causes defined in the permit process and reveal the most significant causes affecting the performance of the prediction.

Research data are gathered from a previous study that also analyzed the occupancy permit process. Delay causes of 80 new building occupancy permit applications made to the Izmir Konak Municipality and their issuance durations are used to design the prediction model.

Artificial Neural Networks (ANN) is used for predicting the issuance durations of occupancy permit applications. The model is constructed to predict the issuance durations of least once rejected applications made to Izmir Konak Municipality during year 2008. Then, sensitivity analysis is carried out to detect the most significant delay causes affecting the issuance duration.

Permit data are examined to reveal the delay causes of occupancy permit process. Six inputs are generated from the delay causes and used in ANN model: 1) Number of missing approval letters, 2) Number of missing payment documents, 3) Number of non-conformances of project to codes and regulations, 4) Number of all missing documents, 5) First permit application season, 6) First permit rejection season. Total issuance durations of the occupancy permit applications are used as the output parameters of the model.

The results of the analysis indicate that the prediction accuracy of the model is 86% and the number of missing approval letters, the number of missing payment documents, and the first application season are respectively the three most significant inputs affecting the prediction performance of the model. This study proves that the total issuance durations are so bound to the delay causes in the permit process that it can be learned and predicted by the ANN model and the occupancy permit process is required to be reengineered.

ÖZET

YAPI KULLANMA İZNİ BAŞVURULARINDA İZİN ALIM SÜRELERİNİN YAPAY SİNİR AĞLARI İLE TAHMİN EDİLMESİ

Bu çalışmada, gecikme sebepleri kullanılarak yapı kullanma izni başvurularının izin alım sürelerinin tahmin edilmesi ve tahmin başarısına etkiyen en önemli sebeplerin ortaya çıkarılması amaçlanmıştır.

Çalışmanın verileri, yapı kullanma izni alım sürecinin analiz edildiği önceki bir çalışmadan elde edilmiştir. İzmir Konak Belediyesi'ne yapı kullanma izni almak üzere yapılmış 80 adet başvurunun gecikme sebepleri ve izinlerinin onay sürelerinden tahmin modelinin kurulumunda yararlanılmıştır.

İzin alım sürelerinin öngörülebilmesi için Yapay Sinir Ağları (YSA) yöntemi kullanılmıştır. YSA modeli, İzmir Konak Belediyesi'ne 2008 yılında yapılan yapı kullanma izni başvurularından, izin alım süreci içerisinde en az bir kez reddedilmiş başvurular ile kurulmuştur. Daha sonra izin alım sürecindeki en etkili gecikme nedenlerini bulmak için duyarlılık analizi yapılmıştır.

Yapı kullanma izni alım sürelerinin gecikme sebepleri, araştırmanın verileri değerlendirilerek ortaya çıkarılmıştır. Gecikme sebeplerinden altı adet girdi parametresi üretilmiş ve YSA modelinde kullanılmıştır: 1) Eksik onay belgelerinin sayısı, 2) Eksik makbuzların sayısı, 3) Yapının yönetmeliklere ve ilgili inşa kanunlarına uygunluğuyla ilgili eksik evrakların sayısı, 4) Başvurudaki toplam eksik evrak sayısı, 5) İlk başvurunun yapıldığı mevsim ve 6) Başvurunun ilk reddedildiği mevsim.

Araştırmanın sonuçları, tahmin başarısının %86 olduğunu göstermiş ve sırasıyla eksik onay belgelerinin sayısı, eksik makbuzların sayısı ve ilk başvurunun yapıldığı mevsim girdilerinin modele etkiyen en önemli ilk üç girdi olduğunu ortaya koymuştur. Bu çalışma yapı kullanma izni alım sürelerinin gecikme sebeplerine direk bağlı olduğunu ve öğrenilip YSA modeli tarafından tahmin edilebileceğini kanıtlamıştır. Böylece, yapı kullanma izni sürecinin yeniden yapılandırılması gerekliliğini de vurgulamıştır.

To My Beloved Family

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LIST OF ABBREVIATIONS

Abs   : Absolute

AKS   : Adres Kayıt Sistemi

          (Address Registration System)

App   : Application

APP   : Appendix

BIS   : Buildings Information System

CIF   : Construction Inspection Firm

CO   : Certificate of Occupancy

DCRA   : Department of Consumer and Regulatory Affairs

DEAR   : Department data enters application details

ISD   : Inspectional Services Department

Max   : Maximum

MAPE   : Mean Absolute Percentage Error

MERNİS   : Merkezi Nüfus Veri Tabanı

          (The Central Civil Registration System)

Min   : Minimum

MSE   : Mean Square Error

Rej   : Rejection

TCO   : Temporary Certificate of Occupancy

YOİKK   : Yatırım Ortamını İyileştirme Koordinasyon Kurulu

(The Coordination Council for the Improvement of Investment

Environment)

CHAPTER 1

INTRODUCTION

Occupancy permit proves that the new constructed or new restored building provides all the required conditions for the health and safety of users (Turkish Construction Law, 1985).

Legally, construction starts with the building permit gathered from the related municipality by the property owner or the assigned construction applicant. Occupancy permit application follows the completion of the construction of the building. Property owner or the assigned construction applicant should apply to a permit for occupancy as well. The applicant is responsible to submit all required documents and drawings of the building to the related department of the municipality. Appendix B includes the list of the required documents for obtaining occupancy permit from Izmir Konak Municipality (Izmir Konak Municipality, n.d.). Permit officials review the submitted documents, drawings, and the building in-situ (Figure 1.1). Technical supervisors (assigned architect and the mechanical engineer) visit the building in-situ in order to check the compliance of the construction to the codes and to the architectural design drawings, mechanical specifications and installation projects submitted to the municipality. Technical supervisors, the Head of the Department of Occupancy Permit and the Directorate of Local Planning and Settlement Authority are required to respectively approve the occupancy permit. Upon the approval of the application, the applicant receives the permit issuance from the Occupancy Permit Registration desk of the municipality.

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┌─────────────────────────────────────────────────┐
│        Gathering of Required Documents for         │
│           Occupancy Permit Application             │
└─────────────────────────────────────────────────┘
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┌─────────────────────────────────────────────────┐
│   Submission of All Occupancy Permit-Related Documents   │
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│      Application to the Occupancy Permit Department of      │
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├─────────────────────────────────────────────────┤
│      Approval of Head of the Occupancy Permit Department      │
├─────────────────────────────────────────────────┤
│   Approval of Director of the Local Planing and Settelement Authority   │
└─────────────────────────────────────────────────┘
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┌─────────────────────────────────────────────────┐
│          OCCUPANCY PERMIT ISSUANCE and            │
│          PROGRESS PAYMENT DOCUMENT                │
│              ready to be picked up                 │
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Figure 1.1. Occupancy Permit Process
(Source: Demirciefe, 2009)

1.1. Problem Definition

Obtaining occupancy permit is a complex and an arduous process including series of activities that are carried out in the municipalities. Process involves many stakeholders such as permit officials of the municipality, inspectors of the Construction Inspection Firm (CIF) and project owners. Complex relations between the stakeholders, difficulties in gathering the required documents such as approval letters, taxes and fees, etc. from related agencies and municipality offices, excessive maze of regulations and

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paperwork in municipalities consume time, lead to the unwarranted delays, increase project cost and cause needless frustration and aggravation. Delays in the issuance process of the occupancy permit harm the economy, as well. Delays obscure the suggested occupancy permit issuance date for applications by law and cause problems in purchasing, selling, renting or using any buildings for residential, commercial, industrial, etc purposes. The problem has been widely discussed in a report of The Coordination Council for the Improvement of the Investment Environment which is called as YOİKK (Turkish Republic The Ministry of Public Works and Settlement General Directorate of Technical Reseach and Implementation, 2009). Council has worked on the occupancy permit regulations to reveal the problems in the permit process and reform the requirements of the process for meeting the European Union (EU) standards. However, fortiori analyses and applicable solutions about the occupancy permit procedure are needed for providing permanent and faster improvement.

In this study, analyses about the informative subjects and delay causes of the occupancy permit process are made to improve the timeliness and efficiency of the process in Turkish Municipalities.

This research may guide to the YOİKK in their studies for improving the quality of the occupancy permit process and to the municipalities for revising their occupancy permit procedures. This research could also be an initial study to establish an electronic based system in municipalities which may estimate the occupancy permit issuance duration and warn both the applicants and the municipal officials about the possible issuance duration in order to raise their awareness and speed up the process.

1.1.1. Data

Data are gathered from an early study that revealed the chaotic situation of the occupancy permit process in Konak Municipality Izmir (Demirciefe, 2009). Out of 107 occupancy permit application files gathered between the period of January 1st and the December 1st of 2008, 80 of them are found appropriate for this study. All applications are examined according to their status of approval. Only, the approved occupancy permit applications are used in the study.

1.2. Objectives

The aim of this research is to predict the issuance durations of occupancy permit applications. During the research two main objectives are composed; primary and secondary objectives. The primary objectives of the research are;

  a. to develop an Artificial Neural Network (ANN) model that is capable of predicting accurate issuance durations of occupancy permit applications,

  b. to offer a simple but reliable method to the construction sector for predicting the permit issuance duration.

The secondary objectives of the study are;

  a. to find out the causes that delay the issuance of the occupancy permit in municipalities;

  b. to explore the most sensitive delay causes of occupancy permit process that are used in the ANN model;

  c. to make contribution to the development of the occupancy permit processes in Turkish municipalities for meeting the EU standards;

1.3. Methodology

ANN is used as the prediction method to predict the issuance durations of occupancy permit applications. Permit data are examined to reveal the delay causes of occupancy permit process. 6 inputs are generated from the delay causes and used in ANN model. ANN software NeuroSolutions (The NeuroDimensions Inc., n.d.) is used to generate the ANN model. Sensitivity analysis is carried out to explore the effectiveness of the inputs on the prediction performance of the model. In order to evaluate the sensitivity of the model, inputs are individually activated with the output and the prediction performances of the activations are measured.

1.4. Outline

This dissertation consists of five chapters. The 'Introduction' chapter reveals the contribution of this research to the problem area together with the briefly explained objectives and the methodology of the research.

The 'Review of Occupancy Permit Process' chapter includes the review of the occupancy permit process in Izmir Konak Municipality, the analysis of the interview about the occupancy permit process in county municipalities of Izmir. There are also observations about the occupancy permit process information represented on the official web pages of Turkish metropolitan cities' municipalities and the municipalities belong to the cities in U.S., Canada, Australia and EU countries.

The 'Method and Model Construction' chapter includes the descriptions of ANN methodology and gives information about the model construction of a new model that is specifically built up for the case of the study.

Fourth chapter, which is the 'Results and Discussions' chapter, presents the results of ANN model, sensitivity analysis and discussions about the research results.

The last chapter is the 'Conclusion' chapter. Chapter involves a brief summary of the study and the implementations of the present study.

CHAPTER 2

REVIEW OF OCCUPANCY PERMIT PROCESS

Occupancy permit presents the compliance of the newly constructed and/or restored building with the Building Codes and Regulations and the availability of the building to be operational according to its technical and physical comfort (Demirciefe, Doğan, Günaydın ,2009; Doğan, Günaydın, Demirciefe, 2009a; Doğan, Günaydın, Demirciefe, 2009b). Obtaining the occupancy permit is a compulsory for any living unit such as a simple house, or a multistory apartment or any commercial units. It is approved by the directorate of the Local Planning and Settlement after the permit officials and inspectors inspect the building in-situ and approve the operations.

2.1. Occupancy Permit Process in Izmir Konak Municipality

Occupancy permit process starts with the application of the property owner or his/her notarized agent to the related municipality as soon as the construction of the building ends. Inspectors check the general conformance of the newly constructed building and/or restored building to the Building Codes and Regulations with in-situ inspections and the permit officials review the required documents and the drawings submitted in application file to the related department of the municipality.

Figure 2.1. shows the occupancy permit issuance process that consists of five sub processes; submission process, application process, review process, in situ inspection process, and approval process (Demirciefe, 2009).

Submission process includes gathering of required documents from the related offices such as proof of tax payment to the department of social security, approval letter of the department of telecom services and distribution inc. com., approval letter of the department of city water supply and sewage administration, and application file for elevator permit. However, field inspections containing layout inspection with pre-pour inspection of footings, under-floor inspection up to plinth level, and installation and structural framing inspection have to be approved before.

Application process follows the submission process. The applicant submits the permit application file to the registration desk of Occupancy Permit Department of the municipality. Appendix B includes the list of all required documents and drawings to obtain the occupancy permit.

All submitted documents, drawings and the archive file of the building are reviewed in review process.

Mechanical engineers and architects visit the construction site and check the compliance of the drawings, documents and their applications to the building in in-situ inspection process. They conduct the electrical, plumbing and mechanical inspections and final general building inspections. Directorates of Civil Defense inspection officials make another in-situ inspection to check the compliance of bomb shelter of the building with the Building codes and Regulations, as well. Buildings having elevators need further inspection. The compliance of the required documents submitted to the Chamber of Electrical and Mechanical Engineers are controlled with the elevators operated in the building with in-situ inspections.

The occupancy permit and progress payment document are delivered to the Head of the Occupancy Permit Department in order to be assigned after the approval of the inspections and the review of the required documents. The property owner may pick up the approved permit and progress payment documents from the registration desk, in the end.

Upon the approval of progress payment document the CIF gets its full progress payment for the approved construction work. The property owner may apply for the services of water supply and electricity to the Izmir Water and Sewage Admin (IZSU) and Electric Distribution Incorporated Company of Turkey (TEDAŞ). In the end, the building gets ready for occupation.

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┌─────────────────────────────────────────┐
│         Building Permit Issuance         │
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┌─────────────────────────────────────────┐
│            Construction Ends             │
└─────────────────────────────────────────┘
                     ↓
┌─────────────────────────────────────────────────┐
│           Occupancy Permit Application            │
│  ┌──────────────────────────────────────────┐    │
│  │ 1.  Submission of All Occupancy Permit-   │    │
│  │     Related Documents                     │    │
│  │  • Proof of tax payment to the Department  │   │
│  │    of Social Security                      │   │
│  │  • Approval letter of the department of    │   │
│  │    Telecom Services And Distribution Inc.  │   │
│  │    Com.                                    │   │
│  │  • Approval letter of the Department of    │   │
│  │    City Water Supply and Sewage            │   │
│  │    Administration                          │   │
│  │  • Application file for elevator permit    │   │
│  └──────────────────────────────────────────┘    │
│                     ↓                             │
│  ┌──────────────────────────────────────────┐    │
│  │ 2.  Application Process                   │    │
│  │  • Application to the Occupancy Permit     │   │
│  │    Department of the related Municipality  │   │
│  └──────────────────────────────────────────┘    │
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│  │ 3.  Review Process                        │    │
│  │  • Review of required documents and        │   │
│  │    archive file of the building            │   │
│  └──────────────────────────────────────────┘    │
│                     ↓                             │
│  ┌──────────────────────────────────────────┐    │
│  │ 4.  In Situ Inspection Process            │    │
│  │  • Inspectors: Architect and Mechanical    │   │
│  │    Engineer                                │   │
│  └──────────────────────────────────────────┘    │
│                     ↓                             │
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│  │ 5.  Approval Process                      │    │
│  │  • Occupancy Permit and Progress Payment   │   │
│  │    Document Issuance Process               │   │
│  └──────────────────────────────────────────┘    │
└─────────────────────────────────────────────────┘
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┌─────────────────────────────────────────┐
│         Occupancy Permit Issuance         │
│  By Directorate of Local Planning and     │
│        Settlement Authority               │
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┌─────────────────────────────────────────┐
│        Application to IZSU and TEDAS      │
└─────────────────────────────────────────┘
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┌─────────────────────────────────────────┐
│      BUILDING READY FOR OCCUPANCY         │
└─────────────────────────────────────────┘
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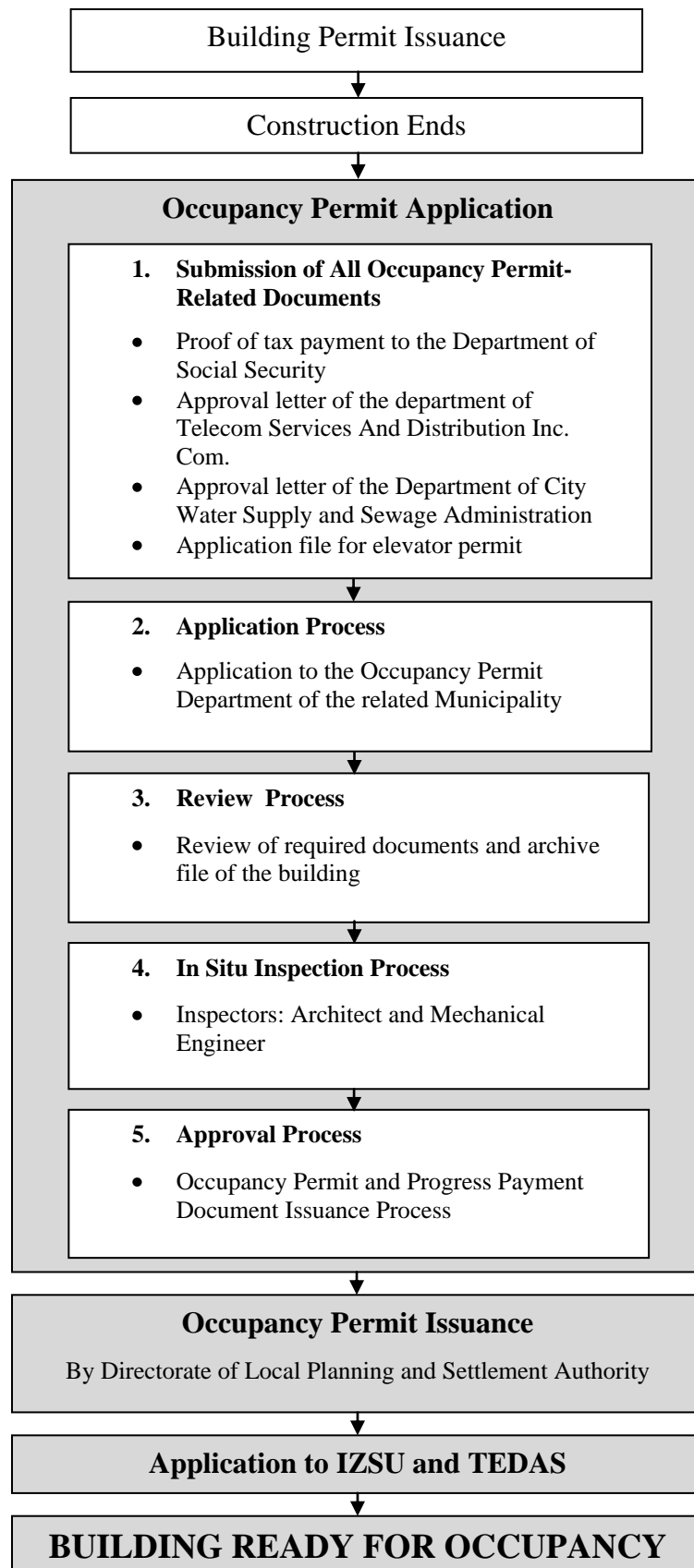
Figure 2.1. Occupancy Permit Process in Izmir Konak Municipality
(Source: Demirciefe, 2009)

2.1.1. Delay Causes

80 occupancy permit applications for newly constructed buildings made to the Housing Department of Izmir Konak Municipality in 2008 are analyzed in this study. 16 rejection reasons derived from rejection letters are studied and grouped under 3 titles as listed in Table 2.1. (Demirciefe, 2009).

Table 2.1. The rejection reasons

Missing approval letters	Approval letter of the directorate of civil defense
	Document from TEDAŞ
	Application file for elevator permit
	Approval letter of the department of city water supply and sewage administration
	Approval letter of the department of telecom services and distribution inc. com.
	Proof of changed title deed
	Approval letter of the department of fire authority
	Approval of the CIF
Missing payment documents	Proof of progress payment to CIF
	Proof of tax payment to the department of social security
	Proof of real estate tax payment
	Proof of parking lot payment
Non-conformances of project to codes and regulations	Non Conformance of the Construction to the Approved Project
	Proof of conformance by original photographs of the building dated
	Proof of the final service charge of CIF
	Approvals of the architect and engineers of the project

2.1.1.1. Missing Approval Letters

Missing approval letter group includes 8 rejection reasons related with the approval letters in occupancy permit application process.

1. Approval letter of the directorate of civil defense

The approved letter presents the competence of the bomb shelter construction of the building to the current codes and regulations. It is approved by the civil defense experts after in-situ inspection of the building.

2. Document from TEDAŞ

The document presents the adequacy of the existing electrical power units or states the requirement of the construction of a new electrical power distribution unit for the specified building. It is received from Turkish Electricity Distribution Corporation (TEDAŞ) in building permit process.

3. Application file for elevator permit

An application file including mechanical and electrical project specifications is required for elevator permit. In-situ inspections, mechanical and electrical engineers from the Chamber of Mechanical Engineers and the Chamber of Electrical Engineers check the project specifications in place. Upon the approval of the inspections, the application file is returned to the Occupancy Permit Department for approvals of the Department Head and the Local Planning and Settlement Authority. Elevator permit is issued with the occupancy permit.

4. Approval letter of the Department of City Water Supply and Sewage Administration

The approval letter represents the conformance of the water supply installation and the domestic and storm sewage disposal units' installation to the requirements of Water Supply and Sewerage Administration of Izmir Metropolitan Municipality (IZSU). The technicians of IZSU inspect the installations and upon the approval of the inspections the letter is approved.

5. Approval letter of the Department of Telecom Services and Distribution Inc. Com.

Technicians from Telecom Services and Distribution Inc. Com. inspect the building in-situ. The conformance of the mechanical installations to the requirement of

the Telecom Service is controlled and upon the approval of the installations, the letter is approved.

6. Proof of changed title deed

It is required to change the title deed from a land title deed to a building title deed and the property owner is responsible for this task. Upon the submission of the title deed together with the plot share distribution table, original photographs of the building and cadastral survey pages to the title deed department the proof of changed title deed can be obtained.

7. Approval letter of the department of fire authority

Inspectors from fire department inspect the fire detection, extinction and evacuation projects according to the fire codes. They have the authority to approve the letter.

8. Approval of the CIF

It is required to get approval from CIF that the property owner contracted with. The approval of CIF shows that the building and the projects are checked and the final building is compliance with the current building codes and technical specifications.

2.1.1.2. Missing Payment Documents

There are four rejection reasons about payment documents as stated below.

1. Proof of progress payment to CIF

Third level in-situ inspection, namely insulation and structural framing inspection, is required to have been conducted. Property owner is responsible to have made the 80% progress payment to the CIF and provide a payment clearance document for the occupancy permit application.

2. Proof of tax payment to the department of social security

A dept clearance document which confirms that all construction workers' social insurance rates and taxes have been made is gathered from the Department of Social Security and has to be submitted to the occupancy department of the municipality.

3. Proof of real estate tax payment

A tax clearance document presents that the property owner had paid all taxes that he/she owes. It is obtained from the related tax department and submitted to the municipality for the occupancy permit application.

4. Proof of parking lot payment

A signed contract made during the building permit process marks the legal fee for not allotting a parking lot. Project owner is required to submit receipts of parking lot payment upon the completion of final building inspection. Once receipts submitted, permit official requests a debt clearance document for parking lot charge from the financial services of the municipality. Proof of parking lot payment is required for occupancy permit issuance.

2.1.1.3. Non-Conformances of Project to Codes and Regulation

There are required documents and drawings identifying the physical condition and structural features of the building. Missing of these documents and/or the drawings cause rejections in occupancy permit applications.

1. Conformance of the Construction to the Approved Project

The document shows the approval of the in-situ inspections of the building and the compliance of the mechanical and architectural projects to the Building codes and Regulations.

2. Proof of conformance by original photographs of the building dated

Permit officials are responsible to examine the required dated photographs belong to all facades, parking lot, views from the terrace and mechanical pressurization

units that are submitted to the occupancy department of the municipality in application file.

3. Proof of the final service charge of CIF

The final payment of CIF depends on the approval of occupancy permit issuance and it is %20 of total service fee. CIF makes the payment application by itself after the final in-situ inspection. Upon the approval of the permit, the payment is confirmed over the web-based building audit commission system.

4. Approvals of the architect and engineers of the project

According to the final condition of the building, the architect and engineers approve the building. The approve shows that the architect, civil, mechanical and electrical engineers are authorized that the building is constructed under their supervision in compliance with their projects.

2.1.2. Time Data

Building codes and regulations define occupancy permit issuance duration as thirty days for investing an occupancy permit application file. In some cases as stated in rejection reasons, delays occur and the issuance extents. Two types of delays are defined in law. The first one is related with the business of the occupancy permit department of the municipalities, but the enforcement of the law makes the officials complete the review process in thirty days despite any reason. The second type is related with the applicants' unconsciousness and lack of information about the permit issuance progress which cause lateness in submitting the required documents and drawings.

The law allows ten extra days for the applicants to complete and submit their missing documents to the municipality. In such circumstances, if the missing documents could not be submitted in ten days, the permit process turns back to top and the applicant may wait thirty days for the issuance of his/her second occupancy permit application again. The occupancy permit issuance process repeats itself in each permit application.

Despite the legal durations, the permit issuance durations of the applications made to İzmir Konak Municipality between the dates of 1st of January 2008 and 3rd of February 2009 are in the range of 36 days to 350 days and the average issuance duration is calculated as 99 days for new buildings. Only 11% of the applications could get the permit issuance in 8 weeks, 75% of them are obtained their issuances within 50 weeks (Demirciefe, 2009).

In the light of this data, a short interview is prepared for the 29 county municipalities of Izmir to have a general aspect about the occupancy permit process in Izmir.

2.2. Interviewing Officials in County Municipalities of Izmir about the Occupancy Permit Process

29 County municipalities of Izmir are reviewed. Interviews are carried out on the phone and the permit officials working in occupancy permit process are questioned. These interviews are essential to get a better understanding about the consciousness of the municipalities and the applicants on the occupancy permit process.

2.2.1. Interview Design

The interview questions are designed to reveal the exact permit issuance duration of the applications that are made without missing documents, the problems that are frequently faced in the permit process and the manners of both the applicants and the municipalities (App. D). The answers of the municipalities represented in the Table 2.2 with 'x' signs and the duration information is shown with numbers under the related column. Cells signed as '-' show that the municipality did not answer the related questions for some reasons as being busy, not preferring to answer the questions on the phone, etc.

2.2.2. Interview Answers

Answers of the municipality officials working in Occupancy Permit Departments to the interview questions are explained as below. In addition to this, Table 2.2. represents the data gathered from the interview for each county municipality.

o Municipality officials claim that the issuance of occupancy permit in each county municipality could be completed averagely in 1 week if the application filing is submitted completely, the in-situ inspections of the building are approved and the drawings are in compliance with the building. According to them, application filings are reviewed without loss of time but missing documents cause delays and rejections in permit process.

o Buildings that are not in compliance with their drawings and missing proof of tax payment documents, specifically proof of tax payment to the department of social security are the problems frequently faced in the occupancy permit process.

o It is so rare for the municipality officials that the applicants make occupancy permit applications with fully completed application filings.

o Municipality officials are observed that the property owners or their notarized agents working in construction sector such as contractors, architects, engineers, etc. are conscious about the occupancy permit process and confront with fewer problems in their applications. Adversely, inexperienced applicants meet with problems in application and review processes. They submit incomplete application fillings in common.

o Each county municipality prepares a list for the required documents and an application form to facilitate the permit application. However, the applicants cannot get enough information about how to obtain the related documents from the related municipal offices and appropriate city agencies. Verbal guidance of the officials or the experienced applicants is common in each municipality.

o A few municipalities offer new implementations in order to improve the occupancy permit process. For instance, Bayraklı and Karşıyaka Municipalities warn the applicants not to apply for the occupancy permit before least 70% of the required documents are completed in their application filings. In addition to

this, Bornova Municipality prepares strategic plans to qualify the municipal services.

o County municipalities mention that there is no significant permit application that could obtain the permit issuances in months. The official attending to the interview from Konak Municipality agrees on this issue despite the permit applications that are made in 2008 represents a different situation.

2.2.3. Interview Results

Results of the reviews present that applicants are insensible and uninformed. On the other hand, municipalities are inadequate to represent detailed information about the application and review processes of occupancy permit. As a result of not being able to get enough information about the processes applicants lose time in document collection, apply with missing documents, not able complete the missing documents on time, etc.

Difficulties in gathering the required documents cause delays in occupancy permit process, as well. Numerous tax and fees that have to be paid to the appropriate city agencies and approval letters that are gathered from related departments of the municipalities or appropriate city agencies cause extensions in the issuance of the permit

The qualifications of the drawings are important in review process, too. Low technical specifications of the drawings and incompliance of the building with its drawings are the problems that the officials are frequently confronted with in occupancy permit process and cause rejections and delays in the process.

Difficulties in gathering of the proof of tax payment to the department of social security are one of the common problems in occupancy permit process. It obstructs or delays the issuance of the permit and cause injustice for the applicants who meets all the qualifications (Turkish Republic The Ministry of Public Works and Settlement General Directorate of Technical Reseach and Implementation, 2009).

As well as the problems about the procedures in occupancy permit process, the missing information is the other predominant factor on the rejection reasons in the county municipalities of Izmir. In order to expand the scope of the study and reach to the general aspects of the occupancy permit process in Turkey, the sixteen metropolitan

municipalities are studied in the next phase and the consciousness of the metropolitan municipalities about representing the occupancy permit process information is searched.

Table 2.2. Occupancy Permit Process in County Municipalities of Izmir

No	Municipality Name	Frequently Faced Delay Causes					Applicants' Manner			Municipalities' Manner		
		Missing Proof of Tax Payment to the Social Security	Non-Conformances of the Building to the Project	Missing Proof of parking lot payment	Approval letter of the Department of Fire Authority	Bureaucratic Obstacles	Being inexperienced	Being Insensible	Missing Information	Oral directions	List of required Documents	Informing from Official Web Page
1	Aliağa Municipality	x	x				x		x	x	x	
2	Balçova Municipality		x	x			x	x	x	x	x	
3	Bayındır Municipality	x	x			x	x		x	x	x	
4	Bayraklı Municipality	x	x			x	x	x	x	x	x	
5	Bergama Municipality	x	x				x		x	x	x	
6	Beydağ Municipality	x	x				x	x	x	x	x	
7	Bornova Municipality		x	x			x		x	x	x	
8	Buca Municipality	x		x	x				x	x	x	
9	Çeşme Municipality	x				x			x	x	x	
10	Çiğli Municipality	x	x				x	x	x			
11	Dikili Municipality	x	x					x	x	x	x	
12	Foça Municipality	-	-	-	-	-	-	-	-	-	-	-
13	Gaziemir Municipality	x	x			x	x			x	x	x

Table 2.3. (cont.)

No	Municipality Name	Frequently Faced Delay Causes					Applicants' Manner			Municipalities' Manner		
		Missing Proof of Tax Payment to the Social Security	Non-Conformances of the Building to the Project	Missing Proof of parking lot payment	Approval letter of the Department of Fire Authority	Bureaucratic bstacles	Being inexperienced	Being Insensible	Missing Information	Oral directions	List of required Documents	Informing from Official Web Page
14	Karabağlar Municipality	-	-	-	-	-	-	-	-	-	-	-
15	Karaburun Municipality	x				x			x	x	x	
16	Karşıyaka Municipality	x	x	x				x	x	x	x	
17	Kemalpaşa Municipality	x	x				x		x	x	x	
18	Kınık Municipality	x					x		x	x	x	
19	Kiraz Municipality		x							x	x	
20	Konak Municipality	x	x	x				x		x	x	
21	Menderes Municipality		x			x	x		x	x	x	
22	Menemen Municipality	x	x		x		x		x	x	x	
23	Narlıdere Municipality	-	-	-	-	-	-	-	-	-	-	-
24	Ödemiş Municipality	x	x				x		x	x	x	
25	Seferihisar Municipality	x	x			x	x	x		x	x	
26	Selçuk Municipality	x	x			x	x	x	x	x	x	

(cont. on next page)

Table 2.4. (cont.)

No	Municipality Name	Frequently Faced Delay Causes					Applicants' Manner			Municipalities' Manner		
		Missing Proof of Tax Payment to the Social Security	Non-Conformances of the Building to the Project	Missing Proof of parking lot payment	Approval letter of the Department of Fire Authority	Bureaucratic Obstacles	Being inexperienced	Being Insensible	Missing Information	Oral directions	List of required Documents	Informing from Official Web Page
27	Tire Municipality	x	x				x	x	x	x	x	
28	Torbalı Municipality	x	x			x	x		x	x	x	
29	Urla Municipality	-	-	-	-	-	-	-	-	-	-	-

2.3. Occupancy Permit Process Information in Turkish Metropolitan Municipalities

Preview studies about the occupancy process in Izmir Konak Municipality and in 29 county municipalities of Izmir give hints about the characteristics and the present status of the permit process in Izmir. Nevertheless, this study aims to see the general aspects of occupancy permit processes in Turkey. For this purpose, the 16 metropolitan municipalities are studied to reveal the occupancy permit process information that is representing on the official web pages together with the Housing and Zoning Ordinances of the municipalities. Web page research is preferred as a result of being the easiest way of getting information, nowadays.

2.3.1. Occupancy Permit Process Information Research in Metropolitan Municipalities of Turkey

Subjects are designed according to the results of the previous research. As a result of being the predominant factor of the rejection reasons, inadequacy of the municipalities in giving information about the occupancy permit process is considered. To quantify the occupancy permit process information represented on the official web pages and the Housing and Zoning Ordinances of the metropolitan municipalities four subjects are constituted; permit definition, process definition, issuance duration information, and tax and fee information. Subjects are elaborated with the subtitles as stated below.

1. Permit Definition
   a. The definition and the necessity of the occupancy permit
   b. Utilization from the public services of the municipality
   c. Locations of agencies assigning required documents
2. Process Definition
   a. List of the required documents
   b. Flow sequence of the permit application process
3. Issuance Duration Information
   a. Examination time of the submission,

If the application is rejected;

    b. Additional legal time allocated for re-submission of the application file

    c. Examination time of the re-submission

4. Current Tax and fee Information

2.3.1.1. Permit Definition

The applicants who are not experienced in obtaining occupancy permit issuance have missing information about the permit and the application procedure and the importance of them. As a result, definitive information is essential to be informed about the occupancy permit, its importance and the offices that the required documents are gathered from.

1. The definition and the necessity of the occupancy permit

Definitive information and explanations about the necessity of the occupancy permit are searched under this subject.

2. Utilization from the public services of the municipality

Occupancy permit issuance is an obligation to utilize from the public services of municipalities in Turkey. As a result, the Housing and Zoning Ordinances and the web pages of each metropolitan municipality are searched to find any explanation about the importance of the permit issuance on this subject.

3. Locations of agencies assigning required documents

The required documents are gathered from appropriate city agencies, different departments of the municipalities, etc. Such kind of information is important to any applicant to accelerate the duration of collecting the required documents and reduce the permit applications with missing documents. The official web pages are searched to find such kind of information on this subject, as well.

2.3.1.2. Process Definition

Required documents have to be collected and submitted to be able to apply for the occupancy permit. Process information including the full list of required documents and information about the sequence of the required documents' collection guides the applicants in preparing the application filing, a lot.

1. The list of the required documents

There are many documents that are required in occupancy permit process. A list of required documents is important to be represented on the official web page of the municipalities to inform the applicants, easily.

2. Flow sequence of the permit application process

Occupancy permit process includes sequential works to do. Informing the applicants about the work flow of the process plays an important role for decreasing the waste of time in application and review processes.

2.3.1.3. Issuance Duration Information

Issuance duration information is necessary for the applicants, as well. It is essential to be conscious about the issuance date and to complete the missing documents on time.

1. Examination time of the submission

In Building Codes and Regulation the accurate inspection duration of occupancy permit application filling is thirty days. Informing the applicants about this legal duration is important to increase their sensitivity and consciousness about the permit process.

2. Additional legal time allocated for re-submission of the application file

Upon the rejection of the permit application filling, the applicant has ten days to submit the missing documents to the related department of the municipality (Consruction Law, Item 30). If the missing documents are not submitted to the municipality in ten days, the process goes back to the beginning and in the next application the applicant has to wait thirty days for the review of the application filing, again. Informing the applicants about this issue is important to make them use this legal duration, sufficiently.

3. Examination time of the re-submission

The submitted missing documents are inspected, as well. Informing the applicants on this issue guides them to predict the utmost occupancy permit issuance date and use their time, efficiently.

2.3.1.4. Current Tax and Fee Information

Taxes and fees are required documents in occupancy permit process and the applicants are responsible to pay for the required tax and fees in occupancy permit process. Being unaware of these payments may cause unexpected economic problems and may exceed the estimated cost of the construction budged. As a result, informing the applicants about recent amount of the taxes and fees prevents the delays that are caused by economic problems.

2.3.2. Results of the Occupancy Permit Process Information Research in Metropolitan Municipalities of Turkey

Table 2.3. includes the positive and negative observations about the subtitles for each metropolitan municipality. However, any Housing and Zoning Ordinances and the information representing on the official web pages of the metropolitan cities do not completely meet the contents of the subjects that are signed positively.

This dissertation reveals that the municipalities do not pay attention to inform the applicants especially about the related city agencies that the required documents are gathered from, the work flow, the application process, the additional duration for

submitting the missing documents, the assessment duration of the missing documents and the recent amount of taxes and fees. As a result, applicants have to visit the related departments of the metropolitan municipalities to get information about the occupancy permit process which also cause to some other problems such as business in municipalities, misunderstandings about the permit process, etc.

It is seen from the review that, any reform on the procedures cannot be enough unless the information about the process is defined to the applicants, clearly. As a result, the implementations of the municipalities for informing the applicants are needed to be qualified together with the procedures in the occupancy permit process, immediately. Indeed, problems caused from the inadequate informing can easily be solved by the municipalities by just representing detailed information about the permit process, in a very short time. But unfortunately, municipalities are unconscious and do not know how to overcome of this situation. That's why they wait for a new legal implementation on the occupancy permit process formed by the government.

To set as an example to Turkey, the occupancy permit process information that is represented on the official web pages of the cities in developed countries such as U.S., Australia, Canada and Europe are reviewed and they are compared with the selected metropolitan municipalities in Turkey.

Table 2.5. Occupancy Permit Process Information in Metropolitan Municipalities of Turkey

No	Metropolitan Municipalities	Permit Definition			Process Definition		Issuance Duration Information			Current Tax and Fee Information
								If the application is rejected		
		The definition and the necessity of the occupancy permit	Utilization from the public services of the municipality	Locations of agencies assigning required documents	The list of the required documents	Flow sequence of the permit application process	Examination time of the submission	Additional legal time allocated for re-submission of the application file	Examination time of the re-submission	
1	Ankara Metropolitan Municipality	-	✓	✓	✓	-	✓	-	✓	-
2	İstanbul Metropolitan Municipality	-	-	-	✓	-	✓	-	-	-
3	Adana Metropolitan Municipality	-	-	-	✓	-	✓	-	-	-
4	Antalya Metropolitan Municipality	✓	✓	✓	✓	-	✓	-	-	-
5	Eskişehir Metropolitan Municipality	✓	✓	-	-	-	✓	-	-	-
6	Kayseri Metropolitan Municipality	✓	✓	-	-	-	✓	-	-	-
7	Bursa Metropolitan Municipality	-	-	-	✓	-	✓	-	-	-
8	İzmir Metropolitan Municipality	✓	-	✓	✓	✓	-	-	-	✓
9	Kocaeli Metropolitan Municipality	✓	✓	-	-	-	-	-	-	-
10	Mersin Metropolitan Municipality	-	-	-	✓	-	-	-	-	-
11	Sakarya Metropolitan Municipality	✓	✓	-	-	-	✓	-	-	-
12	Konya Metropolitan Municipality	✓	✓	-	-	-	-	-	-	-
13	Gaziantep Metropolitan Municipality	-	-	-	✓	-	✓	-	✓	-
14	Erzurum Metropolitan Municipality	✓	✓	✓	✓	-	-	-	-	✓
15	Samsun Metropolitan Municipality	✓	✓	-	✓	-	✓	-	-	-
16	Diyarbakır Metropolitan Municipality	✓	✓	-	✓	-	✓	-	-	-

2.4. Occupancy Permit Process Information Research in U.S., Canada, Australia and European Countries

This dissertation includes the comparison of the occupancy permit process information represented on the official web pages of the selected cities in U.S., Canada, Australia and Europe with the three prominent metropolitan municipalities in Turkey according to the subjects of the previous study. The capital cities of Canada, Australia and European countries are preferred for this study. Washington D.C. is selected as being the nation's capital and other two cities, New York and Boston Cities, are selected as being the popular cities of U.S.

3 cities in U.S. and one city in each other countries are selected for this review. Official web pages of the cities are searched for the information about the occupancy permit. Different than the previous study, their Housing and Zoning Ordinances are not reviewed because of the language problem of the countries not using English. The results of the review are represented in Table 2.4. Similar to the previous study, positively signed subjects does not mean that cities represent full information about the subject on their web pages. Any information about the subjects are accepted and signed positively in the table.

This study reveals that cities in selected countries represent inadequate occupancy permit process information on their web pages, too. However, the procedures about the occupancy permit process in Turkey is not qualified yet as in developed countries and the studies for improving the procedures are still going on (Turkish Republic The Ministry of Public Works and Settlement General Directorate of Technical Reseach and Implementation, 2009). As a result, this situation does not prove that there are similar problems in the occupancy permit process of the selected cities.

It is seen that the cities pay attention to give information about the definition of the occupancy permit. They represent the necessity of the permit but only Madrid represents the importance of the permit for utilizing from the public services. In a similar vein, only Roma represents information for the applicants about the related city agencies that the required documents are gathered from.

Foreign cities are more sensitive to represent the list of required documents on their web pages. New York City and Boston City inform the applicants about the permit application and review processes. Furthermore, New York City represents a work flow

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diagram for the applicants that is defining the permit process step by step as explained below. In addition to this, it is seen that computer aided permitting system is commonly used to automate and streamline the permit process and represents the approval or disapproval status of the permit application in foreign cities in order to reduce permitting time, improve customer service and staff efficiency, enhance quality and make operating funds more productive in municipalities (National Istitute of the Building Sciences, 2002). However, there is no such kind of implementation in Turkey, yet.

As can be seen from the Table 2.4. cities rarely represent issuance duration and tax and fee information on their websites. Distinctively, Rome represents a calculator that easily computes the payments according to the recent amounts of taxes and fees.

Differently from each city, obtaining the occupancy permit is not compulsory in London. It is mentioned that, occupancy permit is mostly preferred by the mortgage lenders and purchasers.

Inversely, the selected Turkish municipalities do not represent definitive information about the occupancy permit and its necessity on their official websites, except Izmir. In addition to this, only the Ankara Metropolitan Municipality gives information about the importance of the permit for benefiting from the public services and the related city agencies that the required documents are gathered from. The delivery of the list of the required documents is common but only Izmir Metropolitan Municipality share information about the occupancy permit process. Ankara and Istanbul metropolitan municipalities share information about the application assessment duration. Also, Ankara Metropolitan Municipality informs the applicants about the additional assessment duration for the submitted missing documents. This study showed that only Izmir Metropolitan Municipality represents information about the recent taxes and fees that have to be paid in occupancy permit process.

A brief description of the occupancy permit processes information gathered from the official web pages of each city is identified as below.

Table 2.6. Comparison of Occupancy Permit Process Information in U.S., Canada, Australia and European Countries

Country	City	Permit Definition			Process Definition		Issuance Duration Information			Tax and fee Information
		The definition and the necessity of the occupancy permit	Utilization from the public services of the municipality	Information about the offices that the required documents are gathered from	The list of the required documents	The work flow of the occupancy permit process	Application assessment duration	Additional duration to complete the missing documents (If the application is rejected)	The assessment duration of the missing documents (If the application is rejected)	
	New York City	✓	-	-	-	✓	-	-	-	-
U.S.A.	Washington D.C.	✓	-	-	-	✓	✓	-	-	✓
	City of Boston	✓	-	-	✓	✓	-	-	-	-
Canada	Ottawa	✓	-	-	✓	-	-	-	-	✓
Australia	Sidney	-	-	-	-	-	-	-	-	-
England	London	✓	✓	-	-	-	-	-	-	-
Scotland	Edinburg	✓	-	-	✓	-	✓	-	-	✓
Spain	Madrid	✓	✓	-	✓	-	-	✓	-	-
Italia	Roma	✓	-	✓	✓	-	-	-	-	✓
	Ankara	-	✓	✓	✓	-	✓	-	✓	-
Turkey	Istanbul	-	-	-	✓	-	✓	-	-	-
	Izmir	✓	-	✓	✓	✓	-	-	-	✓

2.4.1. Occupancy Permit Process Information of U.S. Cities

New York, Boston and Washington cities are selected to be studied as being the outstanding cities of U.S. Three examples are found adequate for U.S. in spite of being easy to reach the occupancy permit information of other cities.

2.4.1.1. New York City

On the official web page of New York City Department of Buildings the required applications, permits and the contents of them are represented such as in occupancy permit process. It is observed that occupancy permit is called as Certificate of Occupancy (CO) in New York City Municipality.

  a. Permit Definition

CO is defined as a document showing the legal use and/or occupancy of a building. Any new building or an existing building having a change of use, egress or occupancy needs a new or amended CO. According to the New York City Law a new building cannot be legally occupied unless there is a final or temporary CO.

  b. Process Definition

The permit issuance process is explained on the official web page of the New York City and supported with a simple process schema. The CO is issued after all necessary documents have been obtained from other appropriate City agencies, all fees owed to the Department are paid, all relevant violations are resolved, and all procedure is completed.

The applicant has to submit 3 copies of each complete set of drawings including energy calculations with related and required forms. A pre-filer receives all permit applications and checks for the completeness of the documents, estimates the cost, determines job type and separates the applications according to their application purposes. Afterwards, the pre-filer enters the basic job information to the Buildings Information System (BIS), assesses the fee and assigns a BIS Job Number to the applicant. Applicants use the BIS job number to follow the recent status of the application file from the internet.

The applicant submits the application folder to the cashier and pays the fee. The cashier transfers the folder to the department Data Enters Application Details (DEAR).

DEAR checks the completeness of the application information and enters the detail of the data.

Plan examiner reviews the plan, checks them for the compliance with the requirements and enters the missing documents to the BIS. Afterwards, he/she approves the application, stamps and signs the 3 complete set of approved plans with the submitted documents and enters the approval status to the BIS.

If the plan examiner disapproves the plans, he/she enters the disapproval status to the BIS, and prepares an objection sheet to email or mail to the applicant. The applicant may call the related departments of the municipality in order to make an appointment for solving the objections. The process repeats till the plan examiner approves the plans.

The applicant is responsible to brings the file to the Record Room to be perforated the plans and forms by the clerk after the approval. He/she microfilms and stamps all approved items and returns the file to the applicant. The permit clerk checks for the fees and validates insurance. In the end, the permit is generated and the permit issuance is entered to the BIS.

2.4.1.2. Washington DC

Information about occupancy permit process is gathered from the official website of the Washington DC. Department of Consumer and Regulatory Affairs (DCRA) is concerning with the permits, zoning, licensing, registration and inspections. Occupancy permit is called as Certificate of Occupancy, as well. Applicants can follow the process on the internet as in New York City.

a. Permit Definition

The CO presents that the building, structure or land is in compliance with the DC Zoning regulations and DC Building Codes in Washington DC. The occupancy permit applications are reviewed by the DCRA's Office of Zoning Administrator.

b. Process Definition

Occupancy permit application process is necessary for the ownership change, the new constructions completeness, the change of use and/or the change of load. This research is related with the occupancy permit processes of new constructions. In order to obtain the CO for new construction, a building permit application is required to be

approved, constructed and inspected prior. Another inspection follows the completion of the construction.

The applicants have to fill an occupancy permit application form completely and submit the completed application form, supporting documents and application filing fee to the DCRA's Permit Center. The permit center transfers the application related and required disciplines for the review process.

CO is approved after the approval of the submittals and inspections by related disciplines. The final status of the permit application is entered to the computer system. The permit certificate can be obtained after paying the issuance fee.

c. Issuance Duration Information

The only notification about the issuance durations of the applications is that the large projects can take 30 days to review. There is no extra information about the occupancy permit issuance except this.

d. Tax and Fee Information

Municipality represents the recent information about fees on the webs page.

2.4.1.3. City of Boston

Information about the occupancy permit process and issuance represented on the web page of Inspectional Services Department (ISD), which is one of the city departments of Boston. The permit approval depends on the compliance of the submittals in application file with the Massachusetts Codes and Boston's Zoning Code. In occupancy permit process the Boston Fire Department plays an important role in obtaining a CO for new residential units and businesses.

a. Permit Definition

ISD describes the situations that CO is needed. A new building or a structure, an existing building or a structure that has been changed, buildings having reconfigured floors and/or egress are need CO. Whenever a Long Form Permit has been issued, CO is required, as well.

b. Process Definition

The applicant is responsible for submitting a signed Yellow Building Permit Card which includes inspector's signatures indicating that the final inspection is approved. The applicant has to fill out a CO application form and pay the requested fee

in submission. The completed structural woks are inspected to control the compliance of the building with the related codes, then.

If the structure includes sprinkler or fire alarm works, Boston Inspection Services request test reports for life safety equipment from the Boston Fire Department.

Architect, engineer and builder shall submit affidavits if the estimated cost of the project is over an amount that is mentioned, recently.

If all steps are successfully completed the applicant deserves to get the CO.

c. Issuance Duration Information

There is no instruction about the application review duration but it is mentioned that if the application is approved the applicant may individually get the CO or it is mailed to the applicant within 3 weeks.

d. Tax And Fee Information

The estimated cost has to be as accurate as possible. If a difference occurs between the estimated and actual costs an additional fee has to be paid in City of Boston. Except this information there are no any other instructions for the fees that are paid during the occupancy permit process.

2.4.2. Occupancy Permit Process Information of Canada

The capital city of Canada, City of Ottawa, is selected for the review. On the official web page of the city, it is mentioned that the occupancy permit does not certify or warrant the work or workmanship of a builder, it only shows a general conformance with the Ontario Building Code. Ontario Building Code is administered by the Building and Development Branch of the Ministry of Municipal Affairs and Housing. Any required information about the occupancy permit process is represented on the web page of Building By-law with the no 2005-303 in detail; however, limited information is published on the official city web page.

a. Permit Definition

In the City of Ottawa, an occupancy permit proves that the new construction and/or renovation is compliance with the Ontario Building Code based on the approved inspections belong to key stages of construction. This certificate confirms the minimum requirements for the occupancy as set out in the Building Code. It shows the status of the building or the property to the purchaser.

Building Codes signifies that the occupancy permit is issued in accordance with the Building By-Law. It defines that the Building Code Act does not require a permit to be issued but the occupancy is not allowed unless the builder/permit holder complete the construction or the additions meeting the minimum occupancy requirements set out in the Code.

Two types of occupancy permit are defined: Partial Occupancy Permits and Final Occupancy Permits. The first permit is for the permit holders who wish to occupy in an unfinished building. In such situations, the minimum occupancy permit requirements are taken into consideration. The Final Occupancy Permit is issued when whole construction work of the building is completed and all are pursuant to the Building Code deficiencies.

        b. Process Definition

On the Ottawa Building Code web page, only the "minimum occupancy requirements" for a single-family residence are listed item by item. The first one is about the requirements for the fire escape. It includes complete, operational and inspected required exits, handrails and guards, fire alarm and detection systems, and fire separations. The second one includes complete and operational water supply, sewage disposal, lighting and heating systems. Lastly, the third one includes complete, operational, inspected and tested building water systems, building drains, building sewers, and drainage and venting systems.

Ontario Building Code assigns the responsibility to the property owner for the situations that the occupancy process is failed to complete the outstanding work. The city municipality reviews such situations case-by-case and pursues matters or issues orders to the property owner.

2.4.3. Occupancy Permit Process Information of European Countries

Spain, England, Scotland, and Italy are studied in Europe. The capital cities of these countries are selected to be worked on and the countries that the occupancy permit processes can be found on the official web pages of the capital cities are selected for this study.

2.4.3.1. Occupancy Permit Process Information of Spain

Madrid is selected as being the capital city of Spain in order to study occupancy permit information in Spain.

a. Permit Definition

Certificate of Occupancy is defined as a document proving that the building is suitable to be occupied. In Madrid, the certificate is essential firstly for utilizing from public services such as water, electric, gas, etc. and secondly for hiring, lending and selling the building.

b. Process Definition

In Madrid, only the property owner can apply to obtain the Certificate of Occupancy. Five items are listed as required documents on the web page. The first one is two completed application forms, the second one is deed and the third one is a document proving that the applicant's representing status if he/she is a representant. The forth required document is a permission document of the property owner and the fifth document is showing the cadastral status of the building.

The application filing has to be submitted to the related municipality with the required documents mentioned above. The application can be made directly to the municipality or on the internet.

c. Issuance Duration Information

In application assessment process, if missing documents are detected in the application filing, the committee warns the applicant to complete the missing documents in 10 days to continue the permit issuance process. Application filings are recorded by authorized officials utmost three months. Then, records are deleted unless they are issued by the committee.

2.4.3.2. Occupancy Permit Process Information of the United Kingdom

London is studied in the United Kingdom. The official web page of the city is researched for the information about occupancy permit. However there are more information in three other official web pages which are Communities and Local Governments', Legislation's and Local Authorities Building Control's (LABC)

websites of United Kingdom (UK). The user is directed to these websites from the official web page of London city.

a. Permit Definition

The definite information about the Completion Certificate can be only reached from the Building Regulations 2010 represented in Legislation website. It is explained that the building has been completed in accordance with the building regulations.

It is compulsory for the completed buildings to be regarding certain fire safety issues and Fire Safety Regulatory Reform Order. Nevertheless, the Completion Certificate is not a compulsory in the UK. Usually, mortgage lenders and purchasers consequently require a Completion Certificate.

It is mentioned on the web page that the best information about the certification can be obtained from the local building control departments. The local authority is obliged to issue the completion certificate when all works are completed according to the requirements of regulations.

2.4.3.3. Occupancy Permit Process Information of Scotland

Scotland is also determined for the review of occupancy permit process. Edinburgh, the capital city of Scotland, is preferred for this review and the official web page of the city is researched.

In Scotland, it is an obligation to obtain the Completion Certificate. The Building Warrant includes all works of a house extension, installing a new rooflight in an attic, altering the commercial buildings and/or erecting new buildings. Acceptance of the Completion Certificate is finalized the Building Warrant process. Building procedures follow Building (Scotland) Regulations 2004 including the codes of the building regulations and the building standards in Scotland.

a. Permit Definition

The issuance of the Completion Certificate signifies that the building is safe to use and fit for its purpose. The building or part of the building which has been erected, extended or altered is not allowed to be used unless the certificate is issued.

b. Process Definition

The applicant should complete the required form to start the occupancy permit process. The application is made to a verifier. In Scotland, verifiers are appointed by the

Scottish Ministers to provide independent check and each local authority has been appointed as verifier for their own geographical area. The applicant shall submit a copy of the energy performance certificate and a certificate from an Approved Certifier of Construction as certification of specific aspects of work. The verifier checks the validity of the submitted documents but does not need to check the works that are certified.

c. Issuance Duration Information

From the application date the verifier has 14 days to notify the acceptance or rejection of the permit.

d. Tax And Fee Information

Fee is mentioned as payable in occupancy permit process and it is estimated according to value of the work. The information for the fees can be reached from the official home of UK legislation on the net.

It is noticed that further details about the fees and details on all procedures are stated in Scottish Building Standards Procedural Handbook.

2.4.3.4. Occupancy Permit Process Information of Italy

Occupancy permit is compulsory in Italy. There are four reasons identified for the obligation of occupancy permit in residences. The occupancy permit is needed for;

- Buying, selling or renting the residence,
- Using the building for residence,
- Exercising for any business as commercial, industrial, etc. usages.

Roma is studied as an example for the occupancy permit process in Italy.

a. Permit Definition

Occupancy permit is a certification showing that the building is suitable to be occupied with its security, hygiene, health, and energy saving conditions. All the residences need this certificate to able to be occupied. The responsibility of the certificate belongs to the officials who approve the certificate.

The occupancy permit applications are required in such situations:

- Chances in safety, hygiene and health conditions,
- Increases or decreases in the number of the units of the building,
- Unifications or separations of the units,
- Changes in the usage of the units,

- Demolitions or reconstructions,
- Changes in the street numbers.

    b.   Process Definition

The list of the required documents is represented with their explanations. A list of instructions and suggestions are also prepared for the applicants to make the collection of the required documents easy and complete but no directive information about the procedure is represented.

    c.   Tax and Fee Information

Instructions about the fees and taxes are very detailed on the web page. An applicant can calculate the payment for the secretary by a simple calculator represented on the web page.

2.4.4. Occupancy Permit Process Information of Australia

The user searching for the occupancy permit can easily reach the application forms of about 'Occupation Certificate Application' by the official web site of the City of Sydney Municipality but any directive information is represented except the application form. Related information can be gathered from the official legislation website of the Australia.

2.5. Outline and Analysis

In this chapter, the occupancy permit process is studied. For this purpose, occupancy permit process in Izmir Konak Municipality, county municipalities in Izmir, metropolitan municipalities in Turkey and U.S., Canada, Australia and European cities are analyzed. Firstly, the occupancy permit process in Izmir Konak Municipality is defined and delay causes are revealed depending on the rejection reasons stated in the rejection letters. In order to have an evaluation of the process in Izmir municipalities, officials of twenty nine county municipalities are interviewed. Then, sixteen metropolitan municipalities' web pages and regulations are studied to get to a further evaluation about the permit situation in Turkey. Finally, U.S., Canada, Australia and

European cities' web pages and regulations' are reviewed and the various implementations of the occupancy permit process in foreign countries are analyzed.

These reviews reveal that problems in the occupancy permit process depend essentially on inadequate information about the process, either on printed documents or on web pages as well as misconceptions of the construction laws by the applicants. Appropriate briefing about the occupancy permit process is important on the part of both applicants and related officials of the municipalities.

CHAPTER 3

METHOD AND MODEL CONSTRUCTION

3.1. Method

Artificial neural networks and Multilayer Perceptrons (MLP) techniques are computational methods for processing data. They are different from any conventional analytical methods and guiding tools for producing answers to the complex problems.

3.1.1. Ann as a Prediction Tool

It derives its computing power through, first, its massively parallel distributed structure and, second, its ability to learn and therefore generalize. Neural networks offer useful properties and capabilities in solving complex problems with its nonlinear structure, high learning ability of the relationships between the inputs and the outputs, adapting ability of itself to the different conditions and tolerating ability of the faults of the model. Generalization simply means producing reliable predicted outputs according to the inputs of the problem that make possible to reach a solution for complex problems (Haykin, 1999).

The strong structure and the learning ability of ANN depend on its scientific and biological data base, respectively. ANN simulates the neural systems of the brain and overcomes the problems by modifying itself according to the data of the problems in a similar vein of the brain's working principles (Dikmen, Birgonul & Kiziltas, 2005). The historical and the biological fundamentals of ANN are briefly defined, below.

3.1.1.1. Fundamentals of Neural Networks

Studies about ANN go back to 1940s. McCulloch and Pitts (1943) made the first research on this subject. They tried to make explanation about the nervous system; small units abstracting the neural neurons are connected to each other as neural system.

This system then studied by Hebb (1949), who was a psychologist at McGill University. He studied about learning process; he was the researcher building up the learning law for the first time. Rosenblatt (1958) created the first idea of the perceptron. Two years later, Widrow and Hoff (1960) studied on least square error learning rule which was similar to the Rosenblatt's study about perceptron. Minsky and Papert (1969) negatively affect the studies about the perception. They did not believe that perceptrons could give convincing results because of the serious limitations in non-linear problems' solutions. Werbos made the first description of the back-propagation algorithm in 1974, which became a big step for the next studies (Haykin, 1999). Nobel prized Hoppfield (1984) made an important record in developing a number of neural networks. After Kohonen (1982) made a research about self-organizing feature map, Rumelhart, Hinton and Williams (1986) developed back propagation algorithm that make easier to solve complicated (non-linear) problems.

The method certainly developed from the time of McCulloch and Pitts, and continues to grow in theory. There are other publications on this issue but the most influential publications in this research area are represented above.

3.1.1.2. Biological and Artificial Neurons

Artificial neural networks are one of the scientific disciplines that simulate the learning process of the human brain. It is a sub method of artificial intelligence and basically works as neural neurons connected to each other by axons and dendrites in brain (Haykin, 1999).

Biologically, neurons carry the information that comes from outside of the cell or another neuron. A neuron consists of three different parts; soma or cell body, axon or nerve fiber, and dendrites. Dendrites receive the impulses from its specialized surfaces called dendrites spines and carry the signals to the soma. Soma takes the messages from the signals and creates new ones if they are needed in non-linear impulse transformation. Axon carries the impulses from the dendrites or the soma to the far end of the neuron. There are presynaptic terminals which are close to other neurons or muscular cells at the end of the dendrites, but any terminal touches to each other. Such areas are called as synapses and here the impulses transfer from one cell to another by the chemicals called as neurotransmitters (Edelmen, 2006).

Artificial neurons simulate the biological neurons; they get the input signals, activate them with the weights, use the activated signals in functions and reach an output in the end. Figure 3.1. represents an artificial neuron. The input signals received by the dendrites are symbolized by 'x' in the model. They are accelerated by the positive or inhibited by the negative values of the weights that are symbolized as "w" on the connecting links. Weights are used to build up the relationship between the inputs and the output of the system but have to be adjusted in order to reach an acceptable output. Adjusting the weights is the main part of the network and it is called learning or training (Tsoukalas & Uhrig, 1997).
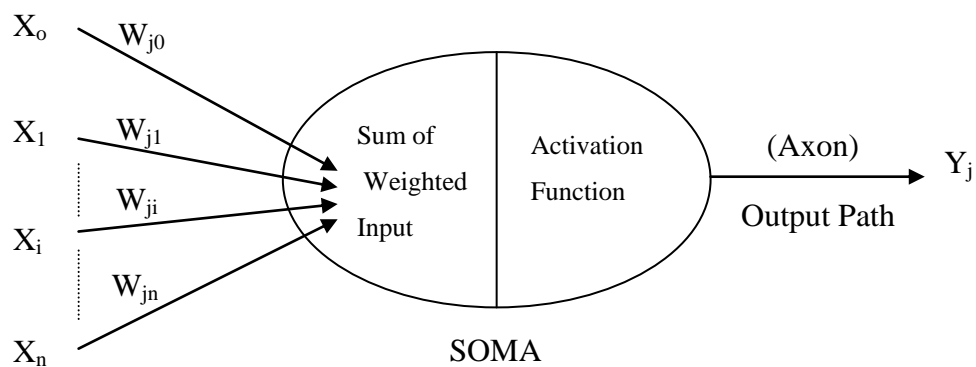

Figure 3.1. An artificial neuron
(Source: Tsoukalas & Uhrig, 1997)

3.1.2. Basic Principles

The artificial neuron represented in Figure 3.1. can be described in mathematical terms as the following pair of equations:

$$(3.1)$$

and

$$(3.2)$$

where $x_0, x_1, ..., x_n$ are the input signals, $w_{j0}, w_{j1}, ...w_{jn}$ are the synaptic weights, $\varphi(.)$ is the activation function and the y_j is the output signal of the neuron. u_j represents the sum of the weighted inputs and b_j is an external effect to the neuron which is called as bias.

The bias increase or decrease of the net input of the activation function according to its positive or negative situation and never weighted as input signals (Haykin, 1999).

The activation function, which is donated by $\varphi(.)$, defines the output of the neuron from the inputs applied to the neuron. A linear model activation function in neural networks defines the inputs as 'ON' (1) or 'OFF' (0) as in digital network. But nonlinear model of neural networks supports a large variety of activation functions such as threshold function, logistic function, sigmoid function, hyperbolic function, etc (Haykin, 1999).

3.1.2.1 Multilayer Perceptrons and Back Propagation Algorithm

In this research, MLP is used for forecasting the delay time of the occupancy permit insurance after the first rejection of the first application. It consist of input layers, one or more hidden layers and an output layer.

There are 3 significant characteristics for MLP (Haykin, 1999):

1. Network is made up of nonlinear functions
2. The network includes least one hidden layer which increase the learning ability of the model.
3. Network is also very sensitive to any changes on the model as a result of its improved connectivity. Network reacts to the changes with its synaptic connections or weights.

Back-propagation algorithm is simple and effective in solving large and difficult problems (Alavala, 2008). Thus, it is used in learning process of the model. It consists of two phases: forward pass and backward pass (Beale & Jackson, 1990). In forward pass, the parameters of the input variables pass though the functions of the network and an output data is produced, in the end. In backward pass, firstly the error is calculated by subtracting the actual output from desired output. Then, it is propagated backward through the network. The weights are adjusted during the backward pass (Ayed, 1997). This process optimizes the weight parameters of the model, decrease the error value and increase the prediction power of the ANN model.

There are methods that significantly improve the back-propagation algorithm's performance (Haykin, 1999):

1. Sequential versus batch update: When the training data set is large and highly redundant, sequential mode of back propagation learning could be preferred than the batch mode of the algorithm.

2. Maximizing information content: The training data should be strong enough to maximize the learning rate or the model. There are two ways to form such strong training information; using data that is having the largest training error, and using data that is oppositely different the other data used before.

3. Activation function: Using sigmoid activation function increases the learning ability of the model. Applying hyperbolic tangent, a nonlinear sigmoid antisymmetric activation function of sigmoid nonlinearity, is popular in this way.

4. Learning from hints: Learning from a set of training examples deals with an unknown input-output mapping function.

5. Learning rates: Learning rate values are important for the network in learning process. Neurons with many inputs should have smaller learning rate parameter, or vice versa.

3.2. ANN Model Construction

The ANN model structure depends on the makeup of the neural network elements, their organization and the parameters affect them (Ezeldin & Sharara, 2006). The model construction process consists of four sub processes as represented in Figure 3.2:

1. 'Input design process' includes the generation of the six input parameters according to the factors affecting the issuance durations.

2. 'Network building process' involves the designing process of the parameters of the network function.

3. 'Training process' includes the training of the model by the training data set according to the parameters that are determined in the previous process.

4. 'Testing process' involves the testing of model validation tasted by activating the model with the testing data set.
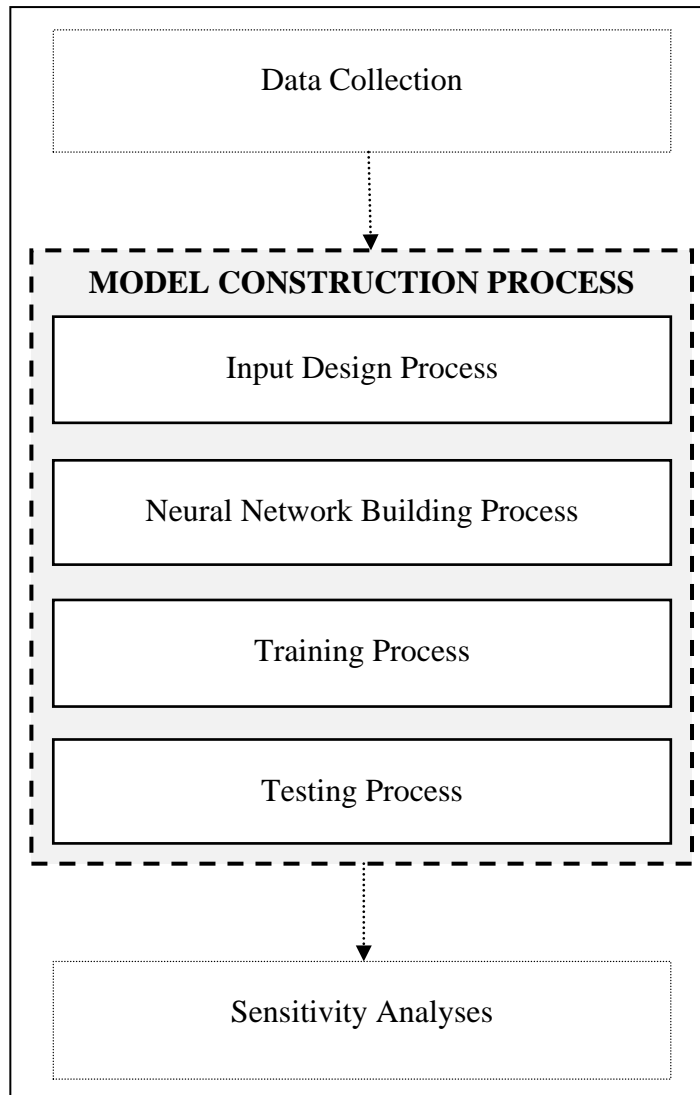
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Figure 3.2. Model construction steps

3.2.1. Input Organization Process

The application records listed in Table 3.2 are analyzed to constitute the input parameters of the prediction model that are important for producing the output parameter supporting the aim of the study.

For this purpose, the causes affecting the issuance durations of the permit processes are investigated in depth. The three delay causes built up from the 16 rejection reasons are determined in this process. In addition to this, the time information about application, rejection and/or issuance dates are considered for designing the input parameters, as well.

The data includes qualitative data in this way; however, the network works with numerical data. Therefore, the delay causes and time information are reorganized to be suitable for using in the ANN model and converted to numerical values as explained further. The six input are built up as represented below:

1) Number of missing approval letters
2) Number of missing payment documents
3) Number of non-conformances of project to codes and regulations
4) Number of all missing documents
5) First permit application season
6) First permit rejection season.

Table 3.1. shows the distribution of the input and output parameters' values and their codes as 'X0, X1, …X6' and 'Y', respectively. The input and output variables used in model are represented belov.

Table 3.1. The input and output variables

Code	Variable	Data used in ANNs Model	
		Minimum	Maximum
X_1	Number of missing approval letters	0	6
X_2	Number of missing payment documents	0	4
X_3	Number of non-conformances of project to codes and regulations	0	4
X_4	Number of all missing documents	1	10
X_5	First permit application season (100-200-300-400)	100	400
X_6	First permit rejection season (100-200-300-400)	100	400
Y	Total Issuance duration of Occupancy Permit Application	36	350

The initial three inputs include the delay causes that are explained in the previous chapter. Their contents are leaved untouched but they are converted to numerical values according to the number of missing situation of the documents.

The first permit application data is preferred as being the start point of the permit process and the first permit rejection date is important to be able to see the feedback duration of the municipality to the occupancy permit application. Both the first application and rejection dates are grouped under four seasons in order to be entered to the model, easily and seasons are encoded as below to be able to use this nonnumeric data in ANN model. NeuroSolutions is able to change the categorized input parameters into numerical values by assigning 0 and 1 to the related categorization; however in this study 0 and 1 are already used values for other input variables of the model. Thus, conversion of categorical values to numerical values is done manually prior to entering data to NeuroSolutions. In order not to block the learning ability of the model, encoding is done by using numerical values different from numbers used by other inputs of the model (Tayfur, 2009-2010). 100, 200, 300 and 400 are selected as distinct numbers for season entries of inputs 5 and 6:

Winter (December, January, February):	100
Spring (March, April, May):	200
Summer (June, July, August):	300
Fall (September, October, and November):	400

Table 3.2. Input and Output Parameters of Occupancy Permit Applications for ANN Model

| FILE NUMBER | Map Section / Plot | INPUT PARAMETERS | | | | | | OUTPUT PARAMETER |
		APPROVAL LETTER	PAYMENT GROUP	PROJECT DOCUMENT GROUP	TOTAL NUMBER OF MISSING	1st App. Date	1st Rej. Date	Issuance – 1st App.
1	2870/640	4	2	1	7	100	100	350
2	7855/8	5	2	2	9	200	300	287
3	42104/13	4	1	4	9	200	200	214
4	42299/26	2	1	2	5	100	200	196
5	30292/3	2	1	4	7	200	200	170
6	6887/19	3	1	3	7	200	200	170
7	13803/3	2	1	2	5	200	200	167
8	31437/3	4	3	3	10	100	200	166
9	2480/13	3	3	2	8	300	300	142
10	42372/1	3	3	3	9	200	200	140
11	3045/30	3	2	3	8	200	300	137
12	3049/88	3	1	3	7	200	200	133
13	892/44	6	2	2	10	100	200	123
14	11233/3	4	2	1	7	300	300	119
15	43349/3	1	0	2	3	100	100	116
16	13548/1	5	2	2	9	200	300	114
17	31114/5	1	1	4	6	300	300	113
18	34545/18	2	2	2	6	300	400	112
19	13455/2	3	1	3	7	200	200	111
20	101/164	3	2	4	9	100	200	110
21	8542/12	2	1	1	4	100	100	110
22	42435/7	0	1	0	1	400	400	109
23	30116/10	2	1	2	5	400	100	109
24	2831/24	0	0	1	1	100	200	107
25	3555/112	2	0	1	3	100	200	106
26	6552/1	2	3	2	7	300	300	106
27	13715/7	4	2	4	10	200	200	105
28	3544/84	3	2	4	9	300	300	105
29	8525/1	4	2	4	10	200	200	104

Table 3.2.(cont.)

FILE NUMBER	Map Section / Plot	INPUT PARAMETERS						OUTPUT PARAMETER
		APPROVAL LETTER GROUP	PAYMENT GROUP	PROJECT DOCUMENT GROUP	TOTAL NUMBER OF MISSING DOC.	1st App. Date	1st Rej. Date	Issuance −1st App.
30	31389/6	2	1	3	6	300	400	103
31	31360/4	2	0	3	5	200	300	103
32	2730/99	5	2	3	10	300	300	103
33	3181/82	3	1	3	7	200	300	102
34	7820/22	4	1	2	7	200	200	101
35	10450/42	3	1	1	5	100	100	101
36	2834/49	4	2	3	9	300	400	99
37	31120/20	2	1	3	6	200	200	94
38	31387/6	2	1	3	6	100	200	93
39	8048/5	5	1	2	8	300	400	92
40	31456/20	1	0	2	3	400	100	91
41	2750/19	2	0	1	3	200	200	91
42	685/1	2	3	2	7	300	300	90
43	6943/10	1	1	0	2	300	400	89
44	1096/18	1	2	1	4	200	300	88
45	566/36	1	2	3	6	100	200	87
46	585/8	0	0	2	2	100	200	86
47	2573/34	1	3	2	6	200	200	85
48	43669/19	3	3	3	9	300	300	81
49	33659/16	2	2	2	6	300	300	80
50	3545/67	2	4	2	8	400	400	77
51	3180/77	1	0	2	3	100	100	75
52	165/11	1	2	2	5	200	200	75
53	7828/1	2	2	2	6	100	200	74
54	42428/8	2	0	0	2	100	100	74
55	31461/4	2	1	2	5	200	200	73
56	6998/17	4	2	3	9	300	300	73
57	3177/36	1	0	1	2	400	100	72
58	31461/5	3	1	4	8	200	200	72

Table 3.2. (cont.)

FILE NUMBER	Map Section / Plot	INPUT PARAMETERS						OUTPUT PARAMETER
		APPROVAL LETTER GROUP	PAYMENT GROUP	PROJECT DOCUMENT GROUP	TOTAL NUMBER OF MISSING DOC.	1st App. Date	1st Rej. Date	Issuance –1st App.
59	3593/242	2	3	3	8	300	400	71
60	13907/3	4	1	3	8	100	200	70
61	36422/4	1	2	3	6	400	400	67
62	31457/31	0	0	1	1	200	200	66
63	30315/5	2	0	1	3	200	200	66
64	6878/22	2	2	2	6	200	200	64
65	1682/11	4	3	3	10	200	200	64
66	561/7	1	1	1	3	300	300	64
67	6912/23	2	0	3	5	200	300	63
68	727/3	2	3	2	7	300	300	63
69	6658/6	1	0	3	4	300	300	61
70	31443/7	2	3	3	8	200	200	60
71	6484/1	2	2	1	5	200	200	59
72	31360/1	5	1	2	8	400	100	58
73	30348/9	1	1	1	3	100	100	57
74	2942/66	2	3	3	8	300	300	55
75	2619/129	2	2	3	7	300	300	54
76	1913/17	1	0	1	2	300	300	54
77	1279/3	3	1	3	7	100	100	50
78	6322/15	1	1	1	3	100	100	45
79	43639/32	2	2	2	6	300	300	42
80	10441/11	3	2	3	8	300	300	36

3.2.2. Neural Network Building Process

The parameters of the network are designed in this phase. MLP is used as a method to reveal the relations of the factors and predict the total issuance duration for obtaining the occupancy permit after the first rejection of the first application. Software is used to make the calculations of the method in order to take more specific and reliable results (The NeuroDimensions Inc., n.d.). Network parameters are entered to the software and the model is activated, then.

In order to increase the performance of the study, the methods that significantly improve the prediction performance of the network are adopted to the network (Haykin, 1999):

1. Data of the research is not highly redundant and complicated for the prediction process of the occupancy permit issuance durations. Therefore, the batch mode of algorithm is preferred than sequential mode of back propagation learning.

2. Data is reviewed to find out the extreme variables. Different than the method defined above data having largest or lowest training errors are not used individually in training set. Data is randomly separated into two groups as training and testing data sets. The variables of the data sets are designed according to the range of the issuance durations of the permit applications and both training and testing data sets include similar data ranges in order to get results that are confirming to each other (Tayfur, 2009-2010). The maximum and minimum variables are determined in training data set in order to make the model learn the extreme situations of the permit issuance durations.

3. TahnAxon is preferred as the activation function of the model by the virtue of being successful in interrelating the input and output parameters.

4. The 75% of the occupancy permit application data, 60 data line, is left for training data set and the rest of the data, 20 data line, is left for testing data set in order to improve the learning ability of the model. Cross validation data set does not seem necessary for this study (Tayfur, 2009-2010).

5. The process for assigning the learning rate parameters except the weights is carried out by trial and error method. Range of the learning rule parameters

is determined between 0,01 and 1. For each step size and momentum rate values of the learning rule parameters, values between the ranges are tested and the performance of the network is monitored. Values having the optimum performances in network are preferred, in the end. The weights are assigned randomly and then optimized with back propagations by the software itself.

Figure 3.3 shows the structure of the best performing ANN model including input, hidden and output layers. The circular shapes in figure symbolize the inputs, hidden layer and output neurons. Their connections are represented as lines which are in fact, symbolizing the weights of the functions. The features of this model could be detected by countless training and testing processes made after any chances in network parameters.
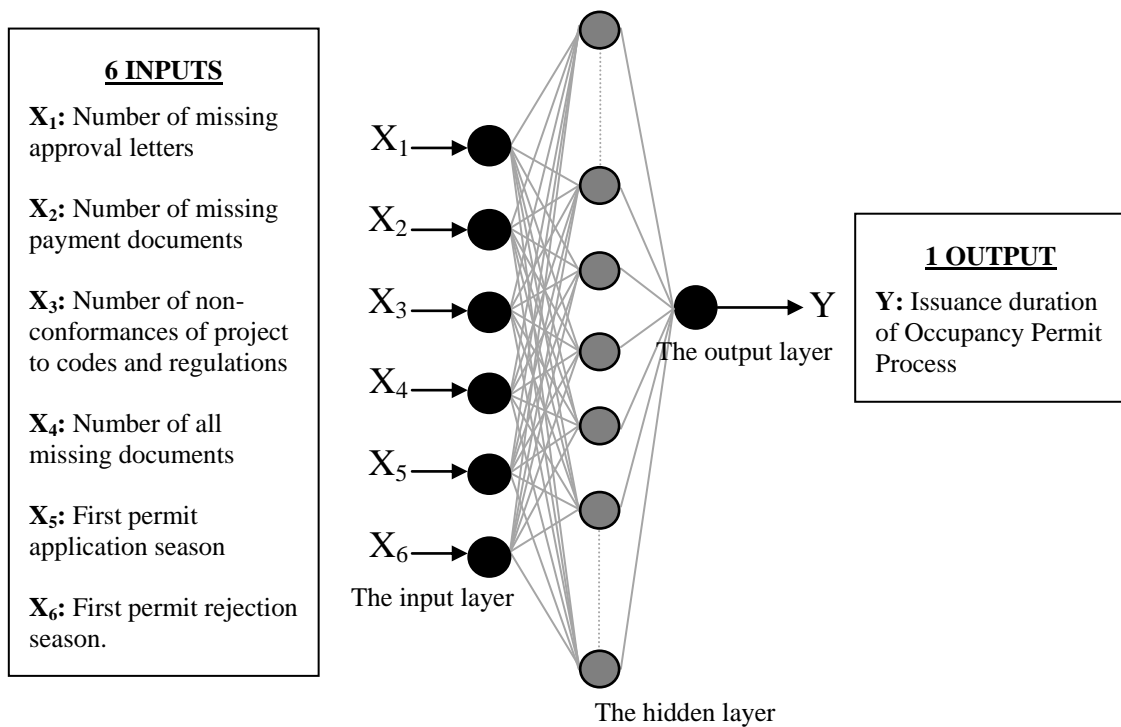
Figure 3.3. Neural network model of the research

The formula 4.1 represented below is preferred in calculating the neuron numbers in hidden layers (Tayfur, 2009-2010). The number of neurons in hidden layer is increased when the learning rate parameters are decreased. (Tayfur, 2009-2010). In this study, learning rule parameters are given values of 0.2 for the step size and 0.1 for

the momentum rate of the hidden layer and one hidden layer with 50 neurons is found to be best performing one after numerous trials (Günaydın and Doğan, 2004).

$$(2 \text{ x (number of input neurons)} + 1) \ / \ 2 \qquad (3.3)$$

Output layer parameters also have to be entered for building the model, too. Same values with the hidden layer parameters are used for output layer parameters; 0.2 for the step size value and 0.1 for the momentum rate value.

The ANN model is run employing sigmoid axon, linear axon and tanh axon functions and using the learning rule parameters defined above. The prediction accuracy of the model is calculated as 57%, 82% and 87% using sigmoid axon, linear axon and tanh axon functions, respectively. Thus, tanh axon is preferred as the activation function of the output layer.

Supervised learning control parameters for designing the number of iterations over training data set are entered, as well. Practices on these parameters showed that 1000 is appropriate for this study. Mean Square Error (MSE) termination, is important for the representations of the MSE graphics in training part, as well. Minimum option is activated for the MSE termination and the threshold value is determined as 0.01 for the model which means that the iterations over training data set will automatically stop when the error value of the training data set falls under the determined threshold value.

3.2.3. Training and Testing Processes

Model is activated after its network building process is completed. The model works on the training data set, firstly. The software calculates the error value of the model and decreases the error as much as possible by the predetermined number of iterations and randomly designated weight values. At the end of the training, the software lists the error values of each propagation and represents them on a line diagram. Minimum MSE and Final MSE are indicated, as well.

Testing process follows the training process. The aim of this process is carrying out the validity of the ANN model by activating it with the testing data that are not used in network building process. The testing data set is entered to the model with the weight parameters that the model just learned in training process. The results gathered at the

end of the testing process shows the success of the prediction performance. Normalized MSE (MSE / variance of desired output), Mean Absolute Error (MAE), Minimum Absolute Error (Min Abs Error), Maximum Absolute Error (Max Abs Error) and linear correlation coefficient values (r value) are represented together with the comparative line graphic belong to desired and actual model outputs at the end of the testing process.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter includes the results that are obtained from the ANN model, sensitivity analysis that reveals the effect of each input parameter on the prediction performance of the model and discussions about them. They are defined under three subsections named as results, sensitivity analysis and discussions, respectively.

4.1. Results

The ANN model is constructed in order to produce predictions about occupancy permit issuance durations as displayed in the previous chapter. In order to increase the prediction performance of the model, the error value is aimed to be decreased by iterations; however, a low learning error is not a guarantee for a good model performance (Alava, 2008). In Figure 4.1., decreasing values of the MSE per each iteration are represented. The 'L' shaped fall of MSE values show the validity of the decrease in error value (Tayfur, 2009-2010). Epoch shows the number of iterations that are carried out during the training process. In this study, iterations are repeated 1000 times and the value of minimum MSE is calculated as 0,032 at the last epoch.
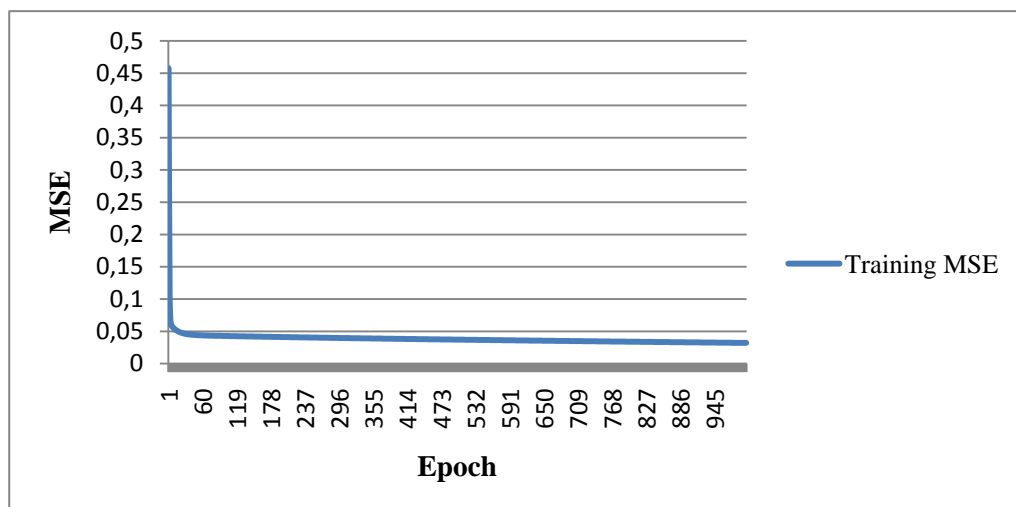
Figure 4.1. MSE versus Epoch

The testing data set is tested after the completion of the training process, as explained in the previous chapter. ANN model produces the outputs predicted according to the input variables and the network parameters used in training process. The prediction performance of the model depends on the similarity between the desired and actual outputs of the ANN model. As a result, it is expected from the model to produce outputs similar to the existing ones as much as possible.

Table 4.1 represents the actual and predicted output values of this study. The minimum and the maximum absolute errors are calculated as 0,49 and 19,58 in testing process. In testing process the best prediction is achieved for the twelfth exemplar and the worst prediction is got for the first exemplar of the testing data set (Figure 4.2). The Mean Absolute Error (MAE) is calculated as 7,84 which means that the prediction model could predict the issuance durations of the occupancy permit applications with approximately eight days error. Figure 4.2 shows the values of the actual and the predicted outputs on a line graphic.
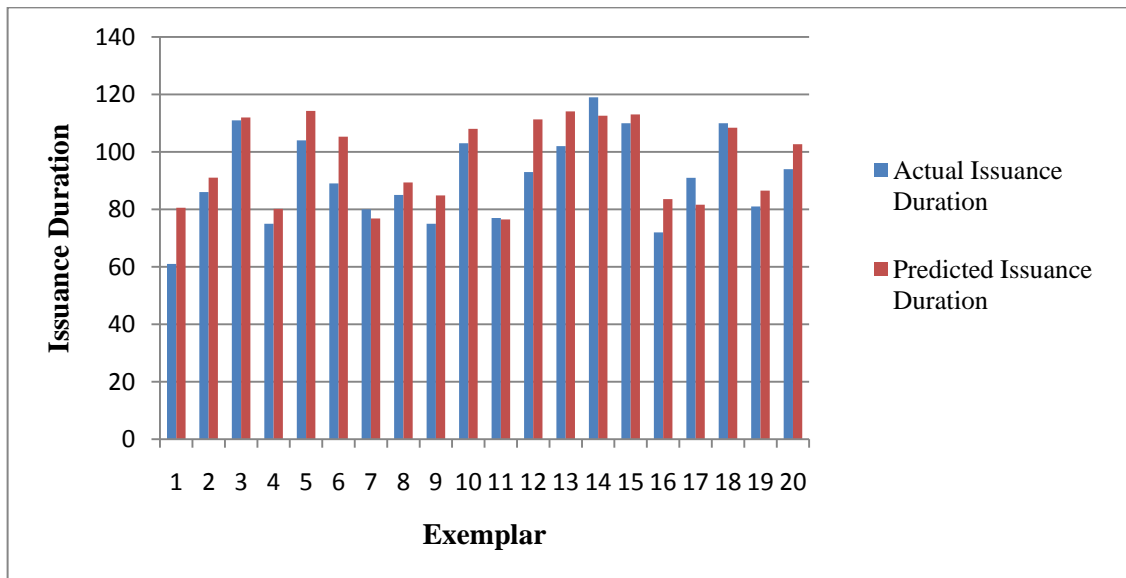
Figure 4.2. Predicted and Actual Network Output

The linear correlation coefficient value, r value, is sensitive to make linear relationship between two variables and used for measuring the strength of the linear dependence (Blyth, 1994; Stigler, 1989). In other words, it shows the prediction performance of the model. In this study, the r value is measured as 0,87 which is acceptably high for this study.

To assess the prediction capacity and the persistence of the ANN model, mean absolute percentage error (MAPE) is calculated according to the formula defined below. Here, n symbolizes the exemplars, At and Pt show the actual value and the predicted values, respectively. A MAPE of 0% indicates a perfect fit of the model and in this study, MAPE on the test set is calculated as 7%.

$$\qquad\qquad - \qquad\qquad \overline{\qquad\qquad} \qquad\qquad (4.1)$$

Table 4.1. Results of Testing Process

INPUTS						OUTPUTS	
APPROVAL LETTER GROUP	PAYMENT GROUP	PROJECT DOCUMENT GROUP	TOTAL NUMBER OF MISSING DOCUMENTS	FIST PERMIT APP. SEASON	FIST PERMIT REJ. SEASON	ACTUAL ISSUANCE DURATION	PREDINCE DURATION
1	0	3	4	300	300	61	80,5827913
0	0	2	2	100	200	86	91,0461502
3	1	3	7	200	200	111	111,989457
1	0	2	3	100	100	75	80,164058
4	2	4	10	200	200	104	114,26436
1	1	0	2	300	400	89	105,290684
2	2	2	6	300	300	80	76,8048485
1	3	2	6	200	200	85	89,385454
1	2	2	5	200	200	75	84,8249135
2	0	3	5	200	300	103	108,028765
2	4	2	8	400	400	77	76,5113334
2	1	3	6	100	200	93	111,320232
3	1	3	7	200	300	102	114,097105
4	2	1	7	300	300	119	112,589105
3	2	4	9	100	200	110	113,052831
1	0	1	2	400	100	72	83,5651626
2	0	1	3	200	200	91	81,6064987
2	1	1	4	100	100	110	108,410744
3	3	3	9	300	300	81	86,5159627
2	1	3	6	200	200	94	102,669452

4.2. Sensitivity Analysis

Any changes in inputs cause drastic differences on the prediction power of the model. Sensitivity analysis reveals the relations between the inputs and the output, the consistency of the prediction, and the response of the model as further explained later. As a result, sensitivity analysis is necessary to see the performance of the inputs and the output of the model, in detail.

The performance of the prediction depends on the effectiveness of the inputs. Using effective inputs increase the prediction performance of the model and inversely, using ineffective and/or defective, too much and/or too less input parameters in the ANN model decrease the performance of the model. Sensitivity analysis reveals the effectiveness of the inputs and guides the researcher to decide among the inputs for improvement purposes of the model.

The consistency of the prediction is related with the strong relationship between the inputs and the output. Model having such a strong structure could achieve to produce closer predicted outputs in further activations.

The success of the model depends on its adaptation response to similar cases. The better adapted the model to newer cases, the more strongly the model proves itself.

In this study, each input parameter is tested with output values in order to measure its sensitivity on the prediction performance of the model (Tayfur, 2009-2010).

The sensitivity analysis revealed that the number of missing approval letters input is the most effective input with 70% sensitivity ratio. Number of missing payment documents, first permit application season, number of all missing documents and number of non-conformances of project to codes and regulations follow it with 54%, 41%, 39% and 37% sensitivity ratios, respectively. First permit rejection season is the least effective input displaying 12% sensitivity in the model as represented in Figure 4.3, graphically.

The prediction accuracy together with the sensitivity analysis results showed that the model can produce reliable results for other occupancy permit data unseen by the model, specific to Izmir Konak Municipality.
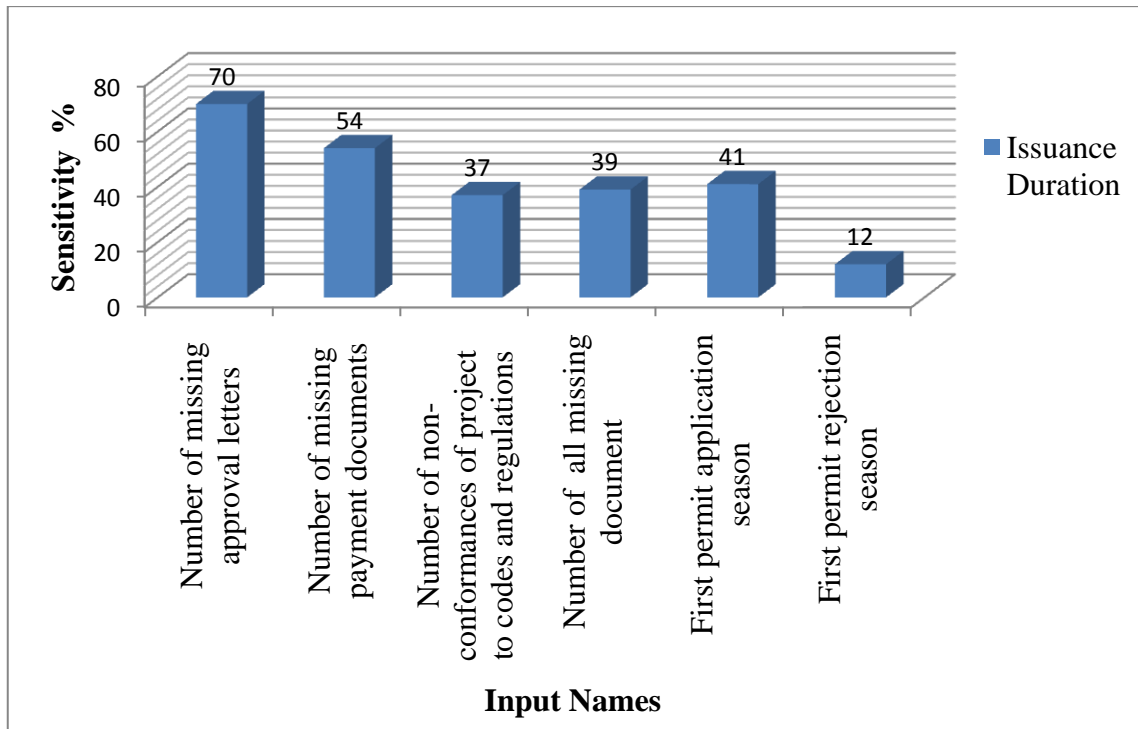
Figure 4.3. Sensitivity About the Mean

4.3. Discussions

The results show that the ANN model constructed is capable of predicting the issuance durations of the occupancy permit applications with 86% accuracy. The linear correlation coefficient value (R=0,86) and the mean absolute error (MAE=7,8) show that the ANN model could predict the occupancy permit issuance durations with an approximately eight days' deviation.

Designing various ANN models to reach to the optimum one showed that the prediction performance of the model is strongly related with the training and testing data sets' sizes and range of the data included. The number of the outputs and the range of the output values to be used for training could improve the learning ability of the model increasing the prediction accuracy (Tayfur, 2009-2010; Haykin, 1999). Therefore, various training and testing data sets are studied to achieve the best-learning model. Best performing model consists of 25% of the data available in the testing set and the rest is used for training the model (Tayfur, 2009-2010).

ANN model construction is a trial and error process and the performance of the model is affected by other components rather than the number and the range of the data

included in training and testing data sets. The value of the learning rate parameter and the number of hidden layers could increase or decrease the prediction accuracy (Alava, 2008; Ezeldin & Sharara, 2006; Dikmen, Birgonul & Kiziltas, 2005). Starting with one hidden layer up to five hidden layers, each with various neuron sizes differing from one to a hundred are evaluated in the training process. For this study, best model happened to have one hidden layer with fifty neurons. The learning rate parameter of the model is entered to be between 0.01 and 0.1 as recommended by previous studies (Tayfur, 2009-2010), and the values between 0.1 and 0.4 are found to increase the prediction performance of this particular model.

Sensitivity analysis is a final verification for the prediction performance of the model. Its power to reveal the most significant inputs could be utilized to improve the performance of the model by re-arrangements of input parameters. However, for this study each input parameter is important for the prediction performance of the model. For instance, the first permit rejection season input is the least effective input compared to the other inputs with a sensitivity ratio of 12%; however excluding this input decreases the prediction performance of the model as any missing situation of other inputs. A prior trained ANN model with the same data shows that the prediction performance decreases to 75% when the ANN model is built up with the same input and output parameters except for the first permit rejection season input (Kontbay, 2010). The prediction performance of the model is increased to 86% by including this input parameter.

CHAPTER 5

CONCLUSION

This study dealt with the occupancy permit applications made to Izmir Konak Municipality. It concentrated on the occupancy permit issuance durations and aimed to develop an ANN model that is capable of predicting the occupancy permit issuance dates of initially rejected applications with high prediction accuracy. The ANN model designed proves to the stakeholders of the construction industry that the delay causes of occupancy permit issuances are so rooted those issuance dates could be stated regarding the initial rejection status comprising missing documents, approval letters, non-conformances to the building codes and application-rejection seasons.

Turkish building codes and regulations define and write down the time allocated for obtaining occupancy permits. That offers a maximum 30 days examination time for an application file and 10 extra days' legal time for the applicant to re-handle for any missings and non-conformities (Turkish Construction Law- Item 33a, 1985). Exceeding 10 days' time for upgrading requires a re-application for the occupancy permit, resetting the 30 days' legal examination time. An initial rejection in the occupancy permit process extends occupancy permit issuance date at average 30 days' period. Furthermore, the findings of a recent research prove that an average duration of 99 days is required in Izmir Konak Municipality to obtain an occupancy permit for a new building construction (Demirciefe, 2009).

The report published by The Coordination Council for the Improvement of Investment Environment (2009) supports the research findings of Kontbay et al. (2010), Demirciefe, Doğan Günaydın et al. (2009) and Doğan, Günaydın and Demirciefe et. al. (2009a, 2009b) discussing that the delays in building and occupancy permit issuances are extending the due dates of affidavits and construction contracts harming the national economy.

This study proves that the occupancy permit issuance durations of initially rejected applications made to Izmir Konak Municipality can be predicted with an approximately eight days of error by the ANN model developed by utilizing delay causes as input parameters. In this respect, this study may become a guiding one for the further research required to focus on the structurally embedded delay causes for

streamlining the building and occupancy permit processes for the improvement imposition of EU standards; regarding improvement of the permitting process is among the demands for harmonization of building codes with EU standards.

Six groups of delay causes for generating input parameters are utilized in this study: (1) number of missing approval letters, (2) number of missing payment documents, (3) number of non-conformances of project to codes and regulations, (4) number of all missing documents, (5) first permit application season and (6) first permit rejection season. The sensitivity analysis is conducted to reveal the significant input parameters. The results of the sensitivity analysis show that the number of missing approval letters is the most effective input with 70% sensitivity ratio. Number of missing payment documents, first permit application season, number of all missing documents, number of non-conformances of project to codes and regulations, and first permit rejection season follow with 54%, 41%, 39%, 37% and 12% sensitivity ratios, respectively. This study may further guide studies for revealing other hidden significant delay causes. Streamlining permit process would benefit from conducting further sensitivity analyses on a wider range of delay causes.

The sensitivity analysis of this study targets the missing approval letters as the most significant delay cause. The interview results of county municipalities support this finding specifically referring to the missing situation of the approval letter of the Department of Fire Authority. The sensitivity analysis second most significant delay cause indication missing payment documents is supported by interview results as the missing documents mentioned to be the proof of tax payment to the Department of Social Security and the proof of parking lot payment.

Both interview results and the web-site analyses conducted for the county and the metropolitan municipalities show that applicants being inadequately informed about (1) the locations of agencies assigning required documents; (2) the flow sequence of the permit application process; (3) the additional legal time allocated for re-submission of the application file, (4) the examination time of the re-submission and (5) the currently required tax and fees are the most common delaying factors for the issuance of occupancy permits.

Findings emphasize the chaotic situation of the occupancy permit process in Turkey and the urgency to enhance the municipal bureaucratic procedures. Similar foci points exist in the recent progress reports of the YOİKK (Turkish Republic The

Ministry of Public Works and Settlement General Directorate of Technical Reseach and Implementation, 2009)

Reviews about the occupancy permit processes in US cities, Canada, European countries and Australia show that computer based tools and services are commonly used to automate and streamline the permit process in order to reduce permitting time, improve customer services and staff efficiency, enhance quality and make operating funds more productive for the benefits of municipalities (National Institute of the Building Sciences, 2002). The Ministry of Public Works and Settlement encourages the implementation of the electronic permitting system and include feasibility studies in its progress reports (2009). This study may also be an incentive for establishing an electronic permitting system in Turkey that could be integrated to the system of Central Civil Registration, MERNİS in Turkish. Central Civil Registration System matches the address data with the corresponding personal data for providing faster and efficient public services and reduce the costs and bureaucratic problems by the standard address form set out currently by the municipalities and provincial special administrations (Turkish Republic Ministry of the Interior General Directorate of Civil Registration and Nationality, 2002). The system works utilizing an electronic national address database called Address Registration System, abbreviated as AKS in Turkish (Turkish Republic Ministry of the Interior General Directorate of Civil Registration and Nationality, 2007).

The findings of this study offer to arrange due dates in construction industry for better precision of submission times. Better time precision is likely to support the national economy by fostering the time and cost goals of construction management. High prediction accuracy in occupancy permit issuance dates reduces the wasted time and costs in the process.

Finally, this research serves as a guiding step for the occupancy permit streamlining process studies aiming to shorten the issuance durations and keep up with the period proposed by the Construction Law (Turkish Construction Law − Item 33a, 1985). Additional benefits may contribute to the improvement of the construction regulations and the implementation of an e-permitting system.

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APPENDIX A

YAPI KULLANMA İZİN BELGESİ MÜRACAATINDA GEREKLİ EVRAKLAR

İlk defa (yeni yapı) yapı kullanma izni alacaklar için gerekli evraklar ;

1. Dilekçe.
2. Tapu Fotokopisi.
3. 9 Eylül Vergi Dairesinden İlişik Kesme Belgesi
4. Dış Kanal Belgesi (İZSU).
5. Telekom Olur Yazısı.
6. Sigorta İl Müd.'den Borcu Yoktur Yazısı. (6.7.2004 Tarihinden Sonra Ruhsat Alan Binalar İçin)
7. Emlak Vergi Dairesi' nden Borcu Yoktur Yazısı
8. (4708'e Göre Ruhsat Alan Binalarda)Yapı Denetim Ve Proje Müellifleri Raporları.

(3194'e Göre Ruhsat Alan Binalarda Tüm Fenni Mesullerin Uygunluk Raporu)

9. Cephe Fotoğrafları (13 X 18)
10. Bina Asansörlü ise;

    Asansör Firmasından ,

    - TSE Belgeleri
    - AB Uygunluk Beyanı
    - CE Belgesi
    - Garanti Belgesi
    - Mühendislerin SMM (Serbest Mühendis Müşavirlik) Belgeleri
    - Asansör işletme ruhsatı (3 Adet)
    - Asansör Uygulama Projeleri (Makine Mühendisleri Odası Tasdikli)
    - Asansör Elektrik Projeleri (Elektrik Mühendisleri Odası Tasdikli)
11. İtfaiye Raporu (Binada Korunumlu Merdiven Var İse)
12. Sığınak Uygunluk Belgesi (Binada Sığınak Var İse)
13. Otopark Taksitlerinin Tamamının Yatırıldığına Dair Yazı

APPENDIX B

REQUIRED DOCUMENTS FOR OCCUPANCY PERMIT APPLICATION

1. Occupancy permit application form
2. Parcel deed
3. Proof of changed title deed
4. Approval letter of the department of city water supply and sewage administration
5. Approval letter of the department of telecom services and distribution inc. com.
6. Proof of tax payment to the department of social security
7. Proof of real estate tax payment
8. Approvals of the CIF and the architect and engineers of the project
9. Proof of conformance by original photographs of the building dated
10. If building have an elevator; Elevator conductor firm prepares,
    - Quality Management System Certificate
    - Manufacturer's EC-declaration of Conformity
    - Certificate for Full Quality Assurance System (Module H)
    - Warranty Certificate
    - Consultancy Certificate of Public Liability Insurance
    - Elevator Permit (3 Copies).
    - Elevator Application Projects (approved by the Chamber of Mechanical Engineers)
    - Electrical Projects of the Elevator (approved by the Chamber of Electrical Engineers)
11. Approval letter of the Department of Fire Authority
12. Approval letter of the Directorate of Civil Defense
13. Proof of parking lot payment

(Source: Izmir Konak Municipality Official Web Site, 2010)

APPENDIX C

GÖRÜŞME SORULARI

1. Bütün evrakları tam olan bir dosyanın incelenmesi ortalama ne kadar zaman alıyor? Ne kadar zamanda yapı kullanma izni onaylanıyor?

2. Dosyaların bekleme sebepleri en çok hangileridir?

3. Belediyeniz tarafından eksikliklerinden dolayı başvurusu bir çok kez reddedilmiş ve uzun bir süre sonunda eksiklerini tamamlayarak yapı kullanma iznini almış bir başvuru oldu mu? Ne kadar sürede iznini aldı?

4. Belediyenizde süreci hızlandırmak için her hangi bir uygulama yapılmakta mıdır?

5. Vatandaş ne kadar bilinçli ve nasıl yönlendiriliyor?

APPENDIX D

INTERVIEW QUESTIONS

1. How many times does it takes to review a fully completed occupancy permit application filing and approve the permit?

2. What is the frequently faced problem of the occupancy permit applications?

3. Is there any application rejected once or more because of its deficiencies that head obtaining the occupancy permit off and gathered its approval after a long time because of that situation? If there is how many times does it take to be approved?

4. Is there any implementation to accelerate the occupancy permit process in your municipality?

5. How much does the applicants conscious about the occupancy permit process?