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Property Tax Mapping and Assessment Using GIS: Case study of Rawalpindi City

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PROPERTY TAX MAPPING AND ASSESMENT USING GIS

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Abstract

This study aims at exploring the use of spatial technologies in the taxation process to improve property tax assessment procedures and work efficiency. The research would help to bring uniformity and consistency in the property tax management system. Likewise, property tax recovery is considered one of the most challenging tasks for the governments around the globe in general and in third world countries including Pakistan, India, and Sri Lanka in particular. Today, the existing real property assessment and tax collection system are under pressure to increase its efficiency. Moreover, monitoring and updating of property units are not being carried out regularly which results in loss of revenue. For example, change in the number of floors, land area, covered area, building type, property occupation, tax categories, property usage, and land use, etc. are not updated regularly. Each property unit has both spatial and non-spatial data. The integration of both data sets can improve the efficiency of property tax assessment procedures and monitoring systems. The introduction of geospatial technologies to the existing databases will not only simplify the assessment and management of property taxes but it would also improve the tax collection process. Furthermore, this technology will also enable the government to monitor property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, a total constructed area of each building, individual plot areas, details of locality and road facing details with the applied tax calculation principles. Comprehensive geo-statistical reporting along with visualization and thematic maps will enable the governments to identify the potential of revenue collection and accordingly devise the proper policy instrument. Tax defaulters, hidden properties, and potential areas for tax recovery and tax categories of properties can be easily identified with the help of analysis and visualization. Geographical Information Systems (GIS) and Remote Sensing (RS) are the tools to identify and locate the exact location of the properties with relevant tax attributes. Among others, tax assessment variables such as land area, tax categories, main-off road, building types of properties can also be observed and updated with the help of GIS and remote sensing techniques. As a result, the property tax system will become more transparent, efficient, updated, and considerable enhancement in government revenue.

Keywords: GIS, RS, Spatial Data, Attribute Data, Property Mapping, Property Tax

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List of Abbreviations

ArcGIS	Suite of GIS software products developed by ESRI
ARV	Annual Rent Value
CAD	Computer Aided Design
DBMS	Database Management System
ESRI	Environmental Systems Research Institute
GIS	Geographical Information Systems
JPEG	Joint Photographic Experts Group
GCP	Ground Control Points
GPS	Global Positioning System
GRAV	Gross Annual Rent Value
MS	Microsoft
PIN	Property Identification Number
PKR	Pakistan Rupee (Currency Unit, ISO)
QGIS	Quantum Geographic Information System (Software)
RGB	Red, Green ,Blue
RS	Remote Sensing
Shp	Shape file
UIPT	Urban Immovable Property Tax
UTM	Universal Transverse Mercator
USGS	United States Geological Survey

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Chapter-1: Introduction

1.1 Background and Motivation

Property tax recovery has remained one of the challenging tasks over the years for almost every government around the world, especially in third world countries. People often do not want to pay taxes to the government thus following illegal ways of hiding their real attribute/status of the property. Proper assessment of properties and efficient collection of tax is vital for municipal corporations and other government departments as it is the primary source of income for these authorities. In Pakistan, the tax collection system is antique and defective in many ways. The tax collecting personal often do not have relevant knowledge, education, and training. Furthermore, the government has very limited financial and human resources to properly dealing with tax collection. Tax defaulters are usually influential persons and had a cordial relationship with tax recovery staff. As a result, the tax department staff doesn't put the properties on record and they receive illegal amounts through unfair means. The tax department has manual and outdated methods for tax collection. The relevant revenue department collects factious and bogus tax data. As a result, the government is deprived of real tax revenue (Property tax department Rawalpindi, 2014). Here are some main issues being faced by the relevant authorities in Pakistan:

i. Wrong assessment of property tax.
   The assessment of property tax is not calculated according to the prescribed formulas. Assessment is not made according to property specifications.
ii. Delaying tactics in preparing of the list of tax defaulters.
   Manual preparation of the defaulter list is a hectic task. Staff usually hesitates to prepare defaulter list.
iii. Alteration of records.
   Staff changes the manual record as per their personal interest.
iv. Manual property record is maintained on registers.
   Hand written property tax record is maintained manually on the registers. It is very difficult to check every property unit in detail on the manual register. The manual record is beyond the access of public.
v. A large number of un-register properties.
   Those property units which have not been registered in the tax network intentionally due to individual interest.
vi. Inaccurate and incomplete property data.
   The complete and accurate data for the assessment of property tax is not collected by staff of tax department.
vii. Non-existence of property tax mapping system.

There are not any types of maps of property units available in the existing tax system.

The GIS and RS technology had an effective role in the improvement of the tax collection system due to its spatial and statistical analysis and visualization *(*Cheplong, 2013*)*. Hence, it is essential to use GIS techniques in Pakistan to improve the tax collection system as adopted in developed countries. Property mapping is the most convenient source available to the public to determine the location and property-related attributes (like a street address, locality, category, main/off-road and tax status, etc.).

It also helps in better understanding and easily visualizing the impact of sales, foreclosures, and assessment appeals on property value in a neighborhood or tax district, eliminating multiple views and unnecessary queries. One can quickly detect outliers, errors refine valuation models and deliver more accurate data and assessments for the stakeholders and taxpayers (GIS for Land Administration & Land Records, 2015).

Property mapping reflects the accurate size and shape of the property. Every property has both spatial and other attributes data. The attribute data of parcels are available in the local tax department office in the form of a paper register. The unique feature available in GIS is to link the spatial and attribute data. Linking at both types of data, a variety of spatial and attributes analysis are available to be performed with several tax variables.

The GIS could help monitor the property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, the total constructed area of each building, individual plot areas, details of locality, and road facing details with the applied tax calculation principles *(*Pareta, 2017*)*.

The property tax system can be corrected and monitored with the help of RS and GIS using analysis, measurements, statistics, and visualizations. Tax assessment variables such as parcel area, tax categories, main-off road, building types, land area, number of floors, etc. of the properties can be monitored and corrected. As a result, the property tax system becomes more transparent and efficient.

The GIS is used to support decision-making processes in public and private institutions around the world and can contribute significantly to the design of administrative and management procedures that are more efficient, transparent and customer-friendly (Wehrmann and Glavina, 2009).

1.2 Aim of study

The main aims of study are as under

1. Explore the use of spatial technologies in the taxation process to improve property tax assessment procedures and work efficiency.
2. Enhance tax revenue and bring transparency.
3. Improve planning and decision making process.

1.3 Research Questions

The study is based on the following research questions:

1. How to bring transparency, efficiency, better control and decision making in the property tax system through computerization and integration with the Geographic Information System (GIS) which will lead to effectively overcome the tax leakages, corruption, and malpractices resulting in a considerable rise in revenue collection?
2. How to prepare maps by digitizing the imagery of urban areas to provide the printouts of these maps to the surveyors for identification of properties on maps for integration with GIS?
3. What is the extent of tax evasion/misclassification in the study area and how does the correct classification, assisted with mapping/GIS increase tax recovery?
4. In what ways the property tax defaulters could be identified?
5. How to monitor, rectify and evaluate property tax system with different spatial, visual, and statistical analyses?

The following hypotheses to be tested are:

1. The GIS can be used as an effective tool for property tax assessment, monitoring, and information management system in the study area as compare to the manual paper-based system.

2. GIS-based property tax system safeguards the government revenue and boost up tax recovery in the study area by rectifying the anomalies/misclassification, identifying the pattern of tax defaulters and potential area of tax revenue than the manual paper-based system.

3. The GIS system can effectively overcome issues of the tax leakages, corruption, and malpractices in the study area as compared to the manual paper-based system.

1.4 Rawalpindi City Overview

Punjab is the biggest province of Pakistan. Most city governments depend on the revenue collection from property tax to finance their infrastructure and daily operations of the city. In Punjab province, property tax provides an abysmally small percentage of total provincial revenue by 2%. Property tax has the potential to grow very fast and can be more than double its current size with better administration and decision making. The government of the province has put tremendous pressure on tax authorities to increase their tax revenue by incorporating modern technologies in the property tax system. The property tax systems are one of the mandatory reforms.

The study area of the thesis is located in Rawalpindi city. Rawalpindi is one of the biggest cities of the province which is located in the northern region of Punjab province. It is situated in the pothar plateau near Islamabad, the capital of Pakistan. This area is selected because a variety of taxable property types exists and the implementation of the current system will increase government revenue inconsiderable amount. The area of Rawalpindi city is 259 square kilometers which comprise more than 25 zones/circles. The city is highly populated. It has a population of 2,098,231 persons as per the census 2017 *(Population Census | Pakistan Bureau of Statistics, 2017).*

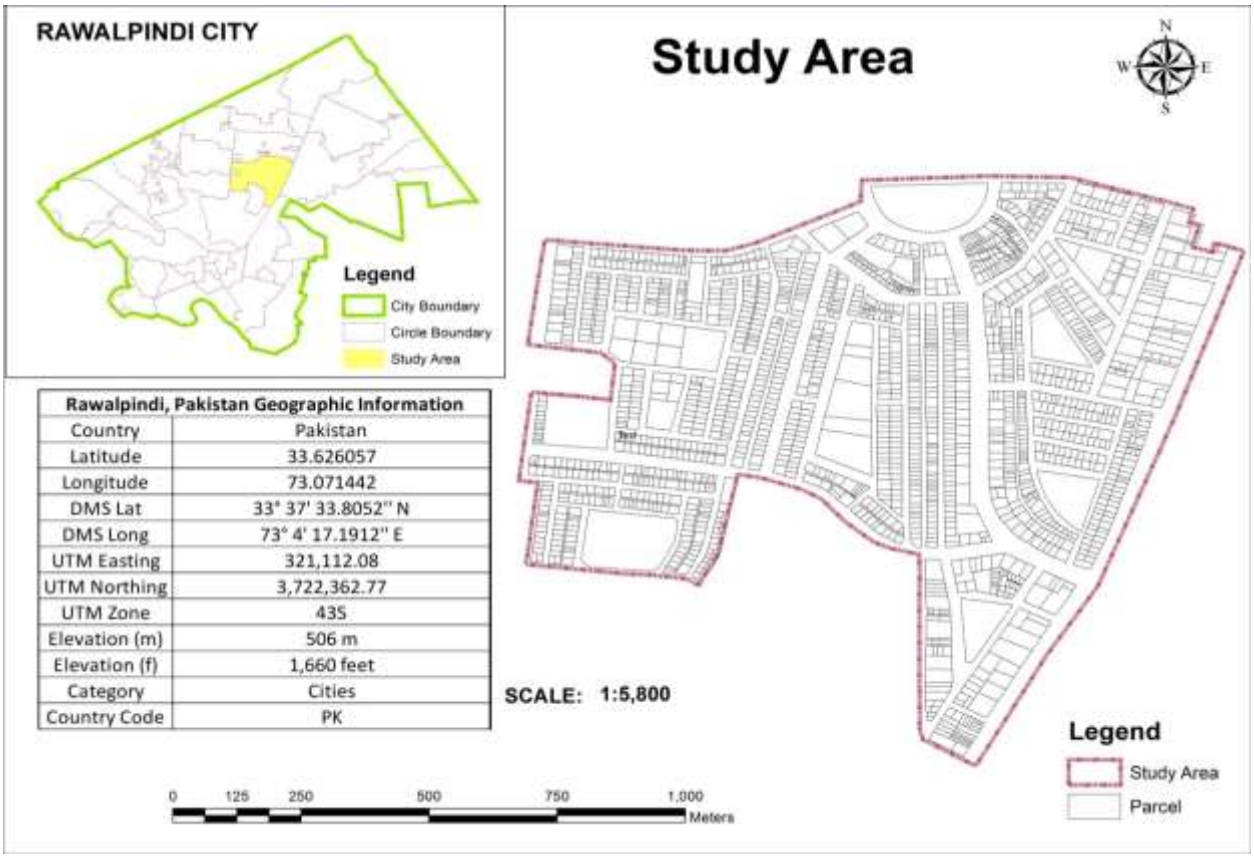

Figure 1: Map of Rawalpindi city and study area (Data Source: IRIS Punjab (2015) IRIS: It's a brand name of GIS based web mapping application that provides a spatial frame work to host, geo code and view numerous other layered data-sets through internet.

1.5 Overview of Study Area

Rawalpindi city has been divided into 25 circles/zones for revenue collection and management. This is a vast area that requires a lot of resources, time and human resources. For this reason, only one zone namely Zone-II has been selected for this study area. I have selected Zone-II of Rawalpindi for study purposes because it is located in the hub of the city, contains a variety of properties, the record is in better condition, easily accessible, and can enhance the considerable amount of tax revenue. For the identification of the boundary of Zone-II, I marked the boundary of the zone on satellite imagery in collaboration with the revenue department staff. On identifying and marking the boundary of Zone-II, it has been overlaid on the satellite imagery and the zone boundary is verified in the field with the help of the tax department.

Satellite Map of Study Area

Figure 2: Map of study Area with satellite imagery. (Satellite imagery Source: Urban unit planning and development Government of Punjab for Study and research Purposes.)

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Chapter-2: Methodology

2.1 What is Property Mapping?

In the past, the most common technique of keeping track of land ownership was surveying and deed registration but it was not actual parcel mapping. Property mapping is a method of identifying real property units, establishing property boundaries, determining actual use and discovering undeclared properties (Cheplong, 2013). Property mapping of an area usually represents the ownership of the property. The advantage of parcel mapping is that it allows easy identification of a property where it is located relative to public ways and adjacent properties. A parcel map is perhaps the most convenient resource available to the public to determine the location and parcel identification number of a property. In property mapping, the location and extent of a property/parcel are marked/digitized on land and a unique property identification number is assigned.

Due to rapid development and increasing property values in cities and towns, the relevant government departments and organizations began to realize the importance of having accurate parcel mapping in Pakistan. Property number is the unique key to identify and fetch information. When a unique Property Identification Number (PIN) is assigned to the parcel, the relevant property information (location, property and tax detail) pertaining to the said property is retrieved. An adequate parcel/property mapping should reflect the size and shape of each individual parcel owned in a town/city (PARCEL MAPPING USING GIS, 1999). Property mapping can be used for a variety of purposes which can be integrated with different systems and databases. For example, it can be integrated with land use, tax collection and cadastral mapping system, etc.

2.2 Different Methods of Property Mapping

The data in a GIS system is usually collected from the following sources:

I. Manual digitizing from existing map or satellite imagery.
II. Scanning analog map.
III. Automatic vectorization.
IV. Heads-up digitizing.
V. Coordinate geometry.
VI. Positioning property corners with GPS.
VII. Transfer of existing CAD map.

(Handbook on Geographic Information Systems and Digital Mapping, 2000)
Practitioner's Guide: Digital Tax Parcel Mapping, 2009).

Data from the other sources are deficient and obsolete due to the non-availability of accurate paper maps, cad map and coordinates data. As there was no CAD drawing or analog map existed for the study area, therefore, this option was obsolete. Moreover, the collection of corner points through GPS was also time-taking.

Therefore, as a researcher, I concluded that the current study heads-up digitizing method on satellite imagery is more efficient due to its most suitability and relevancy for my study.

Heads-up digitizing is defined as the manual digitization by tracing a mouse-over feature displayed on a computer screen, used as a method of vectorizing raster data (GIS for Land Administration & Land Records, 2015). In the heads-up digitization, the raster imagery (satellite imagery) is used as the background image. Operators perform digitization on the computer screen and work can be distributed among several persons.

2.3 Preparation for the Property Mapping

Spatially mapping and registering all properties within the study area is critical to the development of the research's comprehensive and integrated property tax information system (ZONEH, 2013). The assembling of an inventory on all property units is the very first step in identifying and describing properties. The tax cannot be collected if those properties are not properly located. As discussed earlier, there is no base map, cad map, and coordinated data available. The first task is to develop a base map for the property tax database that is the property tax mapping with the help of satellite imagery.

The property tax department Punjab requires two types of data pertaining to all parcels of property in the property tax implementation:

1. Spatial Data
2. Non-Spatial Data

The spatial data refers to all types of data objects or elements that are present in a geographical space or horizon and that can be represented by numerical values in a geographically coordinated system. The non-spatial data contains the attribute information that describes spatial data such as the property address, property ownership, occupant, taxpayer, land use and, building type. It is explained here that the capturing process involves mapping and collecting current and relevant property information on all properties within the study area for the purpose of taxation.

Credentials and information regarding the property units which falls under the tax is periodically updated to keep records up to date and to monitor the changes being developed in property with the passage of time. This information is mostly updated with the help of field survey and sometimes the information is updated with conversation with the property occupant or the property owner. In more than 100 developed and underdeveloped countries in the world like Canada, Japan, the United Kingdom, The Netherlands, Switzerland, and Australia, etc. property data collection is done through field surveys. In the United States cadastral maps are used by the property tax administration to prepare parcel maps for property tax purposes. (Kayuza, 2006).

In Pakistan, the property tax survey is conducted every five years. The purpose of conducting a survey is to collect updated, accurate and detail information about each property unit. Furthermore, there is also a program to collect information about changes occurred in the status of property units from time to time by the tax department staff.

2.4 Data Sets

Datasets for the current study were prepared with the help of the excise and taxation department government of Punjab. First of all, I demarked the zonal boundary of the study area with the help of the staff from the excise and taxation department on Google Earth as well as in the field. As a second step, I mapped individual parcels on high resolution satellite imagery of the Quickbird satellite following a manual digitizing technique. Road networks and landmarks were extracted from the study area using high resolution satellite imagery as well as field visits. As a last step of data collection, I collected property attributes from property tax registers of the excise and taxation department. The detail is given below:

Table 1: List of Data sets

Sr.no	Data Type	Description	Source
1	Zone boundary	Boundary of the zone or circle	With the help of GPS Survey
2	Property mapping	Property mapping of an area	On screen digitization with the help of satellite imagery
3	Road	Road network	From satellite imagery and field work
4	Land marks	Important land mark of area	From field work/Google Earth
5	Property attribute data	All the tax related attributes of a property	Existing database of property tax & manual registers (convert to Excel work book)
6	Satellite imagery	Satellite imagery of the study Area	On request from the urban unit planning and development Government of Punjab for Study and research Purposes.

2.5 Methodology for Property Tax Mapping

The step by step process flow/methodology for the property tax mapping is shown in Figure-3.

Figure 3: Process flow/methodology for the property tax mapping.

2.5.1 Data Entry and Creation of Property Tax Data Base

All the property tax was available in the form of old manual paper registers. The next step was to create a property tax database system on Microsoft Excel. After understanding and with the help of tax department staff, data entry of the property units will be made from the paper registers and a database of the property tax record of the study area was created.

2.5.2 Acquiring Satellites Imagery

The next task is to digitize the parcel for property mapping. For this purpose, high resolution satellite imagery was used. QuickBird satellite offers high resolution image data up to 0.65 meters pixel. QuickBird provides industry-leading geo-locational accuracy of up to 23-meter (CE90%), excluding any topographic displacement.

Ground location is derived from refined satellite attitude and ephemeris information without requiring the use of Ground Control Points (GCPs). QuickBird sensor satellite imagery is used for property mapping, change detection and forestry image analysis, etc. (QuickBird Satellite Sensor Satellite Imaging Corp, 2015). The satellite imagery acquisition date September 24, 2014 and after a long struggle, conversations, applications, and verification, it was made possible to get the satellite imagery of the study area from the government of Punjab for the study purposes.

Table 2: Quick Bird Satellite Sensor Specification

(QuickBird Satellite Sensor | Satellite Imaging Corp. 2015)

Launch Date	18-Oct-2001
Launch Vehicle	Boeing Delta II
Launch Location	Vandenberg Air Force Base, California, USA
Orbit Altitude	450 Km
Orbit Inclination	97.2°, sun-synchronous
Speed	7.1 Km/sec (25,560 Km/hour)
Equator Crossing Time	10:30 AM (descending node)
Orbit Time	93.5 minutes
Revisit Time	1-3.5 days, depending on latitude (30° off-nadir)
Swath Width	16.5 Km x 16.5 Km at nadir
Metric Accuracy	23 meters horizontal (CE90%)
Digitization	11 bits
Resolution	Pan: 61 cm (nadir) to 72 cm (25° off-nadir)
	MS: 2.44 m (nadir) to 2.88 m (25° off-nadir)
Image Bands	Pan: 450-900 nm
	Blue: 450-520 nm
	Green: 520-600 nm
	Red: 630-690 nm
	Near IR: 760-900 nm

2.5.3 Identify the Study Area on satellite Imagery

After getting the satellite imagery, the boundary of the study area was marked with the help of the tax department. For defining the boundary of the study area, the relevant properties of the area were included. This phase will involve the active participation of tax officials for providing the spatial extent of a region, zone or circle. Therefore, localities and many other properties in the study area were verified. On the ground, property verification number, property bills, and other necessary information were mentioned.

During the digitization, it was ensured that access or ways to every parcel should exist. Moreover, every parcel of land was digitized for the revenue collection processes. All properties/parcels were digitized as polygon feature, line feature (Roads), and point feature (land mark).

2.5.4 Digitization

Digitization is one of the most important stages in map production since the quality of the final work, the subsequent analysis and results are relatively depending on the accuracy of the digitized data (Cheplong, 2013). The utility of a parcel/property map is that it allows for easy identification of where a property is located relative to public ways and adjacent properties (PARCEL MAPPING USING GIS, 1999). Property tax mapping is the core element of any integrated real property tax administration and tax management. It establishes the link between the real properties in the field and the property assessment and the tax record of tax administration (Handbook on Geographic Information Systems and Digital Mapping, 2000). After the demarcation of Zone-II boundaries, digitization will be performed on satellite imagery to acquire unique urban features on the ground. In terms of GIS, every unique entity on the ground is known as a parcel, which has an area, a spatial reference, and unique id, whereas, in terms of tax, it is regarded as a property unit. Thus, every parcel of the study area was digitized.

2.5.5 Data Verification Sheets

For ground-truthing, the data verification sheet (Figure 5 and Figure 6) was prepared that contained landmarks, map legends, and roads, etc. This helped the surveyors to locate and verify the attributes of property in the field. Figure 5 shows that parcels are blank and surveyors have to collect the parcel number from the study area. The parcel number is defined as the property number/Street address mentioned on each property.

2.5.6 Indexing of the Study Area for Work Distribution

For efficient planning and management, the zone area is indexed to divide it into the smaller portions (A3 sheets), so all the study area can fit into the sheets (A3 size) for field verification. The said work was managed by dividing the area into sheets. Thus, for the field verification, the property to property verification on the ground was required.

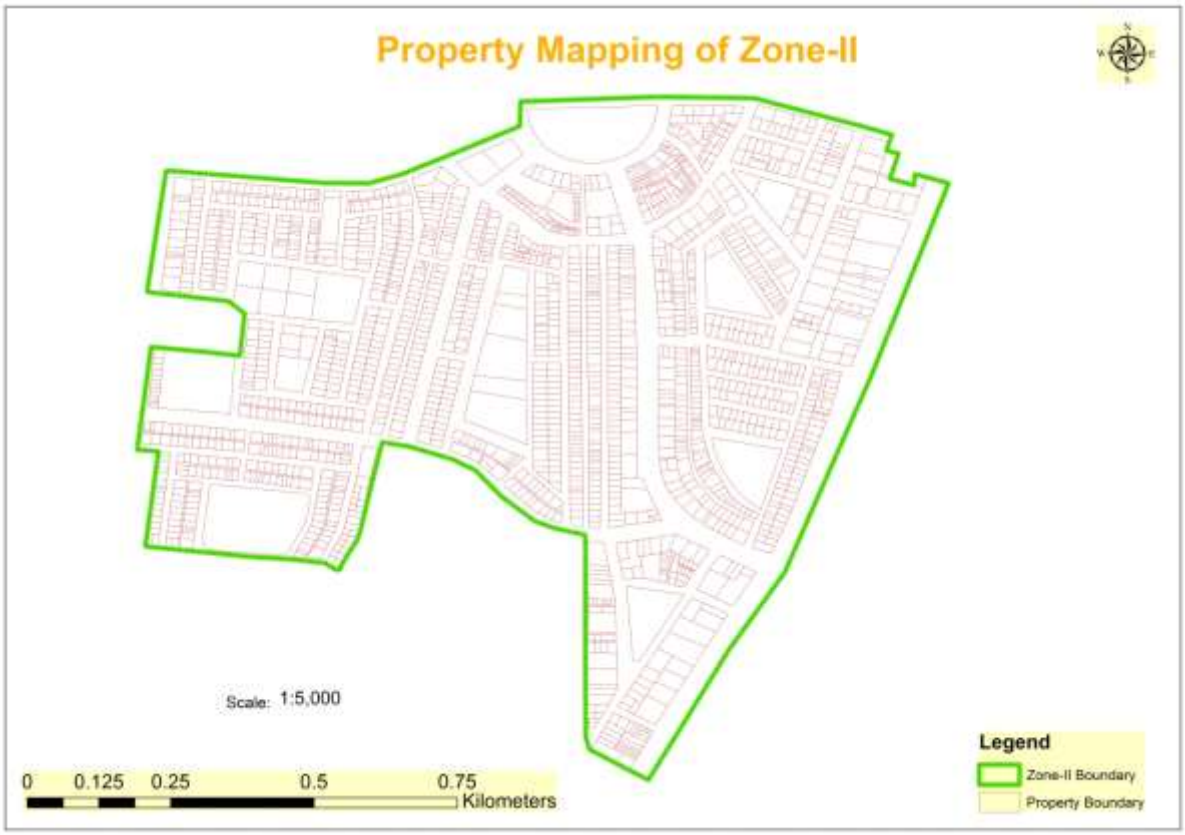

Figure 4: Parcel Mapping of Study Area (Source: Digitization of parcel on satellite imagery)

2.5.7 Field Survey

The field verification was essential and prerequisite to collect the relevant information from the study area with the co-operation of the tax department. After digitization phase, a door to door survey was carried out in the study area. The maps will be prepared and provided to the surveyors for mapping the location and relevant attributes of the property units with the help of the tax department staff.

At this stage, attributes only will involve land use (Commercial, residential or both), property number and ownership status, etc. In the study area, surveyors identified the relevant property number and attributes and assigned them. This data was then correlated with the data available with the municipal corporation *(GIS simplifying property tax collection in India-Geospatial World 2019).*

A high-resolution photograph of each property is captured during the field survey and attached to each property unit. This property photograph helped in the identification, verification, and assessment of property tax.

Figure 5: Image of Survey Sheet for before Field Verification

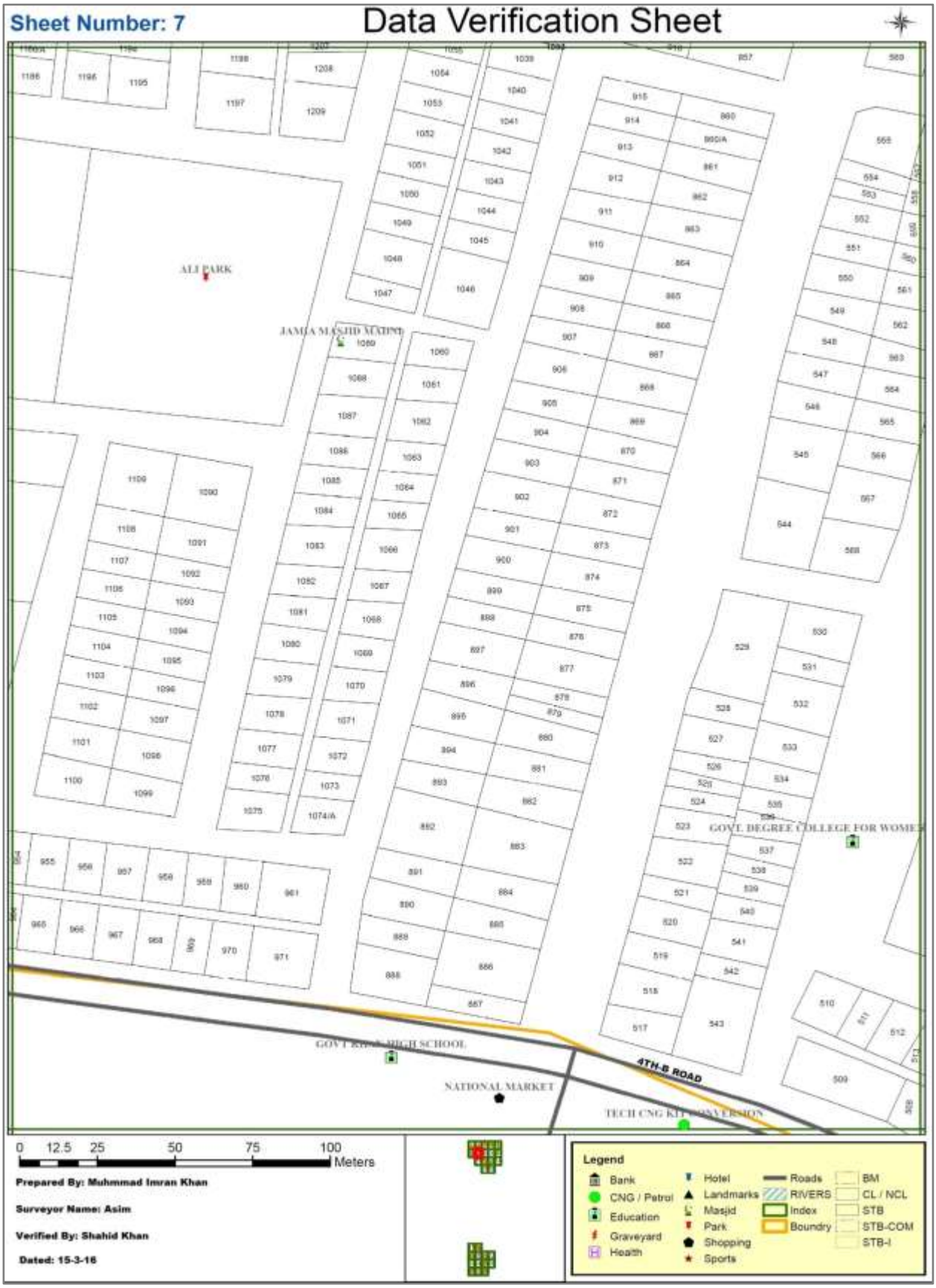

Figure 6: Image of Survey sheet after Field Verification

Unique property number marked on the survey sheets. The size and shape of the property are also verified with reference to the map scale. They used maps to determine the land and covered area of the property. Measuring tapes were used where building maps were not available. Surveyors performed the job of splitting and merging the parcel on the survey sheets according to reality. Moreover, they provided road access to every property or parcel according to reality.

2.5.8 Geo-referencing the Survey Sheets and Building Property Geo database

The survey sheets are scanned in JPEG format and geo-referenced in the UTM projection system. This was done by identifying some (not less than four) identical points from the satellite imagery and the survey sheet. This introduces minor shifting and distortion which was rectified by increasing control points and using the 1st order polynomial (affine) transformation. The first-order polynomial transformation is commonly used to geo-reference an image.

All four points of the corner were used as the ground control points for registering. After geo-referencing the scanned survey sheets, these were superimposed on the satellite imagery. When both the imagery and survey sheets were superimposed on each other, it was easy to update the information from the survey sheet to the relevant parcel attributes in the database table and necessary corrections can be made in the parcels according to the survey sheet and satellite imagery.

One can clearly see the information in the survey sheets and transfer this to the respective parcel. From the survey sheet, a unique identification property number as mentioned in the survey sheet to the property in the database was assigned. The updating process was undertaken in respect of all the parcel status with the unique property number as collected from the study area mentioned in the survey sheets.

2.5.9 Linking Attribute and Spatial Data

During the filed activity, some basic property related information such as street address, housing unit or population estimates and documentation information will be compiled for the study area. This external information about the property units will be stored in separate data tables in a generic database management system. From there, it can be linked as needed to the boundary data through the common identifier. Similarly, after field survey completion, the above attribute information is stored separately in a database management system. In order to create results (thematic maps), the spatial and non-spatial data are then linked via the unique identifiers in the polygon attribute table (Handbook on geographic information systems and digital mapping, 2000).

Currently, the property tax record is maintained in the form of a register prepared by the survey staff of the tax department. The property tax data is verified from these manual registers. Furthermore, the property tax data is obtained from the property tax management information system that is also available in Microsoft excel format.

On updating data from the survey sheets, a complete parcel data with a unique property number (primary key) was assigned to each parcel. In the property tax system, property number/street address has a unique key which provides detailed information about the property by searching unique property identification number (primary key). Both attribute and spatial databases are available now.

Implementation of GIS based revenue collection system will commence once the digital map base and the automated billing databases are in place. The necessary building blocks are the map and attribute databases. The GIS system has to be able to handle all operations in revenue collection including creating a new property unit in the system, valuation, tax bill delivery, tax collection, arrears control, and splitting and/or amalgamating two property units (Nieminen, 2002).

The next step was to create a link between them so that both the property tax management information system and GIS system could be integrated. In the property tax management, information system and GIS system, property number is unique and relevant information can be retrieved with the property identification number. In order to achieve this goal, join in ArcGIS. Now establish a link between the property location on to GIS map and its corresponding property details with photographs.

Property tax mapping establishes the link between the real properties in the field and the property assessment and the tax record of tax administration (Handbook on Geographic Information Systems and Digital Mapping, 2000).

By establishing a link between the document and the related property, the workflow from submission to property assessment to GIS mapping is strengthened. The workflow is more direct and less error-prone. The GIS and property record integration create a value-added product for all property records stakeholders (GIS and Land Records Integration A PRIA White Paper, 2017).

Table3: Table Showing Fields of Geo-Database and Attribute Table

GIS Table Attribute	**Property Tax Database**
City name	City Name
Zone Name	Zone Name
Area Code	Area Code
Street address	Street Address
Locality	Taxable/Exempted
	Covered Area
	Land Area (Plot Size)
	Building Type
	Location (Main/Off Road)
	Payable Tax
	Category (Residential)
	Category (Commercial)
	Owner name
	PIN
	Year of constructions
	Number of stories
	Accommodations
	Locality
	Arrears

Property Types

View Tax Categories

Property Land Use

Tax Defaulter Search

Land Area and Covered Area

Working Model

Existing Manual Property Tax

Property Tax Data Base

Integrate/Join

Acquisition of Satellite Imagery of Study Area

Property Mapping/Digitization

GIS Field Survey

Geo Data Base

Figure 7: Working Model of the Study

Attribute Table Detail

Table 4: Attribute Table Detail

Attribute	Detail
City Name	Name of city
Zone Name	Name of the area
Area code	Code of area assign by the department
Street Address/Property Unit number	Property Address
Taxable/Exempted	Type of property Unit
Building Type	Type of building (For example Office, House, Factory, industry, shop etc.)
Covered Area (Sq ft)	Built up area (It is the actual area of a house that is under the roof.)(
Land Area (Sq yards)	Total area of land (plot size)
Location	Main/Off road
Payable Tax	Current year tax
Category Res	Residential category
Category Com	Commercial category
Owner Name	Name of property owner.
PIN	=16 digit code (district code+citycode+zonecode+Localitycode.....)
Year of construction	Year of property construction
Number of Stories	Total flour /Building stories
Accommodation	Detail of rooms
Locality	Subsector of Area. For example, an area is divided in to four sub parts called sub sector.
Arrears	Previous year's tax balance

Two common attributes in both databases/tables are created. The attribute joins are not permanent, so it can be created or removed whenever it is desirable.

If you want to create a permanently joined layer, you will need to export the joined layer to a new feature class/shape file in ArcGIS. The study area is just a smaller segment/part consisting of only one zone of the city. Every property unit has a unique property number/street address that is assigned by tax department staff and is mentioned on every property of the study area. This unique property number is used in the property tax management information system.

Every property in the study area is identified with the help of this unique number. A Property Identification Number (PIN) is developed for future use when applying this system to the entire city. At the zone level, the property number/street address is unique in the study area. It is important that while proceeding to broader levels (city), a PIN is needed to avoid duplication.

2.6 Creation of Geo Database

The primary function of the database is to store and manage the data in an organized way. Similarly, the geo-database is defined as the physical store of geographical information primarily using the database management system (DBMS) or file system. Geo-database is a built-in data structure for ArcGIS that provides a comprehensive information model for representing and managing geographic information. The geo-database contains three primary dataset types:

1. Feature class
2. Raster database
3. Table

The personal geo-database has been used in this study because it is commonly used as original format for Arc GIS and fulfills its requirements i.e. topology creation (not supported in shape file), all raster and vector data in one file, flexibility, data sharing, file size limit, raster support (not supported in shape file), support null values, ability to compress files and filed name length limit up to 64 characters, etc. Personal geo-databases are available in Microsoft Access file format.

2.7 Building Topology

Topology refers to the relationship between spatial features or objects. Topology defines the standard rules point, line and polygons are connecting share their geometry. Topology checks and validates the spatial relationship between neighboring and overlapping features. Topology is stored in a geo-database and provides the editing environment to identify and fix errors.

Topology ensures better data quality and greater data integrity. Topology is essential for database integrity helps to validate and maintain better feature representations in geo-database. The following topology rules have been used as given below:

1. Must not overlap.
2. Must not have gaps.
3. Must not overlap with (the interior of polygons in another feature class or subtype).

Chapter-3: Property Tax System

In this chapter, the property tax system of Punjab province, Pakistan is described briefly. The chapter also discusses the types of properties in the property tax system, assessment procedure and different types of property tax notices. The property tax system is applicable in the urban area limit only. Each city/district government determines and notifies the limit of urban areas for the purpose of tax collection.

The property tax system is entirely based on the Punjab Urban Immovable Property Tax (UIPT) Act 1958 (UIPT, 1958). In case of any change/amendment in the Act; the provincial legislative assembly passes the bill and is finally approved by the provincial governor. This act provides a basic guideline for the property tax system.

3.1 Types of Properties in Property Tax System

There are two types of properties in the property tax system:

1. Taxable
2. Exempted

3.1.1 Taxable

The identification and registering of the taxable property units is base for revenue generation. The successful property tax system is based on proper identification and subsequently registering of taxable property units (M. Bird and Slack, 2002). Property tax calculations are based on the value of the taxable property. Commonly, the tax rate is fixed by law or based upon the capital (or market value of the property), rental or annual value of the property being taxed. The assessment of property tax calculations are based on the valuation table approved by the revenue authorities given in Appendix-1. The assessment of the different types of properties is based on the methodology defined in the table given in Appendix 2.

3.1.2 Exempted

Exempting a few properties in some areas in the taxable property tax net is a common thing being practiced in many parts of the world and in almost every country. These exemptions are mostly sanctioned by the national and sub national governments whereas sometimes these rights are also given to the local level administrations. Sometimes these exemptions are provided at both the national and the local level depending upon the nature of case and the exemption provided. These exemptions are always based on the special cases and also on the ownership or the use of the property i.e. some properties are belonged to the persons having more attention for the government or the state due to some disability or due to the age factor and in some cases nature of property or ownership also defines some special exemptions like the property belongs to some charity which works for betterment of the society and is purely a nonprofit organization. Some of the common practices which are used in almost each and every country, below is the detail of commonly exempted properties i.e. educational buildings, churches, cemeteries, government buildings, public hospitals, public roads, libraries, foreign embassies and property owned by international organizations (Kayuza, 2006).

In Pakistan, the following properties units have been exempted from the tax by the government. The detail of the exemptions is given in Appendix 3.

3.2 Procedure of Assessment of Property Tax

Property tax is always calculated based on the market price of the property and some other techniques for valuation of property are also used in many developed countries. Most common method for assessment of market value of the property is sales comparison approach whereas sometimes for few cases depreciated replacement cost and income approaches are also used. In Denmark, Switzerland, Sweden, and in many parts of the United States mostly use depreciated replacement cost method whereas in United Kingdom, the estimation of residential and domestic properties is based on the pre-defined classes and commercial properties operating any type of businesses are valued on the basis of their open market information. (Kayuza, 2006).

Most of the underdeveloped countries use the unit approach or area based in the valuation of property tax due to insufficient resources, lack of property information, technical expertise and lack of restricted and limited market. These approaches are commonly used in South African countries, Indonesia, Kenya, Tanzania, Philippine's etc.

In Pakistan, the assessment of the property is based on the valuation table approved by the authorities. The valuation table for the assessment of property tax is given in Appendix 1. The annual value of the buildings and lands is determined on the basis of reasonable rent of properties prevailing in a locality (Mohalla, Colony, Town, Road or Street, etc.), having similar characteristics and the use of the property. This reasonable prevailing rent of properties (Residential or Commercial) in a particular locality has been transformed into Per Sq. Yd. rent for land area and per Sq. Ft. rent for the covered area in the formulation of valuation Tables. For

general residential & commercial properties, the figures recorded in the respective column of the valuation table shall be multiplied with the total land area (Sq. Yard) and covered area (Sq. Feet) of the building, the figure arrived at shall be multiplied by 12 to determine the reasonable Annual Rent Value of a property. The procedure will involve the following steps:

a. Total land area of a property (Actual) X per Sq. Yard Rent prescribed in the valuation table against the locality in which the property is located.
b. Total Covered Area of a property (Actual) X per Sq. Yard Rent prescribed in the Valuation table against the locality in which the property is located.
c. (a) + (b) above X 12 = GARV (Gross Annual Rental Value)
d. GARV – 10% = ARV (Annual Rental Value)
Where payable Tax is 5 % of ARV,

Tax categories from A to G have been defined by the tax department as given in Appendix 1. The relevant category is assigned to each locality/property based upon the value of the property, geographic location, civic facilities, and business activities. A category has the highest tax rate and F has the lowest. Assessment of Special properties is made as per government notifications shown in Appendix-2.

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Chapter-4: Results and Analysis

4.0 Overview

The GIS based property tax system is an appropriate solution for all these problems. The Geographic Information System (GIS) has been developed and built to equip institutions like the tax department with the ability to deploy standardized and best practices of management to improve overall administration. GIS is capable to integrate different sources of information with geographic features to create a complete database for policy maker (Zhao, 2002). Here the property tax information system is linked with a geographic information system (GIS) to obtain spatial dimension and aid in the analysis of the assessment of the property taxation process till parcel level.

The GIS has emerged as an important instrument in improving operational efficiency in planning and management of urban infrastructure and services (Bhan, 2011). The GIS system helps to streamline property tax collection mechanism and officials will be able to make informed decisions.

Cartographic presentation provides a powerful means for visualizing the results for better decision making. This supports the identification of local patterns of important demographic and social indicators. Maps are thus an integral part of policy analysis in the public and private sectors (Handbook on geographic information systems and digital mapping, 2000).

Maps will enable the tax officers to track down the tax defaulters by each displayed parcel. Analysis and statistics reports are available in a few minutes with high precision. This system has functionalities that enable the integration and analysis of a wide range of information based on their spatial locations. Potential revenue area identification of assessed and un-authorized properties is done through the new technology of GIS to bring them in assessment and maximize coverage of properties into the tax net. The GIS is also capable of monitoring and correcting tax parameters such as tax category, main/off road, land area, covered area, etc. The GIS also provides the detail of tax defaulters with the exact location. The property tax as well as tax recovery system becomes more streamlined and transparent.

4.1 Property Tax Mapping

Visualizing large amounts of information interactively is one of the most attractive and useful capabilities of GIS. Visualizing location data can help identify new areas of opportunity and potential problem areas (By and Huisman, 2009). In Figure 8, the parcel/property mapping of the study area overlaid on the satellite imagery has been shown as a map. These parcels were digitized on high resolution satellite imagery and then verified through field surveys by using GPS. This map provides excellent visualization of the study area.

What is needed is a system that allows city managers to identify all taxable units and determine the tax payable. This information needs to be linked to GIS and an accounting system that will produce bills, monitor receipts and notify the need for action on arrears (Nieminen, 2002). The digitized parcels were linked with the property tax database of the property tax department. There are two types of properties in the property tax systems which have been shown in Figure 9. One is taxable and the second is exempted. The map clearly indicates that where parcels which are exempted from tax are and at what location mostly parcels are taxable.

The capability to trace out each parcel of taxable property is basic and important for the proper functioning of any property tax system. Table-5 shows the comparison of the number of property units, type and their tax demand before and after the implementation of the GIS system in the study area.

Table 5 Property unit's types and tax demand details before and after GIS implementation in the study area

	Before		**After**	
Type	**Number of property units**	**Tax demand Amount Rupees (PKR)**	**Number of property units**	**Tax demand Amount Rupees (PKR)**
Taxable	2,402	32,581,356	2,933	69,838,599
Exempted	635	19,442,032	425	11,253,628
Total	3,037	52,023,388	3,358	81,092,227

The digitized parcel is integrated with the property tax database of the excise and taxation department to map rented and self-occupied properties as shown in Figure 10. The ability to determine the rented and self-occupied status of each parcel of taxable property is a complicated task for property tax collecting staff. People usually misreport the type of property due to the different rates of tax as discussed below. Self-occupied and rented property units are defined as below. The rented property units are very important in the property tax system and the main source of revenue. The rented property units had five times more tax rates than self-occupied. (Refer to Appendix-1 to see the valuation table for assessments of property tax).

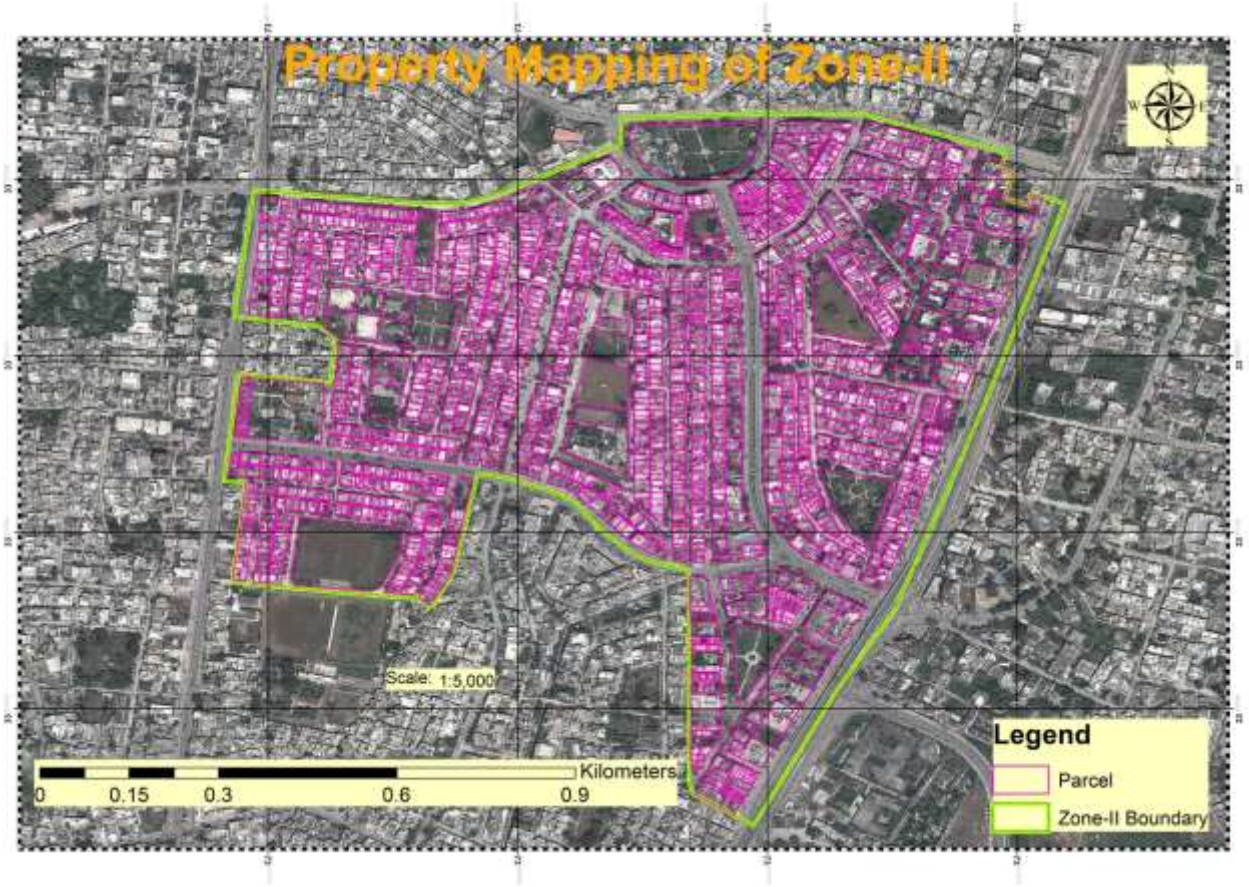

Figure 8: Parcel mapping of zone-II with satellite imagery

Once GIS is integrated with the property tax database, it is able to show details of tax liability such as amount paid and the amount due. This integration not only enables the corporations to identify defaulters and check whether appropriate tax is assigned as per current land/building use but also allows the taxpayers to monitor their tax records (Bhan, 2011).

Property picture:

High resolution image (above 5 Megapixel) of each property is captured during the field survey. These images help in identification, verification and, tax assessment. From these property images, the property tax assessment can be analyzed i.e. building type, land use, number of stories, occupant type, land area, covered area, plaza, open plot, etc.

Picture of shop

Picture of shop

From these property images, it can be clearly analyzed that these are shops used for commercial purposes so the commercial rate will be applied to these property units.

Picture of Residential of Property with two stories

Picture of Residential Property with three stories

From these property images, it can be clearly analyzed that these are residential houses. The left side has 2-storey and the right side has 3-storey, hence these will be assessed as the residential properties and residential rate will be applied. I have captured these pictures during filed survey.

Picture of Plaza

Picture of Plaza

From these property images, it can be analyzed that these are multistory plazas so commercial rate for multistory building will be applied and it is pertinent to mention here that this plaza had various commercial businesses so that multiple entities not charged as a single entity and revenue collection will also be accelerated.

Picture of School

Picture of commercial property-bank and school with three stories

Picture of open plot

From these property images, it can be clearly analyzed, it is a school (right side); a commercial property with two stories with multiple uses in the middle and it is an open plot (left side). So that a separate rate could be applied on each property. Now a link has been established between the property location on the GIS map and its corresponding property details with photographs that are helpful in analysis, visualization, and property tax assessment.

The GIS can help improve efficiency and transparency of tax assessment and collection. First, the GIS can be used to calculate and collect real estate taxes. Arial photographs within a GIS can be used to calculate surfaces and values of parcels or buildings. In the attached data-base, additional information on the owner and property can be held. Secondly, the GIS can be used to map and monitor the tax payment status of any direct tax. This information (map) can easily be made public through web-based GIS (Wehrmann and Glavina, 2009).

Rented: The property unit rented out by the owner to a tenant for commercial as well as residential purposes.

Self-Occupied: The property unit remained in self-use of the owner for both commercial and residential purposes.

Both: The property unit with both self and rented status. Rented properties had more tax than self. Due to this reason, many properties were mis-reported by property tax staff as self-status. Resultantly, the government lost a large amount of tax revenue. Correction of properties occupant type with the help of satellite imagery, property photographs and under the supervision of relevant authorities enhanced the considerable amount of revenue by 3.03 %.

The next target was to map the number of stories through the integration of property tax database and GIS databases for each property unit as shown in Figure 11. The map identifies multi-storey (plaza) buildings, which is helpful for the assessment of tax. The multi-storey building has a different rate of tax for each portion and depending upon the number of storey as described in assessment of special properties in Appendix 2.

Figure 12 shows the land use of the property units in the study area. The different categories of land uses were mapped with different symbols by using information available in the property tax database of the excise and taxation department. This land use was validated through the overlapping of parcels with high resolution satellite imagery as well as the surveyed sheets by visual interpretation. For the assessment of property tax, the authorities define two types of valuation table: One is for residential, and second is for commercial as described in Appendix 1.

Residential: Properties which are purely used for only living/residential purpose.

Commercial: Properties used for commercial purposes such as shop, banks, educational institutions, offices, godowns, factories and industrial units etc.

Residential/Commercial: Properties usage is for both residential and commercial purposes. The residential rate is applicable on residential portion while the commercial rate on the commercial portion of the property.

Commercial properties units have more tax rates than residential as you can see in the valuation given in Appendix 1. Property tax staff misreported many commercial properties as residential properties due to their personal interest. Due to this reason, the government deprived of a large amount of revenue.

GIS property mapping is capable of analyzing a property parcel shape to determine the area and dimensions of each identified parcel (1000 GIS Applications & Uses - How GIS Is Changing the World - GIS Geography, 2019). The land area of property units was calculated through parcel mapping and verified with ground realities by surveyors. Figure 13, shows the land area of property units in the study area. The property units falling in the eight classes have also shown with different colors based on land area. Tax calculation of a property is entirely based on the land and covered area of the property as described in Appendix 1. Land area is converted in to square yards. Land area is an important factor in tax assessment. Land area is corrected and monitored with the help of tools available in GIS. I measured exact land area of the property through parcel mapping of remotely sensed data in GIS environment. The present study has found 426 such tax liable properties for which earlier tax was exempted. Property tax calculation depends on the land and covered area of property units which is another important factor in tax assessment. The covered area is converted into square feet. The information was collected from the existing property tax database and verified by the surveyor in the field. The present study has rectified the covered area 205 properties in the study area. Property units falling in eight classes are shown with different colors based on covered area as in Figure 14.

Tax calculation of a luxury house tax is entirely based on the land and covered area of the residential property as described in appendix 1.luxury tax is applied on the residential houses having an area of two kanals or above with a covered area of more than six thousand square feet Luxury houses in the study area have been shown in Figure 15.

Figure 16 shows amount wise tax classes with different colors symbols. The tax amount for a property unit was calculated from property tax database. The map helps to identify potential tax payers which enhances and accelerates tax recovery process. The list of potential tax payers is provided to the concerned staff at the beginning of the financial year. The list of potential tax payers contains the property number, location and ownership information, current year tax, and arrears etc.

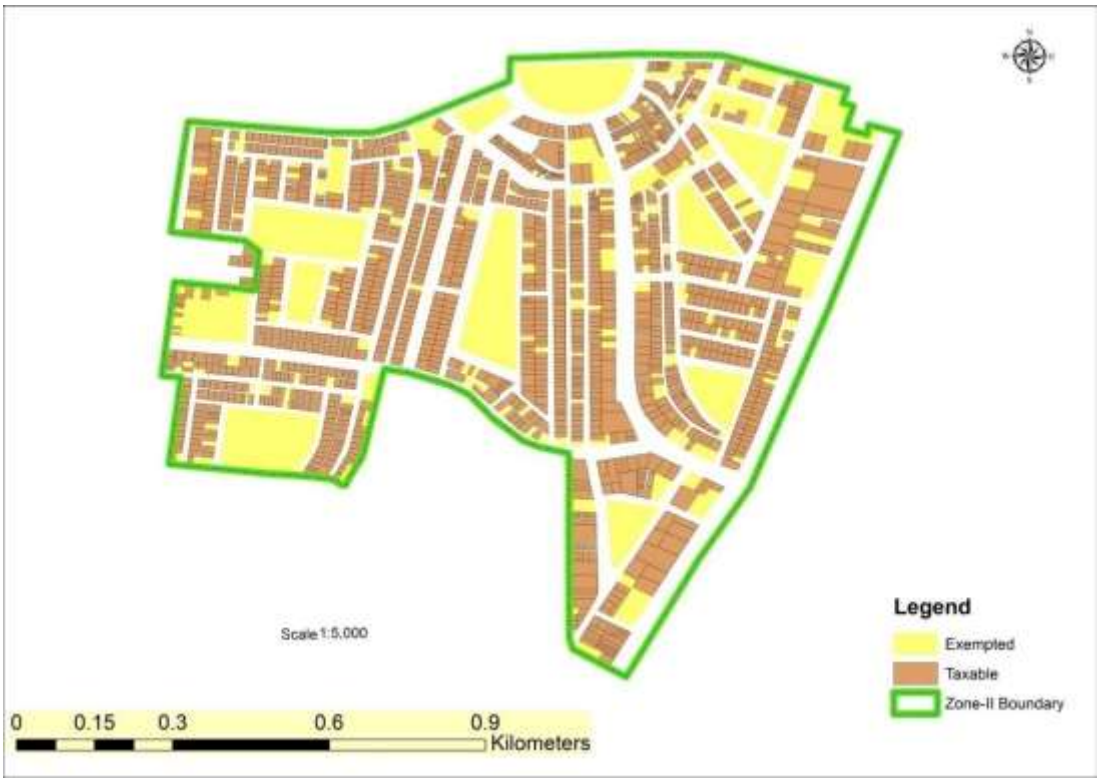

Figure 9: Map showing the taxable and non-taxable units in the Zone-II

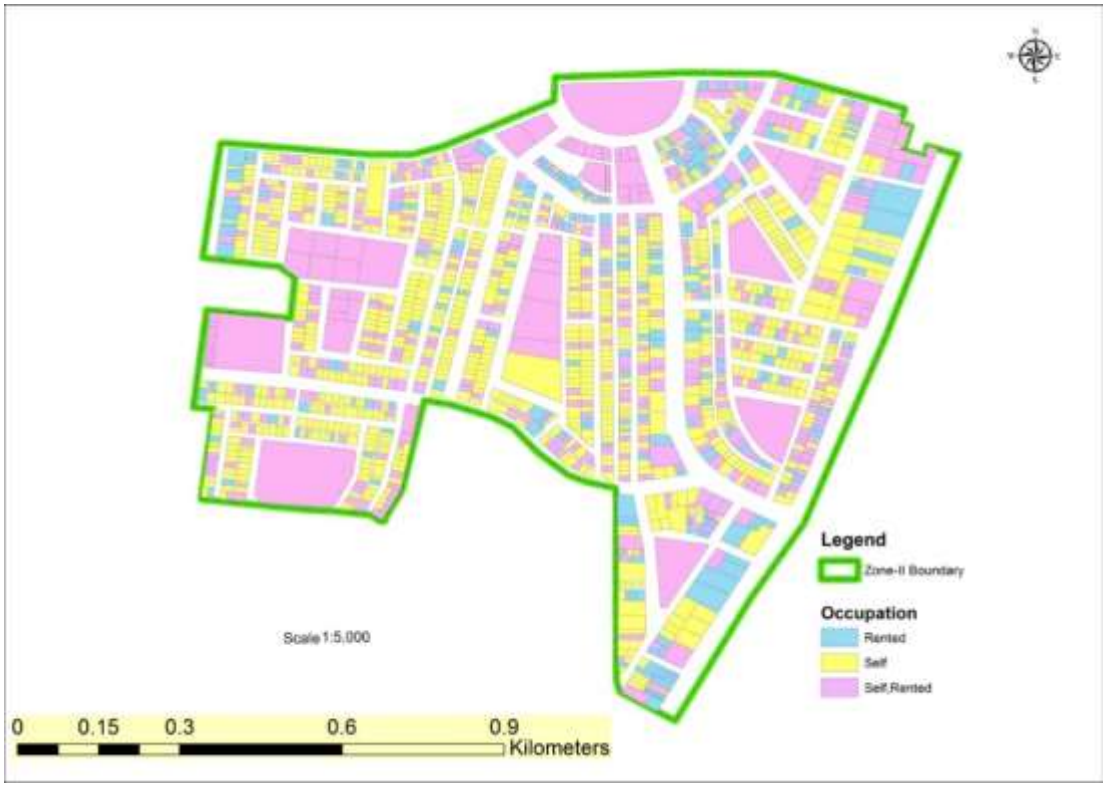

Figure 10: Map of zone-II showing the self-occupied and rented properties

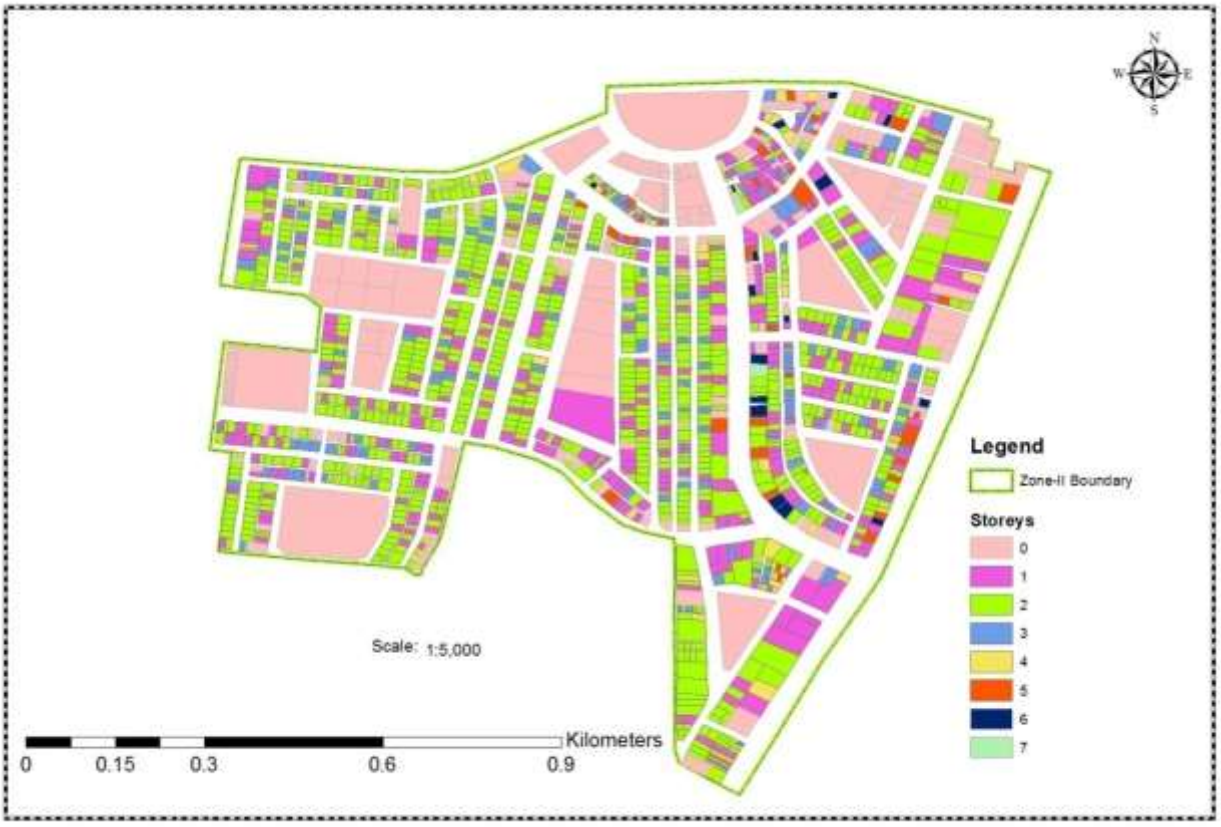

Figure 11: Map showing the number of stories of each parcel in the zone-II

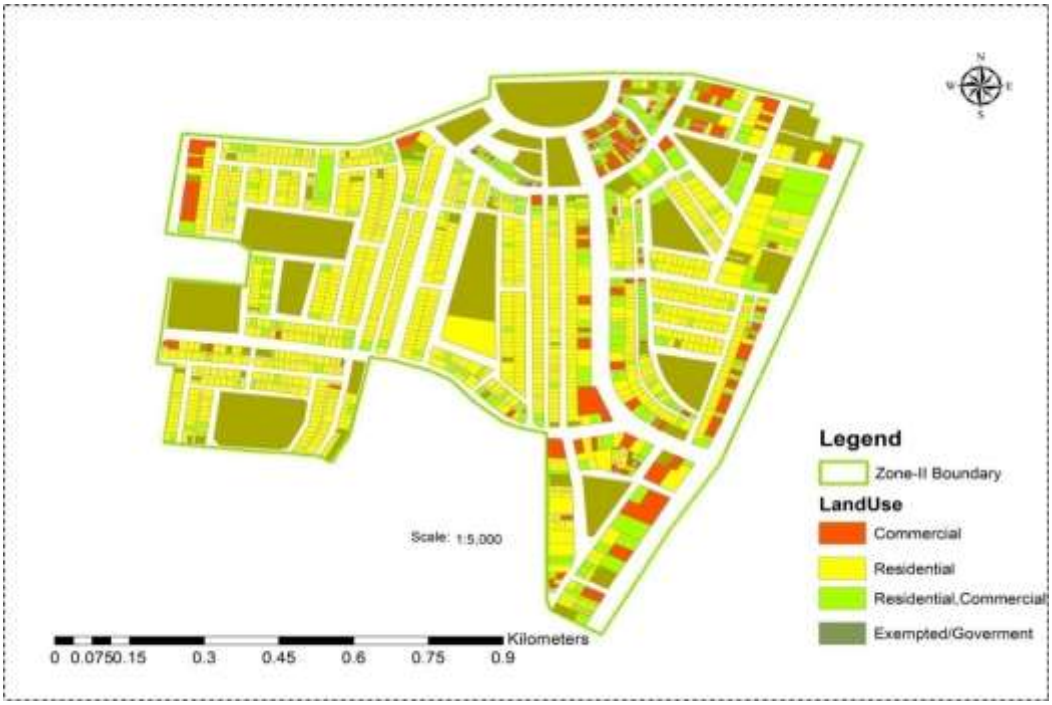

Figure 12: land use map of the Zone-II

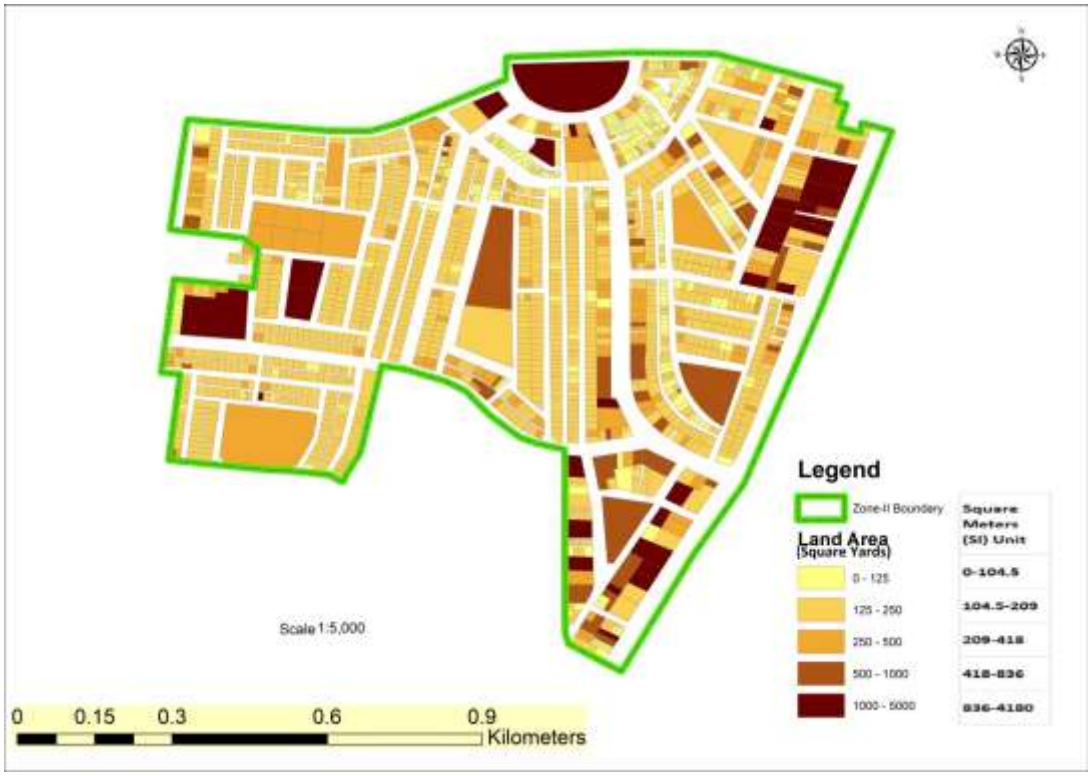

Figure 13: Map of land Area Zone-II showing the land area of each property unit in square yards(local) and square meters (SI)

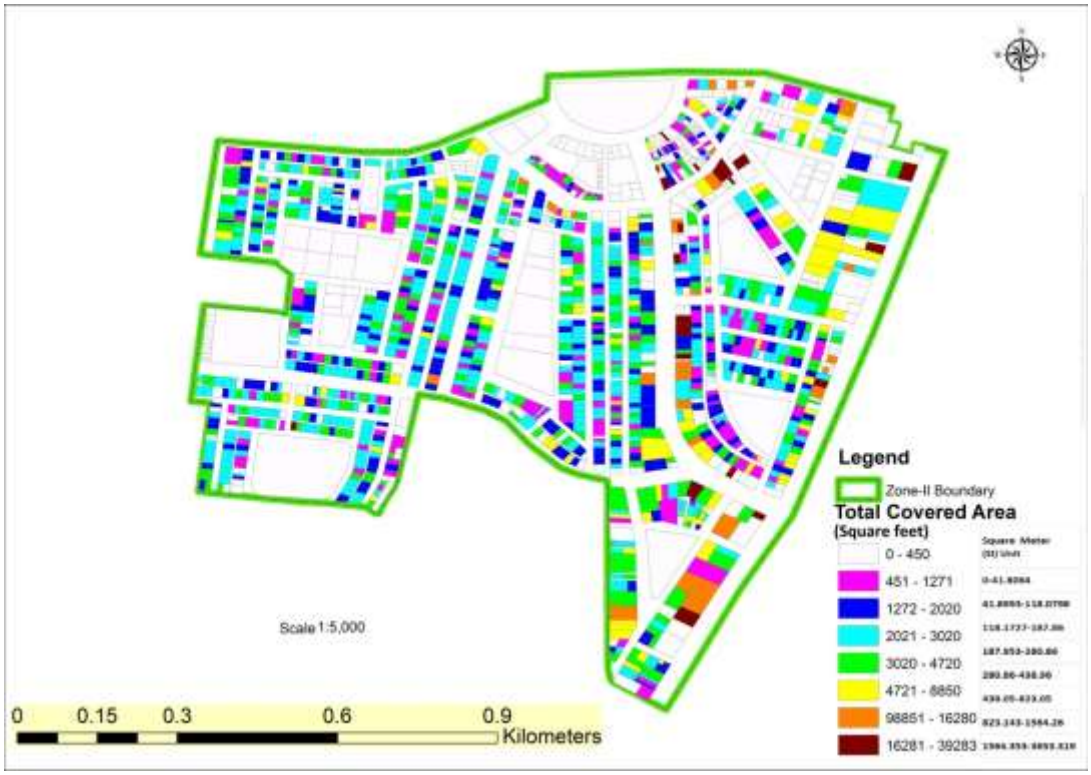

Figure 14: Map of Covered Area Zone-II showing the covered area of each property unit in square feet (local) and square meters (SI)

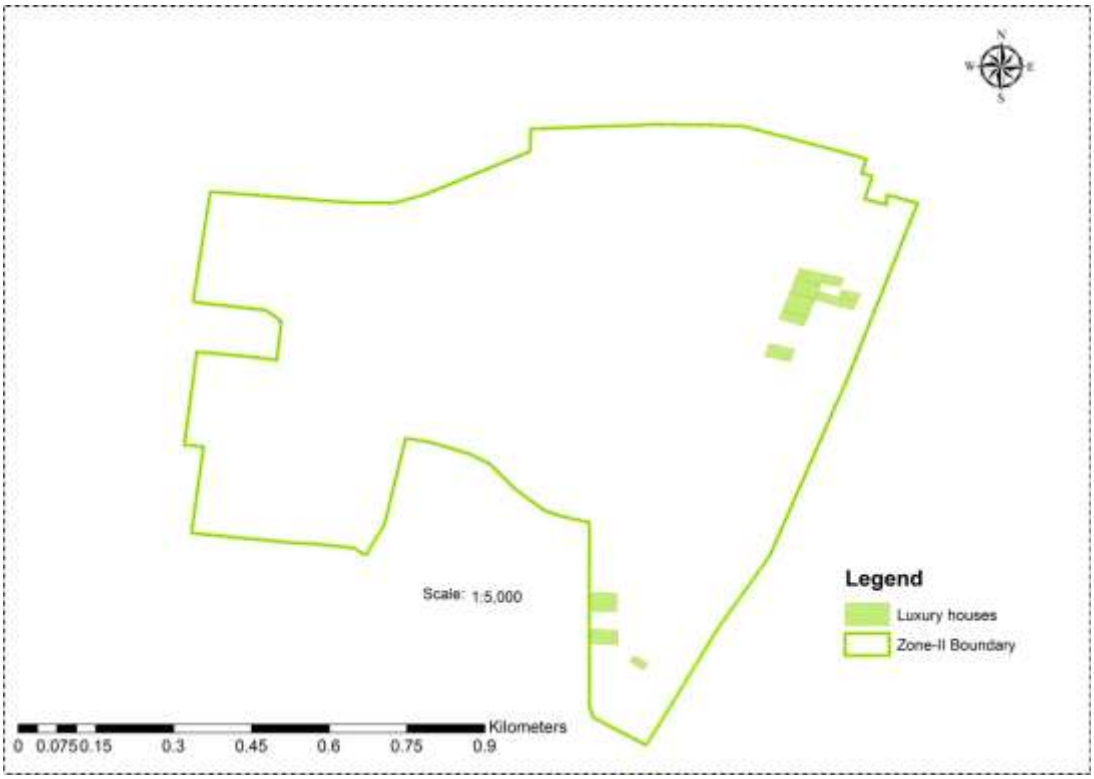

Figure 15: Map of Luxury Houses in the Study Area

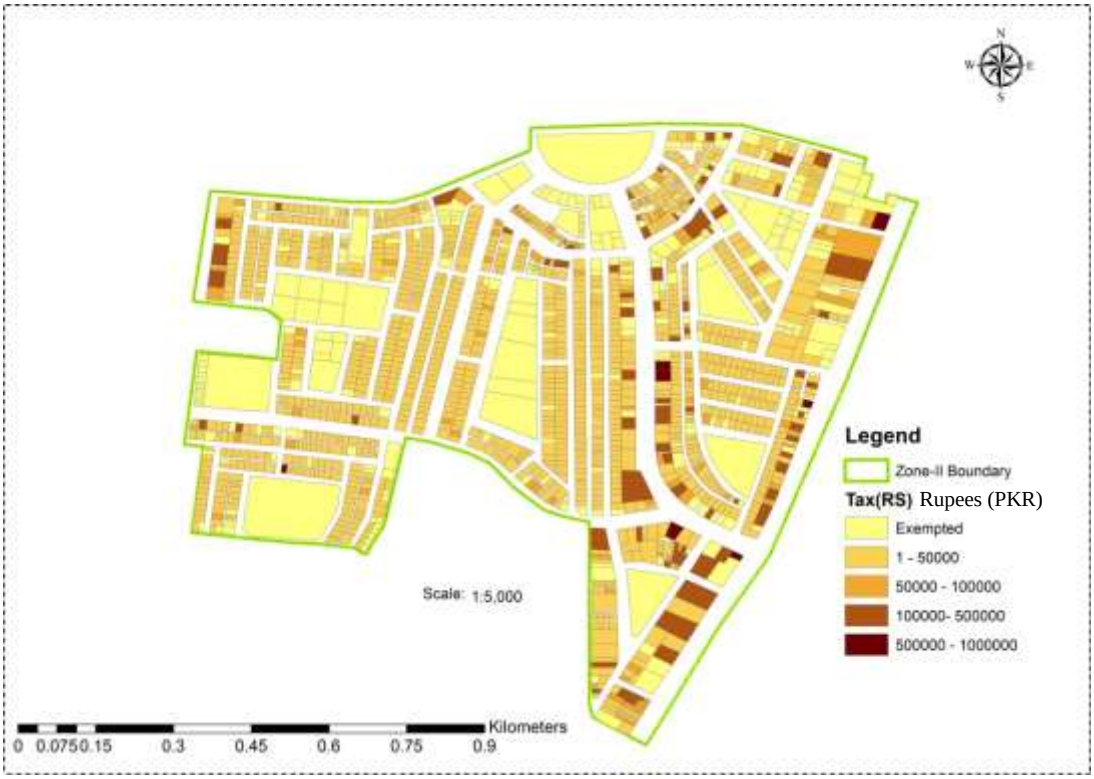

Figure 16: Map showing the categories of the tax (Amount Wise) in Rupees (PKR) of each unit in the Zone-II

Tax-Status Map of zone-II Figure 17: Map showing the tax status of individual property unit. The green color shows units where tax of current year has been paid and defaulters have been shown on the map with red color.

The GIS has proven to be powerful tools in the collection of and tracking delinquent tax payers thus assisting in raising the revenue collect (Birir and Ngigi, 2015).With the help of said list, the tax collecting staff approach/visit the location of each property and consequently, tax dues are recovered. Taxable properties were mapped by attaching attributes of the property tax database with the digitized property units. The integration of both datasets is mostly easy, as I have property number as a common field in both datasets. Based on property number, I join the digitized parcels with property tax database and the relevant information such as owner name, property location, covered area, total area, self or rented etc. is easily copied. The GIS technology facilitates in exposing tax havens by putting it all on a map (1000 GIS Applications & Uses - How GIS Is Changing the World - GIS Geography, 2019). Figure 17 shows the map of taxable property units with green color for paid property units, while, red color for tax defaulters, which identified 425 properties tax defaulters. Instead of wasting time and resources in contacting each property unit owner, only defaulter can be focused for tax recovery. Tax managers can easily direct the staff of the tax department for the recovery of revenue from tax defaulters. The current study has traced out 284 such missing records from the existing property tax system through integration of taxation records and spatial data base with the help of geo-spatial technologies. As a result of identification of these properties amount of government revenue enhanced by 8.45 percent. These properties were un-assessed/misreported.

4.2 Category Detail

Category-wise number of commercial and residential property as per occupation is shown in Table 6. Tax categories are defined and assigned by local authorities from A to F.

Table 6: Count of residential and commercial properties as per occupation

Category	Residential Properties	Commercial Properties	Total
A	2880	2467	5550
B	188	150	238
C	160	28	188
D	120	5	25
E	0	0	0
F	0	0	0

'A' category has the highest tax rate and 'F' has the lowest (as per valuation table explained in Appendix-1). In our study area, the majority of properties fall in category-A while the smallest number of properties pertaining to category –D. Categories E and F don't exist in the study area as shown in table 4. The current study found 254 property units were placed in wrong (lowest tax) categories like B, C, or D which were corrected efficiently through using geo-spatial technologies as discussed in 4.7 section(b).

4.3 Land Area Statistics

Land area is an important factor in tax assessment. Land area is total land or plot size of a property measured in square yards. It is equal to 9 square feet or about 0.836 square meters (SI). Table 7, properties in the study area has been categorized by land area. In our case, there are eight categories of properties by land area. It is clear that mostly property units have up to five Marla's land area and between 5 to 10 Marlas. While only 10 properties have three to four kanals areas and 20 properties have above four kanals areas

Table 7: Land Area statistics

Land Area (Local unit)	Land Area (Square meters) SI Unit	No. of Property Units
Up to 5 m (Marlas)	Up to 126.465	1850
5 to 10 m	126.465 to 252.929	1200
10 to 15 m	252.929 to 379.394	101
15 to 20 m	379.394 to 505.858	85
20 M to 2 k(Kanal)	505.858 to 1011.71	77
2 to 3 k	1011.71 to 1517.57	15
3 to 4 k	1517.57 to 2023.43	10
Above 4 k	Above 2023.43	20

4.4 Building Type Statistics

Table 8 shows that in study area there are two hundred fifty offices, around fifteen hundred shops and more than three thousand houses. There are total twelve different most common building types in our study area. Building type is very important factor in tax assessment because tax rate depends on it as already has been described in chapter-3 during the discussion on assessment of special properties in Appendix 2. Under the supervision of tax authorities, 86 properties building types has been corrected with the help of property photographs, satellite imagery, and field survey result as discussed in section 4.7(d).

Table 8: Building Type Statistics of study Area

Building Type	Property Units
House	3,222
Shop	1,448
Govt Buildings	65
Marriage Hall	10
Office	250
Industry	5
Open Land	27
Educational Institues	45
Hospital/Clinic	35
Mosque	20
Other Buildings	300

4.5 Identification of Hidden Taxable Property Units

Identification of un-assessed and un-authorized properties will be done through new technology of GIS to bring them into assessment and to maximize coverage of properties into tax net. (Urban Immovable Property Tax | Excise, Taxation and Narcotics Control Department Khyber Pakhtunkhwa, 2020).

Missing property units are those which do not exist in the Excise and Taxation record due to staff corruption or lack of knowledge. I found an interesting matter that upon joining the digitized and survey verified parcels with attributes of property tax database mostly parcels were joined correctly but a few of them was missed. Upon investigation, I came to know that there was a couple of properties which existed on ground but missing from Excise and Taxation record.

The GIS integrated property tax system facilitates to trace out properties that have not been registered and not appearing in the tax records. The officials will be able to identify the unaccounted/unregistered properties and so serves as a check on updating of transacted properties due to subdivisions of land parcels and erection of buildings. The updating of property is made easy in the system (Birir and Ngigi, 2015).

The records have been highlighted in maps as shown in Figure 18, so that tax officers may guide their staff properly for tax collection. GIS technology is a smarter way to detect the missing properties as it facilitates capturing, storing, analyzing, visualizing, and managing geographical data related to a property. The GIS provides an accurate measurement of the spatial extent of a property. It can show different kinds of data on a map. Moreover, it provides a real picture of reality and validate each record on the property tax system on ground. When applying the join between the existing property tax data base and parcel mapping, the missing properties are automatically highlighted in the study area. The process of comparing the land record with satellite image is a hectic task and requires a considerable time period, resources, knowledge and, data from multiple sources.

4.6 Identification of Tax Defaulters

The GIS technology could enhance the revenue collection mechanism for Government authorities, whether it is property tax, utility bills (water/electricity/telecom), or municipality tax. A GIS-based database will bring the defaulters under the tax net and help increase revenues of the corporation (GIS simplifying property tax collection in India - Geospatial World 2012). Hence, it provides an efficient, easier and improved mechanism to monitor taxation processes and identifies defaulters. Visualization and spatial analysis identified tax defaulters and the staff was briefed about their spatial information which enhanced taxation recovery in the study area. The property units having nil (zero) balance were considered as clear units, however, those having pending tax amount (greater than zero) were considered as tax defaulter. This information was also attached with GIS system from property tax database attributes through join the datasets.

The GIS integrated property tax system facilitated easy identification of the spatial location of tax defaulters and non-tax defaulters. The tax collectors can use the spatial location to physically locate the tax defaulter. It will also enable them to easily know how much the tax defaulter owe the sub county (Birir and Ngigi, 2015).

This map will be helpful for tax officers to track down tax defaulters as each parcel has been displayed. Through visualization and analysis of thematic map tax collector can detect spread pattern of tax defaulters and make efficient route planning for recovery of tax dues from the defaulters. Based on the route planning, the staff can locate tax defaulters with high accuracy instead of wondering in the field. Hence stipulated time period and resource can be utilized and tax dues from defaulters can be recovered. The pattern of the tax defaulter shows that in most of cases the defaulters exist along the road and properties are commercial type. The most of these property defaulters are found due to court case, ownership transfer cases, issues between the owner and tenant and owner out of city/country.

Table 9: Tax Defaulters and Tax Paid Detail

Tax Status	Property units	Amount (Rupees) (PKR)
Tax Paid	2033	67308287
Defaulter	1325	11763425
Total	**3358**	**79071712**

4.7 Monitoring and Evaluation of Property Tax System

4.7(a) Land Area

Land area is an important factor in tax assessment. However, without parcel mapping, its measurement is not feasible. Property unit in the commercial area (of whatever size) is taxable while in a residential area it may be tax exempted if less than 150 square yards. Usually, taxation staff reported some property units too large while others too small due to corruption. Moreover, owners revealed the lesser size of his/her property to avoid tax; however, I measured the land area of the property through parcel mapping of remotely sensed data in a GIS environment. Few of the measured properties were verified through ground reality by surveyor for accuracy assessment. The present study has found a number of tax liable properties for which earlier tax was exempted.

The spatial support of the GIS for the area based tax calculation will help the management to assess the tax more accurately than the manual (Wyatt, 1996). Figure 19 shows property units in the form of a map, which clearly shows that most commercial properties or property units on the main road were reported smaller. From the map, it can be concluded that I have to focus on commercial property units as their tax rate is higher and their areas were reported wrongly. This correction greatly enhanced the revenue by 7.4 % per year.

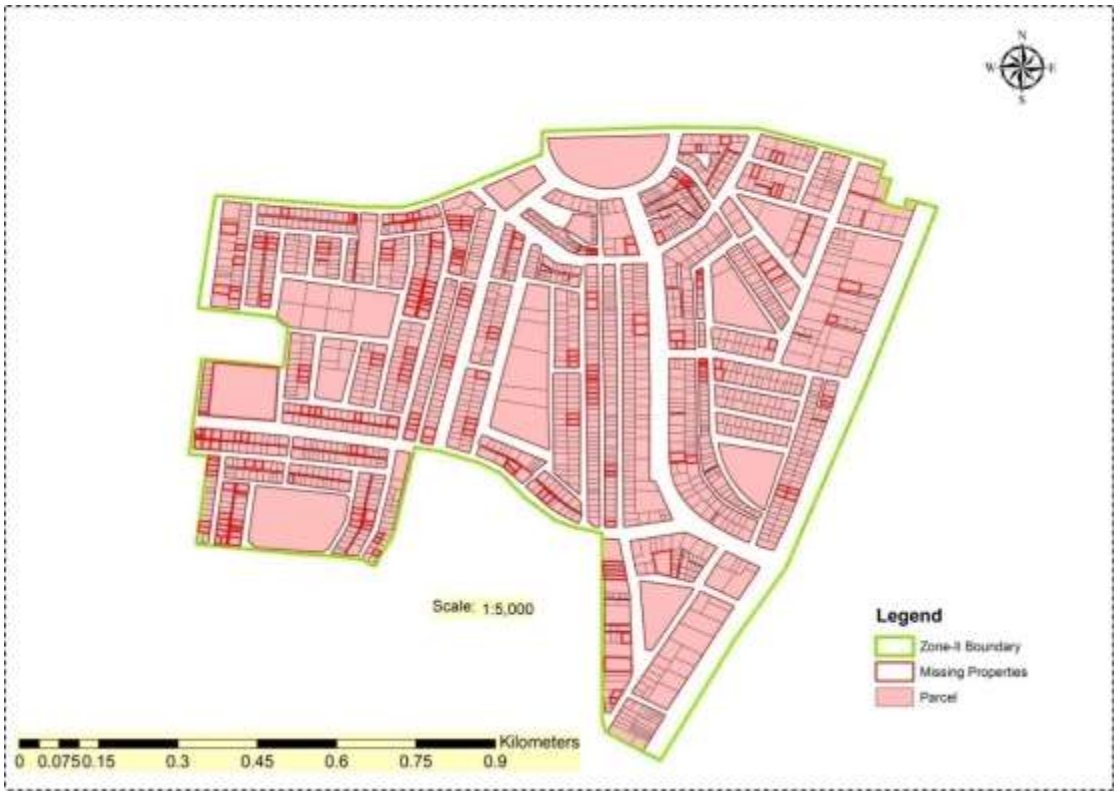

Figure 18: Map showing Hidden and Missing Properties in the Study Area

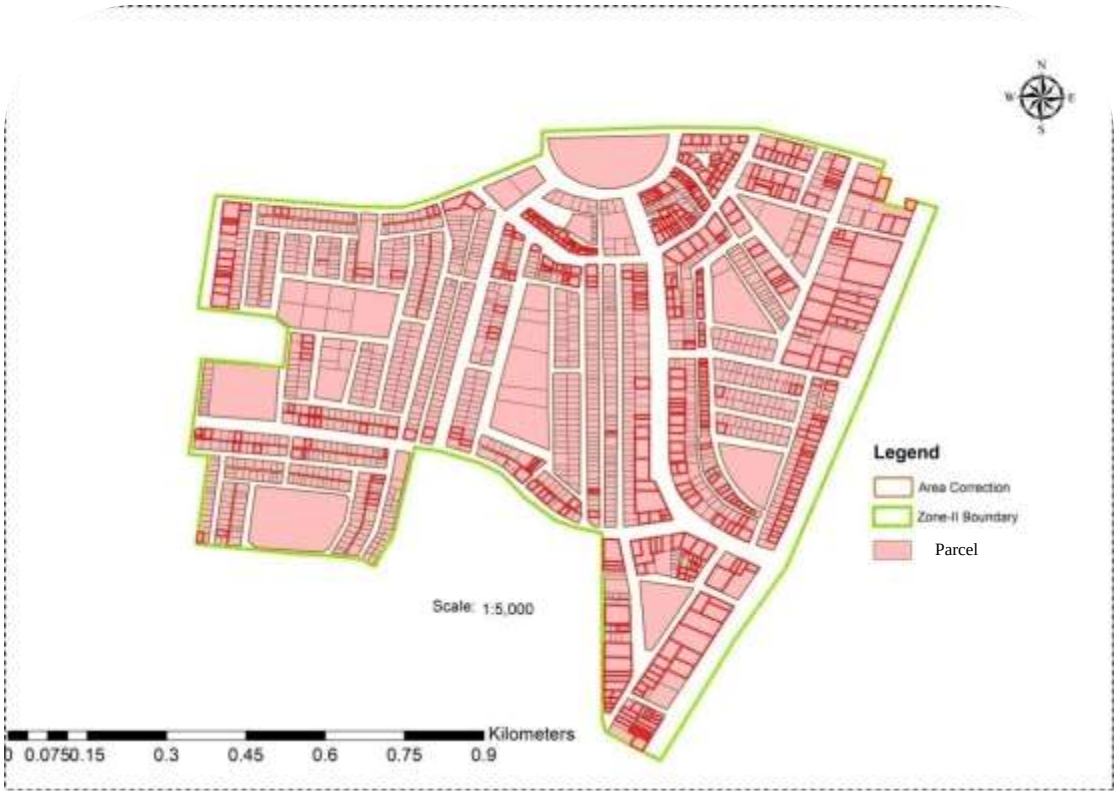

Figure 19: Map showing the area correction of individual property unit.

4.7(b) Tax Categories

Tax categories defined by local authorities are A to F; where 'A' belongs to the highest while 'F' is the lowest tax rates. Through visualization and analysis of thematic maps, tax categories for each property unit in the locality can be monitored and corrected easily. The conventional excise and taxation system usually misclassifies information of tax categories as shown in Figure 20 mistakenly or intentionally.

The integration of GIS with property records better enables the selection of a specific location on a map (GIS and Land Records Integration A PRIA White Paper 2017). Figure 20 shows the categorical map of property units based on attributes of Excise and Taxation records. This figure evidently expresses that the same road or locality having property units from category A while other property units besides category A were placed in category B. Similarly, corrections were performed for categories B, C, and D. It means that the category of properties had been changed intentionally or mistakenly. The anomalies and inconstancies in the tax categories can be rectified by visualization and analysis of the thematic map. Under the supervision of relevant authority rectification of these wrong tax categories to category A, B, C and D was done which enhanced tax revenue by 7.56 % per year.

Figure 20: Map showing misclassified information of tax categories before correction.

Figure 21: Tax categories map of property units of zone-II after corrections

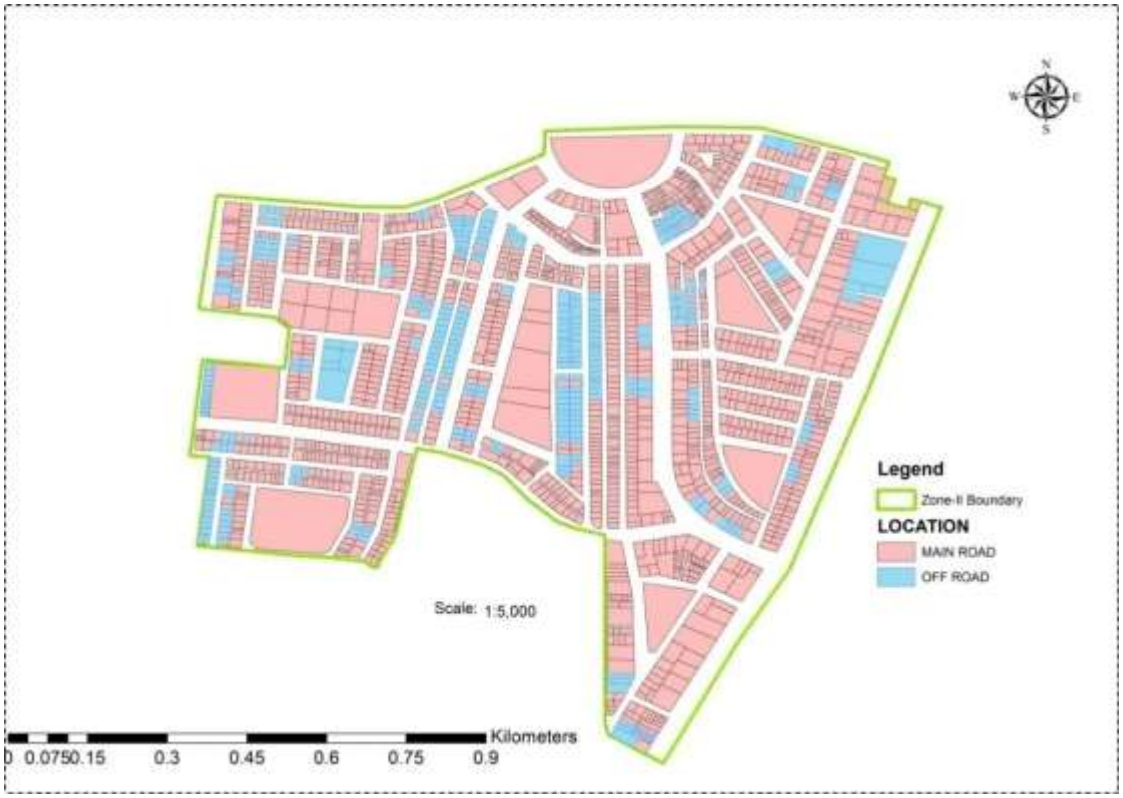

Figure 22: Map showing the location information misclassified main and off-road properties

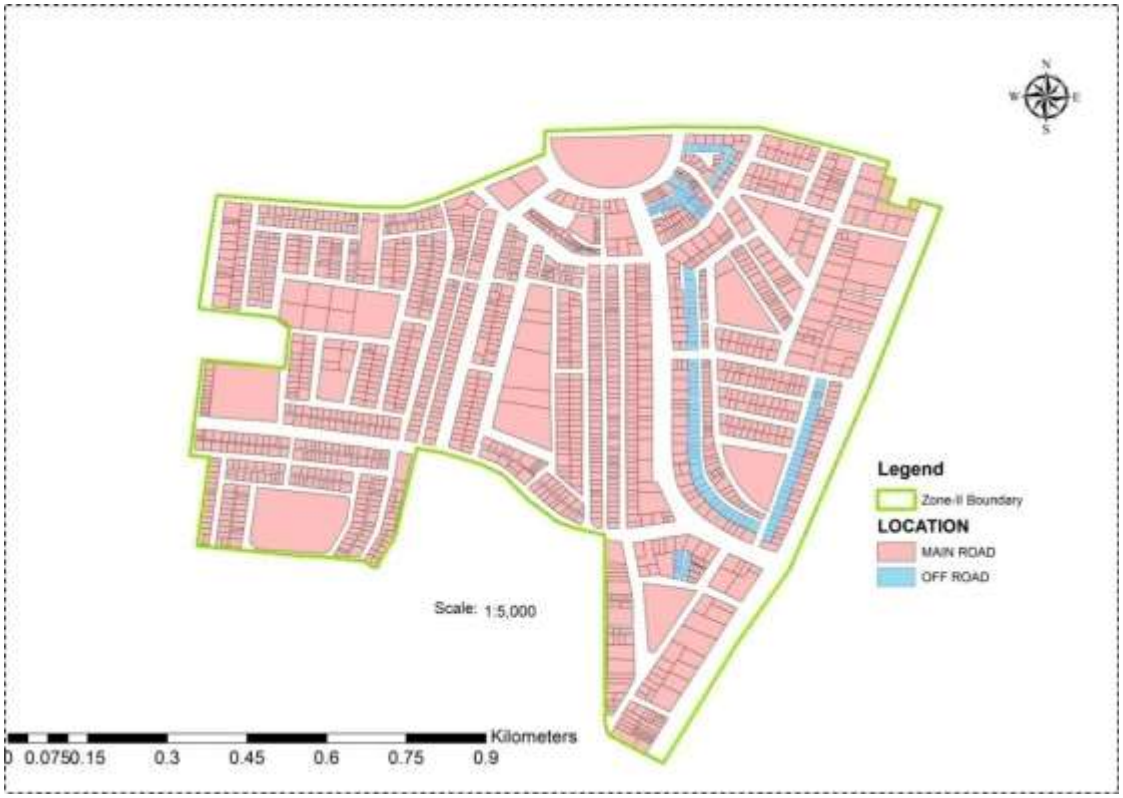

Figure 23: Map showing the corrected location information of property units after rectification (Main /Off Road).

The current study found many property units were placed in wrong (lowest tax) categories like B, C, or D which were corrected efficiently through using geo-spatial technologies. The map of property units along with correction their categories are shown in Figure 21.

4.7(c) Main Road /Off Road

Main Road is wider than 30 feet while Off Road is narrower and properties on the main road had a 15% higher tax rate as compared to off road's properties. The conventional excise and taxation system usually misclassifies main and off-road properties as shown in Figure 22 mistakenly or intentionally. The GIS and remote sensing can precisely and easily measure the road width to access main and off-road tax variable factors for property units.

The existing excise and taxation record contained narrow road width due to the corruption of staff as well as the lack of updating. Moreover, property owners do not reveal whether their properties are on the main or off road correctly. During the present study, the road width was measured in ArcGIS software by using high resolution satellite imagery. Figure 23 shows the main and off-road categories after correction from the current study. Apparently, there is no chance for someone to hide the category of property units or main and off-road categories.

4.7(d) Building Types

The GIS technology is helpful in catching tax evaders by recognizing the potential area of tax revenue such as banks, offices, halls, shops, petrol pump, hotels, hotels or industrial units (1000 GIS Applications & Uses - How GIS Is Changing the World - GIS Geography, 2019). Tax criteria and rates depend on building type which may be residential, commercial, godown, workshop, educational, hospital, cinema, halls, petrol pumps, or industrial units. For example, hotels have different tax rate which depending upon the type as well as the number of rooms.

However, land-use and building type determination are nearly impossible through remote sensing imagery. Hence, during the current study, I followed field survey through GPS for mapping of building type or building use. This will further assist in the tax collection and monitoring system. The tax department staff misreported the building type of many buildings as result the government lost tax revenue. For example, some banks, shops, offices, a hotel which are commercial units and have high tax rates were reported as a residential house (lower tax rate). Due to the wrong building type, the residential rate (lower tax rate) will be applied to these properties and government revenue suffers. Under the supervision of tax authorities, building types have been corrected with the help of property photographs, satellite imagery, and field survey results. The current study found many property units were placed in the wrong building type like residential which were corrected efficiently. As a result, a considerable amount of government revenue enhanced 2.56 % per year.

Figure 24 shows the map of individual property units where the building type was incorrect. The rectified map of building types has shown in figure 25. This map helps us to identify where shop, bank, institute, or residential building located in the study area.

4.7(e) Building Stories

Tax rates depend on a number of stories in a building which may either be single, double, triple or multi-story building. According to the Excise and Taxation Department, Standard Operating Procedures (SOPs) a building is known as a plaza if it has more than four storey. Furthermore, plaza and ordinary buildings had different tax rates. Because of this reason and their personal interest tax department staff reported some of the multi-story building as an ordinary building type.

During the present study, I distinguished and mapped plaza from ordinary buildings as shown in Figure 11. This figure shows that plazas had more than three stories which are situated in Commercial areas. This further indicates that plazas are most important for revenue collection in taxation system. This information is based on the collected data by the tax department.

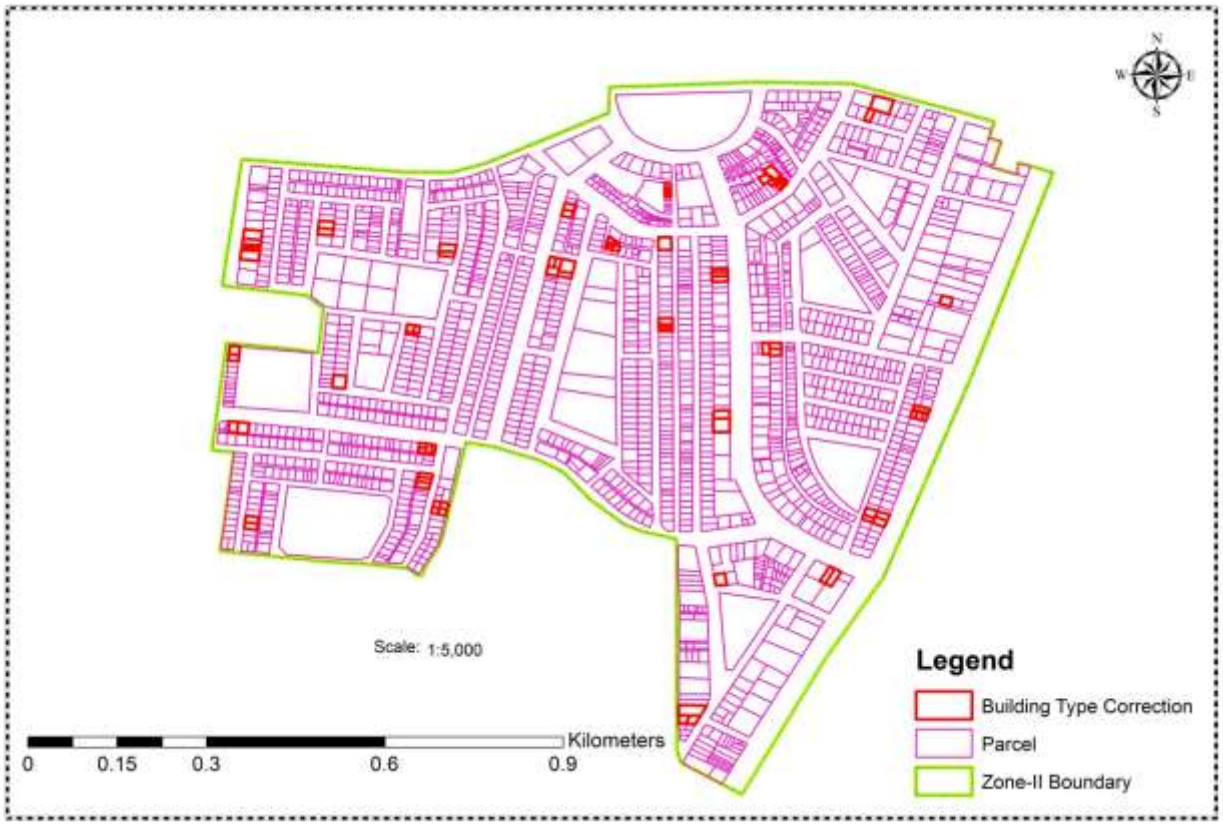

Figure 24: Map showing misclassified information of Building type

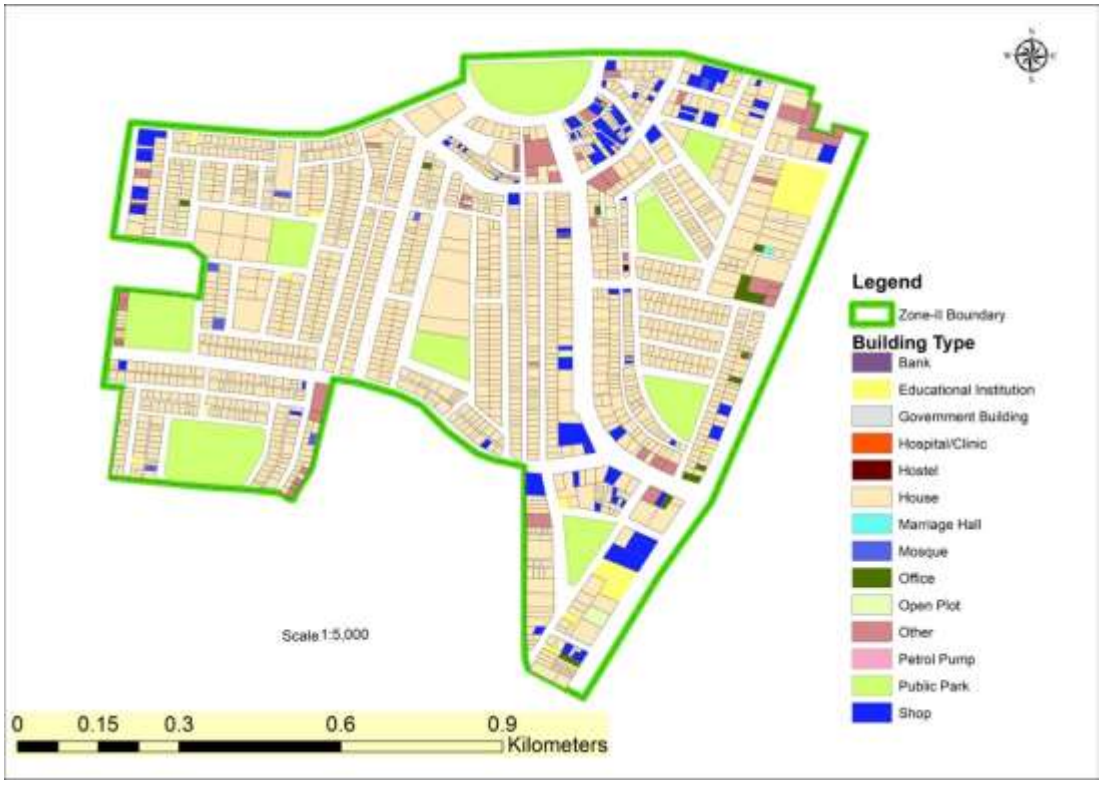

Figure 25: Map showing the rectified building type of individual property unit after corrections.

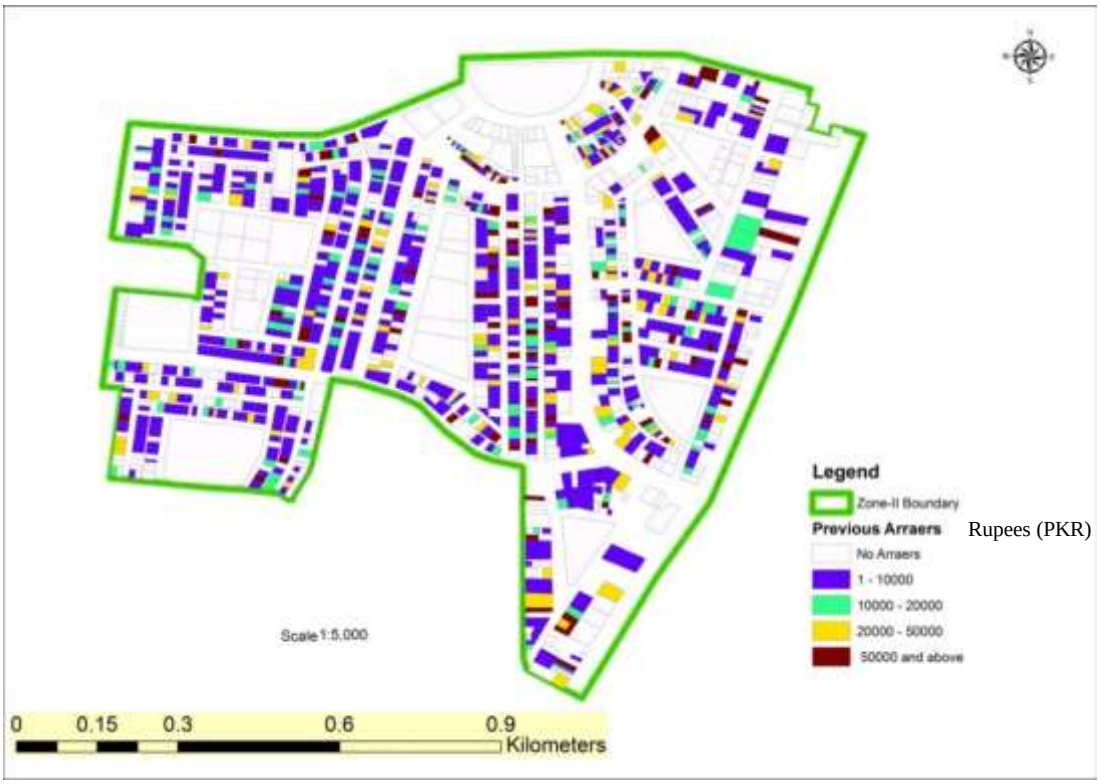

Figure 26: Map showing the arrears detail of property unit (Total balance/ outstanding dues since 2014–Overall)
The Arrears amount is total outstanding dues since 2014 because every year the arrears of each property are brought forward in the total balance or total accumulated amount unpaid (due) as on 1st day of new financial year.

Plazas/multistoried buildings can be identified using RS and GIS technology. The property photographs are attached with each property unit and which helps to detect the number of stories. Under the supervision of tax authorities, many properties stories have been corrected with the help of property photographs, satellite imagery and field survey results. As a result, a considerable amount of government revenue enhanced by 1.48 % per year. Plazas/multistoried buildings are the hub of business activity in the area and contain a large number of commercial units like shops, offices, banks, shopping malls, and showrooms etc.

Furthermore, commercial units are the important source of revenue collection in the excise and taxation system. Because commercial properties have five times more tax rates than residential or others. Therefore, the property tax recovery from plazas/ multistoried buildings can boost up the tax revenue. Tax departments incorporate all the changes and perform standard tax calculations on all properties. Then the result is derived from the impact assessment (increase/decrease in tax demand) of the respective properties.

4.7(f) Previous Year Tax Arrears

Tax arrears are the pending tax money from the previous year. It is really important to determine for which property units tax arrears are pending so that tax collection may be preceded. Property units having property tax arrears in previous financial years were identified on a map through attributes data as shown in Figure 26. This map truly guided the relevant excise inspector (tax collector) that which property unit or owner should be approached first for tax collection.

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Chapter-5: Discussion

5.0 Brief Note

The GIS could help monitor the property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, the total covered and a land area of each building, individual plot areas, details of locality, and road facing details with the applied tax calculation principles (Pareta, 2017).

The current study addresses the vital research questions of how to map property units along with attributes in the study area? How to monitor, enhance, rectify and evaluate the property tax system? To investigate these research questions and improve the management of the property tax system, spatial analysis, visualization, measurement, integrating properties in the field with property tax office record, analysis and rectification of property tax assessment factors with the applied tax calculation principles have been performed. The following discussion addresses the key findings of the study for each of these research questions, followed by the discussion of study limitations and recommendations for future research.

5.1 Financial Impact

The GIS based property tax system was implemented in 2014 which had streamlined the process of property tax collection. The tax revenue was considerably enhanced through the correction of property tax assessment variables and data. Precisely spatial identification of current tax defaulters and arrears of previous years accelerated tax revenues. Furthermore, the use of geo-spatial technologies such as remote sensing, GIS, and GPS brought transparency which further eradicated corruption in the property tax system.

The GIS enabled up to property parcel level for better tax administration, because of which additional properties are brought under Tax net for creating thematic maps such as land area, covered area payment status, land use, building types, property occupations type and number of stories etc. For the tax officer, it is most convenient when these maps can be accessed within the tax administration system (Practitioner's Guide: Digital Tax Parcel Mapping. 2009). The tax recovery in the study area increased by the implementation of following steps (1) implementing the GIS and RS to monitor and evaluate property tax system, (2) property mapping, (3) data integration, (4) different corrections (missing properties, property size, location, tax categories, building type, number of stories etc.), (5) locating the tax defaulters (current and arrears) where they are geographically located, (6) visualization, analysis.
Anomalies in the property tax system were identified and rectified with the help of GIS and RS. As a result, the government tax revenue increases almost twice.

The efficiency of the tax collection system is increased due to the implementation of GIS and RS in the study area. The collective effect of these measures will resultantly accelerate the tax revenue. Other factors are on an increase in tax rate by the government every year. The tax recovery of Zone-II from finical year 13-14 to 15-16 has been shown in figure 27. The recovery progress of zone-V has been shown in Figure 27 for comparison where GIS and RS technologies were not implemented. Zone-V has almost similar features and challenges as in zone-II as shown in Table 10 below. Therefore, I selected the zone-V for the comparison with study area. The calculation is based upon the difference between manual tax record and the current tax record of the properties in the study area after implementation of GIS and RS. The entire business rule related to tax calculation is collected from the tax department. Tax department staff incorporates all the changes and perform standard tax calculation on all properties. Then the result is derived from the tax impact (increase/decrease in tax demand) of the respective properties.

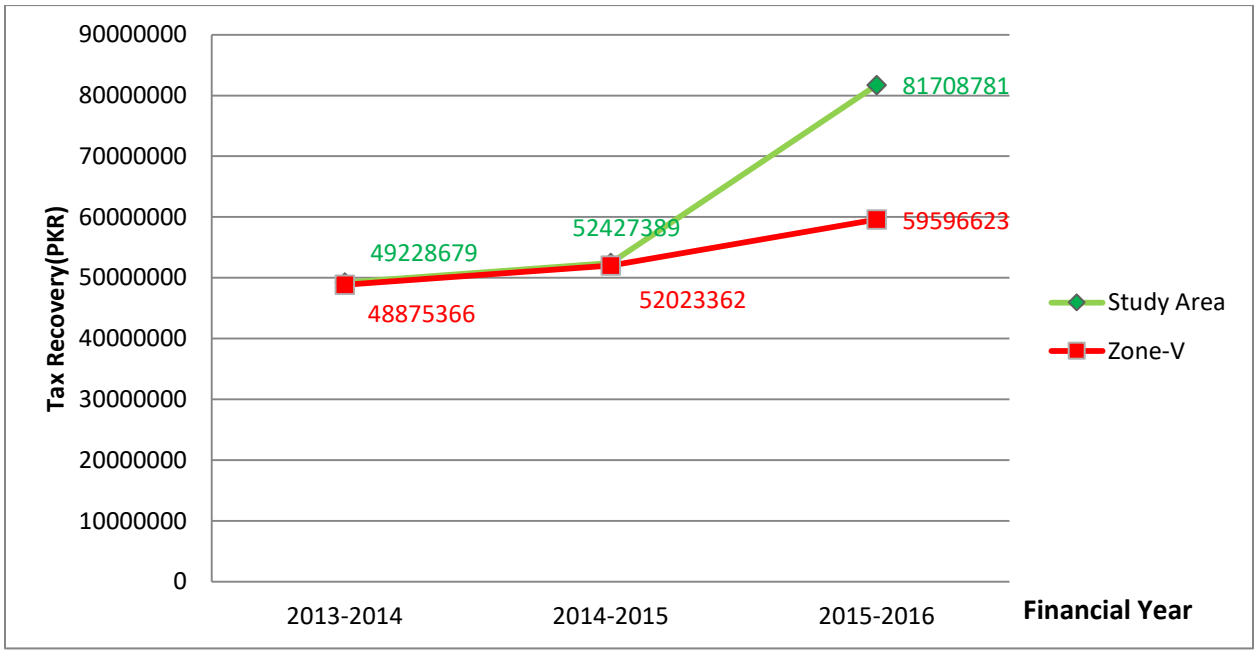

Figure 27: Showing the Year wise Recovery of Zone-II in Rupees (PKR).

*__Study Area__: Represent the study area where GIS and RS techniques were implemented.

*__Zone-V__: is an area/zone where GIS and RS technologies were not implemented.

After incorporating all the changes and then performs standard tax calculation formulas on all properties. The financial impact statement is collected form the tax department staff which is based upon the tax impact (increase/decrease in tax demand) of each property. Note: The GIS based property tax system was implemented in 2014.

Increased tax revenue by updated property and tax related attributes, adding new construction records, and integrated departmental data into a single property tax information and management system (1000 GIS Applications & Uses - How GIS Is Changing the World - GIS Geography, 2019).

Table 10: Comparison of Zone-II & Zone-V

Name of circle	Total properties	Taxable Properties	Exempted Properties	Tax Demand (Rupees) PKR	Nature	Properties Type	Area
Zone-II	3358	2933	425	53427389	Urban Area	Residential/Commercial/Plaza	1.65sq km
Zone-IV	3250	2780	470	52023362	Urban Area	Residential/Commercial/plaza	1.76Sq km

It shows clearly the difference in tax recovery of both the zones from finical year 13-14 to 15-16. The amount collected for tax recovery of zone-II is much higher than Zone-V where GIS and RS have not been implemented. The summary of correction type with finical impact is shown in Table 11 below:

Summary of Financial Impact

Table 11: Summary of Correction and its Financial Impact

Sr.No	Correction Type	Total Properties	Number of Property Units	Correction (%)	Total Financial Impact (Rupees) PKR
1	Hidden/ Un-assessed Properties	3358	284	8.45	5505550
2	Building Type		86	2.56	3,112,000
3	Land Area		426	12.68	35,20,000
4	Location (Main/Off)		250	7.44	3,050,500
5	Multi stories/Plazas		50	1.48	2550500
6	Residential /Commercial		163	4.85	3,053,500
7	Tax Categories		254	7.56	2556000
8	Self/Rented		102	3.03	3,223,500
	Total	**3358**	**1615**	**48.05**	**23051550**

The overall economic benefits of this development are high as tax revenues increased and improved access to information led to increases efficiency and better decision-making in the public and private sectors.

Major differences between the current and previous system, which contribute to increase the efficiency and productivity, are stated below.

Property tax mapping: One of the most important need of tax officials is addressed in this study, is mapping of the taxable and exempted properties within their area of jurisdiction. It helps them to identify the potential revenue sources, taxable and exempted properties. Property tax mapping establishes the link between the real properties and locates them in the field with property tax detail in the office with attached digital photographs.

Property Tax assessment and Monitoring: The current study also improves the assessor's judgment and consistent efficiency of the taxation process through geo-spatial technologies. This study enables tax officials to monitor property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, total constructed area of each building, individual plot areas, details of locality, and road facing details with the applied tax calculation principles. Tax assessment variables such as land area, tax categories, main-off road, building types of the properties are monitored and updated with the help of GIS and remote sensing techniques resultantly system efficiency, productivity, and transparency are improved. Hence, it is very difficult for anybody to steal government revenue by the use of unfair means. This improves the property tax assessment, monitoring and eliminates the corruption in the property tax system, resultantly, an inspection of the properties can be easily done with limited staff.

Identification of Defaulters: Through visualization and analysis of the thematic map, the tax collector can detect the spread pattern of tax defaulters and make efficient route planning for the recovery of tax dues from the defaulters. It is, therefore, tax recovery process was accelerated through real time, accurate, and updated data.

Visualization and Reporting: Comprehensive geo statistical reporting along with visualization and thematic maps enable the government to identify the potential of revenue collection. Based on the route planning, the staff can locate tax defaulters with high accuracy instead of wondering in the field. Visualization enables the tax officials to identify the unregistered properties in the study area and so serves as a check on updating of transacted properties due to subdivisions of land parcels and erection of buildings. The excise department now manages and evaluates the limited staff efficiently in a productive way and evaluates their performance with the help of visualization.

Transparency: All the property tax data is available publicly on the map integrated with property details and attached digital photographs of the properties. The transparency of the property tax system and the public trust is improved on the property tax system. As a result, the public is more enthusiastic to pay property tax.

All the forms, files, registers, and records being used in the assessment & collection of UIP Tax are manual and based upon paper work. On one hand the data present in these forms/files and registers is unreliable, on the other hand the Government has to incur huge costs in maintaining and managing separate registers, files & forms. A very conservative estimation is that it costs almost 600 million rupees if such a manual record is managed in the whole Punjab province. This includes the procurement, managing cost coupled with the implementation and maintenance cost for the manual paper-based system.

5.2 Web Mapping

Web mapping is a technique to publish GIS data on the web and make it accessible globally via the internet. In this research, map is published on web while using open source technologies like QGIS and Geo server etc. Geo server is an open source server for sharing geospatial data. The server is designed for interoperability; it publishes data from any major spatial data source using open standards (GeoServer, 2017).

Creating a web map is a very different process than creating one in a GIS. The GIS users are not typically web programmers and it presents a challenge when one needs to create a web map that is of the same quality as a map creating in a GIS. Fortunately, there are tools available to easily translate your work in QGIS to web maps (Web Mapping with QGIS2Web — QGIS Tutorials and Tips. 2019). Figure 28 shows the property tax mapping of the study area on the web. Everyone can easily access, view, and search the property tax data using this web based technology. This has also brought transparency in the property system.

Figure 28: Web mapping of Study Area

In many developed countries like Canada, Netherlands, Sweden, United Kingdom etc. the property tax system is implemented on the same methodology. Many of the underdeveloped countries are still using conventional and manual systems of property tax management and assessment. However, some underdeveloped countries like India, Pakistan, Kenya, Liberia etc. have adopted this system as a prototype in some major cities and have gained unprecedented success in terms of increment in revenue and computerization of conventional and manual techniques. Resultantly, they are taking a keen interest to expand this system to their whole countries to increase monitoring standards and government revenue and tax collection.

5.3 Difficulties, Problem, and Issues

The existing record found in the register was in very bad condition. In order to get the manual record, one has to be in touch with the staff of the tax department. However, there is a lengthy procedure to get this record as it involves application, approvals, and verification at different levels. After getting all the approvals and verifications, access to tax department data was allowed. The next step was to understand the manual record. The data is on a paper register which is not standardized. In this study, the whole property tax system and standardization of the data were understood by the researcher. This was also achieved with the help of tax department staff.

The next step was to create a property tax database system on Microsoft excel. After getting the old record written on the paper register, it was very difficult to understand and transfer the information on excel as these were not in good shape. Anyhow, after understanding and with the help of tax department staff, data entry of the property units was made from the paper registers and a database of the property tax record of the study area was created. This step is meant to acquire the satellite imagery of the study. For this purpose, several government and semi-government organizations were contacted. After a long struggle, conversations, applications, and verification, it was made possible to get the satellite imagery of the study area from the Government of Punjab for the study purposes.

After getting the satellite imagery, the boundary of the study area was marked with the help of the tax department. In this boundary demarcation, several difficulties were faced in boundaries demarcation which again needed a lot of verifications on the grounds. In the field, the property number is in different formats and some properties overlap with other neighbor circles. In many streets, property number does not follow any sequencing and in some properties property number not mentioned. These issues have been resolved in the field with the technical support of the property tax staff. For defining the boundary of the study area, the relevant properties of the area were included. This phase will involve the active participation of tax officials for providing the spatial extent of a region, zone or circle. Therefore, localities and many other properties in the study area were verified. On the ground, property verification number, property bills, and other necessary information were verified.

Tax mapping is a classical method of field operations for identifying real property units (Pareta, 2017). After the demarcation of zone-II boundaries, digitization will be performed on satellite imagery to acquire unique urban features on the ground. In terms of GIS, every unique entity on ground is known as a parcel, which has an area, a spatial reference and a unique id, whereas in terms of tax, it is regarded as a property unit. Thus, every parcel of the study area was digitized. So, when the parcel mapping of the study area was made ready, a sheet for the field verification was prepared. For indexing, the study area, A3 sheets for the field verification were prepared. Thus, for the field verification, property to property verification on the ground was required.

After the digitization phase, a door to door survey was be carried out for each zone. The maps was prepared and provided to the surveyors for mapping the location of the property units with the help of tax department staff. At this stage, only attributes was involved the land use (Commercial, residential or both), property number and ownership status etc.

The main problem emerged in the field when it was understood that the property number mentioned on properties is entirely different from the property number in the tax department record. The tax department has its own numbering system and the property number is not mentioned on most of the properties. So, the researcher could not get the property number from the field.

Door to door survey will be conducted to take the photographs of property units and integrate them with the GIS. Therefore, the tax department was requested to provide the relevant staff for the property identification. The tax department staff work daily in the field and had the idea of numbering and sequencing as they are working in the study area for quite some time. After several requests, the researcher was made able to get the support of tax department staff and started work again in the field for marking the property number on the survey sheets. The tax department has shortage of staff and spared very little time for us. It is due to this reason; the field work took long time. After completion of field work, the survey sheets were geo-referenced with the satellite imagery. After geo-referencing of all the survey sheets, the property unit number of every parcel on the attribute table was updated.

The unique parcel identification number links the mapped parcel polygon with the tax data base (Practitioner's Guide: Digital Tax Parcel Mapping, 2009). The upcoming step was to link the GIS and property tax database. During this final stage, all the spatial data containing land use information was linked with the excise & taxation department. Every property unit would be possible to be seen as a packet of property tax records along with a pictorial view. During this step, it was found that the property number on the property tax database and GIS was not in a standard way. Therefore, the researcher has to study the property tax numbering mechanism of the tax department and standardized the property numbers on the property tax data base and GIS. The standardization of data was very important for linking GIS and property tax data. By defining the same format and pattern for attributes in the GIS and the property tax database the standardization of data was achieved. After the standardization, property tax data base and GIS and data were linked together. Geospatial technologies integrated with databases offers an effective tool for easy assessment and management of corporation property taxes (Wyatt, 1996).

5.4 Summary of Discussion

- Geographical Information Systems have proven power tools in the collection of taxes and tracking delinquent tax payers in assisting and raising the revenue collection. The tax information system has provided an interactive link between real property and office records and can facilitate tracking of the property owners through the use of handheld GPS. Visualization, statistical analyses and thematic maps are useful to identify the potential of revenue collection, planning, and policy making decision purposes. Through visualization and, analysis of the thematic map, tax collector can detect the spread pattern of tax defaulters and make efficient route planning for the recovery of tax dues from the defaulters. Tax assessment variables such as land area, tax categories, main-off road, building types of the properties are monitored and updated with the help of GIS and remote sensing techniques. Based on the route planning, the staff can locate tax defaulters with high accuracy instead of wondering in the field.

- The present study aims to improve the assessor's judgment and consistent efficiency of taxation process through geo-spatial technologies. Geospatial technologies integrated with databases that offers an effective tool for easy assessment and management of property tax and helps to monitor property tax revenue by preparing a common platform that visually links all property-related data such as the number of floors in each building, total constructed area of each building, individual plot area, details of locality and road facing details with the applied tax calculation principles. While in previous studies Property Tax-Excise & Taxation. (2016) and Property Tax-Excise & Taxation. (2016), it is just an information system that only provides information about the properties and tax.

- One of the most important needs for the tax officials was the mapping of the taxable and exempted properties within their area of jurisdiction. This helps the property tax officials to quantify taxable and exempted proceedings of the properties and locate them. The system will enable categorization of properties depending on the proximity according to the number of staff; hence inspection of tax properties becomes manageable. The research found out that there are 3358 properties, out of 1615 properties were corrected through GIS based taxation system. It is pertinent to mention here that 284 new properties were also recorded which were missing in the manual record register.

- As far as this research is concerned, some procedures and automation can be done more to enhance the working capacity of the model. The manual excel database will be replaced with an automated software database. Limitations and concerns related to the study are just due to financial and administrative concerns. When the same idea will be taken up to Government level (city/province/country level) so financial and administrative constrains will be eliminated and this system with more functionalities.

- The Survey in all methodology is performed on hard paper (survey sheets) and then updated on the system. This is because limited resources are available for this project. Government should develop an android application for property tax filed survey and use the tablet on which real time updating, splitting merging, shaping of parcels as well as their attributes are updated which will reduce the chance of errors to much extent. This is one of the automated systems which will minimize the chance of geometric errors in terms of data quality as compared to the paper-based method. Regular change detection will be followed by Government resultantly it will reduce any chance of bribery or corruption by staff which will accelerate revenue generation to its new peak.

- Real time change detection is a very important on-going process in the property tax responsible for monitoring and evaluation of the entire system. This study does not include any methodology for regular change detection in the property and tax attributes. This will surely help to make the system transparent, and safeguard government revenue. Change detection is also helps in the accountability of corrupt staff and accumulative effect on revenue generation.

- In this study, I have created the Microsoft excel data base of the property tax system from the paper register and tax, which is calculated while using a manual procedure. For an efficient system, there is a need to develop a standard-database and automatic tax calculation system for property tax. There is a need to develop proper standard database management systems like Oracle, MySQL, SQL Server, DB2, Postgre SQL, etc. for the property tax. These standard database management systems will address the future needs, and provide high performance, accuracy, security, and reliability. This data base should directly link to the parcel database and provide real time accurate data.

- Increased collaboration between government organizations and departments will ensure consistency in information sharing. Provide an opportunity to improve the effectiveness and efficiency of the services to the public, reducing the cost of delivery.

- In manual paper based system very little information is available to higher management and decision making authorities in a timely accurate manner. This results in less effective planning & development. Centralized decision making will result in more accurate and correct decisions which will allow better allocation of the scarce resources at our disposal.

- For property tax field survey android application should be developed to replace the manual paper-based survey. This development saves time, resources, and provides real time and updated data from the field.

5.5 Recommendations

- The study aims at integrating spatial technologies into the taxation process to help improve the assessor's judgment and work-efficiency in assisting with uniformity and consistency in full operations of property tax collection. The tax payers should provide access to the property record and method of calculating tax. The tax authorities need to address the problems related to tax collection administration and enforcement for proper revenue collection.
- Government should also develop an online web-portal for tax payers through which they can view details of property (land area, cover area, category etc.) and tax amount on the map with the help of satellite imagery. The tax calculation methodology, property search option, property tax relative information and notification should be available on the online web portal. Furthermore, the government should also provide online property tax calculator so that the tax payers can calculate the tax of their properties themselves. Resultantly, this would also help ensure transparency in the data, confidence in the public minds and enhancement in the government tax revenue generation. Hence, the government needs to implement the GIS and RS technology in the entire country.
- It is highly recommended that local authorities should automate their services through GIS for the realization of their goals. The development of a geo-database will save them from many risks of losing important documents either through malice or mistake. The government of Punjab is in the process of introducing e-government and modern technology in almost every department. This application should be available through Web GIS so that more and more people can access and get benefit from it. Many GIS open source servers such as Geo server, map server, map guide etc. are available for publishing the GIS Data. Furthermore, it is suggested that the government should take steps to enhance the technical skills and knowledge of the employees through technical/professional trainings from time to time. The tax department should address the problems associated with tax collection administration and enforcement.
- The property mapping should be applied to all cities and towns of the country so that all properties liable to tax are identified correctly. Subsequently, there should be a monitoring and evaluation system to examine the existing property tax record with the help of RS and GIS. The property tax data should be shared and linked with both the public and private departments like police, municipal administration, solid waste management, real estate management, urban planning to improve their services for the public.
- For the sake of greater transparency and security, it is important to develop a standard data base management system for property tax system capable to perform computerized standard tax calculations.

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Chapter-6: Conclusion

- The main objective of the understudy research was to develop a Tax Information System for the Rawalpindi city government in the Punjab province of Pakistan through integrated emerging technologies like remote sensing and GIS. The system can provide spatial dimensions which will enhance assessment, analysis, and revenue of property taxation up-to parcel level. The GIS and RS are being used as a tool to identify and locate the exact location of the properties with relevant tax attributes is obtained.
- Verification (house to house survey, digitization, and geo-mapping of previously manual property tax records.
- The development of a database integrated with GIS, will automatically eliminate the discretion of staff whereby the units were left un-assessed or otherwise kept under-assessed. In this study 284 new properties are added to the tax net.
- Tax revenue increased from PKR **23051550** in the last three years.
- 425 properties tax defaulters are identified in this study.
- The current study found 86 property units were placed in the wrong building type like residential which were corrected efficiently.
- The current study found 254 property units were placed in wrong (lowest tax) categories like B, C, or D which were corrected efficiently through using geo-spatial technologies.
- 50 properties stories have been corrected with the help of property photographs, satellite imagery, and field survey results.
- Increase in fiscal space through expanding the tax base and increasing tax collections.
- Government has to incur huge costs in maintaining and managing separate registers, files & forms. Savings through reduced use of inaccurate paper based reports, files, register within and outside the government.
- The GIS technology is ideal to analyze, visualize, and map market values of land properties since values are spatial dependent. A combination of numerical, textual, and visual i.e. digital photos of properties including building can be embedded into the system and retrieved based on numerous spatial or statistical selection criteria and provide excellently.
- The GIS integrated property tax system facilitated easy identification of the spatial location of tax defaulters. The potential area for property tax and defaulters were identified and mapped precisely. It is, therefore, tax recovery process was accelerated through real time, accurate, and updated data. Moreover, the un-assessed, and un-authorized properties were identified while using geo-spatial technologies to increase property coverage and assessment in rationalized tax-net.
- The GIS has been proved as a powerful tool in tax collection and delinquent tax payers tracking for raising government tax revenue collection. The purpose of the study is achieved successfully while showing an increase in tax revenue and elimination of corruption.

- The study also aimed at improving the assessor's judgment and efficiency of the taxation process through housing desktop geo-spatial technologies. However, it will be more appreciated if the system is presented through Web-GIS, so that the private departments and public can access their property information and method of tax calculation for ensuring data transparency and comfortable rectification.
- Tax assessment variables such as land area, tax categories, main-off road, building types of the properties are monitored and updated with the help of GIS and remote sensing techniques. Anomalies in the tax assessment of 1615 (which is 48.05% of total properties) were identified and corrected. As a result, the property tax system is more transparent, speedy, and updated. This ensures transparency in the property tax system and considerable enhancement in the government revenue
- With the help of geospatial technology, the decision makers would be able to efficiently plan and execute the property tax collection process with limited resources and staff. Therefore, the taxation staff, existing properties record, and tax recovery process can be monitored and evaluated efficiently with the help of RS & GIS technology. Moreover, properties should be mapped around the country to identify them correctly as taxable.
- Better Government-Citizen Interaction, which will result in better Public Sector Delivery, i.e. efficient collection of tax returns.

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Glossary

Attribute table: Attribute tables are normally associated with a class of geographic features. Attribute table contains rows and columns. Each row represents a geographic feature. Each column represents one attribute of a feature, with the same column representing the same attribute in each row.

Attribute: A trait, quality or property describing a geographical feature.

Arrears: The total accumulated amount unpaid (due) as on 1st day of new financial year.

Band: Band is the specific range of the electromagnetic Spectrum to which the sensor is sensitive. The band is commonly related to wave length.

Base map: A set of topographic data displayed in map form providing a frame of reference or contextual information to the user.

Classification: The Classification is the method of identifying and dividing the feature in to different categories or classification is arrangement or ordering of objects

Database: A collection of information organized in such a way that a computer program can quickly select desired pieces of data; an electronic filing system.

Digitization: Digitization is the process of converting the coordinates from map, satellite imagery or data available from another source in digital format

Digitizer: A device for manual digitizing. It normally consists of a flat surface that documents can be attached to, and a cursor or puck that is used to locate and input map features into the computer.

Exempted Unit: Residential property unit having land area more than 150 square yards is free from tax.

Feature: A set of points, lines or polygons in a spatial database that represent a real-world entity.

Field: A set of one or more alphanumeric characters comprising a unit of Information.

Geo Server: is an open source server for sharing geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.

Geo-Referencing: To establish the relationship between page co-ordinates on a planar map and known real-world co-ordinates.

Geo-Database: A database that store geo-referenced data among others.

GPS: Global Positioning System (GPS) is satellite-based navigation systems that provide location and time information on anywhere or near the Earth.

Image Classification: Image classification is the process of assigning the pixel values to classes, thematic etc. Image classification can be done with the help of supervised and unsupervised classification.

Integration: The combining of data of different types from different sources and systems to provide new information.

IRIS: It's a brand name of GIS based web mapping application that provides a spatial frame work to host, geo code and view numerous other layered data-sets through internet.

Join: Joining data is typically used to append the fields of one table to those of another through an attribute or field common to both tables.

Kanal Kanal is a unit of area used in Pakistan and India. Kanal is equivalent to about 505.857 square meters.

1 kanal=605 square yards.

1 kanal=20 marlas.

1 kanal=5445 square feet.

Land Cover Land Cover is the physical material or Land type such as forest, water, built up etc. land cover can be defined as the bio-physical cover of the earth surface

Main Road: Road having width of 25 meters is considered as main road.

Marla Marla is a traditional unit of area that is used in India, Pakistan and Bangladesh. One marla is equivalent to about 272.25 Square feet.

1 marla=30.25 square yards.

1 marla=25.2929 square meters

Merging: In Arc GIS the process of combining many selected feature in to single feature.

Off Road: Road having width of less than 25 meters is considered as off road

Overlay: The process of superimposing two or more maps, through registration to a common co-ordinate system, such that the resultant maps contain the data from both maps for selected

features. Although the term overlay can be applied to paper-based maps, more often it applies to the use of digital data; nevertheless, the principal is the same.

Primary key: One or more attributes whose values uniquely identify a row in a database table.

Property Tax data base: The database of property tax is created from the hardcopy of revenue register in the Microsoft Excel format.

Query: A statement expressing a set of conditions that forms the basis for the retrieval of information from a database.

Quick-Bird: It is a very high-resolution satellite that was launched in 2001 and decommissioned on January 27, 2015. Quick-Bird was owned and operated by Digital Globe and collected image data down to a pixel resolution of 0.61m. Quick-Bird satellite collects image data to 0.65m pixel resolution degree of detail. This satellite is an excellent source of environmental GIS data.

QGIS:(previously known as Quantum GIS) is a free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data.

Remote Sensing (RS): Remote sensing is the science of obtaining information about the area from distance or object from the satellite image or aircraft.

Spatial Data: Any data that have information of position coordinates.

Spatial Resolution: Spatial resolution of the sensor is the smallest size of smallest feature that can be detected or it can be defined as the size of cell in the raster data set.

Spectral Resolution: Specific wavelength intervals in the electromagnetic spectrum for which a satellite sensor records the data.

Splitting: In Arc GIS is the process of dividing the one feature into many features.

Square foot is a unit of area. It is the size of a square that is one foot on a side. It is 144 square inches, 1/9th of a square yard, or approximately 0.093 square meters.

Square yard: is a unit of area equal to the size of a square that is one yard on a side. It is equal to 9 square feet or about 0.836square meters.

Taxable units: Residential property unit having land area less than 150 square yards is liable to tax. But commercial property whatever the size is taxable

Thematic map: A map depicting selected kinds of information relating to one or more specific themes. Examples are soil type, land classification, population density and rainfall maps.

Topology: In geo-databases, the arrangement that constrains how point, line, and polygon features share geometry. Topology defines and enforces data integrity rules.

Vector data: An abstraction of the real world where positional data is represented in the form of coordinates. In vector data, the basic units of spatial information are points, lines and polygons.

Unique identifier: Common field to at least two databases chosen to perform a relate, link or join.

Union Council: Union Councils is the 5^{th} lowest level of government in Pakistan. Union Councils is a geographical region of tehsil used for administrative and other purpose. It comprises about 20,000 to 30,000 population in urban and rural areas of the tehsil (subdivision of district).

Vector data: A GIS data model in which the location and shape of objects is represented by points, lines.

Zone: Zone is an area containing an average of 3000 to 8000 properties.

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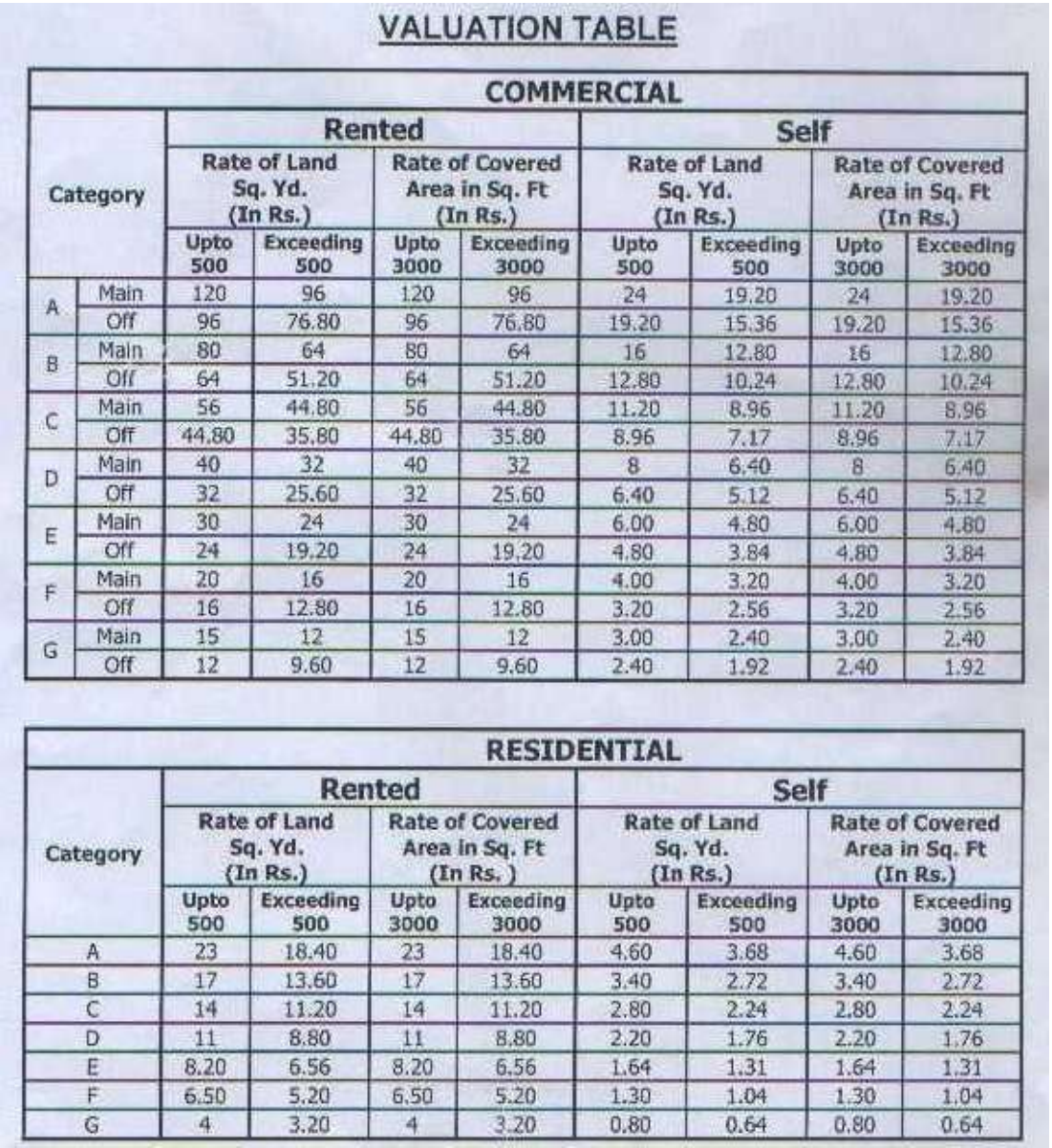
Appendices

Appendix 1: Valuation Table for Assessments of Property Tax



VALUATION TABLE

COMMERCIAL

Category		Rented				Self			
		Rate of Land Sq. Yd. (In Rs.)		Rate of Covered Area in Sq. Ft (In Rs.)		Rate of Land Sq. Yd. (In Rs.)		Rate of Covered Area in Sq. Ft (In Rs.)	
		Upto 500	Exceeding 500	Upto 3000	Exceeding 3000	Upto 500	Exceeding 500	Upto 3000	Exceeding 3000
A	Main	120	96	120	96	24	19.20	24	19.20
	Off	96	76.80	96	76.80	19.20	15.36	19.20	15.36
B	Main	80	64	80	64	16	12.80	16	12.80
	Off	64	51.20	64	51.20	12.80	10.24	12.80	10.24
C	Main	56	44.80	56	44.80	11.20	8.96	11.20	8.96
	Off	44.80	35.80	44.80	35.80	8.96	7.17	8.96	7.17
D	Main	40	32	40	32	8	6.40	8	6.40
	Off	32	25.60	32	25.60	6.40	5.12	6.40	5.12
E	Main	30	24	30	24	6.00	4.80	6.00	4.80
	Off	24	19.20	24	19.20	4.80	3.84	4.80	3.84
F	Main	20	16	20	16	4.00	3.20	4.00	3.20
	Off	16	12.80	16	12.80	3.20	2.56	3.20	2.56
G	Main	15	12	15	12	3.00	2.40	3.00	2.40
	Off	12	9.60	12	9.60	2.40	1.92	2.40	1.92

RESIDENTIAL

Category	Rented				Self			
	Rate of Land Sq. Yd. (In Rs.)		Rate of Covered Area in Sq. Ft (In Rs.)		Rate of Land Sq. Yd. (In Rs.)		Rate of Covered Area in Sq. Ft (In Rs.)	
	Upto 500	Exceeding 500	Upto 3000	Exceeding 3000	Upto 500	Exceeding 500	Upto 3000	Exceeding 3000
A	23	18.40	23	18.40	4.60	3.68	4.60	3.68
B	17	13.60	17	13.60	3.40	2.72	3.40	2.72
C	14	11.20	14	11.20	2.80	2.24	2.80	2.24
D	11	8.80	11	8.80	2.20	1.76	2.20	1.76
E	8.20	6.56	8.20	6.56	1.64	1.31	1.64	1.31
F	6.50	5.20	6.50	5.20	1.30	1.04	1.30	1.04
G	4	3.20	4	3.20	0.80	0.64	0.80	0.64

Figure7: Valuation Table for Assessments of Property Tax

Refrence: *Property Tax-Excise & Taxation. (2016) Property Tax | Excise & Taxation, 2016)*

Appendix 2: Assessment of Special Properties

Table 5: Assessment of Special Properties
(Property Tax | Excise & Taxation, 2016)

Sr.No.	Type of Property	Criteria for Assessment
1	Cinemas/Theaters/Auditorium /Multipurpose Hall	Commercial rate self or rented as the case may be specified in the valuation table of the respective locality
2	Factories/Industrial units (Manufacturing units)	Residential rates notified, (self or rented as the case may be) with the following rebate for land area: Up to 1 acre: Normal Rate Exceeding 1 acre up to 4 acres: 20% reduction Exceeding 5: 30% reduction
3	Marriage Hall / Banquet Hall, Marriage Lawn /Event Hall/ Marquee / Exhibition Centers.	Self-properties shall be assessed @ 175% of the commercial rate of the valuation tables prescribed for the locality. Rented properties shall be assessed as per rate prescribed for the rented properties
4	Properties built as residential properties but used for offices/ Educational intuitions	150% of the rate specified in the valuation table of the residential properties of the respective locality.
5	Hotels/Motels/Guest Houses & such other furnished properties.	1. In case of portion consisting of rooms/boarding/lodging units used as residential accommodation 40% of the gross annual (365 days) rent shall be taken as GRAV. The gross rent shall be worked out on average /normal charges received per room per day. 2. The commercial area shall be assessed self or rented as the case may be as per valuation table prescribed for locality. 3. While calculating covered are, lobby/kitchen/mosque and ancillary portion shall be excluded.
6	Hostels	150% od rates specified in valuation tables for rented residential properties of the respective locality.
7	Hospital	Commercial rate self or rented as the case may be prescribed for the locality.
8	Petrol pumps/CNS station/Car wash service station	Commercial rate self or rented as the case may be. Underground area for storage/tanks/canopy shall also be accounted for as covered area.
9	Plaza and multi storeys buildings	Normal commercial rate self or rented as the case may be. However, 10% reduction in case of 1st floor and first basement and further 5% reduction for each floor/basement up to maximum of 40% shall be allowed for floor above and below ground floor. In case of single owner ship land shall be assessed only once. However, in case of individuals and different ownership land equal to the respective portion shall be assessed in each case.

10	Customized parking plaza / Parking Lots	25% of the commercial rate self or rented as the case may be meant for the locality.
11	Old Residential Building	10% rebate for building older than 20 years up to 30 years 15% rebate for building older than 30 years
12	Agriculture Lands, Orchards, Nurseries	As per actual rented in case of rented and Rs.1000/- per Kanal, per annum case of self-occupation / cultivation
13	Poultry Farms, Cattle Shed and Brick kilns	50% of the residential rate self or rented as the may be prescribed for the locality.
14	Transmission /Communication Tower	Actual rent in case of rented properties. Self-commercial rate of valuation table shall be applied in case of company own properties.
15	Grid station	Land area and covered are including are having installation /equipment shall be assessed on self -rented commercial rates as the case may be
16	Properties built as used as commercial properties (including offices and customized educational institutional buildings)	Commercial rates of the localities self or rented as the case may be.
17	Airport/ Runway strip /Dry Ports /Open yards	1. Land and covered area shall be assessed as per self or rented, commercial rate of the locality. 2. Runway strip & taxi area, dry ports open yards including logistic tracks to be assessed at 25% of the self or rented commercial rate of the locality.
18	Open plots being used for commercial purposes	200% of the rate of the valuation table meant for the land are prescribed for the locality, self or rented as the case may be
19	Stadium , Sports complex such like sports sites including swimming pools	1. Commercial area self or rented to be assessed as per commercial rate of the locality. 2. Playing fields/areas to be assessed at residential rate of the locality self or rented as the case may be. 3. Open area / land other than the above to be assessed at residential rate rented or self as the case may be.
20	Godowns and workshops	50% of the commercial rate rented or self, as the case may be.
21	Cold storage	Self-properties shall be assessed @ 175% of the commercial rate of the valuation tables prescribed for the locality. Rented properties shall be assessed as per rate prescribed for the commercial rented properties. However, portion of the premises being used as offices or other ancillary purpose shall be assessed as per occupied Commercial.

Appendix 3: Exemptions According to UIPT Act 1958

The tax shall not be livable in respect of the following properties, namely: -

(1) Buildings and lands other than those leased in perpetuity [owned by] the Federal Government.

(2) Buildings and lands other than those leased in perpetuity owned and administered by the Government of the Punjab or a local government as defined in section 2 clause (xvi) of the Punjab local government ordinance, 2001 (XIII of 2001) (Punjab Local Government Ordinance, 2001).

(3) Buildings and lands, the annual rental value of which does not exceed [one thousand and eighty] rupees; or

(4) One building occupied by an owner for his residence, the annual value of which does not exceed one thousand, six hundred and twenty] rupees subject to the condition that the owner or any member of his family does not own any other property in that rating area and such other conditions as may be prescribed:

(5)Provided that if such building or land is in the ownership of a person who owns any other building or land in the same rating area, the annual value of such building or land, shall, for the purposes of this clause, be deemed to be the aggregate annual value of all buildings and lands owned by him in that area.

(6) Buildings and lands or portions thereof used exclusively for educational purposes including schools, boarding houses and hostels owned by the Government or by a body owned or controlled by the Government.

(7) Public parks, playgrounds and libraries.

(9) Buildings and lands or portions thereof used exclusively for public worship or public charity including mosques, temples, churches, dharmsalas, gurdwaras, hospitals, dispensaries, orphanages, alms-house, drinking water fountains, infirmaries for the treatment and care of animals and public burial or burning grounds or other places for the disposal of the dead. Provided that the following buildings and lands or portions thereof shall not be deemed to be used exclusively for public worship or for public charity within the meaning of this section, namely: -

(10) buildings in or land on which any trade or business is carried on unless the rent derived from such buildings or lands is applied exclusively to religious purposes or such public charitable institutions as may be prescribed.

(i) Buildings or lands in respect of which rent is derived, and such rent is not applied exclusively to religious purposes or to public charitable institutions; and

(ii) Buildings and lands annual value of which does not exceed rupees [forty-eight thousand and six hundred] belonging to a widow, a disabled person or a minor orphan:

Provided that where the annual value is more than rupees [forty-eight thousand and six hundred] the tax shall be levied on the amount in excess of the said amount].

(11) One residential house measuring an area up to one kanal (505 square meters) owned and occupied for his residence by a retired Government Servant of the Federation or a Province.

Provided that in this clause Government Servant shall not include a servant of a body corporate owned, established or controlled by the Federal or a Provincial Government.

(12) One self-occupied residential house having an area not exceeding five Marla's (126.465 Square meters) in a Katchi Abadi notified under the law relating to Katchi Abadis (Urban slums).

(13) One residential house, measuring an area not exceeding five marlas, used for residential purpose except a residential house with annual value of more than five thousand rupees situated in a part of a rating area which is category A area.

Exemptions in UIPT Act 1958: *(Property Tax | Excise & Taxation, 2020)*

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