A QUEST IN URBAN MORPHOLOGY

An analytical approach in formation and transformation of a traditional city: with special reference to case of Yazd, Iran

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Abstract

This study examines the morphological development of urban spaces. It proposes a method for morphological analysis which views the built environment as an existing object. The emphasis is on an objective view of an urban situation, treating its present state as a fact.

It is assumed that the study of morphology can contribute substantially to the search for appropriate concepts of urban space in both traditional and new built environments in Iran. There is ongoing discussion between designers and government about the identity of Iranian architecture and urban design. One problem is the apparent lack of an effective and relevant way of treating urban spaces, both new and existing. In the absence of an accepted method of analysis, much emphasis is placed on an intuitive type of thinking, based on personal styles and experience. A systematic method may reduce the difficulties faced by urban professionals.

The concept of systematic morphological analysis is applied in this thesis to the city of Yazd, which is centrally located in Iran. Yazd is famous not only for its individual buildings but also for its spatial pattern and for the environment of its traditional housing. In addition there is a comparatively wide range of new housing over a considerable area.

In the research, the settlement of Yazd was analysed at five levels: City, District, Block, Building group and Unit (although some overlapping proved to be present). The entire city was studied briefly at the first level then three carefully selected smaller areas were examined in detail at the other levels. These areas were erected at different times and are described as 'historical', 'old', and 'new'. The aim was to identify the main characteristics of the urban form in three typical areas.

The results identify morphological components of the built environment of Yazd and suggest that the morphological patterns of a settlement reflect underlying rules that regulate the spatial arrangement. The results also demonstrate that functional alterations sometimes preceded the physical changes that occurred when new concepts of urban spaces and new morphological patterns were introduced into parts of the city. The nature of these changes was found to vary at different levels of morphology.

This research aims to make two contributions: firstly to extend urban morphological analysis to the case of cities in the Middle East and, secondly, to provide a practical approach and new results that will aid future urban planning and design in Iran.

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M.R.N.Mohammadi

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This thesis is dedicated to my wife ***Behdokht****, my son* ***Abbas*** *and my daughter* ***Zahra*** *.*

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The arts were born of Chance and Observation, fostered by Use and Experiment and matured by Knowledge and Reason.

Leon Battista Alberti

Chapter One:

1. INTRODUCTION AND BACKGROUND

The identity of Iranian architecture and urban design is the subject of continuing controversy among the country's designers and between designers and government. One outcome of this is the lack of a consistent and relevant approach to the design of urban spaces, an approach based on knowledge of the existing built environment and in particular, of its processes of evolution. There is a clear need for an objective method of urban analysis to provide a framework for new guidelines for the design of urban spaces, both in traditional urban areas and in new developments. At present, in absence of any guidance, there is a predominant reliance on an intuitive type of thinking, a subjective approach to urban design based primarily on personal style and experience.

1.1. AIMS AND OBJECTIVES

This research is therefore a study of urban morphology. Its overall aim is to increase understanding of the form of a typical traditional Iranian city, particularly its processes of transformation. The first part of the work to be undertaken was an extensive literature review; and, as a result of this, three principal objectives for the study were chosen:

- To identify what appear to be the morphological elements and their disposition in a traditional city in Iran,
- To analyse how these changed with time,
- To develop morphological analysis as a practical tool for use in city planning, particularly for urban analysis in the Iranian context.

The urban fabric of a city is continually built and rebuilt, and the objectives imply that this research should be an investigation of the processes of transformation and change over a relatively long period – a time span that covers the history of the city as it now exists. The underlying questions must be, simply, 'What, at any given point in the past, was the character of the built environment?' and 'What were the processes of change that brought about the present situation?'

But change and continuity must be understood in context: the processes depend not only on physical factors but on the nature of the society and its needs. This implies that there are two separate avenues of research:

- Analysis of the physical settlement to assemble evidence of its formation and transformations

- Examination of possible agencies of change and their relationship with urban form.

The present research concentrates on the first of these approaches. The form and structure of a particular environment are studied in an attempt to record the nature of its morphological changes. The intention is to establish an objective foundation both for further physical analysis and for later work on the processes by which human beings interact with their physical and social environments. By identifying morphological elements of a settlement and the links between them, it may also be possible to construct a framework of guidelines for the future design of its urban spaces.

1.2. URBAN DEVELOPMENT IN IRAN AND THE NEED FOR MORPHOLOGICAL STUDY

One of the main issues in the discussion and practice of urban development in Iran is the search for appropriate concepts of urban space. In recent years, Iranian architects and urban planners have been facing a challenge. On the one hand, in the era of rapid socio-economic development, modern architecture and urban planning have been seen as a means of undertaking large scale social projects, and creating a new urban fabric and efficient urban land use, while ensuring sensible employment of available funds. On the other hand, the old urban environments and certain historical areas, as evidence of urban culture and architectural tradition, have attracted increasing interest.

This conflict raises certain issues such as how a particular urban form comes to be what it is today, and whether some urban forms are better able than others to assimilate elements of modern architecture and planning. The fact that some urban patterns appear to be built and rebuilt over a relatively long period has to be taken into consideration. Attempts might more often be made to play down the characteristics of modern realisation and use historical ideas as a base for development or re-development.

As a result of modernisation, which started in the early 20th century and particularly promoted for the last five decades, architects and planners have tended to adopt the so-called International Style of architecture for urban development and redevelopment. This has resulted in the large scale demolition of some traditional urban areas and the construction of frequently unimaginative modern developments, such as wide and straight streets, modern housing areas, and high-rise buildings, based on sometimes inappropriate plans.

Some people who are worried about the disappearance of the urban continuity have increasingly questioned this practice. In recent years, urban historical preservation has become an important theme, although architects and planners involved have often lacked the real means to achieve their aims and ideas which often resulted in piecemeal intervention. It is argued that a better understanding of the Iranian urban tradition is required in order to solve the problems which are occurring in the old cores of Iranian cities.

This research is, therefore, intended to assist in the study of continuing development concepts and ideas by providing information on patterns of development. The attitude which forms part of the background of this work represents a sincere concern about the future of the built environment in Iranian cities. An understanding of the existing urban structure can, it is suggested, provide a platform upon which ideas concerning urban areas may be developed.

1.3. THE CASE STUDY

As this research project developed it became focused, therefore, on the morphology of the Iranian City. It was clear that a significant depth of analysis would be required, with separate examination of different levels of the built form from the district to the individual unit. Within the scope of a PhD project, it seemed likely that only one settlement could be studied, and the choice of this became a matter of some significance: the areas chosen had to be reasonably typical if any results were to have wider relevance and application.

In making the choice, the first stage was to identify attributes which a chosen settlement should possess, and to give reasons for these. The following seemed to be appropriate:

1- The settlement should have been established for a long period of time and the development and redevelopment of the settlement during different ages should be clearly in evidence. In addition, although older areas might have undergone recent changes, the traditional pattern of development should overall be still in evidence so that comparisons could be made between periods. The historical form could well be very different from the modern form.

2- The settlement should consist of a significant number of smaller parts, varying in date, so that detailed cross-period comparisons could be made between these parts.

3- The settlement to be studied should be reasonably typical of others to be found in Iran. In this way, the results may be of relevance to other settlements of the country.

After examining the full range of historical urban centres in Iran, the city of Yazd was selected.

1.3.1. YAZD AS A SUBJECT OF THE STUDY

The city of Yazd is famous for its traditional housing environment. Architects and designers often use it as a source for examples of such development, and it is famous not only for its individual buildings, but also for its spatial pattern and its traditional housing environment. There is also a comparatively wide range of new housing over a considerable area. Although there are several other cities in Iran with similar characteristics, Yazd was selected for the following reasons.

- The old structure of the city is still very much in evidence.
- In comparison with other cities the old part of Yazd is functionally much more active.
- In the city there is the possibility of a comprehensive study of the various structural patterns existing in different ages, such as the historical and the old parts and the new and contemporary fabric.
- There is the opportunity to examine the various changes occurring in the settlement and their effect on the morphological elements in evidence.

There have been a number of studies on the city of Yazd, but little academic research on its spatial characteristics. As for other cities in Iran, most of the studies on Yazd have been concerned with the historical core of the city. They have concentrated either on some historical aspects of urban fabric, specific components of the built environment, such as houses, or have emphasised broad aspects of the historical city from a socio-cultural viewpoint.

There are also personal reasons for this selection. The experience of living, teaching, and working in Yazd has helped the author develop his ideas about urban morphology, made him more familiar with Yazd than any other urban area, and given rise to an enthusiasm for research in this particular city.

1.4. URBAN MORPHOLOGY AS AN APPROACH

The study has adopted morphological analysis as a multi-disciplinary approach involving theoretical, historical and analytical research. The theoretical debate explored issues relating to urban morphology for analysis of the urban fabric. A number of urban morphological studies in the fields of urban architecture and urban geography have been carried out in recent years, and various different research projects have been undertaken in order to meet the differing intentions. Such studies in the field of urban morphology have largely consisted of an examination of the physical and spatial characteristics of an urban structure, in terms of what exists at the moment and can thus be viewed directly and with regard to the previous stages which have culminated in, or had some possible influence on, the present arrangement. It provided a discussion to the conceptual framework of the study and helped to establish a methodical framework to elaborate an analytical approach. This analytical framework will be applied to the case of Yazd.

An historical framework was drawn up of the metamorphosis of the form of Yazd -- a traditional Iranian city in transformation. This established three morphological periods reflecting the development phases of the city which included the historical city or the 'walled city', the immediate development beyond the wall or the 'old city' and new development or the 'new city'. Three case studies, consisting of districts of Fahhadan, Godal-e-mosallah, and Immam Shahr, were selected to represent these phases respectively. The settlement was then analysed at five levels of scale, from the city to the individual building. The first, the city as a whole, was examined at particular periods in history, using the present city as the principal evidence. The second is 'district' scale, the level of individually defined city areas. The third and the fourth levels identify blocks and groups of buildings respectively, and the final level is that of the single unit. Of course, the relative importance of each of these levels and the emphasis placed on them in the research varies with the type and historical background of the selected areas.

1.5. SCOPE OF THE RESEARCH

The assumption behind this work is that tracing the gradual processes of formation and transformation of the urban form and identifying the morphological structure will help in understanding its present situation. This stems from the belief that the construction, use and transformation of the traditional built environment cannot be understood, and that new interventions cannot be made, unless there is a comprehensive understanding of the spatial morphology which has developed and changed in order to meet the needs of the inhabitants, and of the way in which the people use the spaces.

The emphasis is on the spatial morphology of the built environment, but this is not to ignore the importance of the relationship between socio-cultural changes and physical form of the built environment. People not only continuously adapt themselves to their environment, they also intervene in their environment in order to adapt it to their needs. Although, some socio-cultural changes will not always lead to physical–spatial changes, the major social forces which have a direct influence on the formation, and transformation of the morphological structure of the built environment will receive some attention, in an attempt to provide some useful information on the reasons for the forms adapted. However, it has to be acknowledged that the account of these social changes has been limited in scope since the study of links between human activities and the built environment is a vast and complicated subject.

It was never intended that this research should supply solutions, such as plans, or intervention policies for problems encountered in the traditional built environment or new development areas. It is hoped, however, that a relatively comprehensive understanding of the context of such problems will be obtained, so that a methodical approach towards solutions may become apparent and some significant insights about the perspectives of the traditional built environments in transformation in the Iranian City might be generated.

1.6. ORGANISATION OF THE STUDY

This thesis has been arranged in eight chapters, the aim and basic content of each chapter being as described below (See Figure 1.1):

Chapter One or the introductory chapter generally discusses the overall background of the research, the aims and objectives and the scope of the study. It also describes very briefly the selection of the case study as a subject matter for the research. It was, of course, intended that the settlement chosen to form the subject of the study should be reasonably typical of others to be found in Iran, and that the results of the work may thus be expected to have wider relevant application.

Chapter Two has been arranged in two sections. The first section gives an account of how urban morphological studies have been developed in recent years. Three schools of thought, those of English, Italian and French, classified in two distinct categories of urban geography and architecture, are discussed and some common points with regard to the methods already employed are identified. It is basically established that the physical form of a settlement follows a certain degree of rational development and can be studied accordingly, that the physical form of a settlement is more likely to comprise an organised whole than to be a loose accumulation of elements, that the architecture of a settlement has a history and hierarchy of scale, and that the formal elements, dispositions and activities are common components of urban morphological studies.

The second section of Chapter Two gives further clarification of the concepts of urban morphology with regard to this research by providing a description of how the survey and analytical work was to be undertaken and what was to be covered. The research work, in terms of the form of the existing settlement, was expected to include three: site survey, analysis and conclusion. The concept of examining the morphology at five levels of scale, city, district, block, building group, and building or unit is introduced.

Chapter Three gives a general description of the morphological elements and structure of Yazd at settlement level and thus sets the background for the more detailed work. It also provides a brief account of the settlement chosen, traces its growth from the initial stages up to the present situation. To understand the main characteristics of the city and appreciate the origins of this living entity, an account is given of the physical and social transformation of the city. Some changes have occurred to the old pattern, such as in the expansion of some main roads and introduction of new commercial facilities. However, the morphology is still influenced by elements remaining from the past. The city has also rapidly grown and some newly developed areas with new concepts of the built environment have emerged. The chapter also concentrates on the various development and master plans which have been prepared at various times. At the end of the chapter, a description is given of how the areas to be studied in detail were chosen.

In Chapters Four, Five and Six a detailed description is given of the morphology of the three study areas, Fahhadan, Godal-e-mosallah, and Immam Shahr. The morphological analysis of each study area is undertaken at four scale-levels: district, block, building group and building. The basic characteristics of the areas are described and certain primary elements and basic patterns are identified at various levels and generally described in terms of open space and built form, disposition and relationship. Changes in the morphology are also examined to illustrate the development which has occurred in the pattern where it was appropriate.

The Fahhadan area is essentially a typical historical residential environment developed within the walled city, while the Godal-e-mosallah area developed immediately beyond the wall and close to the grand bazaar. It has a commercial as well as a residential component and contains an area where some traditional elements are still in evidence. The Immam Shahr area has developed recently and is essentially a typical modern residential environment.

Chapter Seven includes some further consideration of all building groups observed in the three study areas, which are examined in terms of general size, internal spatial arrangement and access system. Some comparison is also made between building groups identified in these three areas.

Chapter Eight provides a summary of the overall findings of the study of the city of Yazd, observed at various scale-levels of the morphology. An assessment of the methods applied in the present study is also given, together with an account of the possible application of the results.

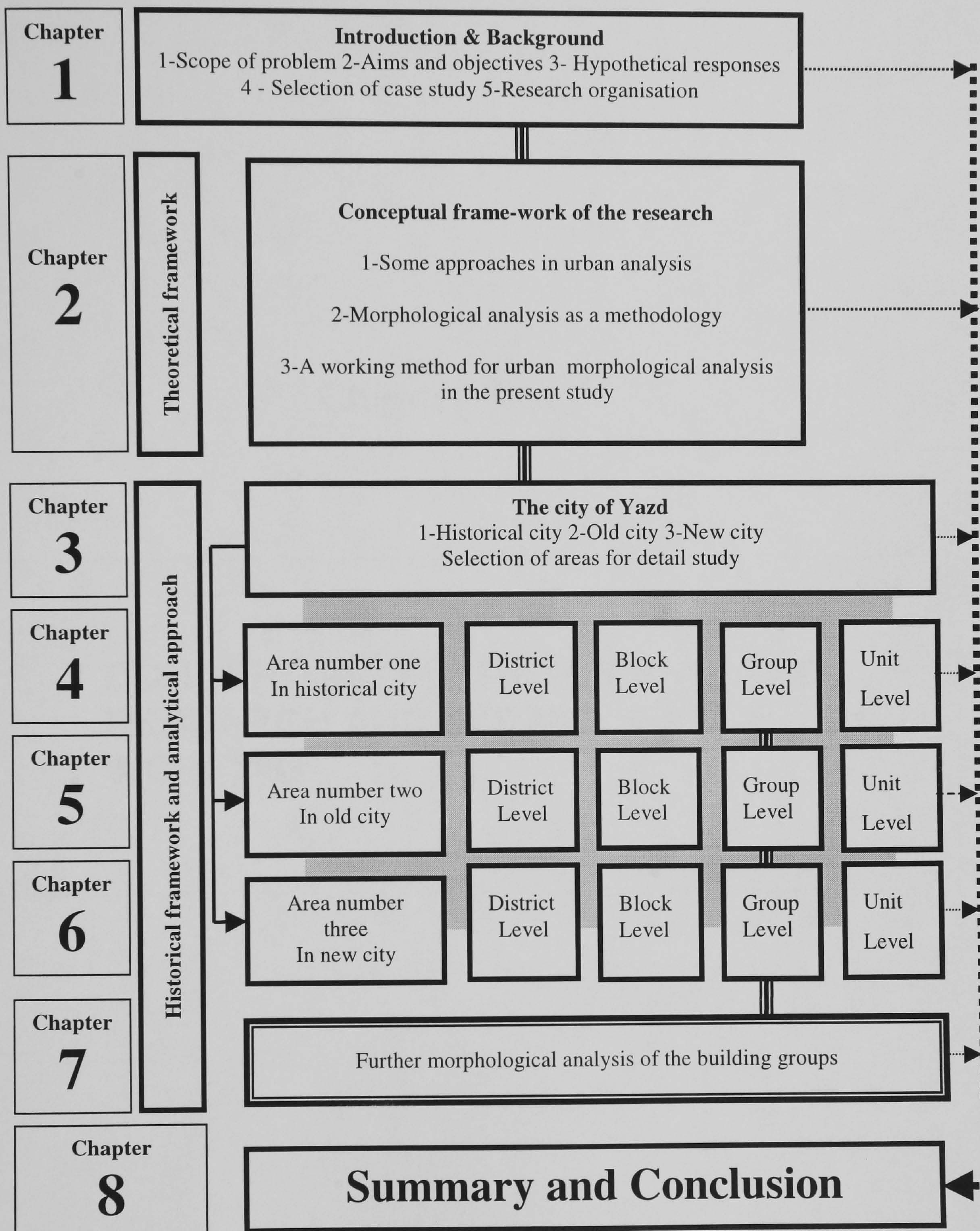


FIGURE 1.1: THE PROCESS OF DEVELOPING THE STUDY OF THE URBAN MORPHOLOGY OF YAZD

Chapter Two:

2. CONCEPTUAL FRAMEWORK OF THE RESEARCH AND THE METHOD OF WORKING

This chapter is divided into two sections. First, general concepts involved in urban morphological studies are examined. Three schools of thought in urban morphology are discussed together with other experiences in morphological analysis of cities. The purpose of reviewing these approaches is to examine ideas which may be helpful in determining the course of the research. Second, the development of the methodology for the research, which is partly a consequence of the first part, is described. Both conceptual ideas and the proposed methodology are elucidated in a more or less self-contained framework. In the second section the conduct of the case study and the research method applied are also examined.

2.1. SOME APPROACHES IN URBAN ANALYSIS

2.1.1. DEFINITIONS OF URBAN MORPHOLOGY

The term 'morphology' which is derived from the Greek word 'morphe', meaning, 'form', refers to 'the science of form' (Shorter Oxford Dictionary, 1997), in particular the 'shape, form, external structure or arrangement, especially as an object of study or classification' (Supplement to the Oxford English Dictionary, 1976). It has been mainly used in biology to mean the study 'not only of shape and structure in plants, animals and micro-organisms, but also of the size, shape, structure, and relationships of their parts'. Although it is often typically contrasted with the study of functions of organisms and their parts, namely them physiology, the separation is somewhat artificial due to the close interrelation of the function and structure of organisms (New Encyclopaedia Britannica, 1984). In an extension of the original definition, the word is often currently used to infer the examination of the form and structure of many things. Thus, urban morphology may be understood as the examination of the form and structure of a settlement. The study of urban morphology involves an objective analysis of the settlement considering (Gebauer, 1981: 1):

- The settlement as a physical fact.
- The settlement as a built environment in evolution, involving the subject of transformation and change accompanying changes in urban society.

- The settlement as the focus of interaction between social forces and the built environment that contains them.

Urban morphology has also been defined as the systematic study of the form, shape, plan, structure and functions of the built fabric of towns and cities, and of the origin and the way in which this fabric has evolved over time. (Small & Witherick, 1986; Clark, 1985; Goodall, 1987) At one extreme the term can be understood largely as the study of the physical and spatial characteristics of an urban structure. Conzen (1990: 143-144) has given a detailed description of this nature of urban morphology: '... if urban form connotes a very general conception of the physical structure of cities, it may be useful to consider urban morphology as a term referring more precisely to the particular character of the urban landscape; the detailed interplay of land subdivision, buildings and their combined pattern of use'. At another extreme, the term can infer the study of urban form and structure as part of and in relation to a dynamic context. In general terms, this concept of urban morphology involves not only the study of urban form and structure but also the study of socio-cultural forces, acknowledging the fact that the urban form has not only a physical nature but also a socio-cultural nature.

In its widest perspective, therefore, the concept of urban morphology involves not only the study of urban form and structure but the study of socio-cultural forces as well. Some scholars have suggested that an urban form and its socio-cultural context cannot be studied separately. 'They are two aspects of same phenomenon and relate dialectically; that is to say that socio-cultural context should not be considered as the cause for physical changes which would then be taken as the effects, but that changes at the physical level will facilitate and maybe even promote certain social processes' (Etchegrary, 1978: 2).

In this particular research topic one underlying theme is that the urban form and structure of a particular built environment may be observed and analysed. References to matters of socio-cultural nature are made from time to time, although on the whole they are of a general nature. This may provide a basic foundation for a better understanding of urban form and decision making and may be used as a setting for other urban considerations.

2.1.2. RESEARCH BACKGROUND IN URBAN MORPHOLOGY

Form, resolution, and time constitute the three fundamental components of urban morphological research. These are present in many studies, whether by geographers or architects, and whether they focus on a medieval, baroque, or contemporary city (Moudon, 1997). The smallest cell of the city is recognised as the combination of two elements: the individual parcel of land together with its buildings and open spaces. The characteristics of the cell help to define the urban form's shape and density, as well as its actual and potential use over time. Studies show that the attributes of the cell and its elements reflect not only a time period of history, but also the socio-economic conditions present at the time of land development and building. Over time, these elements may be used differently- for example, by different social classes-transferred physically, eliminated, or replaced by new forms. The rate of change in either the function or the form of the cells varies from city to city, though it often fits into cycles related to the prevailing economy and culture. Building and transformation cycles are important processes to explore for city planning and real estate development purposes, yet are rarely studied in contemporary cities (Moudon, 1997).

Studies also focus on what Conzen calls the 'plan unit' and what Italians term 'tessuto'. Plan units or 'tissues' are groups of buildings, open spaces, lots, and streets, which form a cohesive whole either because they were all built at the same time or within the same constraints, or because they underwent a common process of transformation (Moudon, 1997).

Furthermore, while much morphological analysis is carried out for the purpose of developing theory, several distinct purposes exist among urban morphological traditions, which yield different kinds of theories. The three schools each have different intentions in their theory-building efforts as follows (Moudon, 1997):

1- The study of urban form for descriptive and explanatory purposes, with the aim of developing a theory of city building. Such studies are concerned with how cities are built and why. This is the primary purpose of geographers, and the Birmingham school in particular. Social scientists in the French school also have this purpose in mind when they carry out morphological studies.

2- The study of urban form for prescriptive purposes, with the aim of developing a theory of city design. Such studies concentrate on how cities should be built. This is the primary focus of the Italian School which has given this purpose a special direction, namely to develop a theory of building design resting on historical city-building tradition. A few French researchers have had the same intentions in their morphological analyses.

3- The study of urban form to assess the impact of past design theories on city building. This is in the realm of design criticism, which makes the distinction between the theory of design 'as idea', and the theory of design 'as practised'. Such studies assess the differences or similarities between stated objectives about what should be built (normative theories) and what has actually been built. The French School has championed this use of morphological analysis, tracing successfully the roots of modernism in urban design back to the eighteenth century. However, it tends to remain a difficult exercise for many designers and planners, who tend not to spend time assessing the impact of their actions on the long-range life of cities.

With the rise of interest in functional classification and economic bases of urban systems, urban morphology was severely criticised as being mainly descriptive, lacking in good measurement techniques and failing to develop a general theory, and focusing merely on the observable and inanimate (Herbert & Thomas, 1982). After a period of quiescence, research activity in the subject has renewed since the late 1970s. In its revived form, urban morphology has focused on town plan analysis and building form. A theoretical framework was established which referred to the creation of morphology by 'actors' in 'stages' (Gordon, 1984). Whitehand (1987: 288) agues that for more realistic perspective, it is necessary to ' set individual decision makers into a wider framework of morphogenetics, economics, property interests and artistic considerations'. He sums up the research questions of one of the most important lines of investigation in British urban morphology in the 1980s as dealing with the location of the individuals and firms involved in the development process, their relationship with each other, and the implications of these relationships for the change of building form. These are the questions in response to which new studies have been carried out (Larkham, 1986).

2.1.3. A REVIEW OF APPROACHES TO URBAN MORPHOLOGY

For Gordon (1984: 3), morphology is formed of 'plots, buildings, use, streets, plans, townscapes'. It is dealt with largely in urban geography, which spatial aspects of urban development are studied from inter-urban and intra-urban viewpoints. In the case of the latter, 'urban areas are studied in terms of their morphology, producing concepts and generalisations related to the character and intensity of land use within the urban area and to the spatial interactions of one part of the urban area with another, i.e. internal structure and processes' (Goodall, 1987).

When the focus was placed on the social geography of nineteenth-century cities, they were often studied on the basis of the ecological theory of the Chicago School and social area analysis (Dennis & Prince, 1987). The spatial structure of the cities was reconstructed and compared with a few standard types, such as Sjorberg's pre-industrial city, Burgess's concentrically zoned city, and Hoyt's sectors. It was then possible to locate the city in question somewhere along a transition form 'pre-industrial' to 'modern'. In the 1970s the studies were still principally descriptive and observed changes were accounted for only by the most general of processes such as modernisation. But over time, the concept of modernity has become less unilinear and more historical through the observation of modern attitudes, perceptions, political philosophies and forms of class-consciousness together with the spatial patterns (Dennis & Prince, 1987).

In Germany, studies of urban growth during the nineteenth century often involved the investigation of processes and agents, political, functional, social, and economic, that lay behind urban expansion (Denecke, 1987). Detailed studies often focused on urban fragments and their morphogenetic and functional changes reflecting the processes that the town as a whole underwent. The researcher was thus allowed to go into detail and to follow threads, which finally knit everything together on a more general and theoretical level.

Urban morphology is also defined as the study of the city as human habitat (Moudon, 1997). The city may be described as 'the most complex of the human inventions, ...at the confluence of nature and artifacts' (Lévi-Strauss, 1954: 137-138). Urban morphologists concur: they analyse a city's evolution from its formation, identifying and dissecting its various components. The city is the accumulation and the integration of many individual and small group actions, themselves governed by cultural traditions and shaped by social and economic forces over time. Urban morphologists focus on the tangible results of social and economic focuses: they study the outcomes of ideas and intentions as they take shape on the ground and mould our cities (Moudon, 1997).

Buildings, gardens, streets, parks, and monuments are among the main elements of morphological analysis (Moudon, 1997). These elements are considered as organisms, which are constantly used and transformed through time. They also exist in a state of tight and dynamic interrelationship: built structures shaping and being shaped by open spaces around them, public streets serving and being used by private landowners along them. The dynamic state of the city, and the pervasive relationship between its elements, have led many urban morphologists to prefer the term 'urban morphogenesis' to describe their field of study.

Several generations of scholars had been active in urban morphology, not only in England, but also in Italy and in France (Moudon, 1997). In the summer of 1996, a group of urban morphologists from a variety of disciplines including architecture, geography, history and planning, formalised the International Seminar of Urban Form (ISUF) the group which included individuals from England, France, Germany, Ireland, Switzerland, Japan, Australia, and USA. This group acknowledged the expansion of urban morphology beyond its original confines in geography, and its emergence as an interdisciplinary field. They highlighted the need to promote international exchange and to investigate the scope of the field's theoretical basis (Moudon, 1997).

This coming together of researchers from different language areas and disciplines is founded on common ground. First, there is agreement that the city or town can be 'read' and analysed via the medium of its physical form. Further, there is widespread acknowledgement that, at its most elemental level, morphological analysis is based on three principles (Moudon, 1997):

1- Urban form is largely defined by three fundamental physical elements: buildings and their related open space plots, and streets.

2- Urban form can be understood at different levels of resolution. Commonly, four are recognised, corresponding to the building/lot, the street/block, the city, and the region.

3- Urban form can only be understood historically since the elements of which it is comprised undergo continuous transformation and replacement.

2.1.4. APPROACHES TO MORPHOLOGICAL ANALYSIS

Basically, the approaches that will be investigated in this work are mainly classified in three schools of thought (Moudon, 1997). These three approaches including some other practices in this field will be examined as follows:

2.1.4.1. URBAN GEOGRAPHICAL APPROACH (MORPHOGENETIC TRADITION)

(The urban morphological approach as practised by members of the English School of Geography such as Conzen, Whitehand, etc)

Probably the oldest, the most intensively researched and the most widely documented stand of urban morphology studies is that which lies within the field of human geography and has been called the morphogenetic tradition (Whitehand, 1981). Morphological studies in geography started much earlier than those in architecture and planning, and in a more empirical way, among which the English school has particular importance. Until the 1960s, the main concern of urban geographers was the internal structure of the city and focused on morphology which, mostly being historical, involved the plotting the ages and types of buildings and identified different historical components of town plans (Dennis & Prince, 1987). Urban morphology in its most active period emphasised the classification of sub-regions within individual cities in relation with the phases of urban growth (Herbert & Thomas, 1982).

Urban morphology in the German-speaking world was flourishing in the inter-war years and remained an integrated part of urban geographical research in the post war period (Whitehand, 1987: 254). Architects and historians as well as geographers contributed to the development of urban morphology and of the origin and the way in which this fabric has evolved over time (Blumenfeld, 1982: 44-56). This line of central European research was introduced to Britain mainly through the work of M.R.G.Conzen (1969), who tried to explain the present structure of a town plan by examining its development. The basic idea behind Conzen's study is that 'the past provides the key to the future' (Whitehand 1978: 371). This was the beginning of the formation of the English school with Conzen's works, particularly his famous case study: <u>Alnwick, Northumberland: a study in town-plan analysis</u>, which is described by Whitehand (1987: 254) as having five achievements:

1- The establishment of a basic framework of principles for urban morphology
2- The adoption for the first time in geographical literature in the English language of a thorough-going evolutionary approach
3- The recognition of the individual plot as being the fundamental unit of analysis
4- The use of detailed cartographic analysis, employing large-scale plans in conjunction with field survey and documentary evidence
5- The conceptualisation of developments in the townscape

To find out some significant characters of this school of thought it is very useful to highlight some ideas, emerging from morphological studies are implemented by Conzen. He suggested that the geographical character of a settlement be functionally determined by economic and social significance within its regional context (Conzen, 1966: 13). Nevertheless his morphological study is clearly distinguished from a functional one which intends to understand the perceptual aspects and social values of human beings in connection with the urban form.

One of the major aims of a morphological study is to investigate and understand the formal processes of urban development impulses in long term requirements of people and to categorise this man-made end product (Conzen, 1978: 144). Therefore, the form of the settlement is a direct product of processes in which the essence of the attitudes involved at the time and in place of its origin (Conzen, 1966). In this regard the urban form as an object of study is not only defined its physical being but also explicates a clear interaction between a specific human settlement and the society.

Conzen (1975: 100) refers to the way that the spirit of a society is evident in its urban form. He considered that cities and towns have a life history. The townscape is viewed as a manifestation of the values pertaining in that society in each historical period. When one period has achieved the manifestation of its own requirements in the pattern of land use, streets, plots and buildings, another substitutes it in turn and the built up area, in its functional organisation and in its townscape, becomes the accumulated record of the development of town (Conzen, 1966: 7). Complexity arises out of the co-existence and spatial arrangement in the townscape of features reflecting different cultural periods, but the connections between the building types and tissues characteristic of different periods are not explored. Buildings and tissues created in particular periods are not interpreted as deriving their forms from types that existed in previous periods.

Conzen emphasises the close relation between the socio-economic on both the political requirement of a society in particular period and the form taken by buildings constructed in that period. Here emphasis is on the history of towns. In this view, history is embodied in townscape, which may be described in a town as evidence of different layers. Therefore, the townscape is the appropriate subject to investigate in seeking knowledge of the built environment within the time sequence.

Conzenian townscape is a heritage (Marzot, 1998). This is articulated, in practical terms, by utilising the division of the townscape into three basic form components: town plan, land-use patterns and pattern of building forms (Conzen, 1966: 4). These three components of the urban form are regarded as to some extent a hierarchy in which building forms are contained within plots or land-use units, which are in turn set in the framework of the town plan.

According to Conzen, a town plan consists of three particular main complexes, streets and their arrangements in a street system, plots and their aggregation in street blocks, and buildings or, more precisely, their block-plans. The term 'street' refers to open space bounded by street-lines and reserved for use of surface traffic of whatever kind. The arrangement of these open spaces within an area of urban form, when viewed separately from the other elements of the town plan is called the street system.

The area unoccupied by streets and bounded wholly or in part by street-lines are called the street-blocks. A street-block represents a group of land parcels and each parcel is essentially a unit of urban land-use. Physically, it displays a distinct spatial character defined by boundaries on or above ground and is called a plot, whatever its size. The arrangement of plots is evident from the plot boundaries and when, considered separately from other elements of urban form, is called the plot pattern. The fact, which represents one of the most important geographical characteristics, is that the street-blocks can differ widely in their plot patterns. Another distinct character of morphological elements is the block-plans which are the areas occupied by buildings and defined on the ground by the lines of their containing walls.

Conzenian's study intended to show that these three distinct elements enter into combinations in different area of a settlement. They combine at the most local level to produce the morphologically homogeneous areas, so-called 'townscape cell' (Whitehand, 1990: 372). These defined cells are grouped into townscape units which, in turn, combine at different levels of integration in order to form a hierarchy of intro-urban regions. The complexity of physical reality is thus reduced into manageable proportions, which are suitable for morphological study. What is also important is that the town plan originates, develops, and functions within a physical and human context. Plan analysis properly includes the evaluation of the physical conditions of the site and situation, as well as of relevant and social developments. The main purpose of town plan analysis is to reconstruct the development process of the city in a time-span that is termed by Conzen as a 'morphological period' (Conzen, 1966: 7).

In the process of town plan analysis, another significant factor is the conceptualisation of the way in which urban forms develop. His development of the concepts of the 'fringe belt' and 'the burgage cycle' and his tripartite division of the urban landscape into town plan, building forms and land use have been widely accepted as fundamental advances (Whitehand, 1992). The first one is a threshold between different morphological areas created either by a physical barrier, such as a city wall, or a socio-economic condition, and a change of land values. The later concept refer to a process that is consists of the progressive filling in with building of the backhand of burgage which often terminates in the clearing of buildings and a period of 'urban fallow'. Basically Conzen's work shows a general attempt to elucidate why things happened in the way they did. He found that certain matters such as the street system and building arrangement influenced the changing form of development.

Conzen's work undoubtedly added an important dimension to the study of urban morphology. Whitehand has continued to develop some of Conzenian's idea, particularly on the nature of ' urban fringe-belt'. (Whitehand, 1987: 245-256) he has studied the way in which the outcomes of the competition for fringe-belt sites have to be seen in the context of building cycles and the activities of house-builders.

Other contributors to this field of town plan analysis have suggested alternatives which are often complementary methods of analysis. Daives (1968) has focused on the interrelationship between form and function through time and space. He was particularly concerned to conceptualise the time-lag before the change of form occurred in response to a change of function. In his study of South Wales coal-field area he identified 'a cycle of form-function relation' (Daives, 1968: 108) which he suggested could be applied elsewhere. In addition, from a different contextual background, Bourne (1967: 2)) argues for the need to recognise the effect of the physical structures, the real-estate, and the inherited urban fabric on modern functional change, especially in the inner city areas.

The research activity of morphology in urban geography has revived since the late 1970s, particularly focusing on town-plan analysis and building form (Dennis, 1987: 9-23). In its revived from, a theoretical framework was worked out which referred to the creation of urban morphology by 'actors in stages' (Gordon, 1984: 1-10). It is argued that it is necessary to set ' individual decision-makers into a wider framework of morphogenetics, economics, property interest and artistic considerations' (Whitehand, 1987: 285-296).

2.1.4.2. THE URBAN TYPO-MORPHOLOGICAL STUDIES

(The typological and morphological approaches as practised by Italians such as Muratori, Caniggia, Rossi, Krier, etc.)

The theoretical and methodological aspects of Italian school of thought in urban morphology perhaps be made clear by description of the role and contribution of Gianfranco Caniggia and Aldo Rossi. Furthermore, it can not also be judged without investigation into the school of thought, research, and architecture that came into being in Rome in the 1960s based on the teaching of Saverio Muratori (Cataldi, 1997).

The teaching of Saverio Muratori (1910-73) at the faculty of Architecture in the University of Rome inspired the Muratorian School. All of Muratori's educational, scientific and project work appears to be inspired consistently by the necessity for a profound renewal of architectural methodology (Cataldi, 1999). He was convinced that architects are capable of gaining a comprehensive understanding of the processes of transformation of built form. Muratori's teaching and method aroused great hostility within the architectural culture predominant at the time in Italy. Muratori was thwarted, isolated, and systematically ignored. Some particular distinctive feature of his thought is visible in the research works of one of his most recent followers, Paolo Maretto who died in Jan. 1999.

Maretto reassessed the nineteenth-century town, which had been much underrated by official critics. He stressed the continuity of its evolutionary processes, and its unity and historicity, characteristics that continued to the present. Part of his purpose was to draw attention to the dangerous split occurring in town planning between 'historic' cities and 'modern' cities. Further, while architecture was being repeatedly put forward as the remedy for failings of modern cities, Maretto stressed the importance of 'tissue' (Cataldi, 1999).

Maretto also synthesised and simplified Muratori's so-called 'table' creating a chart in which four scalar degrees such as architecture, building, town planning and territory are related to four paradigms through which the building realm is interpreted in the form of type, fabric, plan and centre. It is the reading of architectural and building structure by direct observation, recognising what he defines it in 'four areas' of: basement, upstanding part, connection, and roof. These are the keys to his magisterial analyses of buildings of various eras in different European countries (Cataldi, 1999).

Muratori's group also proposed some solutions in which formative phases in development of the historic building fabric provided tools for resolving three different design problems.

Caniggia's contribution to the study of urban form – and that of his school in Florence which continues his work- is one of the most important in this field. Emphasis must be placed on Caniggia's constant interest in building as a way of interpreting architecture, the latter not by chance defined by him as specialised building, and process usually derived from basic building. His arguments were based on these assumptions, particular importance being attached to the identification of substratum type as matrix of processes of building in the human environment.

One could describe Caniggia's line of thought as morphogenetic. He attempts to grasp the dynamics of urban form in its historical development through its constituent types and through the evolution of these types (See Figures 2.1, 2.2, 2.3). He calls these dynamics a typological process. His principal concern is with the historical formation and transformation of the types and of the urban fabrics that result. He distinguishes two large categories of types: the basic or residential type- the most common- and the specialised type which fulfils a diversity of functions (for example, collective, religious or civil functions). The reconstitution of the genesis of types and their mode of aggregation leads him into a veritably archaeological study to find the ancient pre-existing traces and layouts 'which he calls formative matrices' that conditioned the formation of successive local building types, of mediaeval urban fabrics more particularly. He does not hesitate to go as far back as prehistory in his attempt to grasp a type's origin- the initial type, which is the stating point of the typological process.

For Caniggia every building is a product of modifications to previously existing buildings, in a never-ending process of derivations. In other words, the story of each building does not start when the building itself is constructed, but begins when the town starts. His point of view is concerned with the evolution of the form that buildings take in what he calls the 'typological process' (Cataldi, 1999).

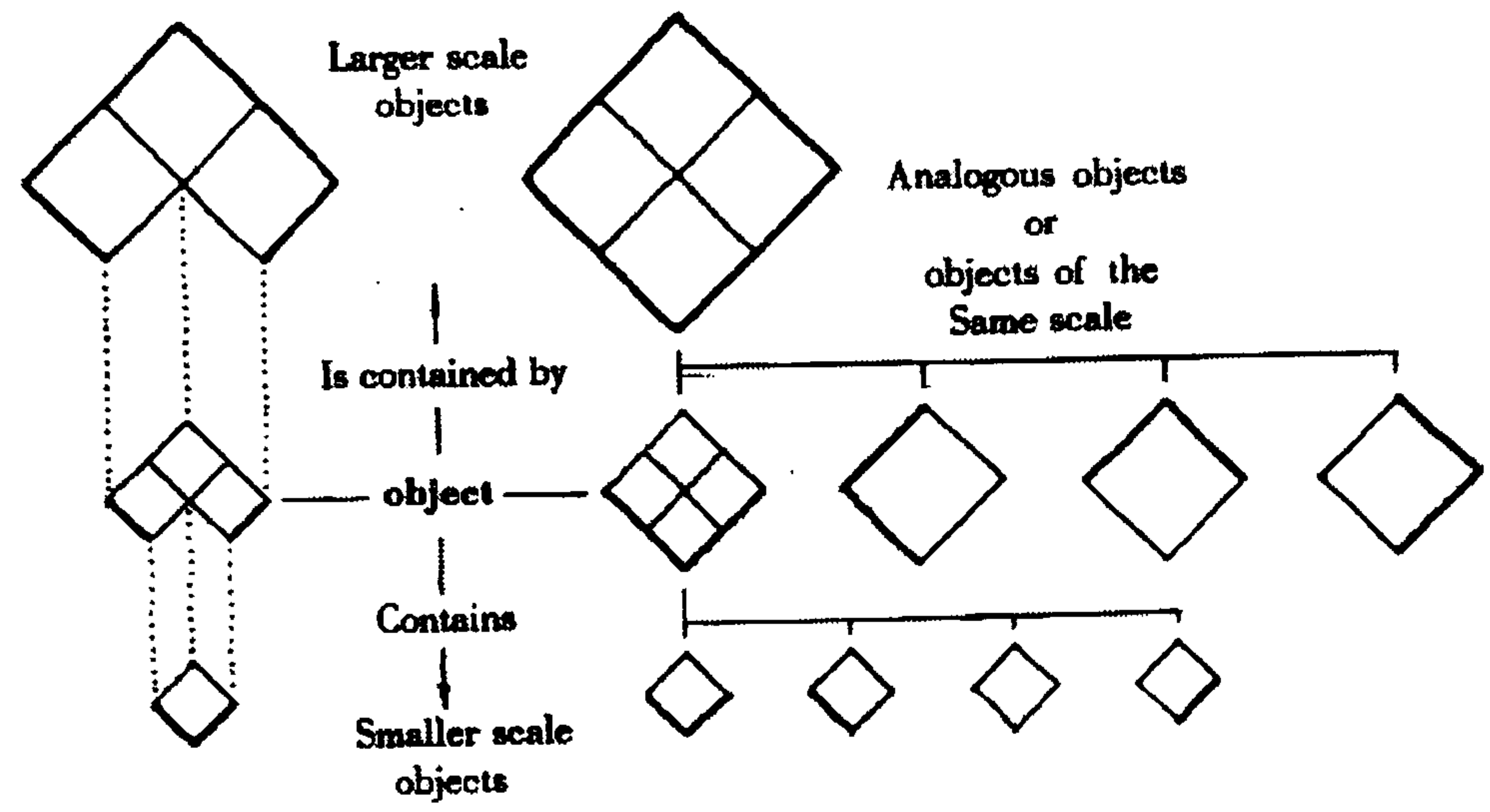


FIGURE 2.1: CANIGGIA'S GENERAL CATEGORIES OF OBJECT AND THE RELATIONS BETWEEN THEM

(Source: Kropf, 1993: 401)

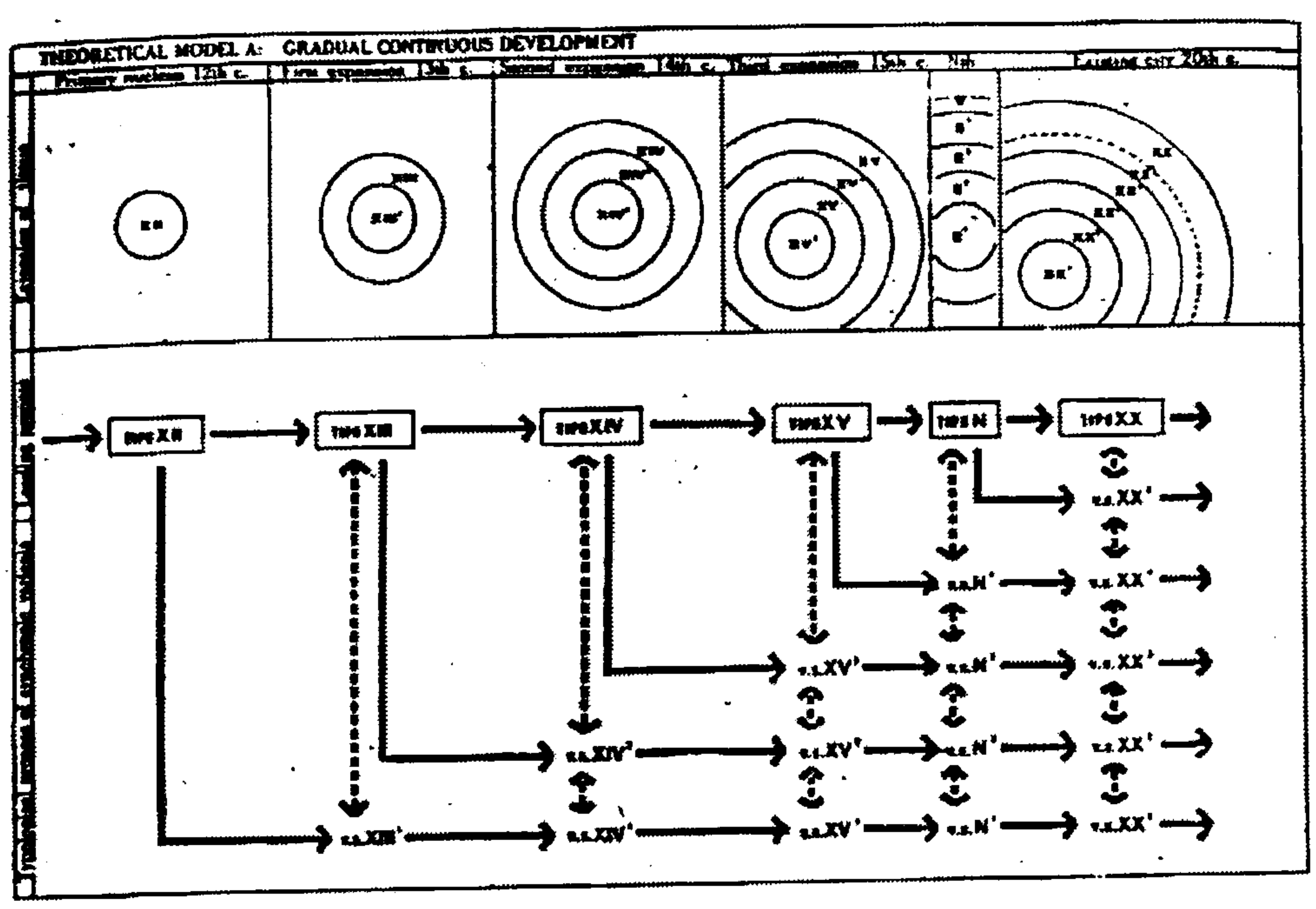


FIGURE 2.2: THE TYPOLOGICAL PROCESS AND THE GROWTH OF TOWNS
(Source: Caniggia, 1984)

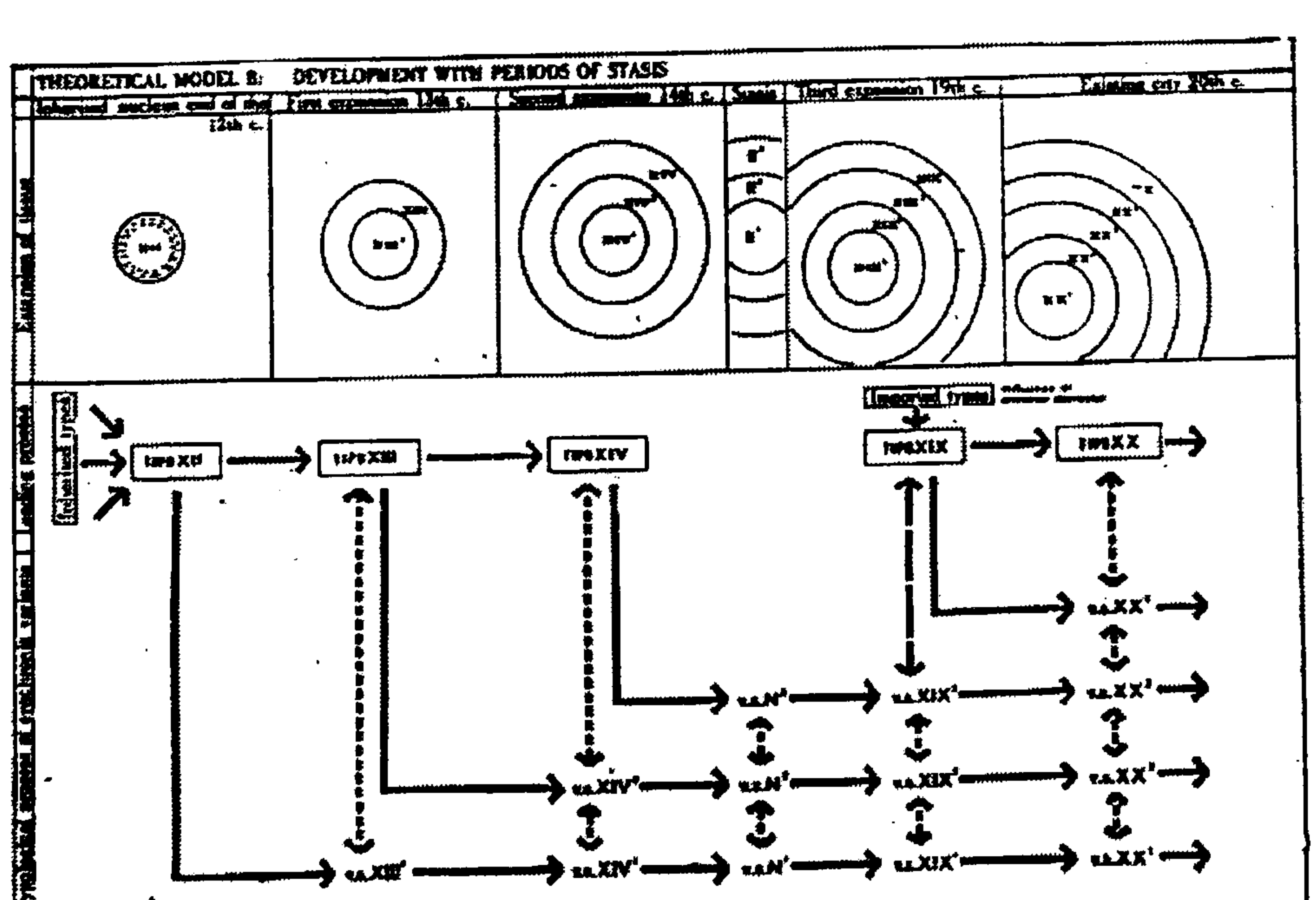


FIGURE 2.3: THE TYPOLOGICAL PROCESS AND THE GROWTH OF TOWNS
(Source: Caniggia, 1984)

In Italian school of thought, history suggested a system of rules for planning practice that was deeply rooted in local tradition. In this point of view there was a conceptual framework for control of the built environment. Here, Caniggia equated human history and natural history in a way that each entailed the process of birth, development, maturity, and death. And there is a clear implication of the continuity of human endeavours.

In this way Caniggia recognised, in traditional urban forms, rules for solving planning problems. Despite the socio-economic differences between historical periods, history provided for him a firm basis for action here and now. His distinction between 'cycles' and 'phases' is only understandable in this context. It is intended as a conceptualisation of a historical theory for purpose of planning the modern town in continuity with traditional one (Marzot, 1998).

The diffusion of Muratorian ideas followed the general rise in popularity of Italian architecture throughout the world (Moudon, 1997), particularly with translation into English of Aldo Rossi's works in the 1980s. Although Rossi close to remain silent about Muratori's considerable influence on his early professional development, he successfully promoted a return to 'traditional' building types (Moudon, 1997), thus kindling a renewed interest in the historic city and promoting its significance in architecture.

On the other hand, the modern movement and its influence on cities raised a new situation to provide a link between new buildings and those of the past. In the late 1950s, a group of architects and scholars introduced the concept of ' return to the city', attempting to set up a contextual authority for new development (Quaroni, 1983, Krier, 1978: 38-42, Vidler, 1978: 23-32). This new concept was derived from the study of the urban structure, and manifests itself in typo-morphological studies, which have largely been undertaken with the purpose of achieving continuity with older architectural and urban traditions (Gosling, 1984).

The main concept of the typo-morphological approach, although there are many differences of detail, may be described by an investigation in the works of Aldo Rossi. The most successful source of Rossi's work is in his book: The Architecture of the City. His starting point is a critique of modern architecture which has destroyed much of the historical continuity in our cities. Indeed, cities should be regarded as historical texts containing man-made objects which retain traces of their time. History is seen as analogous to the skeleton which bears the imprint of past actions. More importantly, the city is the collective memory of its people, and this memory is contained within urban artifacts. According to Rossi the concept assumption involved that the city is one of the most important manifestations of human society. It was created in a continuous but piecemeal process of human collective building activity, what Rossi called 'the unconsciousness of social life' (Rossi, 1982: 29-35).

The justification for typo-morphological studies was initially a concern for the restructuring and preserving of the urban heritage against certain characteristics of modern architecture and planning. Frampton (1980) described precepts of these studies as follows:

1- The relative autonomy of architecture and the need for its re-articulation as a discourse in terms of types and rules for the logical combination of its elements.

2- The socio-cultural importance of existing urban structures and the role played by monuments in employing and representing the continuity of public institutions over time.

3- The resource of the historical urban form as a fertile legacy which is always available for analogical reinterpretation in terms of the present.

A result of this approach has been the attention given to the city as a piece of architecture. Urban type forms from the past have been studied not purely in terms of the spatial organisation but with reference to positions in urban morphology (Gencel, 1992). A major contribution is that architecture takes at least part of its meaning from the context, which is based upon certain ideas of cultural coherence, homogeneity, and historical continuity (Keogh, 1976: 11).

The city is thus regarded as an artifact resulting from these collective efforts throughout history. It is assumed to represent the traces of the past multiple aspirations of human beings, themes, and events that constituted the city in the course of its construction. The nature of human collectivity is also such that each individual, such as an architect, planner, and builder, etc., may be able to add his own valuable contribution to the formation and transformation of the city. Through this common fund the city is assumed to express the link between its architecture and individuals as a social whole.

Rossi proposed and employed a particular technique to study the continuity and permanencies of the city. This technique is 'typology'. Here the city's considered as a formal structure and architecture as a process of building from the single dwelling to the whole of the city. On this basis, the permanence and continuity of the city exist within the logic of architectural form which lays in a definition of type. Type is supposedly expressed in the unchangeable or stable features of an object's so-called permanence (Moneo, 1978: 14).

According to Rossi the city developed with the passing the time. In the process of its growth there were certain original themes which persisted and some others which were modified. The city in this procedure acts as a record of past events through its permanencies and the continuity of the city come from these permanencies. According to this theory Rossi defined 'permanence' as a past we are still experiencing (Rossi, 1982: 59). He and his followers identified urban monuments, streets, and block plans as the most meaningful elements of urban permanencies.

Ultimately, Rossi does not have an ideal model of a city in the 20th century. His belief is that every city 'possesses a personal soul formed of old traditions and living feelings as well as unresolved aspiration' (Rossi, 1982: 162), and that this consciousness can be most effectively realised through the creative potential of the typological apparatus.

Historical analysis is important, particularly in identifying monuments and other primary elements which create 'permanence'.

Rossi has worked closely with a number of other architects in Italy whose work has not been as widely exported. In particular Aymonino, who has worked extensively on the effective definition of building typology (Aymonino, 1977). He regards the building type as a key to studying the city and defines elements as 'a part of a whole which can be isolated by analysis' (Aymonino, 1985: 49-51). Aymonino includes in the category of architectural artifacts all urban elements, such as walls, gardens, etc., the whole urban fabric of the settlement. His complete definition reads ' the analysis of the artificial, organisational and structural elements wit the aim of classifying them in relation to the urban form of a specific historical period' (Aymonino, 1985: 50). An important conceptual difference remains, however, between the two theorists. Rossi looks at the city as a whole in his search for the urban artifacts which characterise it, while Aymonino looks at the artifacts in his exploration of the nature of the city.

The study of types has thus become an essential commodity in the processes of urban analysis, providing the tools with which to reconstruct the city. The work of Krier brothers in this field is therefore of importance, extending the analysis of urban space undertaken by Comillo Sitte(1979). Sitte Classifies three major organisational patterns of city planning: the gridiron, the radial and the triangle, plus all the subsequent hybrid formations. However, Sitte's work is concentrated in the creation of urban aesthetics within the settlement (Sitte, 1978). In this way R. Krier, main hypothesis is that there exist only two typo-morphological elements, 'streets' and 'squares' (Krier 1979) for the recreation and preservation of the public realm. He expands the range of his exploration to include interior spaces, facades, building types by form, and the elements which define and modify these forms, such as corners, courtyards, staircases, etc (Krier, 1983).

Leon Krier, perhaps one of the most notable exponents of 'the reconstruction of the city', extends the issue by identifying 'quarters' 'urban blocks' and 'distinct building typology' (Krier 1978). In his article 'The Reconstruction of the City', he offers a social and political critique of the city, addressing the commercialisation of urban land, the destruction of the public realm by bureaucracy, and destruction of historic city centres caused by peripheral growth and modern transportation systems. His concern is for a physical and social re-definition of an urban district or quarter as a centre of work, leisure and culture. Consequently, the type provides a way of studying the city's history (Porphyrios 1984: 16).

The typo-morphological approach is thus currently directed towards the study of spatial types, building form types and the elements of public space drawn from the past, particularly the nineteenth century European city, which are seen as the major components of the urban morphology, (Krier 1984: 43)

2.1.4.3. THE FRENCH APPROACH IN URBAN MORPHOLOGY

A fairly similar, though less extensive tradition than the Italian school is also in evidence in France. The French school of Versailles, whose most representative members are Jean Castex, Philippe Panerai, and Jean Depaule, is the most recent and claims its origin both from Rossi and Aymonino and from S.Muratori (Petruccioli, 1998: 13). Here a multi-disciplinary group of architects, urban designers and sociologists have undertaken typo-morphological studies for over thirty years. Though their output is in many ways similar to that of the Italian architects, in contrast to the widespread influence in practice of the latter, in France, the impact of such work has tended to remain largely academic.

More recently typo-morphological researchers have consolidated as a research laboratory called LADRHAUS (Labourite de Recherche 'Histoire Architecturale et Urbain-Sociétés'), which is working with groups in Italy, Spain and Latin America (Moudon, 1992). It may be that as this grouping develops a higher profile its influence will become more widespread. One of the leading members of this group is Philippe Panerai. Much of his work has focused on an attempt to identify, explain and classify elements of urban fabric. This is achieved by examining the evolutionary development of a range of different places, both typical and unique. In 'Formes urbaines: de I'ilot a la barre' (Castex, 1980), he collaborated with Castex and Depaule to present detailed interpretations of places ranging from Haussman's Paris to the garden suburbs around London. In particular the evolution and transformation of the European urban block or 'I'ilot' is examined from the 19th century through to the 20th century.

L'histoire de l'urbanisme was published in three volumes between 1926 and 1982 which was based on a distinction, essential for the author, between developed towns and created towns, a distinction between spontaneous urban evolution and town planning (Darin, 1998). According to Lavedan (1926) only the latter type of town is of any interest to the history of urbanism, which is thus concerned with the creation of new towns, the planned extension of existing ones, and the planned transformation of old urban fabrics. The aim of the general history of urbanism, like that of the general history of art, is to create a kind of genealogy of ideas, in this case of planning ideas (Darin, 1998).

A more general review of the growth and development of urban areas through the 19th and the 20th centuries is contained in 'Elements d' analyse Urbaine' (Panerai, 1980). Rather than analysing particular places, in this case specific elements of urban fabric are examined in some detail: characteristic patterns of growth, building typologies, the role of particular movements and the importance of urban landscape are included. Generally it seems that the variety present in traditional urban areas contributes considerably to their social and cultural character.

The morphological history of cities, as it has been developed in the last thirty years, is nourished by two historiographical traditions: the history of urbanism and topographical history. In France, these two traditions arise in the first half of this century. A major difference between these works is their positions within the traditions to which they belong: one laid the foundation of a new tradition, while the second was the apogee of a two-century-old tradition.

In contrast, topographical or morphological history focuses traditionally on the physical aspects of particular cities. It has, for the most part, been the field of local historians, each studying perhaps a single town or city virtually without reference to other cities. Many cities have been studied in this manner. In Paris, this tradition goes back at least to 1550, with the publication of a book by Gilles Corrozet. This summarises the legends of the foundation of Paris, explains the creation of many public buildings, and gives the etymology of street names. The new field of archaeology and the large public works of Haussmann enriched the topographical history of Paris. At the same time, the available maps and plans of Paris were recognised as a valuable source for the history of the city and studied as such.

According to Marcel Poete, the history of Paris of the past and of the present were not successive beings: they were one and the same being under constant evolution. He wanted to understand and describe the soul of the city and see how it related to its physiognomy (Darin 1998).

The paths of Lavedan and Poete crossed in two different ways. First these contributed to the shaping of entire generation of student and secondly and some publications which are still the best introduction to the morphological history of Paris.

Later Raoul Blanchard published some case studies, which provided a homogeneous body of scholarship based on the same approach. All of these case studies are divided into three parts: first, the site and its influence on the city; secondly, the development of the city and thirdly, the main functions of the city.

In the architectural realm, the interest in urban form was expressed in different ways at the beginning of the century. In the Ecole des Beaux Arts, the subjects studied by the Winners of the Prix de Rome gradually evolved from isolated monuments to groups of several monuments and then to entire towns. At the same time another development occurred: architects began to be interested in ordinary buildings in rural areas, which led to a typological survey covering the whole of France during the Second World War.

Whether or not the operational studies are examined alongside the academic ones, one thing is clear: in France, since the 1970s, the study of urban form has emerged as a field of knowledge. Admittedly it is very fragmented, with work carried out here and there, in different towns and institutions. Most of the time, those involved are not aware of each other's work. It is a non-hierarchical field, dominated by nobody. Therefore, it is not possible to speak of a French 'school' of urban morphology. The lack of uniformity is its weakness and its strength. Many had to improvise objectives and methods. In so doing they enlarged the field, and few are conscious that it exists.

2.1.4.4. THE SETTLEMENT AS A TISSUE MODEL AS PRACTISED BY NETHERLANDS RESEARCHERS (SAR GROUP)

The SAR (Stichting Architecten Research) approach initiated by Habraken (1972) in his book Supports: an alternative to mass housing, was in the place an attempt to create an innovative method of housing design, in which the main emphasis concentrated on the decision making processes (Kapteijns, 1978: 4). In a later effort to extend the method into urban design, particularly the design of the dwelling environment developed a series of concepts of urban morphological analysis was developed.

According to their point of view the built environment of an urban area as an existing interweaving of built and open spaces which is described as 'tissue' (Stichting Architecten Research, 1978: 5). The concept attempts to describe the built environment as a morphological phenomenon in which certain kinds of buildings and spaces recur in an ordered relationship. It suggests the existence of some systematic morphological agreements, a weaving pattern, concerning the mutual relationship between the buildings and theirs surrounding spaces (Stichting Architecten Research, 1978: 3).

Analysing the built environment of an urban area itself as a 'tissue' means studying patterns of interweaving of built and open space and trying to formulate the main morphological themes underlying this interweaving. It is suggested that such themes reflect a general rule or a constant factor in the form of an urban area, and can expressed in a tissue model. From this point of view, thematic and non-thematic elements and zones and margins are considered as the importance within the model.

Thematic elements are those parts of the built environment, which are of a similar nature, occurring throughout the area, and generally placed in the same position with respect to other elements. They are the recurrent elements of the settlement, such as the straight streets in a regular grid and the housing types in a residential area. Non-thematic elements are those which occur incidentally and which are placed in a more or less unique way, such as churches, markets, schools, etc. in short, thematic elements tend to follow 'fixed' rules whereas non-thematic elements may not necessarily do so.

In the further elaboration of Habraken's concept of support, SAR 73 also proposed a distinction between 'zones' and 'margins' (Stichting Architecten Research, 1978:.4). The former are 'fixed' areas that will as a rule either be built or remain unbuilt, while the later are ' fixable' areas that may be built on, partly built on, or not built on at all. The morphological relationships in such a tissue model can thus be described in terms of position, dimension and function of elements. The detailed content of an urban morphological analysis is thus made up of, '... A map of the built and unbuilt area with a tone indicating public spaces in schematic representation; a zoning drawing (whenever possible); an analysis of open and built spaces as well as margins between them; profiles of thematic spaces and selections of thematic buildings, as well as an indication of the position of non-thematic elements in the tissue on the zoning drawing (Stitching Architecten Research, 1978: 5).

2.1.5. VIEWPOINTS ON VARIOUS URBAN MORPHOLOGICAL APPROACHES

There are several points in various urban morphological approaches which have some significance for the present research. Some of these viewpoints may be summarised as follows:

2.1.5.1. GEOGRAPHICAL APPROACH

According to Conzen's works, the physical form of a city has a certain degree of independence from socio-cultural context, and can be analysed accordingly. The form of an old urban fabric is often a major determinant of new development, and sometimes means that gradual transformation or adaptation is often more likely to occur than replacement. The urban form can be studied at several morphological levels, such as streets, plots and buildings, which provides a useful method of analysis.

The geographical approach is clearly placed in a historical context, urban form being considered as an inherited structure. The main consideration has thus been given to the morphological origins of towns and cities rather than their contemporary development and present-day problems.

The geographical approach has mostly involved the analysis of the urban form in a formalistic and purely morphological way. Less attention has been paid to certain interrelationships, such as those between the forms and the technology and materials used in building construction, which can have an important part to play in changing structure of urban form.

2.1.5.2. TYPO-MORPHOLOGICAL APPROACH

The typo-morphological approach suggests that the architecture of the city has a nature amounting almost to complete independence from the socio-cultural context of human society. For example, architecture is supposed to be appreciated as something that contains the trace of human building activity virtually from its first moments (Rossi 1982: 52). The essence of architecture, it is argued, does not come with the processes of urban development but supposedly remains a constant feature represented by building type in which technological and social evolution is scarcely relevant. However, it would seem to be much more obvious that changes in society and technologic provide at least some of the reasons for the transformation of the urban architecture.

According to Rossi, the concept of continuity comes from the fact that monuments play an important role in the dynamic processes of urban development. In such a way, the continuity of the city is a result of the capacity of a monument to constitute the city, its history and art. However, it may be pointed out that, in the context of a particular environment, it is not necessarily the elements, such as monuments but other structures or ideas of a long-standing nature that contribute to the continuity of the city.

It seems that the typo-morphological analysis of the city undertaken by Rossi and the others puts more emphasis upon typology than morphology. For Rossi, typology provides the mean of identification and classification of the building types which contain ' the very idea of the architecture', while morphology is only 'a study of the forms of an urban artifact' (Rossi 1985: 97). This method, which is confined comparatively to a few fragments of the urban architecture, rather ignores the interrelationship is sometimes so important that the elements contained may even lose something of their impact and meaning if the link between them is dismantled. For instance, the private space or the private courtyard of traditional housing may become a private route or pathway if it is surrounded by multi-storey apartments.

The elevation of type over morphology seems intensive towards local variation in the typo-morphological approach. The influences of the interaction between urban structures and their environment cannot be disregarded. These influences, such as a change of transportation system, are often very dynamic and major reason for the transformation of a building type. The study of block dimensions and building grouping configurations should thus argue the way that a type may be manipulated by the regional variations and specific socio-cultural conditions. In this approach, the study of 'types' such as buildings, squares, streets and blocks, is used merely as a tool with which to reconstruct the settlement. Nevertheless, particular emphasis may undoubtedly be placed on the evolution and adaptation of such types in direct response to the urban values and morphological considerations of a specific context.

The typo-morphological approach based on its rationalist nature has tried not only to restore the formal complexity of urban architecture but also to recognise modes of growth. The assumption appears to be that the future condition of urban architecture can almost be predicted if a precise architectural and historical situation is in evidence. It can be argued that, although the present stage of a settlement may find its root in the past stage, it will not necessarily lead to a predetermined future stage.

2.1.5.3. FRENCH APPROACH

Two important general characteristics differentiate the French approach to Italian school, one related to the dialectic of urban form and social action, and the second related to the dialectic of modern –non modern. As distinct from the Italian method, here the social component is always first, due to the influence of the French sociologist Henri Lefebvre. In particular it is evident in the work on Cairo conducted by Depaule, where the attention to the physical space is the same as that given to use, furniture, the material culture, and the etymology of the terms of dwelling (Petruccioli, 1998: 13).

According to Panerai and Castex, the urban form may be examined at four levels of analysis. First, the overall urban form set in relation to the site, especially the roads and routes which allowed commercial exchange, and the stage of its growth. Second, the monuments and the institutions whose nature, insertion, displacement and change of usage caused modifications of the urban structure. Third, the ordinary fabric, layout and division of land, such as overlapping of residence and work places and finally, the disposition of the house.

2.1.5.4. SAR APPROACH

The SAR approach suggests that a particular built environment can be understood by means of its underlying principles of themes, which guide the way of formation of the urban environment. Those principles, expressed in the tissue model in terms of dimension, position and function, have, it is suggested, an almost constant or stable nature in the settlements being analysed. It is therefore further suggested that these principles are accepted by society and that they may help to achieve consistency and continuity.

In the SAR approach, the concept of both thematic and non-thematic elements may also assist in making a judgement as to whether an urban element is likely to follow the principles under investigation. The definition of margin provides a grey area in which some rulers for 'zones' may or may not be applied. Such an area is more fixable for different building activities, and may well achieve some degree of diversity within a general morphological theme.

In SAR approach, the urban form is examined in perhaps too simple a way, involving the interweaving of a limited set of elements which differentiate building types according to their repetition or uniqueness in a city pattern.

Morphological Approaches		View Points
Geographical Approach		▪ The physical form of a city has a certain degree of independence from socio-cultural context, and can be analysed accordingly. ▪ The form of an old urban fabric is often a major determinant of new development. ▪ The urban form can be studied at several morphological levels. ▪ It is clearly placed in a historical context, urban form being considered as an inherited structure. ▪ Less attention has been paid to certain interrelationships, such as those between the forms and the technology and materials used in building construction, which can have an important part to play in changing structure of urban form.
Architectural Approach	Typo-morphological Approach (Italian Approach)	▪ The typo-morphological approach suggests that the architecture of the city have a nature amounting almost to complete independence from the socio-cultural context of human society. ▪ The concept of continuity comes from the fact that monuments play an important role in the dynamic processes of urban development. ▪ It puts more emphasis upon typology than morphology. ▪ The influences of the interaction between urban structures and their environment cannot be disregarded. ▪ Typo-morphological approach based on its rationalist nature has tried not only to restore the formal complexity of urban architecture but also to recognise modes of growth.
Architectural Approach	French Approach	▪ Two important general characteristics differentiate the French approach to Italian school, one related to the dialectic of urban form and social action, and the second related to the dialectic of modern –non modern. ▪ The urban form may be examined at four levels of analysis.
Architectural Approach	SAR Approach	▪ A particular built environment can be understood by means of its underlying principles of themes, which guide the way of formation of the urban environment. ▪ The concept of both thematic and non-thematic elements may also assist in making a judgement as to whether an urban element is likely to follow the principles under investigation. ▪ The urban form is examined in perhaps too simple a way, involving the interweaving of a limited set of elements which differentiate building types according to their repetition or uniqueness in a city pattern.

TABLE 2.1: SUMMARY OF SOME USEFUL VIEWPOINTS ON VARIOUS URBAN MORPHOLOGICAL APPROACHES

2.2. A WORKING METHOD FOR URBAN MORPHOLOGICAL ANALYSIS IN THE PRESENT STUDY

In this section the aim is to find out a working method for urban morphological analysis, which has evolved and been used to analyse western cities. The focus has been largely on historic townscapes but a similar method might be applied to a city in a developing country such as Iran. Therefore, this section provides a comprehensive explanation of the research methodology selected such as the conceptual approaches, processes, principles, and procedures resulted from the previous section. In brief, this part illustrates the means by which the research was conducted and justifies the choice of particular techniques and methods for study of a settlement within the field of urban morphology. Furthermore, it is essential in a research study to have a suitably defined framework and logical working order. This section investigates the methodology which is employed within the thesis, and ways in which to approach the subject matter in the most effective manner.

2.2.1. THE WAY FORWARD

Urban morphology seems to provide the necessary frameworks for the study of urban form. Nevertheless, there are some major issues, which it leaves unaddressed. The review of the urban morphological approach to the analysis of urban form suggested and clearly identified different ways of approaching urban morphological issues.

Various conceptual approaches of urban morphology have some differences and some common points. On the one hand typo-morphological and geographical approaches place emphasis on the history of the city whereas tissue model approach gives the present-day situation of the city rather more importance. On the other hand where the geographical approach concentrates on the process of urban morphological development the other two suggest that one aim of urban analysis should be the identification of prototypes or pattern principles. Meanwhile, the French school places an emphasis on the history of urban form and the process of development on different scale levels.

Although urban morphology is in its broadest sense an essentially descriptive concept, attempting to describe and analyse the way in which urban complexes evolve, many of the great variety of methodologies employed could have a role to play in directing future development patterns.

Therefore, the approaches to urban morphological analysis examined in the previous section have indicated several possible ways in which a study may be carried out. A historical approach, for example, may deal with the study of architectural styles and development processes in different historical periods. Such an historical approach to urban form may become an attempt to understand and explain the relationship between social processes and these developments.

The study of the settlement as a historical process therefore focuses upon the formative reasons of urban form rather than its influence on the existing environment. However in the present research some common points can conclude from the examination of the different approaches in urban morphology. These points are as follows:

- The physical form of the city follows some degree of rational development, and can thus be studied accordingly. In morphological analysis, however, some consideration should be paid to the link between the physical form and socio-cultural context.

- The physical form of the built environment is more likely to take the structure and form of an organised whole than being a loose accumulation of urban elements. In a morphological study, the organisational rules of comparatively less significant elements, their arrangement and disposition, are just as important as the location and frequency of the monuments.

- Since the architecture of the city has a history and hierarchy of scale, a morphological analysis should involve not only the overall urban form but also the different levels of scale that come together to form the basic structure and the characteristics of the city.

2.2.2. CONCEPTUAL BASIS OF THE RESEARCH

The methodology, which has been selected, is partially a consequence of the literature review. Drawing together the concepts which have resulted from the review of the theories of urban morphology, and its various approaches, provide a proper platform from which to examine the selected settlement as a subject.

In this part of research an attempt is being made to examine the existing morphology of the selected part of a particular built environment, that of the city of Yazd. It is based on the idea that morphological changes are a logical phenomenon and are part of the urban continuity. Several reasons may be given for this approach.

- First, the existing morphology of a built environment can provide substantial source material for urban analysis, since it can be observed directly. Cities as physical entities act as mirrors to the societies which produce them through its history, one can 'read' them socially and culturally. Therefore the existing morphology of the built environment can be seen as reflecting the urban development process.

- Second, the analysis of the existing morphology is not intended to be limited in its scope; it will deal with the whole built environment, i.e. with its negative or ugly features, its positive or attractive aspects its deteriorated parts, as well as its prestigious areas. This concept is different from certain historical approaches in which consideration of the 'pureness' of some grand high period in the past, and of a few attractive aspects of the urban form, is often the norm,

- Thirdly, since the present approach involves the fact that every city is liable to continuous change. The assumption is that every present situation of a city has a past and is also the beginning of a future. In this sense, the latest development or on-going processes of a city may be seen as a set of urban facts or as constraints to the next step in urban development or re-development.

- Finally, the understanding of the existing morphology of a settlement may form a useful key in stimulating appropriate new development ideas for intervention. The morphological analysis may thus subsequently be used as a tool in the processes of urban design.

Therefore it is clear that the main emphasis of the present study will be concentrated upon the existing situation of a particular built environment, which involves direct observation, by site survey and intensive fieldwork. At the same time, to assist in understanding how a morphological phenomenon has evolved to be come what it is today, attention will also be given to historical evidence of the nature of previous urban development. Evidence may thus be found of the underlying reasons for some features of a particular urban morphology, such as the interrelationship between space use and built form. This process is intended to lead not only to an objective observation and description of the settlement, but also to a deeper understanding of the existing built environment. In this regard, Sommer (1978: 97) states that '... the problem is no longer posed as the designing of a completely new environment, but rather on the rebuilding of what already exists. Not the discovery of a new order for the city, but the improvement of what is already there; not the discovery of new conceptions, but the rediscovery of proven principles, not the construction of new cities but he re-organisation of the old ones'.

2.2.3. THE BASIC COMPONENT OF THE MORPHOLOGICAL ANALYSIS

The basic components of an urban morphological analysis may be considered to the identification of particular features and the way in which they are related, that is the 'morphological elements', the 'morphological structure' and 'the socio-cultural context' (See Figure 2.4). However, the emphasis on each feature may vary from one analysis to another. Furthermore, it is generally depends on the research interest. Therefore, in the present study, it is appropriate to clarify the specific way in which these three basic components of urban morphological analysis can be examined.

According to the reviewing of different approaches in urban morphology it may generally be accepted that 'morphological elements' mainly involve spaces and buildings. The common denominator of these elements is that they may be recognisable as a set of functional objects or features, such as traditional and modern housing or old and new public open spaces. However, the point has to be made clear is that morphological elements will be studied at different scale levels. Consequently, the morphological elements involved may be more than merely spaces and building, possibly combine accumulations of these elements. Therefore, the analysis at the district level may identify different morphological elements from those identified at the block level. In turn, the morphological elements identified at the block level may differ from those identified at lower level.

In the study of 'morphological structure', the emphasis is to examine the way in which morphological elements at a particular scale level are interwoven into a more or less organised morphological entity. The term 'urban morphological structure' is particularly understood as a set of underlying rules or principles which appear to regulate the organisation of a settlement and the way changes occur in it. Since the change of an entire morphological structure is clearly more difficult to achieve than the change of a single element, the morphological structure is generally expected to be comparatively durable.

The 'socio-cultural context' can include all aspects of human action that lead to the formation and transformation of a built environment. If an architectural space is inhabited, this means more than just the use of an existing built environment. The architectural space gets its character in part by the various acts of the people inhabiting it, such as a private space gaining character from the activities of a single person or a group of people. Changes may be generated by human intervention, possibly involving the adaptability or change of the urban form within which human activities are carried out.

Finally, the importance of the relationship between social changes and physical form is fully accepted, as is the fact that there should be some analysis of the social forces that have resulted in or may lead to spatial changes in a city. However, due to the nature of the research topic, only the major factors are able to receive attention in what is acknowledged to be a complicated subject.

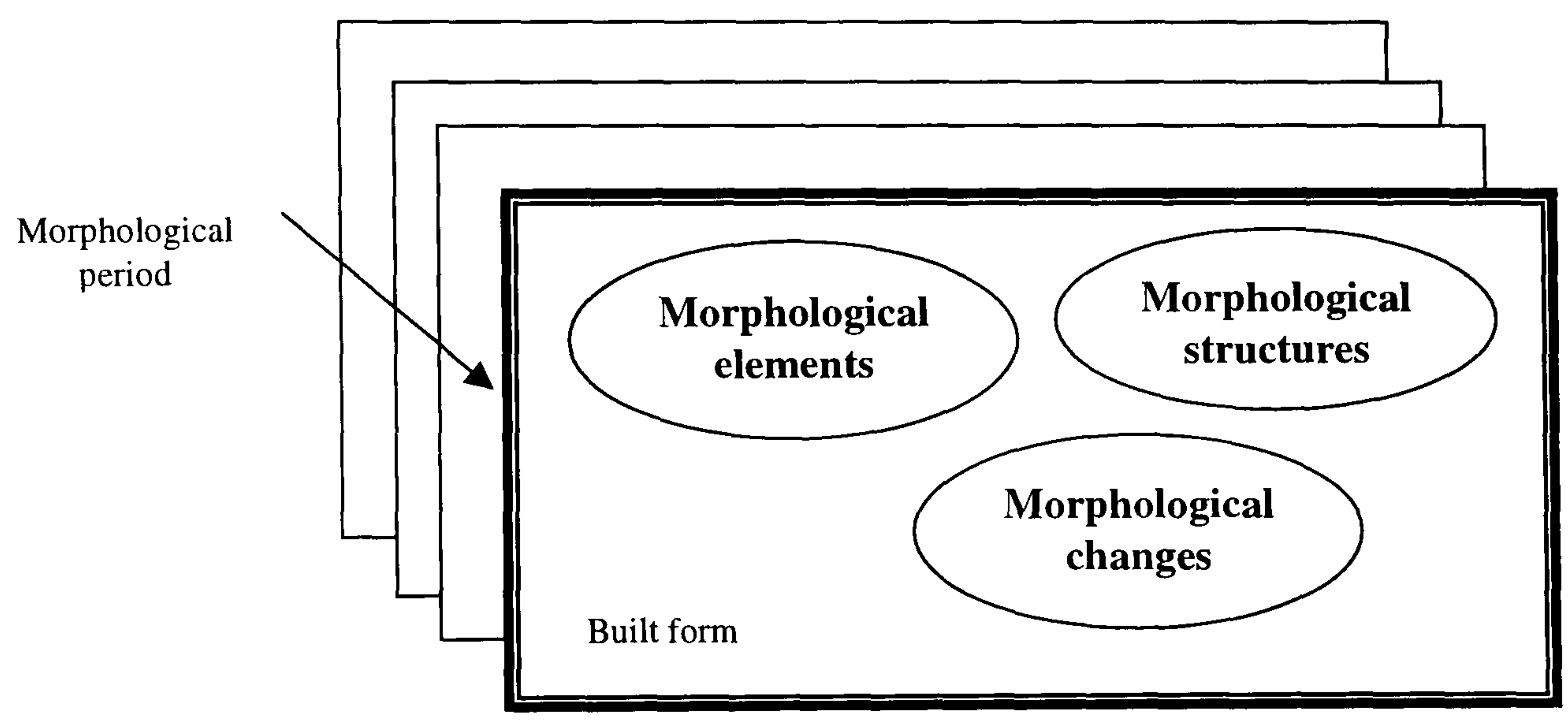


FIGURE 2.4: THE BASIC COMPONENTS OF AN URBAN MORPHOLOGICAL ANALYSIS, BUILT FORM AND MORPHOLOGICAL PERIOD

2.2.4. THE RESEARCH PROCEDURE

The emphasis of the study will be placed upon the existing situation of the built environment, which involves direct observation, by site survey and intensive fieldwork. The processes being intended to lead not only to an objective observation and description but also to a deeper understanding and analysis of the existing built environment. Therefore, the morphological study of a built environment is likely to be involve three stages: investigation and observation; analysis and conclusion (See Figure 2.5).

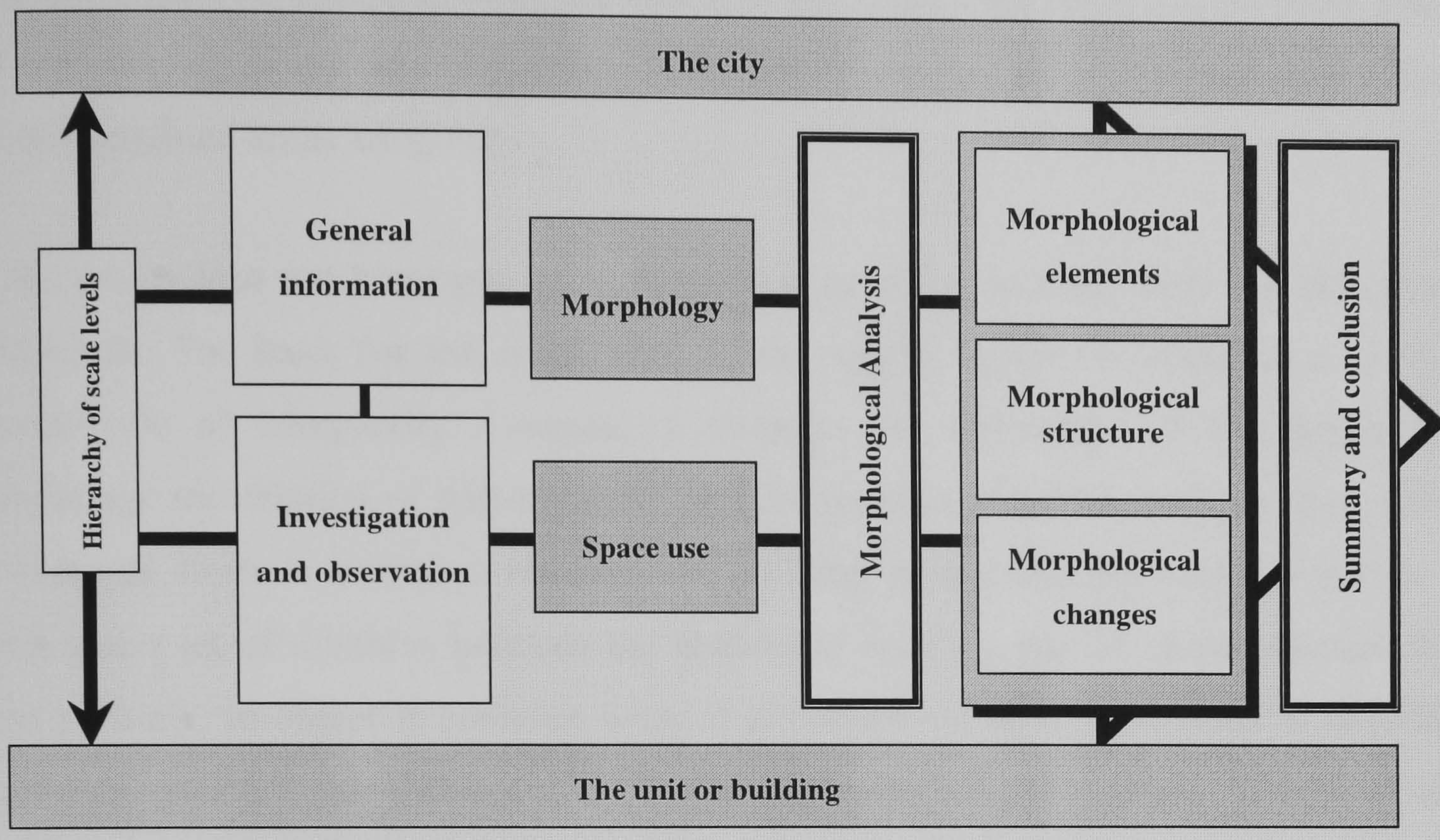


FIGURE 2.5: URBAN MORPHOLOGICAL ANALYSIS AS A PROCESS

2.2.4.1. THE INVESTIGATION AND OBSERVATION

The first stage of the morphological study is an attempt to examine the existing built environment in order to gather together the necessary information which the second stage, the analysis, requires. In undertaking such a field survey it is expected that the material collected will cover the history of the built environment as well as its present situation.

The present morphological analysis of a settlement assumes that the settlement has a nature of totality, which initially refers to a sense of integration and structuring. It is obvious that in the settlement there is a great variety of physical elements and activities in evidence, such as houses, factories, commercial zones, public services and activities, streets and communication networks, etc. Altogether these elements comprise territorial habitats within which people live, work, and seek their physical, spiritual, and intellectual interest. Therefore, a morphological study should not limit its scope, but deal with comparatively large areas. It has to be noted here, however, that in the present research only some small parts of defined geographical areas of Yazd have been chosen to be the subject of analysis. It is clear that a larger study area could not be dealt with comprehensively in the time available. At the end of chapter three, the reasons for the choice of defined areas are given.

As the city is also not homogenous, a distinction needs to be made between different scale-levels. The basis for the subdivision of the spatial aspect of urban areas is the characteristic of complexity. Complexity assumes the distinction of two kinds of relationship: the relation of part-to-whole and the relation of part-to-part. In the block for example, there is a relation between the building groups and the block of part-to-whole and a set of relations between the individual building groups of part-to-part. In terms of form, an object is complex when it is considered to be composed of several smaller objects. A block within a town, for example, is a complex object. The block is identified as an entity but on examination can be seen to be an arrangement of individual building groups. The subdivision of the form of urban areas is based of this complexity. Therefore, it should be noted that it is not easy to identify scale levels and the boundaries between them and each scale level may have its own logical arrangement, it may not be possible to analyse it as a completely independent entity.

In practice, The distinction between different scale levels may also be made based upon following considerations:

- a clear functional boundaries of the area such as urban built up housing estate, shopping area etc.
- a clear bordering features, such as city walls, railways major traffic roads, etc.
- an administrative definition,

In the present study, at the outset it was intended to examine the chosen settlement at four scale levels, the city, district, block and unit. However, after a preliminary site survey and collection of data it was realised that for more precise analysis and the nature of built environment it might to be altered into five scale levels (See Figure 2.6). Therefore, the examination of the physical fabric of the selected settlement that of Yazd has been conducted at five scale levels, the city, the district, the block, the building group and the building or unit. These may be described in more detail as follows:

1- City level: the study area examined at this level is, for example, that within the limit of the settlement bounded by the city wall or other administrative boundaries. At this level emphasis tends to be on transport and on broad morphological changes. The area generally consists of buildings erected at different periods.

2- District level: a city tends to be divided in a relatively uniform manner into often fairly similar portions loosely called districts, of which one or more may be chosen for detailed study. The area is frequently broad enough to include a large number of the elements of the city.

3- Block level: within the district or districts, a number of blocks may be identified for more detailed analysis in terms of their spatial organisation. Usually a block occupies a piece of land of several hectares, including several building group and surrounded by first or second layer of street system.

4- Building group level: within the blocks, a number of building group may be identified for more detailed analysis in terms of their spatial organisation. Usually buildings group includes several units and dwellings and may define as a cluster of units which is surrounded by a mean of alley system.

5- Building or unit level: at this level of study the dwelling or functional unit within the building group is given more detailed study.

It may be the case, nevertheless, that distinctions between scale-levels are not all that easy to identify that some overlapping may be present. It may not be possible to analyse each scale –level as a completely independent entity.

The processes of investigation and observation therefore carried out at five scale levels as a top-down procedure. In this way through the processes of analysis the lower level case(s) may be examined in the light of investigation and analysis which already carried out in the upper levels. Therefore, the study will examine the settlement and move from broad area toward the smaller components.

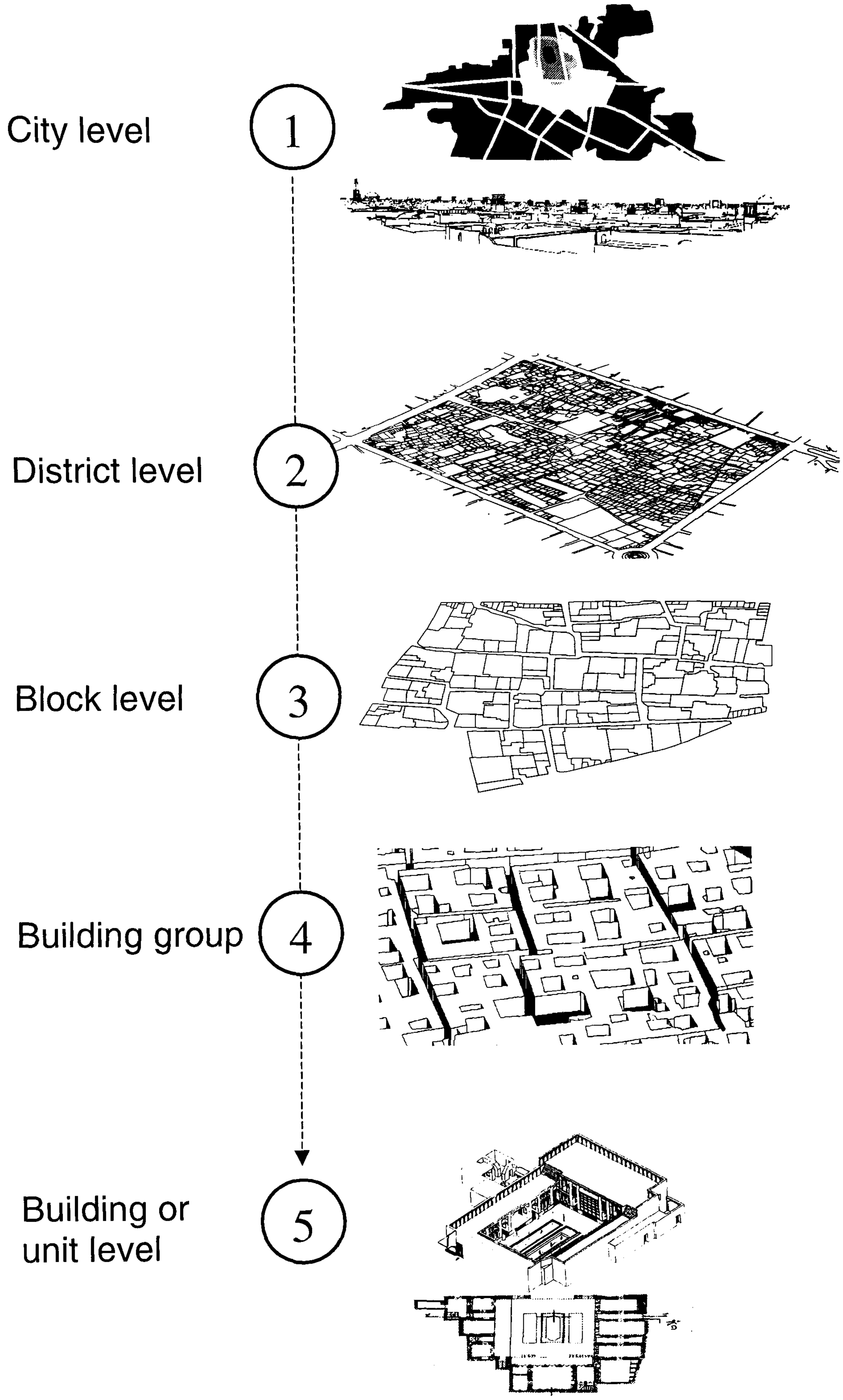


FIGURE 2.6: MORPHOLOGICAL ANALYSIS AND SCALE LEVELS

2.2.4.1.1. SOURCE OF INFORMATION

The main sources for sources such as historical investigation and observation are history and urban historical books and other archives. Maps and original pictures are particularly valuable, since they transmit most directly the physical reality of the spaces. In this way, the starting point for morphological analysis is the map and other relative information. In this case, the map is based on the latest available survey map from the Yazd City council (1998) in addition to a map which was produced by the office of the Yazd Water and Sewerage Co. (Sazmane-Ab-va-fazelab-Ustan-e-Yazd) in a digital format in 1998. Other information collected from the latest city survey in a very detailed form on Yazd by the Yazd City Council (1998). Historical maps belong to the period before the first Iranian Census in 1956 are very rare. However by reference to some historical books and other works on Yazd the historical form of the city is demonstrated.

Additional information can be found in old and recent writing on related subjects, such as those from state organisation, local and municipal leaflets, comments in journals, published and unpublished research works carried out at Iranian and other universities, and so on. However, since not every step of the urban development will necessarily have been recorded, a full picture may not be available. The processes of historical investigation should thus not be expected to present an entire picture of urban development.

Information on the existing urban form, including buildings and spaces, in the city of Yazd has been collected principally from direct site survey and from plans produced at various times. The data collecting process was not expected to be carried out as a phase distinctly separate from the phase of analysis. Both were likely to be undertaken virtually simultaneously in a process where each informs the other. In addition to the available maps, the actual physical data including the situation and conditions of the study area will come from field surveys using maps and plans as a basis, such as 1/20,000 plans for examination of the city level and 1/2000 plans for the district level, 1/500 plans for the block and building group levels and 1/200-1/100 plans for the building or unit level. Furthermore in this work try to use computer aided design as a tool to reproduce maps and data analysis.

At the outset a preliminary list of the subjects upon which information would be collected was made. However, in no way did this exclude the possibility that initially unconsidered features would perhaps have an important part to play in determining the morphology at a particular scale-level and would thus be identified. As the observations proceeded the importance or otherwise of the certain elements was expected to become apparent. Figures 2.7, 2.8, 2.9 and 2.10 give the basic list that was used as an aid to the collection of information. The collected information was intended to be recorded in graphical form and in writing, grouped in the selected case study areas according to various scale-levels of the morphological analysis.

2.2.4.2. THE PROCESSES OF ANALYSIS

The second stage involved an analysis of the collected information, particularly in relation to the case study areas. The intention of the exercise was to consider the data collected with the following aims in mind.

- To identify those elements, their positioning, functions and dimensions, that seemed to be responsible for determining the morphology at each scale level in each selected area and to seek the relationship between them.

- To give some account of development rules or principles which generally appear to have produced the existing morphological structure.

- To note ways in which the current morphological structure seemed to be changing in order to meet new requirements.

It was realised that it may be possible for different interpretations to be placed on the survey data at this stage. The urban morphological analysis was by no means necessarily expected to present clear and simple solutions.

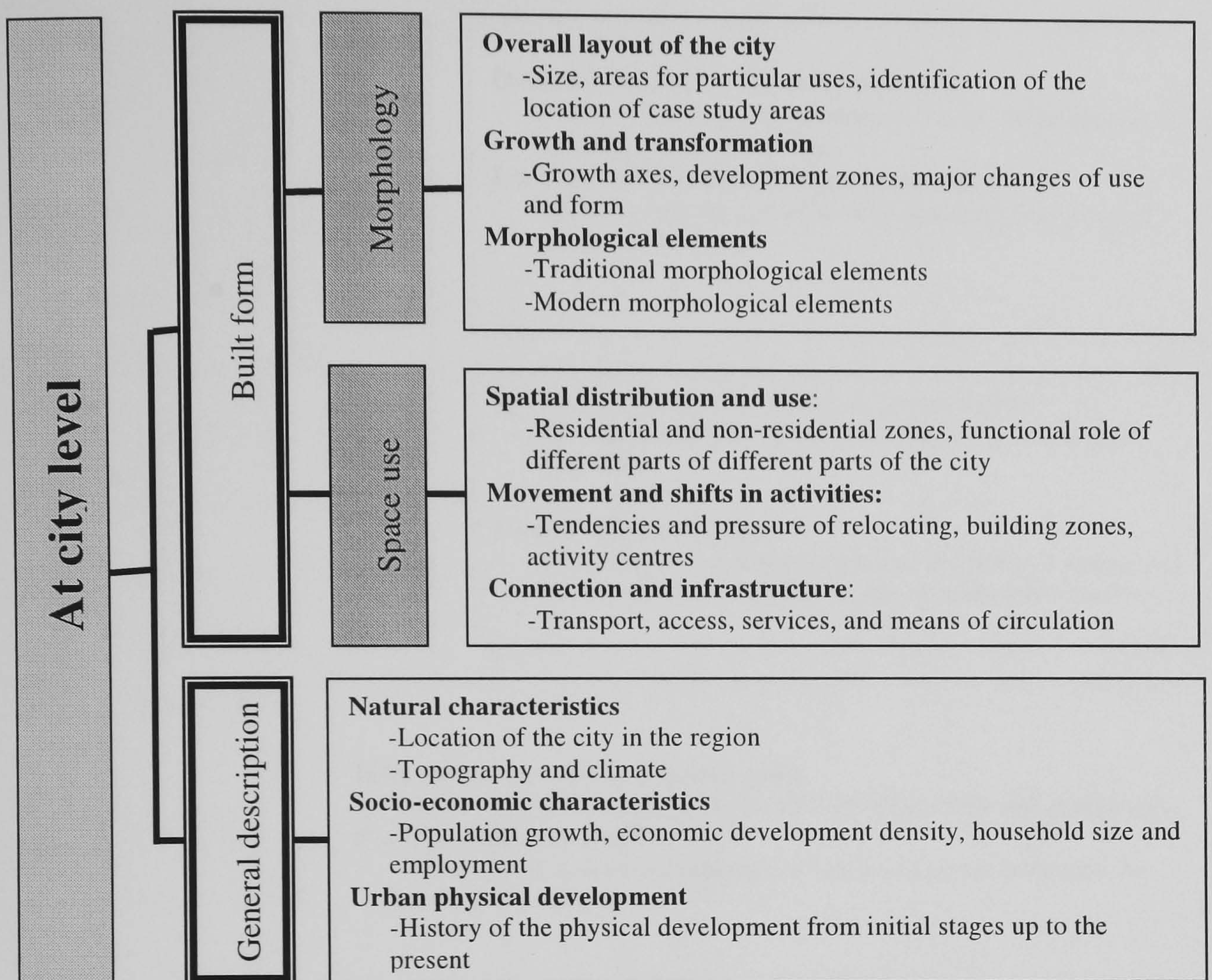


FIGURE 2.7: THE DATA COLLECTION PROCESS AT THE CITY LEVEL

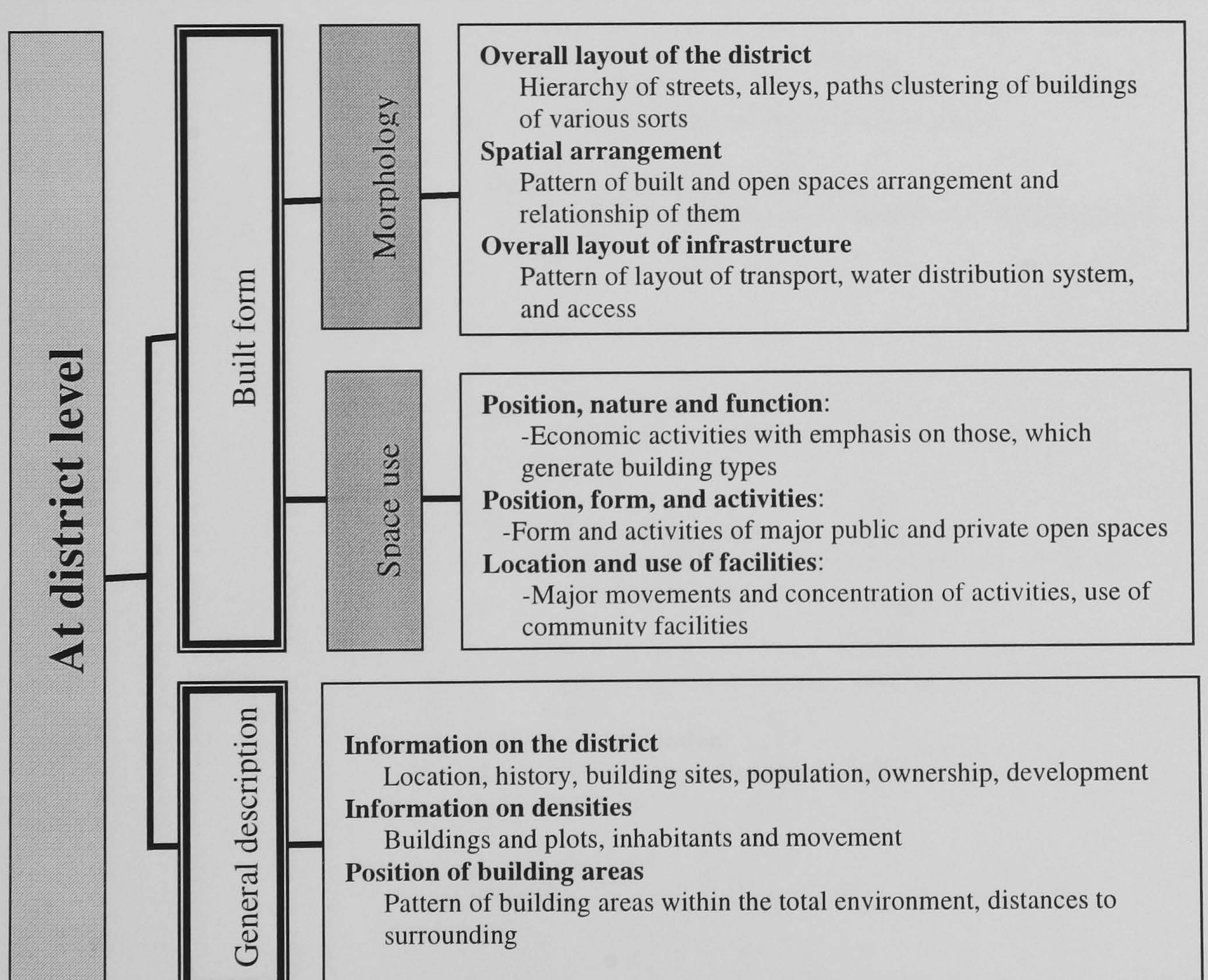


FIGURE 2.8: THE DATA COLLECTION PROCESS AT THE DISTRICT LEVEL

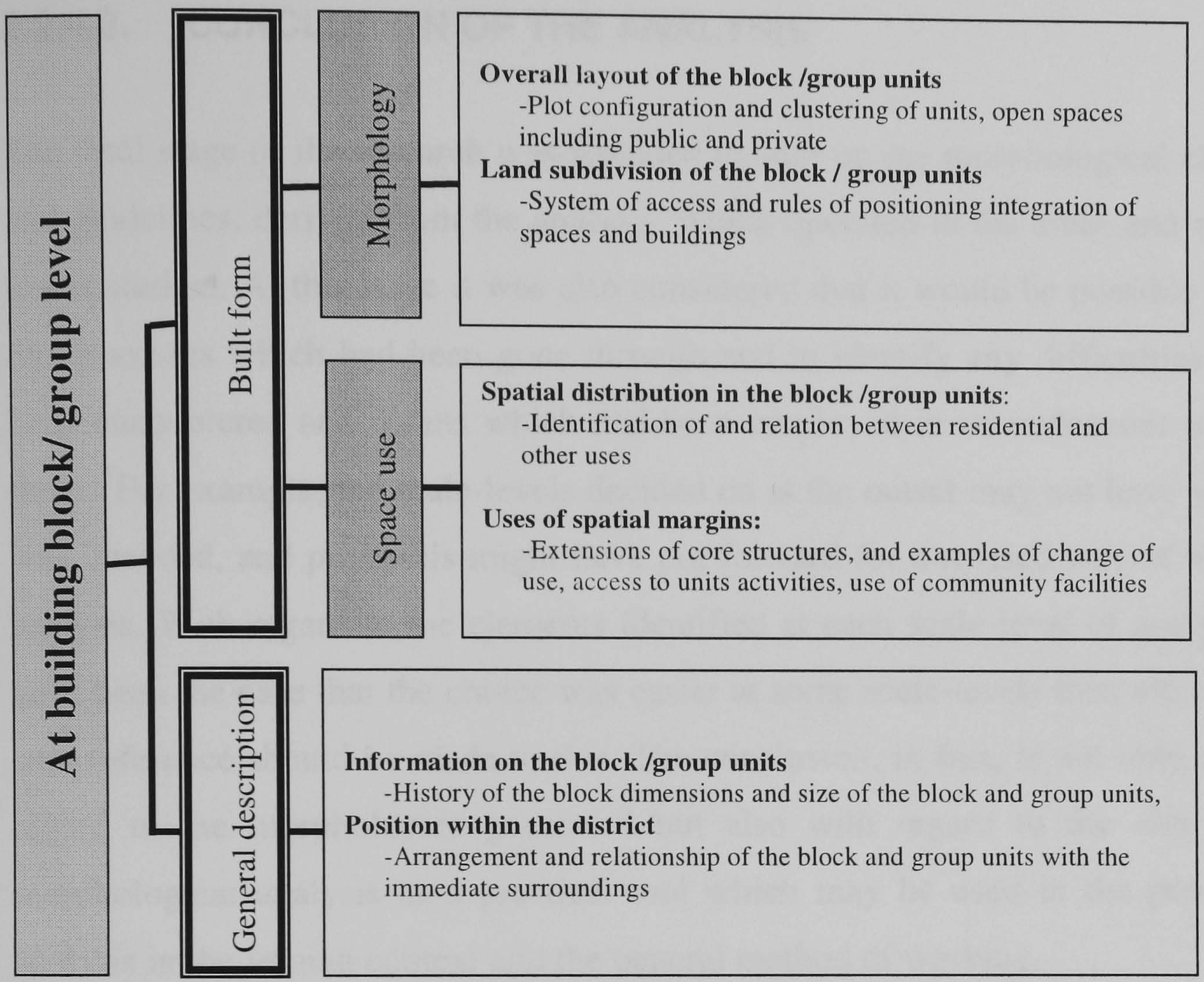


FIGURE 2.9: THE DATA COLLECTION PROCESS AT THE BLOCK AND BUILDING GROUP LEVELS

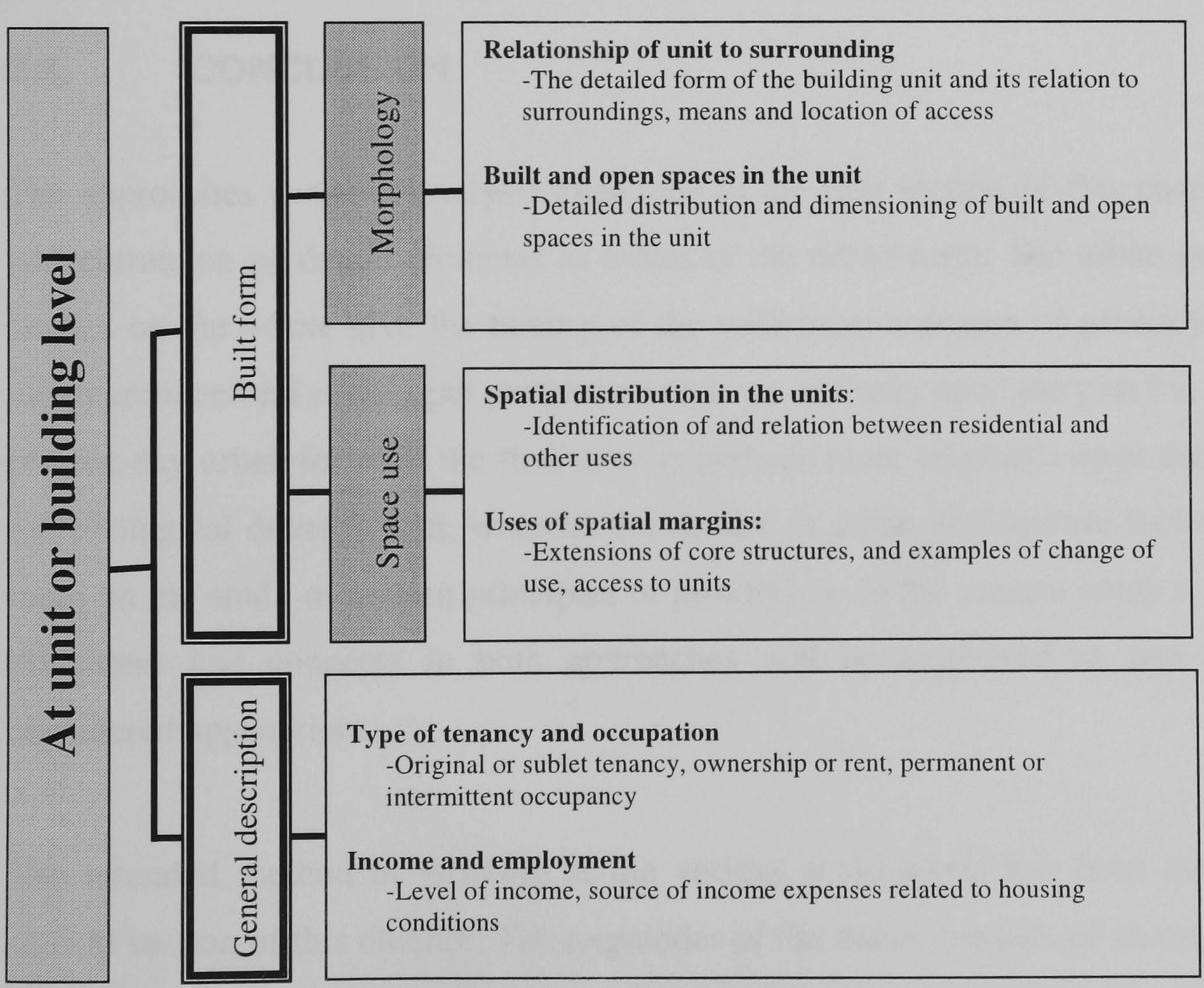


FIGURE 2.10: THE DATA COLLECTION PROCESS AT THE UNIT LEVEL

2.2.4.3. CONCLUSION OF THE ANALYSIS

The final stage of the research was intended to sum up the morphological characterises and guidelines, derived from the analysis, which operated in the areas and at the scale-levels studied. At this stage it was also considered that it would be possible to examine the processes which had been gone through and to identify any difficulties which had been encountered and means which had been employed in an endeavour to overcome them. For example, the scale-levels decided on at the outset may not have worked as it was intended, and proposals might have put forward for a revised way of working and analysis. With regard to the elements identified at each scale level of analysis, it may have been the case that the choice was easier at some scale-levels than others, in which case reference should be made to this. The conclusion, in fact, is not only simply with regard to the morphologies generated but also with regard to the aim to develop morphological analysis as a practical tool which may be used in the process of city analysis in the Iranian context and the general method of working.

2.3. CONCLUSION

The approaches to urban analysis examined in the first section of this chapter tend to concentrate on particular elements as issues of the urban form. The urban geographical studies on the whole give the history of the settlement a degree of primacy, while the urban architectural studies put particular emphasis not only upon the past but also on the present-day urban form. In the first there is perhaps more emphasis upon the process of morphological development, whereas the studies in urban architecture focus somewhat more on the study of pattern principles or prototypes. In the present study it is intended that ideas and concepts in both approaches will be employed as and when it is considered appropriate.

The intended method of working at the various scale levels has been outline in the second section of this chapter. The remainder of the thesis consists of an explanation of the results of the survey and analysis, initially for the city of Yazd based on its historical background and then for selected case study areas or districts within it.

Chapter Three:

3. THE CITY OF YAZD: A TRADITIONAL CITY IN TRANSFORMATION

This chapter concentrates on an examination of the basic physical and spatial aspects of the main elements of Yazd[1]. The city of Yazd is, as previously mentioned, an outstanding example not only of a present-day Iranian city but also of an Iranian traditional city. This part of the research consists of a brief description of the region in which the city is located, followed by a general discussion on the morphological formation and transformation of the urban fabric of Yazd. The stress on the physical-spatial aspect of the built environment and a historical review emphasis the importance of the morphological approach and identifies the important events in the city history and the periods associated with them. Finally, for more detailed analysis, it identifies some parts of the urban form, which resulted from these periods. The considerations for the choice of the particular area selected for further morphological study are given at the end of this chapter.

3.1. GENERAL DESCRIPTIONS

3.2. THE CITY IN ITS REGION

The city of Yazd is located in central Iran and the capital of the Yazd province. It is close to the desert (Kavir) at the centre of Iran. It is situated at a distance of 677 kilometres from Tehran, the capital of Iran. Yazd province is bounded in the north and west by Esfahan, in the east by Khorasan, in the south-west by Fars and in the south-east by Kerman, provinces (See Figure 3.1-a).

Due to climatic conditions, there is a great shortage of upper ground water in this province and in the neighbouring areas. Water is supplied to the different parts of the province through about 2615 Qanats (tunnels dug to carry water) and several deep wells. The Qanat is a natural way of extracting underground water and carrying it to the surface without pumping. Today the shortage of water is one of the main reasons for the tendency of the province to industry rather than agriculture. Because of the lack of underground water reservoirs and the rapid growth in population, a project has been started to transfer water to Yazd from Esfahan, a province located to the north of Yazd

[1] In some English documents the city's name is spelled as 'Yezd'

and more than 400 km from the city of Yazd. This project is expected to be finished in 2001.

According to the history of Yazd (Afshar, 1995), since the Sasanian dynasty (224- 651) the city and its region have been famous for beautiful silk textiles which were rivalled in later periods only by those of Kashan and Esfahan. The region is still a major centre of silk weaving. It has spinning and weaving mills, a plant for the manufacture of water purification and filtration equipment, and considerable mining and quarrying activity; copper deposits nearby are processed at the Sar-Cheshmeh (a region near Yazd) facilities.

Although there was a shortage of water in the region, the economy of the area in which Yazd is situated was dominated by agriculture and was modernised through the establishment of farm corporations and processing centres for agricultural products. The chief crops grown include wheat, barley, cotton, oilseeds, indigo plants, fruits, and vegetables. Almonds, fruit, and some grain are grown near the city. The city is developed as one of the main industrial regions in Iran. Textile industries and handicrafts, carpets, rugs etc had an important root in the historical background of the city in the past. Today industry has made considerable progress in the Yazd province.

The province contains a population of 763210 (1.25 per cent of total population of Iran), of which 588491 are urban (Sazman-i Barnamah va Budjih, 1998). The surface area of the province is 76156 square kilometres (4.54 per cent of the total area of Iran) (Sazman-i Barnamah va Budjih, 1998). The province includes eight urban regions (See Figure 3.1-b) in which there are 15 Cities and 40 rural regions located in 15 counties. Administratively the Yazd urban area is divided into four urban and two rural regions. Table 3.1 listed the eight urban regions in Yazd province.

Counties	Number of regions	Number of cities	Rural regions
Yazd	1	4	2
Abarkoh	2	1	4
Ardakan	3	1	5
Bafgh	2	2	6
Taft	2	2	9
Sadogh	2	1	3
Mehriz	2	3	7
Mybod	1	1	2
Yazd province	15	15	40

TABLE 3.1: YAZD PROVINCE AND ITS URBAN AREAS

(Source: Sazman-i Barnamah va Budjih-i Ustan-i Yazd, 1998).

3.3. THE CITY OF YAZD

The city of Yazd is centrally located in Yazd province (See Figure 3.1-c). The city dates from the fifth century and was described as the 'noble city of Yazd' by Marco Polo. It stands on a mostly barren and sand-ridden plain area. Historically, Yazd has been the link between the provinces of Fars and Khorasan and between the west of Iran and Kerman, and it was situated at the intersection of the trade routes from central Asia and India. It earned the title of Dar-ul-ebadah (Home of Piety), owing to its many religious buildings. Some of the city's inhabitants are Zoroastrians whose ancestors had fled toward Yazd and Kerman when the Muslim Arabs conquered Iran. Yazd is now an important centre of Zoroastrians in Iran.

The city is well linked by road with Kerman, Qom, Esfahan, and Tehran and other cities in Iran and it is located on the main north-south railway route; it also has an airport.

For many years Yazd maintained its traditional typical Islamic-Iranian characteristics and is still known as one of the most interesting and charming of the cities in Iran. It is especially famous for its humanistic scale (Pirnia, 1992), organic city fibre and the traditional courtyard houses of extended families. In 1970 Yazd was selected by the 'Sazman-e-Mirase-Farhangi Iran'[2] as one of 27 cities and towns throughout the whole country for revitalisation of the historical part of the city. The idea behind this goes beyond the concept of placing cultural relics such as traditional buildings and monuments under state protection for restoration and preservation. The master plan of Yazd and the comprehensive plan for the old part of the city also aimed to preserve the old part of the city, not only for the enjoyment of tourists, but also for the protection of the historical character of the old part of Yazd to continue its normal life within the city as a whole. The main aims and objectives of these plans will be discussed in part 3.5.3 in this chapter.

Many of the inhabitants of the old and historical parts of the city and some people from outside the area like to live in the old part of the city, however, some of them are not in the position to pay for proper maintenance and some others mentioned the lack of facilities in the area (Mohammadi, 1993). Many of the often very beautiful old houses have therefore been neglected; even to the extent that utter dilapidation has taken place. However, these areas are still living quarters for many families.

On the other hand the city expanded very fast during the last century and today it not only consists of some old built environment but also includes a diversity of new urban tissues. These newly built environments confronted some basic spatial problems such as lack of functional and spatial organisation (Mohammadi, 1999).

Today the city of Yazd contains a population of 326776 and 73228 families in an area of 99.5 sq. km (Sazman-i Barnamah va Budjih, 1997: 31). The city is generally divided into two parts the old city and the new city. The old city covers an area of about 550 ha,

[2] Organisation of Cultural Heritage in Iran

in which the historical (walled) city is centrally situated. The area covered by the walled city is around 98.5 ha. The city itself is divided into 8 regions.

3.4. THE ARCHITECTURE OF YAZD AND ITS GEO-CLIMATE

The city of Yazd is located at the edge of a large desert area more than 1320 meters above sea level. The city is situated on the southern borders of the desert of the Iranian plateau and, as is common in desert regions its climate is hot and arid. The weather during the summer is hot and dry. It is cold and dry during the winter. The maximum temperature in summer is about 42 degrees and in winter it may come down to –8 degree. The temperature here varies greatly from day to night, as well as between the long summer and the short winter, while the average humidity rate is about 10%. The average rainfall on the plains is about 50 mm and 112-240 mm in mountain areas.

Most of the villages and places where the weather is pleasant in the province are situated around the towering mountains like Shirkuh (4075 meters) located to the south and south-west of the city from where most of the water-storage of the city is supplied. A network of Qanats links the city with the edge of this nearby mountain.

The main feature of the environmental conditions of Yazd is heat and aridity, which is a severe condition for human existence. The hostile living conditions in the hot and dry desert have forced the people of this city and its region to try to overcome their environmental problems, using a variety of means. In arid climates nature always threatens man, and the human way of life represents no identification with nature. In this way there is a conflict between man and nature. Whatever man can create, with his intelligence and work, is highly valued.

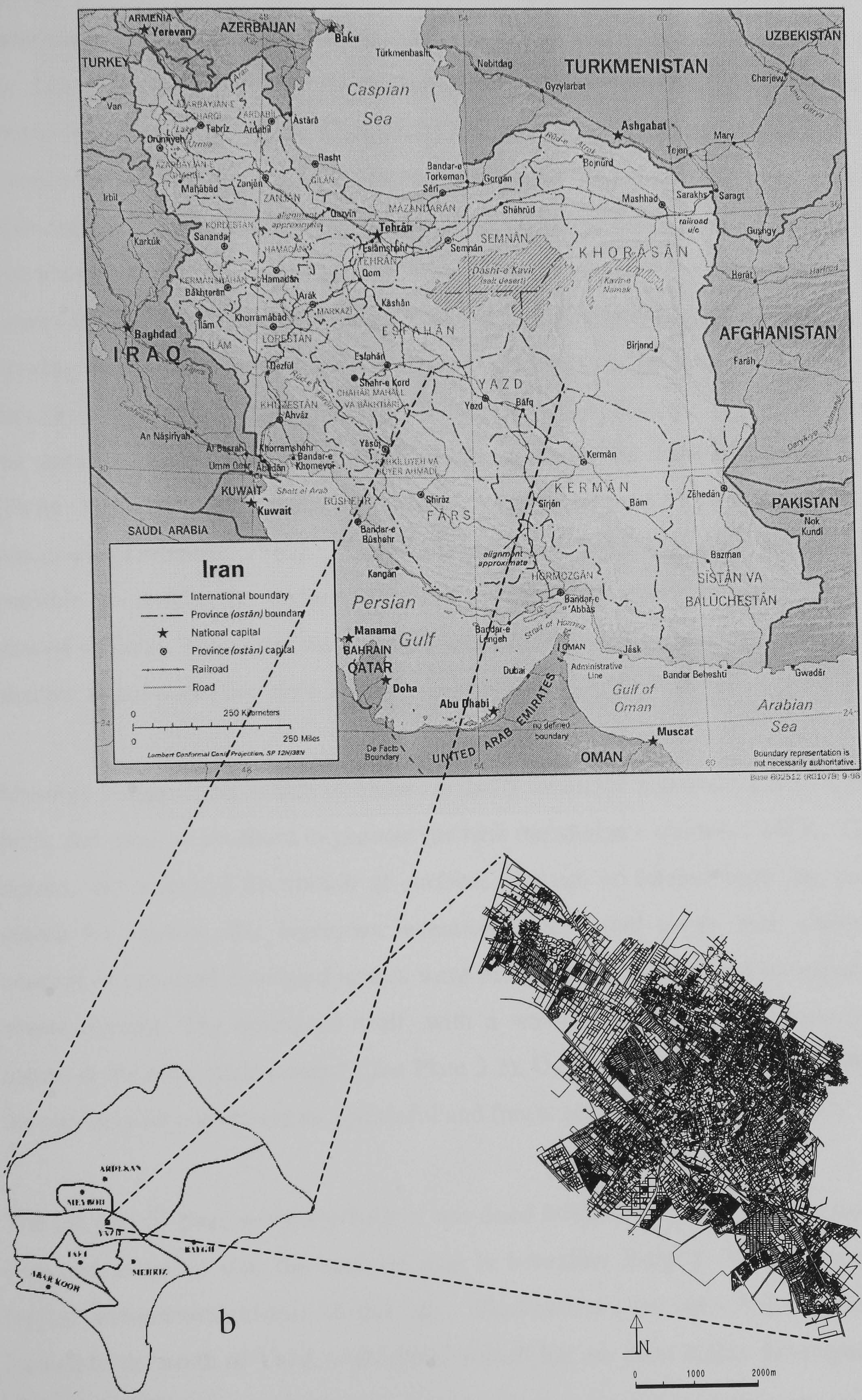


FIGURE 3.1: A- LOCATION OF THE PROVINCE OF YAZD IN IRAN. B - THE PROVINCE OF YAZD IS INCLUDED EIGHT URBAN REGIONS (SAZMAN-I BARNAMAH VA BUDJIH, 1998). C – THE CITY OF YAZD IS CENTRALLY LOCATED IN THE YAZD PROVINCE

Special climatic conditions of the region might have constrained the people to follow a particular architectural style. The architecture of the historical part of Yazd is perhaps the most traditionally Persian to be found, preserved by the hot and dry climate and spared the devastation of the Mongols (1220) and other invaders (Afshar, 1995). The layout of old Yazd was strongly adapted to climatic conditions. (Gideon, 1983). It has been argued that, the marked uniformity in the historical urban area of the city of Yazd like many other cities of Iran and the Middle East is due to the significance of climatic factors in their urban forms. This has been best characterised by two features: narrow, twisting alleys, and large open courtyards and internal gardens. The narrow alleys served as reservoirs of cool fresh air. The courtyards with their close vistas performed the same function by retaining any cool air that may be deposited during the night (Fathy, 1986: 64). High walls and deep courtyards were used to enhance these cooling processes (Tavassoli, 1982). The walled city of Yazd was built as compactly as possible, to reduce the surfaces in direct contact with sunshine and to increase the shaded surfaces. The alleys were narrow and twisting with overhangs to create as much shadow as possible (See plate 3.1).

Masonry construction, which is based on easily available material such as earth, crude brick and mud, is excellent to prevent the heat transference (Gideon, 1983). The use of domes, the colourful decoration of surfaces, the use of filtered light, the continuous search for shadow, the ingenious invention of the wind tower, and, above all, the concept of enclosed courtyard spaces were partly developed in Yazd in response to the severe climate. The courtyard itself, with a water pond, trees and plants represents nature in the man made context (See Plate 3.2). Only the earth-coloured architecture of the city may be considered as a peaceful and free extension of external nature.

The old part of Yazd is mostly built of sun-dried bricks and the walls are plastered with clay and straw so that the summer heat is tolerable. Badgirs (Wind-catchers) are a typical architectural feature of this city. Wind-catchers are seen from Kashan, a city located to the north of Yazd, to the Persian Gulf but are most highly developed in Yazd (See Plate 3.3).

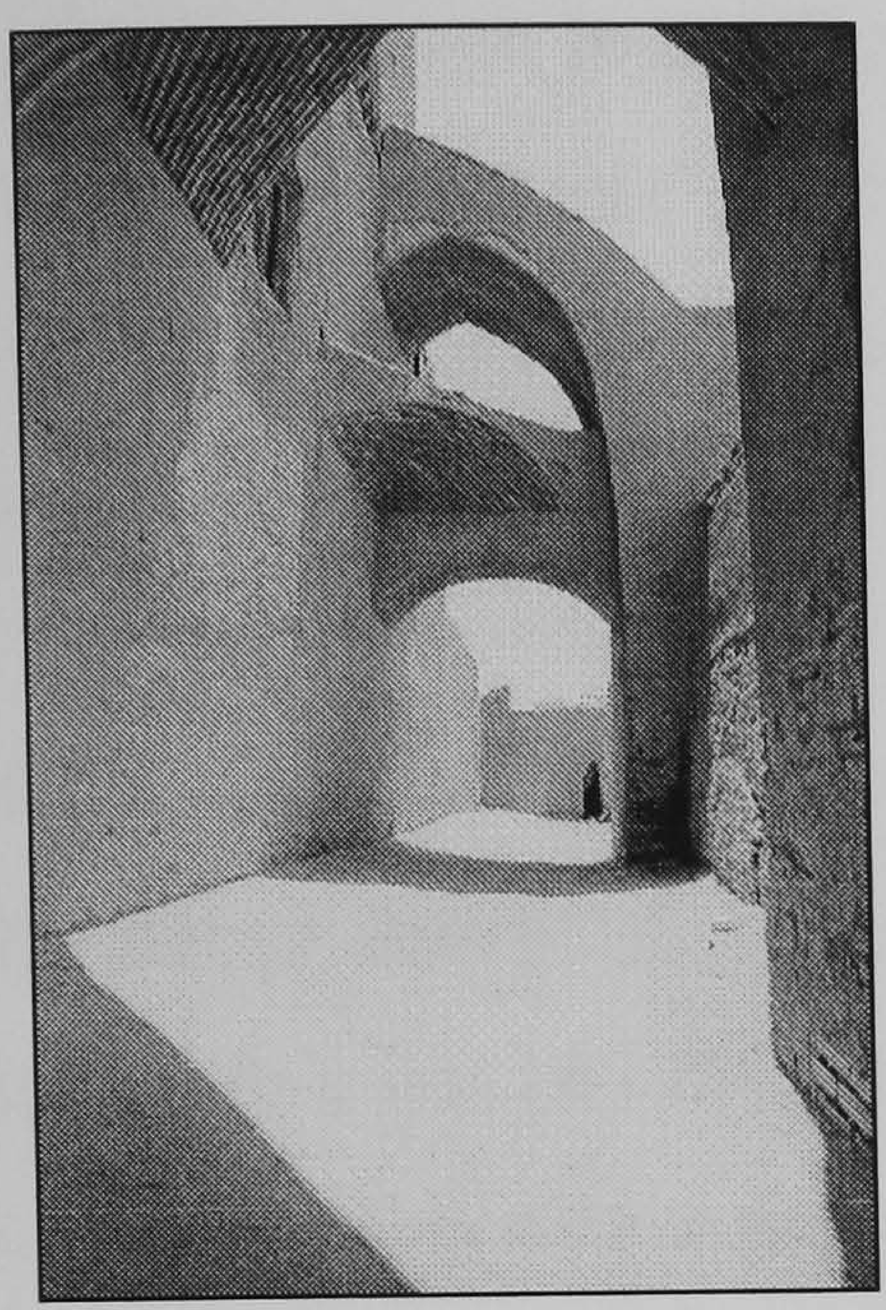


PLATE 3.1: LEFT- AN EXAMPLE OF AN ALLEY WHICH WAS TREATED BY MEANS OF OVERHANGS AND IT WAS NARROW TO PROVIDE SHADE AND SHADOW IN THE HOT AND DRY CLIMATE. TOP RIGHT – A GENERAL VIEW OF THE COMPACT FABRIC OF THE HISTORICAL CITY OF YAZD.

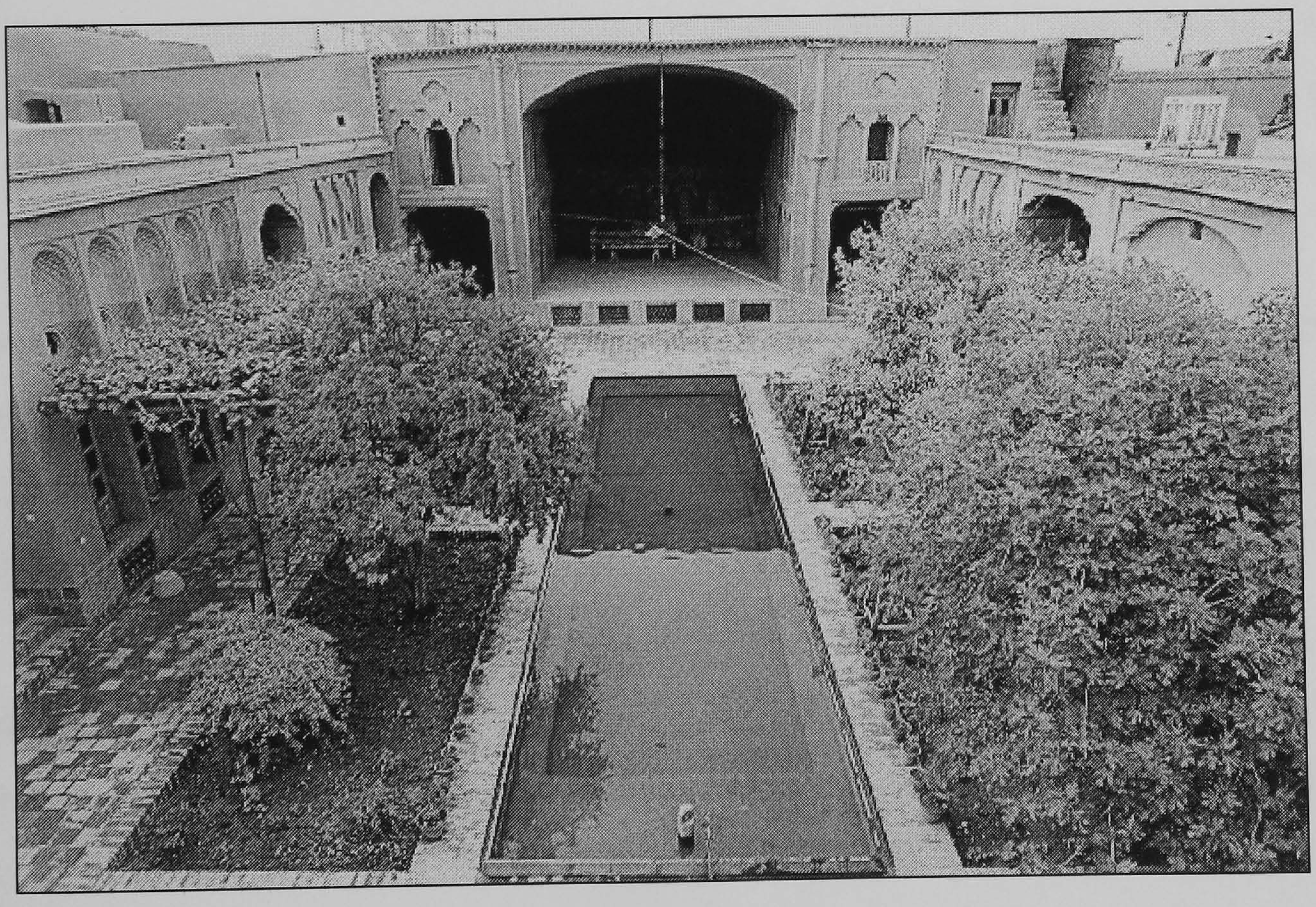


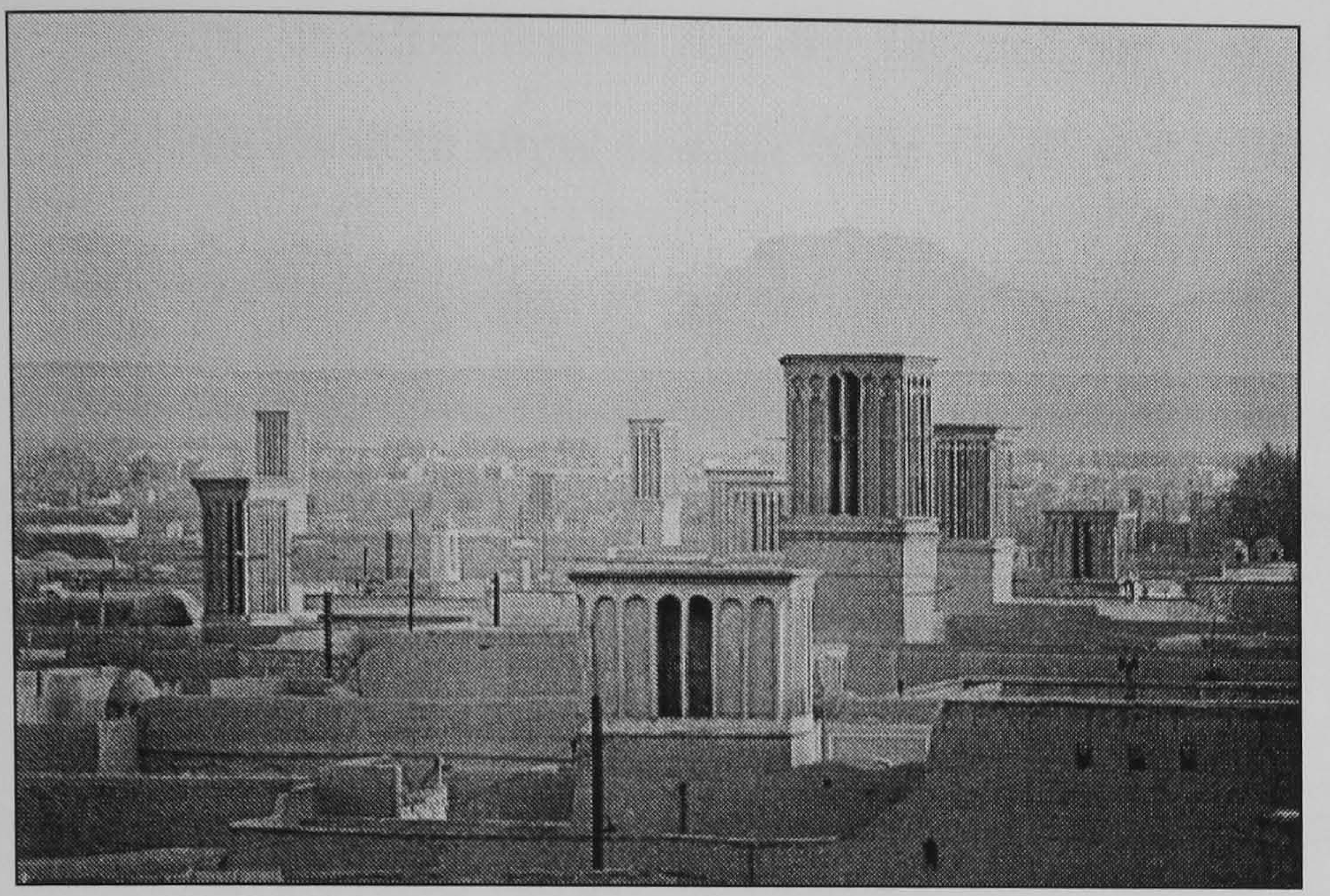
PLATE 3.2: AN EXAMPLE OF THE ARCHITECTURE OF A DWELLING UNIT IN THE WALLED CITY

Yazd is also famous for its striking panorama, adobe dwelling, distinctive domed roofs, arched Talar, wind-catchers which are wholly combined with each other. Water also shows its importance in dwelling units and the walled city of Yazd as a whole, mostly in the form of 'latent water'. According to the nature of water and its level in the location of a building, special spaces are likely to be created to use water and its benefits. There is a latent ground line which is dynamic and varies in different locations. When the level of water is low, spaces such as deep courtyards and under ground basements which have a direct connection to the water encourage the circulation of humid air within the spaces of the dwelling. As a result the spaces are very convenient for residences in a hot and dry climate. In the historical part of Yazd most of the dwelling units have either a direct relation with underground waterways, or in some cases, there might be a well mechanism to ensure proper access to underground water.

The main passageways of the Qanats are mainly under dwelling units or sometimes under the main alleys or close to and parallel with them. The Qanat also serves public water reservoirs and other public buildings, including mosques. Those parts of the city that do not have the possibility of access to the water mainly use a well from which water is extracted and reserved in the water reservoirs near to the kitchen of the house.

The walled city is oriented from the north-east to the south-west. Some urban specialists believe that this orientation allows prevailing south-west pleasant winds to be able to cool the houses and protect them from direct sunshine in summer and to use maximum sunshine in winter (Gideon, 1983).

In contrast with the old city, the new developments in Yazd are marked by wide streets and an absence of central courtyards in most dwelling environments. In the morphology of the new public open spaces which have emerged in new developments, climatic rationality was rarely used as a leading guide. This loss of environmental awareness and predominance of other factors in the making of urban space can also be seen in the choice of building materials and form, although to a lesser extent.



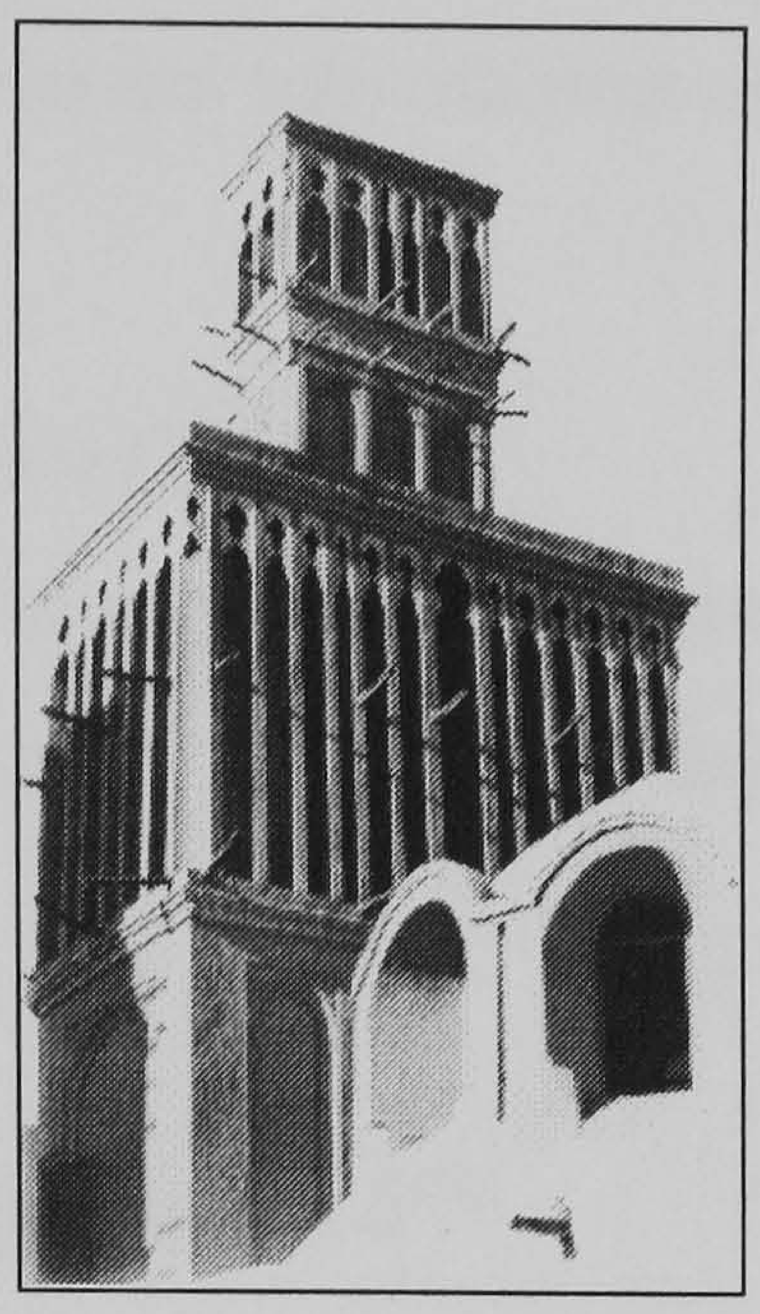


PLATE 3.3: A GENERAL VIEW OF THE OLD CITY. THE WIND-CATCHERS ARE ONE OF THE MAIN ELEMENTS OF THE CITY SKYLINE

3.5. THE CITY-LEVEL MORPHOLOGY OF YAZD

This part of the research concentrates on an examination of the basic physical and spatial aspects of the main elements of Yazd, regarding to their process of development in the history. Whilst examining morphological elements of the city inherited from various recognised periods of development it does not aspire to be a pocket history of Yazd. Attention is paid to the basic city layout and the elements of which it is composed in the certain periods of time. Further emphasis will be placed on the process of formation and transformation of the city as a whole.

From the history of urbanisation in Iran may conclude that the development of most Iranian traditional cities has generally taken place in three historical periods (Habibi, 1996). Each period is characterised by a historical event or/and defined by a physical boundary like the defensive wall or streets. With the exception of some cities in Iran, the major historical periods in the case of Yazd are those applicable to the rest of Iranian cities (Haeri, 1993). In this way the development of Yazd may be divided into three main historical periods as follows:

1- The development of the city within the walled city up to the late 14^{th} century (Historical City)

2- The development of the city beyond the wall up to the introduction of the first modern street system in the 1920s (Old City)[3]

3- The development of the city in the last 75 years (New City)

In the following section, the above considerations are adopted in the classifications of the history of urban development in Yazd and they are employed for morphological analysis of the city.

3.5.1. THE MORPHOLOGY OF YAZD UP TO THE LATE 14TH CENTURY (WALLED CITY)

3.5.1.1. HISTORICAL SETTING

The walled city of Yazd took shape during various stages up to the late 14th century (See Figure 3.2). History says (Afshar, 1966) that before Islam and in the Achaemenian period (550 BC-330 BC) a city known as 'Isatis' established at the locality of the present city of Yazd, though there remains no physical evidence of it. However, it is obvious that there was a city at the present locality of the traditional city or somewhere around it. According to another historical story (Afshar, 1966: 26-27) the foundation of Yazd dates back to the era of Alexander the Great, who established a prison for prisoners of war in the locality. He called the city 'Kasah'. There are a number of references (Masarrat, 1997) about construction of buildings, gardens, Qantas and wall around the city during this era. The most famous evidence of these eras is a building called Alexander's the Great Prison[4] situated at the centre of the present historical city. According to another story in the history of Yazd by Iraj Afshar (1995), during the Sasanian period the city was probably developed by one of the Shah's sons. His name was Yazdegerd. This may be the reason the city became known as Yazd.

The city was captured by the Muslim army during the third Muslim Ghalifa in the eighth century (Afshar, 1966: 30-39). The city grew around the inner city and to the

[3] In some old maps and documents, a new wall around the whole old city is addressed. (Bonine, 1980:103 and Afshar, 1995: 675).

[4] This building was constructed in the 1123. It is possible to be constructed on another ancient building which it was belong to that era

north-west of the Masjed-e-jame (Friday Mosque). Later a bazaar and several other buildings and neighbourhoods were added to the city. In the eighth and the ninth century, the city was developed to the south and new quarters were constructed.

The first recorded wall with four main gates[5] for the city was constructed during the 11th and 12th centuries (Afshar 1966: 61-62). Some parts of this wall are still in evidence in the north of the city. The city was mainly developed to the south-east. In this era the city centre was transferred to a new locality around Masjed-e-jame, where a new commercial centre, called Char Soqu-e-Shahi, including school and water reservoir was constructed (See Figure 3.2-b). The scale of construction during this period of history shows the importance of development in the city history. Perhaps the first major growth of the city was during this period (Afshar, 1995).

During the Mogul period (1256-1346) the city of Yazd like other cities in Iran, underwent no significant change in urban morphology. In the 14th century and during the Al-e-Mozafar dynasty a number of new buildings were constructed and the city grew toward the south and the south-west. A new wall with seven gates was also constructed (Afshar 1966: 83-84) (See Figure 3.2-c).

Three reasons are stated in different historical documents (Masarrat, 1997) (The first master plan, 1973) for selection of south and south-west direction of development. Firstly the direction of sandy winds in the region is from north and secondly suitable lands for building construction are located on the south and south-west. Finally, the direction of the underground water system is from the south and the south-west toward the city.

In general the development of the historical city of Yazd prior to the 15th century occurred in three distinctive stages (See Figure 3.2).

1- The city developed before Islam and in the early Islamic period
2- The city developed until the 12th century
3- The city developed until the 14th century

[5] Different number of gates are addressed for the city in 12th century

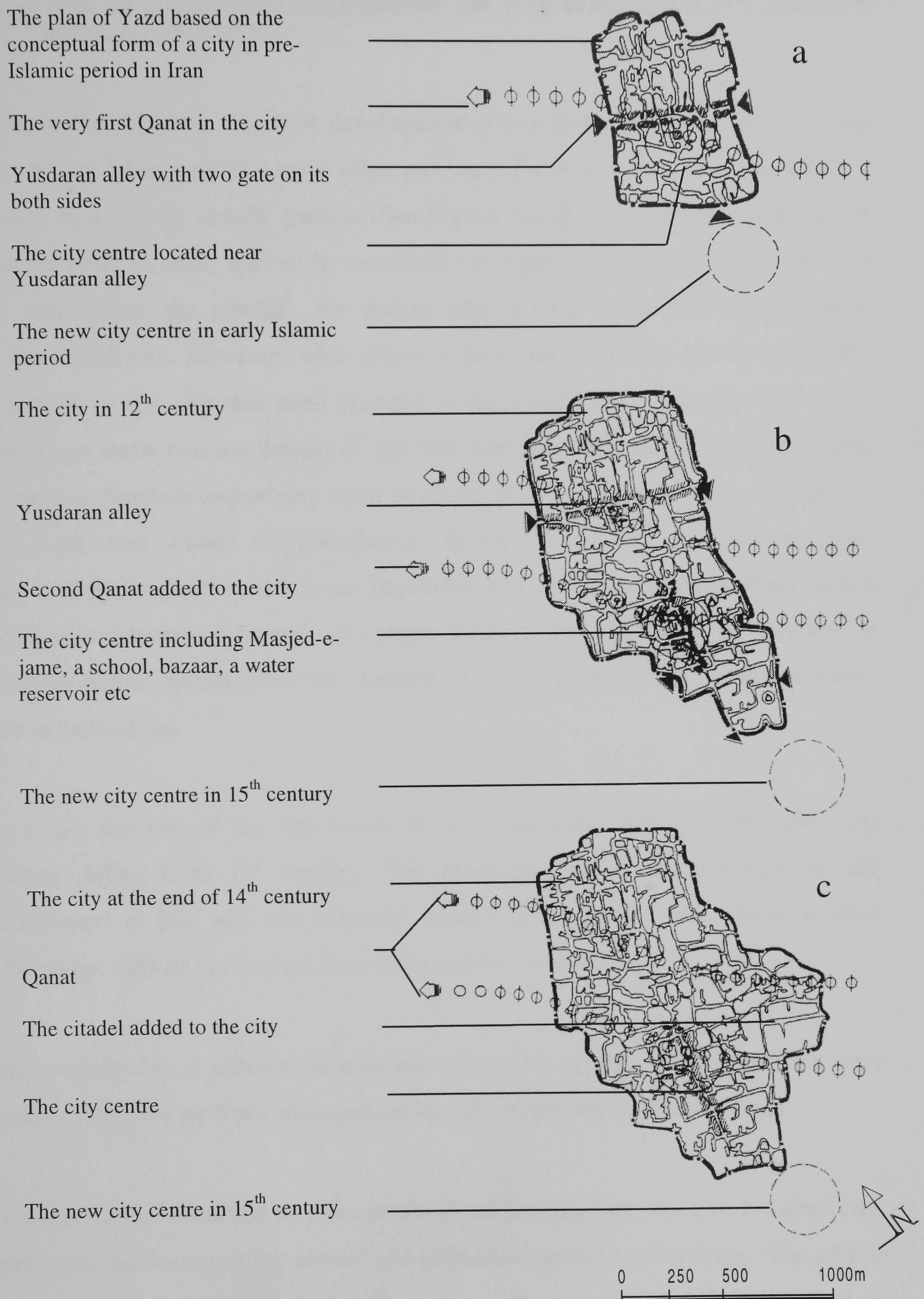


FIGURE 3.2: THE PHYSICAL GROWTH OF YAZD FROM PRE-ISLAMIC ERA UP TO THE 14TH CENTURY

3.5.1.2. THE SPATIAL ARRANGEMENT OF THE WALLED[6] CITY AND ITS MAIN ELEMENTS

According to the different stages of development found in the previous section Yazd was built before Islam and like most other pre-Islamic cities in Iran (Habibi, 1996) it was shaped in a almost regular pattern (See Figure 3.2-a). If the spatial structure of other Iranian cities in same era can be considered as a guide, Yazd may have consisted of three main parts, the citadel[7], the walled city and the immediate developments outside the walled city. However, what seems to be understood from history is that the regular pattern of the city was soon changed to an organic one. Records from about 1000 years ago show that the pattern of the city, like other Iranian post-Islamic cities, was an organic structure comprising main elements of such cities including a bazaar, a Masjed-e-jame, and several neighbourhoods. In the walled city of Yazd, religious buildings and open spaces acted as an important part of the city morphology where major religious activities occurred. At certain times of the year, both by day and at night, certain public spaces could be changed to religious spaces by some temporary structure or decoration.

Besides a few remains of the city walls, the city has many important mosques and mausoleums dating from 11th century. The Masjed-e-jame is distinguished by the highest minarets in Iran and was centrally located in the walled city, close to other public buildings such as the bazaar, the school and the bath-house etc.

The skyline of the city is picturesque with minarets and many tall wind towers that were designed to bring cool air from underground into the chambers of the buildings.

The enclosure can be observed on three levels of the morphology: the entire walled city, the government enclosure or the citadel and individual units like dwellings. The city as a whole was walled from the late 11th century. There is no physical evidence or historical document of a former wall. According to the remaining part of the wall it was

[6] The walled city here referred to is the enclosed city by the 14th century wall.
[7] The citadel was constructed in pre-Islamic time is not physically in evidence

constructed mainly of mud, however according to several historians and travellers there was no evidence of a proper military fortification (Malcolm, 1905). The city, because of its location in central Iran, was rarely attacked by outside enemies and there was no need for such military fortification. The wall protected the city from very occasional attacks by regional brigands. The city wall was rebuilt several times during the history of Yazd, mostly because of expansion of the city. The citadel was located in the south-east of the city and it was mostly developed within its own limited enclosure and it was located to the west of the city.

The enclosed courtyard style dwelling has remained as the common form of typical housing styles in Iranian architecture situated in hot and dry regions. Although the existing dwelling have been reconstructed several times in its history, however, the basic form of the enclosure was remained the same.

The hierarchy of spaces may also be identified in two ways. First, the organisation of the main elements of the walled city such as the sequence of the location of a dwelling unit, neighbourhood centre, mosque and bazaar according to theirs importance. They were occurred from the inner part of the city to the main gates. In this order a dwelling unit had a first degree of relation with a neighbourhood centre and then through a major alley was connected to the main mosque through which it was linked to the bazaar. The bazaar was mostly situated near to the gate inside and sometimes outside the city wall. Secondly a hierarchy of space was in evidence from major alley to semi-public-spaces and then joined to the dwelling units. Within each dwelling unit there were also two types of spaces which acted as a private and a semi-private space for people who were residents in the unit and guests, respectively.

The walled city consisted of several neighbourhoods[8]. (See Figure 3.3) Generally, in the city of Yazd, these neighbourhood subdivisions did not have any physical boundaries and the limit of each neighbourhood unit was usually defined by the

[8] These neighbourhoods are recognised by 'Sazman-e-Miras-e-Farhangi' (Organisation of Cultural Heritage) in Yazd. and also searched by the author within the city

possibility of easy access to those facilities provided in the centre, therefore, the area of each neighbourhood was considered according to this parameter[9].

Some of the main elements of the walled city may be summarised as follows:

- Neighbourhood units without any physical obstacle with each other including a different number of dwelling units and usually a centre
- Mosques and other public building with a direct relationship with neighbourhood units and the city as a whole. They were integrated elements of most neighbourhood units which provided some necessary needs and demands of the people who lived there.
- Religious open spaces located centrally in most neighbourhood units.
- Commercial centres in different scales located throughout the city.
- Alleys as a communication network provided hierarchical access from a dwelling unit to other city elements.
- Dwelling units gradually shaped the building groups and grew in the vicinity of the neighbourhood centres and their surrounding areas.
- Citadel as a governmental centre

As the area was subdivided into different neighbourhoods, major alleys generally separated them. These alleys mostly extended form the north-east to the south-west and extended toward the commercial centre, the bazaar. Most of the neighbourhoods had a centre with some facilities provided in it. There is no evidence of a separate wall around these neighbourhoods or any other physical boundaries.

[9] Though, some other factors like religion, race, profession, etc were also important for defining these boundaries.

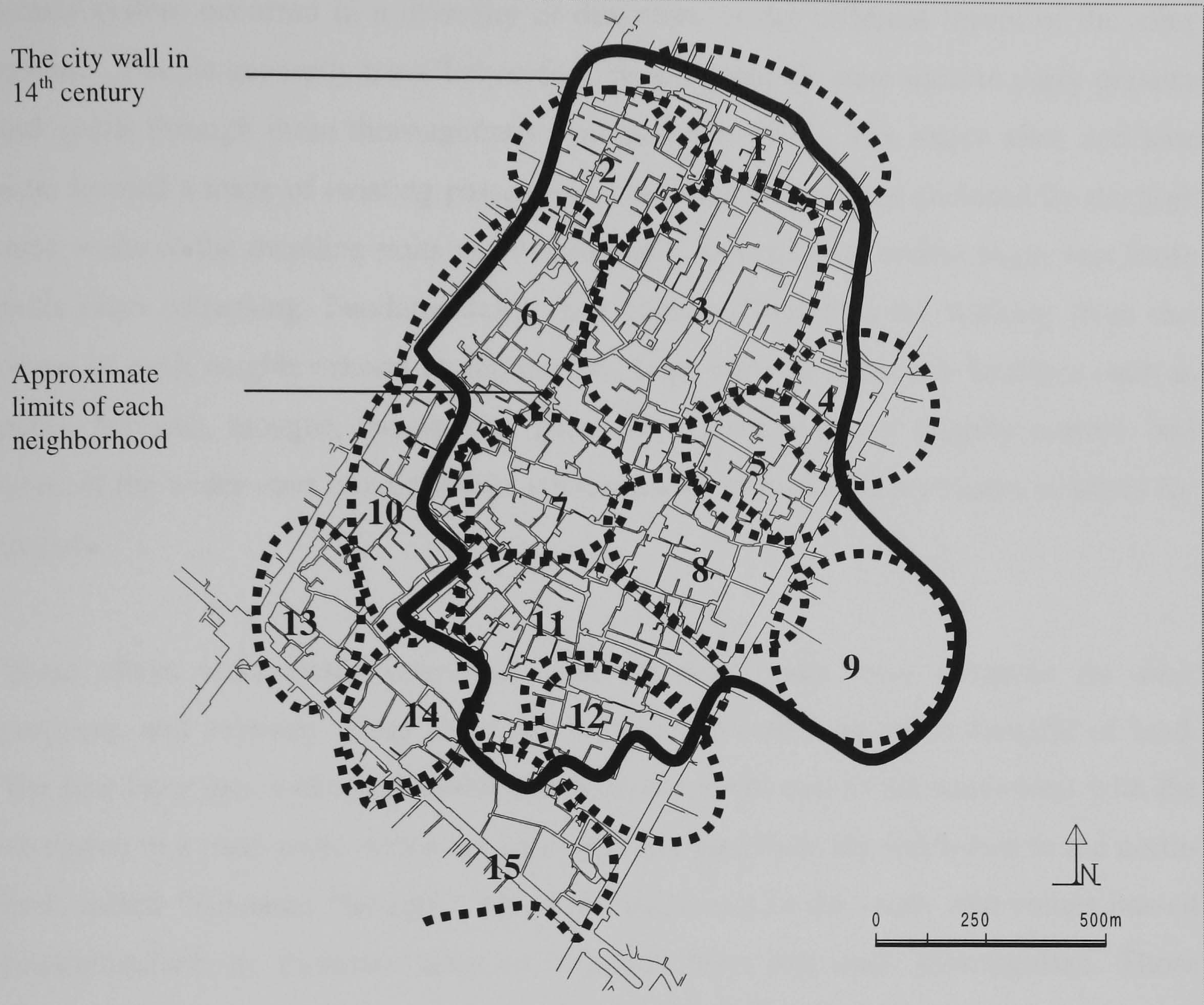


FIGURE 3.3: NEIGHBOURHOOD SYSTEM FOR SUBDIVISIONS OF THE WALLED CITY. IN THE PAST, THE WALLED CITY CONSISTS OF SEVERAL NEIGHBOURHOODS. THESE NEIGHBOURHOODS ARE: 1-JANGAL 2-HAMMAMEGODOUK, 3-FAHHADAN, 4-MALEAMIR, 5-BAZAARENO, 6-KOSHKENO, 7-SHAHABULGHASEM, 8-WAGHTOLSAAT, 9-GHALAH-KOHNAH (THE CITADEL) 10- DARVAZEHSHAHI, 11-DAROLSHAFAH 12-SHAZADEH, 13-SAREPOLOK 14-LABEKHANDAQ, 15- THE BAZAAR.

(Source: Tavassuli, 1982 and the Author site survey and Organisation of Cultural Heritage in Yazd - unpublished information)

3.5.1.3. THE TRANSPORT SYSTEM AND MAJOR OPEN SPACES IN THE WALLED CITY

The transport network consisted of two parts, the major and minor networks. The major network connected the main urban elements together such as gates and commercial areas to the central mosque. The minor network connected the residential building groups to each other and to the major network. The minor network was also divided into two sections; the secondary alleys and cul-de-sacs.

The major alleys of the historical city of Yazd passed through the residential neighbourhoods and provided access to all units through a hierarchy of spaces. The access system occurred in a diversity of directions at the different layers of the alley system. . People generally travelled on foot, though animals were used to carry persons and goods through these thoroughfares (Sultanzadah, 1993). The major alley and lane were formed a maze of twisting passageways and they were often enclosed by the high outer walls of the dwelling units and occasionally covered with arches to prevent those walls from collapsing. Fundamentally, they acted as footpaths for walking from one centre of each neighbourhood to another and from units to other city facilities such as public services, mosque, bazaar, city gates etc. They were not equally narrow, and some of the wider ones cross entire neighbourhoods to provide easy routes of travel for transits.

These alleys were rarely congested and, therefore, they were adequate for their purposes, and anything wider and more elaborate would have been wasteful of land. The first layer was wider and mostly ran from the north-east to the south-west with the exception of a main route which ran from one city gate from the south-east to the north-west, called 'Yusdaran Passage'. All of the north-east to the south-west routes passed perpendicularly to Yusdaran alley or stemmed from this main thoroughfare. Those alleys which were located to the northern side of it were extremely straight and produced almost a gridiron pattern at the city level, although those main routes, which occurred to the southern side of the Yusdaran alleys were much more twisted and irregular in width and direction (See Figure 3.4).

The second layer of the street system in the walled city consisted of alleys mostly shorter in length in comparison with the first layer. These routes appeared between the north-east to south-west thoroughfares. They occurred in a diversity of directions. The lowest level was in the form of some twisted cul-de-sacs and occurred in different direction and widths.

Squares mostly occurred at the centre of a neighbourhood or alongside a main alley. These spaces were generally enclosed by some means of decorated facades. These squares were usually connected to more than one alley, which provided access to the surrounding dwelling environments. These squares were varied in dimensions with a range of 20-30 metres width and 30- 50 metres length.

Squares occurred alongside the first layer of the alley system. These public open spaces in the walled city acted as religious spaces. These spaces were often located where several passages meet each other, and may be called 'Meydan'[10], where they were used for religious activities they were called 'Husseiniah' or 'Tekyeh'. In one corner of some of these spaces a 'Nakhl' was located. This was used for the mourning of Imam Hussein (The Third Shia Imam) and would be covered in black on the anniversary of his martyrdom. Squares, as main public open spaces, were also important points of social and economic contact. Shops at district and neighbourhood level were usually located either behind or around squares.

3.5.1.4. THE WALLED CITY IN TRANSFORMATION

The main morphological elements identified in this section included historical elements. In history the walled city had well-organised morphological structure determined by an organic pattern of alley systems and main morphological elements such as the neighbourhoods which were usually defined by a central open space. The city wall, the citadel, bazaar, Masjed-e-jame, and dwelling units combined together in a form of building groups, which gave the city a typical traditional environment (See Figure 3.4).

Today, even though neighbourhoods are not recognised as an official subdivision of the city, their names are the only remaining evidence of their existence in the traditional city where a substantial part of the built environment still retains the character of traditional urban spaces including public and dwelling units.

Although many of the main elements in the walled city are historical in nature, there are certain new elements in evidence. These elements mainly consisted of some new public open spaces which have been newly constructed streets within the walled city (See

[10] Meydan in larger scale in Iranian cities were used for military marches and some times for traditional sports competitions

Figure 3.5). Some new buildings including residential units are also in evidence. These new elements had introduced to the walled city, on the other hand, are rarely an integrated part of the traditional city. They lack a morphological similarity with the traditional elements, and are in some cases seldom organised in the traditional pattern. . Despite the processes of transformation, however, the city still appears to possess much of the traditional morphology. The transformation has occurred in such a way that the traditional elements of the walled city and their interrelationship are still able be to recognised.

The old transport system has gradually changed due to an accelerating increase in the amount of road based traffic and the means of transportation. For instance, today, there is the likelihood that the householders of the city will have a car for their regular transport. According to one survey (Mohammadi, 1999), more than 80 per cent of residents use some mode of vehicular transport for their daily movements and only the remaining 20 per cent or so move on foot or by bicycle. The original main road system can no longer cope with this new situation. As a result, the circulation system, which was based on pedestrian movement, has changed radically, and has brought about new spaces and configurations. (See Figure 3.5)

The network has changed from a system of twisting alleys and narrow cul-de-sacs to one of wider streets, which are able to transfer vehicles into and out of the internal part of the walled city. In the construction of these new streets the emphasis was on correct width and matters such as the character of the surroundings had little part to play. Changes in modes of transport, and new concepts of spaces, which are designed to meet people's needs and demands, have brought about new streets and open spaces. Four new main streets have been built around the historical city and four further new streets have recently been constructed from those main city thoroughfares into the traditional city. These new roads have exercised a significant impact on the traditional morphology of the walled city. Some newly established building in the vicinity of these streets has influenced the original horizontal landscape of the traditional city. Neighbourhoods have also been subdivided into two or more parts mostly due to the introduction of the new street system.

Although the city has changed from various points of view, for example physically and in terms of the available social life, the historical city is still very prominent. The names of the central square, the gates to the city and the old bazaar are the same as before. The remains of many of the old structures still exist, such as the partial part of the city walls, in which the position of the gates originates from the eleventh century. The historical structures give some valuable information about the spatial pattern of the city at such times.

Today, the historical portion[11] of Yazd covers 98.5 ha and had a population of around 8884 in 1998 (Sazman-i Barnamah va Budjih, 1997). This gives an overall urban density of 90 per/ha, which is quite low when compared with other parts of the city. This figure appears in a different light, however, if the land use pattern is considered, 75 ha or 76 per cent of the wall city consists of residential quarters, 12 ha religious buildings, 5.5 ha commercial and 3.5 ha public services for the neighbourhoods.

The historical city is still a low-rise city, with few buildings of more than two storeys, mostly located in the vicinity of the newly constructed streets. During the last half century, the spatial development has been restrained by building control in an attempt to maintain the traditional landscape of the city.

The initial settlement (before Islam) in the city of Yazd was located to the north of a present neighbourhood named Fahhadan (Masarart, 1998). In general the urban form of the walled city initially tended to follow a regular pattern with some straight roads. Some regular pattern in the street system is in evidence in the north part of the traditional city. The location of underground water may have influenced the form of the settlement. New variations of urban spaces have been introduced and an irregular pattern of street systems is in evidence (See Figure 3.6).

[11] This area includes a portion between the newly constructed streets and southern wall of the historical city. This also excludes the old citadel of the city

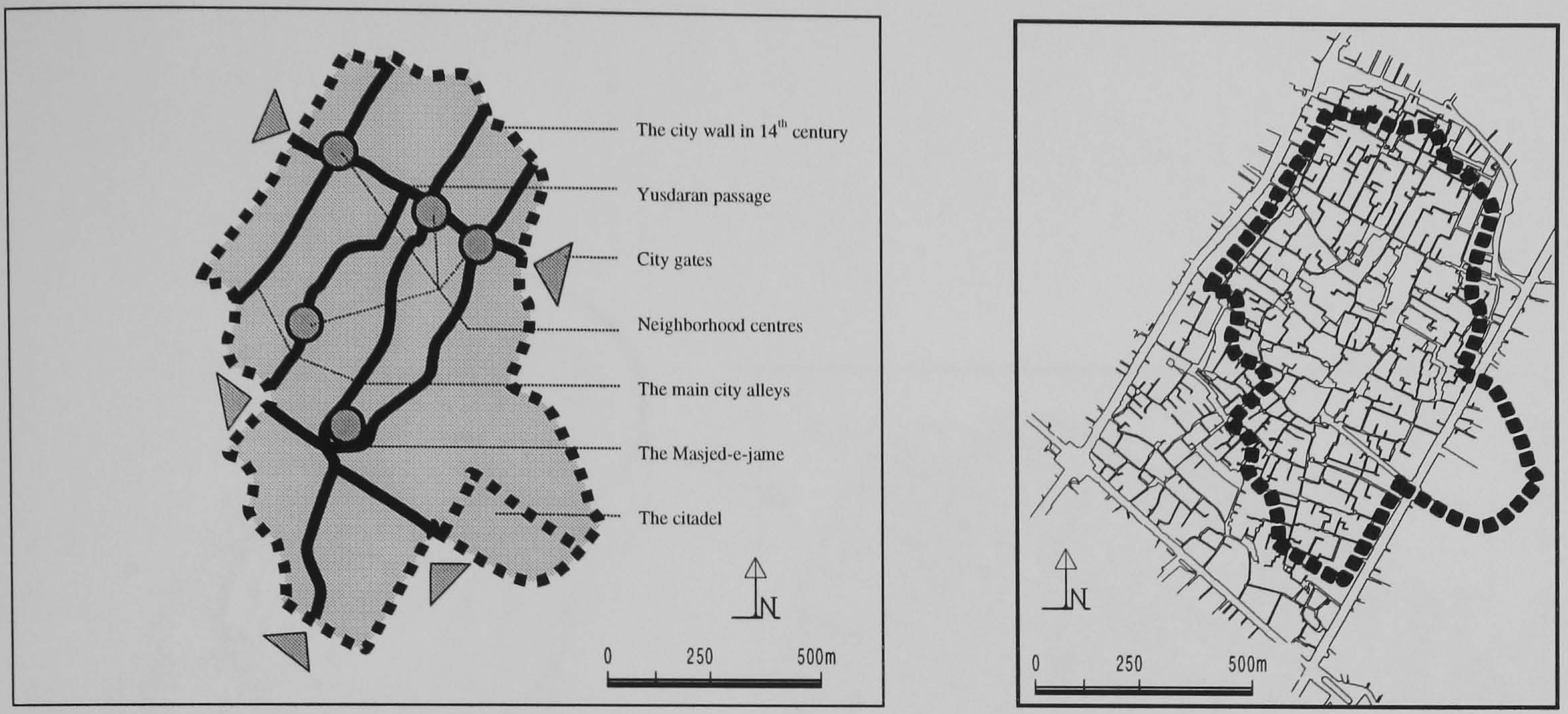


FIGURE 3.4: THE SPATIAL STRUCTURE OF THE WALLED CITY OF YAZD (LEFT) AND ITS PRESENT SITUATION (RIGHT)

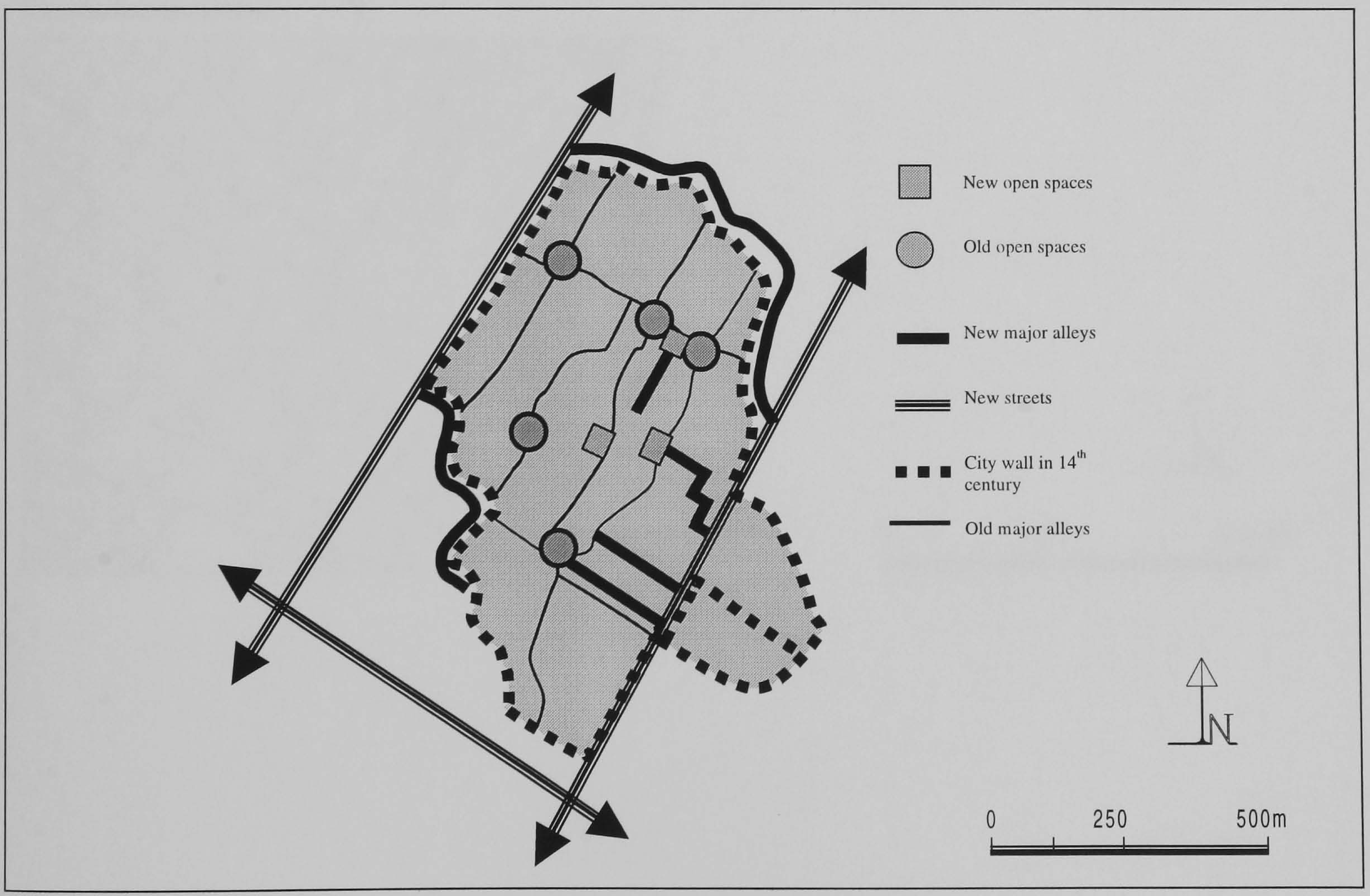


FIGURE 3.5: THE TRADITIONAL URBAN CIRCULATION PATTERN IN YAZD BASED ON THE PEDESTRIAN SCALE. IT SHOWS MAJOR CIRCULATION NETWORKS. NEW STREETS HAVE BEEN INTRODUCED IN THE CITY.

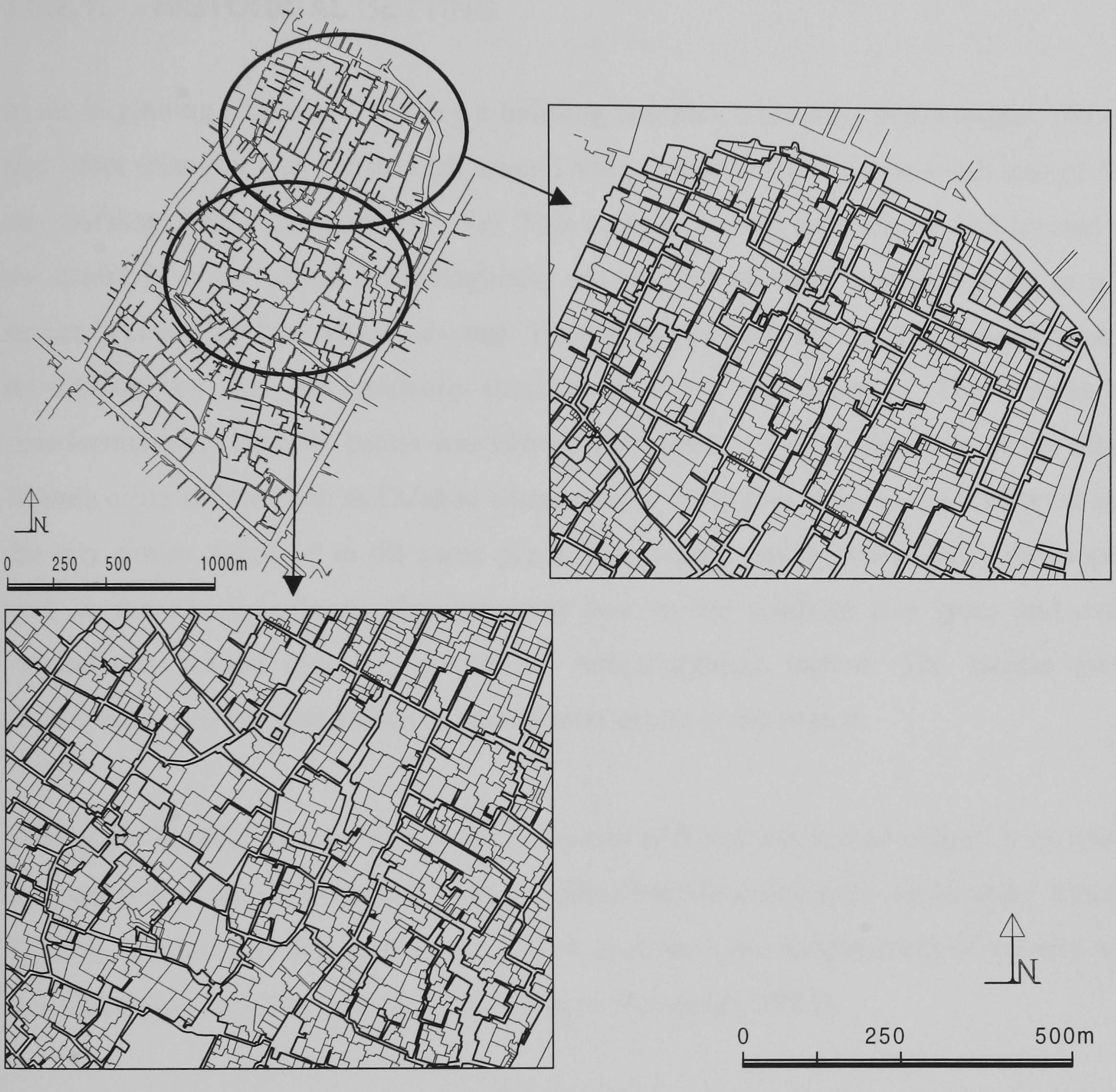


FIGURE 3.6: TRANSFORMATION OF THE STREET SYSTEM IN THE WALLED CITY OF YAZD. THE STREET SYSTEM TO THE NORTH OF THE HISTORICAL CITY IS ALMOST FOLLOWS A GRIDIRON PATTERN WHILE THIS PATTERN CHANGED TO A SYSTEM OF WIDENING ALLEYS AND IRREGULAR FORM

3.5.2. THE MORPHOLOGY OF YAZD FROM THE LATE 14^{TH} UP TO THE EARLY 20^{TH} CENTURY (OLD CITY)

3.5.2.1. HISTORICAL SETTING

In the beginning of the 15^{th} century a building complex consisting of a mosque, bazaar and water reservoir was constructed around a big square at the extreme south-east of the city (Afshar, 1995) (See Figure 3.7-a). This complex is still in evidence and located at the centre of Yazd called Amirchaghmaq square. The mosque[12] situated close to this square is called the new Masjed-e-jame. The city centre from the old Masjed-e-jame and its surrounding area was gradually transferred to this new complex. The process of transformation of the city centre was almost in contrast to the development of the other Islamic cities in Iran such as Esfahan where the old Masjed-e-jame was redeveloped and the city centre remained in the same place. The bazaar, which was initially developed near to the Masjed-e-jame, also appeared near to the southern city gates and even beyond the walled city and joined to Amirchaghmaq square. The bazaar grew significantly and became an active commercial centre in the region.

During the Safavid dynasty (1501-1773) the city of Yazd was not developed very much in comparison with the development of other Iranian cities such as Isfahan, Shiraz, Tabrize, Kerman etc. There was even a slow decline in the development of the city and few buildings were constructed during this era (Tavassuli, 1982).

In 1790s another complex called 'Shahtahmasb' was constructed. This also consisted of a square and other services and was located to the south-west of the walled city, opposite the Amirchaghmaq square (See Figure 3.7-b). These two squares were connected to each other by an axial alley acting as a commercial route. The city centre remained at the same place as before and the city gradually began to grow in the outskirts of the walled city. The city grew toward the west and south-west where several new neighbourhoods were added.

[12] This mosque was built in 1419

During the Qajar dynasty (1796-1925) the city was divided into two parts: the old to the northern part which is presently called the historical city or walled city and the new to the southern part presently called the old city. The city wall surrounding the old part and the new section was expanded immediately outside the southern city gates. Construction of a new city wall was started in 1815 (Afshar, 1995: 675). However, this new wall never acted as a proper boundary for the city. Development of the city to the south and south-west continued.

In the later half of the 19th century, the development of the city continued toward the south and south-east and several residential quarters were added to the city. A complex unit consisting of school, mosque and water reservoirs was constructed to the south-west and at the middle of the major commercial alley between Amirchaghmaq and Shahtahmasb squares (See Figure 3.7-c). This new complex was called Khan square. The construction of this complex unit played an important role in providing a spatial arrangement for attracting commercial activities and unity of the main bazaar with other elements of the city, which were developed in the late 19th century.

In general the developments beyond the wall in the 14th century occurred in the form of some central spaces, which gradually joined with each other. These developments with the entire walled city were considered as the old city of Yazd in the beginning of the 20th century (See Figure 3.8).

Table 3.2 shows variations in the city population from 14th century until 19th century. Around 1910 the population of the city was approximately 70000.

Year	1320	1395	1800	1850	1869	1888
Yazd population	40000	30000	24000	30000	40000	50000

TABLE 3.2: YAZD POPULATION FROM 14TH CENTURY UNTIL 19TH CENTURY

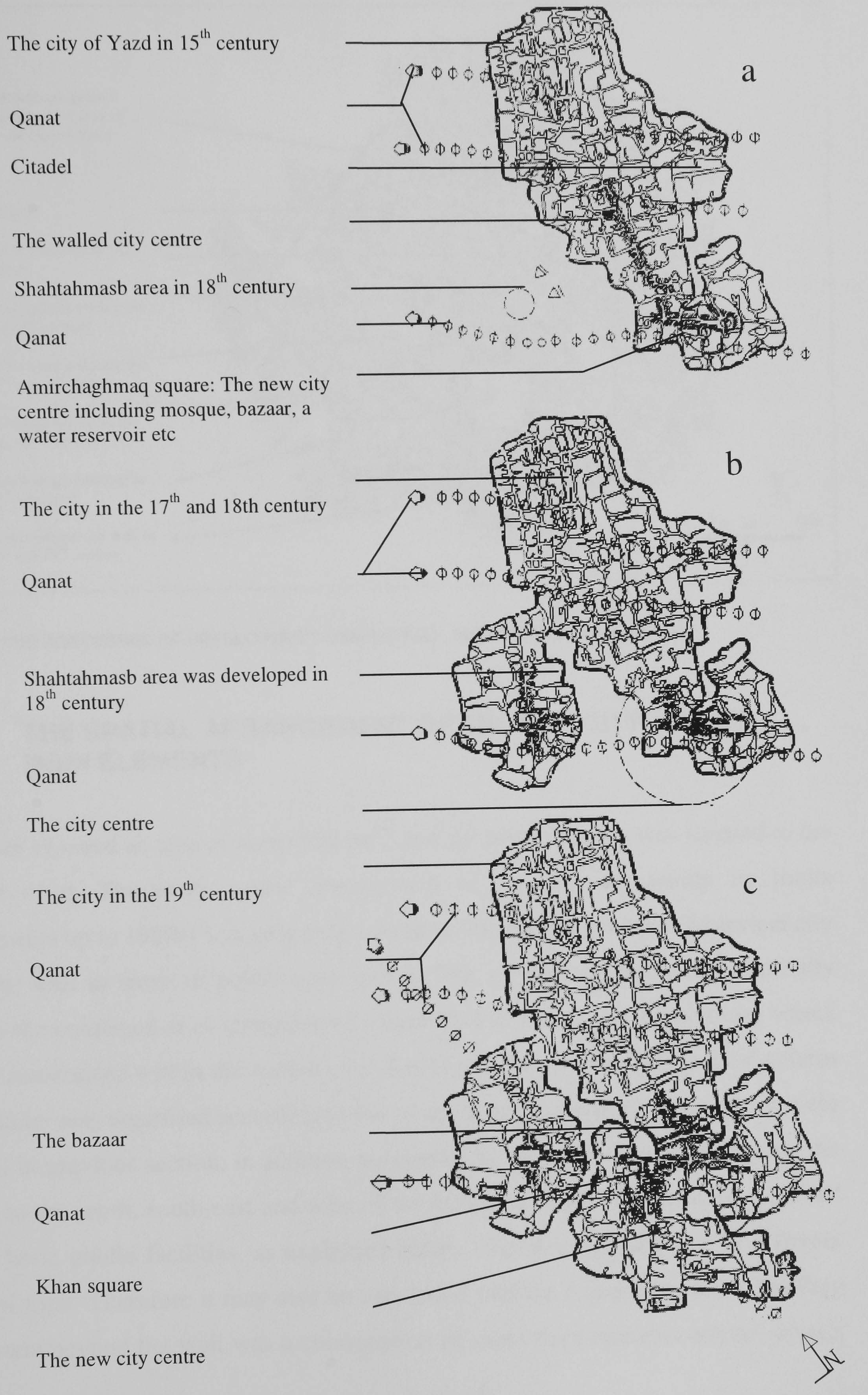


FIGURE 3.7: THE PHYSICAL GROWTH OF THE CITY BEYOND THE WALL

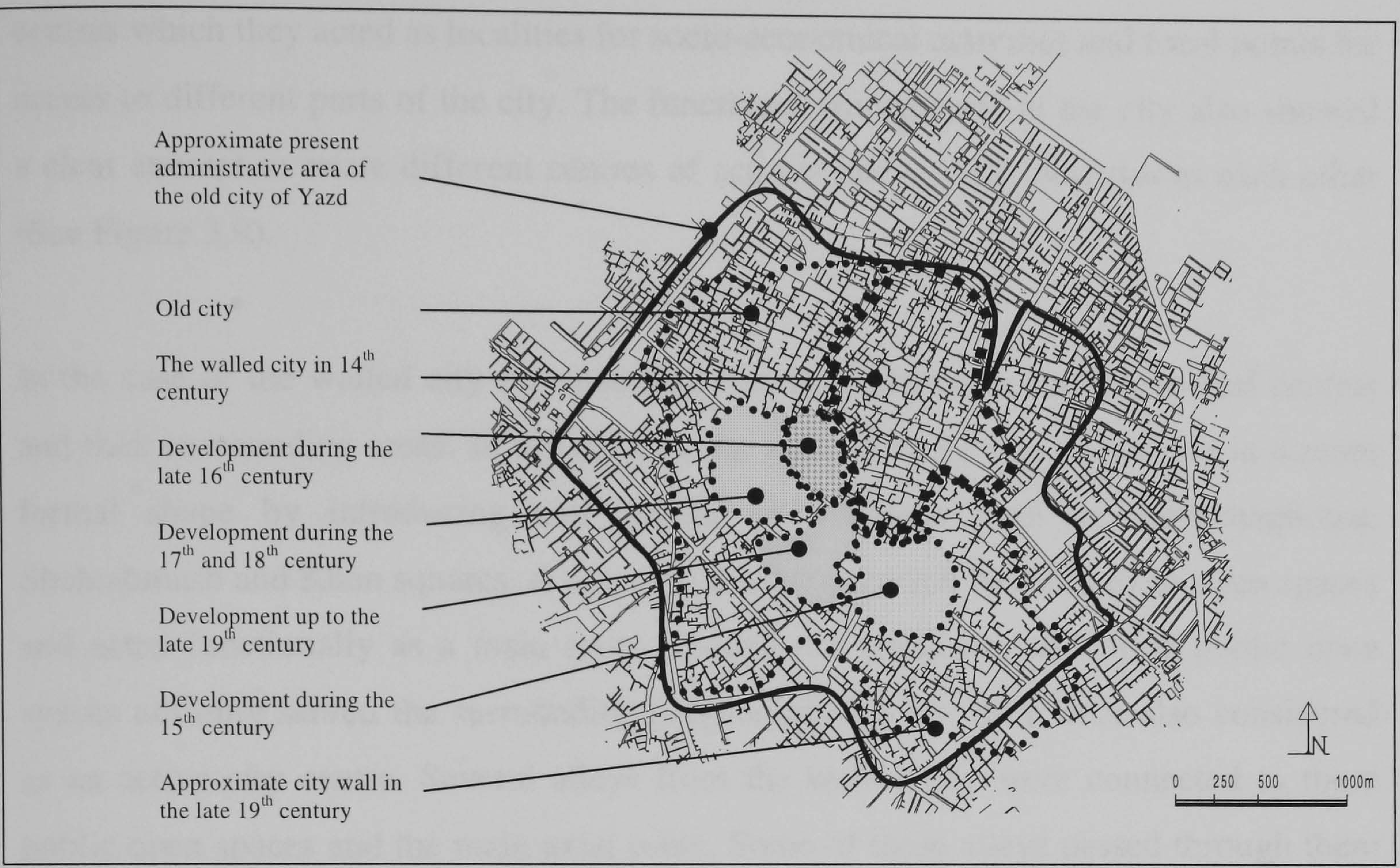


FIGURE 3.8: THE PROCESSES OF DEVELOPMENT IMMEDIATELY OUTSIDE THE WALLED CITY

3.5.2.2. THE SPATIAL ARRANGEMENT OF THE OLD CITY AND ITS MAIN ELEMENTS

The old city covered an area of about 550 ha[13], and the historical city was situated to the north-east of it. The inner spatial arrangement of the old city within its limits (developments up to 1920s) was generally a trend in transformation of the historical city beyond the wall in terms of public open spaces. The city developments were initially started by the construction of comparatively larger public open spaces than those which had been constructed within the walled city. Therefore, it is true that the general pattern of the old city was organised according to the components of the walled city which were explained in previous section, in addition to several centres which occurred beyond the wall and to the south, south-east and west of the historical city. These centres consisted of some basic public facilities, as explained before, and were constructed in different periods of time. Therefore it may also be concluded that the expansion of the dwelling environment beyond the wall was a continuation of some developments around several

[13] This area is defined by the city council as the old city of Yazd and belongs to developments until the middle of the 20th century, it is today well defined by a number of streets

centres which they acted as localities for socio-economical activities and focal points for access to different parts of the city. The functional arrangement of the city also showed a clear attempt to relate different centres of activity and central localities to each other (See Figure 3.9).

In the case of the walled city the centrality was in evidence in neighbourhood centres and their surrounding areas. In the old city the same concept was developed in a more formal shape by introducing new public open spaces such as Amirchaghmaq, Shahtahmasb and Khan squares. A main axial route occurred between these open spaces and acted functionally as a main route through the grand bazaar. These public open spaces not only served the surrounding neighbourhoods but they were also considered as an active city centre. Several alleys from the walled city were connected to these public open spaces and the main axial route. Some of these alleys passed through them and ran to the southern part of the city. Although these central spaces were in evidence in the old city, there was no visual sense of centrality, because of scale and the form of the alley system in the old city.

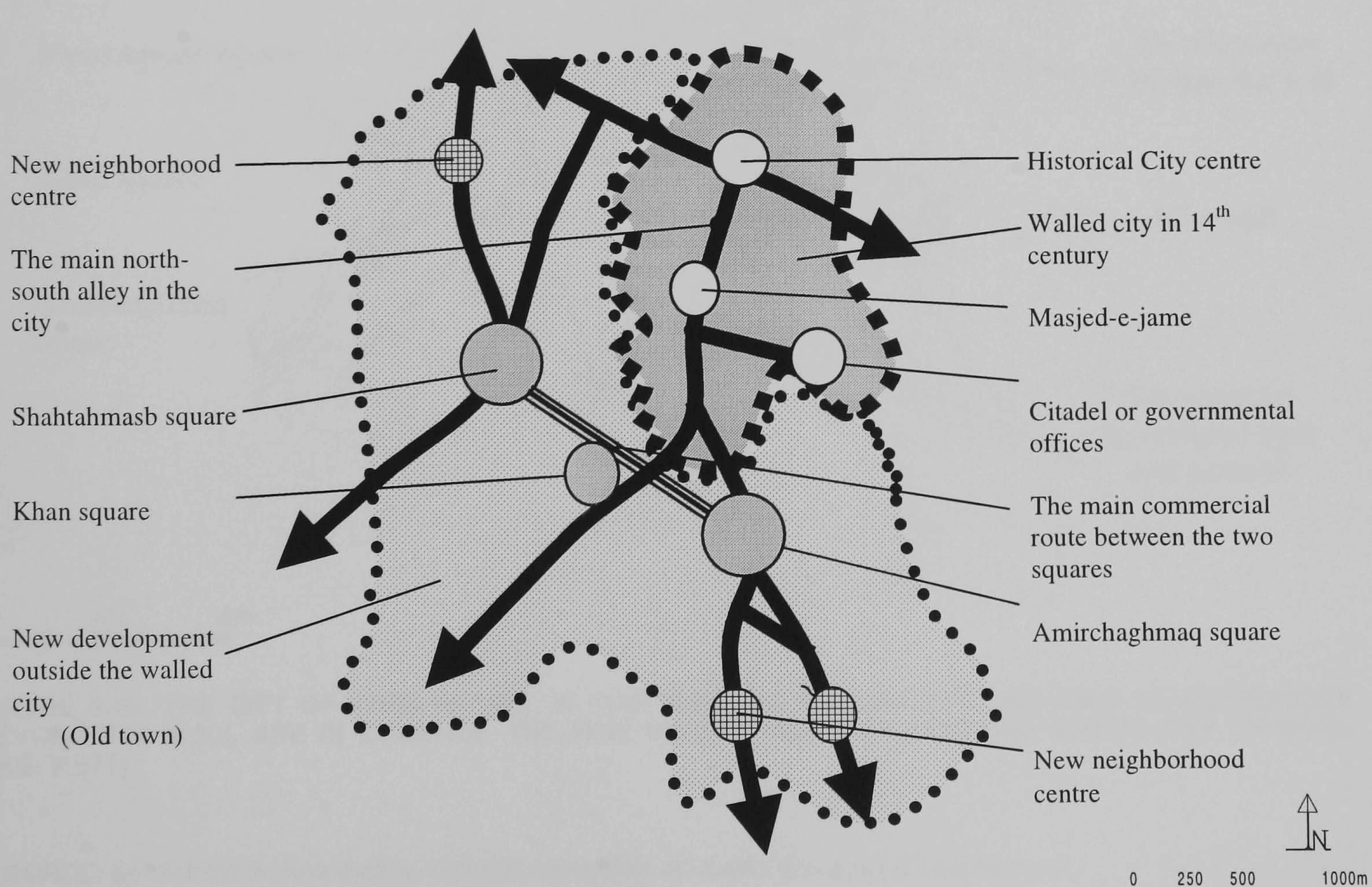


FIGURE 3.9: THE SPATIAL CONFIGURATION OF THE OLD CITY OF YAZD. THE FIGURE SHOWS THE MAIN ELEMENTS OF THE OLD CITY AND ITS RELATIONSHIP WITH THE WALLED CITY

By development of the city beyond the wall, the main elements of the city, which were located in the traditional city, gradually declined. The centres of commercial and religious activities were shifted to the new localities. Later, in this way Khan Square which was located at the middle of the major commercial route in the bazaar, was considered as a main commercial centre for the city.

All the elements: the citadel, bazaar, the Masjed-e-jame and the main squares which form the core of the old city were situated among the residential blocks. The old city was surrounded by agricultural land and some formal and informal gardens. In addition to the agricultural land, there were a number of villages situated in the surrounds of the old city (See Figure 3.10).

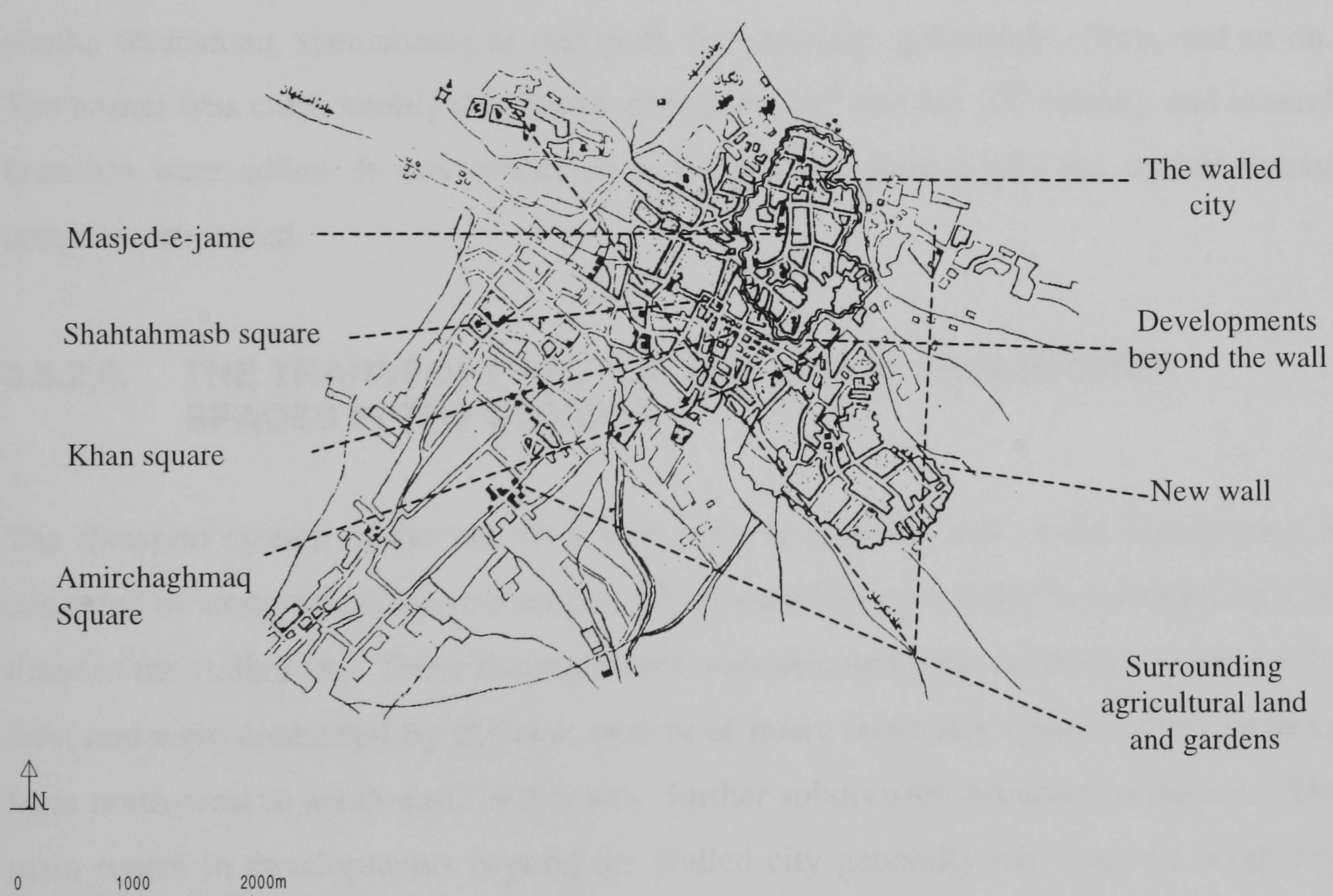


FIGURE 3.10: THE CITY OF YAZD IN 1859. IN THIS MAP THE WALLED CITY AND NEW DEVELOPMENTS BEYOND THE WALL ARE IN EVIDENCE. THE NEW WALL NEVER ENCLOSED THE ENTIRE CITY (AFSHAR, 1995: P.671)

(SOURCE: by Nicollas de Knanikoff in 'Pictorial documents of Iranian Cities in the Qajar period'

3.5.2.3. THE BAZAAR AND MARKET PLACE IN THE OLD CITY

The Yazd bazaar was a maze of interconnecting covered passages. The main bazaar was not within the historical city but was located just outside the wall near to the southern gate of the walled city. The bazaar was one of the most important distinguishing characteristics of the city. It was the major socio-economic gathering space, which acted as a main morphological element in the old town. This marketplace comprised a small, contiguous stall located in numerous passageways or branches, which usually were covered by a series of vaults or domes. These branches were increasingly subdivided in various directions, and accommodated many public activities and functions. The bazaar was linked to the main public open spaces like Amirchaghmaq and Shahtahmasb squares. It attracted a wide variety of commerce, crafts and activities. It contained many units located in several branches, each of which was occupied by similar tradesman, specialising in one craft, for example; goldsmiths, fibre, and so on. The bazaar was considerably developed during the 18th and the 19th century and several branches were added. It was connected to the Khan Square where the central bazaar complex originated.

3.5.2.4. THE TRANSPORT SYSTEM AND MAJOR PUBLIC OPEN SPACES IN THE OLD CITY

The transport system in the old town was more or less like that of the walled city. It consisted of some mostly narrow routes, which were however wider in comparison with those in the walled city. These thoroughfares were oriented form north-east to the south-west and were connected by skeleton system of many secondary narrow alleys running from north-west to south-east. In this way, further subdivision occurred to the area. The main routes in developments beyond the walled city generally ran from the main city gates and were directly or indirectly connected to the public squares which were located outside the walled city. One of the major alleys stemmed from the Yusdaran alley and joined Masjed-e-jame and from there, after passing through the bazaar, continued to the extreme south-west of the old city.

At the city level of analysis, description of the major public open spaces as part of the main public thoroughfare in the old city may lead to a better understanding of the transport system and the morphology of the old city. These are Amirchaghmaq, Shahtahmasb and Khan square (See Figure 3.11-a).

Amirchaghmaq square was located just to the south-east of the walled city and connected to the bazaar and the southern city gate. It was an immense space, 150 metres in length and 80 metres wide. A central axis was marked by a high elevation[14] of its eastern side. It was decorated with tiles and two minarets, which probably, acted as a landmark in the past to show the way toward the city. This high rise elevation is still the outstanding monument of the square. It was also a gate to a bazaar[15] situated behind it. The new Masjed-e-jame is located to the southern part of the square. Just opposite to the mosque a water reservoir was erected. The square also provided access to several caravanserais, some shops and residential environment (See Figure 3.11-b).

To the south-west of the walled city another square was constructed, which was called Shahtahmasb square. It was also a relatively large open space, 100 metres long and 80 metres wide. It was located opposite to Amirchaghmaq Square. These two squares connected together by the main bazaar route which ran from east to west. Like Amirchaghmaq Square, here also there was a central axis defined by a high rise elevation to the western side of the square. This part has been demolished. There was also a mosque[16], water reservoir and some shops located at the vicinity of the square (See Figure 3.11-c).

Somewhere in the midway between Amirchaghmaq and Shahtahmasb squares there was another square, which was called Khan square. This public open space was comparatively smaller than the others. There was an open space, 80 metres long and 25 metres wide in between some covered market places within the bazaar. In addition to shops and market places surrounding the central open space there were some other activities in the vicinity (See Figure 3.11-d).

[14] This high elevation was added to the square in 1870s
[15] This bazaar was called 'Hajighanbar' constructed in 15th century
[16] This mosque constructed in 16th century

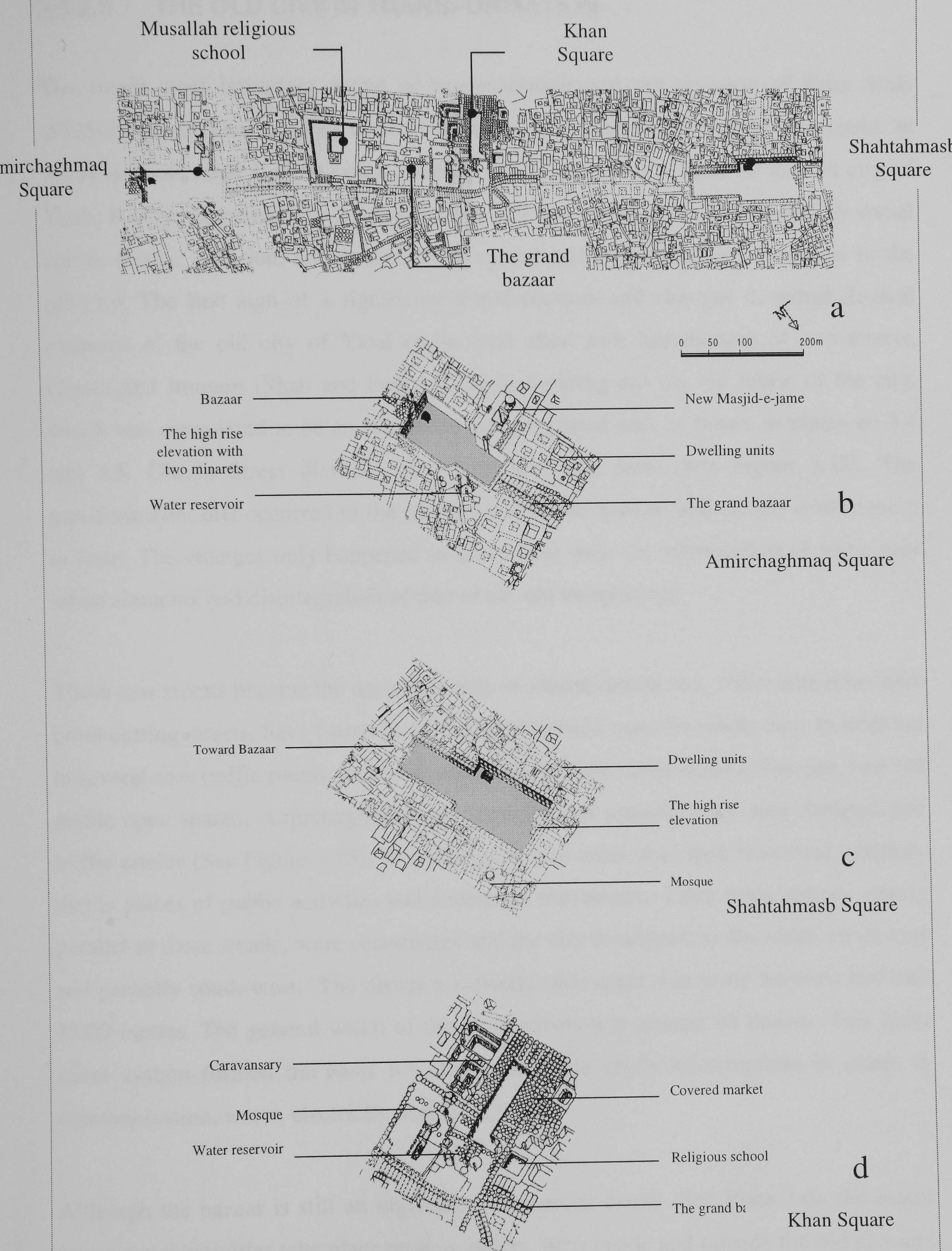


FIGURE 3.11: MAJOR PUBLIC OPEN SPACES OCCURRED IMMEDIATELY OUTSIDE THE WALLED CITY
(Source: Tavassuli, 1992)

3.5.2.5. THE OLD CITY IN TRANSFORMATION

The single most important action of modernisation was the decision of Reza Shah (1925-1941) to drive a major network of long, wide and straight streets, as could be found in most other Iranian cities (Wilber, 1981), through the heart of the old city of Yazd. It was predominantly an engineering solution which paid little regard to social and economic situation, and caused some spatial and morphological disruption in the old city. The first sign of a significant transformation and changes in morphological elements of the old city of Yazd come soon after with introduction of two streets, Ghiam and Immam (Shah and Pahlavi). Their building cut the old fabric of the city, which was considered to be an integrated and congested area as shown in plates no 3.4 and 3.5. Ghiam Street divided the bazaar into two parts (See Figure 3.12). The transformation that occurred in the old city was rather modest and clearly evolutionary in form. The changes only happened in a two-fold way: the introduction of some new urban elements and disintegration of part of the old morphology.

These new streets became the main channels of transportation and, with some other new cross-cutting streets, have formed a grid super-imposed over the whole city. In addition to several new traffic round-abouts (squares) which were constructed in the city, two old public open spaces, Amirchaghmaq and Shahtahmasb squares, were also changed into traffic circles (See Figure 3.13). This change was in contrast to their historical function, that is places of public activities and pedestrian movements. Later other streets, mostly parallel to these streets, were constructed and the city developed to the south, south-east and partially south-west. The distance between each street was to be between 800 and 1,000 metres. The general width of the main streets was around 24 meters. This main street system formed the basis for modernising the city's infrastructure in relate to communication, water, electricity supply, etc.

Although the bazaar is still an important commercial centre (See Plate 3.6), the major commercial activities take place on new streets, both inside and outside the old city and there are no proper links between historical buildings and the bazaar itself. By construction of new streets in the city shopkeepers were encouraged to move to the new street frontages and gradually abandoned the old bazaar which was not accessible by car. These new streets intersect at right angles and along them many irregular crossroads occur with the old pattern of alley system. Some shopping places, dwelling environments and other services have been added to the old town.

In the old city, and specifically in the historical city, the physical presence of most historic buildings and also recently of some houses has been preserved relatively well. However, what has been lost in the old city is the composition and unity of the urban pattern evolved over hundreds of years. The main disruption to the structure of the old city is the disintegration of major morphological elements of the old city and residential dwellings by modern grids. In fact, the incompatibility of the old city components with its more modern streets has created a great deficiency in the spatial organisation of the old city.

There have been some efforts to preserve the old core of Yazd during the last twenty-five years, but most of them were not successful. A considerable amount of money has been spent in the renovation of the historical buildings and houses and on many other projects.

Whereas the first phase of change was limited to the creation of new streets and squares, the second phase, even though very slow but effective, was the development of new residential areas surrounding the city. These developments will be explained in the section 3.5.3.

The principal morphological changes of the old city during this period can be summed up as follows:

- Segmentation of the old city by new streets.
- Construction of new streets along the lines of the old walls and even within the walled city.
- Extension of several new streets outwards from the old city.
- Construction of new buildings such as banks and governmental offices alongside new streets inside and outside the old city.

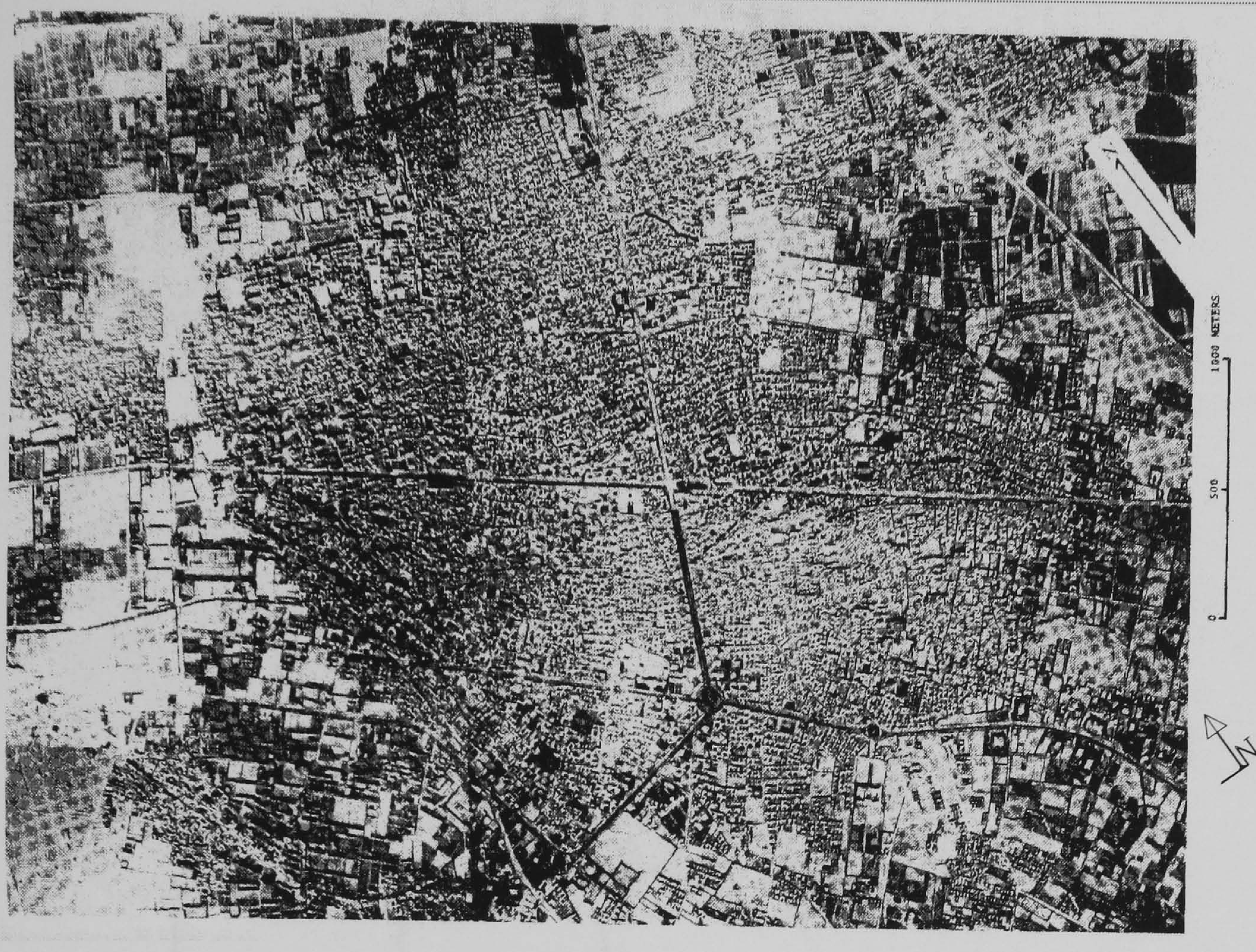


PLATE 3.4: AN ARIAL VIEW OF YAZD IN EARLY 20TH CENTURY. THE TWO CROSS ROADS INTRODUCED TO THE CITY ARE CLEARLY IN EVIDENCE. (Source: Bonnie, 1993: 347)

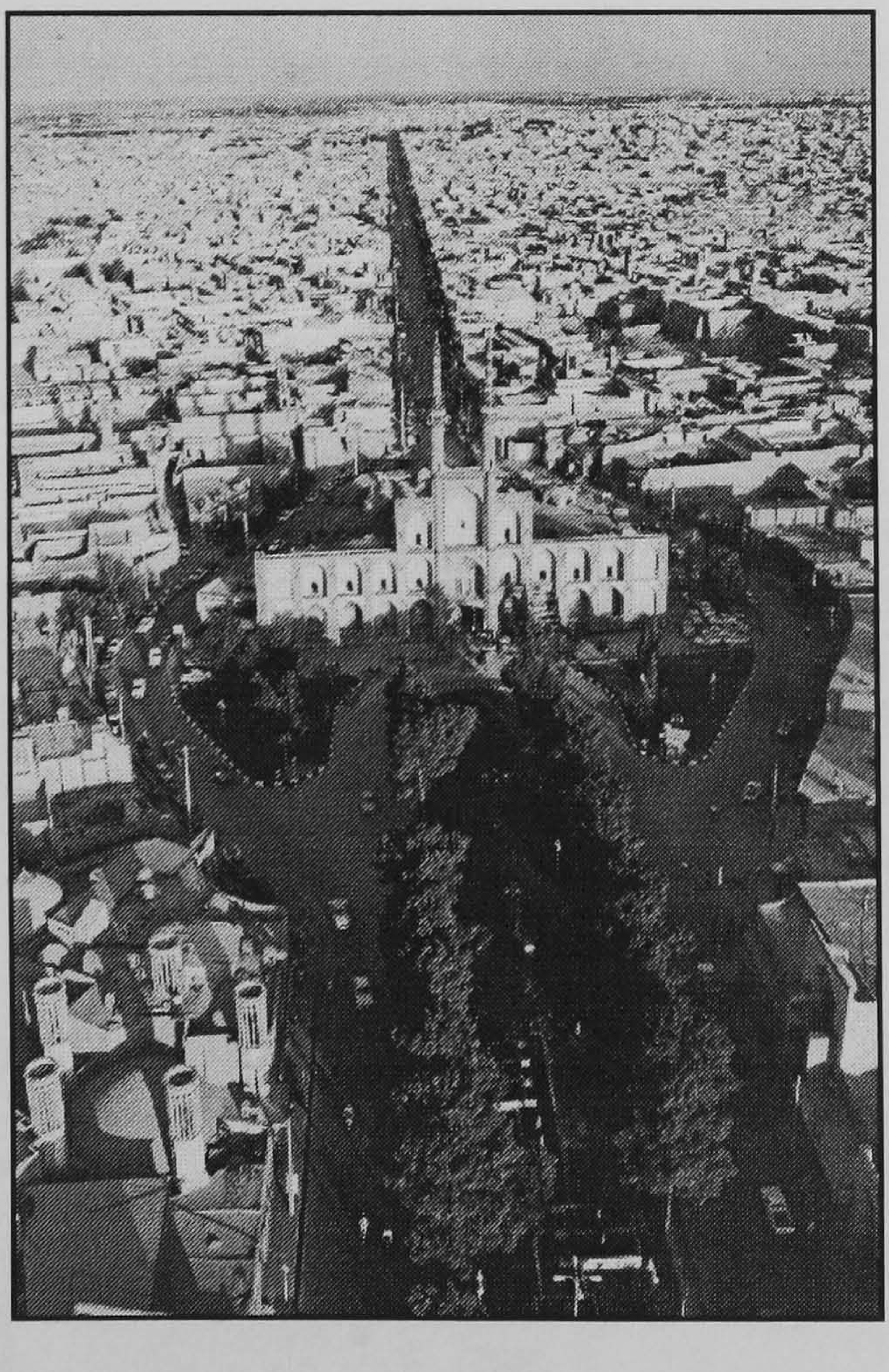


PLATE 3.5: AN EXAMPLE OF TRANSFORMATION IN THE OLD CITY: A NEW STREET CUT THROUGH THE OLD FABRIC IN 1920S. THE PRESENT SITUATION OF THE AMIRCHAGHMAQ SQUARE IS IN EVIDENCE

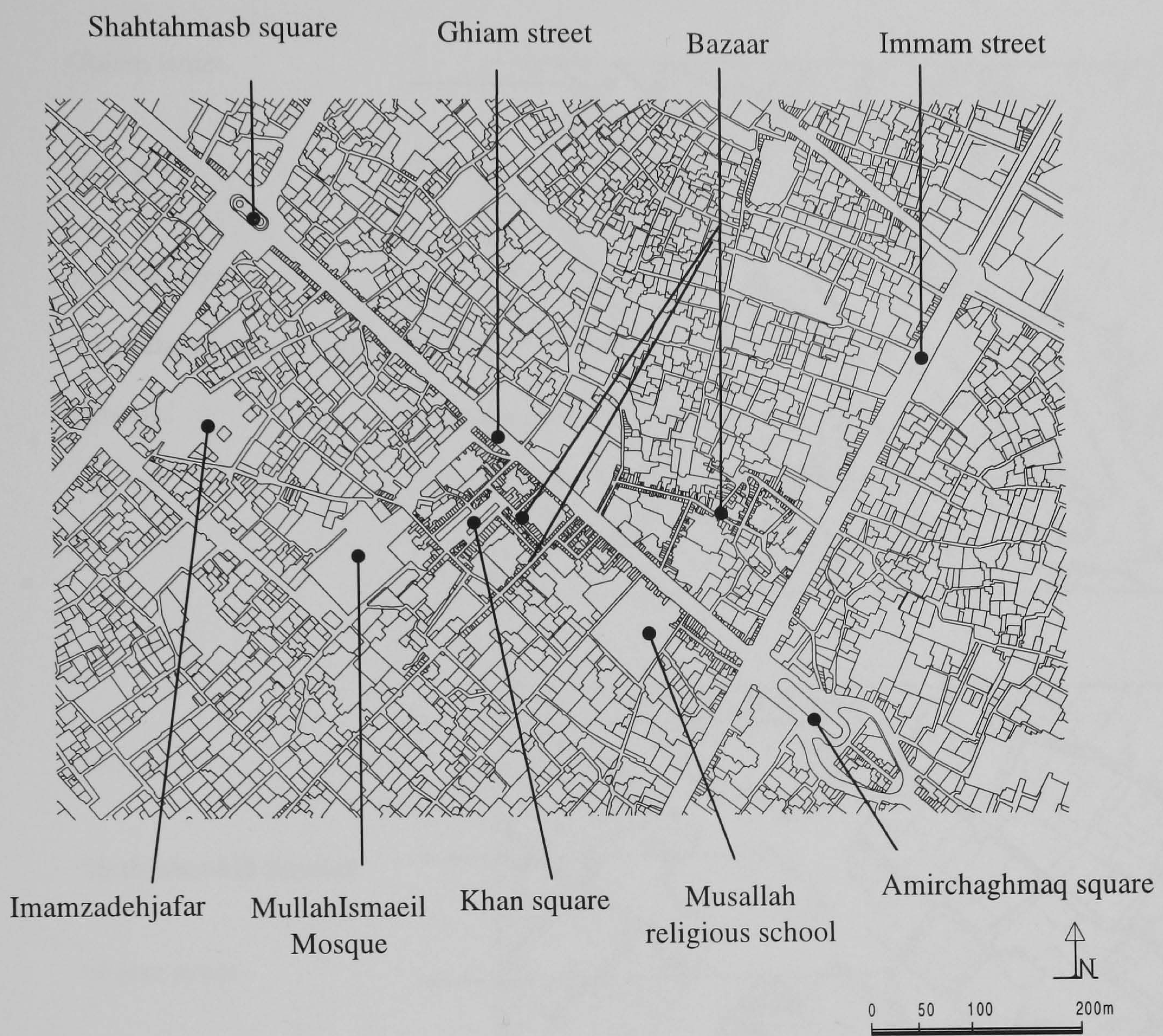


FIGURE 3.12: NEW STREETS CUT THROUGH THE OLD BAZAAR (Source: Yazd City Council, 1998)

PLATE 3.6: SOME PARTS OF THE OLD BAZAAR ARE STILL IN EVIDENCE

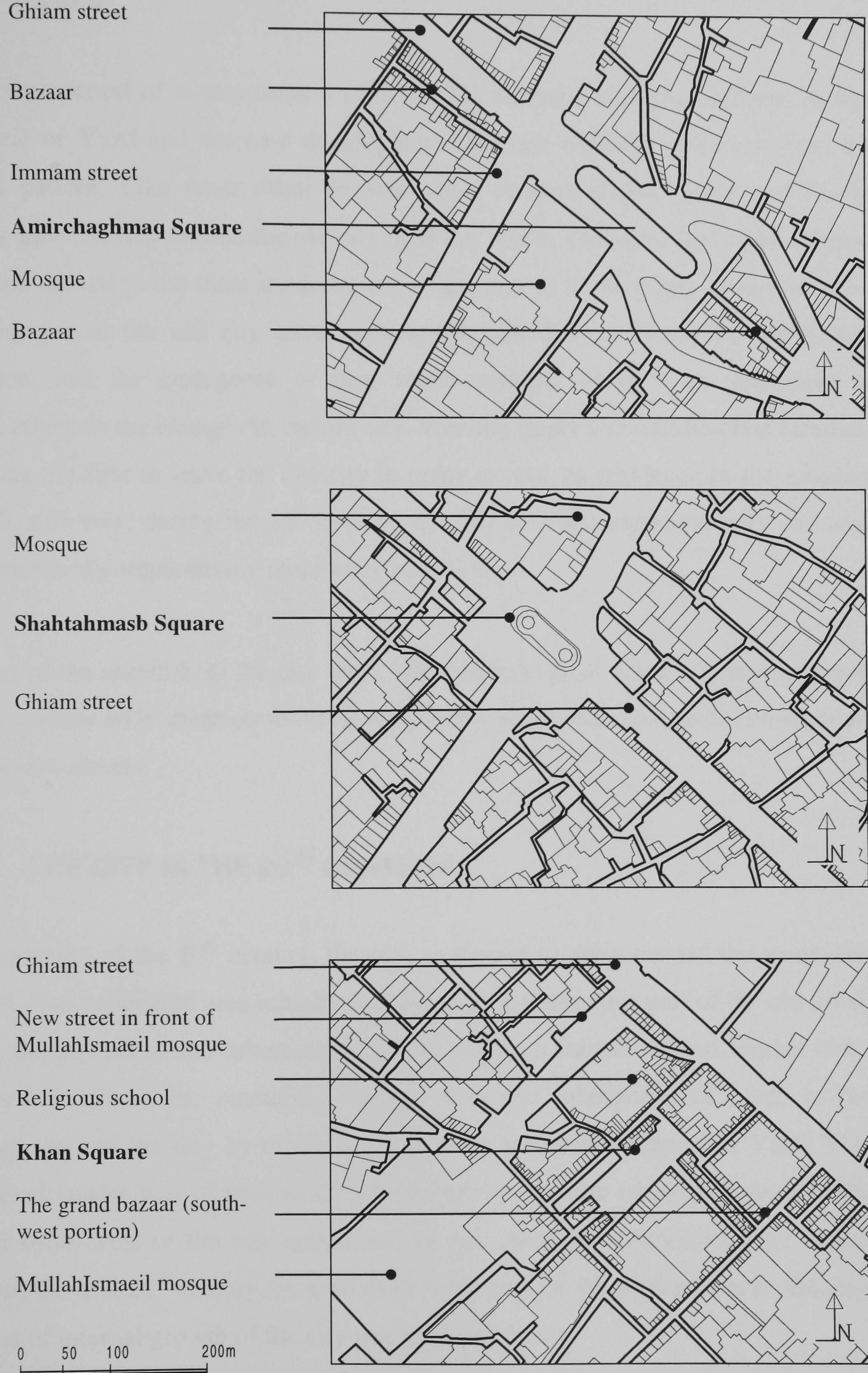


FIGURE 3.13: THE PRESENT SITUATION OF AMIRCHAGHMAQ, SHAHTAHMASB AND KHAN SQUARE

3.5.3. THE MORPHOLOGY OF YAZD IN THE 20TH CENTURY (NEW CITY)

After the first period of modernisation (1925-1945) dramatic changes occurred in the urban fabric of Yazd and the new developments became radically different from its traditional pattern. Like most other Iranian cities, modern-shaped grids and linear extensions grew rapidly around the old city; and the social, economic and spatial focus of urban life moved to the more modern parts of the city or to the edges of new streets. Spatial changes in the old city have been accompanied by a breakdown in social organisation, and the emergence of new social patterns which have performed a multiplier effect on the changes in the old city. Wealthy upper and middle-class families were among the first to leave the old city in order to take up residence in the modern suburbs. In this way, during the 20th century the city of Yazd expanded very fast and faced a process of comparatively rapid transformation.

In this part of the research, at the city level, the morphology of Yazd will be examined in the last century with attention to the developments which occurred after construction of the first new streets.

3.5.3.1. THE CITY IN THE 20TH CENTURY

By the beginning of the 20th century, the city continued to grow toward the south and south-west. The residential area initially developed as a continuous part of the old town. However, the process of sub-urbanisation, which had been started in most Iranian cities in the second half of the nineteenth century with the subdivision of lands in the surrounding area of the city by the aristocracy, also somehow occurred in Yazd. This type of development was intensified by proposing two satellite residential areas to the south and south-west of the city called Safaiei and Azadshar (Ariashar) (See Figure 3.15). Until the mid 20th century, in spite of development of these two areas of the city, the process of internal growth of the city was fairly uniform.

The 1979 Islamic revolution and the start of the Iran-Iraq war of 1980 initiated a massive population movement, causing a large migration from the countryside to the urban areas. This movement was amplified by those who came from the war-affected cities to the other cities like Yazd, which was centrally located in Iran. This has put an added burden on the government to provide sufficient services at the city level. On the other hand, as a consequence of the introduction of some polices regarding the allocation of land to low income people in the urban areas a large number of people moved to cities almost overnight.

From 1979 up to 1998, the physical boundaries of the city expanded dramatically. The population of Yazd in 1976 reached 135,925 with an urban area of 1,157 ha. However, during the last 30 years of the 20th century, this uniform growth changed to a rapid and unprecedented development. By 1996, the city population dramatically increased to 326,776 with an urban area of 9950 ha (See Table 3.3) (See Graphs 3.1, 3.2).

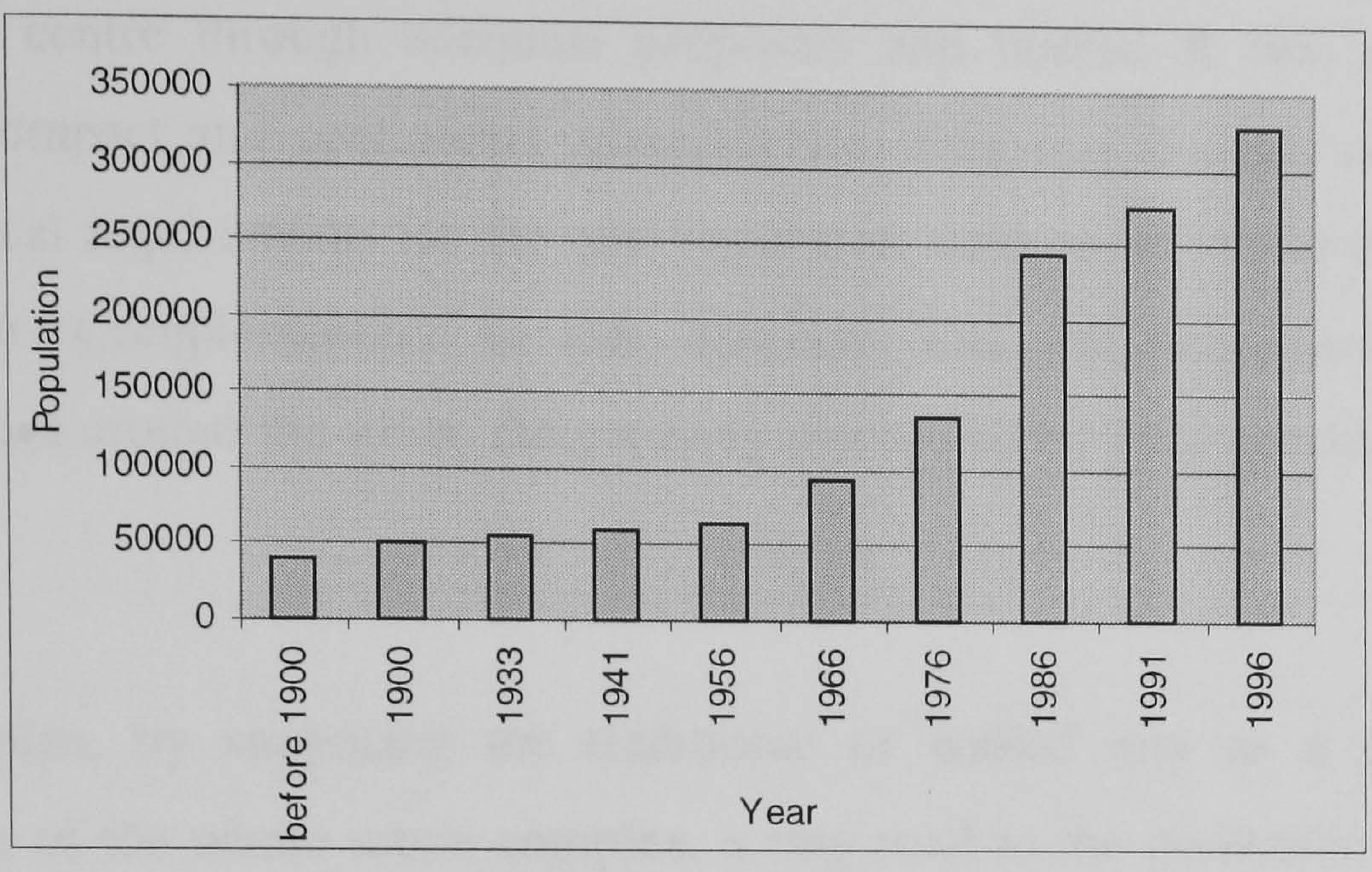
During the second half of the last century two master plans for the city of Yazd and a comprehensive plan for the old city were proposed. In the next section before analysing the inner spatial arrangement of the contemporary city, it is intended to give a brief description of these plans which have been prepared for the city of Yazd. These plans have greatly influenced the spatial pattern of the city (Mohammadi, 1993), which may be very worthful in this study.

Year	Population	Total urban area in ha.	Population density
1996	326776	9950	35.71
1991	275298	7200	38.24
1986	244438	2700	90.53
1976	135925	1157	117.48
1966	93241	710	131.33
1956	63502	650*	97.69
1941	60000	550*	109.09
1933	55150	350*	157.57
1900	50000	250*	200
before 1900	Up to 40000	200*	200

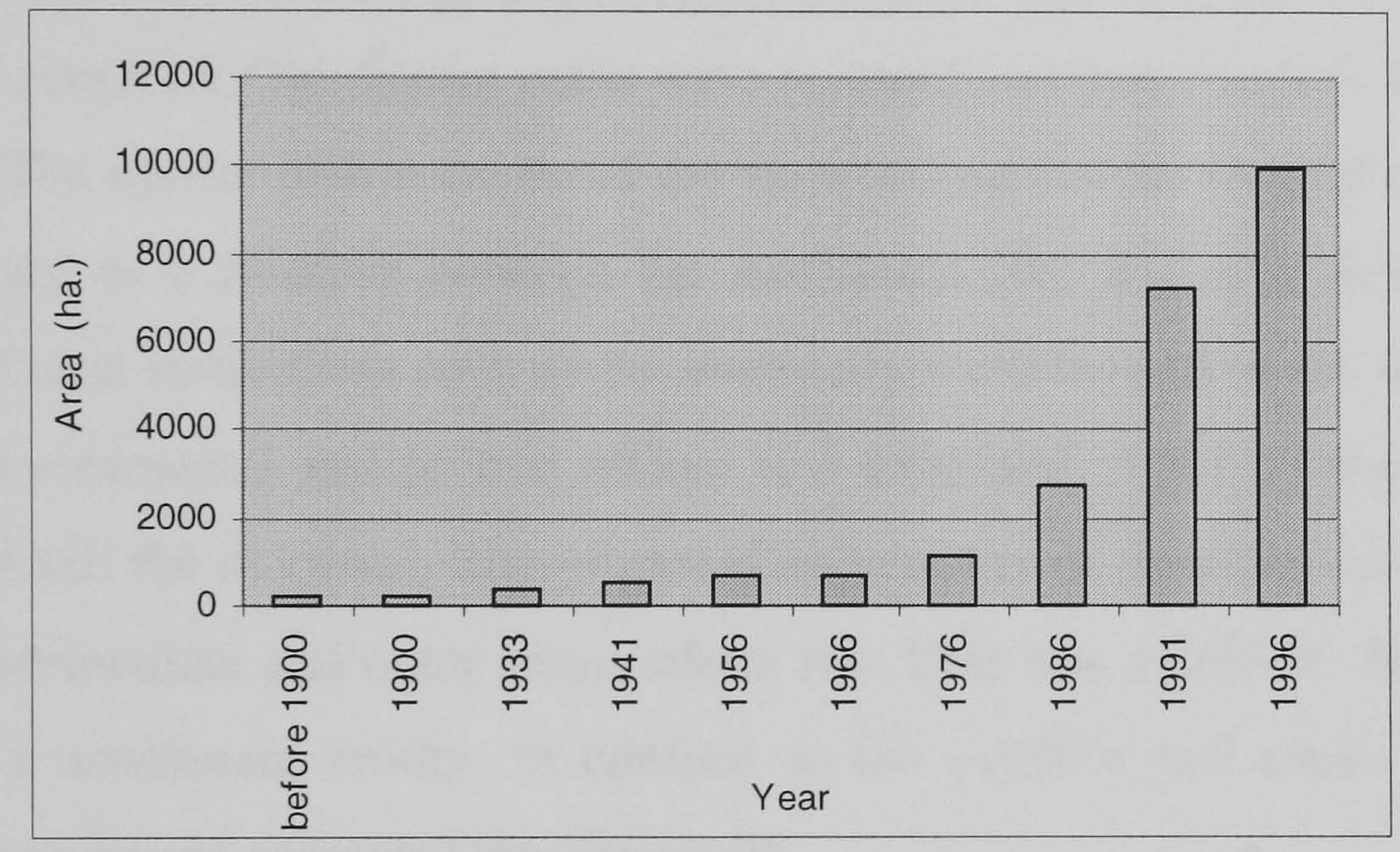
* Approximate total area of the city

TABLE 3.3: POPULATION AND THE AREA OF YAZD DURING THE LAST CENTURY

(Source: Mohammadi, 1993)



GRAPH 3.1: POPULATION GROWTH IN YAZD DURING 20TH CENTURY



GRAPH 3.2: THE GROWTH OF THE URBAN AREA OF YAZD DURING 20TH CENTURY

3.5.3.2. FIRST MASTER PLAN OF THE CITY

In 1977, the first master plan for the city was produced[17] (See Figure 3.15-a). Its major emphasis was on the conservation of the traditional and old part of the city. There was little attention, even perhaps ignorance of the development of the city as a reality (Mohammadi, 1993). Along with the usual research for a master plan that considered the different aspects of the city of Yazd, special attention was paid to the walled city, attempting to define it as the main element of the whole urban complex. Therefore, the master plan for Yazd aimed at the recovery, re-qualification, restoration and renewal of

[17] The first master plan was produced by Tehran University, Faculty of Fine Arts. In this plan Italian architects were also involved.

the historical centre through adequate proposals and norms. It was also aimed at achieving a compact and continuous urban texture. This was strongly commanded by the geographical requirements for the new expansion areas to be vitally connected with the old town. Complementary to this criterion was the protection of precious agricultural land around the town, dangerously threatened by land speculation (Kowsar 1989).

The master plan, by supposing the traditional or walled city as a geometric and symbolic core of the whole urban complex, a ring road to the perimeter of the ancient wall, was proposed to run around it, feeding the principal existing streets. Special attention was paid to recreate a pedestrian path along the layout of the walled city which had partially survived. Old district paths were restored and new services were proposed along them. The master plan considered the surrounding district located on the edge of the walled city as a fulcrum between the traditional city and new developed areas. While the cultural institutions such as the university were located in the old city, a new centre for governmental and private offices was proposed in the southern part of the city, distant from the old town. The proposed expansions of dwelling units were partly located in intermediate and outer areas, where free land was available. So the city was intended as a continuum reality, in contrast to the satellite real estate development, which had everywhere expanded the city limits.

In order to define the residential areas density and housing type, most of the proposed dwellings were single-family courtyard houses, one or two storeys high, in close relation with pedestrian movement. It was proposed that the orientation of the main north-south axis of houses and neighbourhoods should have a diversion of 20 degrees westwards.

Some very influential groups of real estate entrepreneurs and landowners, especially those which had already built the huge residential satellite Safavid several kilometres outside the city limits, started their challenge against the master plan. Due to conflicts between the authors of the master plan and powerful agents in the city the first master plan was never officially submitted to the city council for ratification and the second phase of the master plan was put away. So the city tended to grow without any confirmed plan until the Islamic revolution (Mohammadi, 1993).

3.5.3.3. SECOND MASTER PLAN (THE REVISION OF PLAN ON THE FIRST MASTER PLAN)

After Islamic revolution in 1979 Yazd was not excluded from the rapid changes in population of Iranian cities. The city started to grow rapidly and the population of it reached its peak. One of the main consequences of these dramatic changes of population was an increase in the demand for housing. As a result of this need, some governmental institutions and local policy makers of the city tried to give answers to this demand. They revised the first city master plan and added some new areas to the city, mostly for residential purposes (See Figure 3.15-b).

However, the development of a city without any proposed master plan was a point of confusion. In 1984 to solve and give answer to some problems of the city, the city council made a contract with a consulting Architects & Engineering Co. to prepare the second phase of the first master plan. The consulting company endeavoured to prepare a comprehensive plan for the city. Initially, they tried to use the first master plan as a base. However, during the initial investigation they found out that there was no relation between the actual site of the city and the master plan especially the dramatic changes which occurred in city expansion, land use pattern and population of the city. Therefore, they proposed a comprehensive revision as the second master plan for the city (See Figure 3.15-c).

The main idea for the city development was internal growth of the city within certain limits of the land. However, because of some socio-political problems such as the tendency to the subdivision of lands outside the city limits, this main aim never came to fruition. On the contrary, a new district was added to the city in 1991. In the master plan, the city was divided into six main city divisions.

According to the second master plan, the proposed spatial pattern of the city was a grid structure, in which, excluding the dwelling environment, the city was divided into five main zones (See Figure 3.14). These zones may be classified as follows:

1- Industrialised gardens
2- Home factories and handicrafts
3- The trade zone situated on the old bazaar
4- Heavy and light weight industries
5- Cultural zone located on the central pedestrian passage of the city

The zone number one was proposed for the industrialised gardens and was located to the north-east, the north-west, the south-east and the south-west of the city. These areas were originally accommodated by some villages, which because of the city expansion were gradually immersed in the city. Manufacturing industries were proposed to locate in the vicinity of the first zone.

Zones number two and three were concentrated mainly on the old city of Yazd. These zones were proposed to promote the old city from the socio-economic point of view. The main themes of the master plan for the old city were to consider the old city as a reality and try to give answers to the needs and demand of the people who wants to live there. In this way, the old city was considered as a place not only suitable for living but also an attractive portion of the city for tourists. The plan was proposed for the old town to be a place for home factories and handicrafts in which the products may sell in the bazaar, which was located close to it.

The zone number four was mainly allocated at both entrances of the city to the north and the south. The zone number five was situated along the main proposed pedestrian passage of the city which connected the new city centre to the old city. The main land use in this zone was reserved for cultural and educational activities. This zoning system never came to reality in the city because the idea did not accord to the actual socio-economic situation of the old town and the city as a whole.

The master plan predicted a programme for the city in 2 periods of five years, 1982-1987 and 1987-1992. In 1994, the city contained approximately a population of 380,000 in an area of 7200 ha. These figures are not comparable with the prediction of the second master plan where it was predicted the area of the city would be around 3576 ha which would accommodate a population of 357,561 for 1992. The growth of the city continued mainly in three directions to the south, the west and the south-west. The south-west attracted a large number of settlers and turned it into a quite popular area of the city. In 2000 the city council made a new contract with a consulting Architects & Engineering Co. to prepare the third master plan for the city of Yazd.

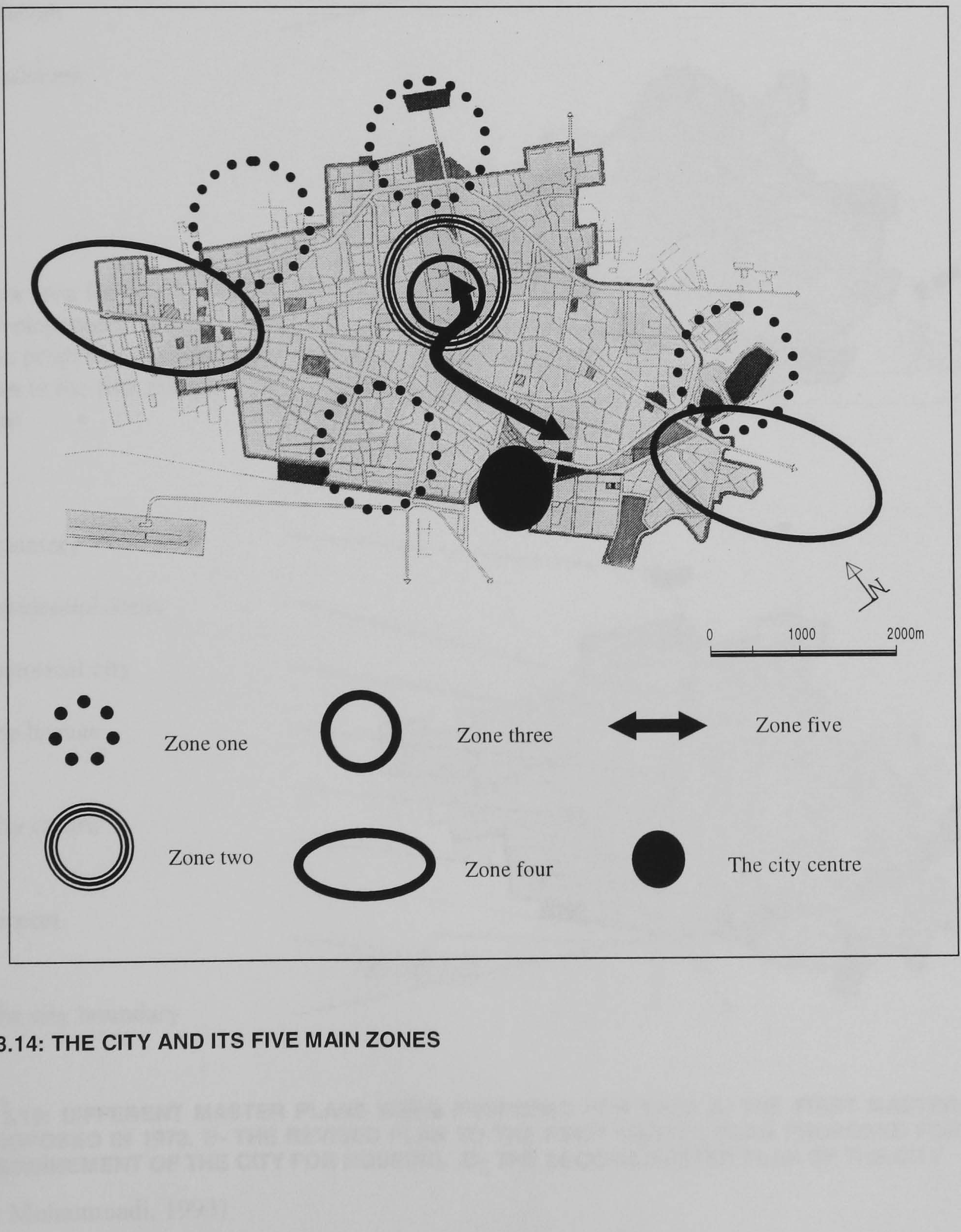


FIGURE 3.14: THE CITY AND ITS FIVE MAIN ZONES

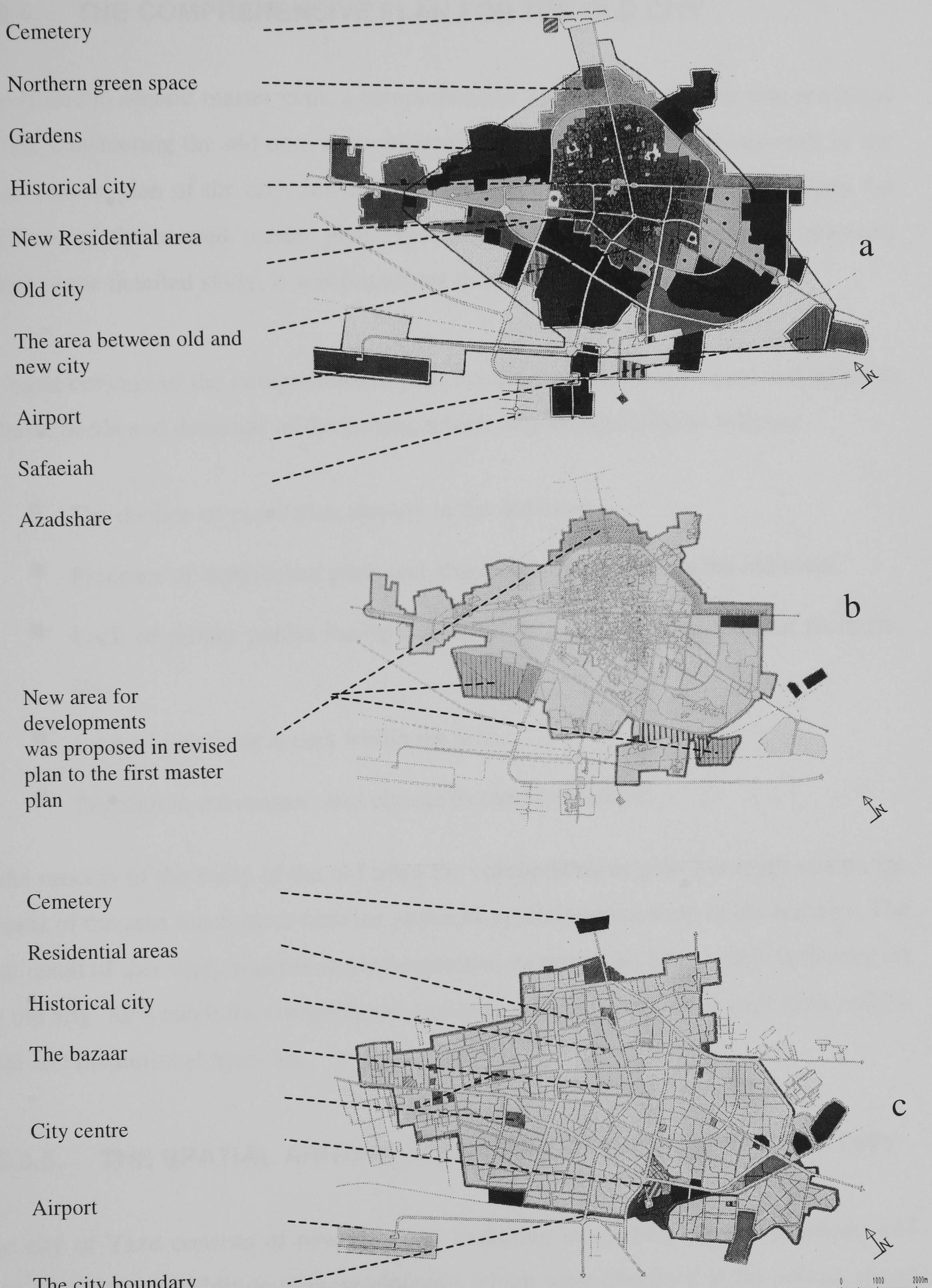


FIGURE 3.15: DIFFERENT MASTER PLANS WERE PROPOSED FOR YAZD A- THE FIRST MASTER PLAN OF YAZD PROPOSED IN 1973. B- THE REVISED PLAN TO THE FIRST MASTER PLAN PROPOSED FOR SOLVING SOME REQUIREMENT OF THE CITY FOR HOUSING. C– THE SECOND MASTER PLAN OF THE CITY

(Source: Mohammadi, 1993)

3.5.3.4. THE COMPREHENSIVE PLAN FOR THE OLD CITY

Apart from the second master plan, a comprehensive plan for the old city was produced in 1988, considering the old core as an independent entity within the framework of the second master plan of the city. Initially, the main aim of the plan was based upon the objectives of the second master plan especially with its proposed zoning; however, through some detailed study, it was found that these aims were unapproachable.

The basic concept of the comprehensive plan for the old town was framed according to the basic needs and demands of the people, which may be classified as follows:

- The decline of population density in the old town.
- Presence of demolished plots and abandoned spaces within the old town.
- Lack of proper public facilities such as green spaces, recreational facilities, etc.
- Lack of vehicular access within the area.
- Population movements and change in family structure.

In the process of the study of the old town the comprehensive plan has emphasis on the context of the area much more than the physical–spatial organisation of the old city. The final result of this study was not implemented and its proposals have a little influence on the old city. As a result the comprehensive plan for the old city was always criticised by local and institutional agencies.

3.5.3.5. THE SPATIAL ARRANGEMENT OF THE CONTEMPORARY CITY

The city of Yazd consists of new elements including large dwelling environments and public buildings in addition to those elements which were observed in the historical and the old city. The recent expansion of the city is completely isolated from the old and traditional part of the city. Space between the new and old parts of the city was filled by scattered construction of residential areas. Therefore, at the present time the city includes a number of big and small residential islands and other elements of the city which are related to each other by a gridiron street system (See Figure 3.16). The pattern of the street system has fairly divided the city into regular super-blocks which may be called districts. New districts are mostly constructed with an average of two storey buildings. There are some high rise buildings in the southern part of the city. In this way, these blocks are considered as a major element in the contemporary city of Yazd.

The new city centre is located in the southern part of the city and close to the city ring road. This centre is related to the old and other part of the city mainly through the ring road and a pedestrian passage proposed by the master plan. This pedestrian route was essentially theoretical and was never fulfilled.

By 1996, the city contained a population of 326,776 and the area had reached to more than 9950 hectares in which the historical city housed a population of 8884 in an area of 98.5 hectares. The total area of the Old City as currently determined is 588 hectares accommodating a population of about 32,400. In 1986, the population of the entire city of Yazd was around 234,000 in an area of 3,934 hectares. (Sazman-i Barnamah va Budjih, 1997)(See Figures 3.17,3.18)

It is worth noting that there is some old fibre of some rural areas, which were located around the old city, and now by expansion of the city they have been immersed into the city.

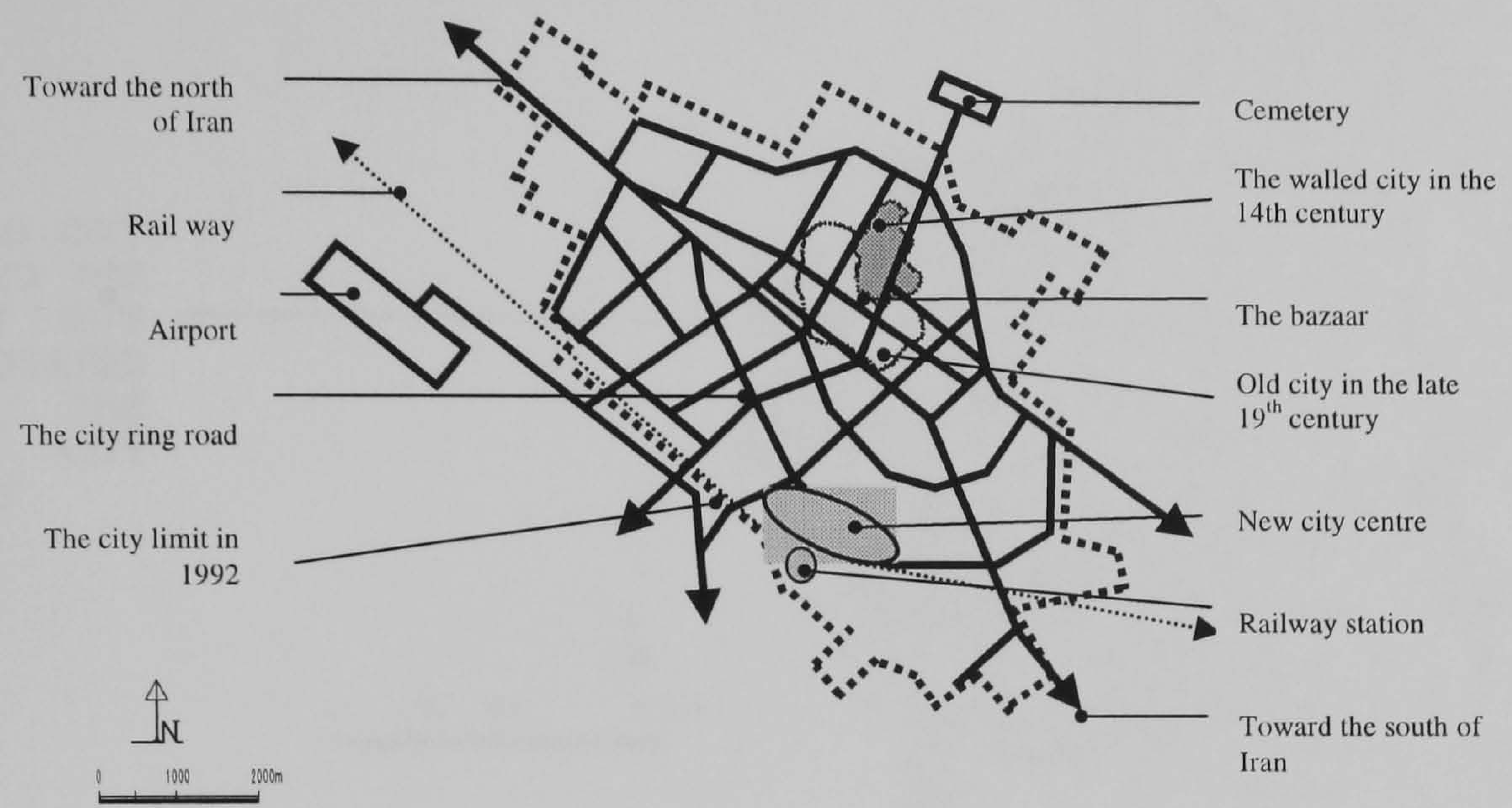


FIGURE 3.16: THE SPATIAL ARRANGEMENT OF THE CITY OF YAZD AFTER THE SECOND MASTER PLAN

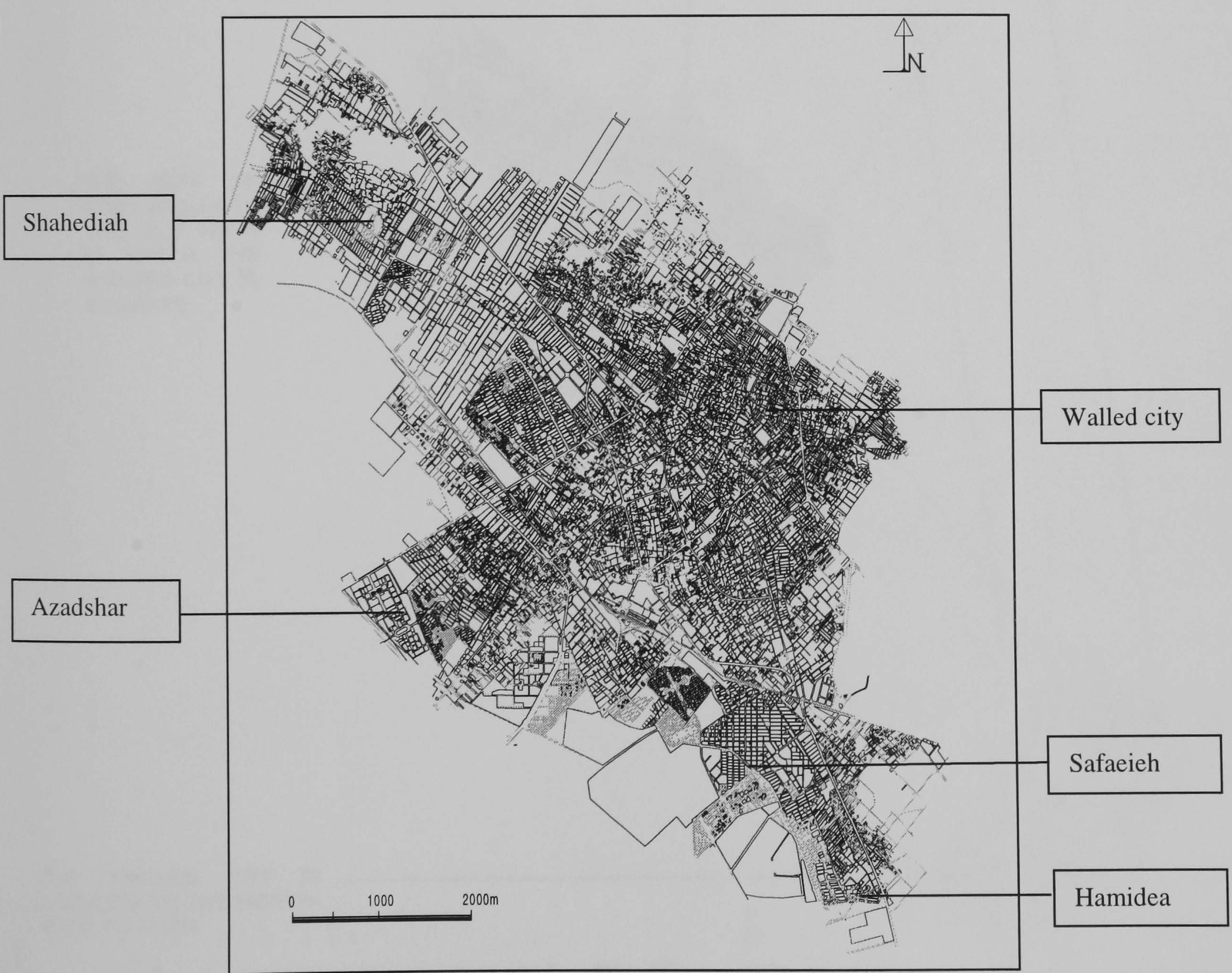


FIGURE 3.17: THE CITY OF YAZD IN 1999. SOME SURROUNDING RESIDENTIAL ENVIRONMENTS AND SMALL VILLAGES ADJOINING THE CITY

(Source: This maps is produced by Sazmane-Ab-va-fazelab-Ustan-e-Yazd in 1/200 scale in 1998)

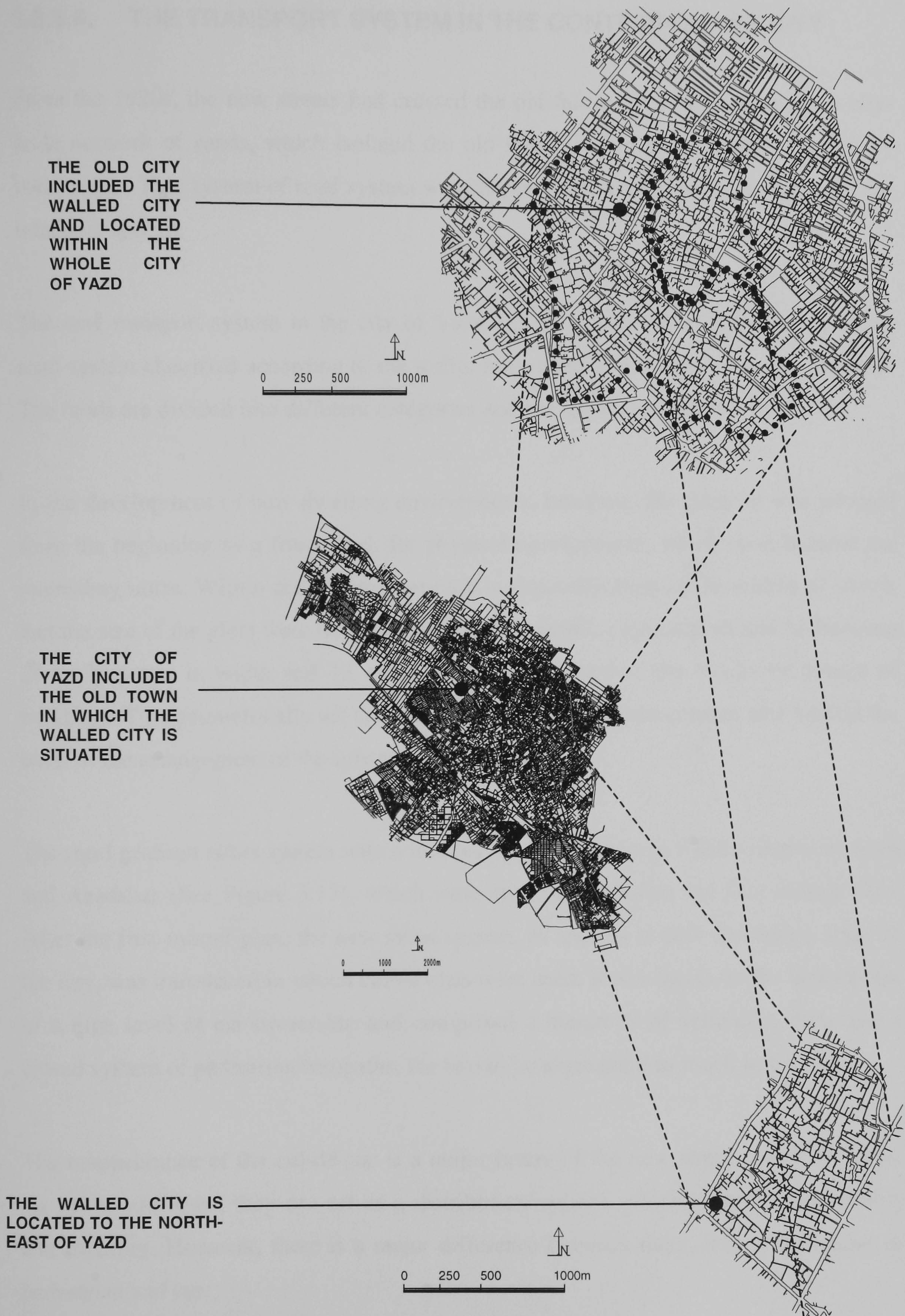


FIGURE 3.18: THE PRESENT SITUATION OF THE WALLED AND THE OLD CITY IN YAZD

3.5.3.6. THE TRANSPORT SYSTEM IN THE CONTEMPORARY CITY

From the 1920s, the new streets had crossed the old fabric of the city to create a city-wide network of roads, which isolated the old fabric within some islands created by these roads. This system of road system was adopted in master plans of the city and the transport system.

The new transport system in the city of Yazd generally consists of different levels of road system classified according to the traffic movement and their port and destination. The roads are divided into different categories and are shown in Figure 3.19.

In the development of new dwelling environments, however, the gridiron was adopted from the beginning as a framework for physical development, which soon became the overriding norm. Within the gridiron network, a standardisation of the widths of streets and the size of the plots were made possible. For example, city roads should be between 24 to 36 metre in width and 12 metres width streets served the blocks or groups of buildings. This geometrically set the pattern for the future developments and formed the basis of the arrangement of the urban form ever since.

The rigid gridiron street system with a number of crossroads was widely used in Safaiea and Azadshar (See Figure 3.17), which were constructed before the first master plan. After the first master plan, the new street system, as applied in new developed areas of the city, was introduced in which cul-de-sacs were used. It was based on the assumption of a high level of car ownership and comprised a hierarchy of vehicular roads and a closed system of pedestrian footpaths, the two to be segregated as much as possible.

The reappearance of the cul-de-sac is a major future of the new street pattern in Yazd. As in the old town, they are act as a distribution system, which controls accessibility and mobility. However, there is a major difference between them, that of the scales of pedestrian and car.

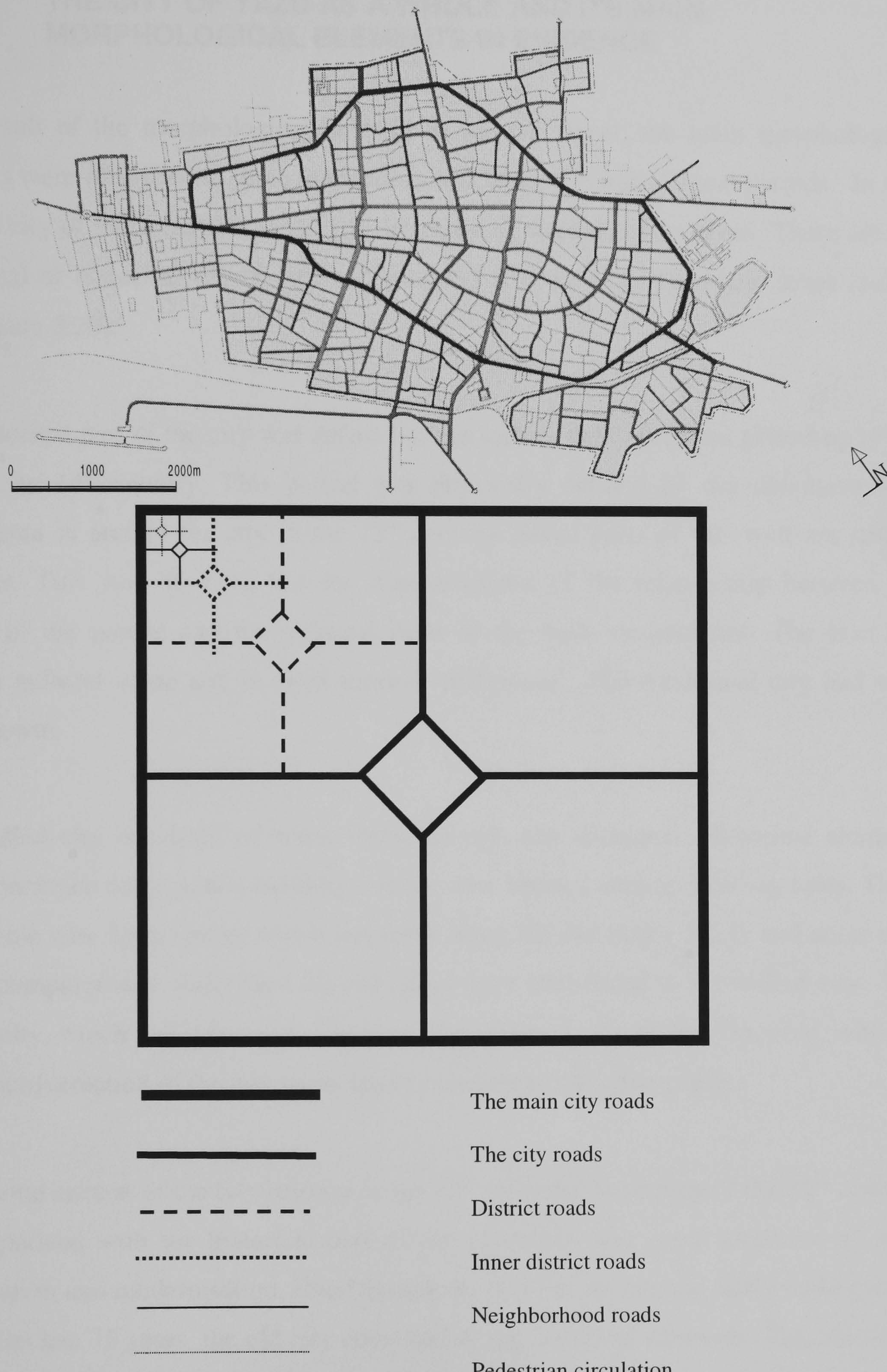


FIGURE 3.19: THE STREET SYSTEM WAS PROPOSED BY THE SECOND MASTER PLAN FOR THE CITY OF YAZD

(Source: Mohammadi 1993)

3.6. THE CITY OF YAZD AS A WHOLE AND ITS MAIN MORPHOLOGICAL ELEMENTS IN EVIDENCE

As a result of the morphological analysis at the city level, the main morphological elements were identified in three distinctions and related morphological periods. In this way the city of Yazd may be physically divided into three main divisions. These are the traditional or historical (inner), the old (middle) and the new developed areas (outer) (See Figure 3.20).

The historical part of the city was defined as the section belonging to a period up to the end of the 14th century. This period was physically defined by the defensive wall constructed in around the city in the 13th century. Some parts of this wall are still in evidence. This part of Yazd has the most evidence of the relationship between the culture of the people and the physical form of the built environment. The area has obvious cultural value and is often termed 'traditional'. The traditional city had very slow growth.

The walled city consisted of some historical and new elements. Historical elements mostly included some public buildings which were located among dwelling units. There were some new open spaces which occurred along the old major alleys and some new streets comparatively wider than the old alleys were introduced to the walled city. The walled city, which was generally shaped and constructed on a pedestrian scale, with the rapid transformation of the city today greatly confronts vehicular traffic.

The second section of the city belongs to the 15th up to the beginning of the 20th century. In comparison with the historical part of the city there was some evidence of rapid urbanisation and modernisation. Even though the city has undergone fairly rapid growth during the last 75 years, the old city consisted of the historical elements. The old city is still in evidence as a sample of the life of the people in the past and the present. The stability of form in the old city began to alter at the beginning of this century, but it has tended to change gradually. Despite a striking structural continuity, some dramatic changes have occurred from the early 20th century onwards mainly through an interaction with new concepts of city planning and lifestyle which is common in most Iranian cities.

Within the limitation of both the traditional and the old city as a whole, there are still many elements of the historical morphology in evidence. Although a large proportion of the old buildings, particularly dwellings, and large section of the city wall have been destroyed, other urban historical elements remain in position, beside a large area occupied by the old town including the walled city. There are 149 buildings including 26 caravanserai, 10 dwelling units, 51 religious buildings, 4 bath-houses, the grand bazaar and several small bazaars in the old town that have been officially registered to have some historical and cultural value. Today, some of these buildings have changed their function, mostly dwelling units into governmental offices, museums or even higher educational buildings like the School of Architecture. In the process of functional transformation there is a basic concept that the internal physical composition of the buildings should not be changed; however, with the passing of time, some minor internal changes have occurred in such units.

Wide streets were cut through crowded residential quarters of Yazd and new streets and traffic roundabouts were established. As a result, the city was physically divided into several parts. These new elements provided a proper opportunity for construction of new buildings within the city, which was somewhat different from the previous one in such as material, elevational treatments, height etc.

The newly built streets were increasingly lined with shops, which tended to compete for customers with the bazaar. Muddy alleys were replaced by asphalt streets, and piped water was introduced to the city parallel to so many other modern facilities. In the 1960s, two new satellite towns were established to the south and south-west of the city. These new towns now are the major parts of the present spatial structure of Yazd.

The pattern of growth and development in Yazd from the beginning until 1973 was basically toward the south, south-west and the west. The city of Yazd during three main stages of development faced a number of spatial transformations, resulting in the development of a comparatively large and thriving urban environment in Iran. The physical boundaries of the city have enlarged considerably since the 1920s and more dramatically since the 1970s, while many new elements added to the old city and a new planning concepts have been introduced not only for new development areas but also the old and historical part of the city.

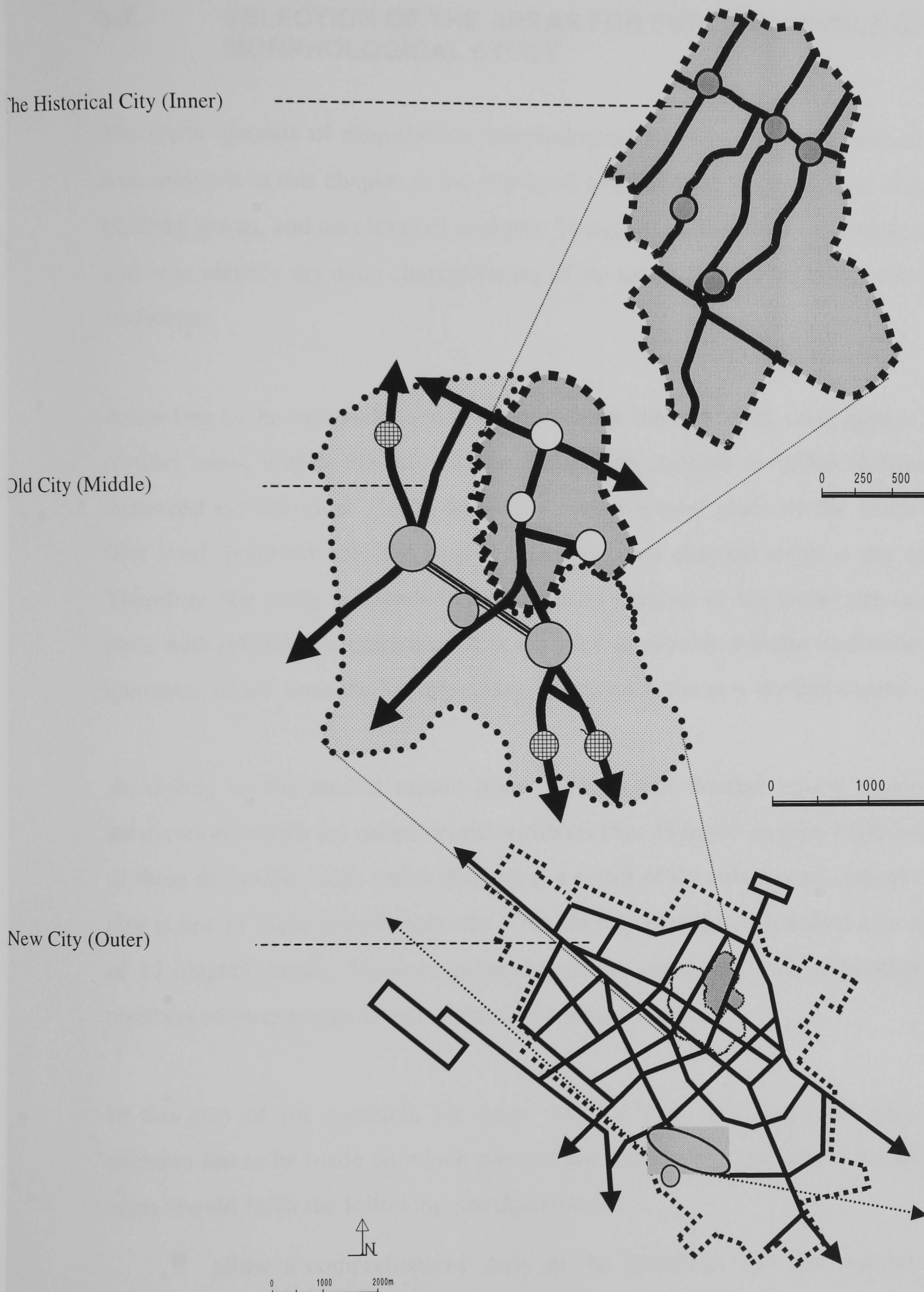


FIGURE 3.20: THE SPATIAL STRUCTURE OF YAZD IN TRANSFORMATION

3.7. SELECTION OF THE AREAS FOR FURTHER LEVELS OF MORPHOLOGICAL STUDY

The study consists of essentially a morphological study of the settlement of Yazd that was analysed in this chapter at the city level and intended to continue at district, block, building group, and unit level of analysis. Therefore, in the three following chapters the aim is to identify the main characteristics of the urban form in some typical areas of the settlement.

According to the morphological study of Yazd at the city level, there appear to be three distinct areas within the city. These areas were erected at different times and are described as 'historical', 'old', and 'new'. After a brief study of the entire city at the first level, precisely selected smaller areas received detailed study at the other levels. Therefore, the study is intended to generate an analysis of the settlement in these three parts with related considerations. It is intended to provide a better understanding of the elements, which form the historical city, old city and the new developments.

According to the second master plan the city was divided into 6 regions and 128 subdivisions which are called neighbourhoods (See Figure 3.4) (See table 3.4). The area of these divisions varies and is defined as a result of the urban road system. The walled city is one of these neighbourhoods. The old city includes the walled city and consists of 14 neighborhoods. These neighbourhoods are combined with each other in various numbers to form higher levels of the city administrations.

In this part of the research, for more detailed scale level morphological studies, a decision has to be made on which parts of the settlement to examine. In this regard, the areas should fulfil the following prerequisites to:

- allow a comprehensive study of the historical, old and new morphological pattern to be made.

- allow the examination of the impact of new developments and possible changes of use in historical and old parts of the city, particularly with regard to the recent new elements such as new streets and land use.
- provide a conceptual basis of transformation processes from the distant past to a contemporary development in an Iranian city, here the case of Yazd.
- allow a comprehensive comparative study of the historical, old and new morphological patterns to be made at a lower level of analysis such as block and building group level.

Furthermore, in order to choose an area within the city, the following criteria also need to be considered:

- They should have begun to be developed at various historical periods of the city developments, thus reflecting the various stages of the transformation processes in the city.
- They should include various land uses.
- The selected areas should also be of a reasonable size, preferably from 50 to 150 ha to allow patterns to be identified. The area may vary and depend upon the density and size of the built environment and proportioned to the total area of each distinctive historical period of the city.

In addition to the above considerations, the presence of information, possibility of data collection and the time available for this research were also taken into account.

According to these tasks and criteria, and by considering the three stages of the development of Yazd, three areas were selected in the city. These areas are parts of the walled, old and contemporary city (See Figure 3.22, 4.23).

The first area is centrally located in a traditional part of the city and almost the entire central parts of neighbourhood no 1162. It is almost located in the same place as the initial settlement of traditional urban spaces of the city. It is a prototype for 'traditional architecture' of the city in the past including some buildings erected in different periods of time. It includes the major thoroughfare of the walled city and the existence of several open spaces and historical buildings within the area adds a particular historical dimension. Therefore, it is intended to be a base to find out the basic values of traditional urban tissues in Yazd. Of course, during the last century many changes have occurred in this part of the city, particularly in street systems and new land uses.

The second selected area is located in the old part of the city, neighbourhood no 4121, it is an immediate development outside the walled city and it contains some valuable urban spaces such as the bazaar and some of main public open spaces together with traditional dwellings. In the selected area in the old city different stages of development outside the walled city are in evidence. Therefore, it is intended to show the different stages of transformation in the morphological pattern of Yazd beyond the walled city. In this area as in the first selected area, due to the implementation of a new transportation system and a new land use pattern some changes have taken place.

The third selected area is located in the newly developed area of the city. It consists of neighborhoods no 5321, 5322, 5411, 5412 and 5311. This area developed in the 1970s and is a prototype of the new development out of the old city. Therefore, an analysis of the existing morphological elements of the area could demonstrate the present spatial pattern of new dwelling environments of Yazd[18]. Obviously, as the area has been constructed quite recently emphasis on the changes within the area is very rare. Therefore, the study of this area will focus on the modern residential environment. It is also intended to show the processes of the formation and transformation of the city up to the beginning of the dominant new type of urban spaces in the city of Yazd in the last century.

The three defined areas which have been selected for further morphological analysis, form the remainder of this research in the next three chapters. These are based on studies of carefully selected parts of the city developed in different periods.

[18] Although the selected area is located in the new part of Yazd, it is not the first new development in the city. The first large dwelling environment in Yazd was located in the area called Safaeiah.

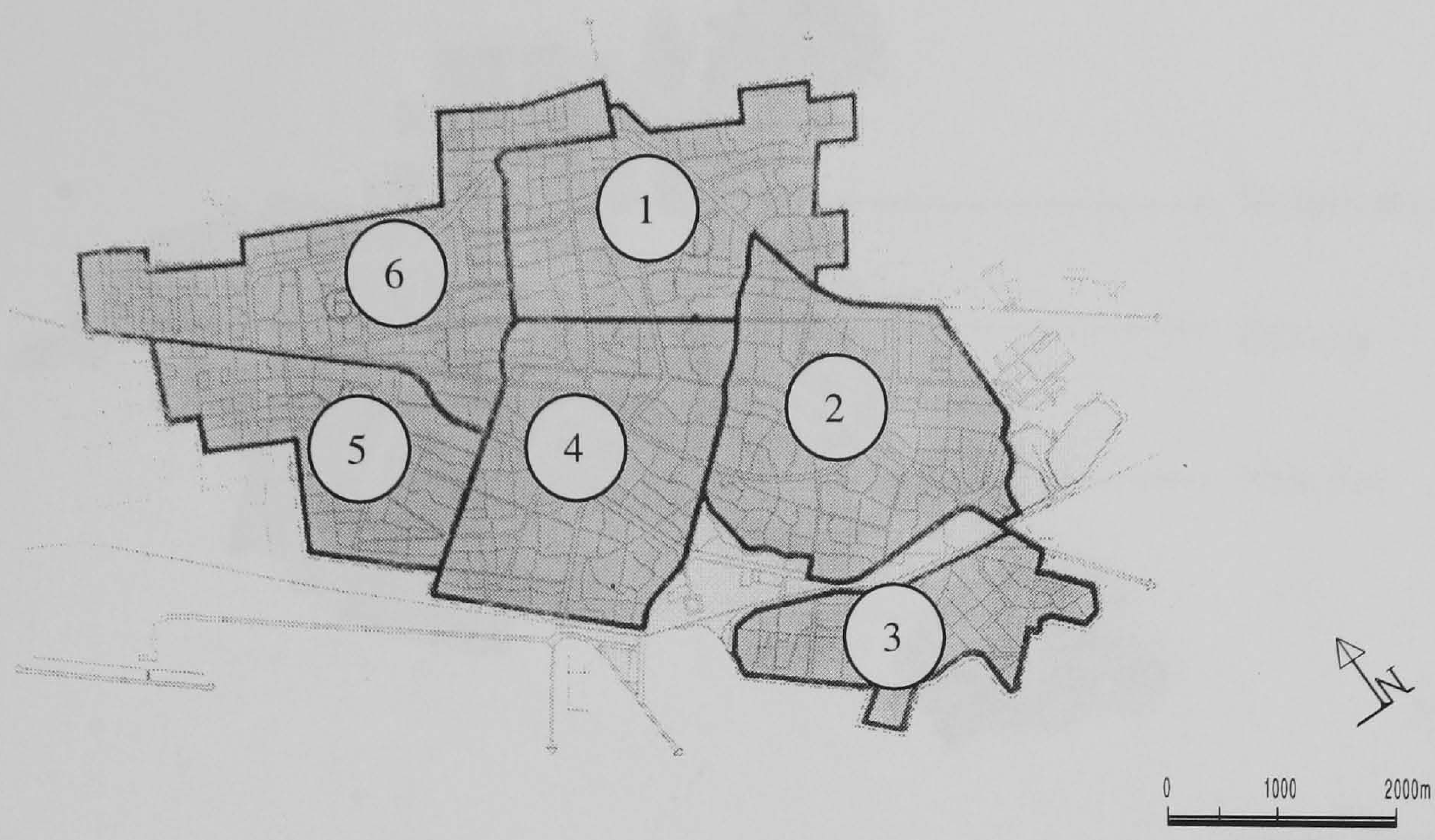


FIGURE 3.21: ACCORDING TO THE SECOND MASTER PLAN OF YAZD, THE CITY WAS DIVIDED INTO SIX REGIONS

(Source: Mohammadi, 1993)

	Unit	Block/Groups			District				City
City subdivisions	Unit	Housing block	Housing group	Neighbourhood unit	Neighbourhood	Quarter	District	Region	City
Average number of lower levels	--------	**12** Units	**12** Housing blocks	**5** Housing groups	**3** Neighbourhood units	**2** Neighbourhoods	**2** Quarters	**4** Districts	**6** regions *

TABLE 3.4: ACCORDING TO THE SECOND MASTER PLAN, THE CITY OF YAZD WAS DIVIDED INTO DIVERSITY OF SUBDIVISIONS

(Source: Mohammadi, 1993)

* In 1996 two new regions were added to the city

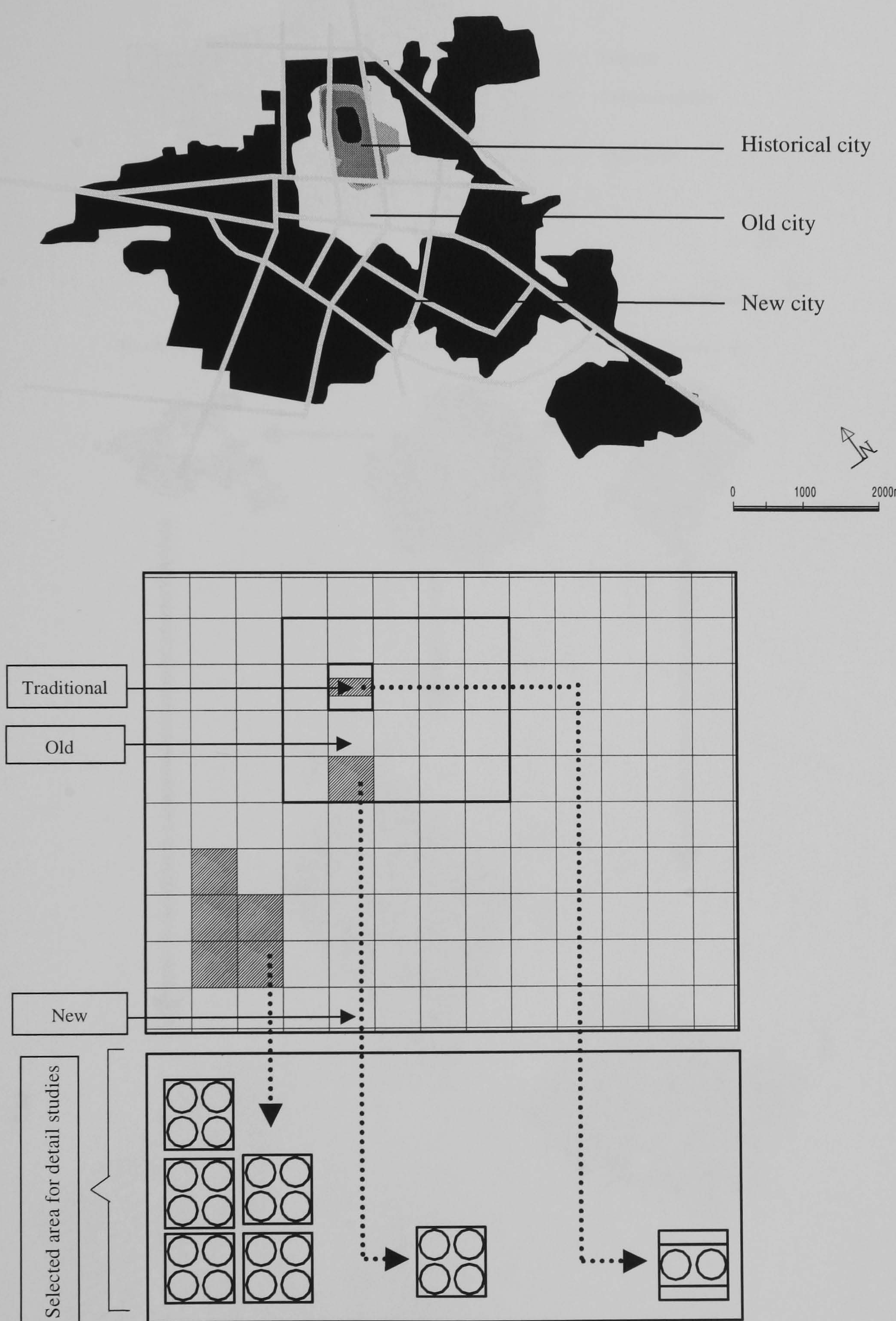


FIGURE 3.22: THE SELECTION OF AREAS FOR FURTHER DETAIL STUDY IN THREE MORPHOLOGICAL PERIODS OF THE CITY. THE LOWER DIAGRAM SHOWS LOCATION, PROPORTION AND RELATIONSHIP OF THESE THREE AREA IN THE CITY AS A WHOLE.

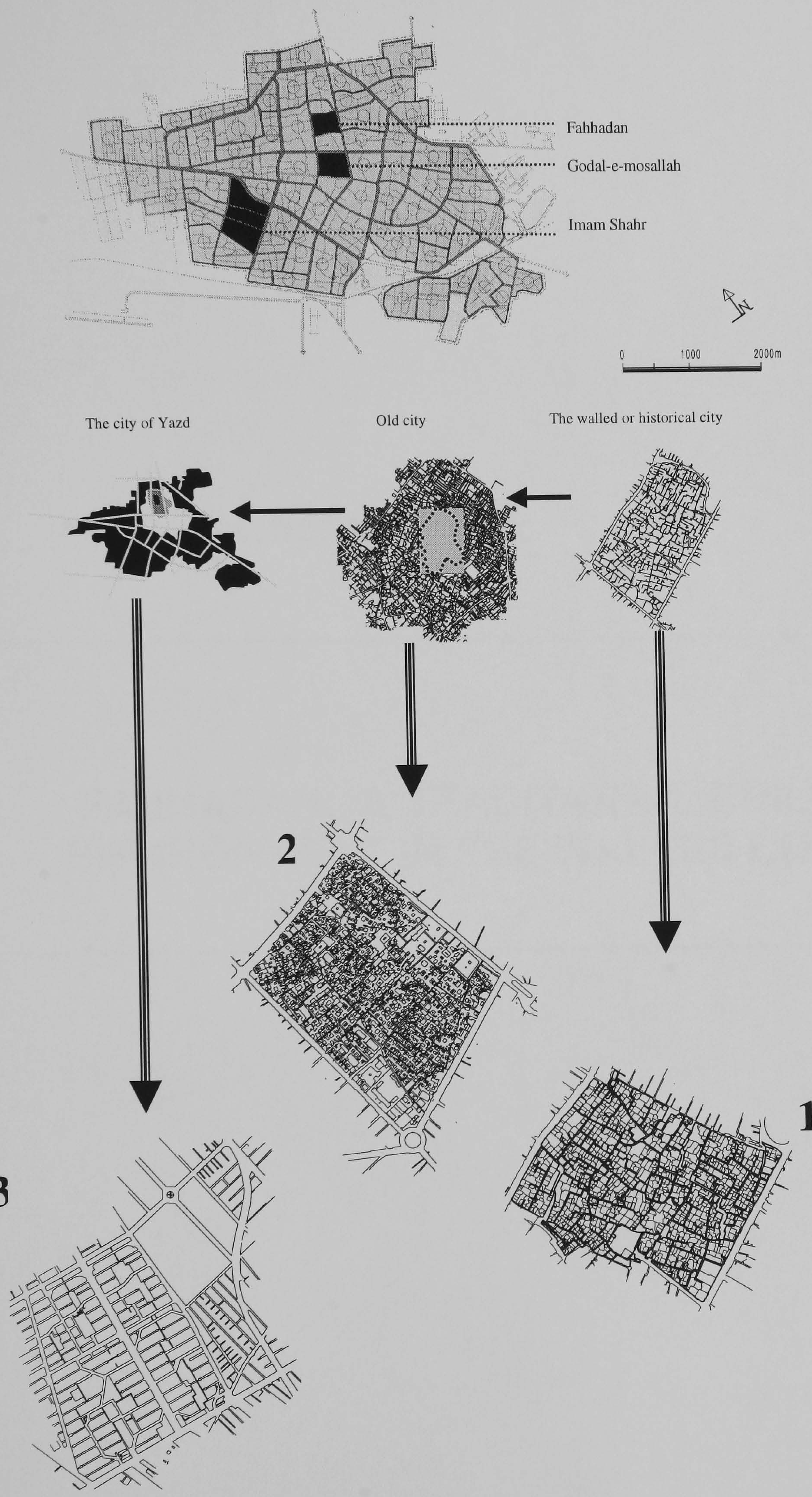


FIGURE 3.23: URBAN SUBDIVISION AND THE THREE SELECTED STUDY AREAS 1- FAHHADAN IS LOCATED IN THE WALLED CITY 2- GODAL-E-MOSALLAH IS LOCATED IN THE OLD CITY 3- IMMAM SHAHR IS LOCATED IN NEW DEVELOPED AREA OF YAZD (NO SCALE)

Chapter Four:

4. FAHHADAN, A TRADITIONAL BUILT ENVIRONMENT IN THE WALLED CITY

The selected area for detailed analysis is the oldest part of Yazd and essentially considered as a traditional dwelling environment. It is a part of the walled city belonging to the period before the 14^{th} century. The area is called 'Fahhadan' which is still the name of a neighbourhood in the walled city. This is the most valuable part of the city as it includes a wide variety of traditional dwellings and historical urban fabric. The analysis in this chapter will cover matters of some detail concerned with the district, block, building group and unit or building level of its urban morphology. The aim is clearly to identify the basic characteristics of the traditional dwelling environment, the elements of which it is composed and the relationship between them and changes in evidence.

4.1. GENERAL SITUATION OF THE PARTICULAR AREA IN THE TRADITIONAL CITY

The selected area (See Figures 4.1 and 4.2) is centrally situated in the walled city and to the north-west of the present city of Yazd. It is currently well defined by a number of boundary elements: to the north-east a main alley known as Yusdaran alley, the oldest path in the traditional city, to the south-west a street known as Masjed-e-jame which continues into the area by a secondary alley toward the western boundary, to the north-west a city street named Seyed Gol-e-Sorkh and to the south-east another street known as Immam street. According to the city administration's subdivisions the selected area is a part of neighbourhood No 1162, and almost a half of the whole traditional city. The built-up area which loosely may be called a district covers 47 ha (See Figure 4.3). The area consists of various categories of functions, mostly residential. The area is subdivided by some north-east/south-west and north-west/south-east alleys.

4.2. THE MORPHOLOGY AT DISTRICT LEVEL

At the district level the Fahhadan area may be identified as an inseparable part of the whole walled city to the north-east and south-west and as a more or less separate morphological entity from north-west and south-east. Its boundary elements, two old major alleys which run from the north-west to the south east, act to facilitate ease of movement not only to the study area but also to the adjacent areas (See Figure 4.3). Two newly constructed streets which run from the north-east to the south-west act as an obstacle between the Fahhadan area and its surroundings. In this way, the morphological analysis of the Fahhadan area at the district level consists of a brief description of the processes of development in the area, the land use pattern and those elements which are considered as the primary elements.

4.2.1. CONCEPTUAL BASIS OF THE DEVELOPMENT IN THE AREA (HISTORICAL SETTING)

It is likely that the history of the selected area is as long as that of the city of Yazd. According to the recorded history of Yazd (Afshar, 1995) the initial settlement in this area can be dated as far back as before Islam. However, it seems that there is no physical evidence of the structure of that era in the present fibre of the city. It is obvious that the present situation of the area is totally the result of a complex process of development in different eras. However, except for some recorded information about the city in 11^{th} century there is a lack of historical information in the form of maps about the area and there is not any detailed historical situation of the area in the past. The most recorded information in different historical books makes reference to the socio-cultural situation of the area with reference to the buildings constructed in that era. The earliest evidence that provides some information on the area morphologically is a map provided in 1859 by a group of Russians in which the overall view and some of main elements of the city are in evidence. From the map the area is divided into several blocks and the walled city in clearly in evidence (See Figure 3.10). The most detailed information from the whole area can be obtained by an aerial photo taken in 1925. Other materials, which may be useful for this analytical study, are some maps belonging to the first master plan of the city provided in 1973.

The oldest buildings in the area are situated in the extreme north of the selected part of traditional city. These date back to the era around 11^{th} century. To the south of the selected area two important historical buildings are in evidence one is the Masjed-e-jame which was constructed during the 11^{th} century and the other is the Syed Roknadin school and a shrine dating from the 14th century. The main alley situated to the north of the area called 'Yusdaran Passage' seems to have been one of the main thoroughfares of the city in the past (See Figure 4.3 and Plate 4.1).

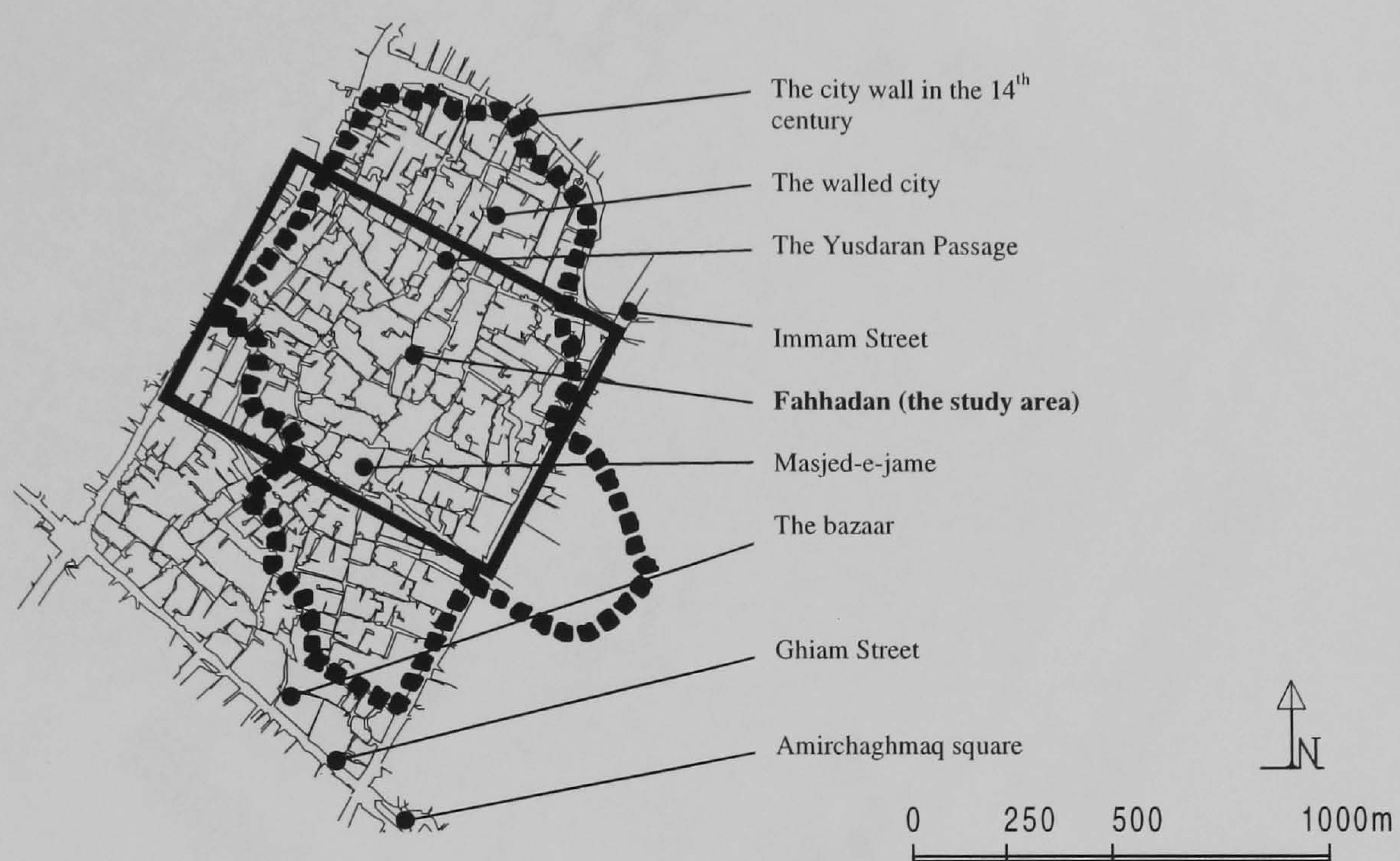


FIGURE 4.1: LOCATION OF THE STUDY AREA 'FAHHADAN' IN THE WALLED CITY AS A TRADITIONAL BUILT ENVIRONMENT. SOME MAJOR ELEMENTS IN RELATIONSHIP WITH THE AREA ARE IN EVIDENCE.

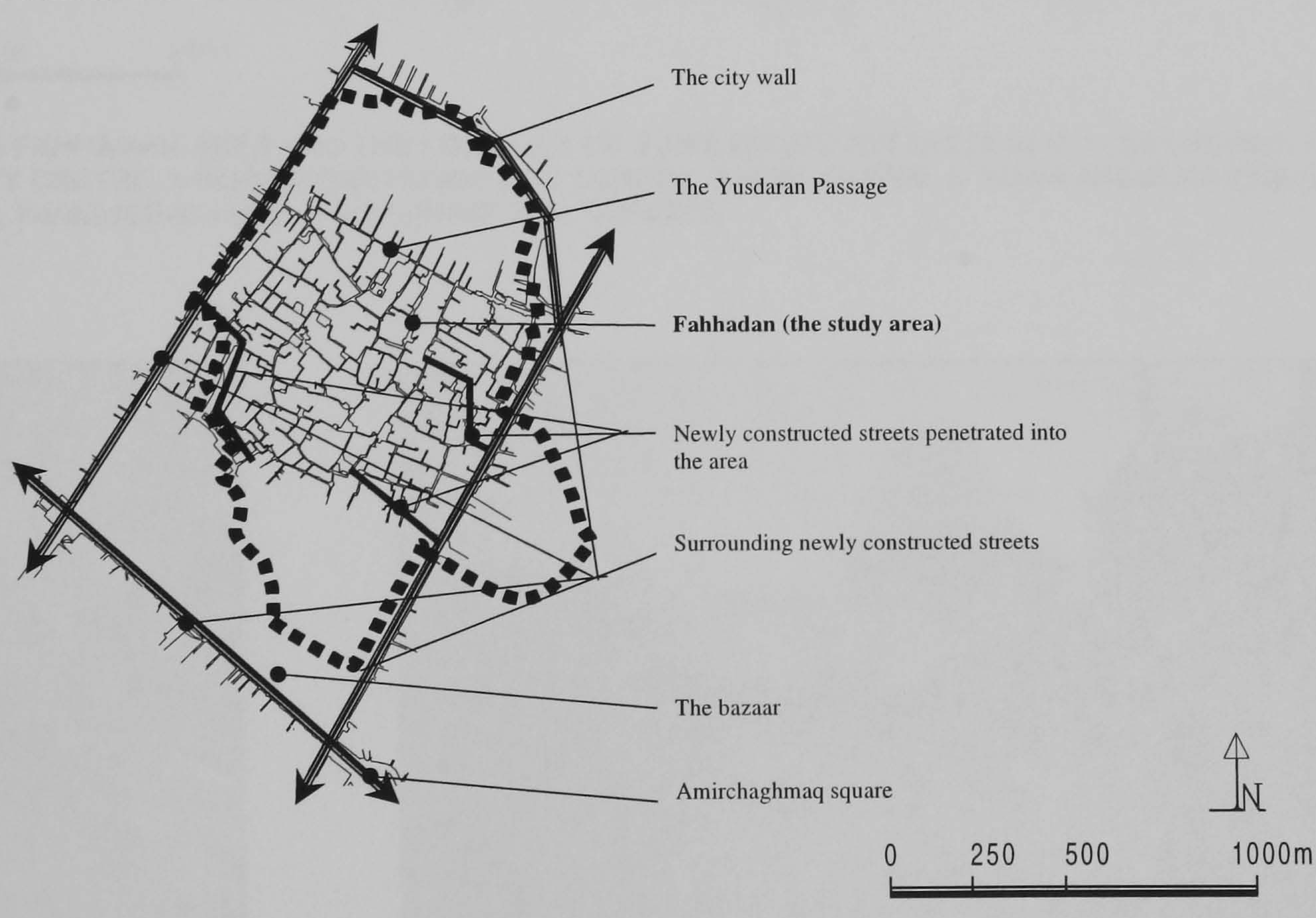
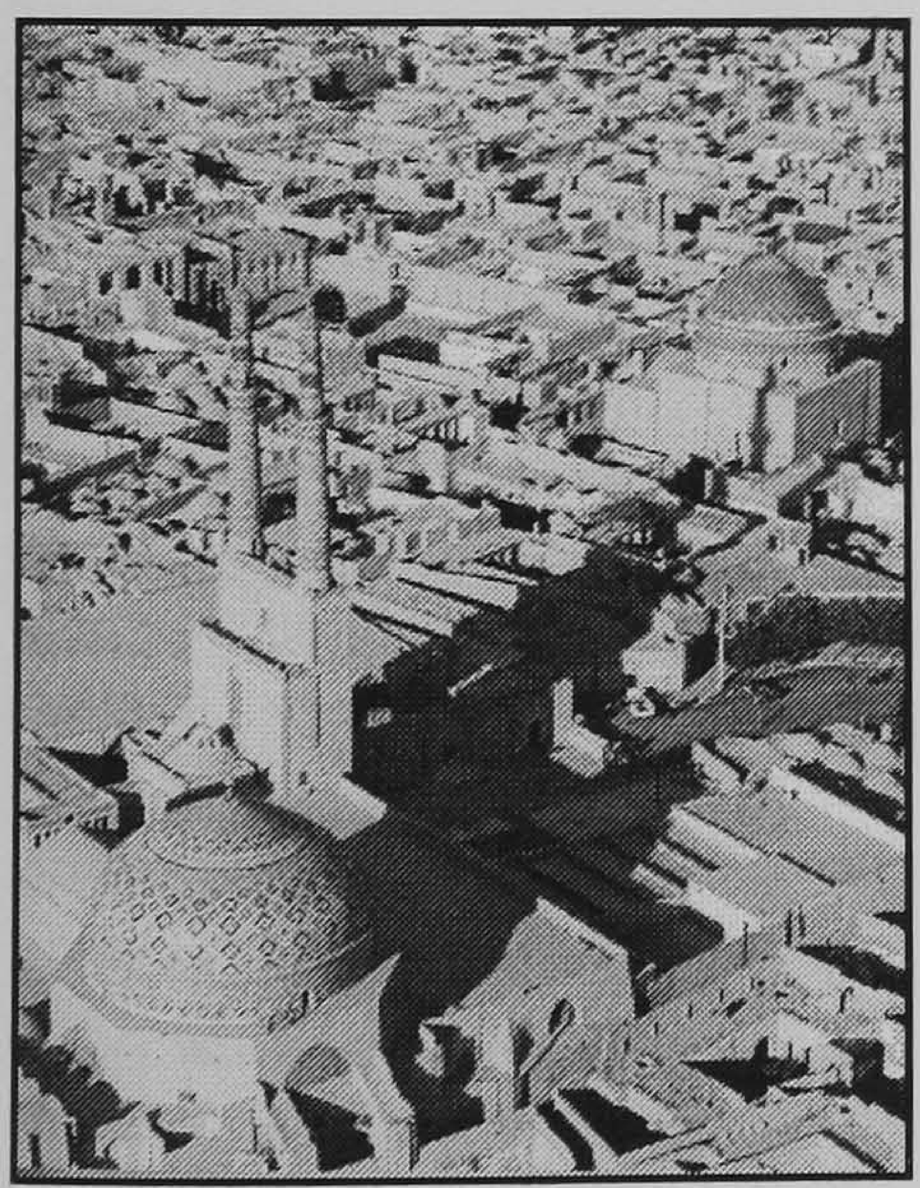


FIGURE 4.2: LOCATION OF THE FAHHADAN AREA AND ITS RELATIONSHIP WITH THE NEWLY CONSTRUCTED STREET SYSTEM ENCIRCLED AND PENETRATED IT.

FIGURE 4.3: THE FAHHADAN AREA AND THE LOCATION OF SOME IMPORTANT UNITS IN IT 1- KOSHKENO, 2- HISTORICAL CITY CENTRE, 3-HOSSEINIAN HOUSE AND SCHOOL, 4-MAUSOLEUM, 5- SHAH-ABOULQASEM, 6-WAGHTOLSAAT, 7-MASJED-E-JAME, 8-GOVERNMENTAL OFFICES



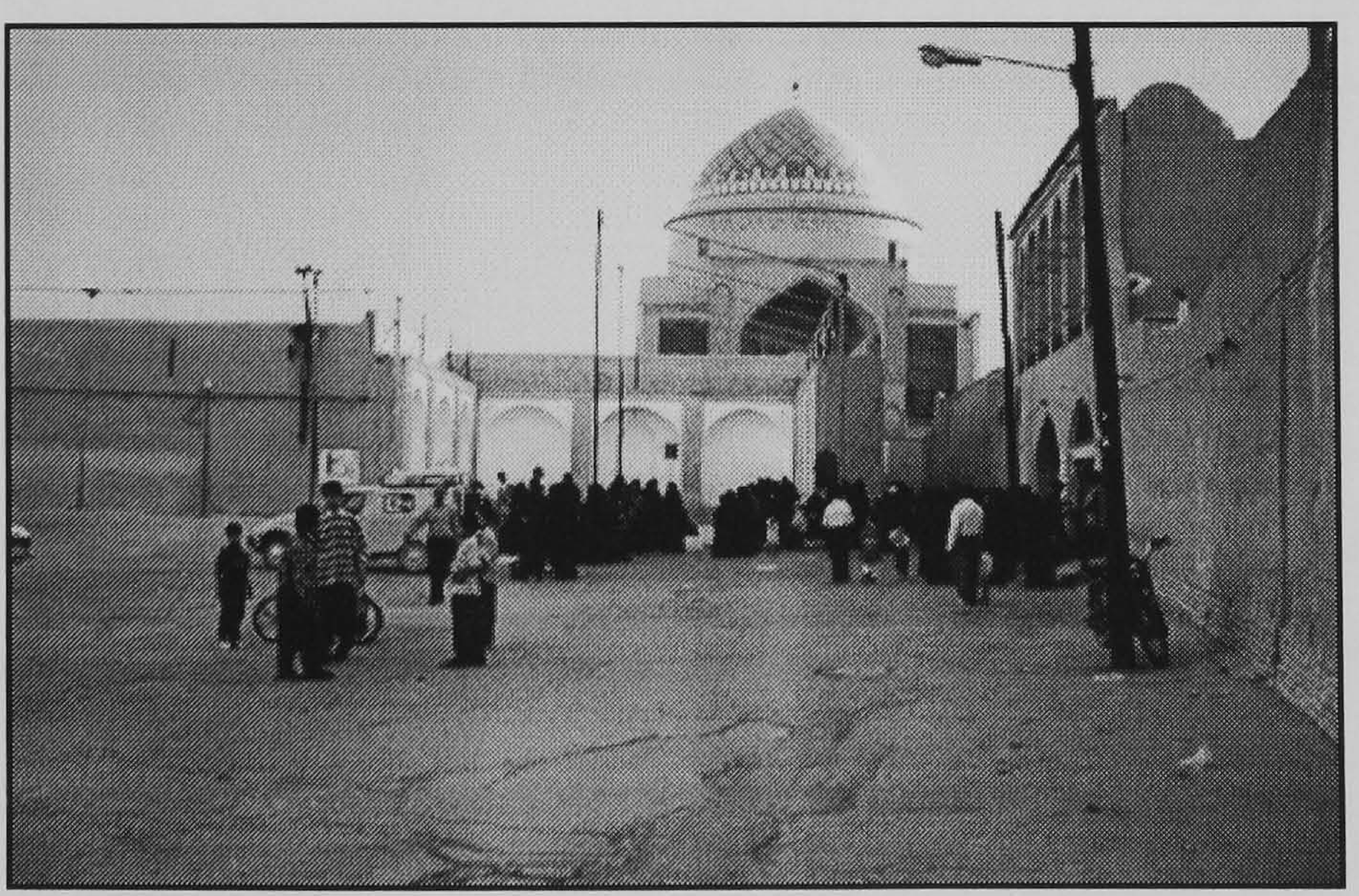


PLATE 4.1: A GENERAL VIEWS OF THE FAHHADAN AREA AND AN EXAMPLE OF OLD OPEN SPACE IN THIS AREA

4.2.2. THE PATTERN OF LAND-USE

The total area of the selected part of the walled city covers 47 ha, of which around 6 ha is occupied by streets, alleys and other public open spaces. The selected area is basically a residential environment mixed with some non-residential, mostly religious and small shops, while commercial activities prevail around the perimeter sections of the area specially on the edge of the newly constructed streets.

According to a recent survey, the total building floor area is 41 ha, currently accommodating a population of around five thousand. Table 4.1 shows that 32.5 ha, or 80 per cent of the total built area are residential (See Figure 4.4), accommodating 1623 families or 5295 inhabitants. This gives an average living space of 254 sq. m per family or 78 sq. m /per person. The majority of building units are under two storyes in height and 51 per cent of all units are likely to have been constructed as long as 100 years ago. Almost 49 per cent of these units are either reconstructed by new material or some changes introduced to them (Yazd City Council, 1998).

The latest survey (Yazd City Council, 1998) on the physical situation of plots in the Fahhadan area shows that (See Tables 4.2 and 4.3) about 35 ha or 84 per cent of total floor area is covered by complete buildings. Only 11 per cent of the area is considered as demolished and 5 per cent of the total area consists of enclosed lands, incomplete buildings, and green spaces. In the study area only 170 units out of 1587 units are recorded in a relatively poor condition.

In the Fahhadan area, about 83 per cent of the properties belong to the private sector, where 11 per cent belong to the religious sector. The remaining 6 per cent of the properties belong to institutions in both private and governmental sectors (See Table 4.4).

FIGURE 4.4: LAND USE PATTERN IN THE FAHHADAN AREA

(Source: Yazd City Council, 1998 and Author's site survey)

LAND USE	Number of plots	Sum of plot area	Percentage of plot area
cultural unit	4	3715	0.90%
educational unit	4	4876	1.18%
government office	2	4662	1.13%
green space & park	4	3825	0.93%
historical building	3	4172	1.01%
medical centre	1	258	0.06%
office	4	2325	0.56%
public services	18	4578	1.11%
religious building	60	30486	7.40%
residential	1195	326144	79.16%
shop	233	15590	3.78%
shop residential	43	10117	2.46%
storage & workshop	14	1272	0.31%
Grand Total	1585	412019	100.00%

TABLE 4.1: LAND USE IN THE FAHHADAN AREA

(Source: Yazd City Council, 1998)

LAND USE	Complete building	Demolished building	Enclosed land	Green space	Incomplete building	Grand Total
Cultural unit	3668	47				3715
Educational unit	4876					4876
Government office	4662					4662
Green space & park			350	3475		3825
Historical building	4172					4172
Medical centre					258	258
Office	2325					2325
Public services	4478		100			4578
Religious building	29081	256	1095		54	30486
Residential	267368	43998	11317	406	3055	326144
Shop	15066	523				15590
Shop residential	9905	212				10117
Storage & workshop	1033	239				1272
Grand Total	346635	45275	12862	3881	3366	412019

TABLE 4.2: LAND USE IN THE FAHHADAN AREA WITH REFERENCE TO THE PHYSICAL SITUATION OF THE PLOTS IN EVIDENCE

(Source: Yazd City Council, 1998)

LAND USE	Complete building	Demolished building	Enclosed land	Green space	Incomplete building	Grand Total
cultural unit	3	1				4
educational unit	4					4
government office	2					2
green space & park			1	3		4
historical building	3					3
medical centre					1	1
office	4					4
public services	17		1			18
religious building	55	1	3		1	60
residential	960	161	55	1	18	1195
shop	229	4				233
shop residential	42	1				43
storage & workshop	12	2				14
Grand Total	1331	170	60	4	20	1585

TABLE 4.3: NUMBER OF PLOTS OCCURRED IN DIFFERENT SPACE USE WITH REFERENCE TO THE PHYSICAL SITUATION OF PLOTS IN EVIDENCE

(Source: Yazd City Council, 1998)

LAND USE	Institute	Private	Religious	Grand Total
cultural unit	1565	1023	1127	3715
educational unit	4395	481	-	4876
government office	1451	-	3211	4662
green space & park	3825	-	-	3825
historical building	3916	900	-	4816
medical centre	-	-	258	258
office	1487	-	839	2325
public services	1358	673	2547	4578
religious building	125	296	30064	30486
residential	5237	316219	4044	325500
shop	501	11813	3276	15590
shop residential	-	10117	-	10117
storage & workshop	-	1068	204	1272
Grand Total	23861.3	342589	45569	412019
Percentage	6%	83%	11%	100%

TABLE 4.4: OWNERSHIP AND SPACE USE OF THE BUILDINGS IN THE FAHHADAN AREA

(Source: Yazd City Council, 1998)

4.2.3. THE PRIMARY ELEMENTS IN EVIDENCE IN MORPHOLOGICAL FORM

At the district level, the morphological elements to be identified are those which give shape and form to the area. In general these are open public spaces such as streets, major alleys, squares, religious open spaces and crossings; built forms occur between them, whether of housing or some more significant monuments. As a traditional dwelling environment, the morphological pattern of the area is characterised by arrangement of its lowest morphological elements to form a valuable feature of a traditional fibre. Therefore, at the district level of analysis, it seems appropriate to describe the Fahhadan district in terms of two primary elements: the open spaces and the blocks.

4.2.3.1. OPEN SPACES

At the district level, the discussion of the open spaces here includes the patterns that major alleys or old street system and the new streets have taken and some spaces occur in between the blocks in the form of squares. The major alleys in conjunction with new streets have formed the general pattern of the street system in the Fahhadan area. In addition to the street system, there is a pattern of a variety of old and new squares, green spaces, and playgrounds which mostly occur in between the blocks.

4.2.3.1.1. THE MAJOR ALLEY SYSTEM

The old street pattern in the Fahhadan area consists of a maze of narrow alleys which pass through the blocks and building groups to provide an access to all units. These accesses occur in different layers of the alley system. In the past, the alley system functionally acted as footpaths for walking from one neighbourhood centre (See Figures 4.5 and 4.6) to another and generally from units to other city facilities such as public services, mosque, bazaar etc. These alleys were rarely found to be congested, as, by this measure, these thoroughfares were adequate for their purposes, and anything wider and more elaborate would be wasteful of land. They are not equally narrow, and some of the wider ones cross entire dwelling clusters to provide easy routes of travel for transients.

Regardless of the width of the alleys and according to the beginning, the end point, the situation of some major building and spaces which are located alongside them, alleys may be classified into three categories: the major alleys, alleys and cul-de-sacs. At the district level of analysis, the alley system of the area will be examined in terms of the major alleys or second layer of the street system.

There are two major alleys, Yusdaran passage and the Masjed-e-jame Street with its extension, which are located to the north-east and the south-west boundaries of the study area. In addition, there are four major alleys running from the north-east to the south-west direction, and link the main Yusdaran alley to the southern parts of the walled city (See Figure 4.6). One of them was historically considered as a major thoroughfare in the walled city and after passing through the whole district joins to the Masjed-e-jame which is located to the south-west of the study area. These four alleys are narrow and winding, though they are straight in comparison with those of other major alleys which occur in the area. These four major alleys divide the area into five portions. These five portions are longitudinal in shape but they are generally irregular in their edges. A further subdivision is in evidence with several alleys occurring in a perpendicular direction from the north-west to the south-east. Even though the importance of these alleys is not similar to that of the four former alleys, they may be considered as a part of the major alley system in the Fahhadan area.

While the distribution of the major alleys running from north-east to the south-west is fairly uniform, that of the perpendicular direction is rather less so. The distance between those alleys runs from north-east to the south-west and generally ranges from 80 to 290 metres, majority occurring in 120 metre intervals (See Figure 4.8). The major alleys which run from the north-west to the south-east are much less uniform and none of them run directly through the entire area.

The Yusdaran alley is situated to the north-east boundary of the study area and oriented from north-west to the south-east (See Figure 4.6). This alley acts as a main axis where some small shops and public facilities such as water reservoir are located alongside it. Most of the major alleys pass or stem from this main access.

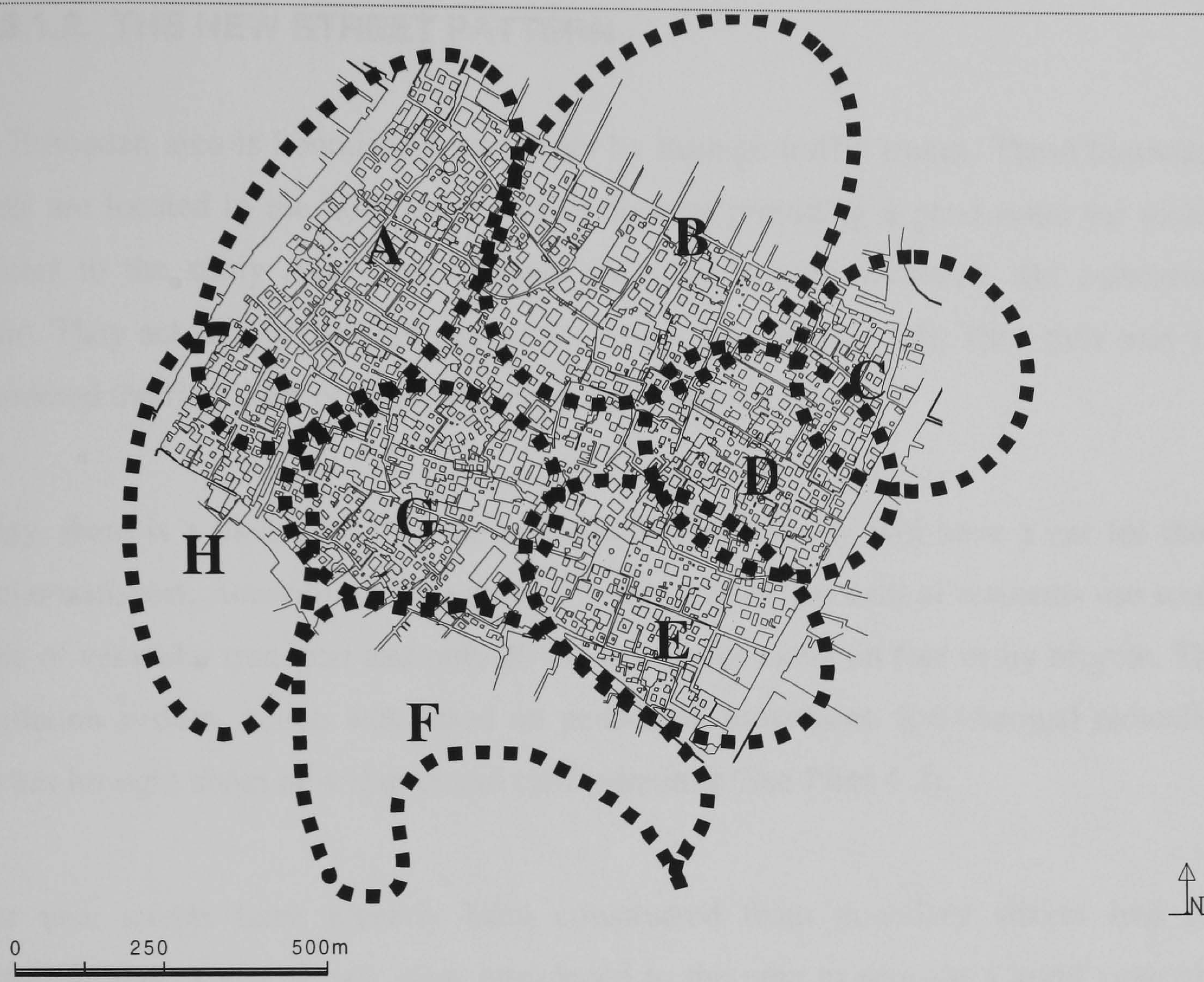


FIGURE 4.5: NEIGHBOURHOOD SYSTEM IN THE FAHHADAN AREA. THE BOUNDARIES MAY NOT BE DEFINED PRECISELY AND THERE IS NO PHYSICAL EVIDENCE FOR THESE SUBDIVISIONS A- KOSHKENO, B-FAHHADAN, C-MALEAMIR, D-BAZAARENO, E-WAGHTOLSAAT, F-DAROLSHAFAH, G-SHAHABULGHSEM, H-DARVAZEHSHAHI.

(Source- The above neighbourhood division are based upon the comprehensive plan for the old city of Yazd and some unofficial information from the "Organisation of Cultural Heritage" in the province of Yazd.)

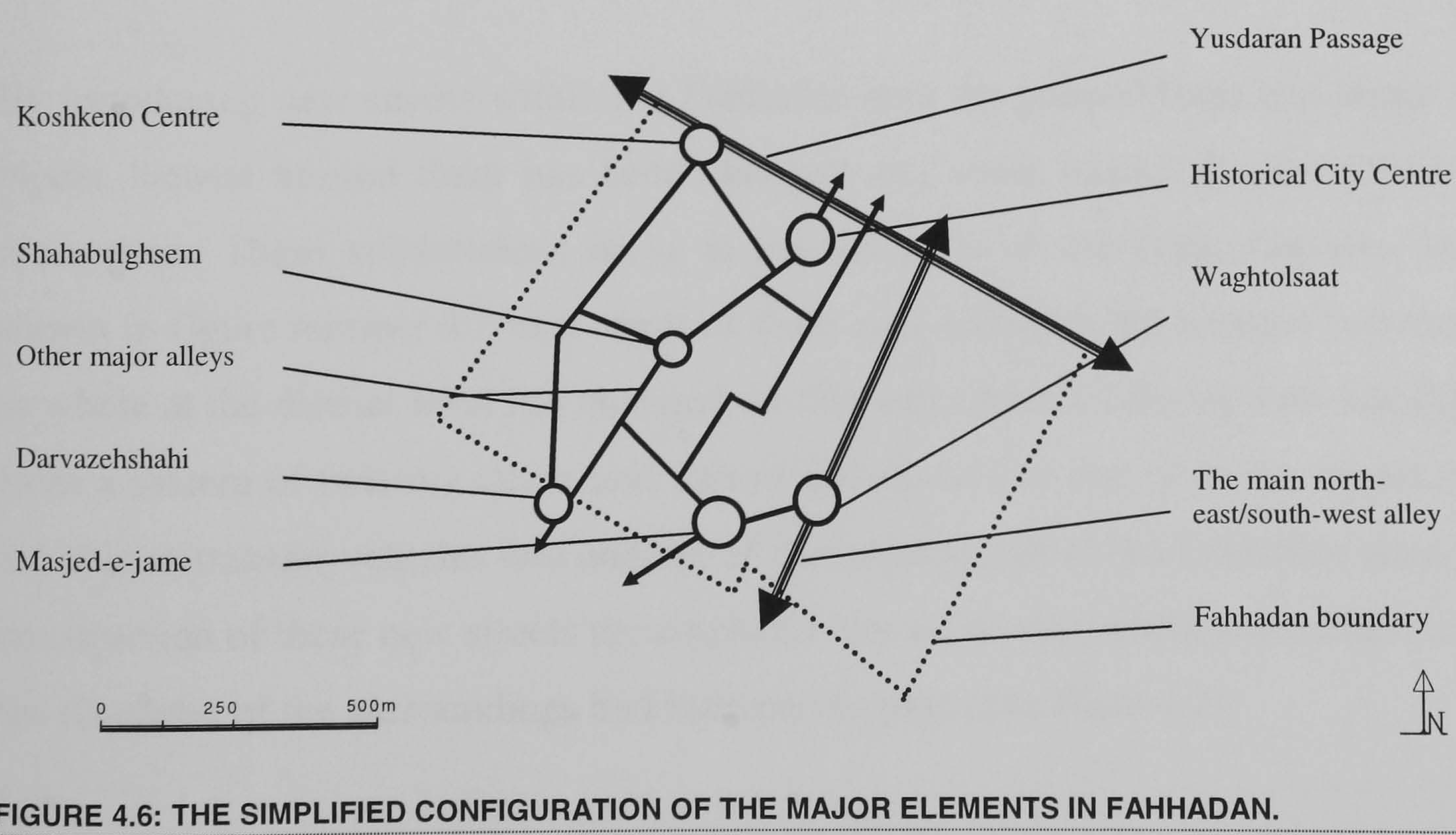


FIGURE 4.6: THE SIMPLIFIED CONFIGURATION OF THE MAJOR ELEMENTS IN FAHHADAN.

4.2.3.1.2. THE NEW STREET PATTERN

The Fahhadan area is bounded on two sides by through traffic routes. These boundary streets are located to the north-west and south-west providing a good route for motor vehicles to the study area. These streets are open to both vehicular and pedestrian traffic. They act as a part of the city street system (See Figure 4.7). Thus they may be considered the first layer of street system in the Fahhadan area.

Today, there is a likelihood that the householders of the city will have a car for their regular transport. According to one survey[1], more than 80 per cent of residents use some mode of vehicular transport and only 20 per cent or so move on foot or by bicycle. The circulation system, which was based on pedestrian movement, has changed radically, and has brought about new spaces and configurations (See Plate 4.2).

Four new streets have recently been constructed from boundary streets into the Fahhadan area. These streets were introduced to the area to provide a good vehicular access routes for the area. They are either partially constructed as a result of widening old alleys or are completely new routes, introduced to the area. These streets act as major alleys and there is no relationship between them and the old pattern of street system which is clearly in evidence in the Fahhadan area.

By introducing new streets within the Fahhadan area the general form and shape of the blocks located around them has been changed and some blocks divided into two or more parts. These subdivisions occur in several parts of the Fahhadan area and are shown in figure number 4.7 as a result of these new elements the relation between part to whole at the district level has changed. In this way, the old alley system has changed from a system of twisting alleys and narrow cul-de-sacs to one of wider streets, which are able to transfer vehicles into and out of the internal part of the Fahhadan area. In the construction of these new streets the emphasis was on correct width and matters such as the character of the surroundings had little part to play (See Plate 4.2).

[1] Author's site survey in summer 1998

FIGURE 4.7: THE OLD PATTERNS OF THE STREET SYSTEM IN THE FAHHADAN AREA. IT ALSO SHOWS THE POSITION OF NEW STREETS INTRODUCED TO THE AREA

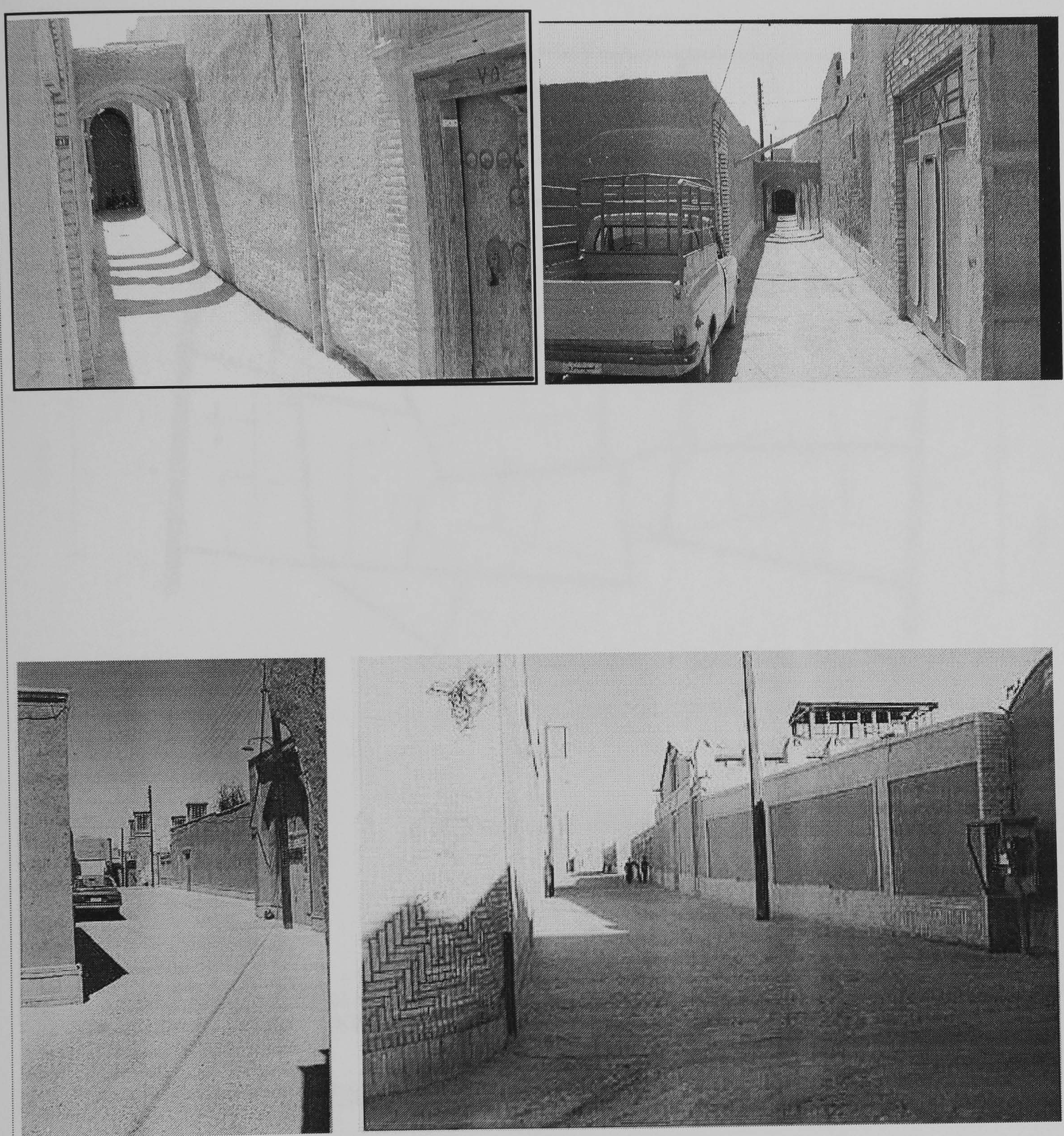


PLATE 4.2: CHANGES TO MEET NEW REQUIREMENTS. TOP: THE OLD CONCEPT OF A PEDESTRIAN PATHWAY. BOTTOM: CHANGES TO THOROUGHFARES TO ACCOMMODATE VEHICULAR TRAFFIC.

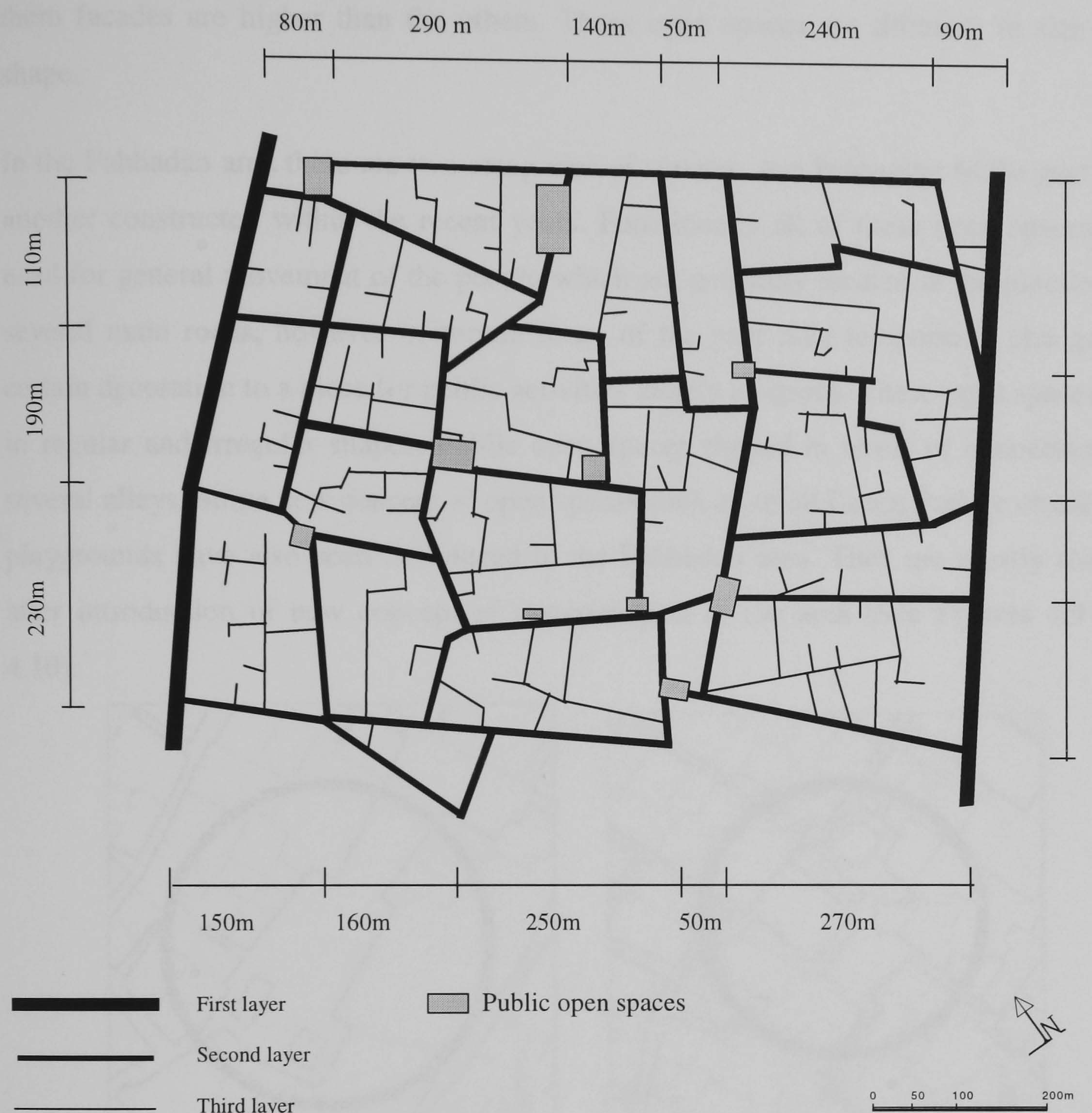


FIGURE 4.8: THE NEW STREET SYSTEM IN CONJUNCTION WITH THE OLD ONE. THE THREE LEVELS OF THE STREET SYSTEM ARE IN EVIDENCE

4.2.3.1.3. PUBLIC OPEN SPACES (SQUARES)

Squares are one of the main actors in the spatial pattern of the Fahhadan area. They are located in the different parts of the area and were placed where people assembled and sometimes different economic, social, cultural and recreational activities took place. Occasionally, where several passages meet, a rectangular square is formed. These spaces are called ‘Meydan’ or in religious point of view ‘Husseinah’. Usually these open spaces are surrounded by simple flattop facades in four directions. In some of them facades are higher than the others. These open spaces are different in size and shape.

In the Fahhadan area there are two categories of squares, one belonging to the past and another constructed within the recent years. Functionally all of these open spaces are used for general movement of the people which are generally located at the junction of several main roads, however in certain times of the year they temporarily change by certain decoration to a place for public activities mostly religious. These open spaces are in regular and irregular shapes. Public open spaces shaped in terms of connection of several alleys. Some new concept of open spaces such as small Green Park or children's playgrounds have also been introduced to the Fahhadan area. They are mostly shaped after introduction of new concept of transportation to the area (See Figures 4.9 and 4.10).

FIGURE 4.9: PUBLIC OPEN SPACES OCCUR IN DIFFERENT PARTS OF THE FAHHADAN AREA. THEY HAVE NOT ONLY SOME RELIGIOUS FUNCTIONS, BUT ALSO ACT AS A PART OF THOROUGHFARE SYSTEM. THESE OPEN SPACES ARE IN REGULAR AND IRREGULAR SHAPES.

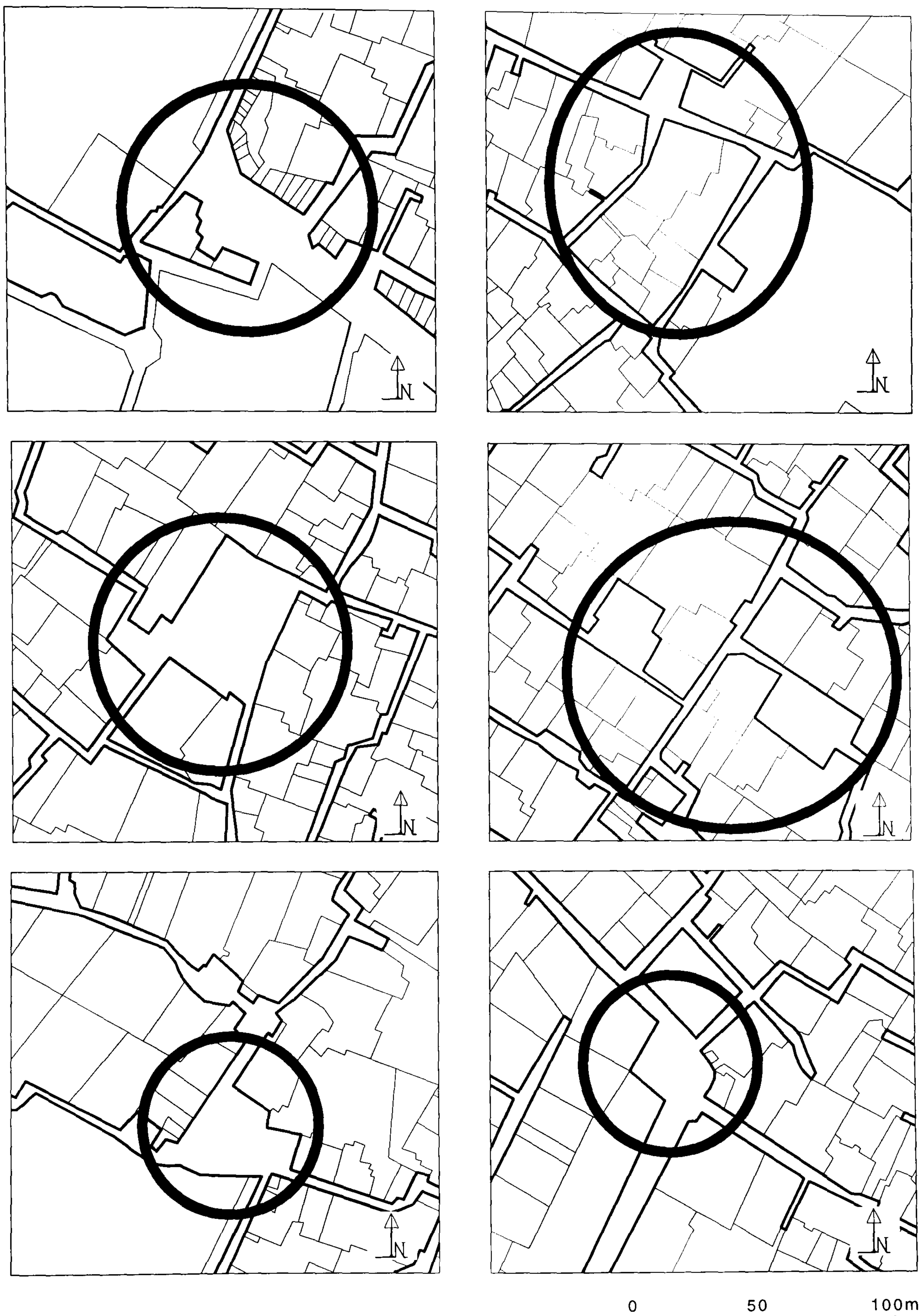


FIGURE 4.10: PUBLIC OPEN SPACES SHAPED IN TERMS OF CONNECTION OF SEVERAL ALLEYS. THESE OPEN SPACES HAVE MAINLY MOVEMENT FUNCTION. THESE ARE MOSTLY SHAPED AFTER INTRODUCTION OF NEW CONCEPT OF TRANSPORTATION TO THE AREA.

4.2.3.2. BLOCKS

At the district level, for further analysis and to make clear the method of the breakdown of the area, it was decided to break down the Fahhadan district initially according to the impotence of the major alleys from the north-east to the south-west. In this way the area divides into five portions or super-blocks (See Figure 4.11). These super-blocks in turn subdivide into various numbers of smaller portions or blocks. Therefore, the blocks in the Fahhadan area are defined by means of major alleys as boundaries and the resultant blocks are far from having a geometrical pattern. According to this consideration there are 21 blocks in the study area in evidence, which consist of several hectares of land, with a minimum area 7600 sq.m to a maximum of 38200 sq.m (See Figure 4.12).

In the changes since the late 1920s, some new land-uses, after the introduction of two wide streets to the north-west and south-east of the Fahhadan area, began to be developed not only alongside them but with some new functions introduced to the area.

Changes in modes of transport, and new concepts of spaces, which are designed to meet people's needs and demands, have brought about new streets and open spaces. This new system of circulation has changed the old arrangement of building block entrances for houses, subdivision of dwelling units and the relationship of the plot and the nearby public spaces. In most of Fahhadan it seems that during the formation of the area a certain portion of land was selected to form the plot and the shape of the plot was not the prime option for the builders.

4.2.4. THE ARRANGEMENT OF SPACES BETWEEN BLOCKS

Alleys are alternately covered and a pattern of open and covered alleys is in evidence throughout the Fahhadan area (See Plate 4.3). The types of coverage used are representative of all types used on the scale of the walled city. The two predominate types of coverage are in evidence as the result of two opposing requirements. The first is the need for extra space from within the building units, particularly housing, creating a space called 'Sabat', which is a room spanning the alley or occasionally the cul-de-sac.

It is usually long enough to create an adequate room. It could also be a succession of rooms which creates continues coverage and a tunnel effect over an alley. The second type is the need of public movement for coverage and protection from the elements, particularly in those parts in which some commercial activities are in evidence. The most common method used for providing coverage is the vault, which is built with bricks, plastered on both sides, and punctuated at regular intervals along its apex providing light ventilation. In addition to these two types of coverage, there is a system of flying buttress arches which is an integral part of the alley system. It is usually located on narrow alleys and cul-de-sacs to provide lateral strength to the opposite walls.

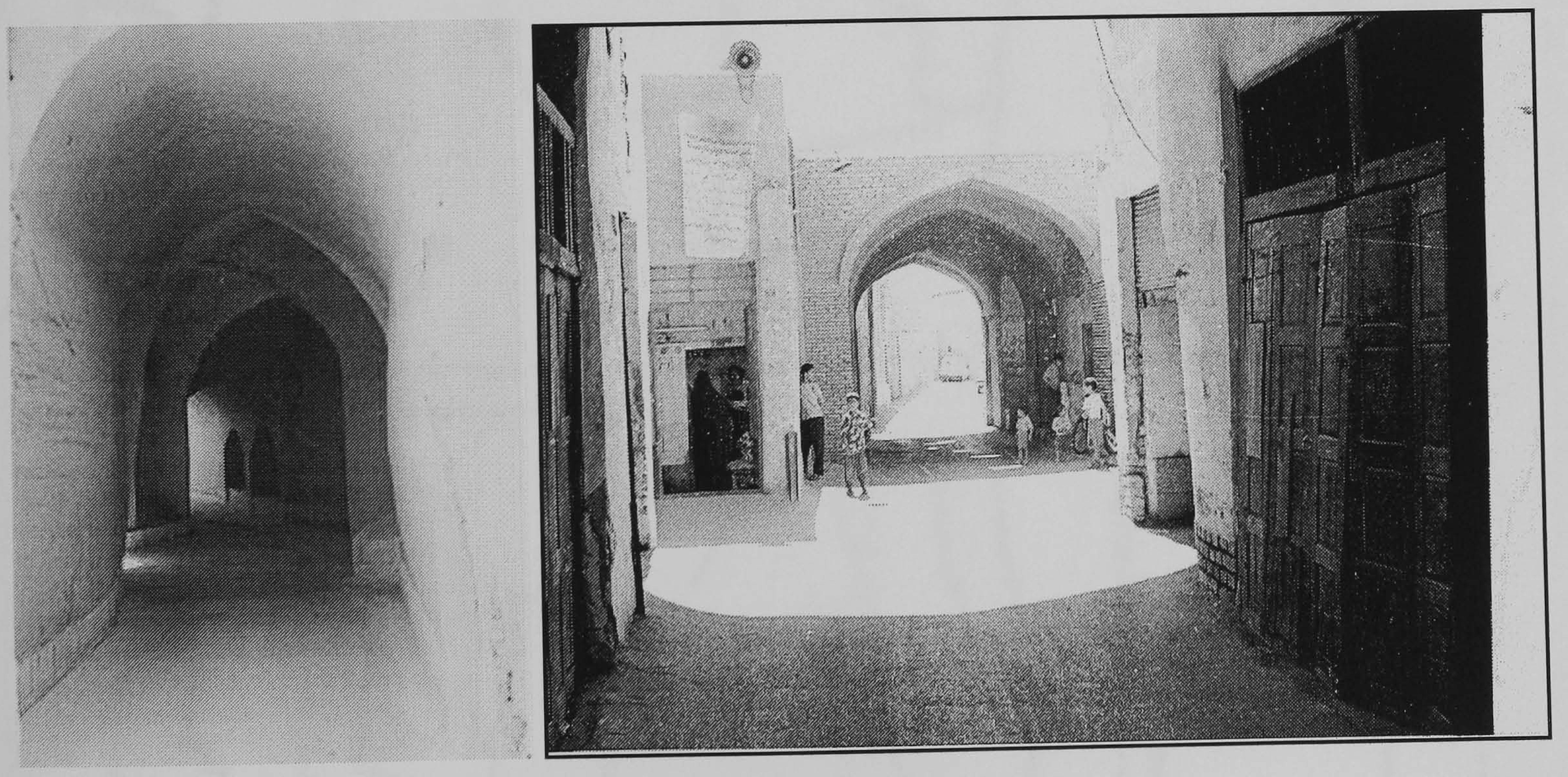


PLATE 4.3: ALLEYS ARE ALTERNATELY COVERED AND A PATTERN OF OPEN AND COVERED ALLEYS IS IN EVIDENCE THROUGH OUT THE FAHHADAN AREA.

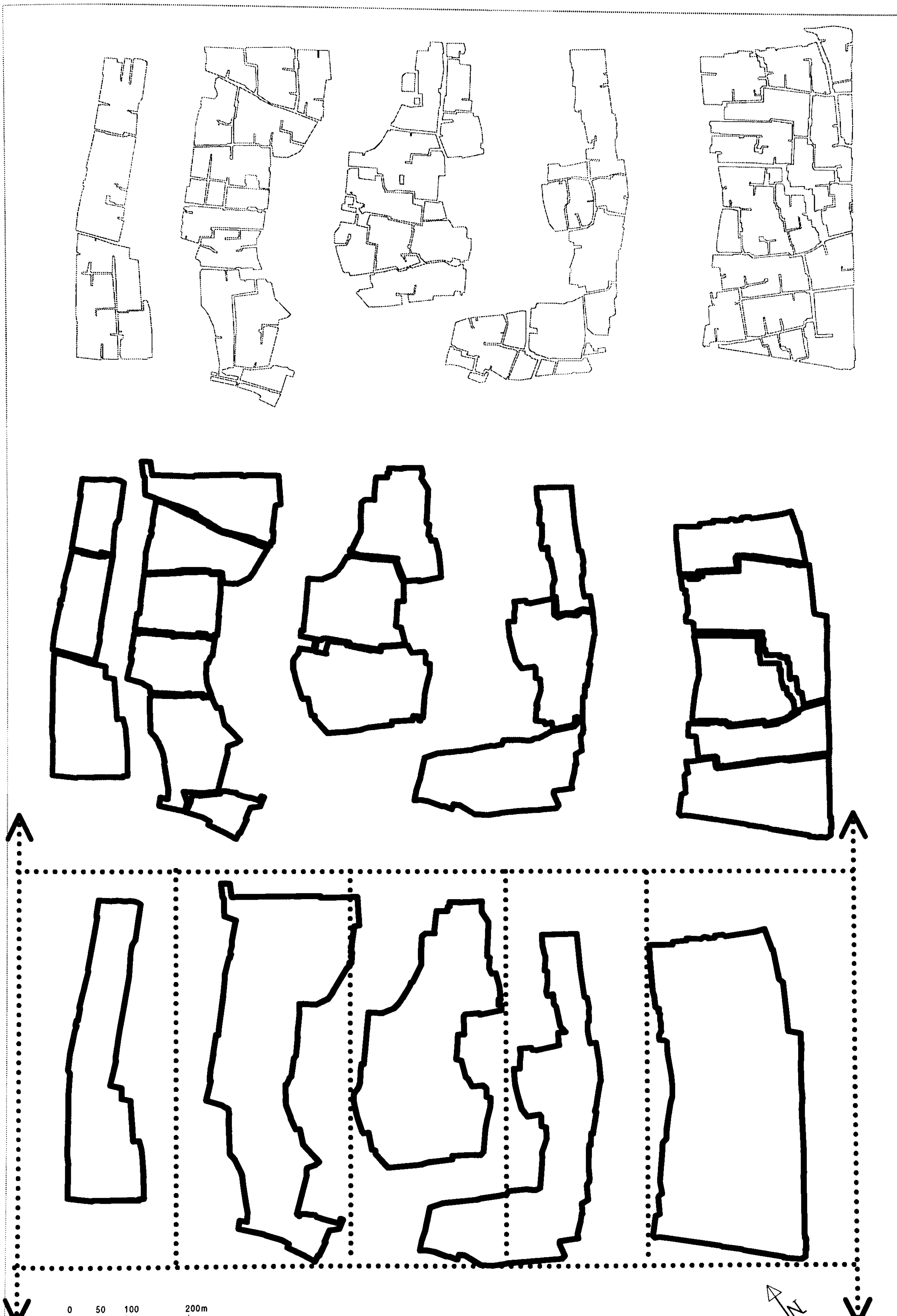


FIGURE 4.11: ACCORDING TO THE IMPORTANCE OF THE ALLEYS THE FAHHADAN AREA MAY BE DIVIDED INTO FIVE SUPER-BLOCKS. THESE SUPER-BLOCKS SUBDIVIDED INTO SEVERAL BLOCKS

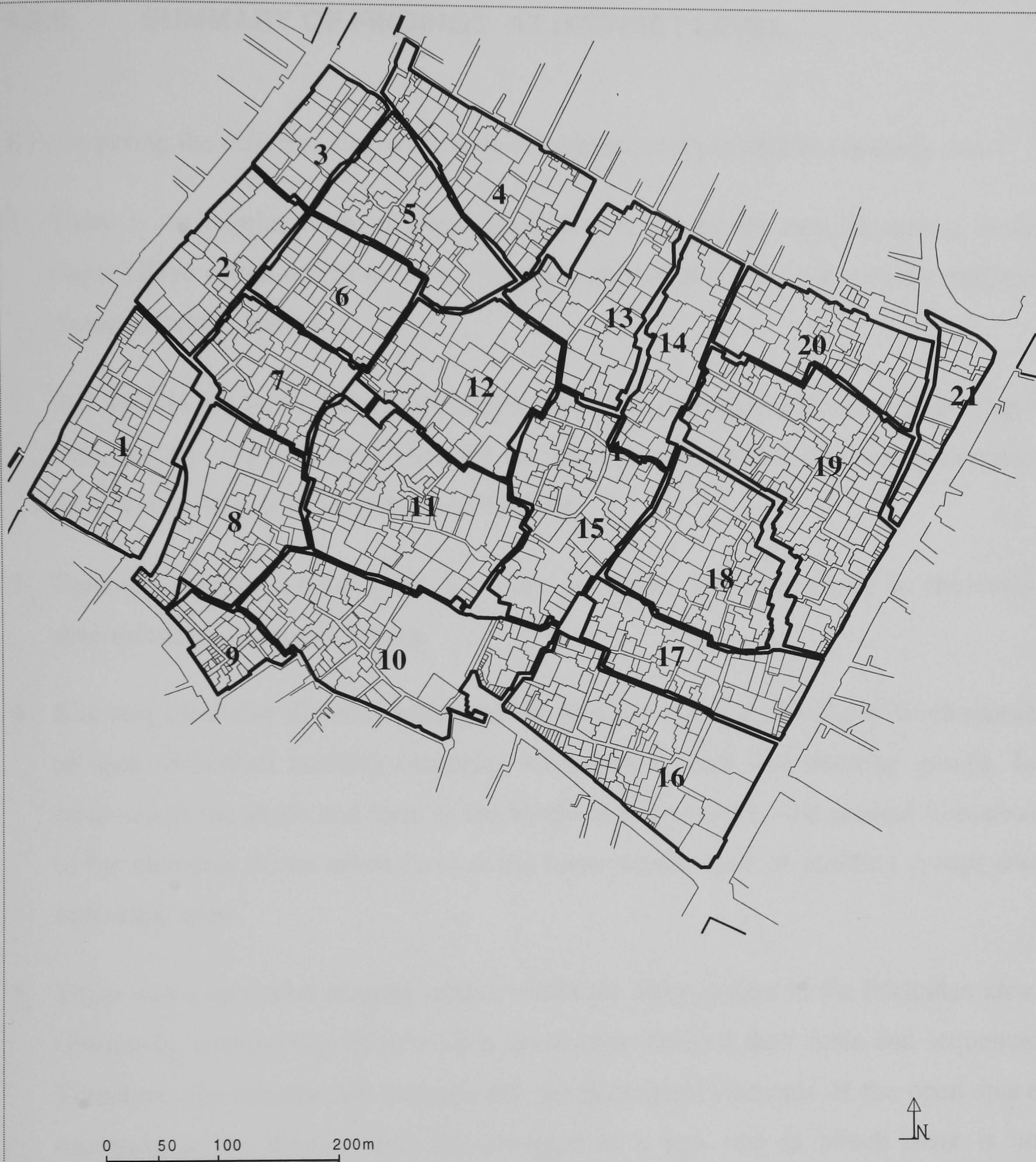


FIGURE 4.12 ALL 21 BLOCKS IN THE FAHHADAN AREA DEFINED BY OLD PATTERN OF THE ALLEY SYSTEM IN CONJUNCTION WITH THE NEW STREETS

4.2.5. SUMMARY OF FINDINGS AT DISTRICT LEVEL

By comparing the different stages of the development, it is possible to conclude that:

1- There is no regular form of alleys applied over the whole area. However, those major alleys which run from the north-east to the south-west occur at fairly uniform distances from each other.

2- Old squares are located alongside major alleys and surrounded by some public land uses, the new squares have changed the general arrangement of open spaces and their relationship with the pattern of land use.

3- Generally blocks are irregular and vary in shape, a factor which is obviously determined by the street pattern.

4- It is very clear that the alley system in the area is a direct result of the development of each individual building occurring within each block and building groups. In other words the shape and form of the blocks is influenced by the gradual formation of the elements of the urban form at the lower levels, such as building groups and individual units.

5- There was a hierarchy of open spaces within the alley system in the Fahhadan area. Obviously, construction of new open spaces has changed their scale and sequence. Therefore, the relationship between the morphological elements of the open space occurring at the district level has changed to a new one in which there is no relationship with that of the old one.

4.3. THE BASIC PLAN FORM OF A BLOCK

At the upper level of analysis, the block was considered as a simple unit, without much attention being paid to its internal arrangement. It is, however, a relatively complex feature and is considered in more detail at this level of Yazd's morphology than that of the district.

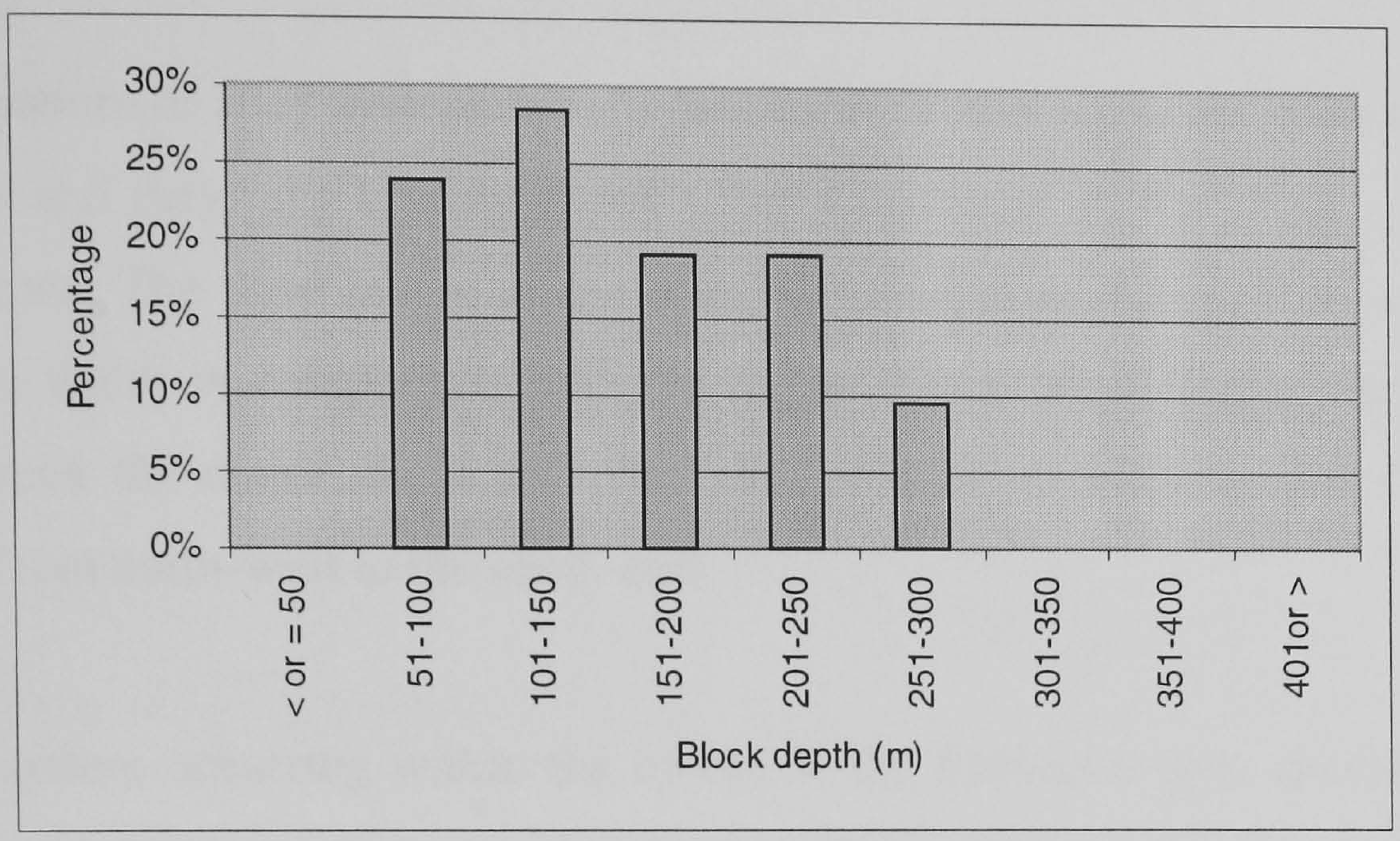
At the block level, the block may be generally treated as a single element, a mass with three-dimensional body in contrast to its surrounding open spaces. Though, in the Fahhadan area because of the scale of surrounding alleys of the blocks, there is a very close relation between the block, open space and adjacent blocks in its vicinity. In this way there is a state of coherence between all blocks in this part of Yazd.

There are a total of 21 blocks in the Fahhadan area in evidence, which result from a subdivision of five super-blocks into smaller blocks. These blocks in turn are subdivided into a number of building groups. The average number of building groups which are located in each block, is 3.8 with a maximum of nine and minimum of one.

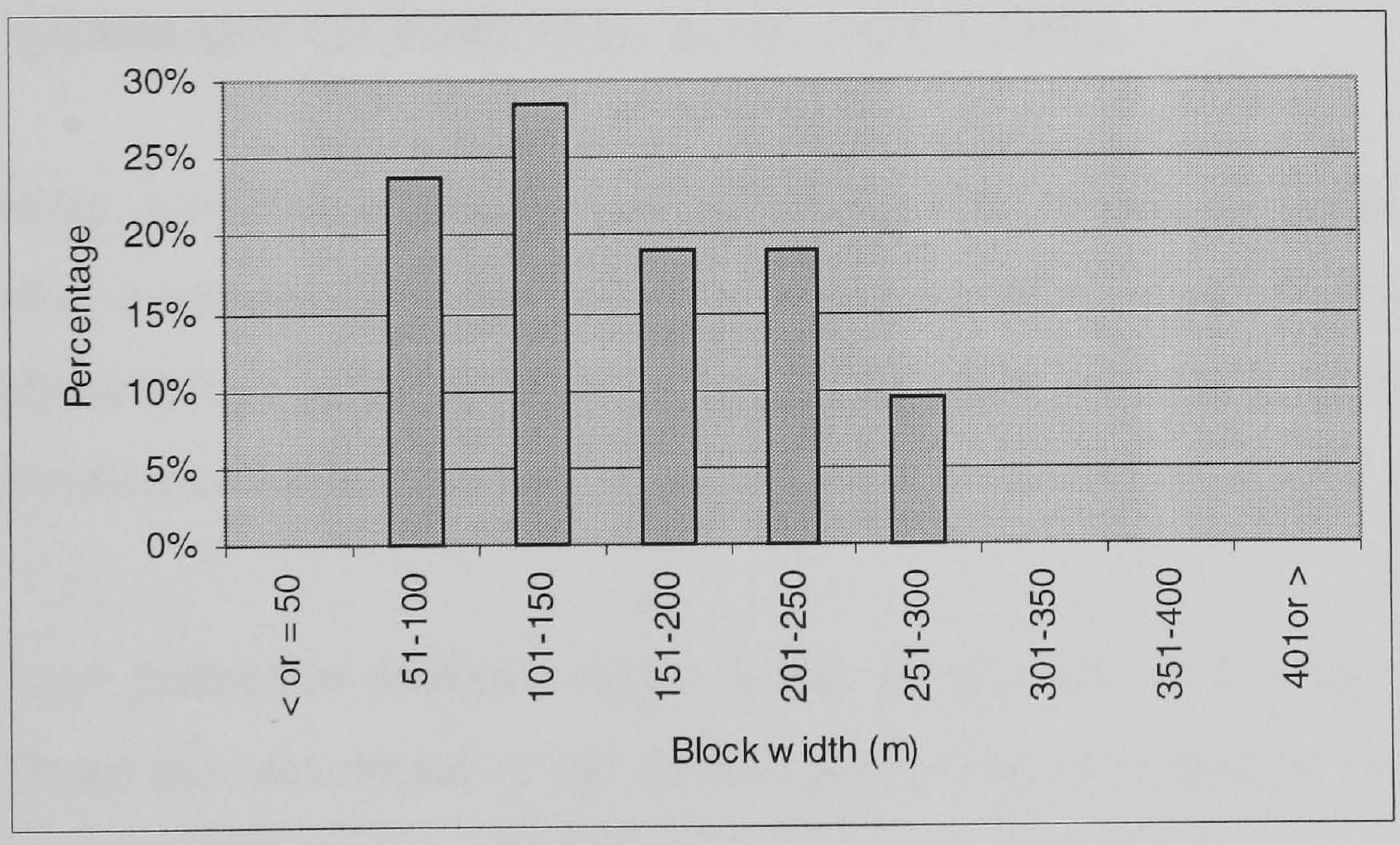
Most blocks have a mixture of functions such as residential and non-residential; the proportions of non-residential to the residential functions vary in each block from two per cent to 62 per cent. Generally in the Fahhadan area the blocks are in use as a dwelling environment. There is only one block with more than 2/3 of its space occupied by non-residential activities. Therefore all blocks in the study area may be considered as residential blocks.

In terms of the basic plan, those blocks which are located to the western parts of the study area are much more regular in shape than those which are located in the other parts (See Figures 4.13 and 4.14). This regularity is also in evidence in their adjacent major alleys. The regular blocks are longitudinally orientated from the north-east to the south-west direction. The majority of the blocks, 71 per cent, occur within a depth (the north-east/ south-east dimension) range of just 100 to 250 metres (See Graph 4.1). Where the width (the north-west/south-west dimension) of the all blocks is taken into account, 51 per cent of the blocks occur within a width range of 50 to 150 and a great majority of them, 95 per cent occur within a range of 50 to 250 metres (See Graph 4.2).

Building heights vary between one and three stories. In some areas recently, even some buildings with several storeys have also started to be built.



GRAPH 4.1: VARIATION OF BLOCK DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 21 BLOCKS IN THE FAHHADAN AREA



GRAPH 4.2: VARIATION OF BLOCK WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 21 BLOCKS IN THE FAHHADAN AREA

4.3.1. OPEN SPACES OCCURRING WITHIN BLOCKS

There is a pattern of alley systems within the blocks. These alleys are generally winding and narrow and they may be considered as the third layer of the street system in the Fahhadan area. The third layers of the alley system are mostly shorter in length and narrower in width in comparison with the major alleys. These narrow alleys usually occur between the major alleys and they are oriented in different directions mostly appearing from north-west to the south-east.

The alley system occurring within the blocks in the Fahhadan area appears to form a major element of the morphology at block level. These alleys generally pass through the entire block and connect two opposite boundaries of the block to each other. Some of them occur in the form of a loop within the block (See Figures 4.13 and 4.14). Most of these alleys are not suitable for vehicular traffic and their width hardly allows a car to pass through.

4.3.2. SUMMARY OF FINDINGS AT BLOCK LEVEL

1- In Fahhadan, a number of blocks can be distinguished which are formed by alleys surrounding a number of building groups in a rather free manner. It seems that the form and orientation of the alleys have been determined in relation to the position of each individual building.

2- Blocks were formed in different stages of the development of the area and vary in shape. Those that developed to the eastern part of the area tend to be irregular in shape.

3- A system of secondary alleys for public use has generally subdivided the blocks into several building groups.

4- A system of central public open spaces like small squares, or 'Hosseinieh', are in evidence between the blocks which are situated in the older parts of the study area.

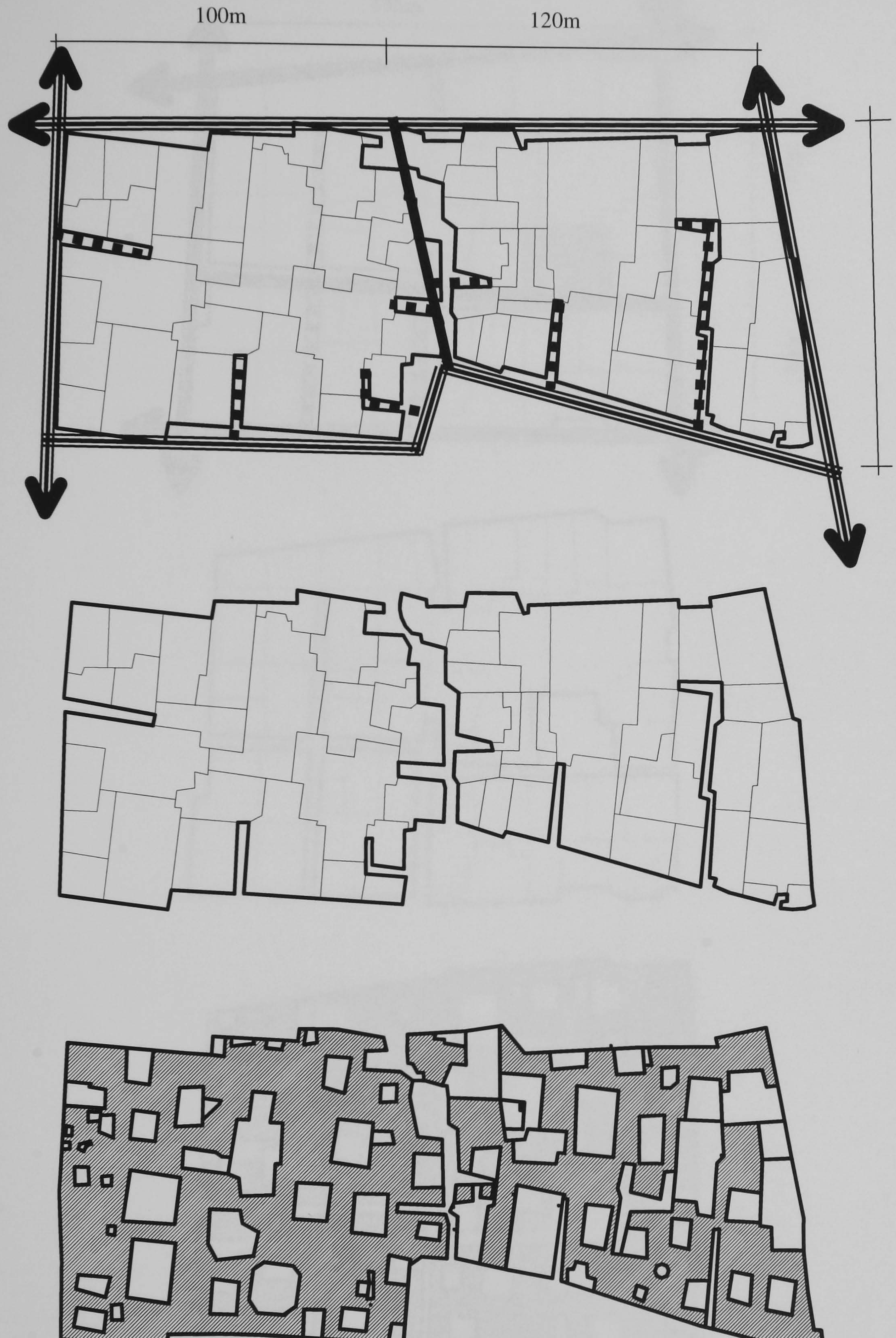


FIGURE 4.13: AN EXAMPLE OF A BLOCK IN THE FAHHADAN AREA. THE BLOCK CONSISTS OF TWO BUILDING GROUPS. THE GENERAL SHAPE OF THE BLOCK IS IRREGULAR

FIGURE 4.14: AN EXAMPLE OF BLOCK LOCATED TO THE WESTERN PARTS OF THE FAHHADAN AREA. THE GENERAL SHAPE OF THE BLOCK IS REGULAR.

4.4. THE BASIC PLAN FORM OF BUILDING GROUP

At the block level of analysis it was clearly found that blocks in turn are broken into several components by the secondary alleys and may be called building groups. Each building group consists of several building units in diversity of function, size and shape.

There are a total of 80 building groups (See Figure 4.15) (See Appendix 1) in the Fahhadan area accommodated in 21 blocks and surrounded by thoroughfares of various sorts. Where the maximum number of building groups in a block is nine, the minimum is one and an average of four building groups are combined together to form a block.

Although most building groups in the study area have a mixture of functions, the proportions of such functions vary. When all the groups are considered, however, they do differ in terms of functional type and spatial characteristics, which 68 are residential (more than 2/3 of land is allocated for non-residential units) and the remaining twelve are considered as non-residential. In terms of the percentage of the total area of each building group in residential use, 51 building groups have between 80 and 100 per cent, 8 building groups have between 60 and 80 per cent, 9 building groups between 60 and 40 per cent, 4 building groups have between 40 and 20 per cent and finally 8 building groups have between 20 and 0 per cent. The average number of units in all groups is about 20 units. Three building groups are completely in use for non-residential activities.

4.4.1. BUILT FORMS

Each building group consists of several units, largely with a number of buildings which are mostly defined by an irregular form of plots and are centrally marked by a rectangular courtyard (See Figures 4.16, 4.17 and 4.18). The groups are very substantially varied in size and shape as might be expected from the nature of the thoroughfares surrounding them and plot subdivision of units which are allocated in them. In the Fahhadan area, the proportion of built space to that of open spaces in a group varies markedly with an average of 66 per cent of total group area.

When all groups are considered, the majority of them, 63 per cent, occur within a depth range of less than 90 metres and another 30 per cent occur from 90 to 150 metres (See Graph 4.3). While the largest proportion of non-residential groups, 58 per cent, have a depth range of less than 60 meters, (See Graph 4.6) the largest proportion of the residential groups, 60 per cent have a depth range of less than 90 metres (See Graph 4.8).

When the width of all groups in the district is taken into account, a rather short spread of dimension is in evidence (See Graph 4.4). Although around, 71 per cent of the groups occur within the range of less than 90 meters, 56 per cent of residential groups have wide ranges of from 30 to 90 meters (See Graph 4.7). The non-residential groups are in general a little shorter than the residential groups and 56 per cent occur within ranges of from 30 to 60 metres (See Graph 4.5).

In some groups, all the units have direct access to the major and secondary alleys, whereas in others the cul-de-sacs provide a significant proportion of the access points. However, it appears that the building plots are basically irregular shapes to the eastern parts of the study area with a trend toward a rectangular shape in the western part of Fahhadan.

Building units are generally linked together in an irregular form within the building groups, however in those parts where they are more regular, they are linked together with the longer sides of the plot. This arrangement is in evidence in western parts of the area. A substantial variation seems to occur in size of plots, even in a single group. The average plot area is around 270 metres for the whole area and 277 for residential units. This average is 235 metres for non-residential units.

At the group level, the basic three-dimensional form of the groups is related somehow to function. For example those groups which consist of some non-residential units, such as mosques or religious buildings, are considerably higher in elevation than dwelling groups. This is also obvious in those groups where some new land use such as private or public offices or even new commercial complexes, are introduced. Almost 60 per cent of the buildings in the district are equal to or less than one storey in height. While only 38 per cent occur between the range of more than one and less than two storeys and only two per cent, or 14 buildings, are in evidence with three storeys or more. Building groups which include more than two storeys are generally allocated alongside the new streets.

FIGURE 4.15: ALL 80 BUILDING GROUPS IN THE FAHHADAN AREA SURROUNDED BY THOROUGHFARES OF VARIOUS SORTS

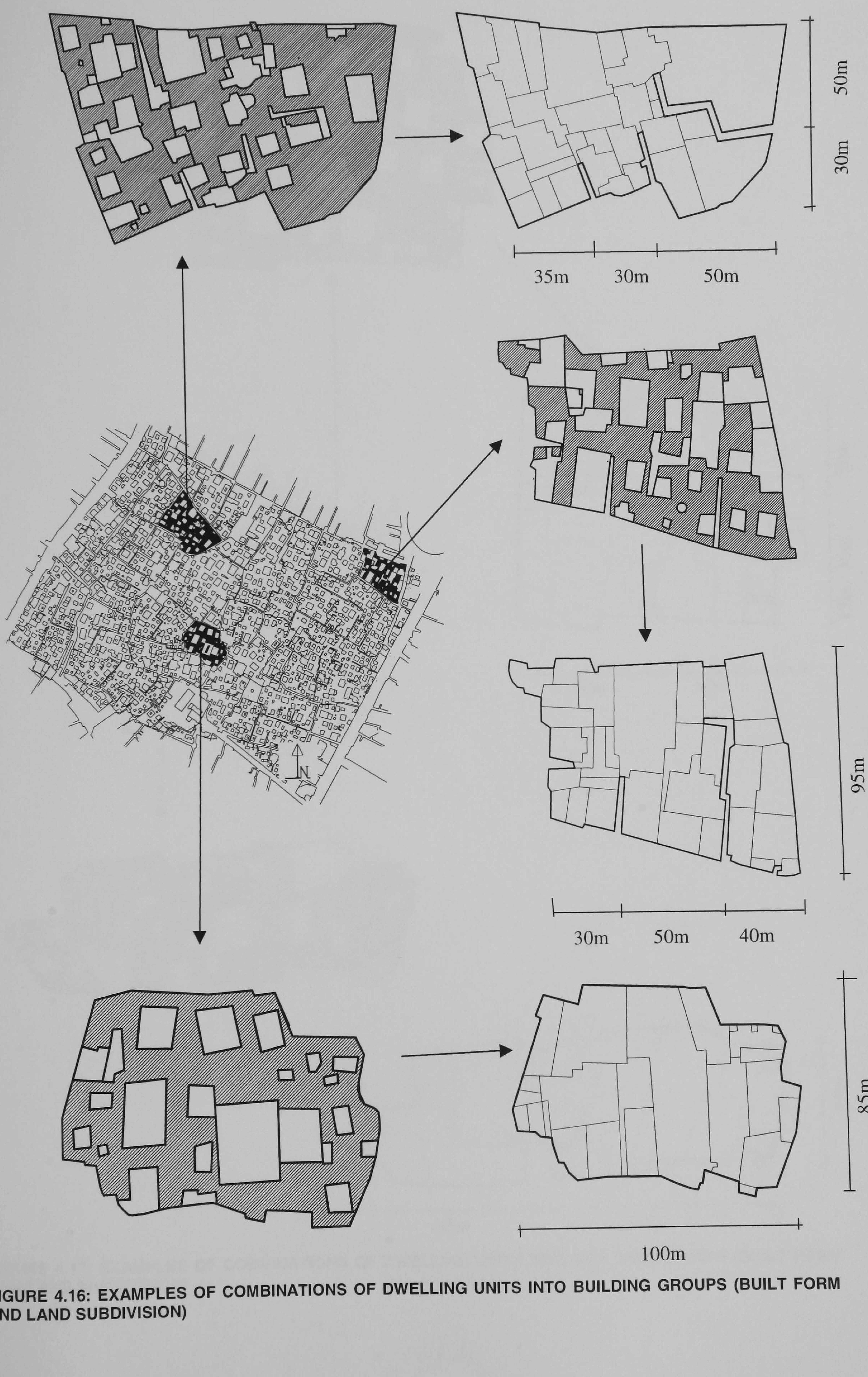


FIGURE 4.16: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)

FIGURE 4.17: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)

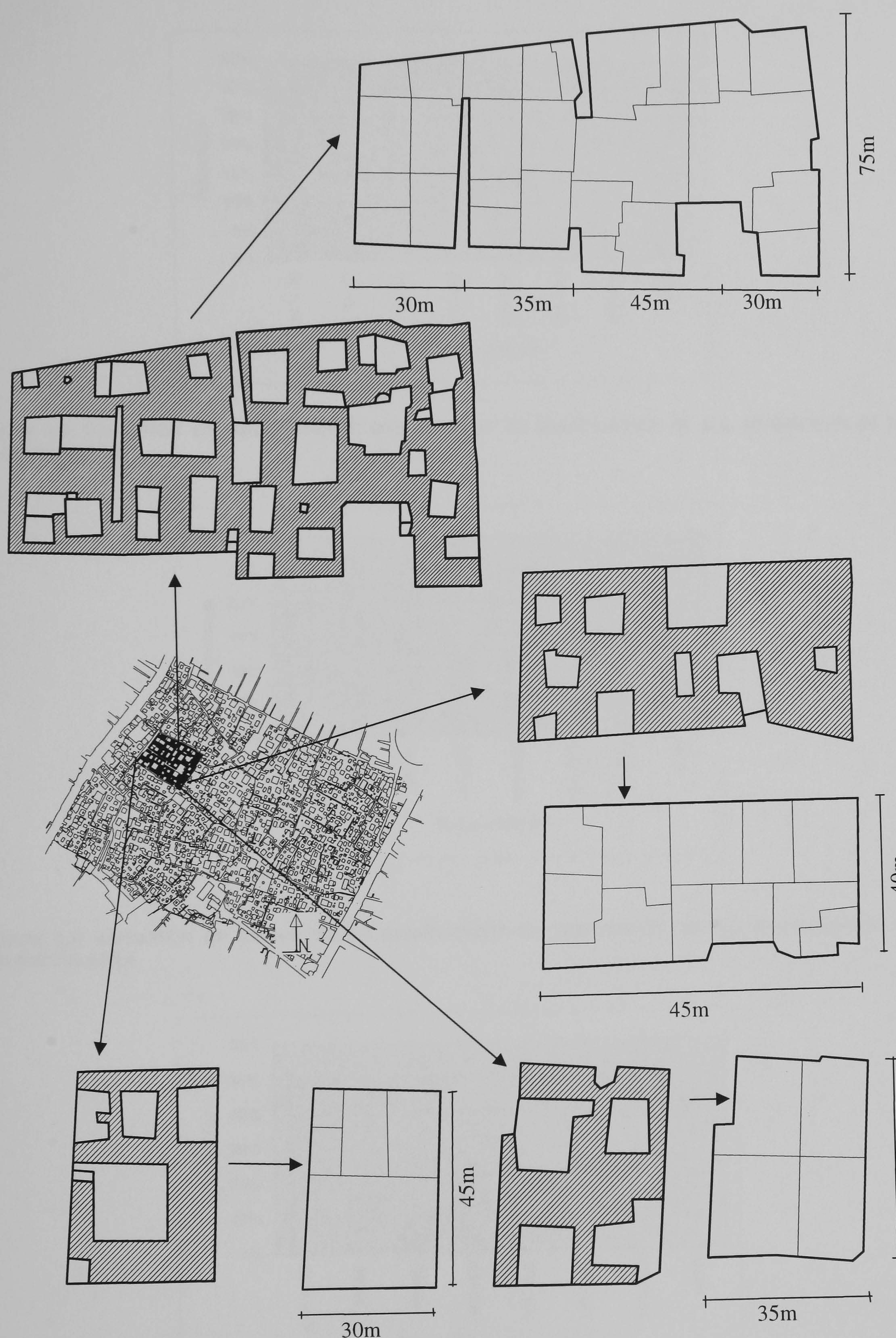
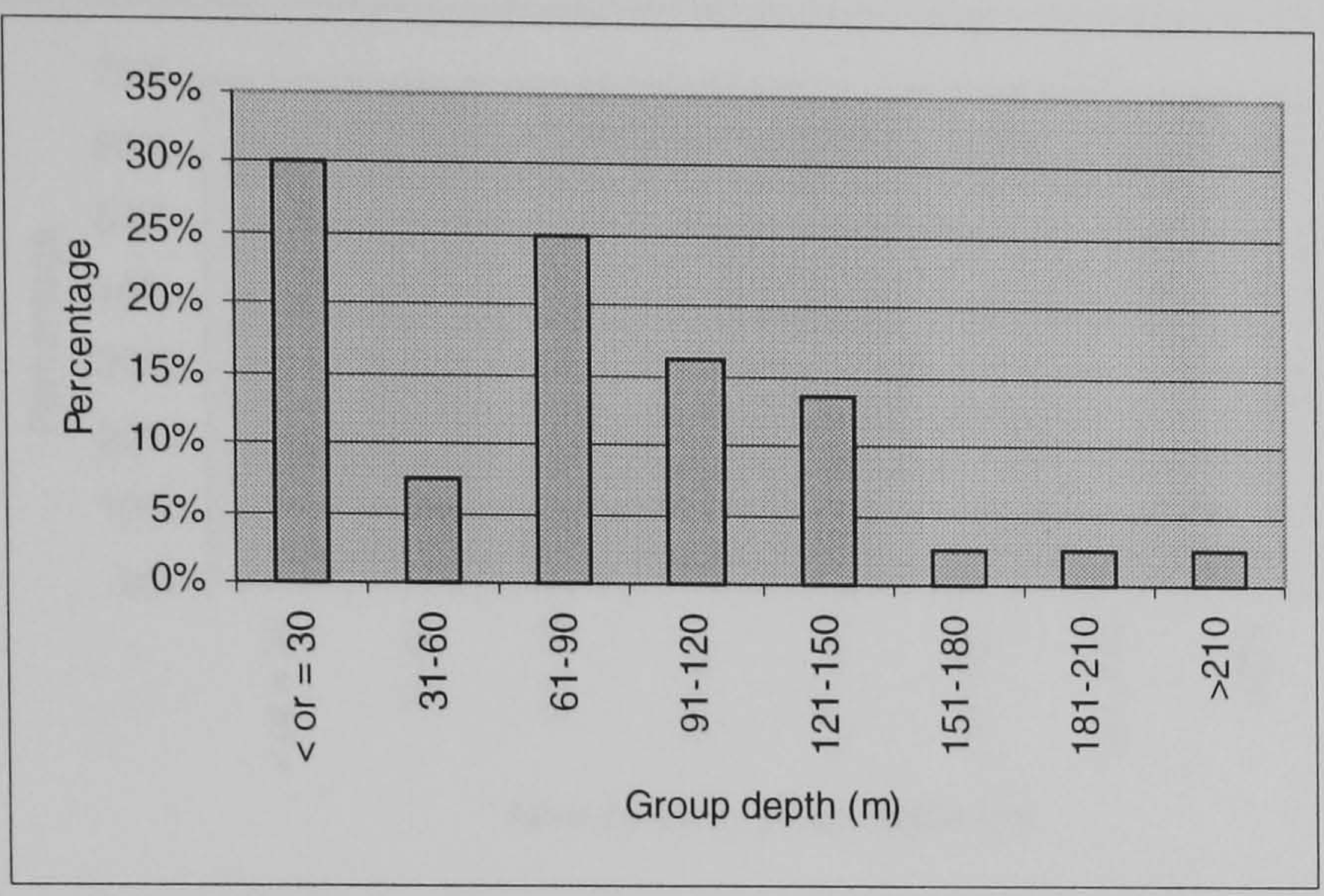
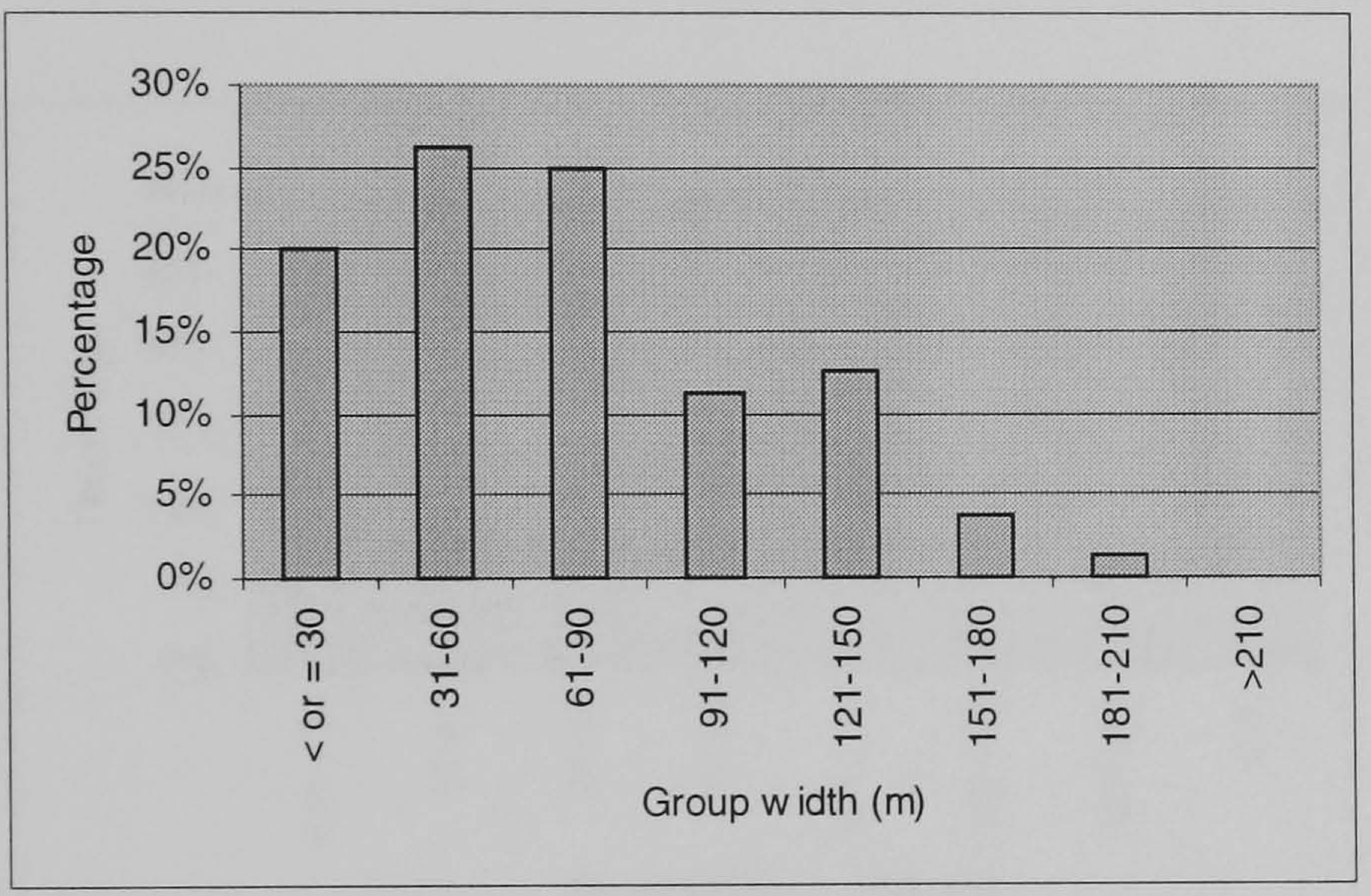


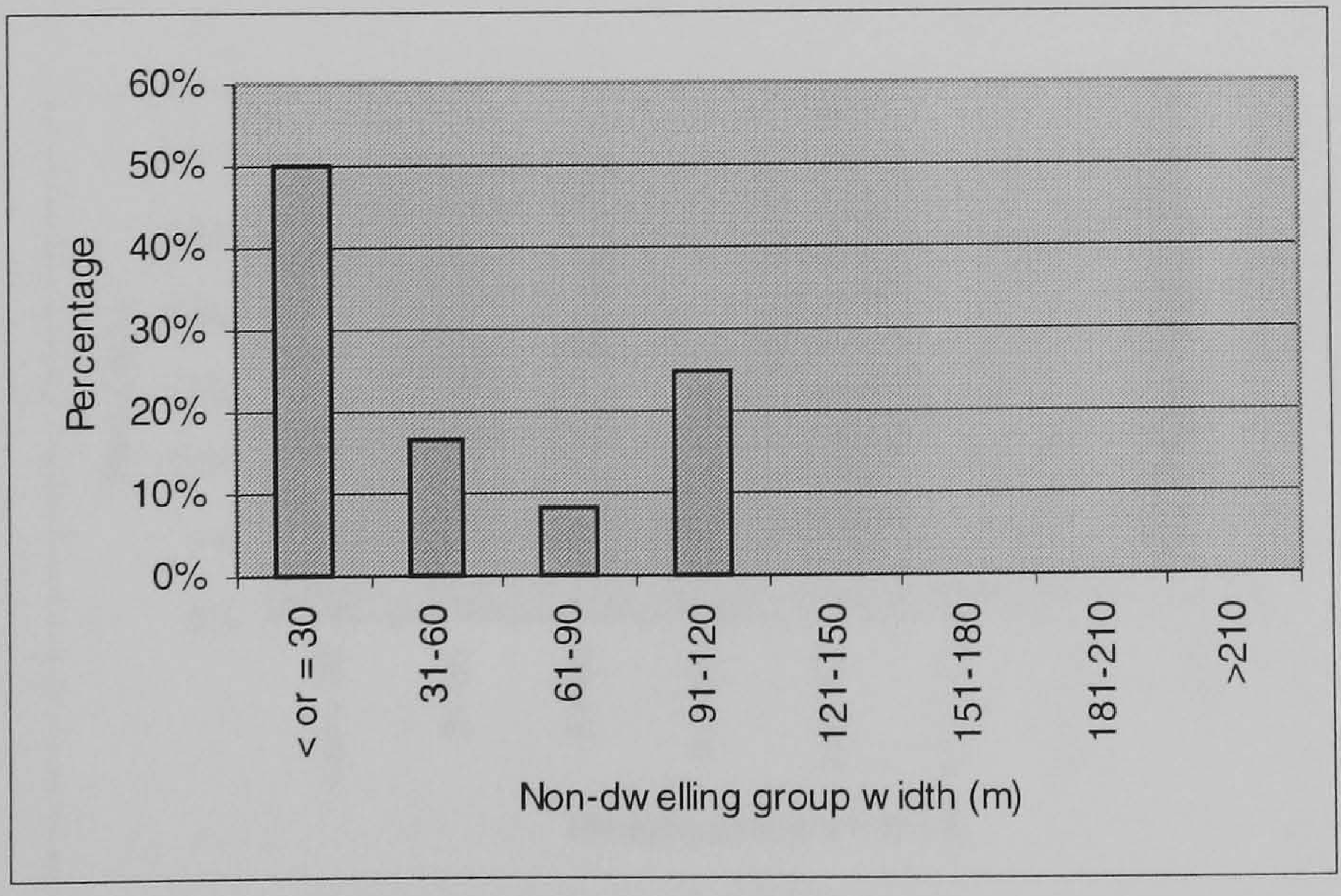
FIGURE 4.18: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)



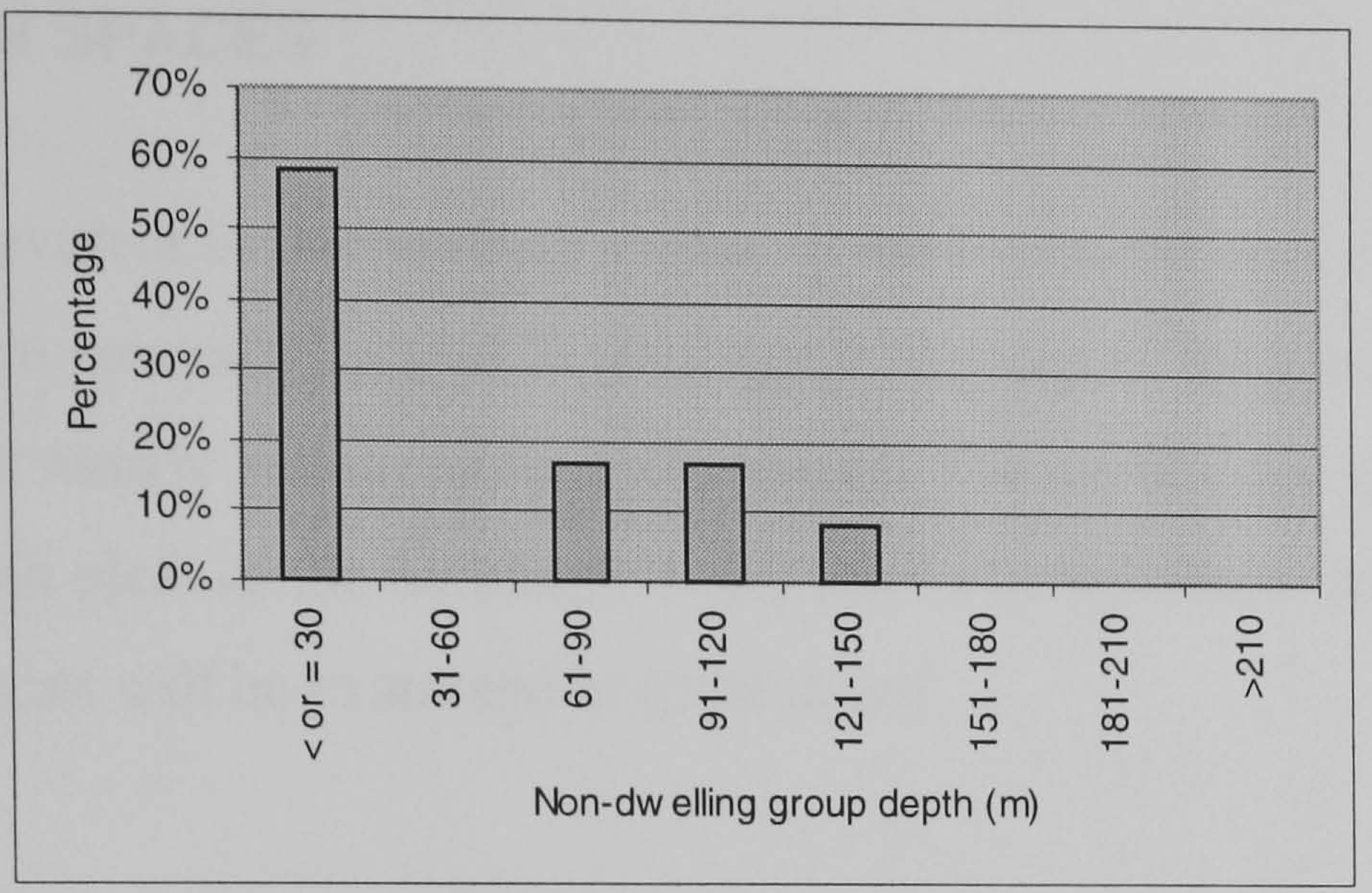
GRAPH 4.3: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 80 GROUPS IN THE FAHHADAN AREA



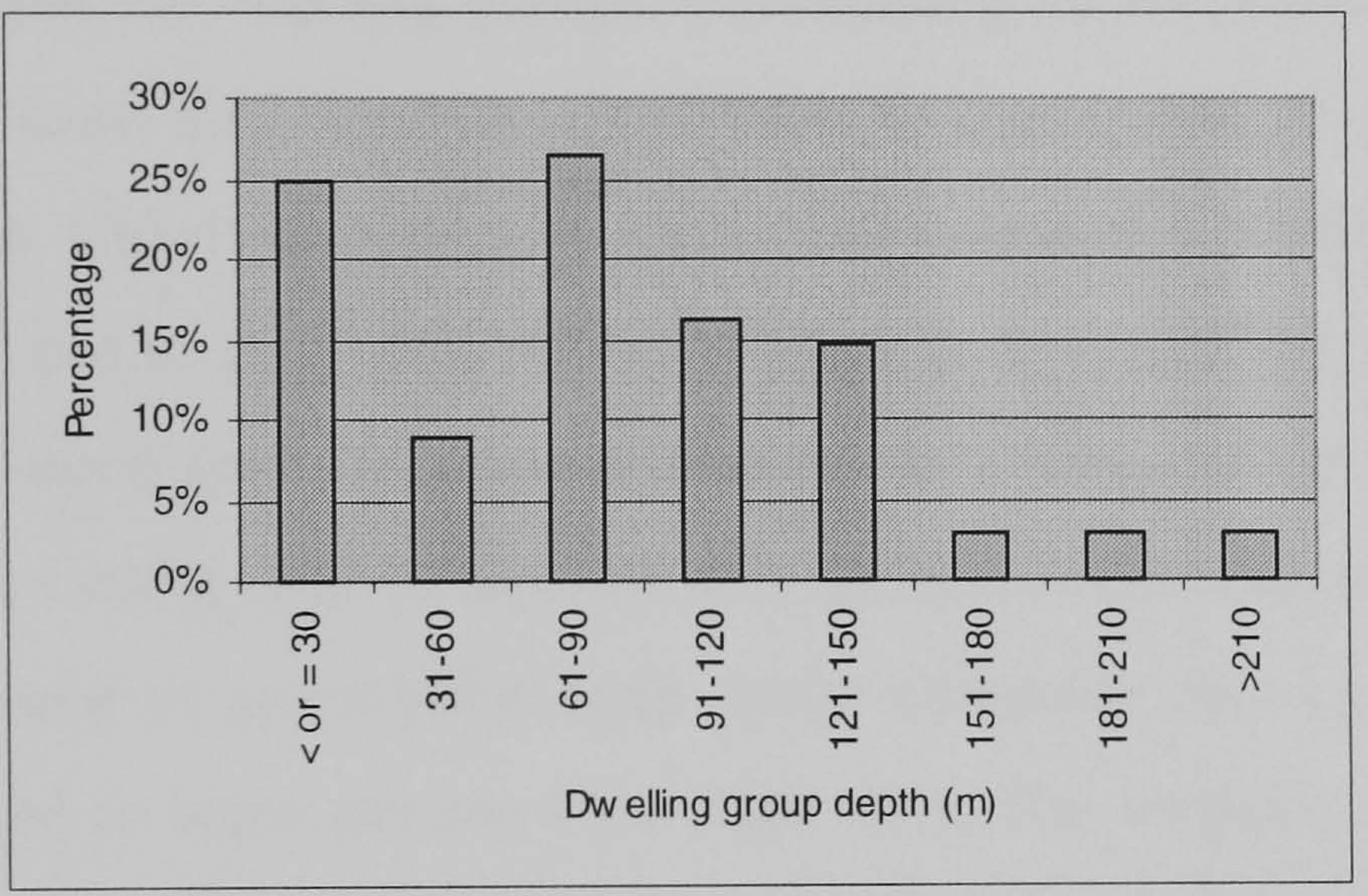
GRAPH 4.4: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 80 GROUPS IN THE FAHHADAN AREA



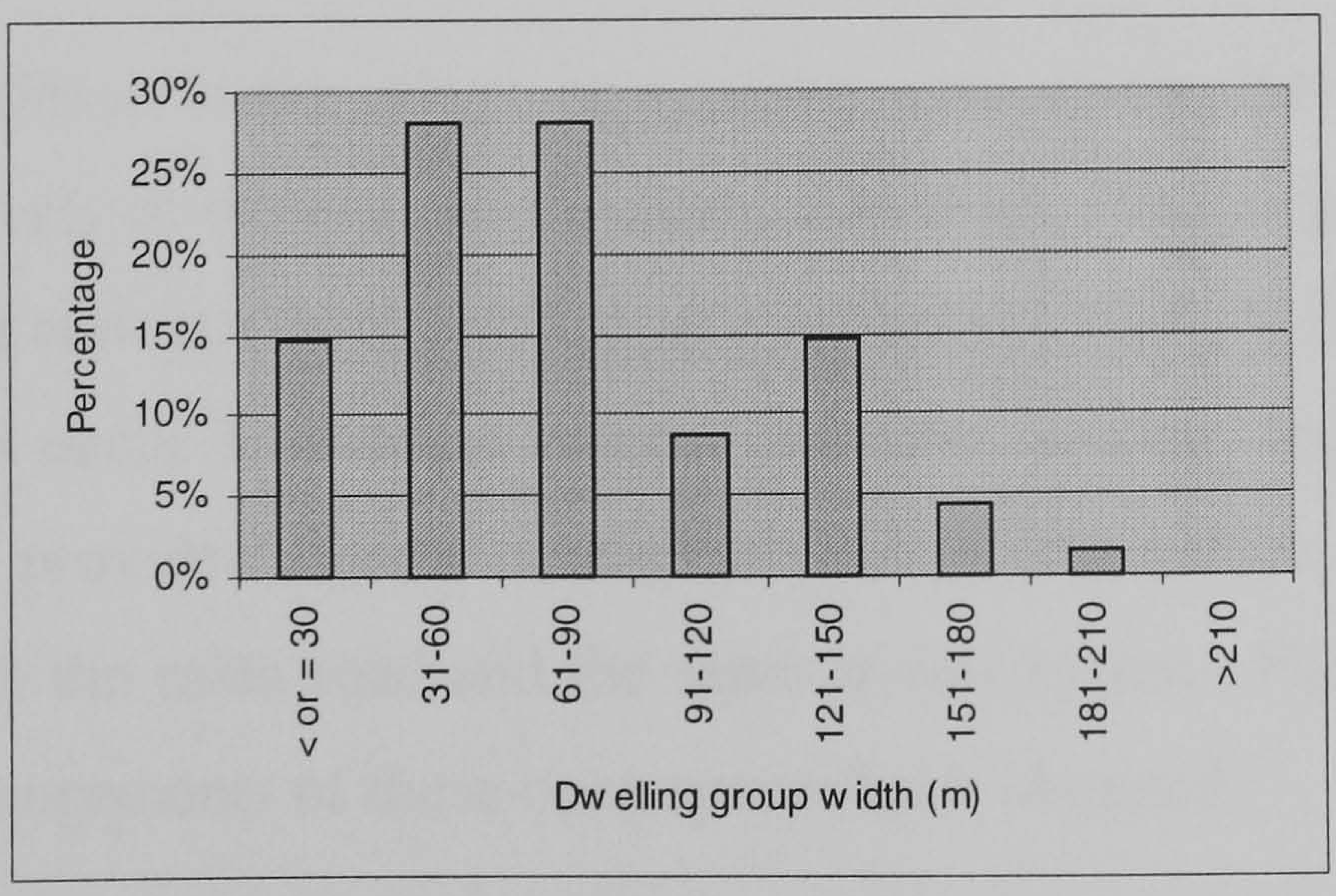
GRAPH 4.5: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN 12 NON-DWELLING GROUPS IN THE FAHHADAN AREA



GRAPH 4.6 : VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN 12 NON-DWELLING GROUPS IN THE FAHHADAN AREA



GRAPH 4.7: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 68 DWELLING GROUPS IN THE FAHHADAN AREA



GRAPH 4.8: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 68 DWELLING GROUPS IN THE FAHHADAN AREA

4.4.2. OPEN SPACES

The open spaces evident in the building groups in the Fahhadan area appear to take two forms. The first are generally located in the interior sections of the groups in the form of cul-de-sacs which mostly act as public open spaces. The second are those open spaces which occur within plots of the buildings in the form of courtyards. In this section both forms of open spaces will be examined in some detail.

4.4.2.1.1. PUBLIC OPEN SPACES

There is a pattern of cul-de-sacs system in existence and these mostly occur with an irregular shape within the building groups. Considering all 80 groups in the area, most of the groups have some sort of private cul-de-sac. In the residential groups, this system is more in evidence. Cul-de-sacs usually stem from major or secondary alleys. In those groups where they occur, they give access to quite a few building units. Functionally these categories of open space in some groups act as a semi-private open space and in some cases there is even a door to separate this space from the secondary alleys. There is usually a polygonal or rectangular open space alongside the cul-de-sacs. They are occasionally covered in some portion (See Plate 4.4). The length and number of these open spaces has a direct relation with depth, area and number of units in each group. These cul-de-sacs and secondary alleys apparently form a significant part of the pedestrian access system. The width range is between 2.5 to 5 metres.

Functionally in addition to the alleys as a public open space, there is in existence a pattern of lower levels of the old alley system, which may be categorised in two main classifications. One acts as a semi-public space occurred within the blocks and the other semi-private spaces occur in building groups. The later is sometimes closed by a main door and there are provided several accesses to the dwelling units. The former makes connection between the main road and the semi-private system. Figures 4.19, 4.20 and 4.21 show how arrangements of these open spaces have changed.

FIGURE 4.19: SELECTION OF THREE LOCALITIES IN THE AREA SHOWS HOW ARRANGEMENTS HAVE CHANGED. THE TOP ROW SHOWS THE SITUATION BEFORE THE INTRODUCTION OF NEW STREET SYSTEM IN THE WALLED CITY IN COMPARISON WITH THE PRESENT SITUATION SHOWN IN THE BOTTOM ROW.

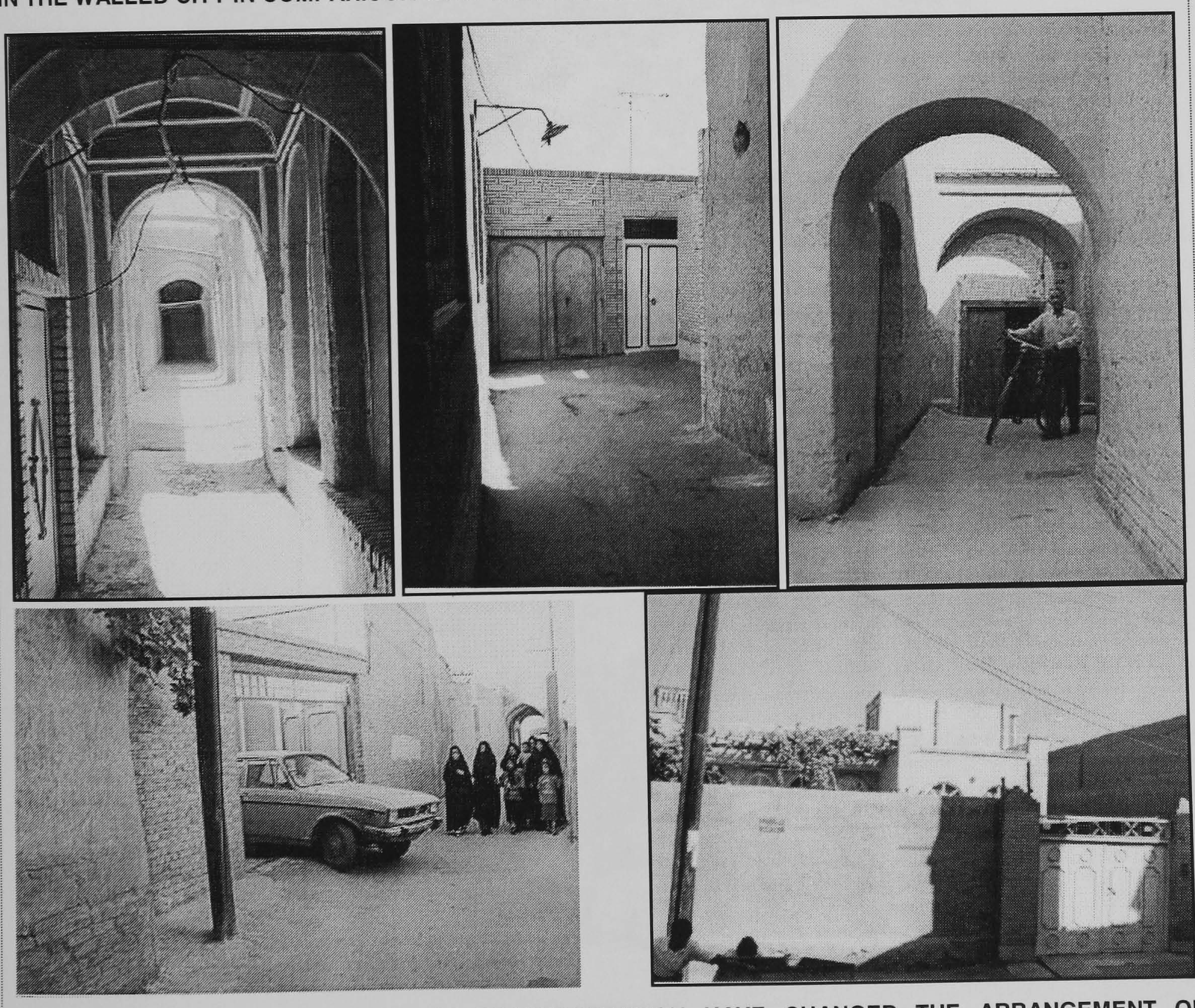


PLATE 4.4: CHANGES IN MODES OF TRANSPORTATION HAVE CHANGED THE ARRANGEMENT OF ENTRANCES TO PLOTS IN VARIOUS PARTS OF THE FAHHADAN AREA

FIGURE 4.20: TOP- THE YUSDARAN PASSAGE AND ITS SURROUNDING OPEN SPACES. BOTTOM-AN EXAMPLE OF OLD OPEN SPACE (HISTORICAL CITY CENTRE) IN THE FAHHADAN AREA

FIGURE 4.21: SOME NEW OPEN SPACES ADDED TO THE OLD CONFIGURATION OF THE YUSDARAN ALLEY AND THE HISTORICAL CITY CENTRE.

4.4.2.1.2. PRIVATE OPEN SPACES

A series of private open spaces is also in existence. These open spaces occur in different plots of the building in the form of courtyards. From the functional point of view these open spaces may be classified into two categories. The first is relatively small open spaces which act as central courtyards for dwelling units. The second occur within the non-residential buildings (See Plate 4.5).

Open spaces occur in dwelling units which are bounded by buildings on all four sides. These open spaces are generally oriented in the same direction. They are mostly of square or rectangular shape. If they are rectangular in shape, the longer length is oriented in the north-east to south-west direction.

The second category of private open spaces acts as a large courtyard mostly for religious activities. Those open spaces, which occur within religious buildings, are mostly open to the public, however, they are properly defined by several gates (See Figure 4.22 left).

Viewed as a whole the above classifications of open spaces vary markedly in size. In dwelling units the depth (north-east to south-west) range is between 4 and 22 metres. This range in non-residential buildings varies between 8 to 90 meters. When the width (north-west to south-east) direction is considered, in dwelling units this range varies between 4 to 16 and in non-residential buildings 8 to 65 metres.

Some private open spaces which occur in the Fahhadan area are large and irregular in shape. These open spaces are in evidence in the southern part of Fahhadan. In this case buildings are bounded by open spaces (See Figure 4.22 right).

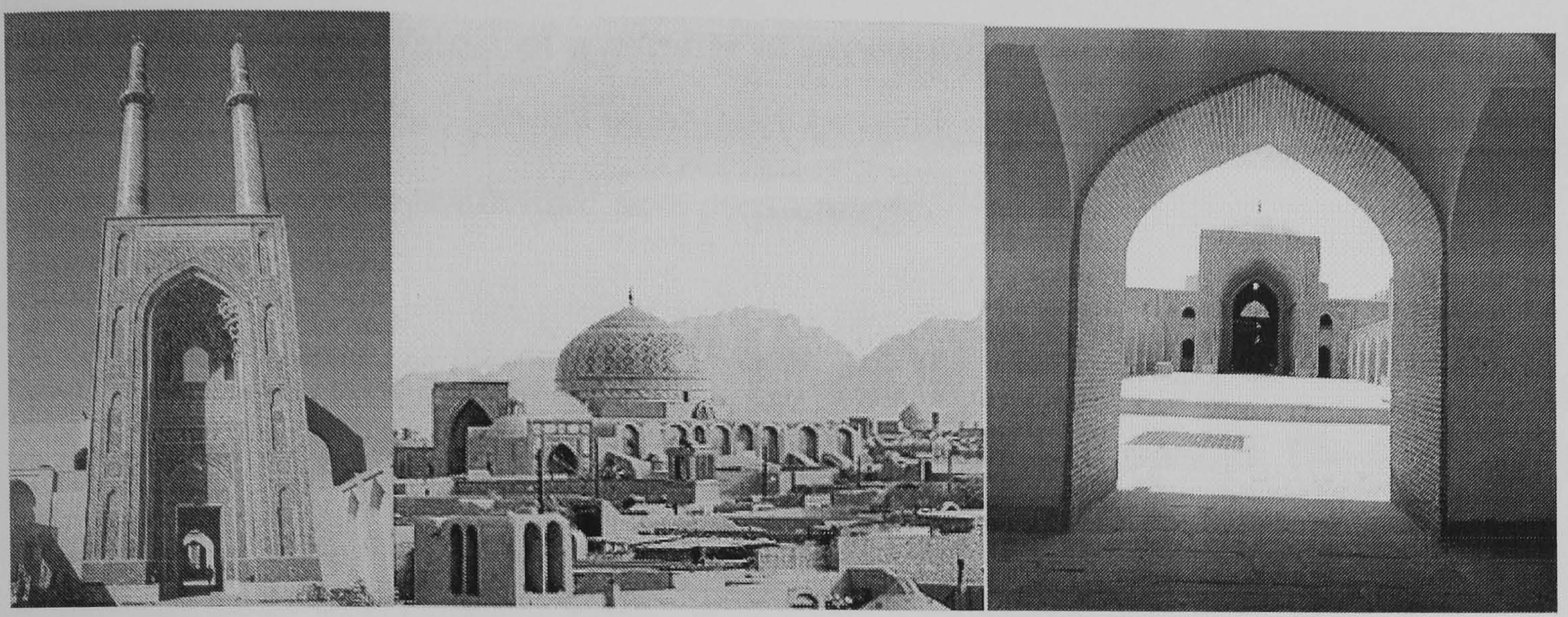


PLATE 4.5: AN EXAMPLE OF NON-RESIDENTIAL (MASJED-E-JAME) PRIVATE OPEN SPACE IN THE FAHHADAN AREA ACTS AS A SPACE USED BY PUBLIC.

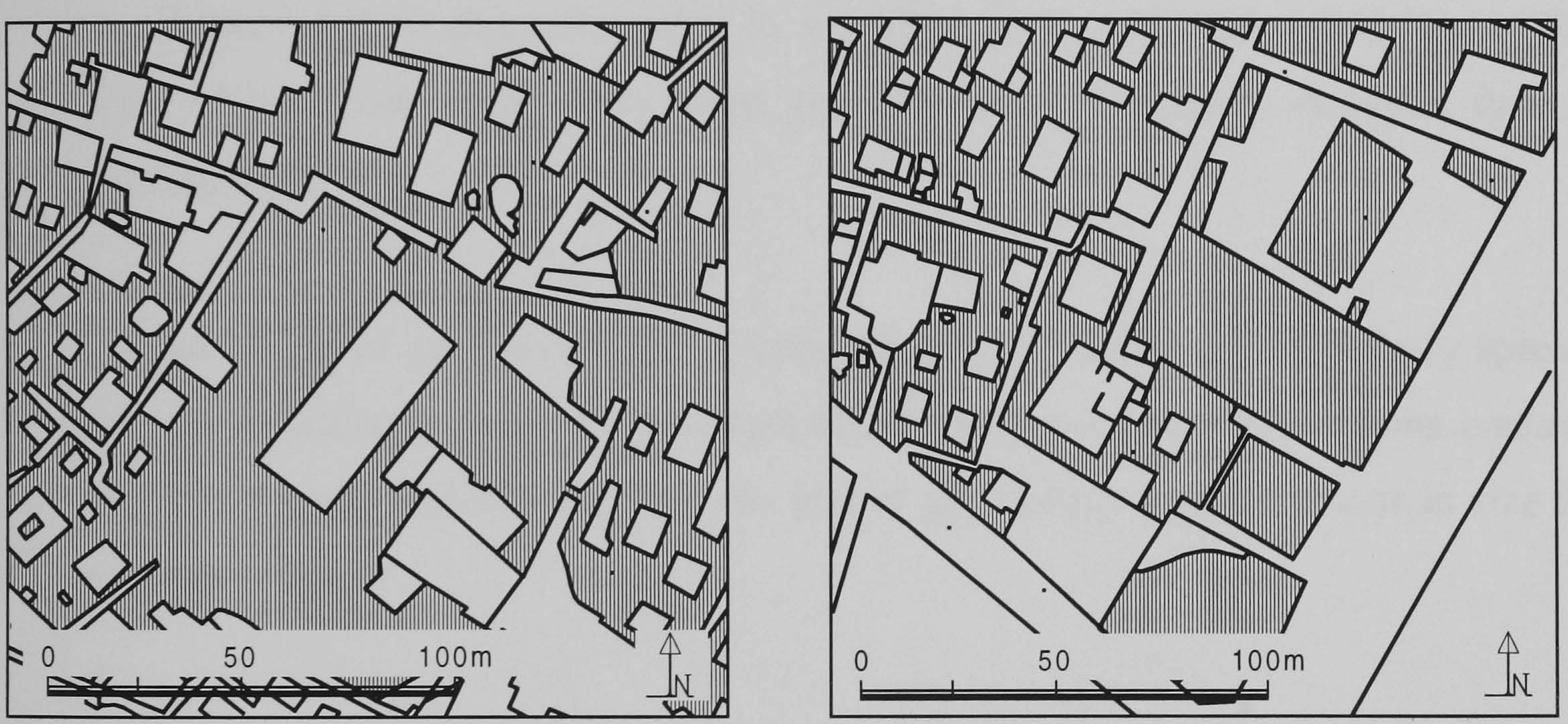


FIGURE 4.22: LEFT LOCATION OF MASJED-E-JAME'S COURTYARD IN THE FAHHADAN AREA. RIGHT: SOME LARGE OPEN SPACE LOCATED TO THE SOUTH OF THE FAHHADAN AREA

4.4.3. SUMMARY OF FINDINGS AT BUILDING GROUP LEVEL

At the group level particular attention has been given to analysis of building groups and building groups in the Fahhadan area. The morphological analysis has resulted in a description of a pattern, which may be summarised by the following points.

1- Building groups in the Fahhadan area are generally irregular in shape.

2- Building groups consist of a number of private open spaces. Such spaces tend to be small in the building groups essentially in residential use and larger in the building groups where non-residential uses predominate.

3- The building groups consist of one, two and very occasionally three storey buildings separated from each other by a system of open and covered alleys. The third layer of street system occurs in between groups which are relatively narrow. They are often around three to six metres wide.

4- Cul-de-sacs occur in building groups in various directions in different parts of the area, however they generally occur in a north-east to south-west direction. If the depth of the group is not very large, the cul-de-sacs are much straighter than a winding route.

5- The built form of groups consists of combinations of building units entirely spread over the building groups with a system of central open spaces. Most units contain open courtyards, which occur in some sort of uniformity with variations in size in building groups.

6- The building units appear to vary to quite an extent in size and the basic form of the plan, even in a single group.

7- By contrast, in the eastern parts of the study area the basic form of the dwelling plots is much more irregular than in the western parts.

8- The overall average of the building group area is 5130 sq.m with a range of between 50 sq.m and 19560 sq.m.

9- The plot form of dwelling units has almost an irregular shape in north-east part and there is a trend to become rectangular shape in the eastern parts.

4.5. THE MORPHOLOGY AT BUILDING LEVEL

Although there are various types of function in the Fahhadan area, the area was defined as a traditional built environment predominated by traditional dwelling units. At the unit level of analysis the emphasis will be made on the dwelling units mostly in their original form which they considers as traditional houses. In addition to these houses, some newly constructed dwellings are in evidence. These new units differ in terms of form, material and structural system from the traditional method. This section concentrates on the more detailed morphology of the dwelling units to be found in the Fahhadan area. These units will be analysed in terms of their basic plan, elevational treatments, structural system, building material, and access system.

The Fahhadan area consists of a large part of the dwelling environment of what were originally courtyard houses. This type of houses has a long tradition and could be found widely in most of Iranian cities, generally with the same climate and some differences in detail. There is evidence of houses with courtyards in Iran from nearly 8000 years ago (Memarian 1998). However, the history of dwelling units in this part of the city is not as long as the history of the city as a whole. Generally, houses have been located in the Fahhadan area dates from the 19th century.

There are a few traditional houses in evidence in the Fahhadan area. Several dwellings have been selected as the examples of traditional dwelling for further study. These dwelling units were chosen because they are typical and contain most elements which illustrate the general morphology. These units are largely with a courtyard but substantially varied in the dimensions. These houses are built back-to back and wall-to-wall, forming a conglomerate mostly separated by some narrow passages.

4.5.1. THE TYPICAL HOUSE

4.5.1.1. BASIC PLAN FORM

Traditional dwellings are mostly regular in architectural plan in contrast to their plot shape, which is usually irregular. These dwelling units have generally a symmetrical private open space in the form of a courtyard lined with rooms facing inward to it. The major part of the dwelling units is located in the extreme north-east, north-west and south-west of the plot and occasionally on the south-east. The diameter of these courtyards is mostly coincidental with the north-east to the south-west direction. The built space of units occasionally occupies the plot in different forms (See Figure 4.23). Regarding the situation of the courtyard within the plot, generally, five basic types of dwelling unit are in evidence in the study area. The basic information of these types is obtained from the analysis of the study area and summarised in table 4.6. The shape of the courtyard is closely related to the size of the plot, the rectangle being the most common shape of the courtyard. In some dwelling units there is more than one courtyard in evidence

Various elements of the house are located around the four sides of the courtyard and faced inward to the open space. Most of the houses are divided into two separate parts. Traditionally one was completely private for the family, the other acted as a semi-private area for guests who may stay there for a long period of time. Sometimes, the latter part was also used for business purposes. Some houses were constructed with a close and direct relationship so as to act as a complex unit where several families lived together.

The type of house built in this part of the city is a dominating factor in the morphology of the walled city. It may be big or small, decorated or plain, however the design patterns, and even the materials used in a private house are all similar. Together the houses form a homogeneous background that makes a coherent fabric in horizontal and vertical elements in an integrated complex. The typical unit is a small house with a small courtyard in the centre, around which rooms are arranged. Rooms are varied in size and dimension and usually named from the number of their door-windows (See

Figure 4.24). Door-windows are a kind of opening that serve as a window; however they consist of double doors, which open toward the courtyard. The most common rooms in this part of Yazd are two-door room, three-door room, five-door room and a room with a moveable sash window. Pirnia (1991) has suggested that traditional rooms in Iranian houses were built according to three sizes; small, medium and large. These rooms had distinctive functions such as the large one for reception purposes or the small one as a bedroom.

Among all rooms in a traditional dwelling unit, there is a relatively larger room which is centrally located to the north-east of the courtyard and acts as a reception space. It is usually rectangular in shape and situated with its long or narrow dimension parallel to the courtyard. In some of the examples a small rectangular space on the rear side of the central room is in evidence. This space was reserved for the sitting of the senior member of the family. In some examples it is located to the south-west of the house where it also served its function during the summer. However, the 'Talar' is dominant space on the south-west of the houses which usually used during summer.

The 'Talar', which is situated to the south-west of the courtyard, is in the form of a three-sided room and is an important part of the house. The one facing north-east is always in shade and is used during the summer, and the one facing south is used during the winter when the sun is shining. These rooms are occupied in different seasons of the year and therefor this type of unit may be called the year-round house.

4.5.2. DETAILED ELEVATIONAL TREATMENTS

The façade of the traditional houses will be examined in terms of interior and exterior parts. The dwelling units mostly have high blank walls for security, privacy, and protection from sun and hot winds (Memarian 1998). The exterior façade of the traditional houses is therefore very simple and the only sign or architectural feature of the dwelling unit is its portal entrance. This entrance is clearly in evidence within the large surface of its blank wall. Some of these entrances are decorated and treated with various elements such as a bench stone, pilasters, portal arch, eaves, and a timber door.

The internal façade of the traditional dwelling units, which have been examined, are predominately defined by the provision of doors for rooms and other relative treatments to them (See Plate 4.6). Therefore, the size, proportions and disposition of rooms are clearly visible in the internal façade of the dwelling. In this way all spaces represent themselves by their elements, opening, size, etc on the internal façade of the unit.

The internal façade of the dwelling units may be divided into three levels. The lower level of the façade is characterised by basically brickwork, while the middle level consists of mud-brick, which is plastered with a mud-straw mixture; all openings are treated in this level. The top level ends with only the eaves in brick.

The dwelling units built are low, one-storey structures, often with a basement. These basements during summer were usually used as a living area. Except for the wind catcher and occasionally 'Talar', the average height of these building is around six meters.

In most traditional houses a wind catcher acts as a main morphological element for providing natural air ventilation and is generally located to the south of the plot in the vicinity of the 'Talar'. It is cubic in terms of form and high enough to provide cool airflow outside and to use it for internal circulation. The wind catcher is visible from outside and act as a major element of the general skyline in the walled city. It is mostly treated by narrow and longitudinal arches.

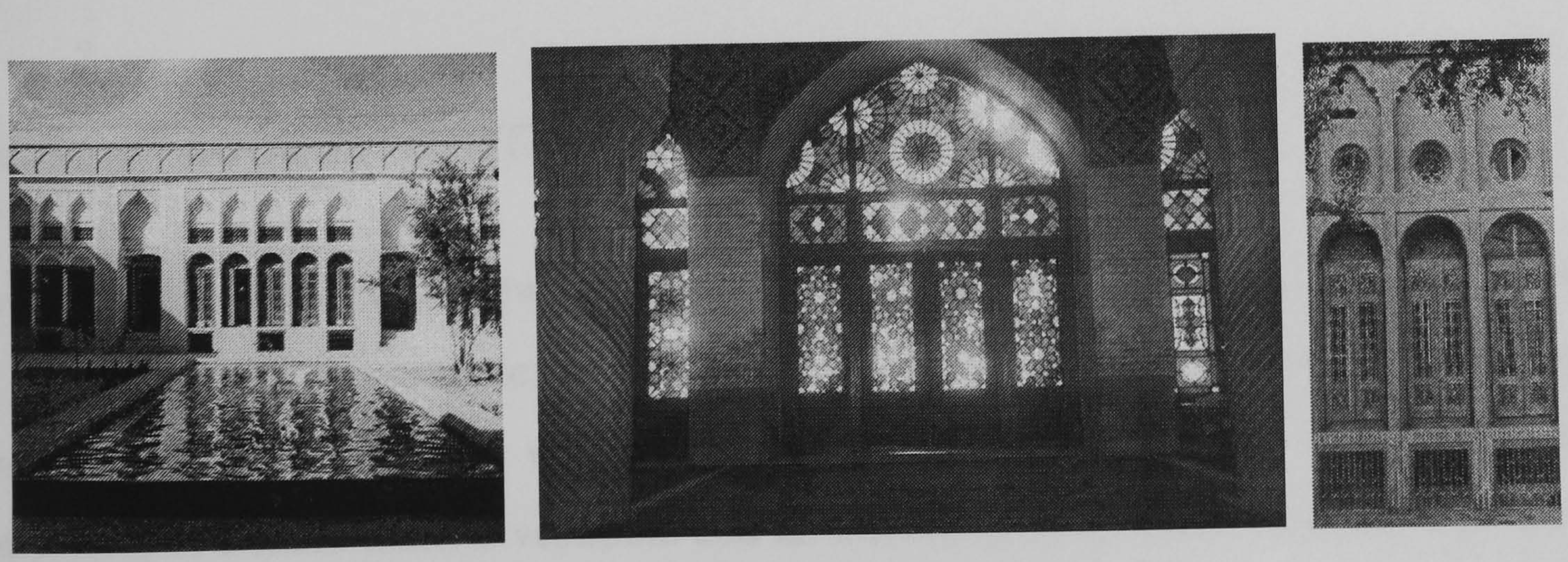


PLATE 4.6: A SAMPLE OF ELEVATIONAL TREATMENT IN A TRADITIONAL HOUSE IN THE FAHHADAN AREA

4.5.3. STRUCTURAL SYSTEM AND BUILDING MATERIAL

The basic unit of the house was possibly a square room with a spherical dome, a rectangular room perhaps with an elliptical dome, two spherical domes centred on an arch, or open ended barrel vault, a so-called 'Talar'. Walls and roofs are thick and made of clay or brick and the courtyard is situated on a lower level to the surrounding passage. Generally the structure of the these traditional dwelling units frequently combined massive walls with vaulted structures, for example, the 'Talar' generally buildings were made of local materials, mostly baked or sun-dried bricks shaped in moulds and smoothed by hand. Since dampness is not the main problem in this region, clay is more extensively used for its insulating properties. The exteriors of these buildings were faced with a plaster bound with straw. High mud walls surrounded all the houses. Table 4.5 shows the dominant material and structure of the dwelling units in the Fahhadan area in comparison with that of more than 40 years ago.

DOMINANT MATERIAL AND STRUCTURE	The city of Yazd in 1956		The Fahhadan area in 1998	
	No. of units	% of total	No. of units	% of total
Sun-dried brick and mud with vaulted roof	10451	67	809	51
Baked brick and use of steel beams for roofing	700	5	418	26
Others, including combination of mud and brick	4250	28	358	23
total	15311	100	1585	100

TABLE 4.5: DOMINANT MATERIAL AND STRUCTURE OF DWELLING UNITS IN YAZD AND THE FAHHADAN AREA IN 1956 AND 1998

(Source: First Iranian Census in 1956 and Yazd City Council, 1998)

4.5.4. ACCESS SYSTEM

Access to the interior of the dwelling usually passed through a semi-private space which is called 'Hashti' or vestibule, in which access may be provided to two or even more dwelling units. In such a way, the access system was rather a spatial sequence consisting of a main door, a vestibule and an indirect passage than a merely a pathway with a unified width. There are various combinations of vestibule and the corridor. In with a unified width. There are various combinations of vestibule and the corridor. In general such provision for access to the units reflected the importance of access in organising the spaces in order to provide a required degree of privacy in the residential environment. Mostly a narrow corridor leads from the vestibule to the private and semi-private (reception) area of the dwelling units

This type of access system varies in the different houses which have been examined. These entrances are located in various parts of the plot, which is located in the vicinity of the public route. They are either to the left, right or even at the centre of this end of the plot. In the majority of cases the entrance is located in one corner of the plot close to the public access. In some cases, before arriving in the vestibule, a covered alley or cul-de-sac with a door acts as a main access to one or more dwelling units.

4.5.5. THE NATURE OF ALTERATIONS

The traditional access system is simplified in some dwelling units by an indirect corridor to the central courtyard. The new system of circulation has changed the old arrangement of entrances for houses, subdivision of dwelling units and the relationship of the plot and the nearby public spaces. The result has been to bring about a tendency towards allowing 'strangers' or non-residents into residential pedestrian communities. The degree of privacy of these areas has changed. The recent changes in pattern of usage of some dwelling units, involving subdivisions or combinations have had some impact on the morphology of dwelling units.

In addition to the traditional dwelling units there are a number of newly constructed dwelling units in the Fahhadan area. In these dwelling units, the method of construction has changed and the built space of the dwelling mostly occurs on one or two sides of the plot. The material for building construction has changed from mud to steel and brick. The structural system is either a wall bearing system or steel frame.

4.5.6. SUMMARY OF FINDINGS AT UNIT LEVEL

The above description of the morphological pattern of the dwelling may be summarised by the following points.

1- The dwelling is organised in a single storey for living space and a basement for storage purposes. They are mostly arranged around a courtyard.

2- Various elements of the house are located around the four sides of the courtyard and faced inward to the open space. The emphasis on the position of each element has some relation with the climatic situation of the area.

3- There is usually an intermediate space, the vestibule, between alleys and internal space of the dwelling units. This arrangement provides a degree of privacy within the dwelling unit.

4- The traditional system of construction, mud as a basic material with vaulted ceiling system, was a common method of construction.

5- There are rarely openings on the external walls of the dwelling units.

6- The plot form of dwelling units is usually irregular with an average area of 360 sq.m.

7- The dwelling are usually organised in two parts private and semi-private (reception area), which may both be defined by a courtyard.

8- The form of the main external door varies in relation to the size of dwelling units.

9- Some changes are in evidence in the pattern of usage of the traditional units.

10- The external walls of some individual dwellings have been replaced by brick, while the concept of the entrance in some units have also been changed.

11- The basic typology of dwelling units in Fahhadan may be summarised in table 4.6

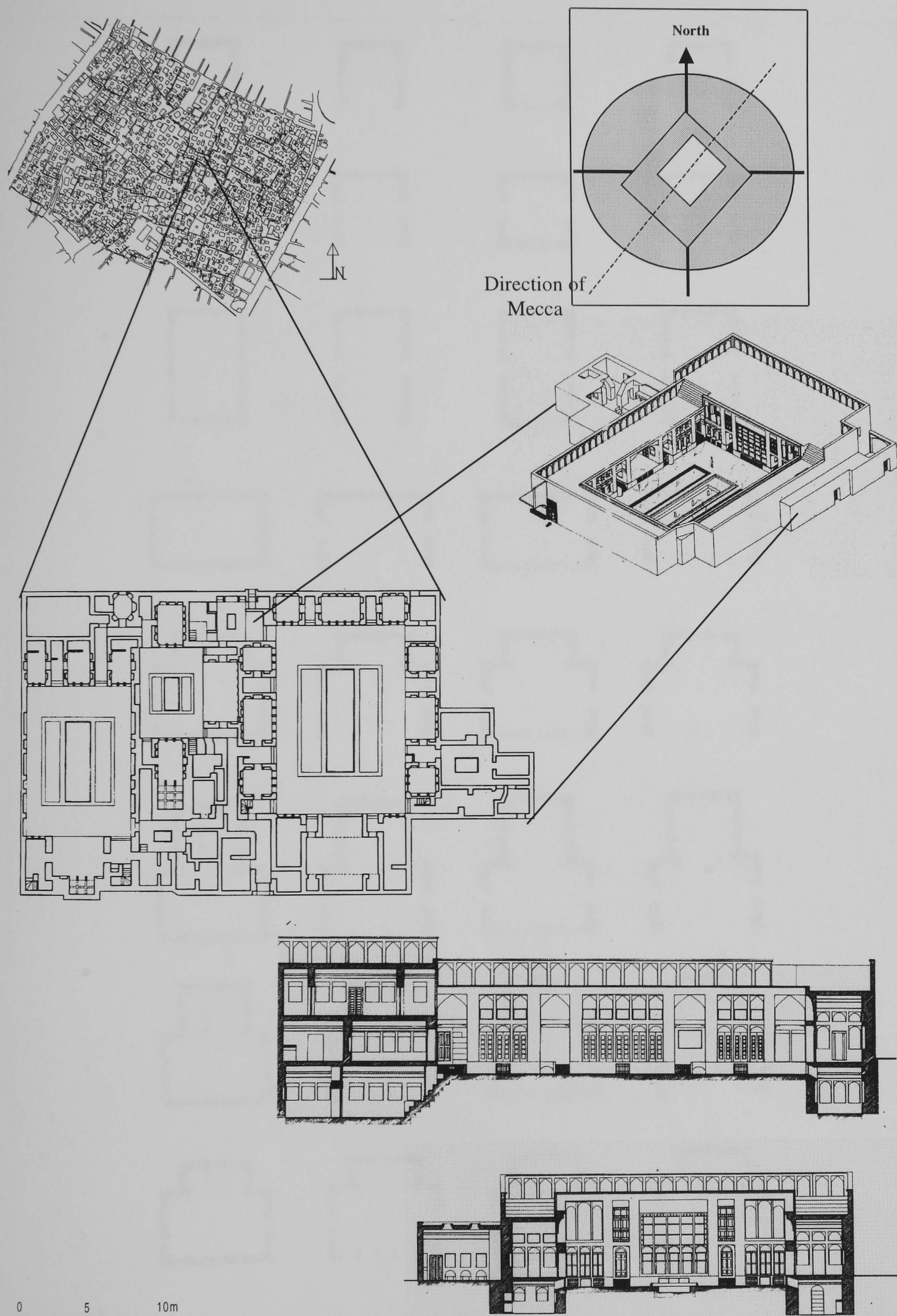


FIGURE 4.23: THE TRADITIONAL TYPICAL HOUSE IN THE FAHHADAN AREA

(Source: Organisation of Cultural Heritage in Yazd)

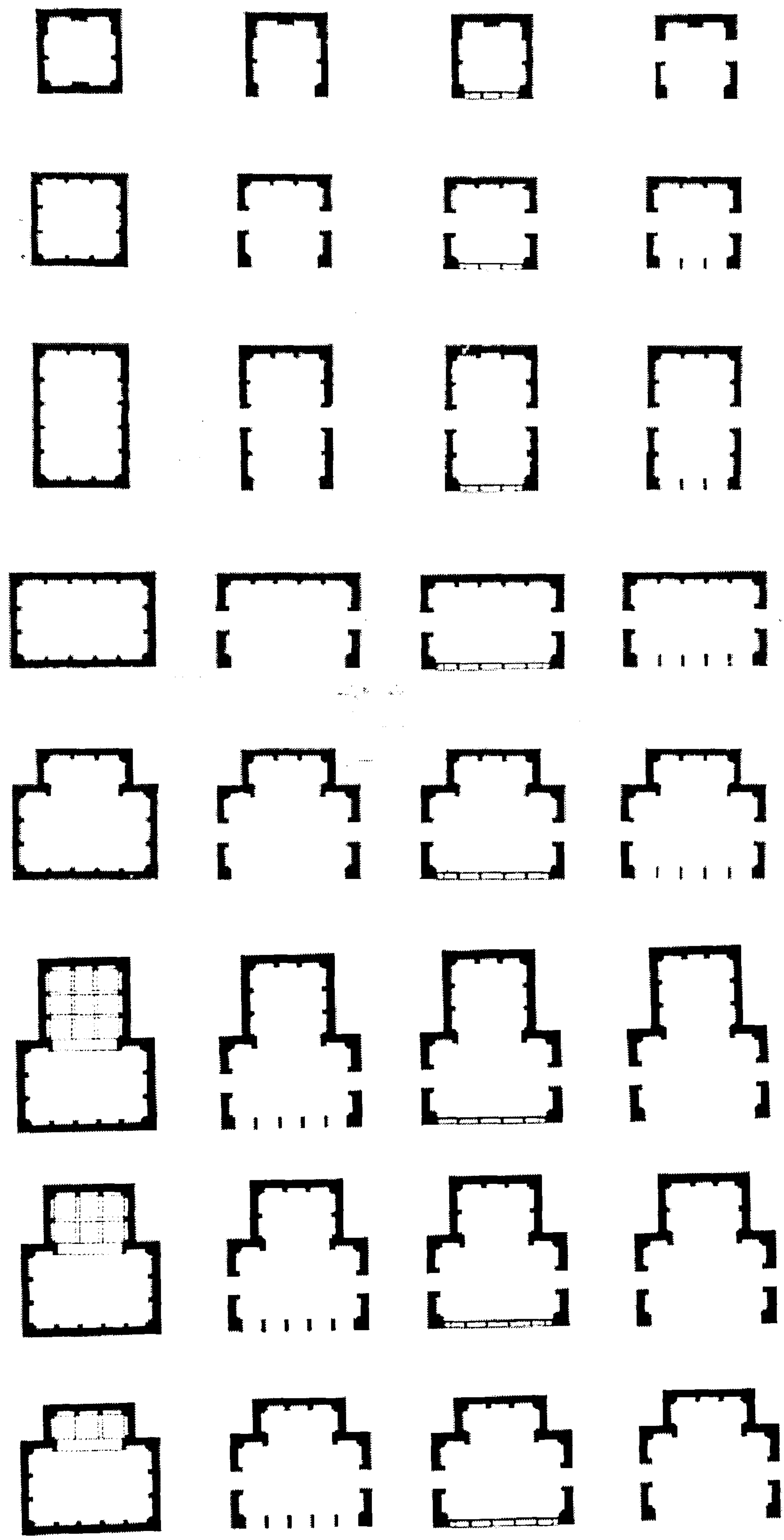


FIGURE 4.24: ROOMS ARE VARIED IN SIZE AND DIMENSION AND USUALLY NAMED FROM THE NUMBER OF THEIR DOOR-WINDOWS

(Source: Ghezelbash, 1985: 45,57)

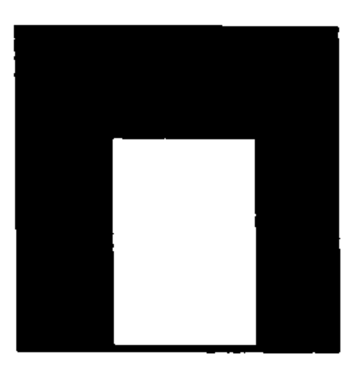
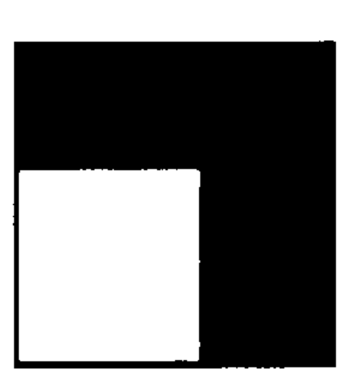
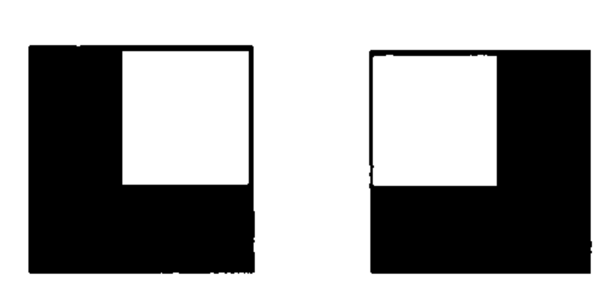
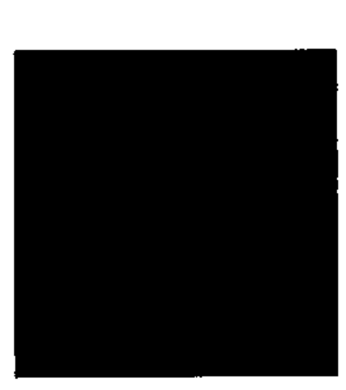
Type	The basic type	Total	Percentage(%)	Subsidiary type
A		358	30	
B		358	30	
C		96	8	
D		120	10	
E		143	12	
F		120	10	Unknown
	Total	1195	100	

TABLE 4.6: A SUMMARY OF DWELLING UNIT'S TYPOLOGY IN THE FAHHADAN AREA. THE DARK PORTION SHOWS THE BUILT PART OF THE DWELLING UNIT(THERE ARE SOME VARIATIONS IN COMBINATION OF BASIC TYPE IN DOUBLE-COURTYARD DWELLING)

(Source: Master Plan of Yazd, 1982, Author's site survey in 1998)

4.6. SUMMARY AND CONCLUSION

This chapter has aimed to study a particular part of the historical city of Yazd, the Fahhadan area, to identify the morphology of urban form which developed in the walled city. The morphology of the Fahhadan area has been studied at four levels - district, block, building group, and building or unit - mainly in terms of built forms and open spaces, and their disposition and relationship to each other.

The morphological findings in Fahhadan indicate that:

- This part of the study has examined the basically residential forms of the area, the prevailing design practices, and their evolution during this century. In the last 75 years, building in this area has undergone significant changes.

- The means of access has been a significant factor at all levels of analysis. However its importance is much more obvious at the building group level of study.

- In the morphological pattern identified at the four levels of analysis and summarised earlier, certain differences have emerged in pattern which are related to the irregular layout of the eastern parts and fairly regular pattern of the western parts of the Fahhadan area.

- The non-residential buildings are obviously taller than the other buildings and the newly constructed buildings which are mostly located alongside the boundary streets of the Fahhadan are also higher than the others.

- Some changes occurred in the access system mostly at the district and block level. For example, in some parts of the area, curved streets and cul-de-sacs have been replaced by newly constructed comparatively wide street patterns. However, the overall pattern of the old street system is still clearly in evidence. Therefore, the changes in the street system which have occurred have had comparatively little influence on the morphology, being mainly in evidence in terms of access and the internal arrangement of building groups.

- The recent changes in the pattern of usage of the traditional dwelling units have had some impact on the morphology.

The Fahhadan area is, of course, essentially historical in terms of its morphological structure. It is also very largely residential, though other functions occur occasionally. In the next chapter attention will be turned to an area beyond the walls which is obviously newer and in which commercial uses, in particular, have a more prominent role.

Chapter Five:

5. GODAL-E-MOSALLAH, A DEVELOPMENT IMMEDIATELY BEYOND THE WALLED CITY

In chapter four an account was given of an examination of what was essentially a traditional dwelling environment within the walled city. Attention is now turned to the study of an area which developed outside the walled city, is obviously newer than the traditional city and is one in which, despite the presence of substantial residential elements, a significant commercial and non-dwelling component are also in evidence. The aim in the study of this particular part of Yazd is clearly to identify the morphology of developments, which have occurred immediately beyond the walled city, the elements of which it is composed, the relationship between them and changes in evidence.

5.1. GENERAL SITUATION OF THE PARTICULAR AREA IN THE OLD CITY

The study area is located to the south-west of the walled city called 'Godal-e-mosallah'. The name is also currently that of an old neighbourhood in the study area. The selected area is situated almost in the present city centre and close to the commercial core of Yazd. It is currently well defined by a number of boundary elements. To the south-east is a street called Immam, the very first modern street in Yazd. Today Immam Street passes through the whole city from the extreme north-east to the south-west. To the north-east the city road known as Ghiam. The Amirchaghmaq and the Shahtahmasb, two old squares, are situated at the two ends of this street. To the south-west is another road named Rajaei Street. A wide street in the form of a boulevard occurs to the north-west of the study area and is called Imamzadehjafar. It is one of the most important city roads jointing the extreme north-east of the city to the south-west (See Figure 5.1).

The area contains the main mosque, which acts as a Friday's praying place, several religious buildings and the busiest shopping streets, which are mostly located to the north-east of the area. The old bazaar, which is divided into two parts by a newly constructed street called Ghiam, is located there. The main section of the bazaar is situated to the northern side of Ghiam Street and to the south-west of the walled city. The other part is situated to the southern side of Ghiam Street and to the north-east of the study area (See Figure 5.6).

Among several religious constructions distributed in the area, there are two large religious buildings, Imamzadehjafar shrine and Mullah-Ismaeil mosque (1807). Imamzadehjafar is the shrine of a saint in the city, and is popular since the people of the city and surrounding regions come here for religious activities. It is located to the north-east part of the area in the vicinity of one of the boundary roads. The mosque is located at the south-west of the bazaar area and has a close relation through surrounding alleys with Khan Square. It has become a place for Friday prayers since the Islamic revolution. Two newly constructed streets serve the mosque.

In addition to the two large public open spaces located to the north and west of the area, there is another public open space at the heart of the south-west portion of the bazaar called Khan square which acts as a focal point for the surrounding commercial activities taking place. There are also some other small squares, which form a part of thoroughfares or have a religious function.

5.2. THE MORPHOLOGY AT DISTRICT LEVEL

At the district level the whole Godal-e-mosallah area may be identified as a more or less dependent morphological entity with some of its boundary elements such as squares and bazaar. In this way, there have been two major influences on the formation and transformation of the morphology of this part of Yazd. The first is the establishment of large public open spaces, Amirchaghmaq and Shahtahmasb squares in the vicinity, to the north and the north-east of the Godal-e-mosallah area respectively and Khan Square which is located within the study area. These three public open spaces in essence led to the formation of Godal-e-mosallah and its surrounding area.

The second influence was the introduction of the new street system. The impact of streets included a change from the traditional bazaar arrangement to modern shop buildings which were developed not only in but also surrounding the study area. These new elements have from the very beginning in the 1920s caused a degree of variation in the morphology and have acted as a main element in the transformation of the area.

5.2.1. CONCEPTUAL BASIS OF THE DEVELOPMENT IN THE AREA (HISTORICAL SETTING)

The recorded history of some of the elements situated in the Godal-e-mosallah area can be dated as far back as 700 years, when a mosque was built to the south-west of the area in the 1320s. Later the shrine of Imamzadehjafar (1374) was constructed to the north-east of the mosque (See Figures 5.1 and 5.7).

In the late fourteenth century, after expansion of the city beyond the wall, the major city market transferred from the Masjed-e-jame which is located in the walled city and its surrounding buildings to the Amirchaghmaq Square. The square consists, in addition to the public open space, of a new mosque called new Masjed-e-jame (1438), a water reservoir, a bath-house, a caravansary and a market place. The developed area was linked to the walled city through a main city axis and was close to the southern gate of the historical city. By the beginning of the 15th century the surrounding area of this new square was expanded toward the south, the south-east and the south-west. This development may considered as the first stage of residential developments beyond the walled city and to the east of the study area (See Figure 5.2).

During the 18th century, at the time of the Safavid dynasty (1501-1773), another square named Shahtahmasb; similar to the Amirchaghmaq Square was established in the north of the study area and to the south-west of the walled city. Its surrounding area was gradually expanded in all direction and a neighbourhood was formed. A part of this neighbourhood is located to the north of the study area.

In the late 18th century, the old bazaar in conjugation with the Amirchaghmaq complex gradually began to expand to the south-west where a new complex with some public activities called Khan Square was built in 1798. Later Khan Square acted as a new commercial centre for the old town.

In 18th and 19th centuries some new neighbourhoods, Godal-e-mosallah, Hashemkhan and Godal-e-abbasi were developed (See Figure 5.7). Other neighbourhoods including the southern part of the Godal-e-abbasi neighbourhood were developed in the late 19th and the beginning of the 20th centuries. The different stages of development in the Godal-e-mosallah area are shown in figure 5.2.

The first modern street was constructed on the south-east side of the study area in 1935 and as a result the Godal-e-abbasi neighbourhood was divided into two portions. Later, in 1943, the second new street was constructed to the north-east of the area, from Shahtahmasb square to Amirchaghmaq square. The new street divided the bazaar and both squares into two portions (See Figures 5.3, 5.4 and 5.5).

From the 1950s, though initially very slowly, modern commercial buildings were constructed in the vicinity of Immam and Ghiam streets and they became the largest trade centres of the city. Immam Street extended towards the north-east and the south-west and acted as an important thoroughfare in the city and a site of numerous active commercial activities. Ghiam Street beyond the two main squares was extended to the north-west as well as south-west part of the city.

In 1928 a school named Iranshahr (See Figure 5.6) was constructed to the south of the study area. Later, in 1955 the Rajaei Street was built to the south-west of Godal-e-mosallah area oriented from the north-west to the south-east and run in front of Iranshah school. Some other educational and governmental offices were developed near to the school and alongside Rajaei Street. The southern part of Godal-e-mosallah area where the school is situated was beyond the new wall which was constructed for the old city in the 1810s.

Godal-e-mosallah area consisted of six neighbourhoods. These are Godal-e-mosallah, Bazaar, Hashemkhan, Godal-e-abbasi, Shahtahmasb, Mir-Qutb and Khalfebagh. These neighbourhoods are shown in figures 5.7 and 5.8 and they were developed in different stages of the city history.

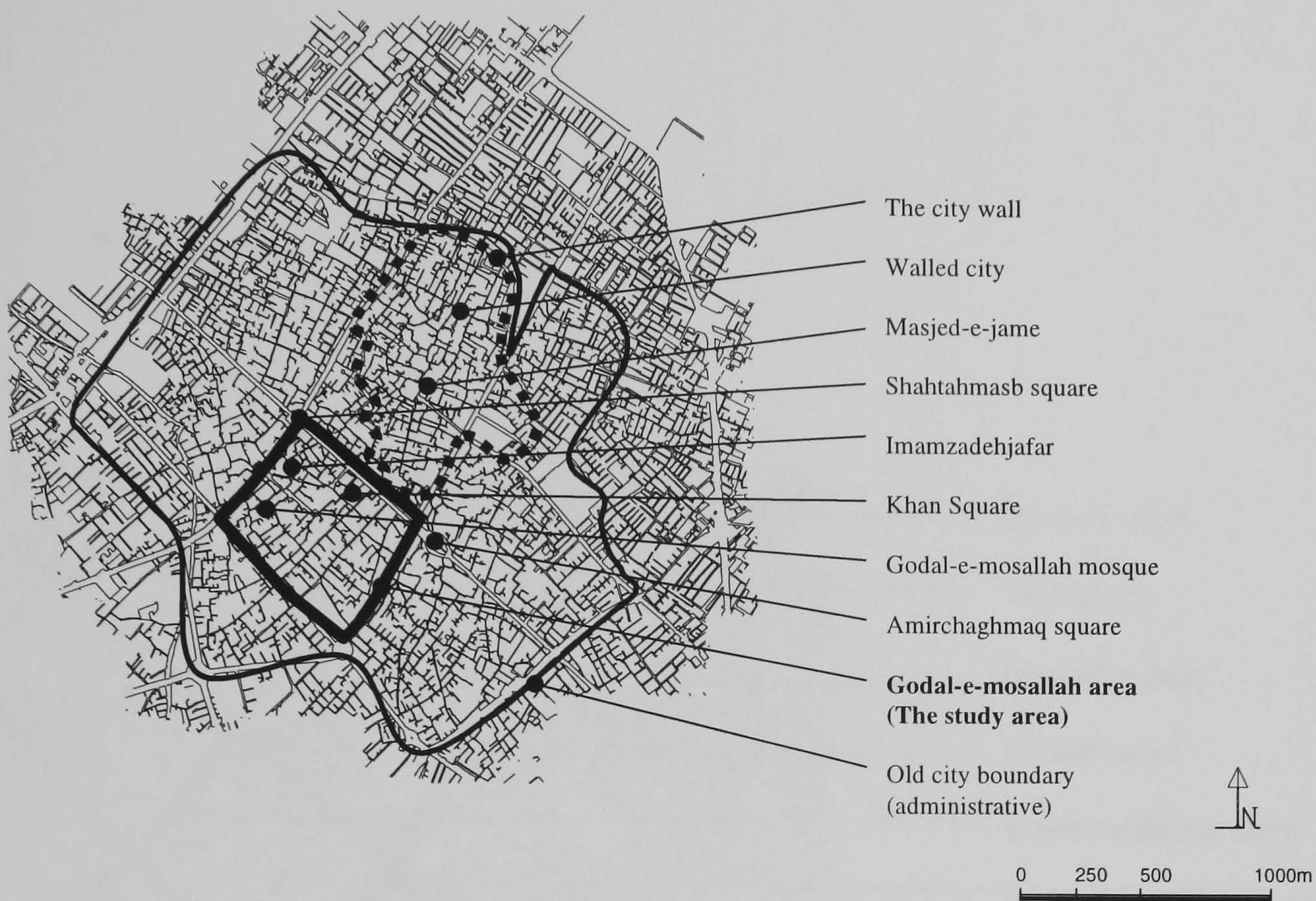


FIGURE 5.1: LOCATION OF THE STUDY AREA 'GODAL-E-MOSALLAH' IN THE OLD CITY AS AN IMMEDIATE DEVELOPMENT OUTSIDE THE WALLED CITY AND SOME MAJOR ELEMENTS IN RELATIONSHIP WITH THE STUDY AREA.

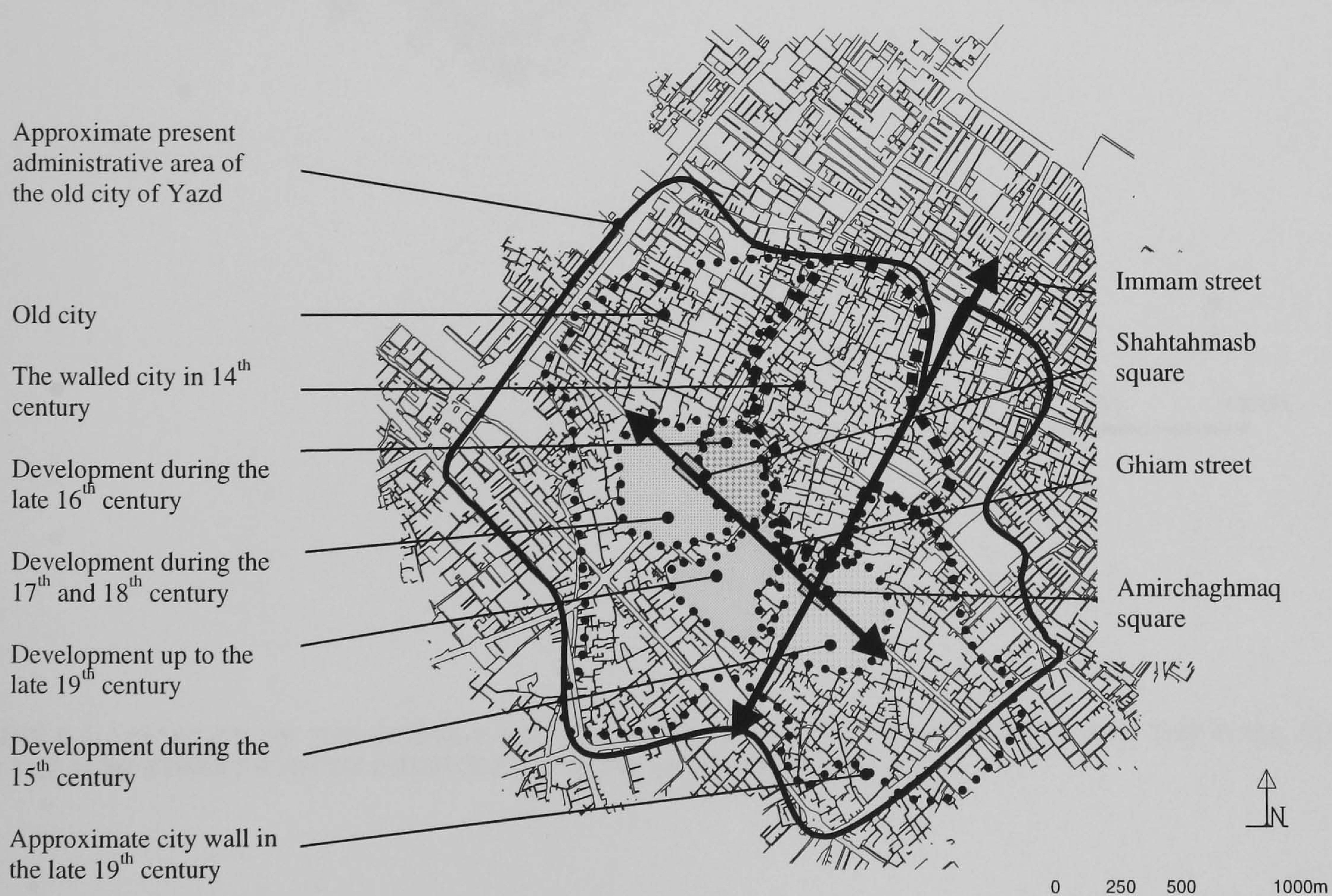


FIGURE 5.2: DIFFERENT STAGES OF THE DEVELOPMENTS IMMEDIATELY OUTSIDE THE WALLED CITY. TWO PERPENDICULAR NEW STREETS INTRODUCED TO THE CITY IN 1920S ARE SHOWN IN THIS MAP.

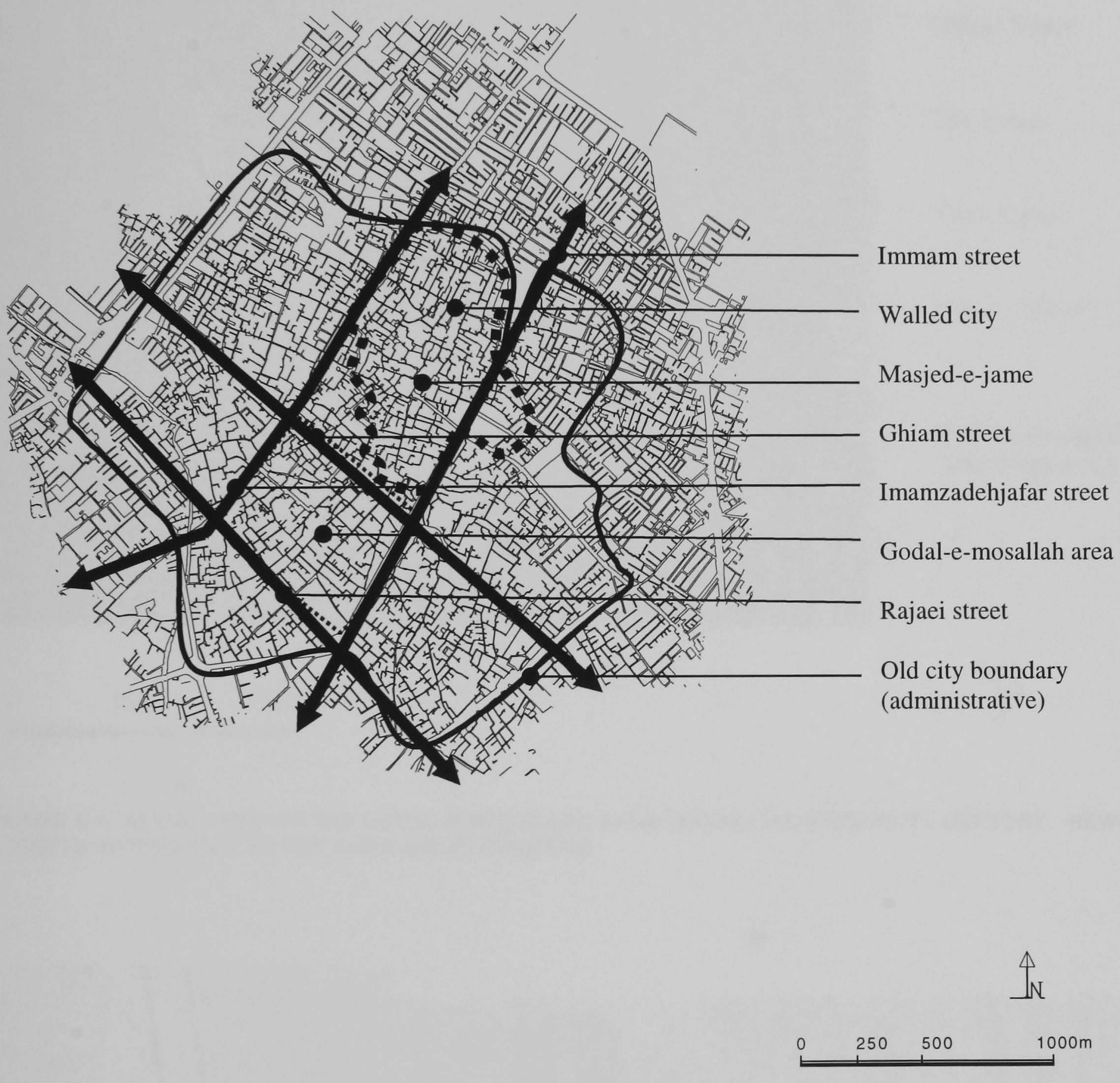


FIGURE 5.3: LOCATION OF THE GODAL-E-MOSALLAH AREA AND ITS RELATIONSHIP WITH THE WALL CITY AND THE NEW STREET SYSTEM ENCIRCLED THE GODAL-E-MOSALLAH AREA

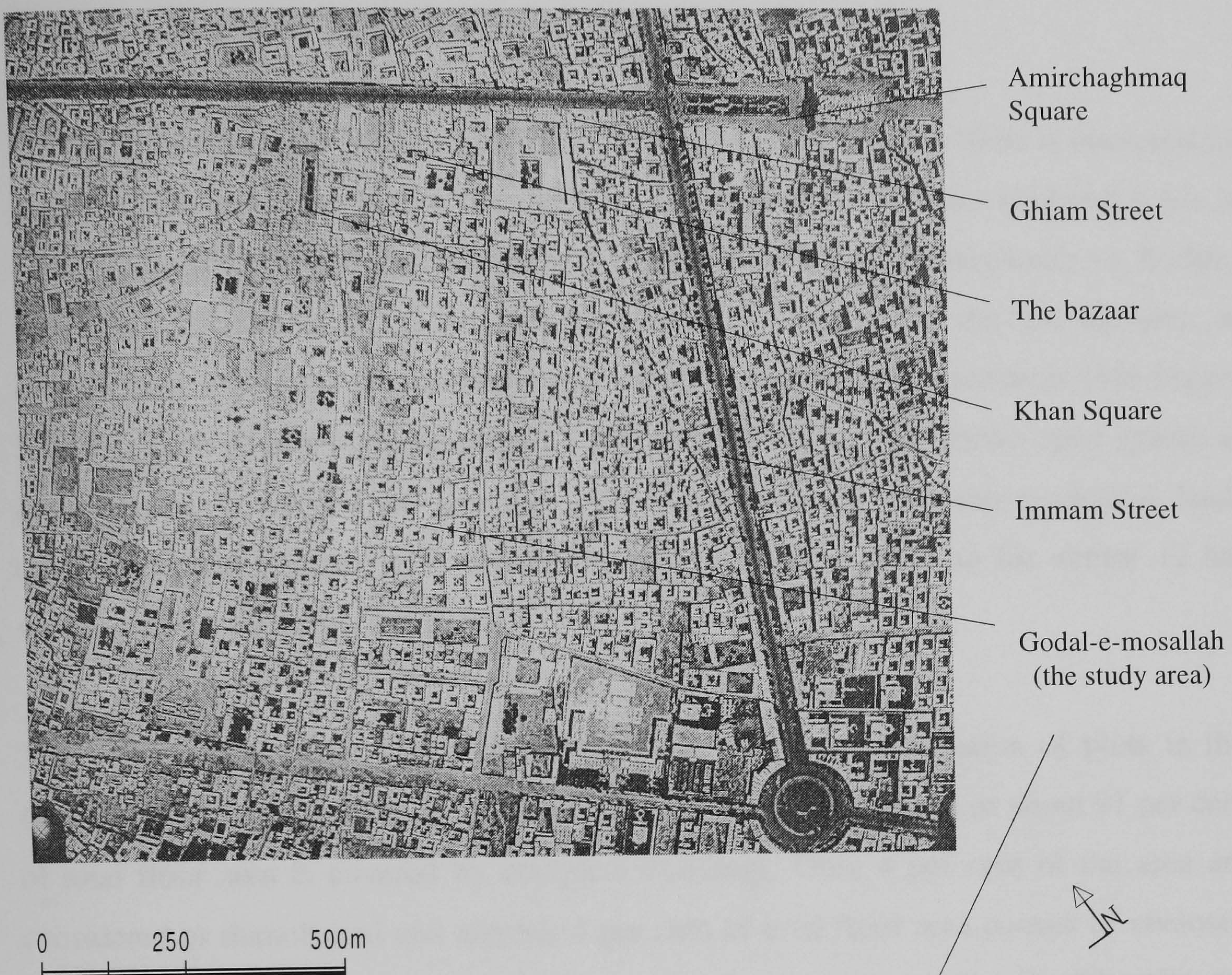


FIGURE 5.4: AERIAL VIEW OF THE GODAL-E-MOSALLAH AREA DURING MID-TWENTIETH CENTURY. NEWLY STREETS INTRODUCED TO THE AREA ARE IN EVIDENCE

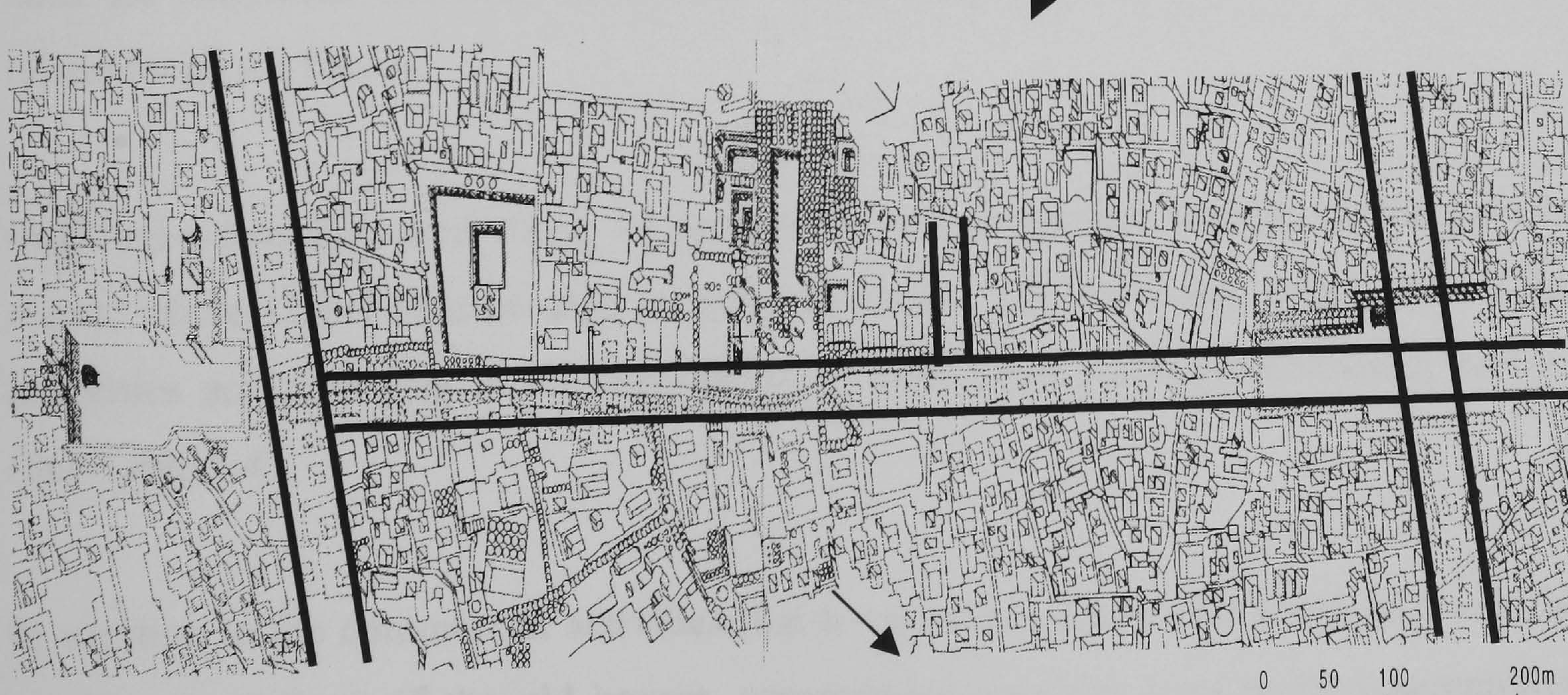


FIGURE 5.5: INTRODUCING NEW STREET SYSTEM IN THE OLD CITY

(Source Tavassoli 1992)

5.2.2. THE PATTERN OF LAND USE

The chosen area for study has a total area of 65 ha of which around 10 ha is occupied by streets, alleys and other public open spaces. The total built up area excluding roads is about 56 ha, currently accommodating a population (Sazman-i Barnamah va Budjih, 1998) of 3581. Table 5.1 shows that the majority of the land in the built-up area, or about 60 per cent of the area, amounting to 33 ha, is occupied by residences (See Figure 5.9). The area of non-residential land, excluding the streets and public open spaces is about 23 ha, or around 40 per cent of built-up area. Of the non-residential land, commercial and business uses occupy the largest share, accounting for almost 12 ha, while other uses account for 11 ha.

The latest survey (Yazd City Council 1998) on the physical situation of plots in the Godal-e-mosallah area is shown that (See Tables 5.2 and 5.3) 50 ha or about 91 per cent of total floor area is covered by complete buildings. Only 4 per cent of the area are considered as demolished and another 4 per cent of total floor area consist of enclosed lands, incomplete buildings and green spaces. In the study area only 80 units are recorded in a relatively poor physical condition. A total of 84 residential units have been converted into non-residential uses. Most of them currently act as storage areas. These units are somewhat unevenly distributed in the study area and tend to have a close relation with the bazaar.

In Godal-e-mosallah area about 79 per cent of the properties belongs to the private sector, where 12 per cent belongs to religious sector. The remaining 9 per cent of the properties are belonging to the institutions in both private and governmental sectors (See Table 5.4).

In addition to the commercial activities that have taken place in the north-east and the south-west portions of the old bazaar, commercial activities tend to be concentrated alongside nearby streets, especially in Ghiam and Immam streets. Commercial activities have performed comparatively less well in Rajaei and Imamzadehjafar streets.

Despite some new shopping complexes distributed in the old and new parts of Yazd, the Godal-e-mosallah area and its surrounding area acts as the largest element in the city's commercial system. In the study area there are about 117,000 square metres of building floor area and about 1300 shops serving customers not only from the city but also from other regions. Approximately 920 shops occur alongside the boundaries of the study area, about three times the number of establishments in the southern part of the bazaar.

The current arrangement of land uses is rather different from the former pattern, which was such that non-residential activities were mostly concentrated in the bazaar area. There have been two particular influences on the formation and transformation of the land-use pattern of the study area.

The first is the development of the bazaar which is located to the north-east of the area and construction of the Khan Square as a focal point for the bazaar. These have influenced on the formation of the pattern of land-use of the area. Thus, many of the activities appear in the area are clearly in relation with commercial activities.

The second is the emergence of modern streets, which have eventually led to the establishment of new commercial sectors in the area. The recent impacts of commercial development alongside the newly constructed streets have also included a change from the traditional bazaar to some modern shop buildings. The emergence of these new commercial activities also changed some residential buildings to a place for storage and even workshops for commercial uses.

LAND USE	Number of plots	Sum of plot area	Percentage of plot area
Cultural unit	6	5066.5	0.91%
Educational unit	15	41116.2	7.39%
Government office	1	928	0.17%
Green space & park	2	807.1	0.14%
Medical centre	2	728	0.13%
Office	6	2563.5	0.46%
Public services	14	8422.4	1.51%
Religious building	39	45203.1	8.12%
Residential	1103	330791.9	59.42%
Shop	953	82247.9	14.77%
Shop-residential	83	25172.8	4.52%
Storage	29	13638.5	2.45%
Grand Total	2253	556685.9	100.00%

TABLE 5.1: LAND USE IN GODAL-E-MOSALLAH AREA

(Source- Yazd City Council, 1998)

LAND USE	complete building	demolished building	enclosed land	green space	incomplete building	Grand Total
Cultural unit	6255	151				6407
Educational unit	38182					38182
Government office	928					928
Green space & park			363	444		807
Medical centre	728					728
Office	2564					2564
Public services	6164		2258			8422
Religious building	43747	559	861.4		36	45203
Residential	293735	18307	16856.5		2746	331645
Shop	77966	2114	1379.2		789	82248
Shop -residential	25175	82	236.6		420	25914
Storage	13639					13639
Grand Total	509082	21214	21954.7	444	3991	556686

TABLE 5.2: LAND USE IN GODAL-E-MOSALLAH AREA WITH REFERENCE TO THE PHYSICAL SITUATION OF THE PLOTS IN EVIDENCE

(Source- Yazd City Council, 1998)

LAND USE	complete building	demolished building	enclosed land	green space	incomplete building	Grand Total
Cultural unit	6	1				7
Educational unit	11					11
Government office	1					1
Green space & park			1	1		2
Medical centre	2					2
Office	6					6
Public services	12		2			14
Religious building	34	1	3		1	39
Residential	999	62	35		9	1105
Shop	915	15	15		8	953
Shop-residential	81	1	1		1	84
Storage	29					29
Grand Total	2096	80	57	1	19	2253

TABLE 5.3: NUMBER OF PLOTS OCCURRED IN DIFFERENT SPACE USE WITH REFERENCE TO THE PHYSICAL SITUATION OF PLOTS IN EVIDENCE

(Source- Yazd City Council, 1998)

LAND USE	institute	private	religious	Grand Total
Cultural unit	4052	747.4	267.1	5066.5
Educational unit	34675.2	1593.9	4847.1	41116.2
Government office	928	-	-	928
Green space & park	807.1	-	-	807.1
Medical centre	444	284	-	728
Office	2294.6	268.9	-	2563.5
Public services	2078	5698.6	645.8	8422.4
Religious building	-	1438.6	43764.5	45203.1
Residential	1114.5	324755.1	4922.3	330791.9
Shop	3076.3	68395.4	10776.2	82247.9
Shop-residential	-	25172.8	-	25172.8
Storage	-	12838.9	799.6	13638.5
Grand Total	49469.7	441193.6	66022.6	556685.9
percentages	9%	79%	12%	100%

TABLE 5.4: OWNERSHIP AND SPACE USE OF THE BUILDINGS IN THE GODAL-E-MOSALLAH AREA

(Source- Yazd City Council, 1998)

FIGURE 5.9: LAND USE PATTERN IN THE GODAL-E-MOSALLAH AREA

(Source: Yazd City Council, 1998 and Author's site survey)

5.2.3. THE PRIMARY ELEMENTS IN EVIDENCE IN THE MORPHOLOGICAL FORM

At the district level the selected area will be analysed according to some main elements. This examination involves the identification of the elements and patterns which give shape and form to the area as a whole and the changes which have occurred in them. In general these elements may be classified as public open spaces including streets, alleys, squares, crossings, and the blocks of the buildings which occur between them.

5.2.3.1. OPEN SPACES

Although open spaces occur at a different level of morphology of the study area, here emphasis is on those parts which have influenced the formation and transformation of the study area at the district level. The focus of the examination will be the old major alley system, which is still clearly in evidence, in conjunction with the new street pattern. The examination of open spaces will be followed by concentration on the squares which are occurred in the study area and other public open spaces which are formed at the junction of or alongside the alleys. This part of the study will also emphasise some changes which have appeared in the old pattern of public open spaces.

5.2.3.1.1. THE STREET PATTERN AND MAJOR ALLEY SYSTEM

There are four major streets, Ghiam, Imamzadehjafar, Rajaei and Immam which form the boundary of the Godal-e-mosallah area (See Plate 5.1). They act as the main city streets and the major alleys (See Plate 5.2) or old street system which occur within the study area are connected to them. In turn the secondary alleys and some cul-de-sacs stem from major alleys, which will be examined in detail at the lower level of analysis.

In this way, the study area is divided into blocks by the combination of four boundary streets and several major alleys. Boundary streets provide a good route for motor vehicles, and they appear to form the upper layer of the street network.

Two new and comparatively narrow streets, one from the north-east and another from the north-west of the study area, penetrate the Godal-e-mosallah area to serve the MullahIsmaeil mosque. The most important reason for the construction of these streets was to provide a proper route for prayers to access the mosque from the main streets (See Plate 5.3).

Major alleys, including two new streets which penetrate the study area may be considered as a subsidiary layer of the street system in the Godal-e-mosallah area. These mostly run from the north-east to the south-west and some occur in perpendicular direction. Those major alleys which are run in the north-east to the south-west direction stem from the old main commercial route which was located to the north-east of the area and later Ghiam street was established on it.

When the north-east to the south-west direction is considered, there are six major alleys in evidence. The four middle ones are almost parallel and are fairly straight. One of them is the newly constructed street stem from Ghiam Street toward MullahIsmaeil mosque. Another runs through the Khan Square and acts as a part of the old bazaar. It is continued to the south-west where it is joined to another major alley in a perpendicular direction. The third major alley is partially acts as a branch of the grand bazaar and is connected to the south-west boundary of the study area. The fourth one directly connects Ghiam Street to Rajaei Street without any obstacle. Except for these four, other major alleys which occur in the north-east to the south-west direction are almost diagonal and join Ghiam street to the north-east and north-west boundaries of the study area (See Figure 5.8).

While the distribution of the major alleys in the north-east to the south-west direction in the Godal-e-mosallah area is fairly uniform (See Figure 5.10), that of the alleys running in a perpendicular direction is rather less so. These alleys occur in various intervals and none of them run directly through the entire area. The only major subsidiary street in this direction is a newly established street which stems from Imamzadehjafar Street and ended just behind the MullahIsmaeil mosque where it is connected to a major alley which run in a perpendicular direction.

Except for Imamzadehjafar Street, which is about 36 metres wide, the width range of streets of the upper layer, including pedestrian ways is between 20 and 28 metres, while that of the subsidiary layer is between 4 and 16 metres. Major alleys occur at irregular intervals with minimum distance of 100 metre to a maximum of 360 and in general no regular alley system applies to the entire area

When the function of streets and major alleys is considered, the boundary streets and two new subsidiary streets which penetrate the study area, are mainly used for vehicular traffic (See Figure 5.11). A margin space is provided on both sides of them for pedestrian movement. A number of new shops have been established at the edge of these streets. Whilst the major alleys or the old street system acted as a place for mainly pedestrian movement, today a very low level of vehicular traffic passes through them. Alongside some of these alleys a row of old shops are in evidence. There is no marginal space for separation of pedestrian movement in such major alleys.

Generally the typology of the street and major alley system in the Godal-e-mosallah area basically consists of a regular grid of some straight alleys in the middle of the area (See Figure 5.12) where non-residential units are much more in evidence, with low-rise buildings occurring on both sides. These alleys are connected to the newly constructed streets which are located on the boundaries of the study area. The pattern of major alleys is irregular to the north and eastern part of the area. Most of the major alleys are of considerable width to cater for not only pedestrians but also, up to certain limits, vehicular movement.

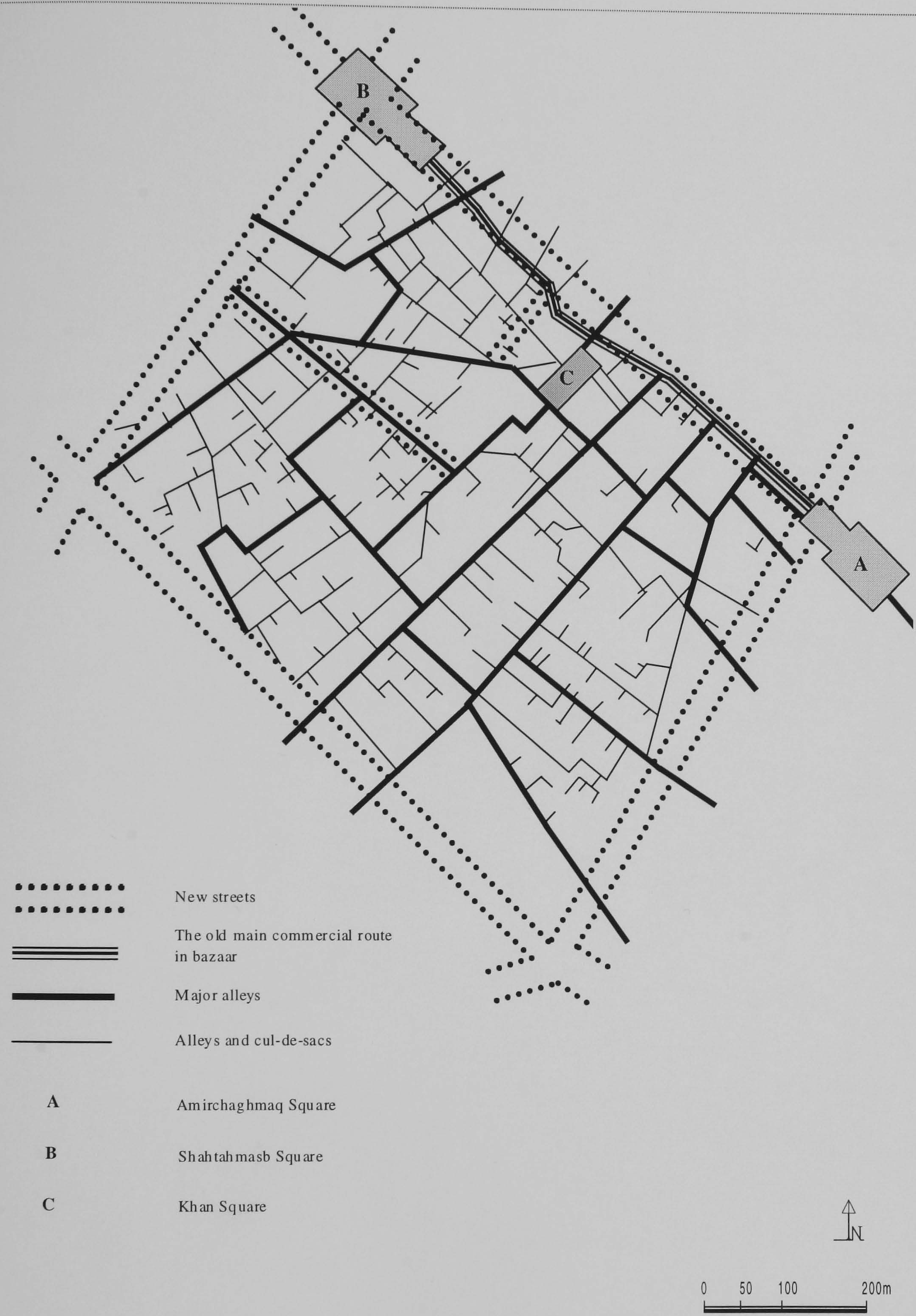


FIGURE 5.10: THE OLD PATTERN OF THE STREET SYSTEM IN THE GODAL-E-MOSALLAH AREA. IT ALSO SHOWS THE POSITION OF NEW STREETS INTRODUCED TO THE AREA AND THE RELATIONSHIP BETWEEN THE ALLEY SYSTEM AND PUBLIC OPEN SPACES.

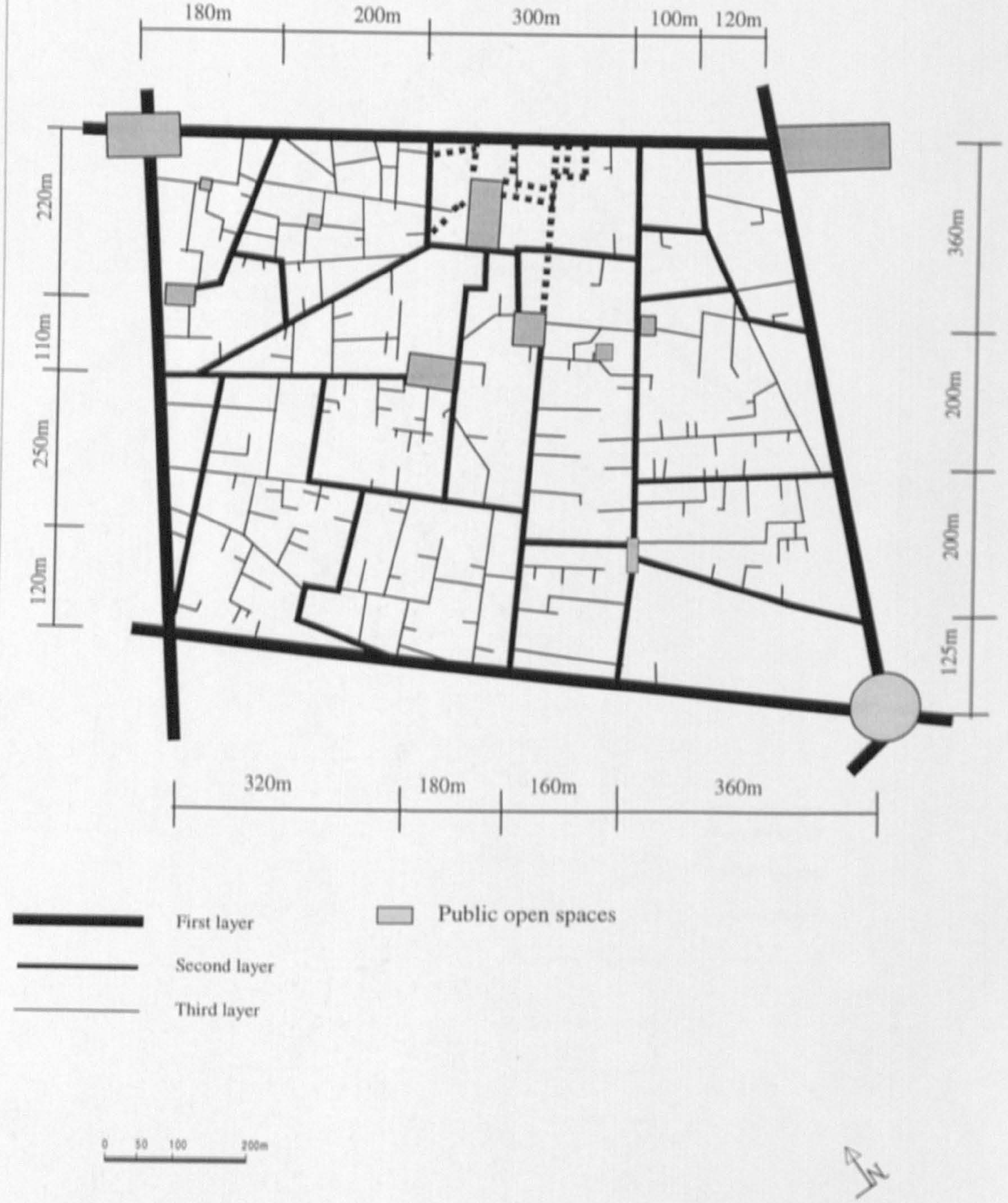


FIGURE 5.11THE NEW STREET SYSTEM IN CONJUNCTION WITH THE OLD ONE. THE THREE LEVEL OF STREET SYSTEM IS IN EVIDENCE

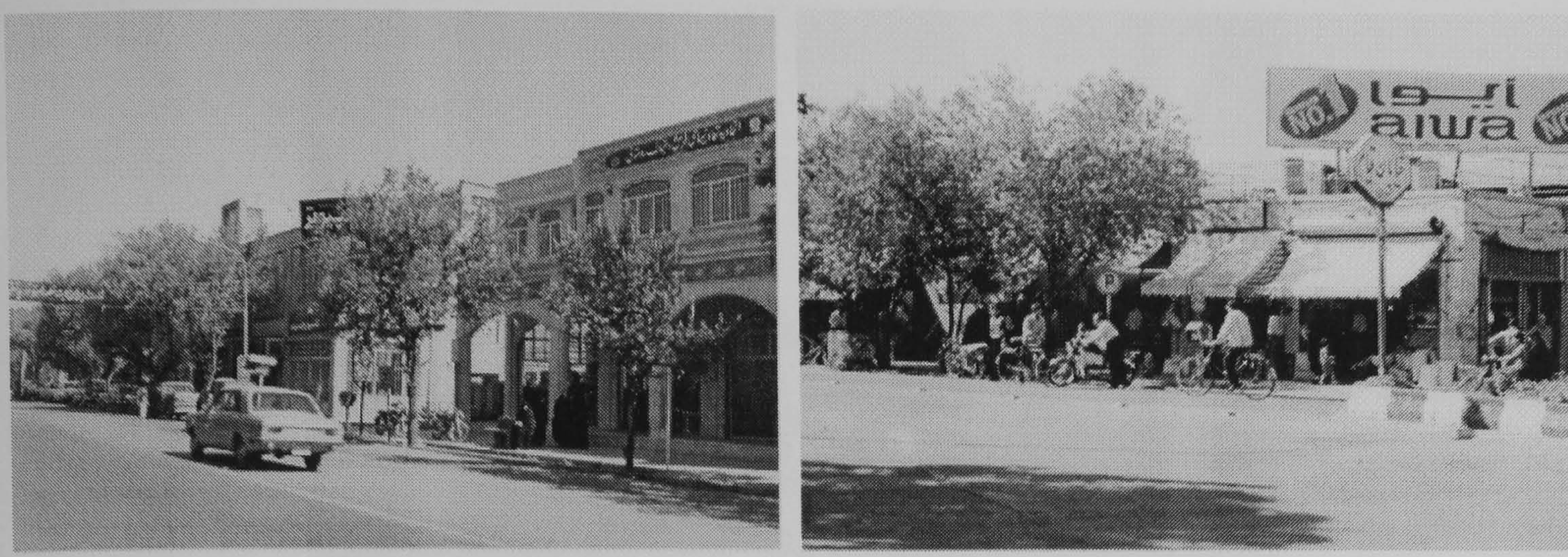


PLATE 5.1: TWO EXAMPLES OF NEW STREETS WHICH THEY FORMED THE BOUNDARY OF THE STUDY AREA.

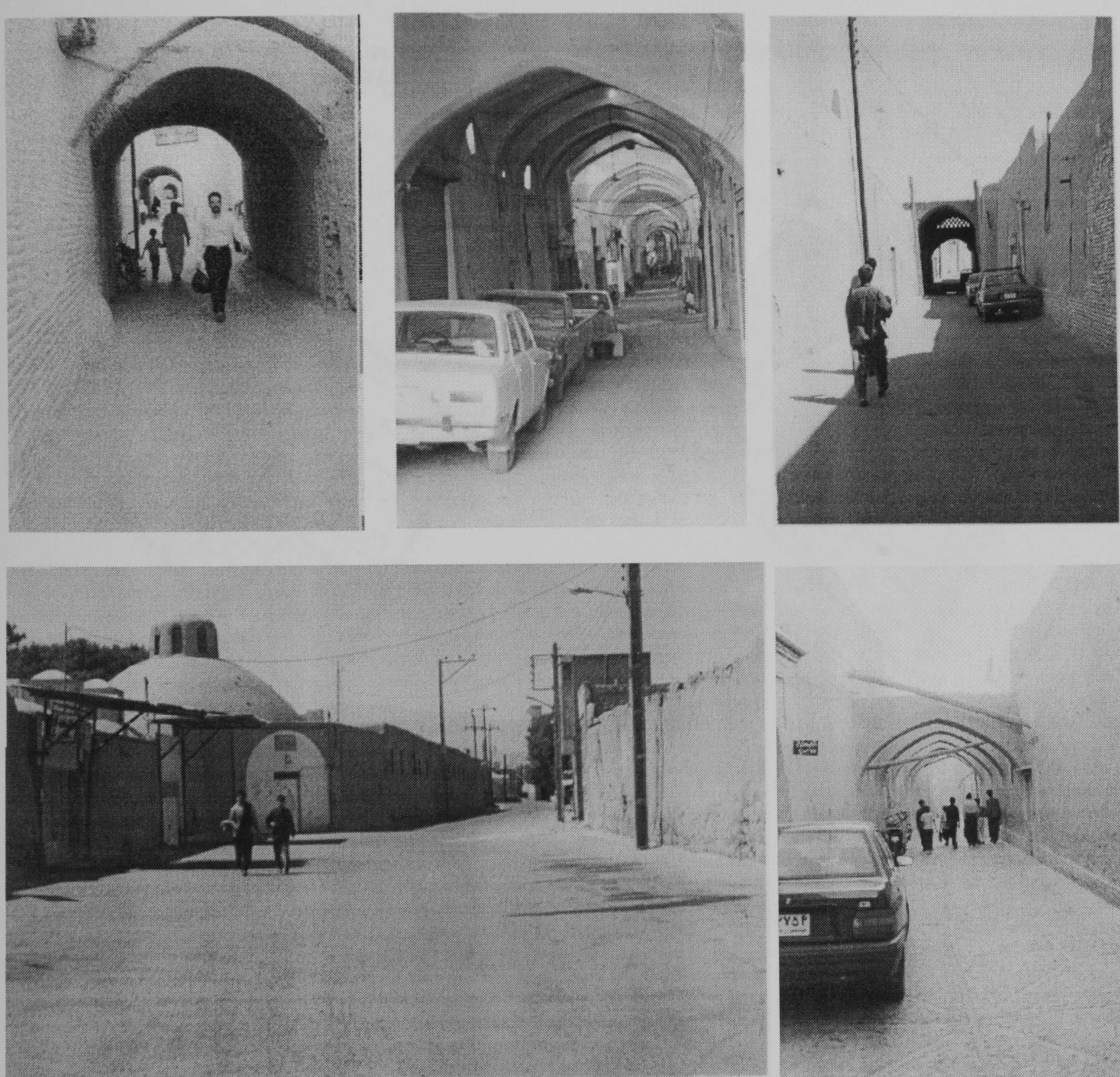


PLATE 5.2: MAJOR ALLEYS IN THE GODAL-E-MOSALLAH AREA ACT AS THE SECOND LAYER OF STREET SYSTEM. THESE ALLEYS OCCUR IN DIFFERENT PART OF THE AREA. THEY ARE RELATIVELY WIDER THAN TRADITIONAL CITY

PLATE 5.3: NEWLY CONSTRUCTED STREETS PENETRATED INTO THE AREA DURING 1980S. THIS STREET IS LOCATED IN FRONT OF MULLAHISMAEIL MOSQUE

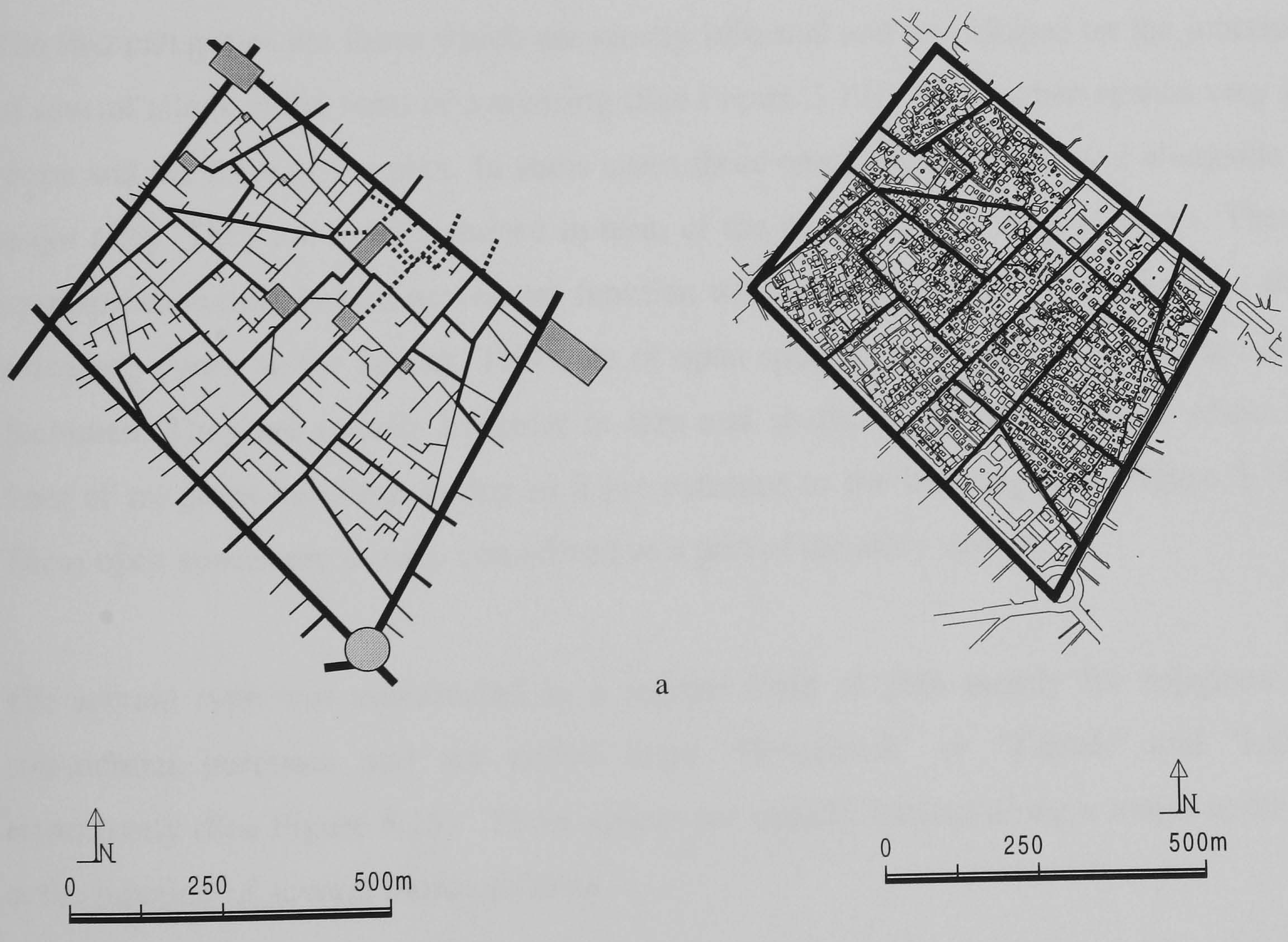


FIGURE 5.12: A-DISTRIBUTION OF THREE LAYERS OF STREET SYSTEM IN CONJUNCTION WITH PUBLIC OPEN SPACES. B- SIMPLIFICATION OF STREET SYSTEM IN THE STUDY AREA AND TENDENCY TO A GRIDIRON PATTERN

5.2.3.1.2. PUBLIC OPEN SPACES (SQUARES)

Public open spaces occur in different places of the study area. At the district level of analysis, it is intended to examine those public open spaces which occur in between the blocks. In the Godal-e-mosallah area these open spaces are generally framed by enclosing some buildings or/and were constructed for certain activities such as religious or commercial purposes. These public open spaces which may be called squares are characterised in terms of their functions, the place in which they occur, the number of streets or alleys connected to them and some physical elements which surround them. From a morphological point of view these squares may generally be categorised into two main classifications.

The first categories are those which are mostly informal and just shaped on the junction of several alleys in the form of a crossing (See Figure 5.13). These open spaces vary in shape and the form of the plan. In some cases these open spaces are located alongside a major alley. They are mostly shaped in term of the connection of several alleys. These open spaces mainly have a movement function with some consideration for loading and unloading goods to the bazaar. This type of open space is not usually pre-planned and decorated. They are usually irregular in size and shape. Some of them also occur in front of religious buildings acting as a pre-entrance to the building (See Figure 5.14). These open spaces are usually considered as a part of the alley system.

The second type was constructed in a regular form of plan mostly for religious or commercial purposes and are called them ‘Hosseiniah’ or ‘Takiah’ and ‘Lard’ respectively (See Figure 5.15). These spaces are usually located along a major route or at the junction of several thoroughfares.

At the district level the only example of a commercial square in the area is Khan Square (See Figure 5.16). This occurs within the commercial centre and is situated to the north-east of the Godal-e-mosallah area. This public open space has a multifunctional and fairly regular shape. The square is connected to the area through six major alleys and branches of the old bazaar. These alleys partially serve the bazaar and are usually covered. These routes are only for pedestrian use and are mostly between 4 to 10 metres wide. The latest development of the alley system around Khan Square belongs to the late 18th and 19th centuries.

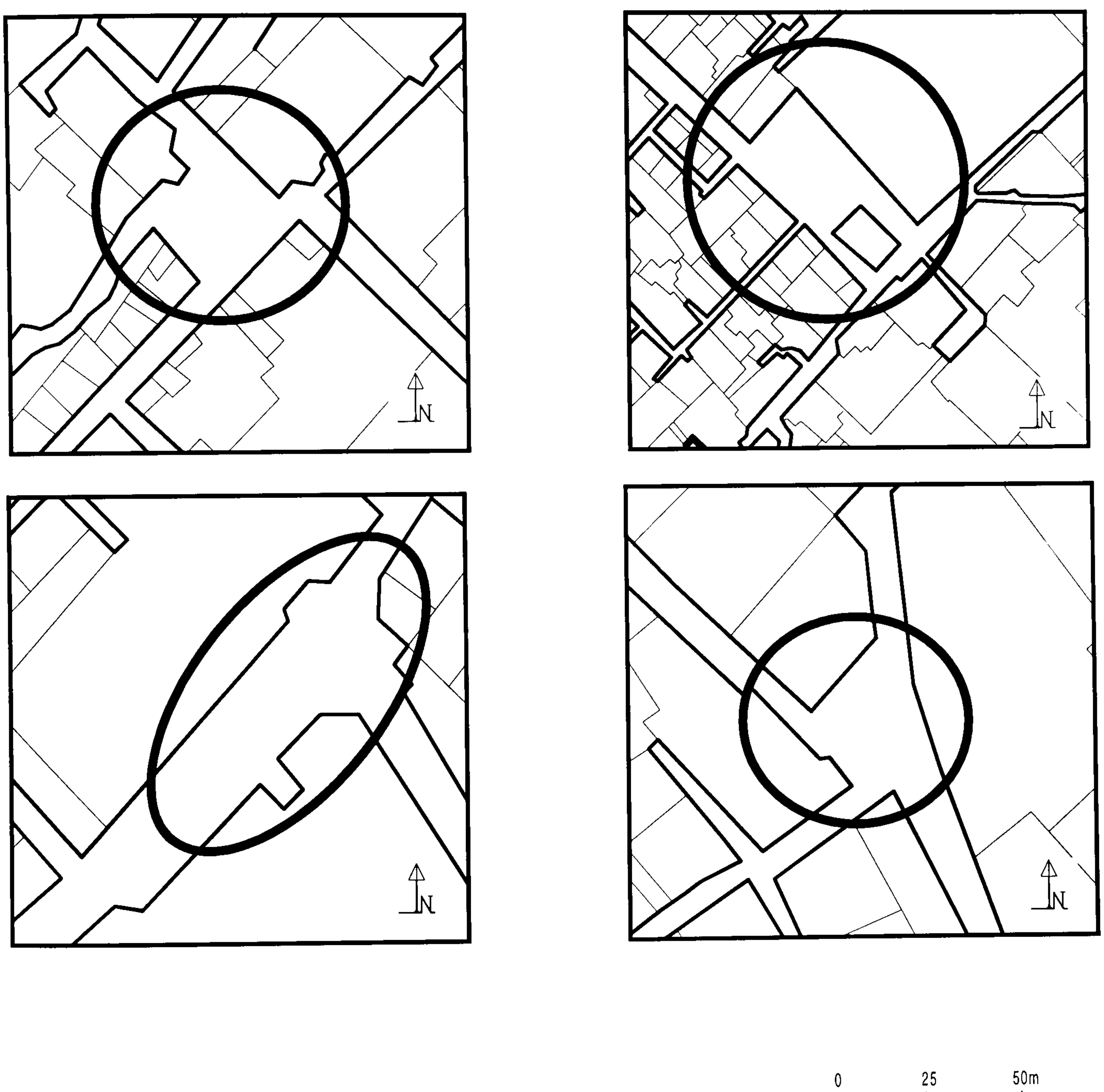


FIGURE 5.13: PUBLIC OPEN SPACES SHAPED IN TERM OF CONNECTION OF SEVERAL ALLEYS. THESE OPEN SPACES HAVE MAINLY MOVEMENT FUNCTION WITH SOME CONSIDERATION FOR TRANSPORTATION OF GOODS TO COMMERCIAL AREAS. THIS TYPE OF OPEN SPACES ARE NOT USUALLY PRE-PLANNED AND DECORATED AND THEY ARE USUALLY IN IRREGULAR SIZE AND SHAPE

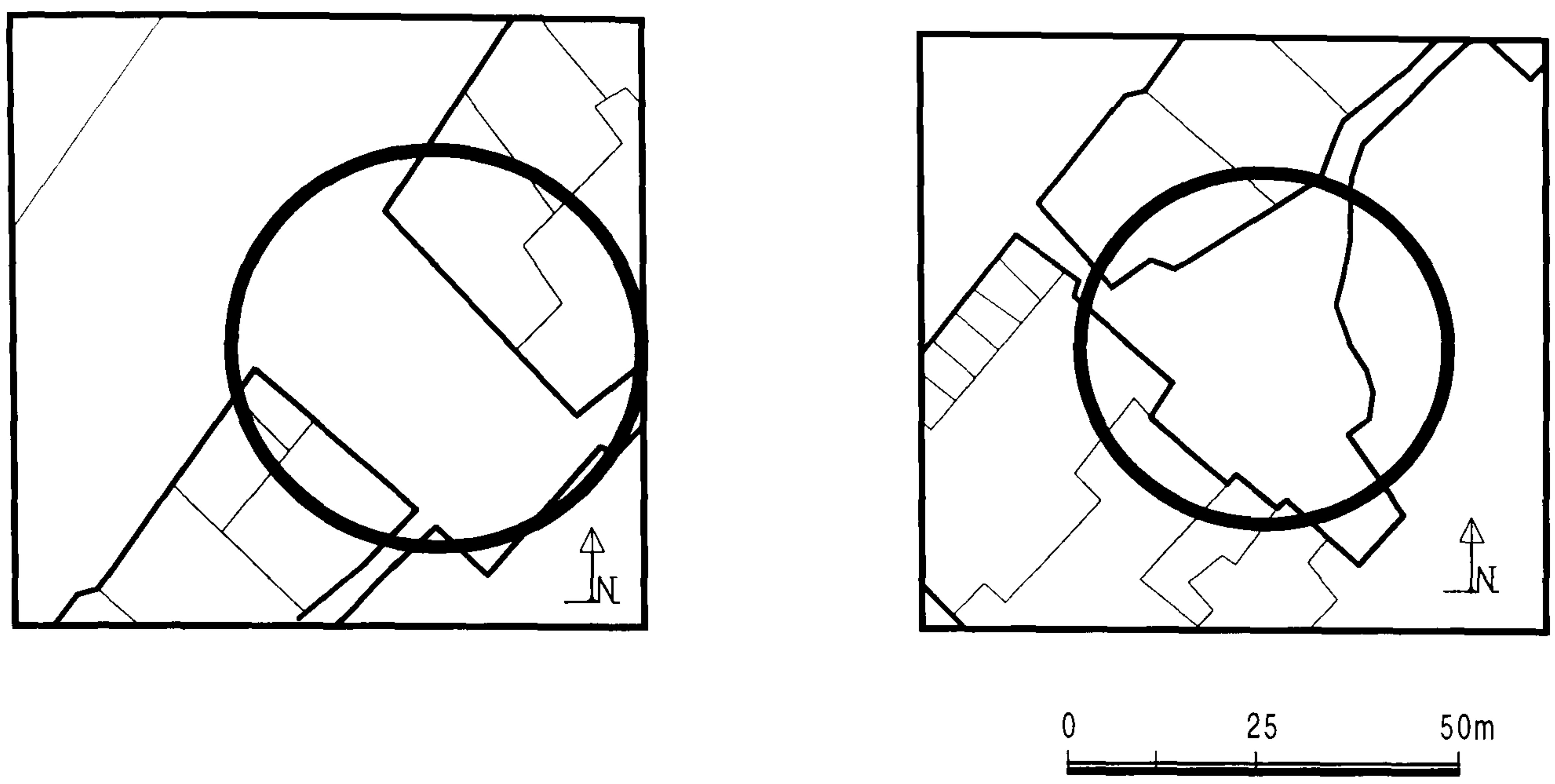


FIGURE 5.14 SOME PUBLIC OPEN SPACES OCCURRED IN FRONT OF RELIGIOUS BUILDINGS ACT AS A PRE-ENTRANCE TO THE BUILDING. THESE OPEN SPACES ARE USUALLY ACT AS A PART OF THE ALLEY SYSTEM

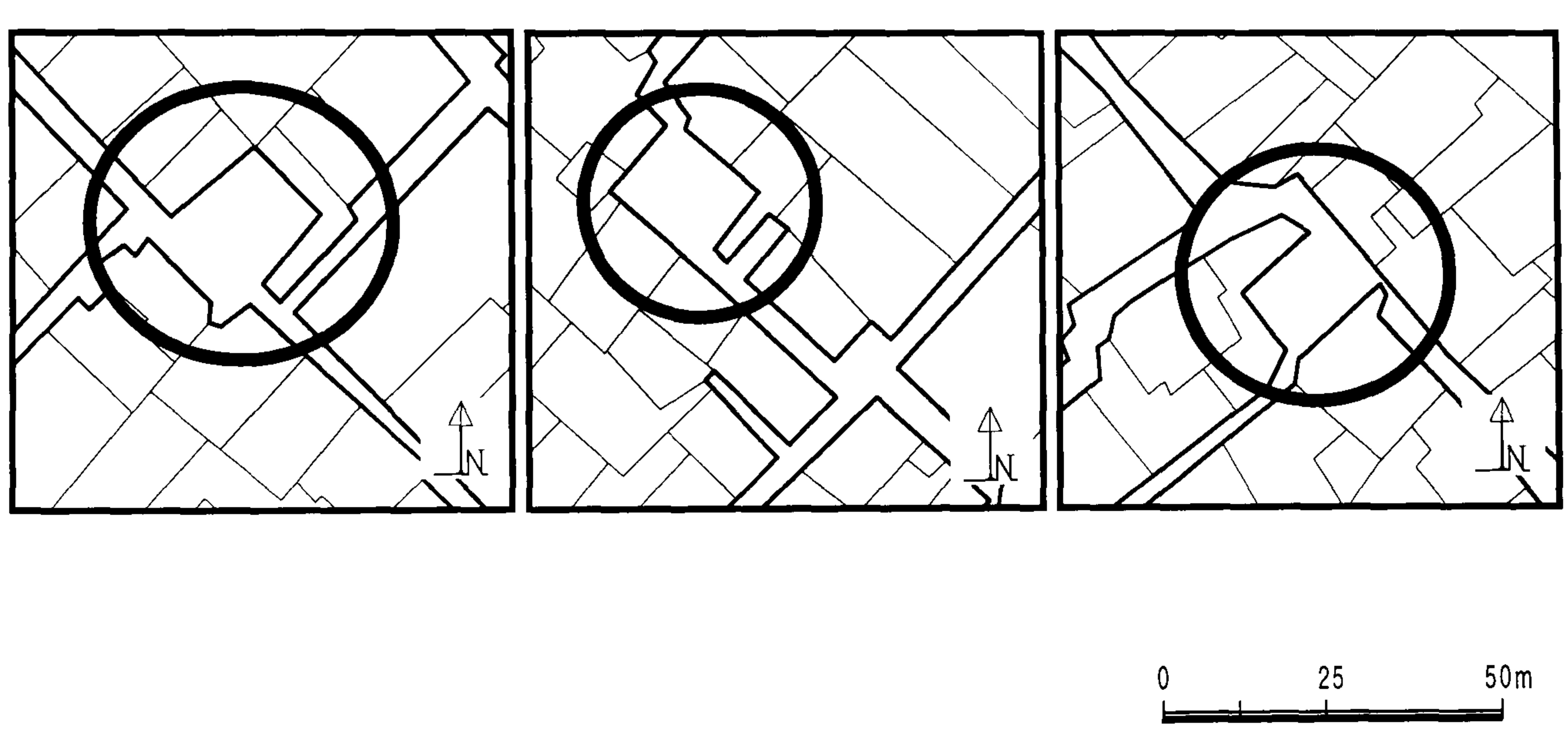


FIGURE 5.15: PUBLIC OPEN SPACES OCCUR IN DIFFERENT PART OF THE GODAL-E-MOSALLAH AREA. THEY HAVE NOT ONLY SOME RELIGIOUS FUNCTIONS, BUT ALSO ACTS AS A PART OF THOROUGHFARE SYSTEM. THESE OPEN SPACES ARE CALLED HOSSEINIAH OR TAKIYAH AND THEY ARE USUALLY PRE-PLANNED IN A REGULAR SHAPE WITH SOME TREATMENT ON THEIR FACADES.

FIGURE 5.16: THE ONLY EXAMPLE OF A PUBLIC OPEN SPACE IN THE AREA (KHAN SQUARE) WHICH IS COMPARATIVELY LARGER THAN THE OTHERS. THIS PUBLIC OPEN SPACE HAS A MULTIFUNCTIONAL AND FAIRLY IN REGULAR SHAPES. THERE ARE SEVERAL ALLEYS RUN FROM IT TOWARDS THE DIFFERENT PARTS OF THE GODAL-E-MOSALLAH AREA. THIS SQUARE ACT AS A FOCAL POINT IN THE GODAL-E-MOSALLAH AREA

5.2.3.2. BLOCKS

In the Godal-e-mosallah area blocks are mostly defined by encircling some major alleys and new streets. They consist of several hectares of land, with a minimum area of 8400 sq.m to a maximum of 61400 sq.m. A block in turn consists of various numbers of building groups. According to these considerations there are a total of 18 blocks in the study area in evidence, which are surrounded by thoroughfares and are mostly in their original condition (See Figure 5.17). In the Godal-e-mosallah area each block consists of one up to 15 building groups.

Through the establishment of commercial premises including Khan square and some other non-residential units like the Mosallah religious school (the entire block number 17 in Figure 5.17) the basic pattern of the old alley system was accordingly formed. Therefore it is obvious that the shape and form of the basic plan of the blocks in the Godal-e-mosallah area are have been influenced by the establishment of non-residential building.

By introducing a new street system the general form and shape of those blocks which were located in the vicinity of them has changed. These changes have happened in two ways. Firstly the blocks have been divided into two or more parts and the relationship between their elements has been disconnected, for example the relationship between the building groups and some facilities located within the block. Secondly, by the construction of new buildings alongside the newly constructed streets the overall shape of the block has changed in terms of function, building height. There is a fairly close link between presence of the new streets and commercial development alongside them and the change in building heights. Those new buildings which have been constructed at the edge of the new streets are mostly two storeys or even more.

FIGURE 5.17 ALL 18 BLOCKS IN THE GODAL-E-MOSALLAH AREA DEFINED BY NEW STREETS AND MAJOR ALLEY SYSTEM OR OLD STREETS

5.2.4. SUMMARY OF FINDINGS AT THE DISTRICT LEVEL

In the Godal-e-mosallah area, the basic morphology at district level may be summarised as follows:

1- New streets have changed the pattern of land use not only at the edges of the study area but also some changes are in evidence within the area.

2- Generally, the area is punctuated by two separate patterns of the street system. The first is a new street system, which now acts as the first or upper layer of the street system. The Second is the major alleys, which were part of the old street system in the area and acted as a subsidiary street network. The main city streets, which encircled the area, are comparatively wider than the major alleys with a range between 20 to 24 metres.

3- The internal parts of the district are defined by a hierarchy of major alleys, alleys and cul-de-sacs system remain from the past. This system was connected to its surrounding area through some major alleys.

4- The Khan square is identified as a focal point for distributing major alleys in contrast to that of the walled city where there was not such a formal open space on this scale in evidence.

5- In comparison to the Fahhadan area in the walled city the Godal-e-mosallah area initially follows the irregular pattern of alley system. However in the next developments the overall pattern will tend to follow a loosely gridiron system.

6- A mostly grid pattern of streets and major alleys is in evidence in the area and as a result fairly regular blocks are formed.

7- The blocks vary in shape, a factor which is obviously determined by the street pattern and the major alley system. In those parts of the district where non-residential activities are more in evidence, the blocks tend to be regular in shape

8- Construction of the bazaar and some other buildings like the Mosallah religious school, in addition to other public open spaces like Khan Square, may be considered as primary factors in the formation of the major alley system in the Godal-e-mosallah area.

9- The height of the blocks in the study area is fairly regular with an overall height being that of a single storey building. In those blocks which they are located at the edge of the study area, some high buildings are in evidence. Non-residential buildings are relatively higher than dwelling units.

5.3. THE BASIC PLAN FORM OF A BLOCK

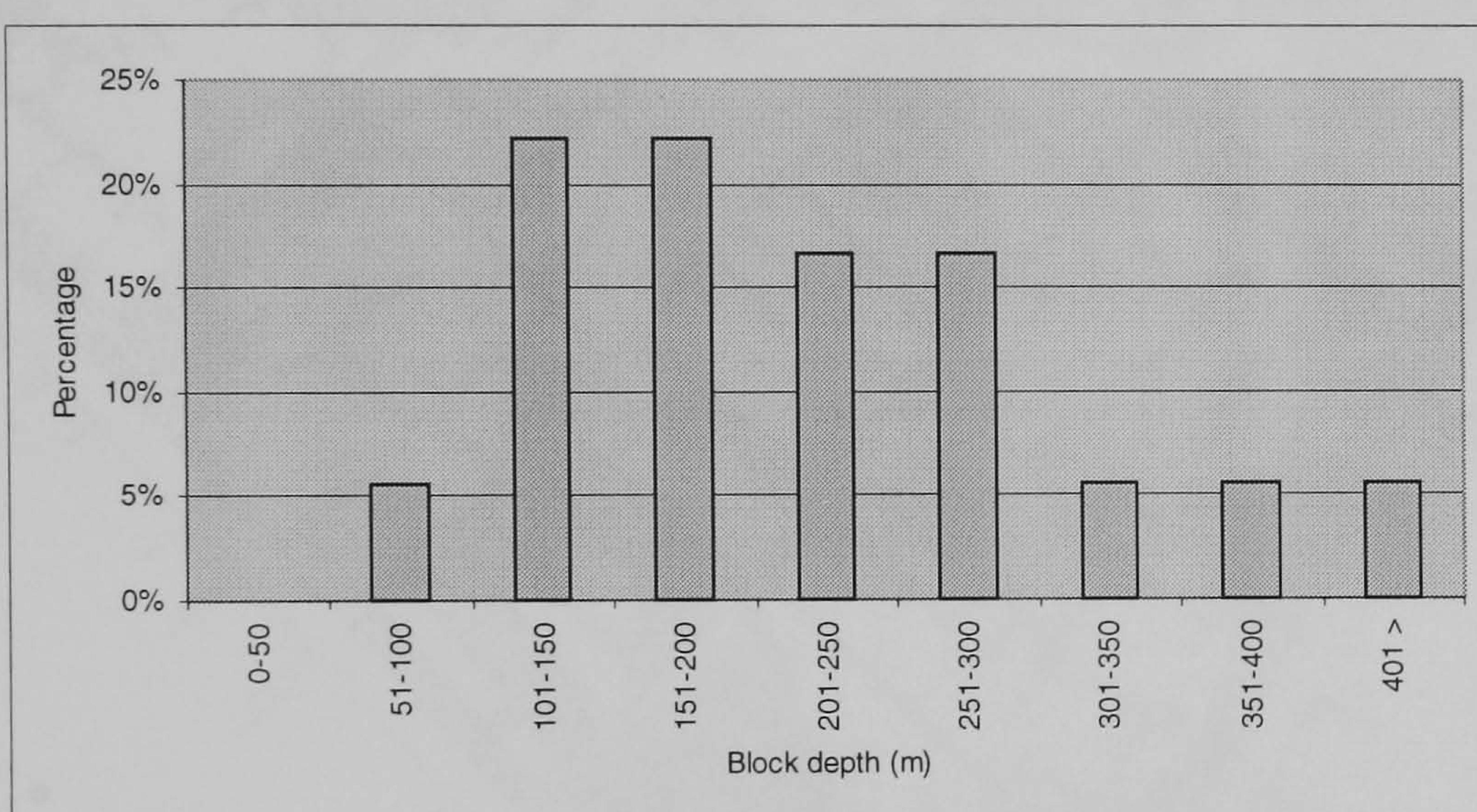
Attention is now turned to the study of the Godal-e-mosallah area at the block level of analysis. Blocks were generally explained at the district level. In this section blocks will be examined on both basic plan and open spaces occur in them, followed by some more concentration on the detailed characteristics of building groups which are in evidence within the blocks.

At the district level 18 blocks are identified as a piece of land surrounded by both the old and the new street systems. According to this definition the overall shape and size of the block in the study area is obviously linked to the street pattern in evidence. In this part of the research the basic plan form of blocks will be examined in some more detail.

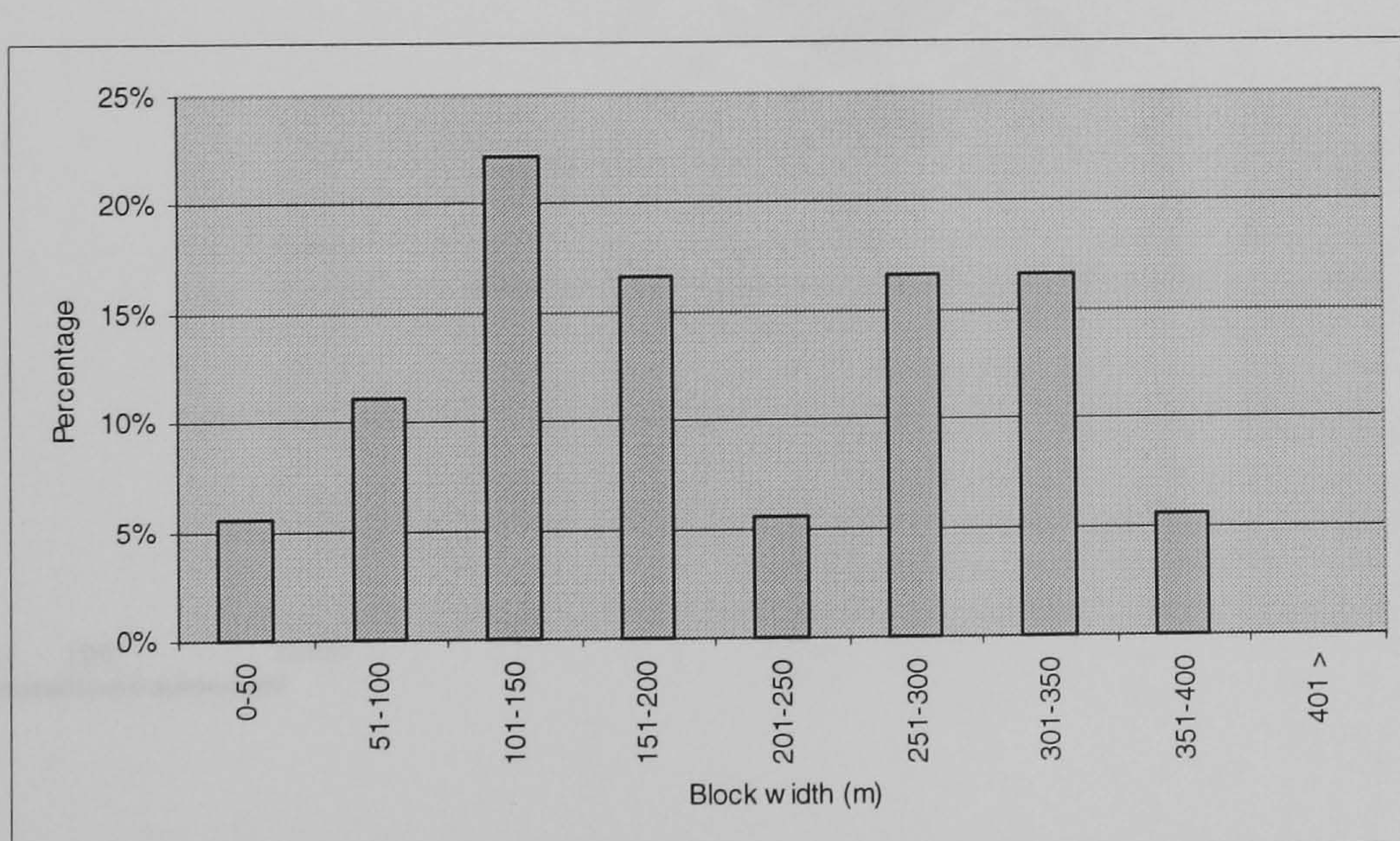
When all the blocks are considered, however, they vary in terms of functional type and spatial characteristics. In this way, blocks may be examined in terms of their basic plan, their three-dimensional form and their function. Blocks in the Godal-e-mosallah area are mostly in a fairly regular shape and in the form of a rectangle. Those blocks, which are located in the middle of the area, are much more regular than the others are. Although most blocks in the study area have a mixture of functions, the proportions of such functions vary. The blocks may be categorised into two basic types: those in which the residential use very much predominates and those where some other functions are present to a significant extent. There are 13 blocks where the great majority of land is in residential use. The remaining four blocks have a somewhat lower proportion of residential land and may thus be termed, by way of contrast, mixed-use groups (more than 2/3 of land allocated for non-residential units). From a functional point of view blocks considered as non-residential are much more regular in shape than the others. In this way, a relationship between the land use and the shape of the block may emerge (See Figures 5.18 and 5.19).

The blocks may also be examined in terms of their basic plan form and their three-dimensional characteristics. With regard to the plan form, a likeness may be found among most of the blocks located in the bazaar and to the south-west of the area. In these localities the blocks tend to be reasonably rectangular and possess fairly similar dimension in width (the north-west/south-east dimension), and a much broader range of dimensions in depth (the north-east/south-west dimension). However, the majority of the blocks 65 per cent, occur within a depth range of just 100 to 250 metres (See Graphs 5.1). Where the width of the all blocks is taken into account there is two range of block depth in evidence. About 40 per cent of blocks occur within the width range of 100 to 200 metres and 35 per cent between 250 to 350 (See Graphs 5.2).

From a historical point of view for some more detail analysis, three blocks in different part of the area has been selected. These blocks shaped in different stages of the development of the area shown in Figure 5.20. In this way they may be analysed in term of their built form and open spaces which occur in each block. The block is shown in Figure 5.21 was built during the 17th century in which there is a central open space in evidence. The overall form of the block is irregular in shape. In this block a combination of narrow and winding alleys and cul-de-sacs are in evidence. The second sample was developed during the 18th century in which the central open space is still in evidence, however the relation between this open space and the entire block is very weak comparatively in term of the connection of alleys and units with the open space. The block is fairly regular and is in rectangular shape (See Figure 5.22). The third selected block was developed in early 20th century. In this block a central open space is not in evidence. Even though the block is generally irregular however building groups appear in the block are regular in form (See Figure 5.23). In general blocks with more irregular shape are mostly located to the north and eastern part of the study area, where the developments belong to 16th to 18th centuries are in evidence.



GRAPH 5.1: VARIATION OF BLOCK DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 18 BLOCKS IN THE GODAL-E-MOSALLAH AREA



GRAPH 5.2: VARIATION OF BLOCK WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 18 BLOCKS IN THE GODAL-E-MOSALLAH AREA

FIGURE 5.18: DISTRIBUTION OF NON-RESIDENTIAL LAND USE IN THE GODAL-E-MOSALLAH AREA

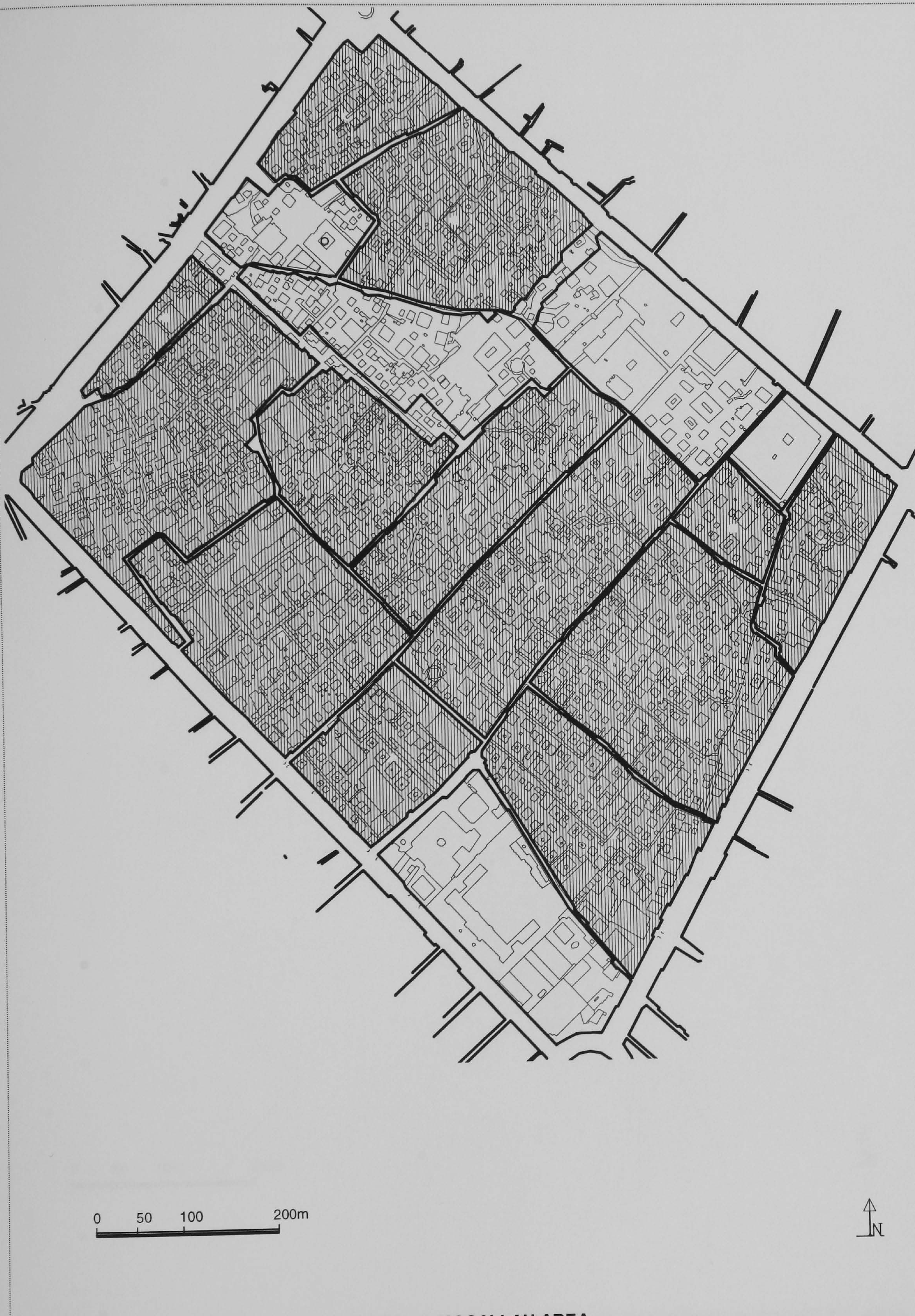


FIGURE 5.19: RESIDENTIAL BLOCKS IN GODAL-E-MOSALLAH AREA

FIGURE 5.20: DIFFERENT STAGES OF BLOCK'S DEVELOPMENT IN THE GODAL-E-MOSALLAH AREA. 1-DEVELOPMENT DURING THE 15TH CENTURY AROUND AMIRCHAGHMAQ SQUARE 2-DEVELOPMENT DURING THE 17TH AND THE 18TH CENTURIES AROUND SHAHTAHMASB SQUARE 3-DEVELOPMENT AROUND THE KHAN SQUARE AND THE BAZAAR DURING THE LATE 18TH AND 19TH CENTURIES 4-DEVELOPMENT DURING THE LATE 19TH CENTURY AND BEGINNING OF 20TH CENTURY

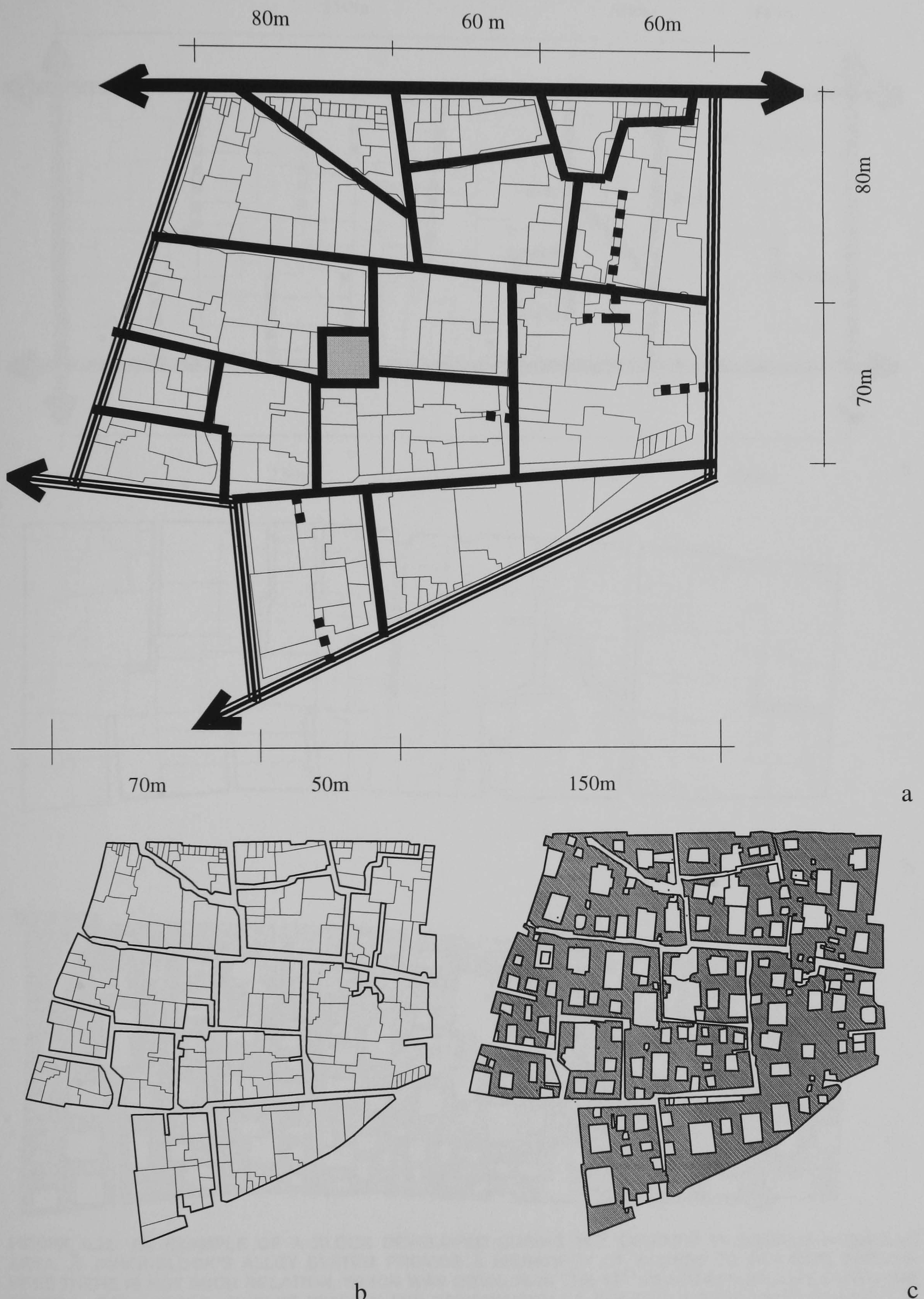


FIGURE 5.21: AN EXAMPLE OF A BLOCK DEVELOPED DURING 18TH CENTURY IN GODAL-E-MOSALLAH AREA. A- INNER-BLOCK'S ALLEY SYSTEM PROVIDES A HIERARCHY OF ACCESS TO BUILDING GROUPS IN CONJUGATION WITH THE CENTRAL OPEN SPACE. B- PLOT DIVISION AND COMBINATION OF BUILDING GROUPS INTO BLOCKS. C- PRIVATE OPEN SPACES OCCURRED WITHIN THE BUILT FORM IN VARIETY OF SIZE. IN THIS PLAN SOME COVERED ALLEYS ARE IN EVIDENCE

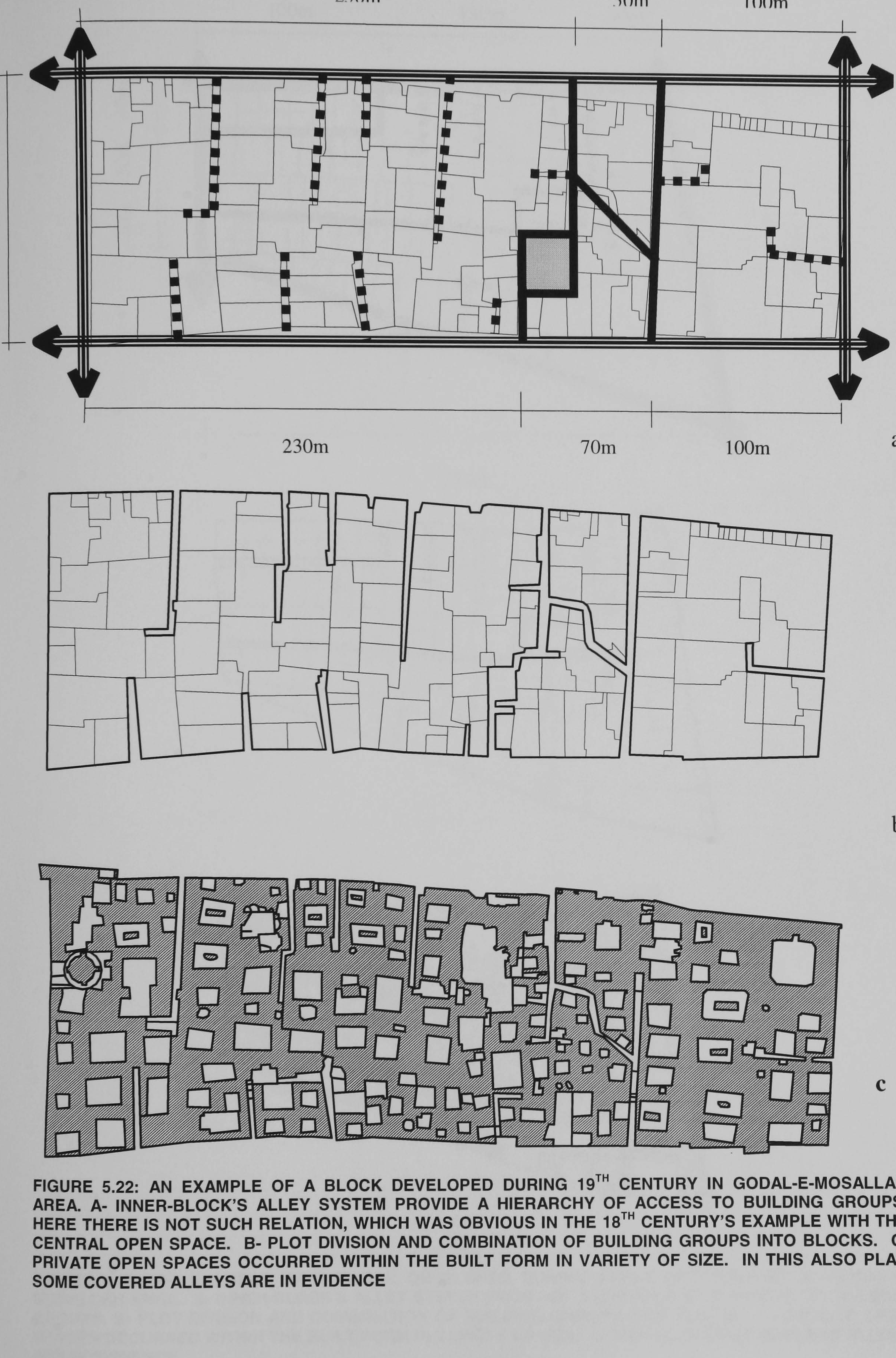


FIGURE 5.22: AN EXAMPLE OF A BLOCK DEVELOPED DURING 19TH CENTURY IN GODAL-E-MOSALLAH AREA. A- INNER-BLOCK'S ALLEY SYSTEM PROVIDE A HIERARCHY OF ACCESS TO BUILDING GROUPS. HERE THERE IS NOT SUCH RELATION, WHICH WAS OBVIOUS IN THE 18TH CENTURY'S EXAMPLE WITH THE CENTRAL OPEN SPACE. B- PLOT DIVISION AND COMBINATION OF BUILDING GROUPS INTO BLOCKS. C- PRIVATE OPEN SPACES OCCURRED WITHIN THE BUILT FORM IN VARIETY OF SIZE. IN THIS ALSO PLAN SOME COVERED ALLEYS ARE IN EVIDENCE

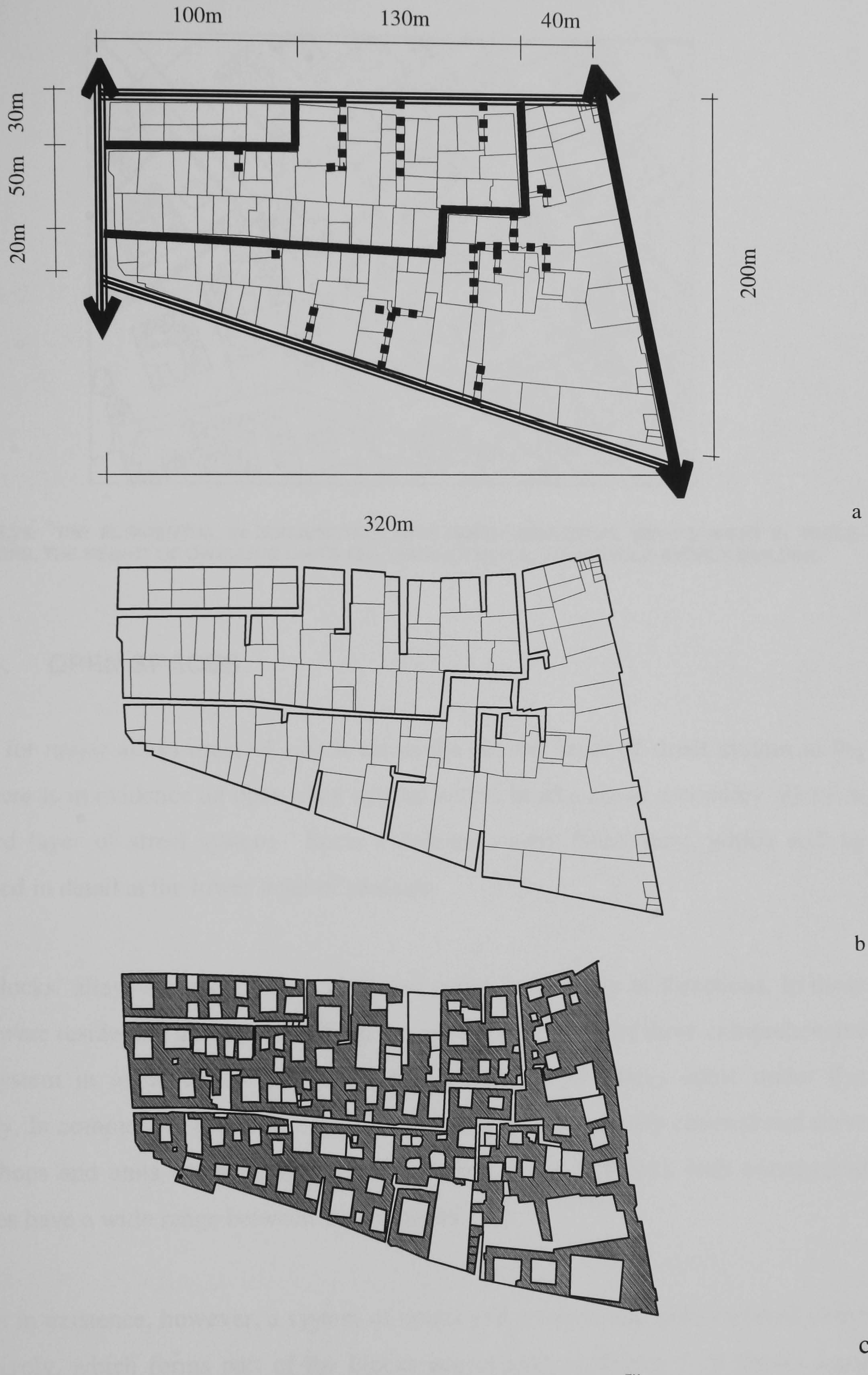


FIGURE 5.23: AN EXAMPLE OF A BLOCK DEVELOPED DURING EARLY 20TH CENTURY IN GODAL-E-MOSALLAH AREA. A- INNER-BLOCK'S ALLEY SYSTEM PROVIDES A HIERARCHY OF ACCESS TO BUILDING GROUPS. B- PLOT DIVISION AND COMBINATION OF BUILDING GROUPS INTO BLOCKS. C- PRIVATE OPEN SPACES OCCURRED WITHIN THE BUILT FORM IN VARIETY OF SIZE. IN THIS PLAN SOME COVERED ALLEYS ARE IN EVIDENCE

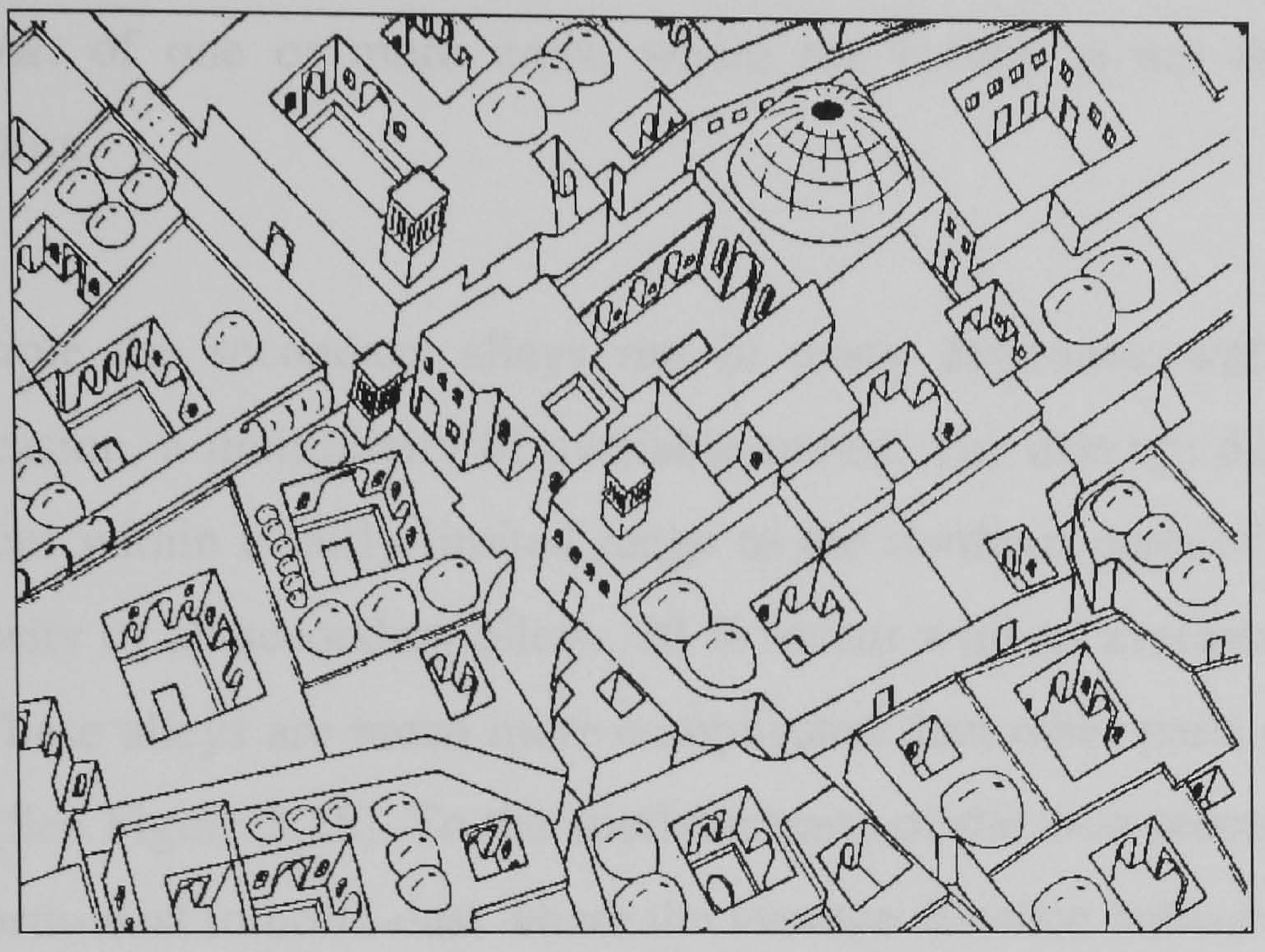


FIGURE 5.24: THE RESIDENTIAL IN CONJUNCTION WITH NONE-RESIDENTIAL ENVIRONMENT IN THREE-DIMENSIONS. THE HEIGHT OF DWELLING UNITS ARE USUALLY EQUAL TO A SINGLE STOREY BUILDING

5.3.1.1. OPEN SPACES

Except for major alleys most of which act as the second layer of street system in the area, there is in evidence an open alley system within blocks act as secondary alleys or the third layer of street system. Some cul-de-sacs stem from them, which will be examined in detail at the lower level of analysis.

Inner-blocks' alleys are open to the public and occur in a variety of directions. In those blocks were residential use predominant there appear to be a rather more comprehensive alley system in evidence. In the commercial portion most alleys come under this category. In commercial area of Godal-e-mosallah, alleys are mostly covered and serve those shops and units occur alongside them. Alleys occur in blocks with commercial activities have a wide range between 3 to 6 meters.

There is in existence, however, a system of opens and covered and semi-covered alleys successively, which forms part of the blocks access system. Figure 5.26 shows some example of the covered alleys and routes within the blocks. A significant difference between the secondary alley and some of the covered cul-de-sacs is that the latter usually form part of one or more units, where the former is not the part of any significant building.

Taken as a whole the secondary alleys run in many directions within blocks and provide, on occasion, a multiplicity of available routes. The average distance between breakpoints occur within a fairly limited range to the northern parts of the study area where the majority of all secondary alleys, 90 %, occur with an average distance of 35 to 50 metres. These alleys are much more complicated than other parts of the Godal-e-mosallah area (See Figure 5.25). To the southern parts of the area secondary alleys run mostly from north-west to north-east where the average distance between them is much more than the northern parts and it varies between 50 and 300 metres.

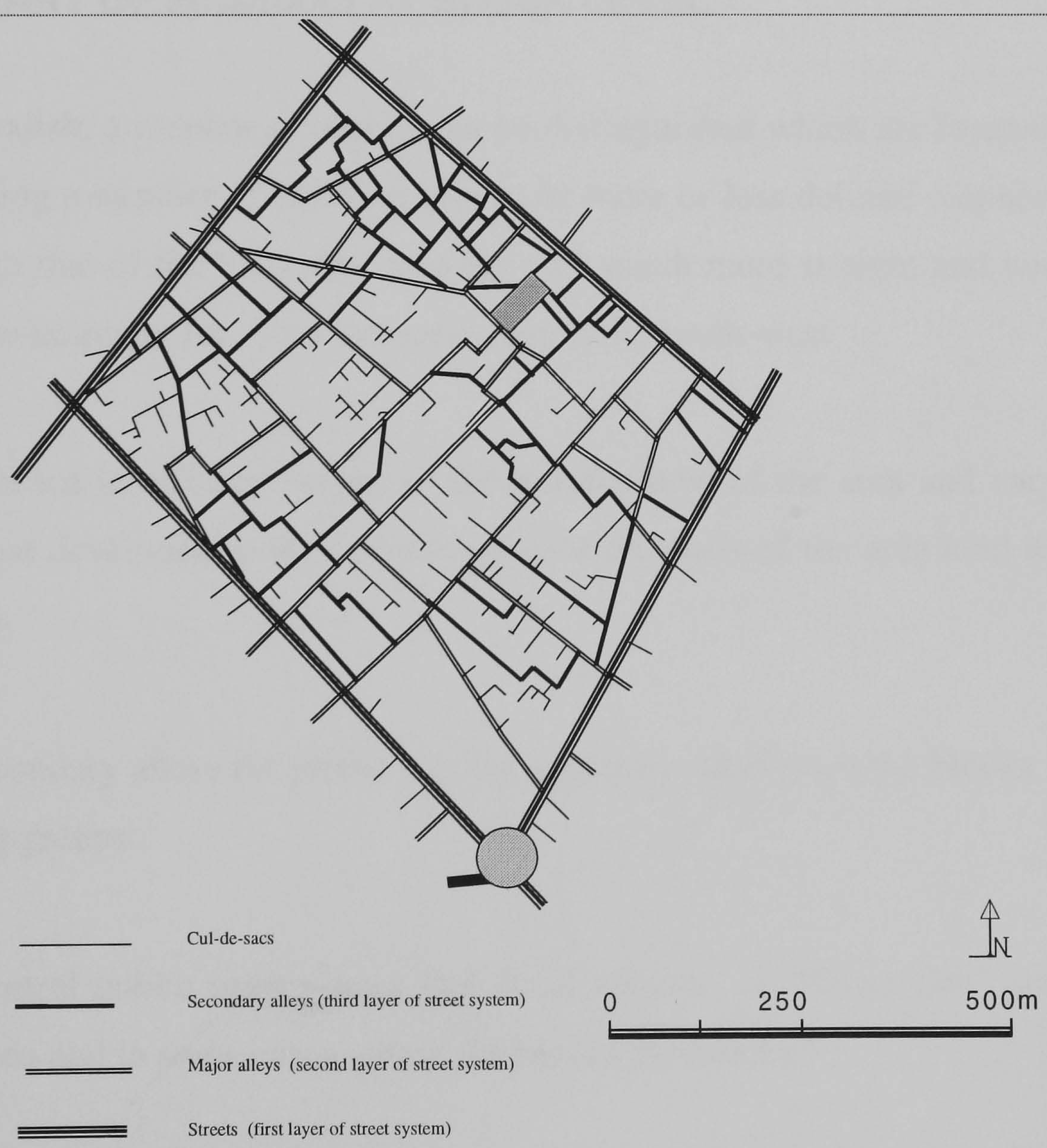


FIGURE 5.25: DISTRIBUTION OF SECONDARY ALLEY SYSTEM IN THE GODAL-E-MOSALLAH AREA

FIGURE 5.26: SOME EXAMPLES OF SECONDARY ALLEYS OCCUR IN DIFFERENT PARTS OF THE GODAL-E-MOSALLAH AREA

5.3.2. SUMMARY OF FINDINGS AT BLOCK LEVEL

1- In Godal-e-mosallah, a number of blocks can be distinguished which are formed by alleys surrounding a number of building groups in more or less defined manner. In comparison with that of the Fahhadan area they are much more straight and wider. These alleys are basically run from the north-east to the south-west

2- Blocks were formed in different stages of the development of the area and vary in shape. Those that developed to the central and southern parts of the area tend to be regular in shape.

3- A system of secondary alleys for public use has generally subdivided the blocks into several building groups.

4- A system of central public open spaces like small squares, or 'Hosseinieh', are in evidence between and in some cases within the blocks the blocks.

5.4. THE BASIC PLAN FORM OF BUILDING GROUP

At the block level of analysis it was clearly found that blocks in turn are broken into several components by the secondary alleys which may call building groups. Each building group consists of several building units in diversity of function, size and shape.

There are a total of 91 building groups (See Figure 5.27) (See Appendix 2) in the area accommodated in 18 blocks and surrounded by thoroughfares of various sorts. Where the maximum number of building groups in a block is 15, the minimum is one and an average of five building groups are combined together to form a block.

Although most groups in the study area have a mixture of functions, the proportions of such functions vary. When all the groups are considered, however, they do differ in terms of functional type and spatial characteristics, which 58 are residential (more than 2/3 of land allocated for non-residential units) (See Figure 5.28) and remaining 33 are considered as non-residential. In terms of the percentage of the total area of each building groups in residential use, 31 building groups have between 80 and 100 per cent, 12 building groups have between 60 and 80 per cent, 15 building groups between 60 and 40 per cent, 10 building groups have between 40 and 20 per cent and finally 23 building groups have between 20 and 0 percent. The average number of units in all groups is about 25 units. Some groups are completely in use by non-residential activities.

5.4.1.1. BUILT FORMS

The built form of building groups consists of combination of building units, largely with number of units which are mostly defined with a rectangular courtyard (See Figures 5.29 and 5.30). The groups are very substantially varied in size and shape as might be expected from the nature of the thoroughfares surrounding them and units are allocated in them. There appears to be a predominating system of location such as major alleys and direction of building unit generally being in a north-east to south-west direction.

The proportion of built space in a group varies markedly with an average of 63% of total group area.

The groups may also be examined in terms of their basic plan. With regard to the plan form. a likeness may be found among most of the groups located in the bazaar and to the south of the area. In these localities the groups tend to be reasonably rectangular and possess fairly similar dimensions in width (north-west/south-east dimension), and a much broader range of dimensions in depth (the north-east/south-west dimension).

When all groups are considered, the majority of them, 53 per cent, occur within a depth range of just 31 to 90 metres (See Graph 5.3). While the largest proportion of none residential groups 58 per cent have a depth range of less than 60 metres, (See Graph 5.6) the largest proportion of the residential groups have a depth range of less than 90 metres (See Graph 5.8).

When the width of all groups in the district is taken into account, a rather wide spread of dimension is in evidence (See Graph 5.4). Although around, 67 per cent of the groups occur within the range of less than 90 metres, 52 per cent of residential groups have wide ranges of from 30 to 90 metres (See Graph 5.7). The non-residential groups are in general a little shorter than the residential groups (See Graph 5.5).

The different range of variations in all 91 building groups in comparison with that of residential and non-residential units In the Godal-e-mosallah area are shown in Graphs 5.9 and 5.10.

In some groups all the units have direct access to the major and secondary alleys, where as in others the cul-de-sacs provide a significant proportion of the access points. However, it appears that the building plots are still basically irregular shapes in the north of the study area with a trend toward a rectangular shape in the southern part of Godal-e-mosallah.

Buildings are generally linked together somehow similar to the Fahhadan area in the walled city, however in those parts where they are more regular, they are linked together with the longer sides of the plot. This arrangement is in evidence in southern part of the area. A substantial variation seems to occur in size of plots, even in a single group. The average plot area is around 247 metres for whole area and 300 for residential units. This average is 196.5 metres for none-residential units and 86.3 metres for only shops.

At the group level, the basic three-dimensional form of the groups is related somehow to its function. For example those groups consist of some non-residential units, such as mosque or religious buildings, are higher than dwelling groups. This is also very obvious in those groups where some new land use such as private or public offices or even new commercial complex, is introduced. Almost 63 per cent of the building in the district are equal to or less than two-storey in height while only 10.5 per cent are more than two-storey and only 48 buildings are in evidence with three storeys or more. Groups including more than two storeys are generally allocated alongside the new streets.

When stages of the developments are considered, groups with more irregular shape are mostly located in the developed area belong to 16th to 18th centuries. Regardless of non-residential groups which are fairly regular in basic plan shape, groups developed in late 19th and beginning of 20th are comparatively more regular than those areas which were developed before.

FIGURE 5.27: ALL 91 BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA SURROUNDED BY THOROUGHFARES OF VARIOUS SORTS

FIGURE 5.28: RESIDENTIAL BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA (SHOWN BY A DARK TEXTURE)

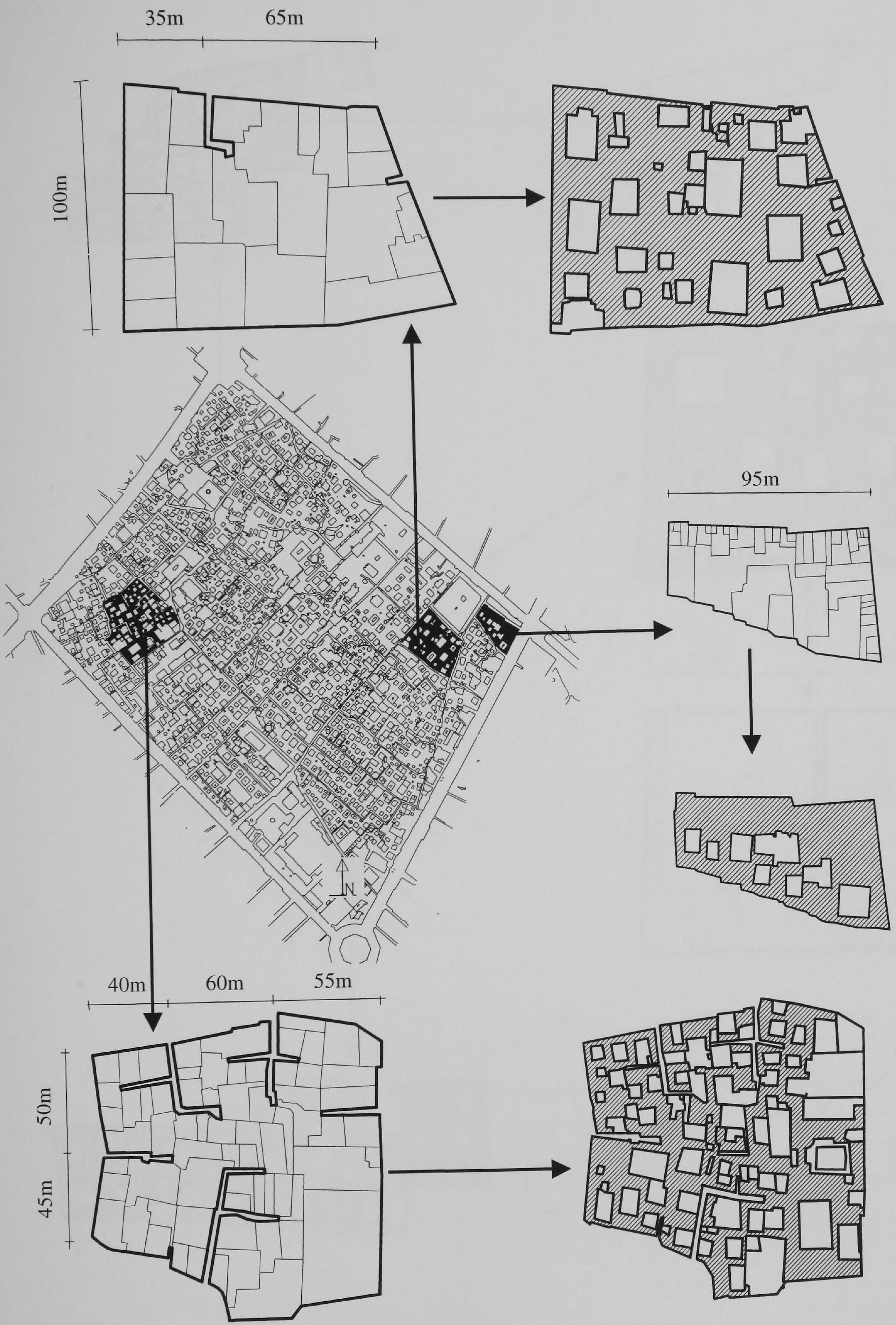


FIGURE 5.29: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)

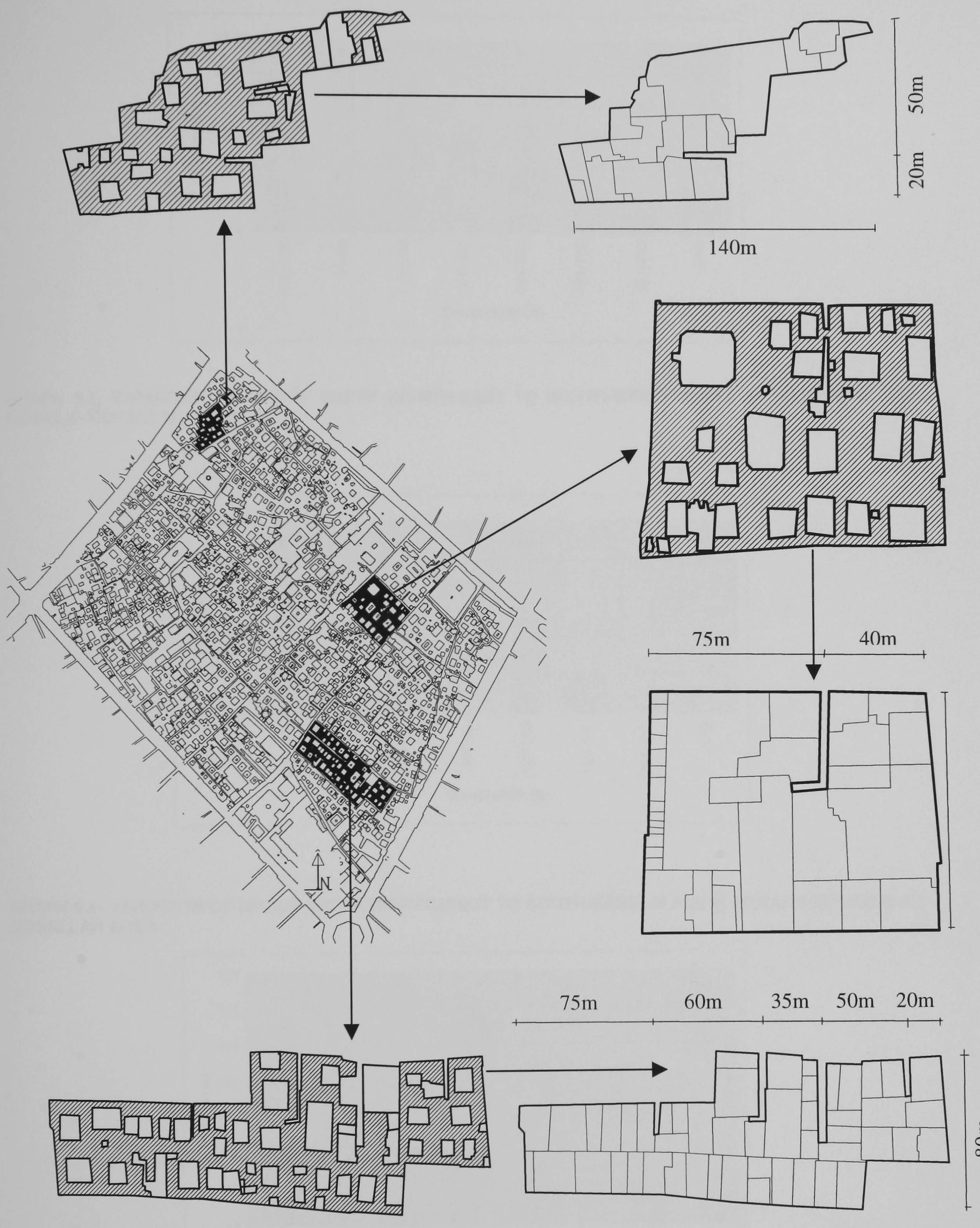
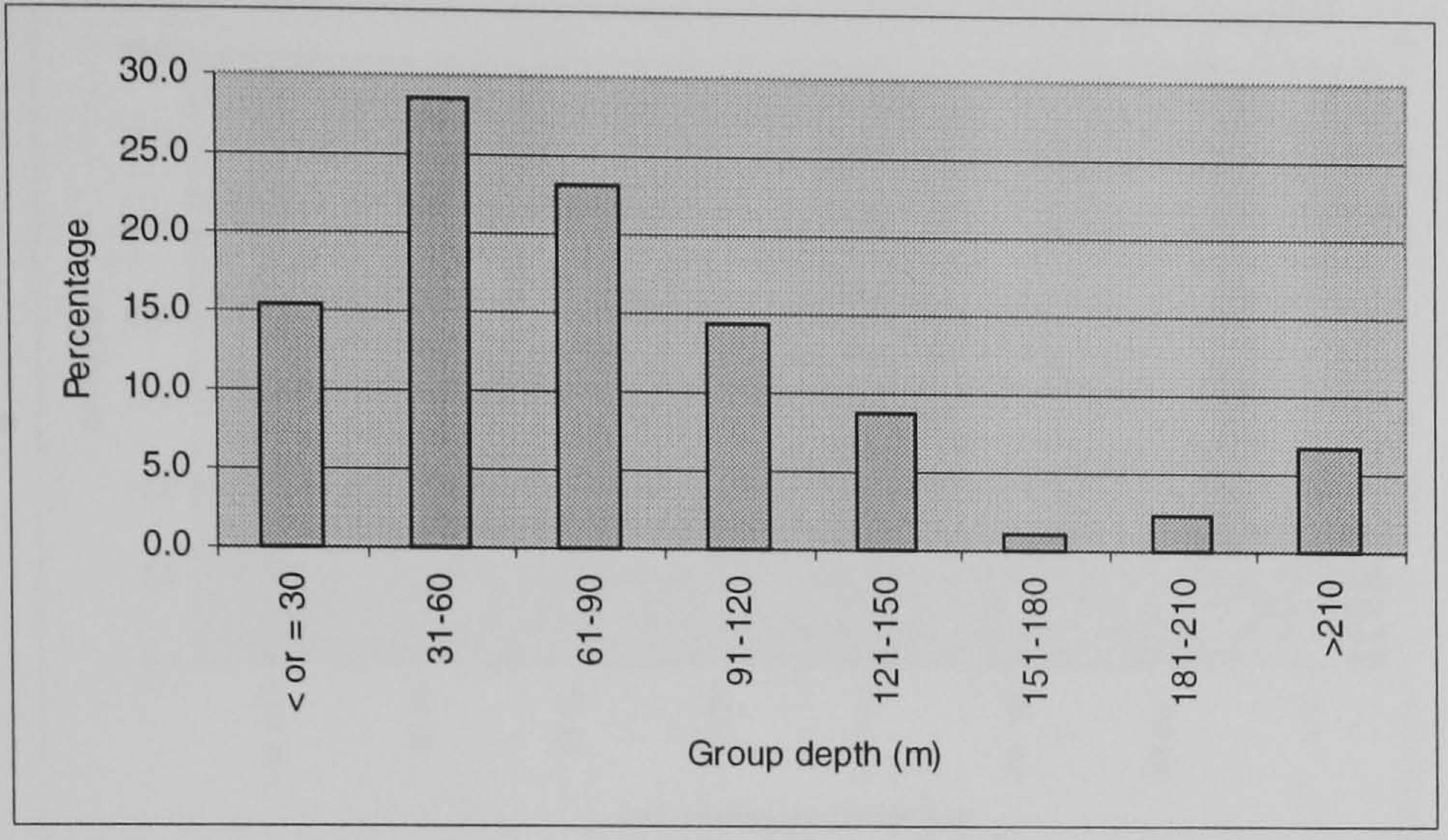
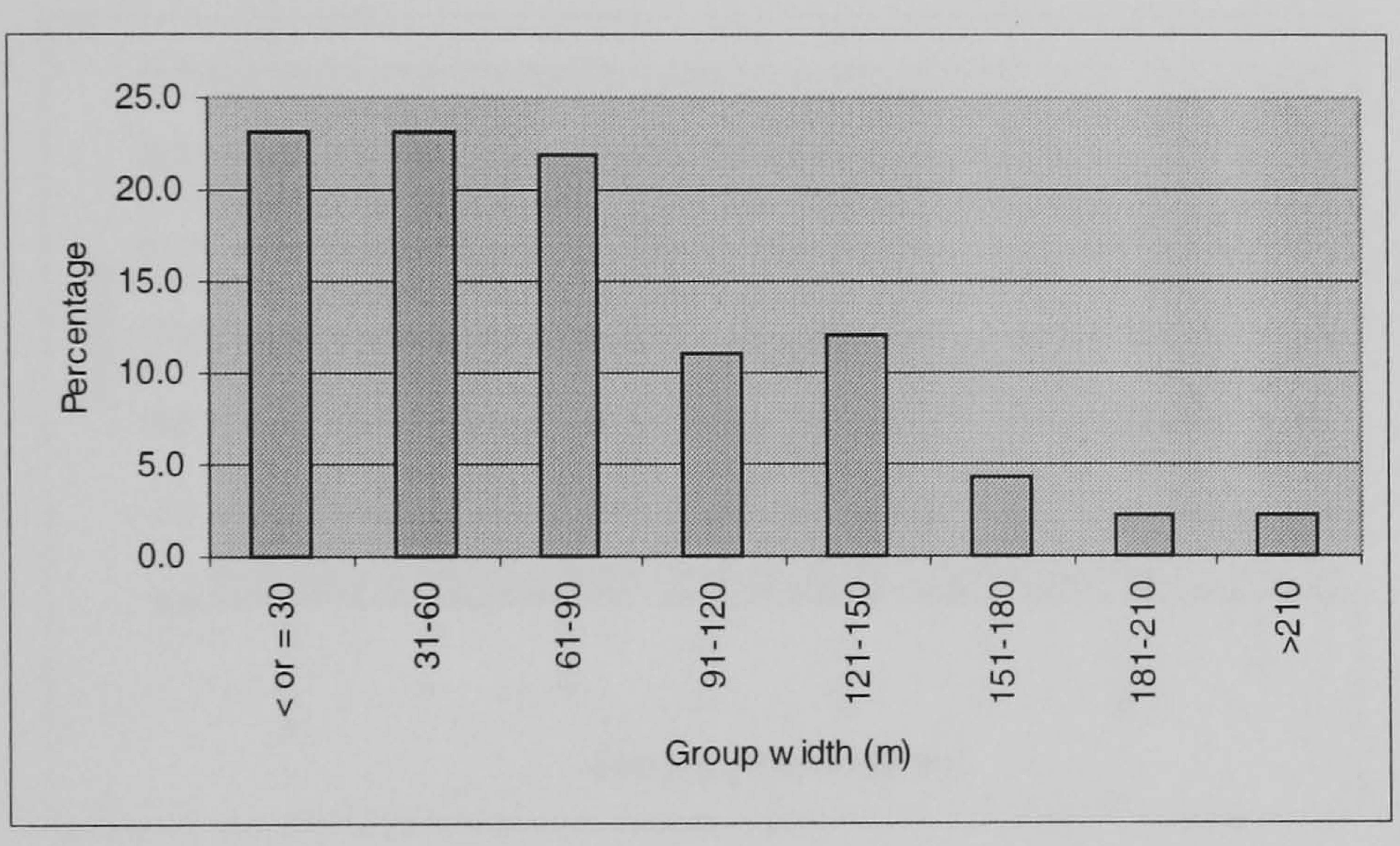


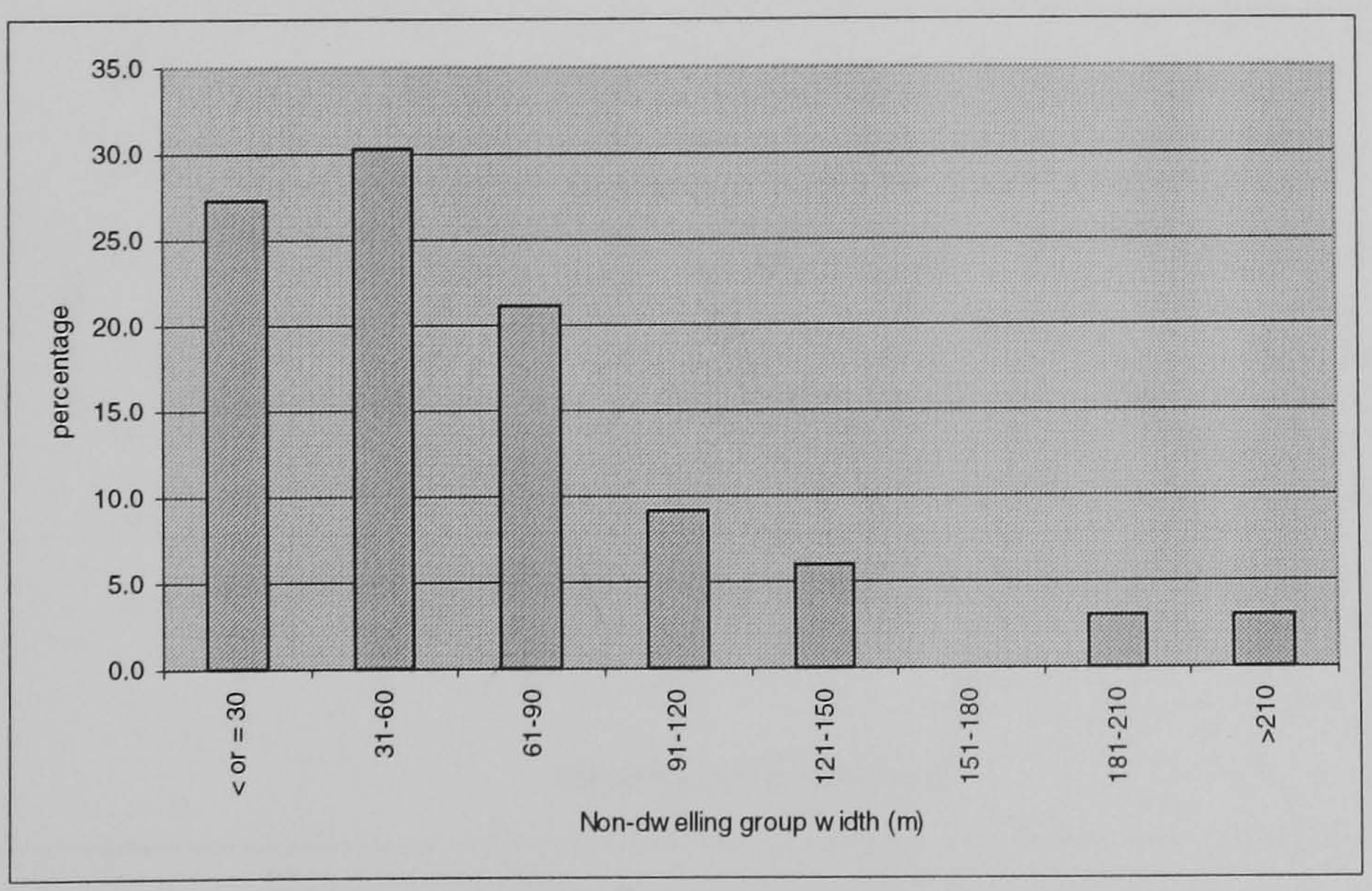
FIGURE 5.30: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)



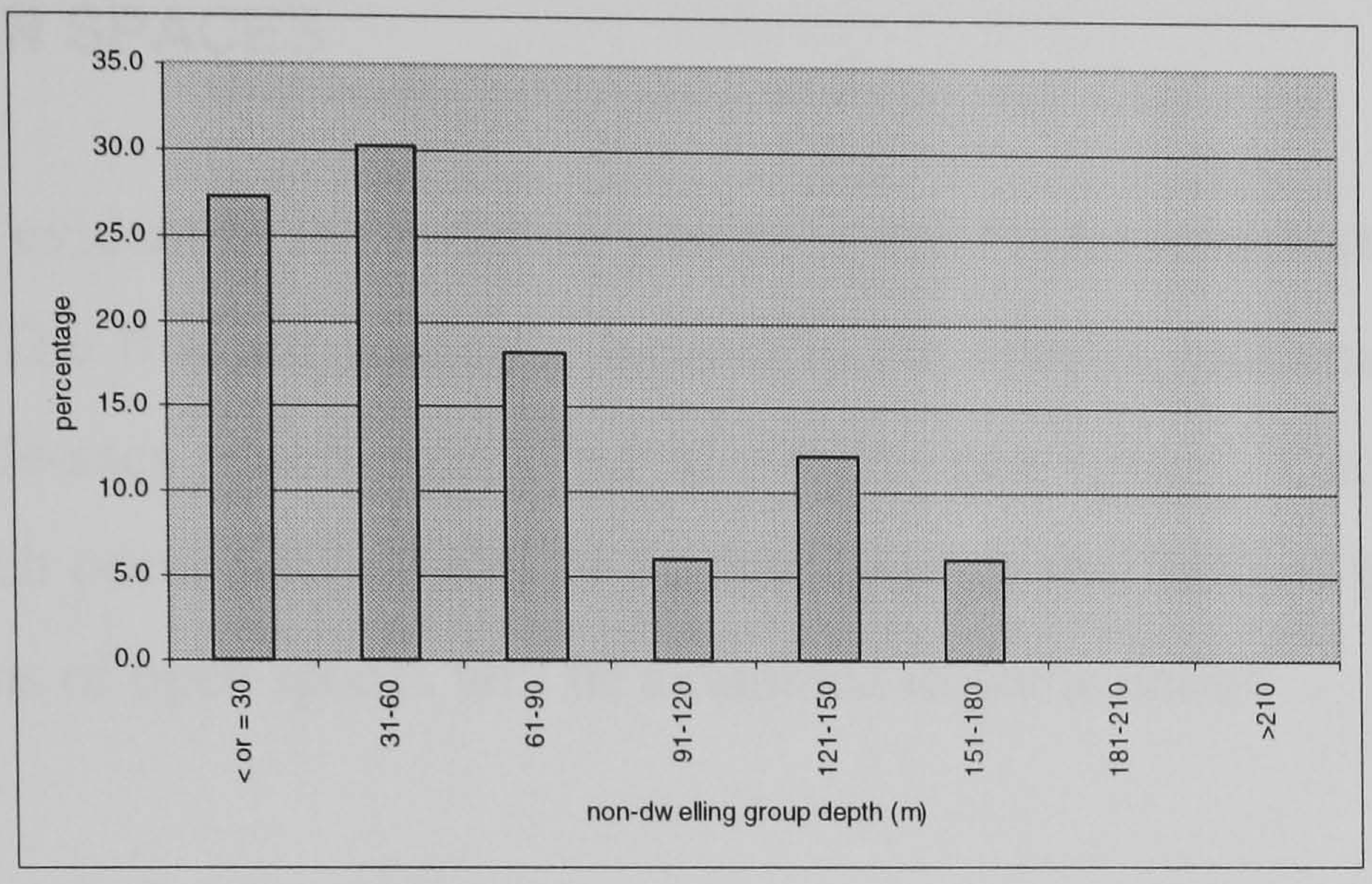
GRAPH 5.3: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 91 GROUPS IN THE GODAL-E-MOSALLAH AREA



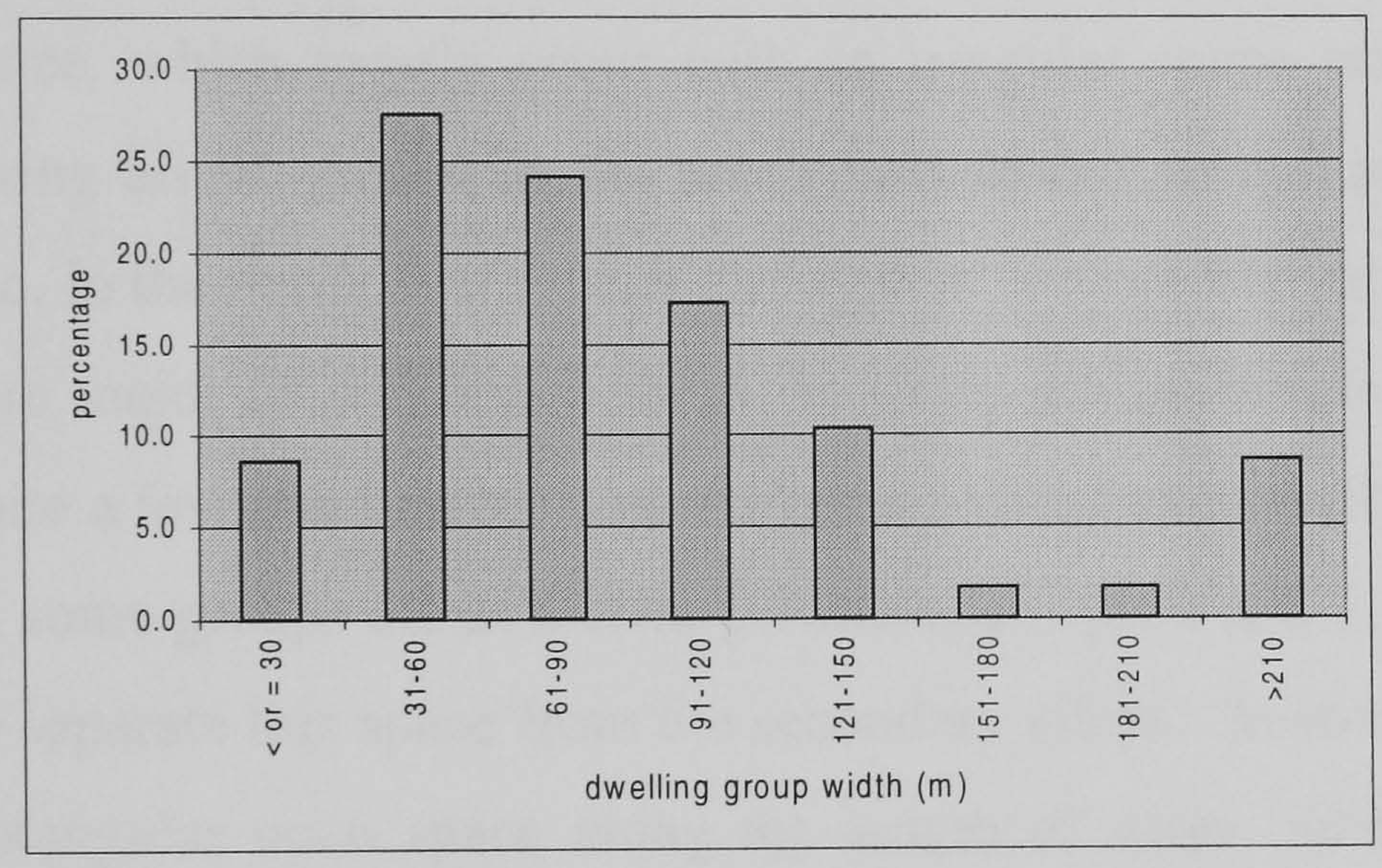
GRAPH 5.4: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 91 GROUPS IN GODAL-E-MOSALLAH AREA



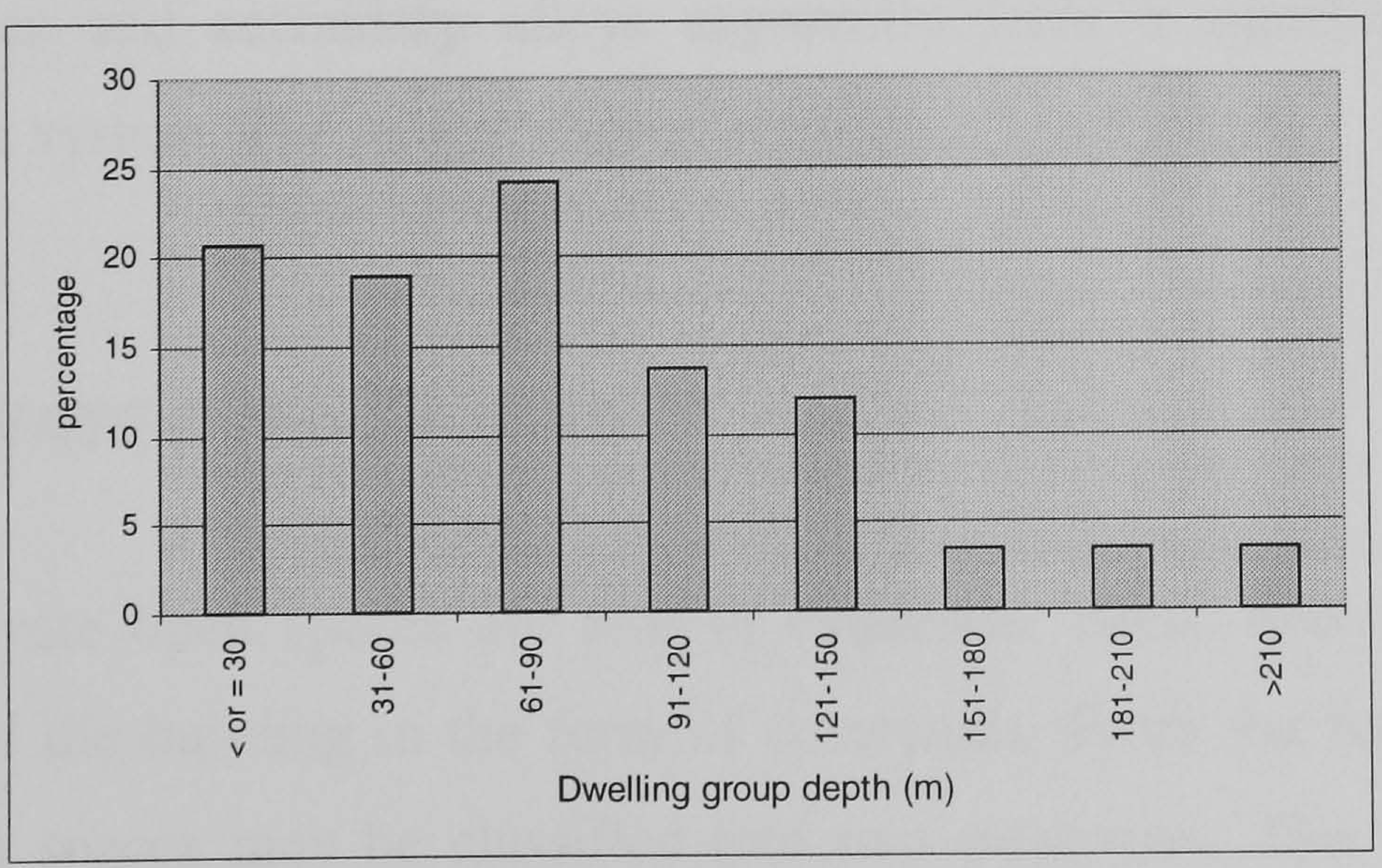
GRAPH 5.5: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN 33 NON-DWELLING GROUPS IN GODAL-E-MOSALLAH AREA



GRAPH 5.6: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN 33 NONE-DWELLING GROUPS IN GODAL-E-MOSALLAH AREA



GRAPH 5.7 : VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 58 DWELLING GROUPS IN GODAL-E-MOSALLAH AREA



GRAPH 5.8: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 58 DWELLING GROUPS IN GODAL-E-MOSALLAH AREA

5.4.1.2. OPEN SPACES

The open spaces evident in the building groups in the Godal-e-mosallah area appear to take two forms. The first are generally located in the interior sections of the groups in the form of cul-de-sacs which mostly act as public open spaces. The second are those open spaces which occur within plots of the buildings in the form of courtyards. In this section both forms of open spaces will be examined in some detail.

5.4.1.2.1. PUBLIC OPEN SPACES

As in the walled city, there is in the Godal-e-mosallah district a pattern of cul-de-sacs system in existence, which mostly occur with an irregular shape within the building groups. Considering all 91 groups in the area, most of the groups have some sort of private cul-de-sac. In the residential groups this system is more in evidence. Cul-de-sacs usually stem from major or secondary alleys. In those groups where they occur, they give access to quite a few building units (See Figure 5.31). Functionally these categories of open space in some groups act as a semi-private open space and in some cases there is even a door to separate this space from the secondary alleys. In some cases there is a polygonal or rectangular open space along the length of some cul-de-sacs. They are occasionally covered in some portion (See Plate 5.4). The length and number of these open spaces has a direct relation with depth, area and number of units in each group. These cul-de-sacs and secondary alleys apparently form a significant part of the pedestrian access system. The width range is between 2.5 to 5 metre.

5.4.1.2.2. PRIVATE OPEN SPACES

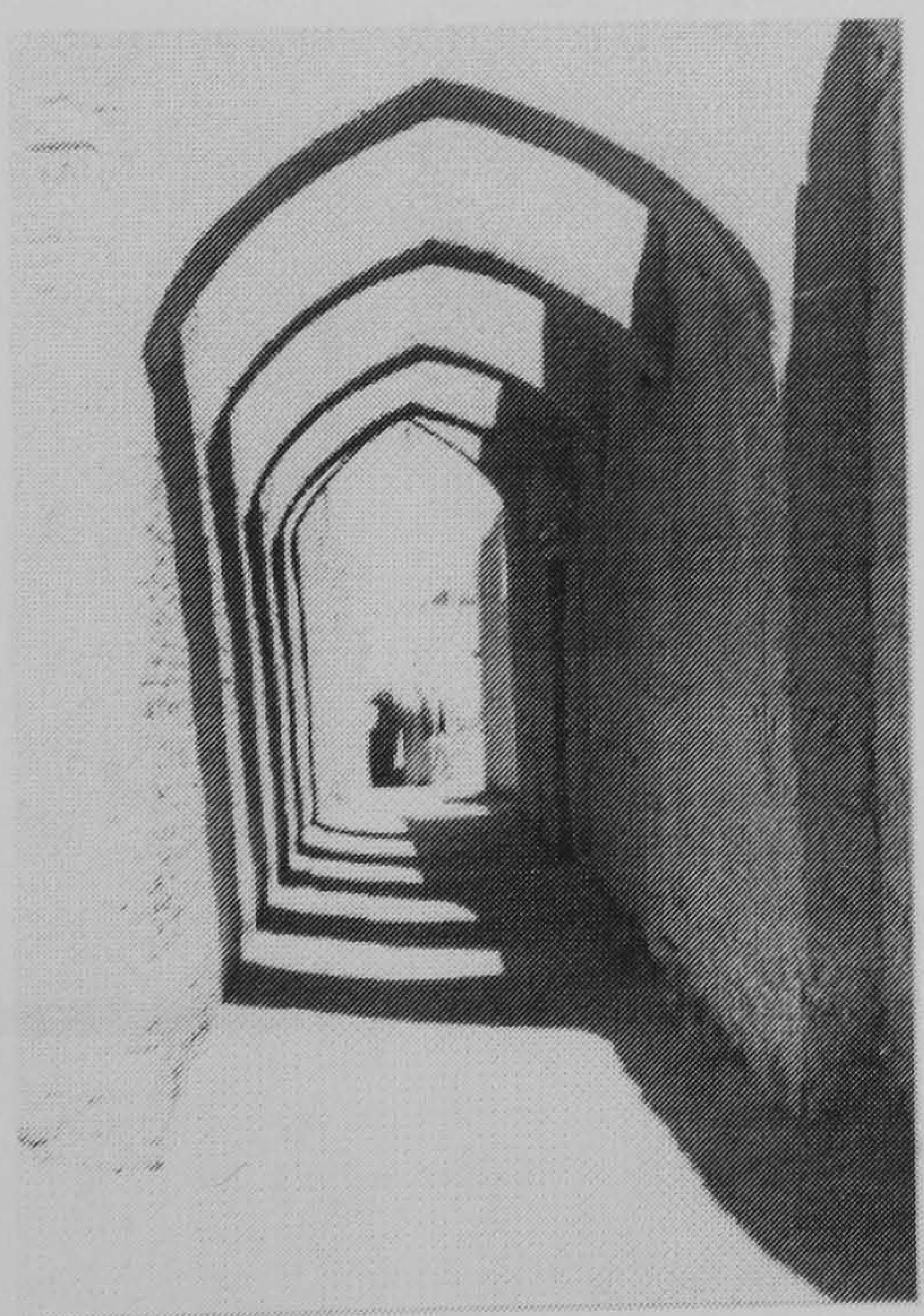
A series of private open spaces are also in existence. These open spaces occur in different plots of the building in the form of courtyards. From the functional point of view these open spaces may be classified into two categories. The first is relatively small open spaces which act as central courtyards for dwelling units. The second occur within the non-residential buildings.

Open spaces occur in dwelling units which are bounded by buildings on all four sides. These open spaces are generally oriented in the same direction. They are mostly of square or rectangular shape. If they are rectangular in shape, the longer length is oriented in the north-east to south-west direction.

The second category of private open spaces acts as a large courtyard for religious, educational and some commercial activities. Those open spaces, which occur within religious buildings, are mostly open to the public, however, they are properly defined by gates.

Viewed as a whole the above classifications of open spaces vary markedly in size. In dwelling units the depth (north-east to south-west) range is between 4 and 22 metres. This range in non-residential buildings varies between 8 to 90 meters. When the width (north-west to south-east) direction is considered, in dwelling units this range varies between 4 to 16 and in non-residential buildings 8 to 65 metres.

Some private open spaces which occur in the study are large and irregular in shape. These open spaces are in evidence in the southern part of Godal-e-mosallah. In this case buildings are bounded by open spaces (See Figure 5.32).



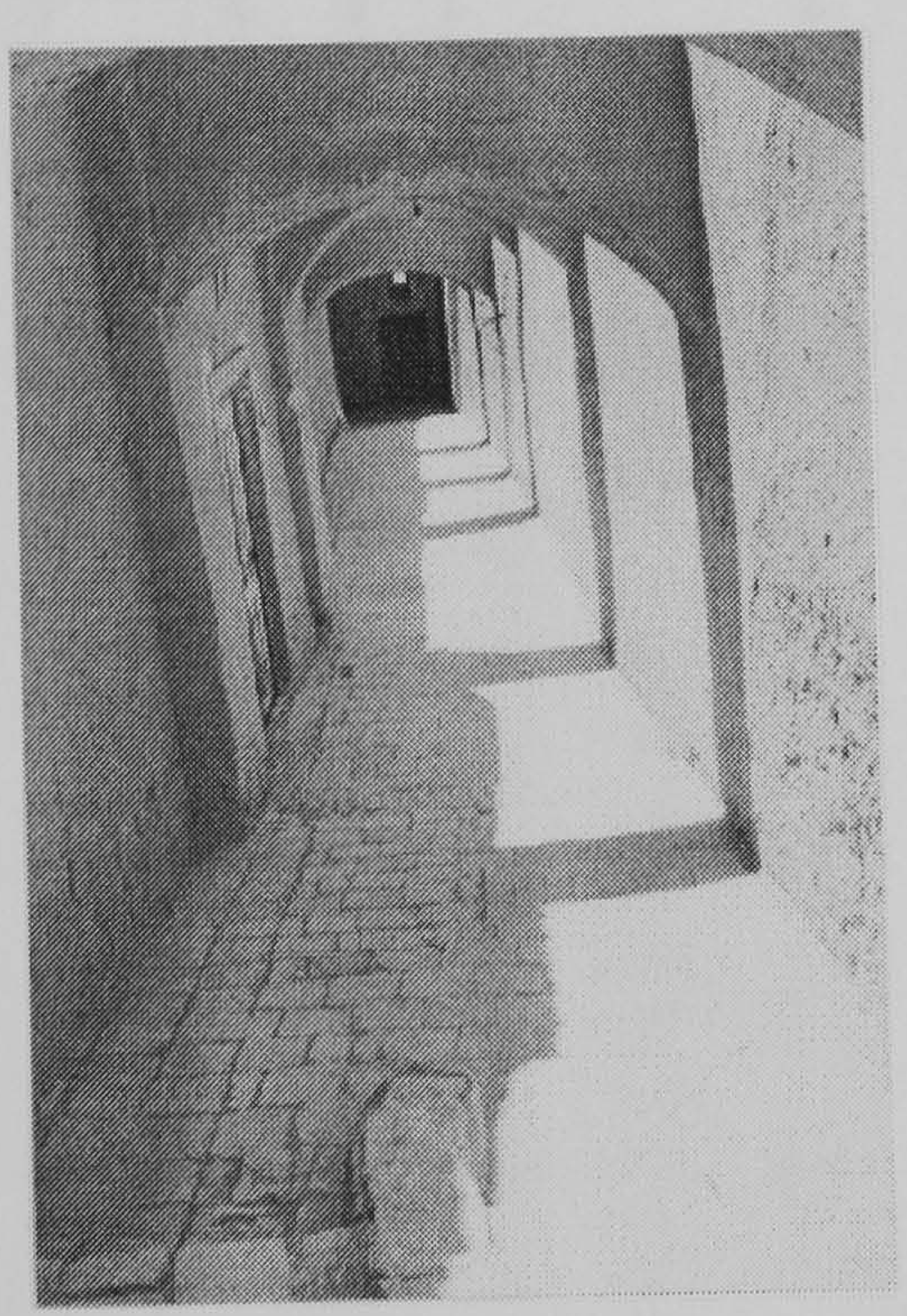


PLATE 5.4: TWO EXAMPLE OF CUL-DE-SACS IN EVIDENCE IN THE GODAL-E-MOSALLAH AREA.

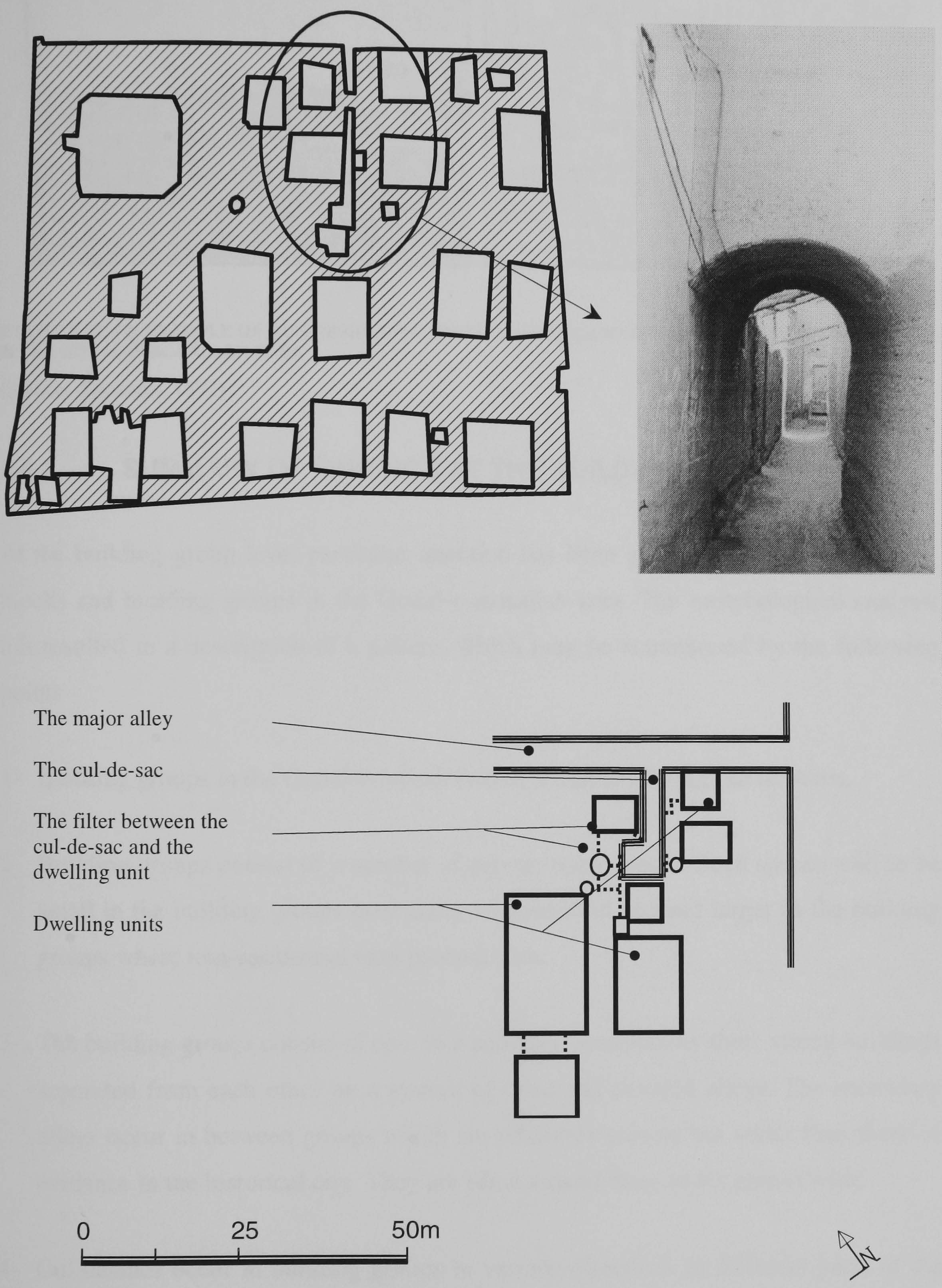
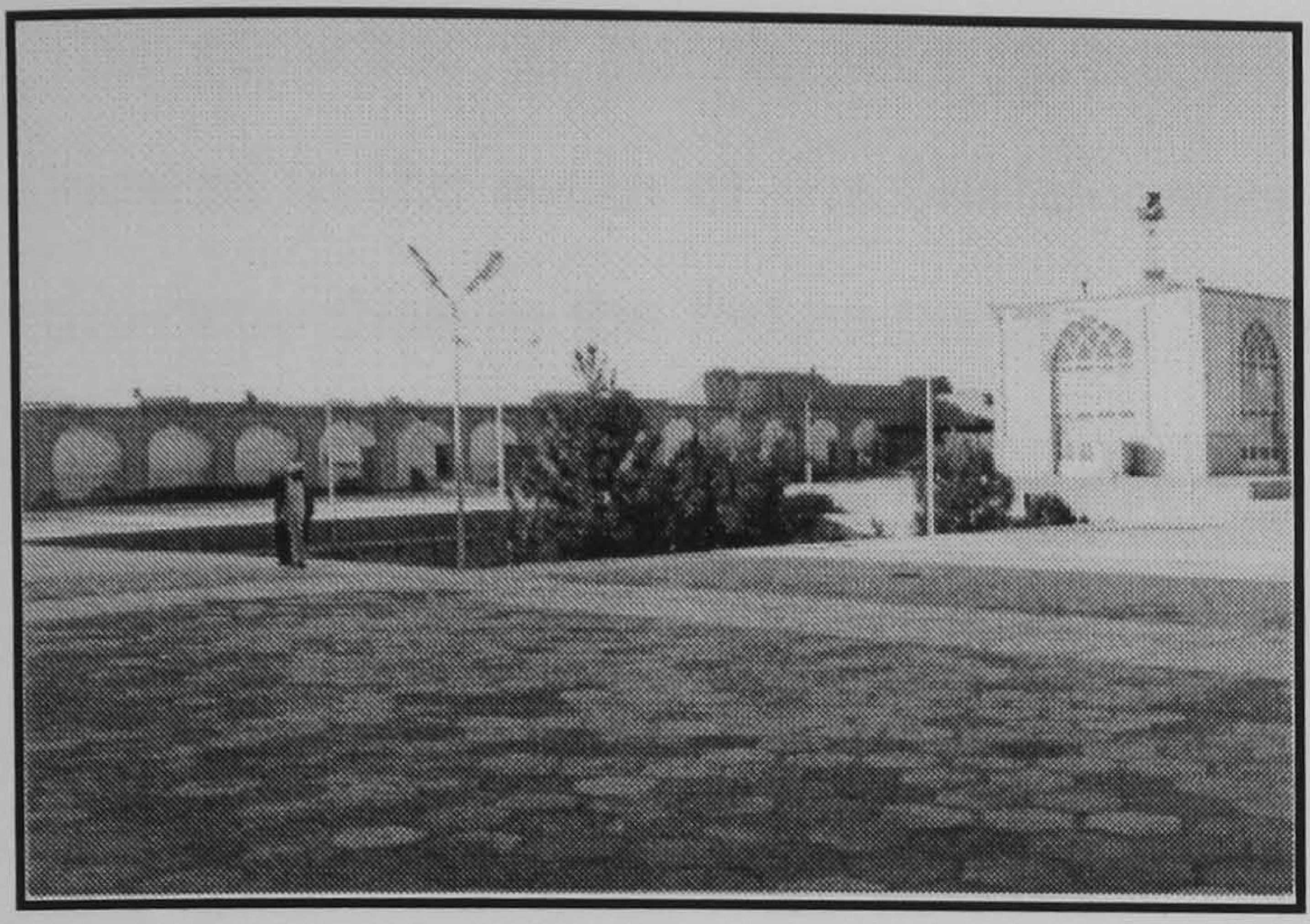


FIGURE 5.31: THE RELATIONSHIP BETWEEN DWELLING UNITS WITH ITS SURROUNDING UNITS AND THE HIERARCHY OF ALLEY SYSTEM IN A BUILDING GROUP IN THE GODAL-E-MOSALLAH AREA.



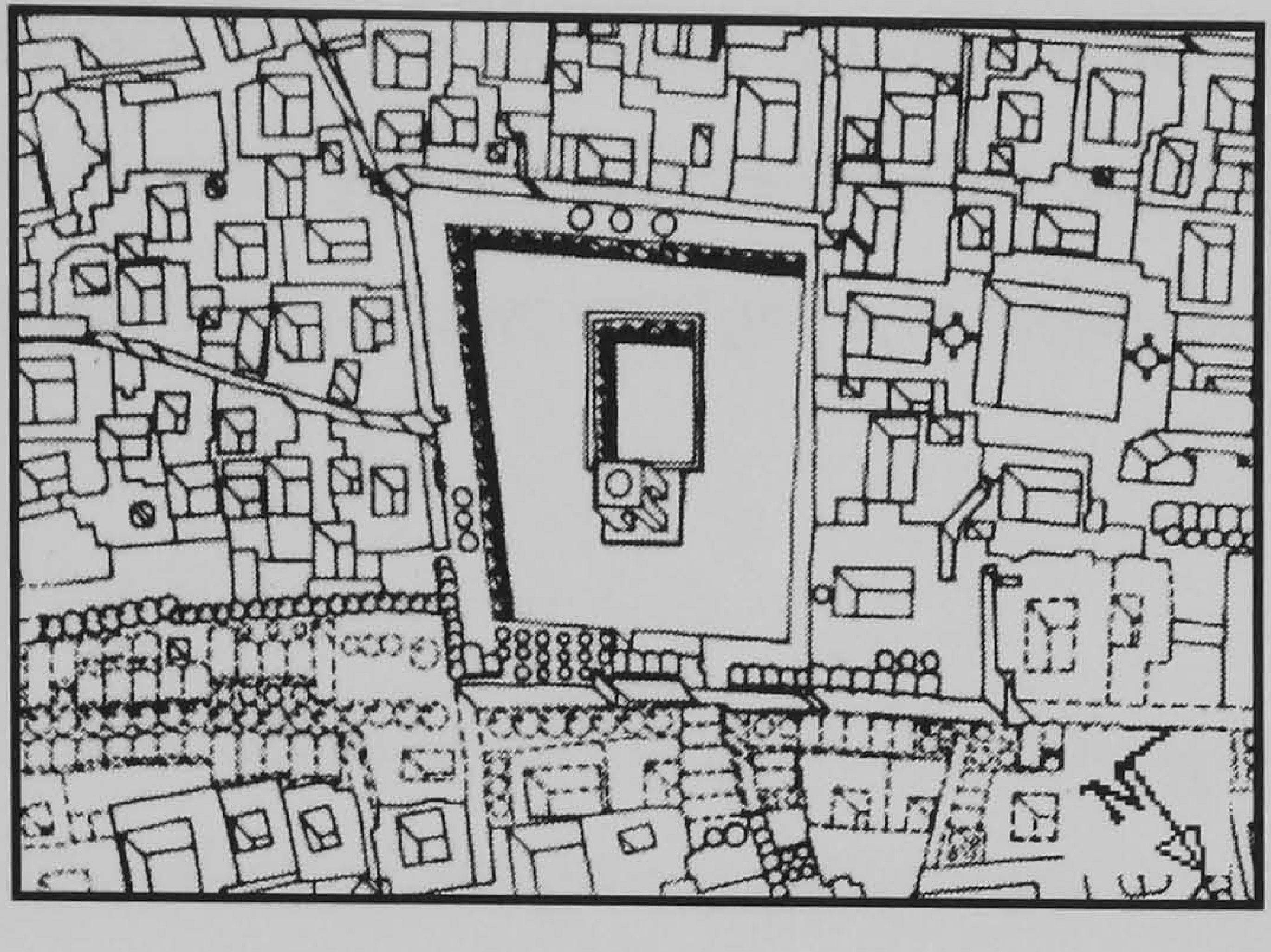


FIGURE 5.32: AN EXAMPLE OF NON-RESIDENTIAL (MOSALLAH RELIGIOUS SCHOOL) PRIVATE OPEN SPACE IN THE GODAL-E-MOSALLAH AREA

(Source: Tavassuli, 1992)

5.4.2. SUMMARY OF FINDINGS AT THE BUILDING GROUP LEVEL

At the building group level particular attention has been given to analysis of building blocks and building groups in the Godal-e-mosallah area. The morphological analysis has resulted in a description of a pattern, which may be summarised by the following points.

1- Building groups in the Godal-e-mosallah area are generally regular in shape.

2- Building groups consist of a number of private open spaces. Such spaces tend to be small in the building groups essentially in residential use and larger in the building groups where non-residential uses predominate.

3- The building groups consist of one, two and very occasionally three storey buildings separated from each other by a system of open and covered alleys. The secondary alleys occur in between groups which are relatively narrow but wider than those in evidence in the historical city. They are often around three to six metres wide.

4- Cul-de-sacs occur in building groups in various directions in different parts of the area, however they generally occur in a north-east to south-west direction. If the depth of the group is not very large, the cul-de-sacs are much straighter than a winding route.

5- The presence of cul-de-sacs is comparatively rare in building groups which are located to the south of the Godal-e-mosallah area. There is generally less access of this type than in the Fahhadan area. These spaces are more straight and wider in the Godal-e-mosallah area.

6- The built form of groups consists of combinations of building units entirely spread over the building groups with a system of central open spaces. Most units contain open courtyards, which occur in some sort of uniformity with variations in size in building groups.

7- The building units appear to vary to quite an extent in size and the basic form of the plan, even in a single group.

8- By contrast, in older parts of the study area the basic form of the dwelling plots is much more irregular than in the newer parts.

9- The overall average of the group area is 6120 sq.m with a range of between 120 sq.m and 41000 sq.m.

5.5. THE MORPHOLOGY AT BUILDING LEVEL

The previous section identified items, which appeared to be the important features of the building group morphology in the Godal-e-mosallah district. This section concentrates on the more detailed morphology of the units to be found in the whole area. Non-residential units will also be analysed in term of their spatial arrangements.

There are 1103 residential and 1150 non-residential units in the study area. The average plot area of dwelling units in the Godal-e-mosallah area is about 290 sq.m. This average for non-residential units is about 348 sq.m.

In the Godal-e-mosallah area dwelling units may be categorised into different types according to their building form. It consists of a large part of the dwelling environment of what were originally courtyard houses and they are the same types as that of Fahhadan area. These types of houses have a long tradition and can be found widely in most Iranian cities. The most general physical characteristics of such houses have been described at the building level of analysis in chapter six. It is not intended here to repeat those descriptions. So a typical house in the Godal-e-mosallah area has been selected (See Figure 5.33) in order to examine the general characteristics of dwelling units at the building level of analysis. There are some simplified forms of this typical house in evidence in the newer part of the study area. The area also includes some newly constructed units the basic plan and general characteristics of which will be explained in the next chapter at the building level of analysis.

5.5.1. THE TYPICAL HOUSE

The selected house is centrally located in the study area. The history of the house dates back to the middle of the 19^{th} century. The house has the name of the famous 'Mortaze'.

5.5.1.1. PLAN FORM AND GENERAL CHARACTERISTICS OF THE HOUSE

The basic plan form of the building consists of two different parts (See Figure 5.33). The first section is much larger and more detailed than the other part. Each portion has a courtyard and an entrance. In this regard they may be considered as two separate dwellings. There is an octagonal space in evidence which provides access between these two portions. The larger portion only served the family and was called 'Andaroni' or private sector whereas the small part served as the public sector where the guests were served and entertained and was called 'Bironi'

In the larger courtyard, the main 'Talar' which is more elevated than the other elements of the facades dominates the courtyard. The large and tall 'Badgir' constructed on the axis of the 'Talar' adds to its overall authority.

However, the elongated and orderly form of the courtyard with its detailed facades and a garden located in the middle of the courtyard, complete with a water pond, is an important rival of the 'Talar'. It should be stated that the relationship between the 'Talar', the 'Badgir' and the courtyard in this building is a spectacular view.

The orientation of the different spaces along the courtyard has the same order and image as the other traditional houses in Yazd. In these houses the main spaces are constructed on the main axis of the courtyard. An annexation of this building is the regular octagonal spaces in the Four Corners of the courtyard. In the lower storey, these spaces act as an access space of which one is connected to the main entrance of the houses while the other provides access to other spaces within the house. In the second storey these spaces form corner rooms facing the courtyard.

The smaller courtyard of the house also has special characteristics of its own. In addition to the closed 'Talar' which is constructed along this space, a number of semi-open spaces of a variety of sizes, are surrounded this space. Two relatively large 'Talar' at the two opposing sides of the courtyard and semi-open spaces at their sides, have been constructed in addition to the arcades at the other end of the courtyard.

Components of this traditional house in Godal-e-mosallah area are rooms of variable sizes and forms with different spatial composition; an orderly and vigilant division of the facades of the courtyards and closed and semi-open spaces, and in addition the design of the courtyards and the ornaments of the facades and the spaces.

The house is located in a fairly regular building group. It is connected to the major alley which is located to the north-east of the building group. There is a hierarchy of space from the major alley to the dwelling unit in the form of a cul-de-sac and several octagonal forms of spaces (See Figure 5.33). The cul-de-sac also served other dwelling units located close to the house.

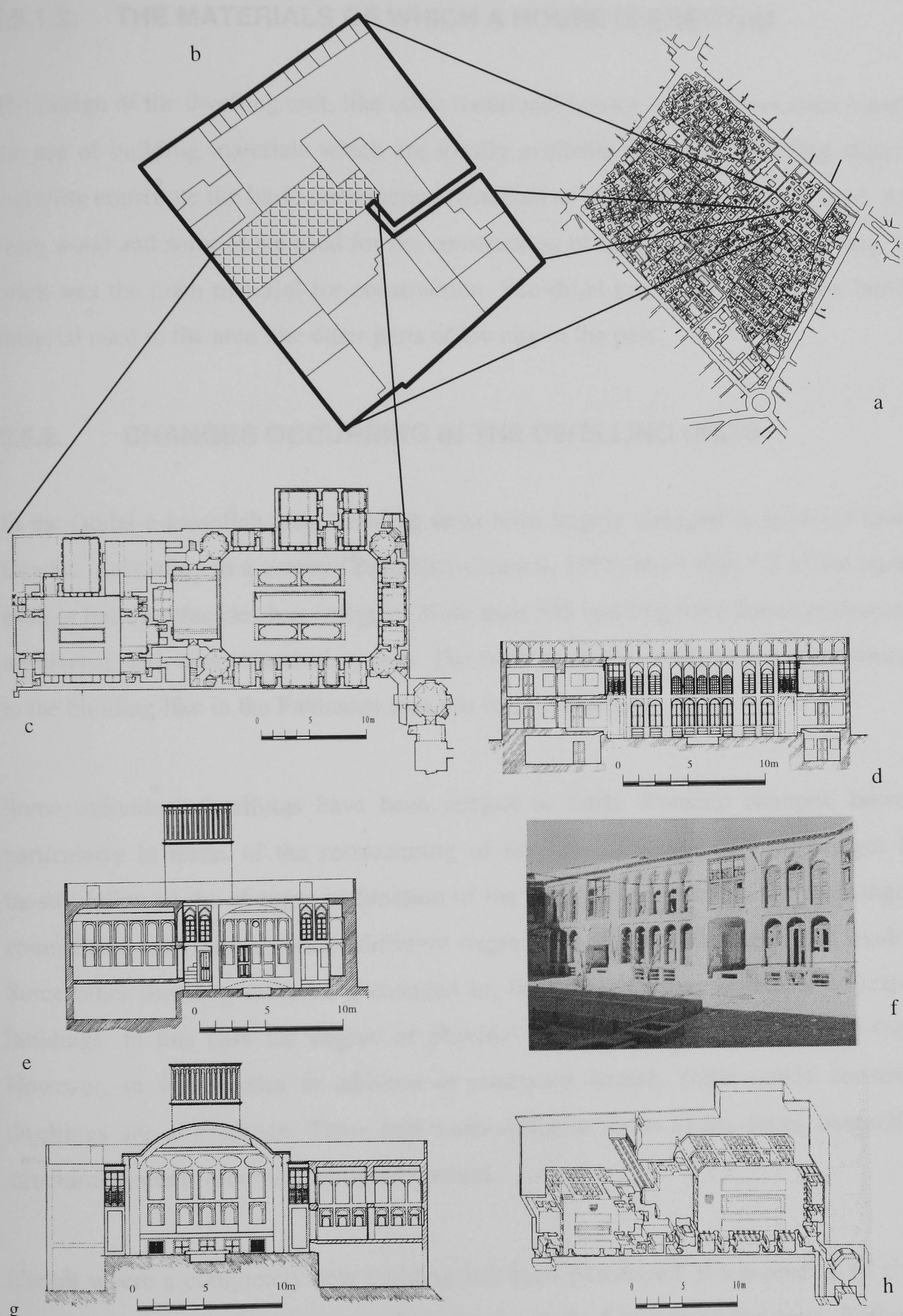


FIGURE 5.33: THE TRADITIONAL TYPICAL HOUSE IN THE GODAL-E-MOSALLAH AREA. A- LOCATION OF THE TYPICAL HOUSE IN THE AREA. B- THE LOCATION OF THE HOUSE IN THE BUILDING GROUP C- THE BASIC PLAN FORM OF THE HOUSE D,E,F,G – SECTIONAL ELEVATION AND GENERAL TREATMENT OF THE INTERNAL FAÇADE OF THE UNITS H- SECTIONAL AXONOMETRIC VIEW OF THE HOUSE (Source: Organisation of Cultural Heritage in Yazd)

5.5.1.2. THE MATERIALS OF WHICH A HOUSE IS ERECTED

The design of the dwelling unit, like other traditional houses in Yazd, has been based on the use of building materials which are locally available. The local building materials therefore constitute the basic construction materials of which the house is erected. Apart from wood and some stone used for the construction of some parts of the building, mud brick was the main material for construction. Sun-dried bricks are a common building material used in the area like other parts of the city in the past.

5.5.2. CHANGES OCCURRING IN THE DWELLING UNITS

In the Godal-e-mosallah area, building units have largely changed in terms of exterior facades. According to a survey (Yazd City Council, 1998) more than 1/3 of the material used in building facades has changed. More than 345 building have been constructed or are treated with new structural system. The concept of the arrangement of the entrance to the building like in the Fahhadan area has largely changed.

Some individual dwellings have been subject to fairly dramatic changes, however, particularly in terms of the restructuring of the interior spaces. These changes have mostly followed the changes in function of the units. Some buildings have changed to commercial activities in which different degrees of physical change are in evidence. Some other dwelling units have changed to, for example, government or educational buildings. In this case the degree of physical change is much less than the former. However, in some cases in addition to courtyard houses, some newly constructed dwellings are in evidence. These new units differ in terms of the form, material and structural system from the traditional method.

Except where a completely new building has been introduced, the processes of change in dwelling units in this area started by change in the function of the units. In the next stage the spaces of the dwelling units either were slightly changed to accommodate new function or completely changed to a new form according to the needs and demands of the user.

In some cases in the newly constructed dwelling units the transformation in concept of the arrangement of spaces around a courtyard has been occurred and the spatial pattern of spaces in a dwelling unit has changed. For example the courtyard moved to one side of the plot and rooms are constructed in one or two side of the courtyard.

5.5.3. NON-RESIDENTIAL UNITS AS A CAUSE OF FORMATION OF A PATTERN

In addition to some commercial activities to the north of the Godal-e-mosallah area there are also two religious schools surrounded by commercial activities. This role follows the general principle of Islamic cities being a close relationship between the bazaar and religious educational buildings.

With the expansion of the bazaar and the construction of the Khan Square some other functions have developed in their vicinity (See Figure 5.34). Selections of site for construction of these elements are mostly regular and defined by surrounding straight roads. These roads mostly continue towards the south-west. Dwelling groups located alongside them have, in turn, been shaped according to the continuity of these routes and are mostly rectangular in shape. Therefore the regularity of the dwelling groups may be considered as a result of the initial site selection of some non-residential units. As such, the form of the alleys and dwelling groups differs in several ways from the alleys between dwelling groups as identified in the Fahhadan area. First the dwelling groups in the Fahhadan area are much more irregular and alleys are comparatively shorter, while in the Godal-e-mosallah area groups are regular in shape and alleys are longer. Secondly, the spaces between groups in the Godal-e-mosallah area are wider in than the Fahhadan area. Thirdly, groups are much more influenced by land subdivision imposed by the alleys in comparison with the Fahhadan area where the selection of land for dwelling units has a great influence in the formation of alley system.

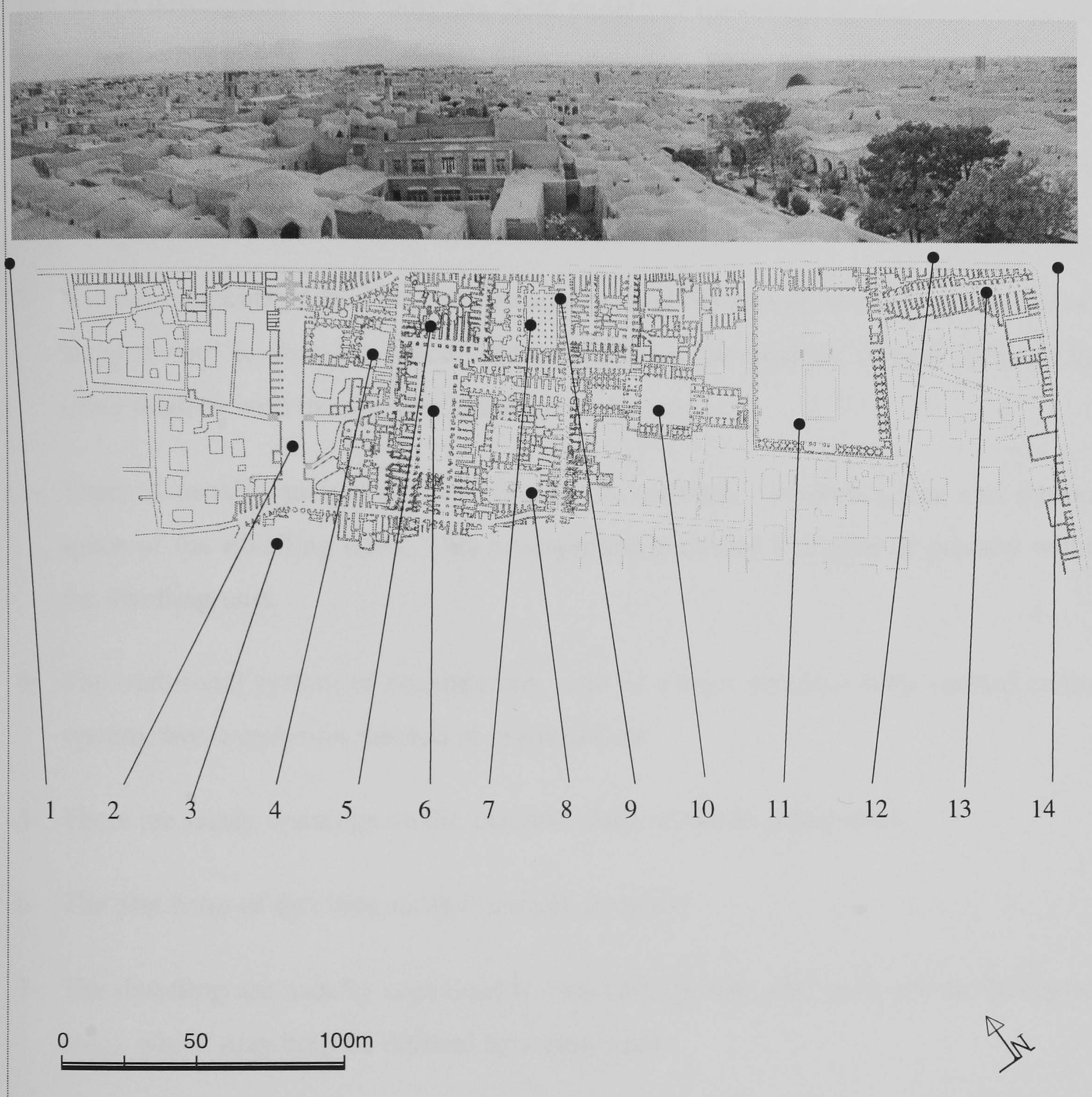


FIGURE 5.34: MOST OF THE NON-RESIDENTIAL UNITS ARE LOCATED TO THE NORTH-EAST OF THE GODAL-E-MOSALLAH AREA. THESE UNITS ARE CONNECTED TOGETHER BY MEANS OF MAJOR ALLEYS AND THE BAZAAR BRANCHES. THEY ARE FAIRLY REGULAR IN SHAPE WITH MOSTLY AN OPEN SPACE ACT AS A COURTYARD. THE MOST IMPORTANT ELEMENTS OF THE AREA ARE AS FOLLOWS.

1-SHAHTAHMASB SQUARE 2-NEW STREET CONSTRUCTED IN FRONT OF MULLAHISMAEIL MOSQUE 3-MULLAHISMAEIL MOSQUE 4-RELIGIOUS SCHOOL 5-WATER RESERVOIR 6-KHAN SQUARE 7-A MOSQUE 8- A CARAVANSARY 9-A BRANCH OF BAZAAR 10- RELIGIOUS SCHOOL (KHAN) 11- MUSALLAH RELIGIOUS SCHOOL 12- GHIAM STREET 13- A BRANCH OF BAZAAR 14- AMIRCHAGHMAQ SQUARE.

5.5.4. SUMMARY OF FINDINGS AT UNIT LEVEL

The above description of the morphological pattern of the dwelling may be summarised by the following points.

1- The dwelling is organised in a single storey for living space and a basement for storage purposes. They are mostly arranged around a courtyard.

2- Various elements of the house are located around the four sides of the courtyard and faced inward to the open space. The emphasis on the position of each element has some relation with the climatic situation of the area.

3- There is usually an intermediate space, the vestibule, between alleys and internal space of the dwelling units. This arrangement provides a degree of privacy within the dwelling unit.

4- The traditional system of construction, mud as a basic material with vaulted ceiling system, was a common method of construction.

5- There are rarely openings on the external walls of the dwelling units.

6- The plot form of dwelling units is usually irregular.

7- The dwelling are usually organised in two parts private and semi-private (reception area), which may both be defined by a courtyard.

8- The form of the main external door varies in relation to the size of dwelling units.

9- Some changes are in evidence in the pattern of usage of the traditional units.

10- The external walls of some individual dwellings have been replaced by brick, while the concept of the entrance in some units have also been changed.

5.6. SUMMARY AND CONCLUSION

This chapter has aimed to study a particular part of Yazd, the Godal-e-mosallah area to identify the morphology of its developments, which occur immediately beyond the walled city, the elements of which it is composed, and changes in evidence. Thus it addresses these questions: What is the essence of the built environment which has developed beyond the walled city in terms of morphological character and how does it change and undergo fabric transformation in different levels of analysis?

The Godal-e-mosallah district is of particular interest in that it contains an area where a diverse pattern of development beyond the walled city in its original form is still much in evidence. In general the pattern of the area has been described in terms of built and open elements, their disposition and relationship to each other. In addition to the northern part which has strong commercial elements, the area includes some parts which have been occupied by residential activities.

The morphological findings in Godal-e-mosallah indicate that:

- The influence of the main public open spaces (squares) and commercial centres in the formation and transformation of the Godal-e-mosallah area development pattern was very much in evidence.

- In the morphological pattern identified at the district, block and building group levels and summarised earlier (sections 5.4.2 and 5.5.3), certain differences have emerged in the pattern which relate either to the land uses which were found in the locality or to the recent street system which has been introduced to the area. In particular, the introduction of a new street system to the area has resulted in a change in land use and overall shape and pattern of the blocks and building groups. Some new elements, mainly in street system have changed the overall pattern and the integrity of the old street system at the district level. New non-residential buildings have changed the overall pattern of the area from a three-dimensional point of view.

- The area has also been examined in terms of historical development and some variations appeared in different levels of morphology. The evolution of the alley system appeared in blocks from a complicated system to a more simplified pattern is in evidence. The basic plan form of the blocks and building groups has transformed from an irregular shape to a regular, mostly rectangular shape. The concept of cul-de-sac with its complexity has been changed to a simple form or even eliminated in the relatively newer developments in the Godal-e-mosallah area.

- The analysis of the particular area shows that there is a general continuity in evidence between the primary elements which appeared in morphological form at the district level, even though as the Godal-e-mosallah area grew the spatial structure of the area altered at the lower level. Therefore, it can be concluded that the pattern of the area at the district level has gradually transformed through out history until the early 20^{th} century. However there is a dramatic change which occurred at the district level later.

- In those parts of the area where commercial use is much in evidence, it is generally occupied by more congested buildings. Furthermore the group sizes in such areas are frequently smaller than those groups which appear in residential areas.

- The morphological pattern evident in the Godal-e-mosallah area shows a state of some similarity in concept of dwelling environment in comparison with that of the Fahhadan area which is located in the walled city. However the plot shape of the dwelling units in comparison with the walled city is much more regular. Furthermore, traditional dwelling units in the Godal-e-mosallah area are much more regular in plan and the form of the plots than that of the walled city.

The method of working, at the four levels, has produced descriptions which do not overlap to any great extent. However, those elements which appeared at lower levels as major elements were described in the upper level of analysis to provide some relationship between the different levels of analysis. In addition, some consideration of the detailed form of the building units was required before it was possible to describe the arrangements of the blocks and building groups. In the Godal-e-mosallah area like those of the Fahhadan area a great emphasis was placed on building groups.

Attention in the next chapter will turn to the examination of one of the recent developments in the city which was basically designed as a dwelling environment for the expansion of Yazd.

Chapter Six:

6. IMMAM SHAHR, A NEW DEVELOPED AREA FOR GROWTH OF A TRADITIONAL CITY

In last two chapters, an account has been given of an examination of essentially a dwelling environment in two areas of the city where developments as long been in evidence. In this chapter, the area studied is essentially a relatively modern residential area. Attention is thus turned to the examination of the morphology of an area where new concepts of the built environment have emerged. The aim as before is to identify the basic characteristics of this newly built environment, the elements of which it is composed and the relationship between them.

6.1. GENERAL SITUATION OF THE PARTICULAR AREA IN THE NEW CITY

After the Islamic revolution and during the war between Iraq and Iran (1980-1988), Yazd grew considerably in terms of population, expanding beyond the limits originally defined by the first master plan. This period represented marks one of the peak points of housing demand in the process of development of Yazd.

Immam Shahr is a relatively modern residential area planned to provide an answer to the high demand for housing in post revolution era. In accordance with the 1983 master plan of the city, it is located in region No. 5 to the south-west of Yazd which was developed after Islamic revolution (See Figure 6.1).

The area developed in three main stages - first during the 1960s, then 1970s and finally 1980s. The first stage was the establishment of a textile factory; the second, subdivision of some agricultural land by landowners and finally subdivision of arable lands situated to the south-west and developed in part by a semi-governmental institute established for housing development and the Ministry of Housing and Planning (See Figure 6.1).

The study area is well defined by a number of boundary elements (See Figure 6.2): to the north-west a boulevard, Kargar, to the south-east another boulevard, Hafdahe Sharivar, to the north-west further boulevard Shahid Paknegad which acts as an inner ring city road and to the south-west a street, Sheikh Sadogh. There are two noteworthy streets running from the north-south to thė east-west, which divide the area into five neighbourhoods (See Figure 6.3). Neighbourhoods No. 5411 and 5412 lies to the south-west, 5321 and 5322 occur centrally and 5311 are to the north-east. Although the area is basically residential, there are other functions, such as industry, commerce, and some offices. These functions are mostly situated in neighbourhood No. 5311 and at the margin of the others.

Excluding the neighbourhood No. 5311, certain functions, such as open space, green spaces, schools, commercial and religious activities are located in the centre of each neighbourhood. These functions have occurred in localities which somehow follow the general pattern of the residential units, while in the neighbourhood No. 5311 such function are rarely in evidence.

6.2. THE MORPHOLOGY AT DISTRICT LEVEL

The morphological analysis of the Immam Shahr area at the district level consists of a brief description of the processes of development in the area, the land use pattern and those elements which are considered as the primary elements.

6.2.1. CONCEPTUAL BASIS OF THE DEVELOPMENT

In the 1970s an outer ring road of the city was built in the eastern part of the area. This generated further development alongside the road. When the city expanded the area quickly became a site for a good deal of residential development. As the first part of this residential development was at the edge the ring road where the pattern of land use was of a mixed shop-residential type in buildings with an average height of two stories. The second phase of the development of the area was close to the shop-residential edge and to the south of the factory. This part, located in the southern sector of neighbourhood No. 5311, had developed in the 1970s. The area was mostly subdivided by owners after the land-use was changed to residential.

The third stage of the growth of the area occurred in 1978 and taken shape in two distinctive steps. In the first, a group of architects and planners in a newly established semi-governmental office for housing development proposed a site and services plan for neighbourhoods No. 5321,5322 and 5412. The plots were subdivided in this neighbourhood and sold at a low price to low-income residents and the staff of some government offices. The construction of building was the buyers' duty while provision of infrastructure and roads was the responsibility of the selling office. In the second step, neighbourhood number 5411 and the remainders the new developed in region number five was designed by a private consulting architect and planners commissioned by the Ministry of Housing and Planning.

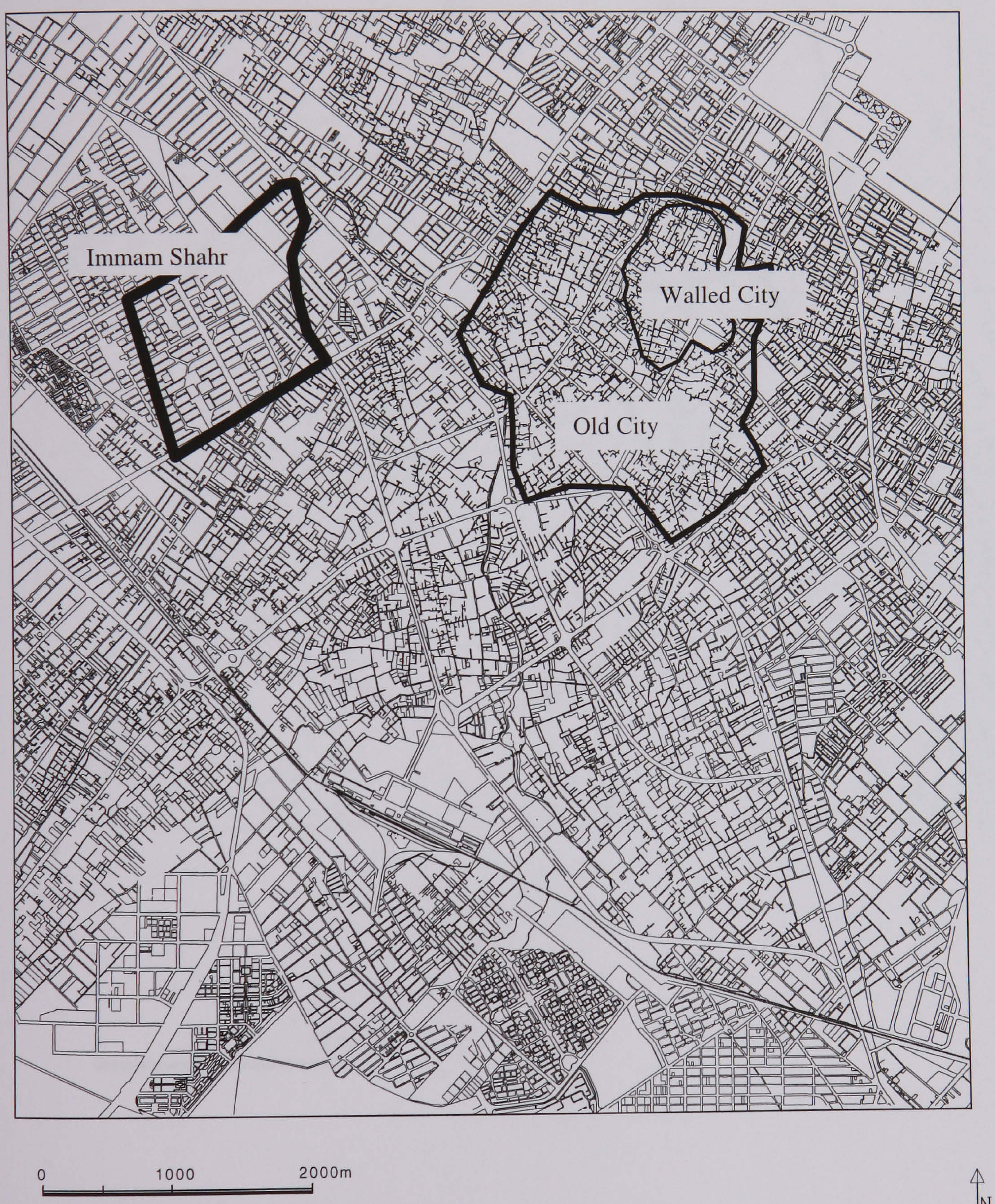


FIGURE 6.1: LOCATION OF THE IMMAM SHAHR AREA IN YAZD AS AN EXAMPLE OF DEVELOPMENT BEYOND THE OLD CITY

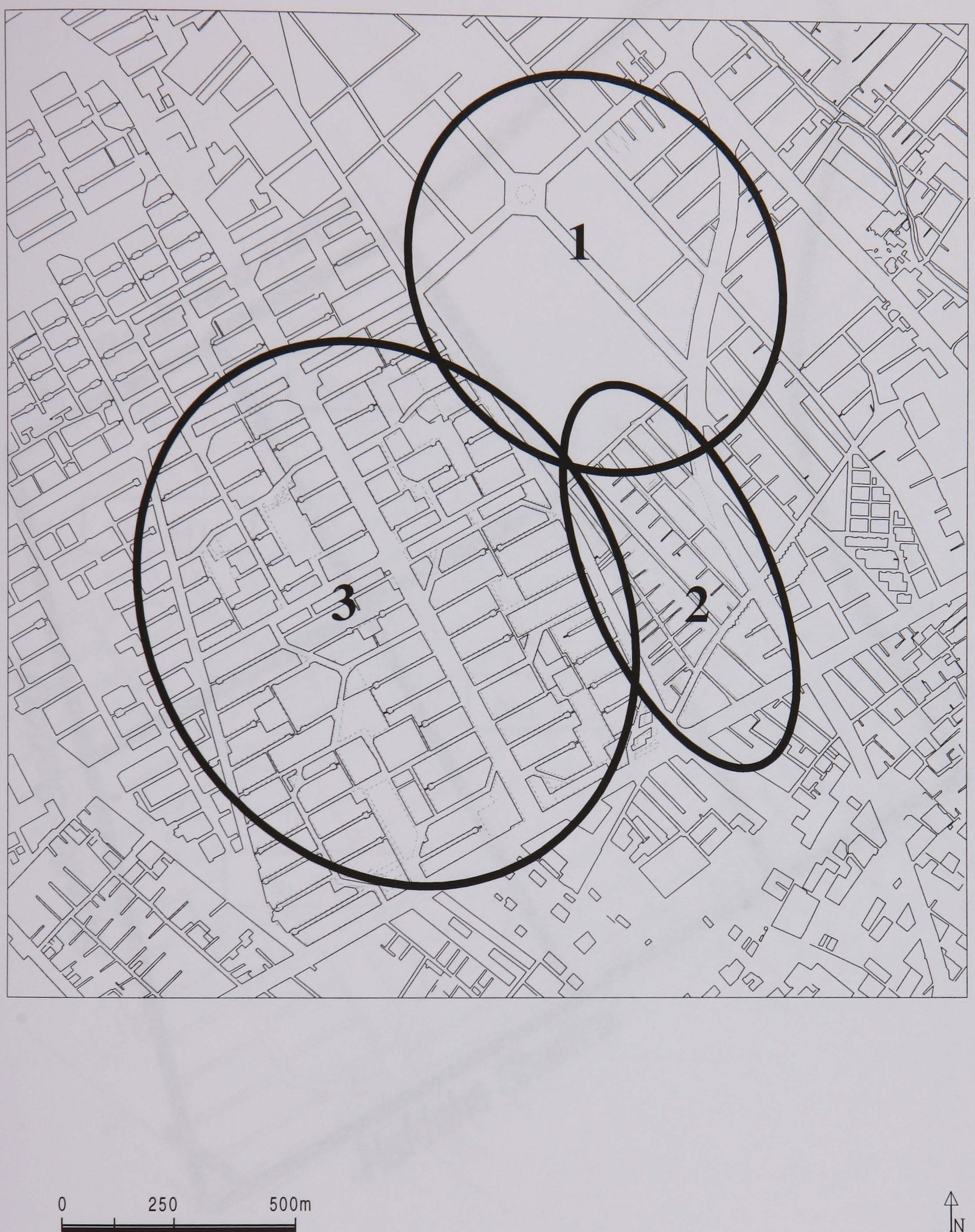


FIGURE 6.2 THE THREE STEPS IN THE DEVELOPMENT OF IMMAM SHAHR

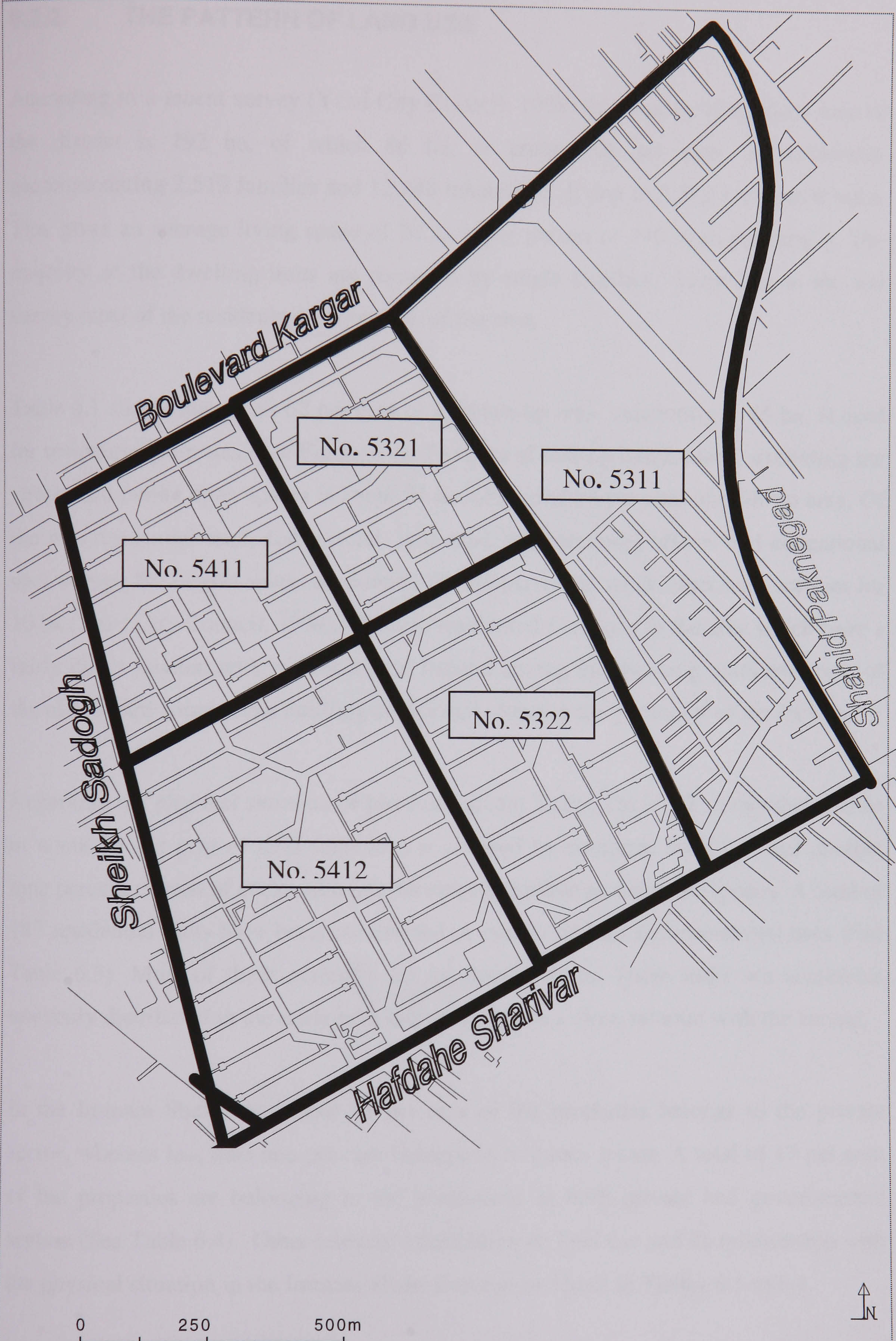


FIGURE 6.3: THE SELECTED AREA IN IMMAM SHAHR AND ITS FIVE NEIGHBORHOODS.

6.2.2. THE PATTERN OF LAND USE

According to a recent survey (Yazd City Council, 1998) the total building floor area of the district is 192 ha, of which 86 ha, or around 66 per cent, is residential, accommodating 2,519 families and 12,240 inhabitants, living in 2,512 residential units. This gives an average living space of 70 sq.m per person or 340 sq.m per family. The majority of the dwelling units are occupied by single families. According to the site survey most of the residents work outside of the area.

Table 6.1 shows that about 62 per cent of the built-up area, amounting to 86 ha, is used for residential purposes (See Figure 6.4). The area of non-residential land, excluding the streets and public open spaces is about 54 ha, or around 38 per cent of built-up area. Of the non-residential land, commercial, industrial, governmental offices and educational uses occupy the largest share, accounting for almost 44 ha, while other uses account for 10 ha (Yazd City Council, 1998). The non-residential functions in the area which have a fairly direct relation with residences are located among the dwelling units and most of the offices and commercial building are located closer to the perimeter of the locality.

Regarding the physical situation of plots in Immam Shahr, Table 6.2 shows that 140 ha or about 91 per cent of total floor area is covered by complete buildings and another nine percent consist of enclosed lands, incomplete buildings and green spaces. A total of 187 residential units have been constructed or converted into non-residential uses (See Table 6.3). Most of them currently act as storage areas. These units are somewhat unevenly distributed in the study area and tend to have a close relation with the bazaar.

In the Immam Shahr area about 82 per cent of the properties belongs to the private sector, whereas less than one per cent belongs to religious sector. A total of 17 per cent of the properties are belonging to the institutions in both private and governmental sectors (See Table 6.4). Other relevant information on land use and its relationship with the physical situation in the Immam Shahr area can be found in Tables 6.1 to 6.4.

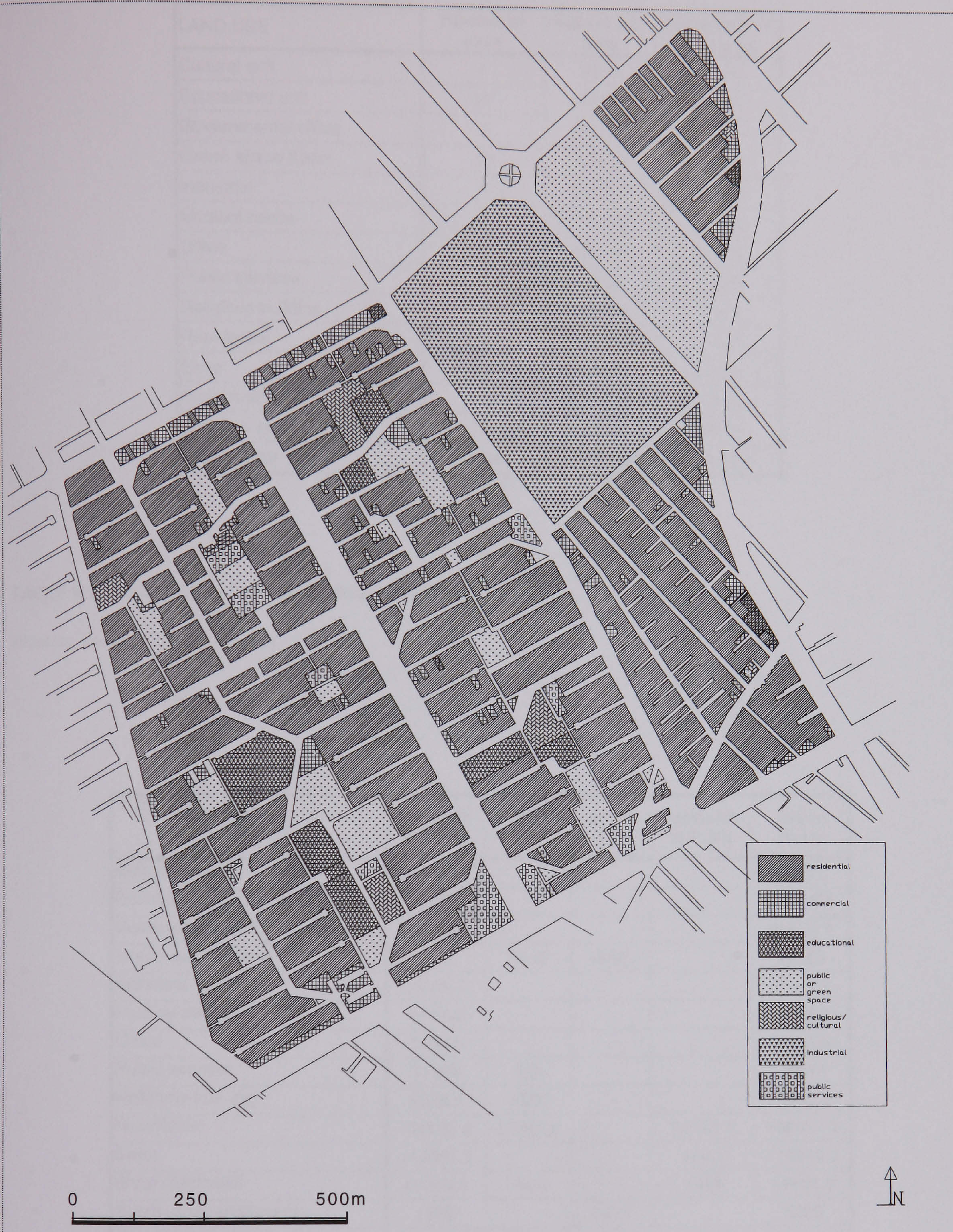


FIGURE 6.4: THE LAND USE IN IMMAM SHAHR

(Source: Yazd City Council, 1998 and Author's site survey)

LAND USE	Number of plots	Sum of plot area	Percentage of total area
Cultural unit	1	3300	0.24%
Educational unit	12	45815.1	3.29%
Governmental office	4	15073.5	1.08%
Green space &park	18	49365	3.54%
Industrial	1	211017	15.15%
Medical centre	1	3109.3	0.22%
Office	5	7066.6	0.51%
Public services	6	14514	1.04%
Religious building	4	9538.5	0.68%
Residential	2628	858687.1	61.64%
Shop	314	114510.3	8.22%
Shop residential	187	51821.9	3.72%
Sports & entertainment	2	9328	0.67%
Grand Total	3183	1393146.3	100.00%

TABLE 6.1: LAND USE IN THE IMMAM SHAHR AREA

(Source: Yazd City Council, 1998)

LAND-USE	complete building	enclosed land	green space	incomplete building	Grand Total
Cultural unit	3300				3300
Educational unit	45815.1				45815.1
Governmental office	15073.5				15073.5
Green space &park		5542	43823		49365
Industrial	211017				211017
Medical centre	3109.3				3109.3
Office	7066.6				7066.6
Public services	14389	125			14514
Religious building	5038.5	4500			9538.5
Residential	790260.2	58385.8		10041.1	858687.1
Shop	114066.2			444.1	114510.3
Shop residential	50319.5	94.4		1408	51821.9
Sports & entertainment	5600		3728		9328
Grand Total	1265054.9	68647.2	47551	11893.2	1393146.3

TABLE 6.2: LAND USE IN THE IMMAM SHAHR AREA WITH THE REFERENCE TO THE PHYSICAL SITUATION OF THE PLOTS IN THE AREA.

(Source: Yazd City Council, 1998)

LAND USE	complete building	enclosed land	green space	incomplete building	Grand Total
Cultural unit	1				1
Educational unit	12				12
Governmental office	4				4
Green space &park		2	16		18
Industrial	1				1
Medical centre	1				1
Office	5				5
Public services	5	1			6
Religious building	3	1			4
Residential	2512	83		33	2628
Shop	310			4	314
Shop residential	182	1		4	187
Sports & entertainment	1		1		2
Grand Total	3037	88	17	41	3183

TABLE 6.3: NUMBER OF PLOTS OCCURRED IN DIFFERENT SPACE USE WITH REFERENCE TO THE PHYSICAL SITUATION OF PLOTS IN EVIDENCE

(Source: Yazd City Council, 1998)

LAND USE	Institutional	Private	Religious	Grand Total
Cultural unit	3300			3300
Educational unit	45815.1			45815.1
Governmental office	15073.5			15073.5
Green space &park	47765	1600		49365
Industrial		211017		211017
Medical centre	3109.3			3109.3
Office	7066.6			7066.6
Public services	13264	1250		14514
Religious building			9538.5	9538.5
Residential	3894	854793.1		858687.1
Shop	87267	27243.3		114510.3
Shop residential		51821.9		51821.9
Sports & entertainment	9328			9328
Grand Total	235882.5	1147725.3	9538.5	1393146.3
Percentage	16.93%	82.38%	0.68%	100%

TABLE 6.4: OWNERSHIP AND SPACE USE OF THE BUILDINGS IN THE IMMAM SHAHR AREA

(Source: Yazd City Council, 1998)

6.2.3. THE PRIMARY ELEMENTS IN MORPHOLOGICAL FORM

At the district level of analysis in the Immam Shahr area, the aim is to identify those morphological elements which are responsible for giving shape and form to this newly constructed area. In general, these may be classified into open spaces (including all public movement areas) and blocks within the Immam Shahr area.

6.2.3.1. OPEN SPACES

The street system in the area may be divided into three basic layers. The first layer of streets surrounds the area and pass through it from north-west to south-east without any obstacles. They range in width from 24 meters to 52 meters. The second layer mostly passes through the area from north-east to the south-west and are between 14 and 18 metres wide. They stem from the first layer of roads and connect to the third layer, which is distributed fairly uniformly and provides vehicular and pedestrian connection to the plots. Streets in the first and the second layers in the Immam Shahr area occur at irregular intervals of 250 to 800 metres (See Figure 6.6).

Within the boundary thoroughfares of the area there are two main streets running from north-west to the south-east. They provide good routes for motor vehicles for internal and external access and may be classified as part of the upper layer of the road network in the study area (See Plate 6.1 left). In addition to these, which pass through the middle of the area, the three boundary roads form the upper layer of street system (See Plate 6.2 right). The other thoroughfares, in both directions, are also suitable for vehicular access but are less wide and apparently less important and appear to form a subsidiary layers of the road network. There is a middle layer of the road network with the width range between 14 and 24 meters, while that of the subsidiary or the third layer is between eight and 12 meters wide (See Plates 6.2 to 6.4). According to the general plan of the area, a rigid hierarchy of street levels planned, but there are a number of direct connections between the third and the first layers (See Figure 6.5 and 6.6).

FIGURE 6.5: THE PRESENT LAYOUT AND HIERARCHY OF THE STREET NETWORK

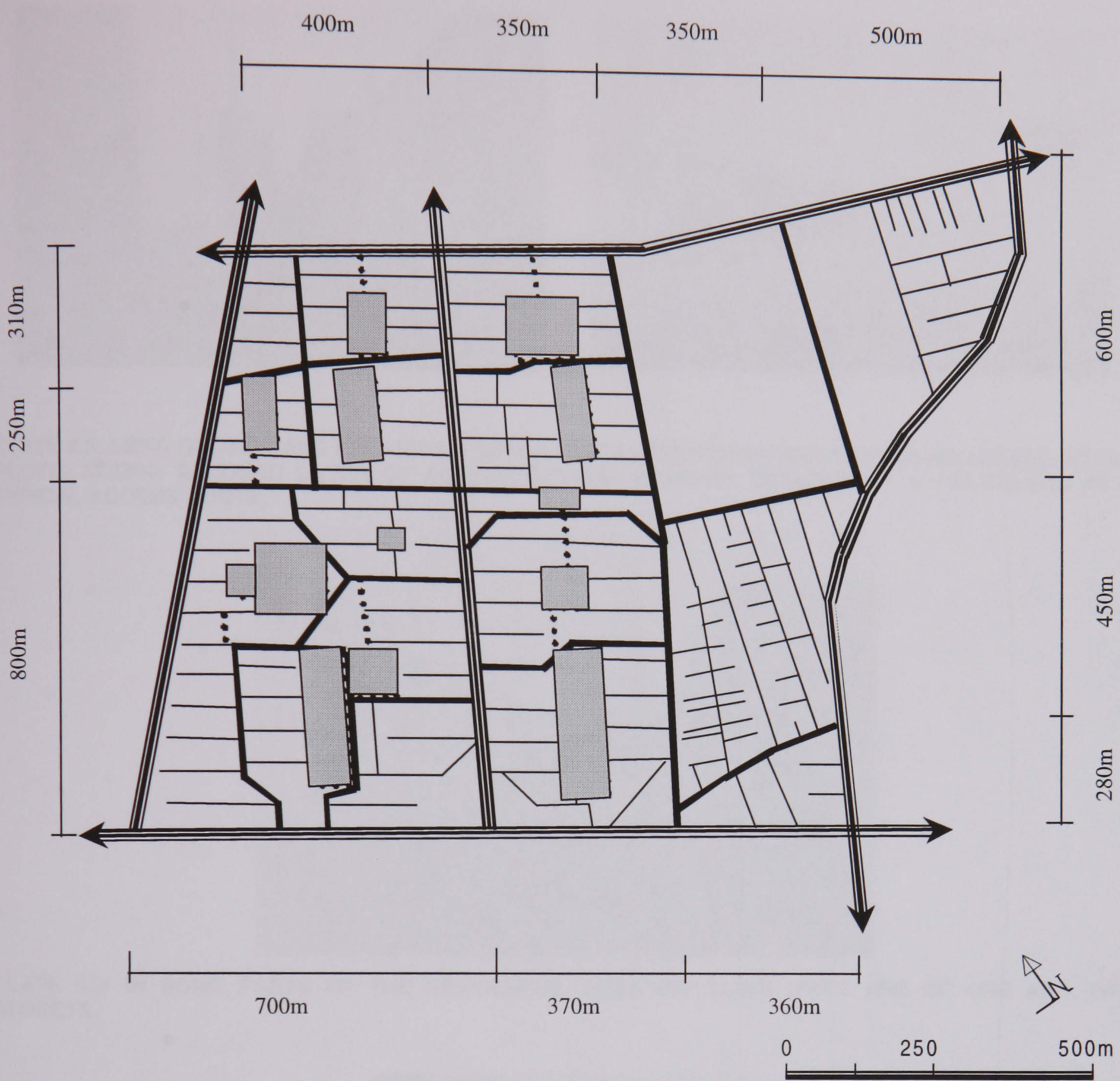


FIGURE 6.6: THE RELATIONSHIP BETWEEN THE STREET SYSTEM AND MAJOR NON-RESIDENTIAL UNITS AND OPEN SPACES SHOWN IN DARK SHADE

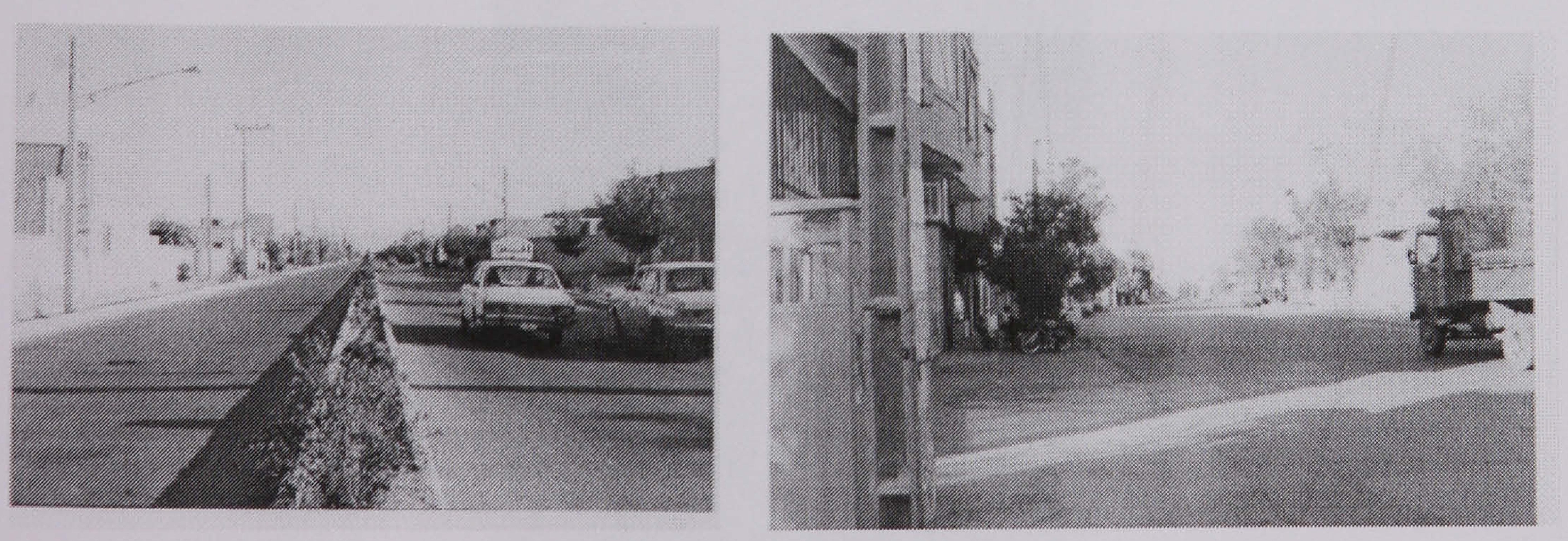


PLATE 6.1: LEFT- AN EXAMPLE OF A WIDE STREET IN AREA ACTING AS THE FIRST LAYER OF THE ACCESS SYSTEM. IT PROVIDES CONNECTION TO THE SECONDARY LAYER OF SYSTEM. RIGHT- AN EXAMPLE OF A WIDE STREET IN THE AREA ACTING AS THE SECOND LAYER OF THE STREET SYSTEM. IT PROVIDES CONNECTION TO BETWEEN THE FIRST AND THIRD LAYER OF SYSTEM SOME ACTIVITIES OCCUR IN THE SOMEWHAT THE UNDEFINED MARGIN AREA.

PLATE 6.2: LEFT- CUL-DE-SACS PROVIDES A SEMI-PRIVATE PEDESTRIAN AND VEHICULAR ACCESS TO THE PLOTS, ACTING AS THIRD LAYER OF ACCESS SYSTEM. RIGHT-AN EXAMPLE OF A CUL-DE-SAC AS A TYPICAL ACCESS ROUTE.

PLATE 6.3: IN SOME PARTS OF THE RESIDENTIAL AREA DWELLING UNITS ARE OF ONE AND TWO STOREYS.

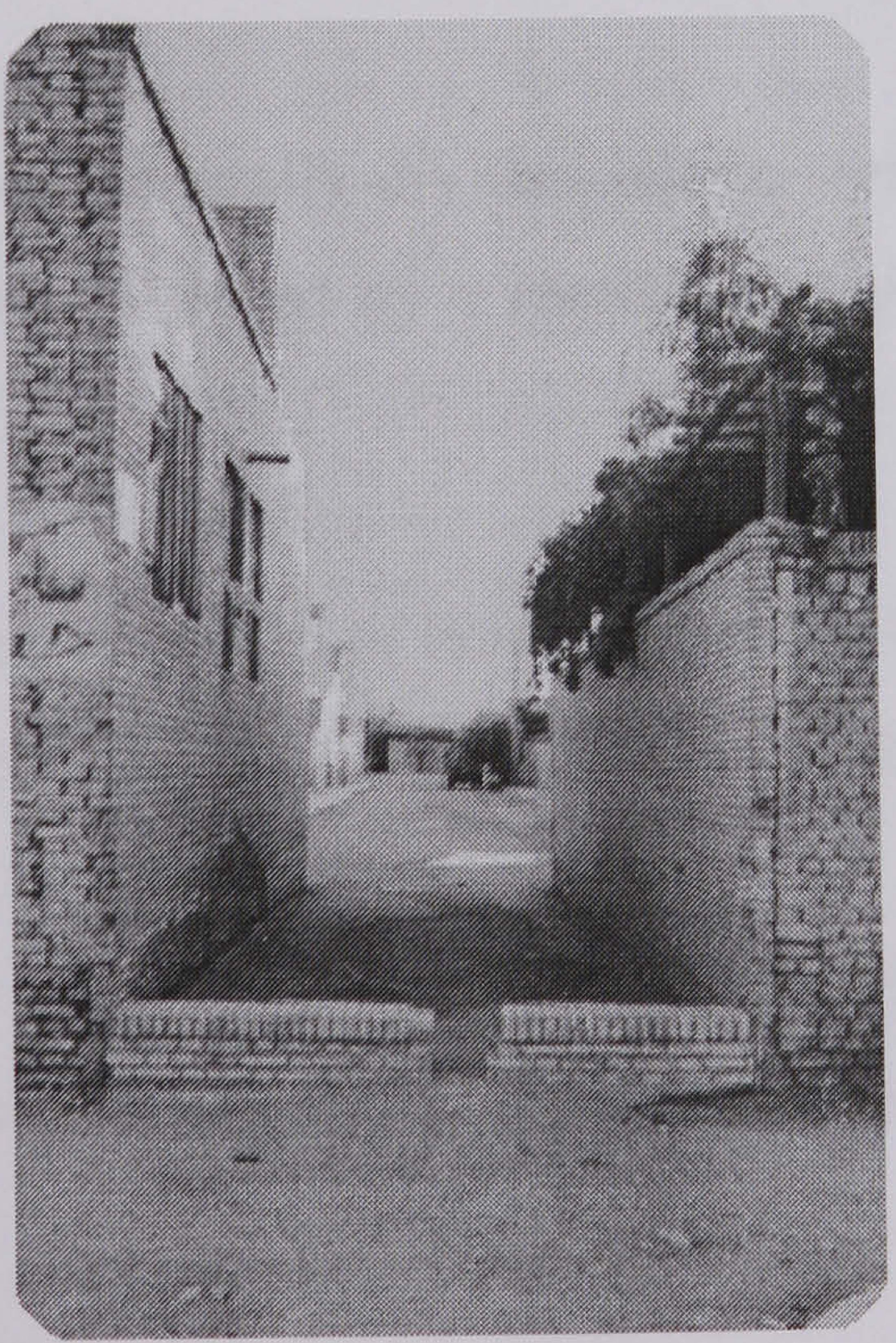


PLATE 6.4: AT THE END OF MOST OF THE CUL-DE-SAC IN SOME DIRECTIONS THERE ARE NARROW CONNECTION TO THE CENTRAL PEDESTRIAN THOROUGHFARE. THESE CLOSE ENDS HAVE CHANGED TO A VEHICULAR ROUTE IN SOME PLACES

6.2.3.2. BLOCKS

In the Immam Shahr area the boundaries of the blocks are marked by routes of either the first or the second layer and defined by a system of open alleys, which fairly follow a stem pattern. These alleys are stemmed from first and second layer of street system. The blocks essentially fall into two categories based on function, residential, and multifunctional. In this way only one block is completely occupied by non-residential functions and the rest are dominantly occupied by dwelling units.

The Immam Shahr area may essentially be divided by the street system into a total of 19 blocks. Each block consists of several hectares of land, with a minimum area 9500 sq.m to a maximum of 210,000 sq.m. The number of building group in each block varies from one to 17.

6.2.4. SUMMARY OF FINDINGS AT DISTRICT LEVEL

The basic pattern at the district level may be summarised as follows:

1- The street system in the area may be divided into three basic layers.

2- The Immam Shahr area is generally divided into several blocks. These blocks are mostly rectangular in shape, served by a rectilinear system of straight intersecting streets.

3- A block is simply defined as a strip of land surrounded by a first or second layer of the street system and therefore, may be identified from the street pattern.

4- The area shows three distinct planning patterns from successive periods of development. These are easily recognised from the layout of neighbourhoods and block subdivisions.

5- Neighbourhoods No. 5411, 5412, 5322, 5323 are fairly similar in their street system pattern whereas neighbourhood No. 5311 differs in the orientation and distribution of its street system.

6- There is usually but not always a distinction between the vehicular and pedestrian zones, marked by the use of different materials in spaces between groups. There are also some special spaces provided for pedestrian and a margin space at the edge of open spaces.

6.3. THE BASIC PLAN FORM OF A BLOCK

A general description for blocks has been given at district level. The following part of the study examines their plan form and the open spaces within them.

6.3.1. BUILT FORM

At the district level 19 blocks can be identified from their definition as pieces of land surrounded by streets in the first and second layers of the system. Block size and shape is therefore linked with the street pattern (See Figures 6.7 and 6.8).

Blocks in the Immam Shahr area are mostly in the form of rectangle. They are fairly regular in dimension but vary more in depth (the north-east/south-west dimension) than in width (north-west/south-east). Graph 6.1 shows that the majority, 58 per cent, lie within a depth range of only 250 to 350 metres; in width (See Graph 6.2), 63 per cent lie in the range 151 to 300 metres but 27 per cent are wider than 400 metres.

The blocks in the study area have a mixture of functions but the proportions of these functions vary. They may be categorized into two basic types: those in which the residential use very much predominates and those where some other functions are present to a significant extent. There is only one block in the area which is completely occupied by non-residential function.

6.3.2. OPEN SPACE

The blocks are defined by encircling of the first and second layer of street system in Immam Shahr. Therefore these streets are the major examples of the treatment of spaces between the blocks

In terms of function, the four boundary streets and other major streets are used as traffic routes for both vehicles and pedestrians (See Plate 6.5). There is usually but not always a distinction between the vehicular zone and pedestrian zone, which is frequently marked by the use of different materials. There is often a margin at the edge of the open spaces, which usually has a different ground treatment from the open space itself. The margin may have a variety of functional uses such as a location for planting trees, or for a building entrance, or on some occasions for the location of street furniture. The minimum width of the margin space observed was one meter, enough to allow a pedestrian passing along it or the planting trees or flowers. The maximum width of margin space was about four metres, providing a space for pedestrian movement, planting trees and providing a gutter for irrigation of trees and rainwater. It seems likely that the margin spaces were given a particular width for reasons in connection with the functions and importance of the adjacent street, thus, the margin space is generally wider along the main streets. The margin space has almost disappeared in the eastern parts of Immam Shahr except at its boundary thoroughfare.

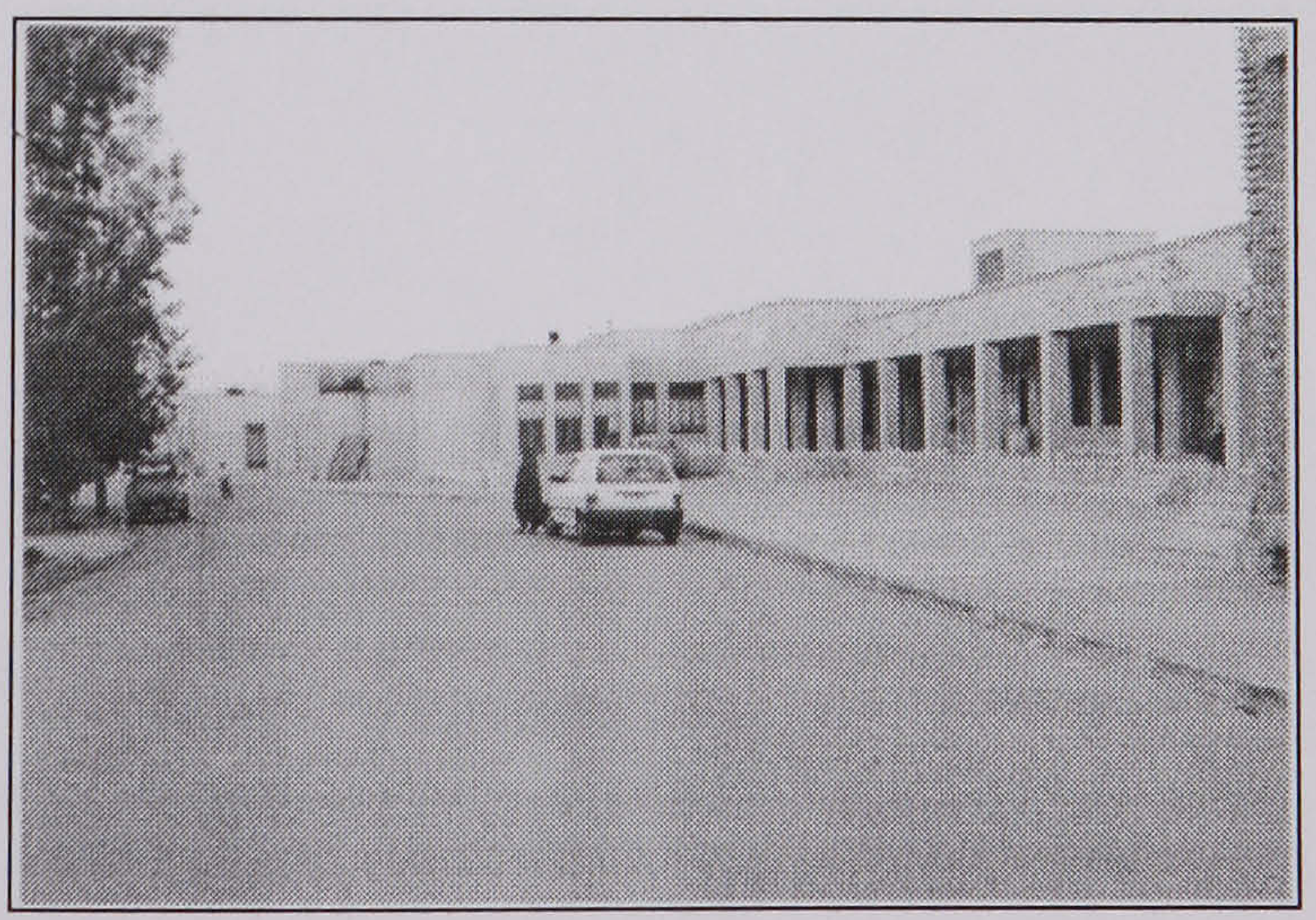


PLATE 6.5: THERE IS USUALLY BUT NOT ALWAYS A DISTINCTION BETWEEN THE VEHICULAR ZONE AND PEDESTRIAN ZONE.

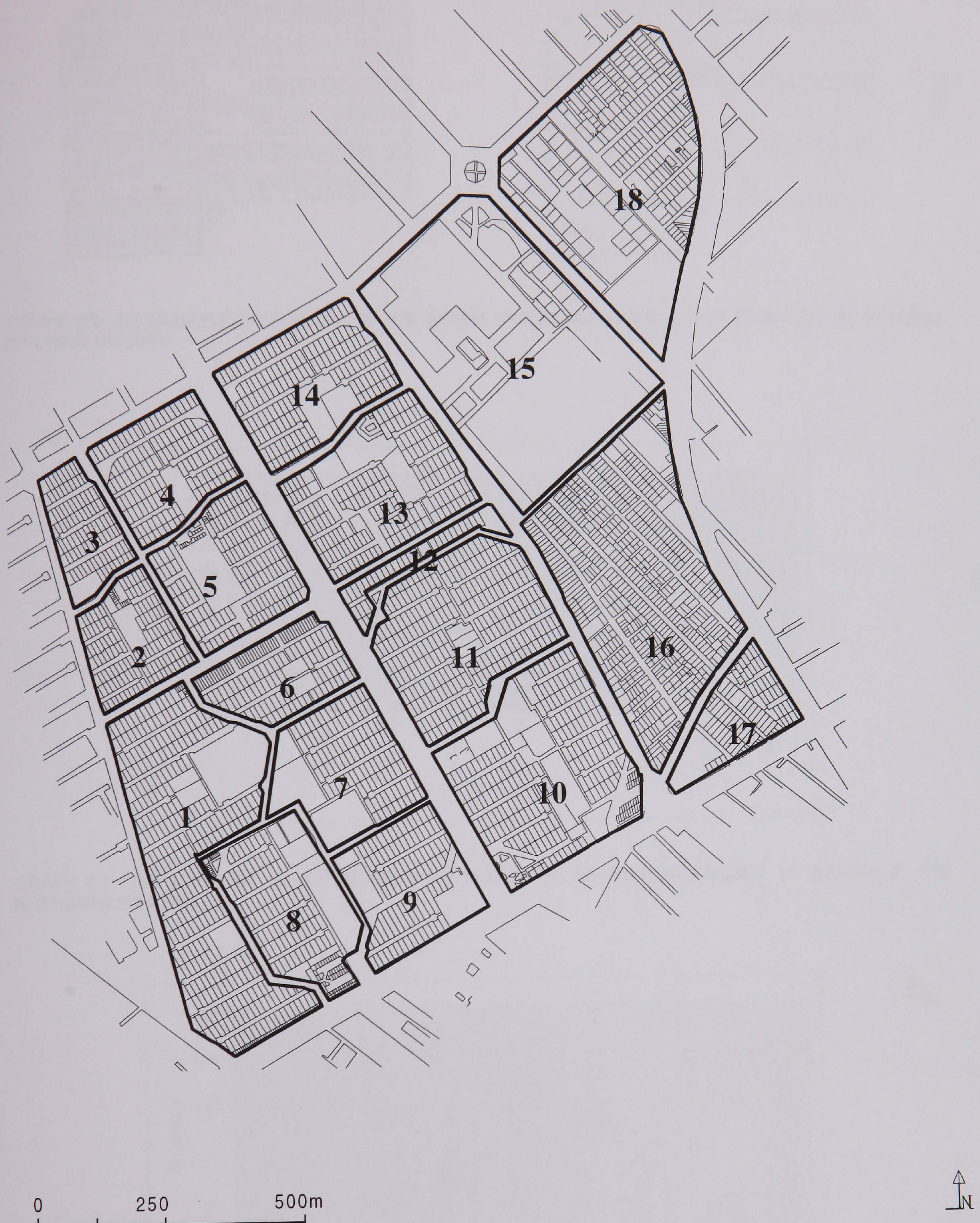


FIGURE 6.7: ALL 18 BLOCKS IN THE IMMAM SHAHR AREA DEFINED BY NEW STREETS

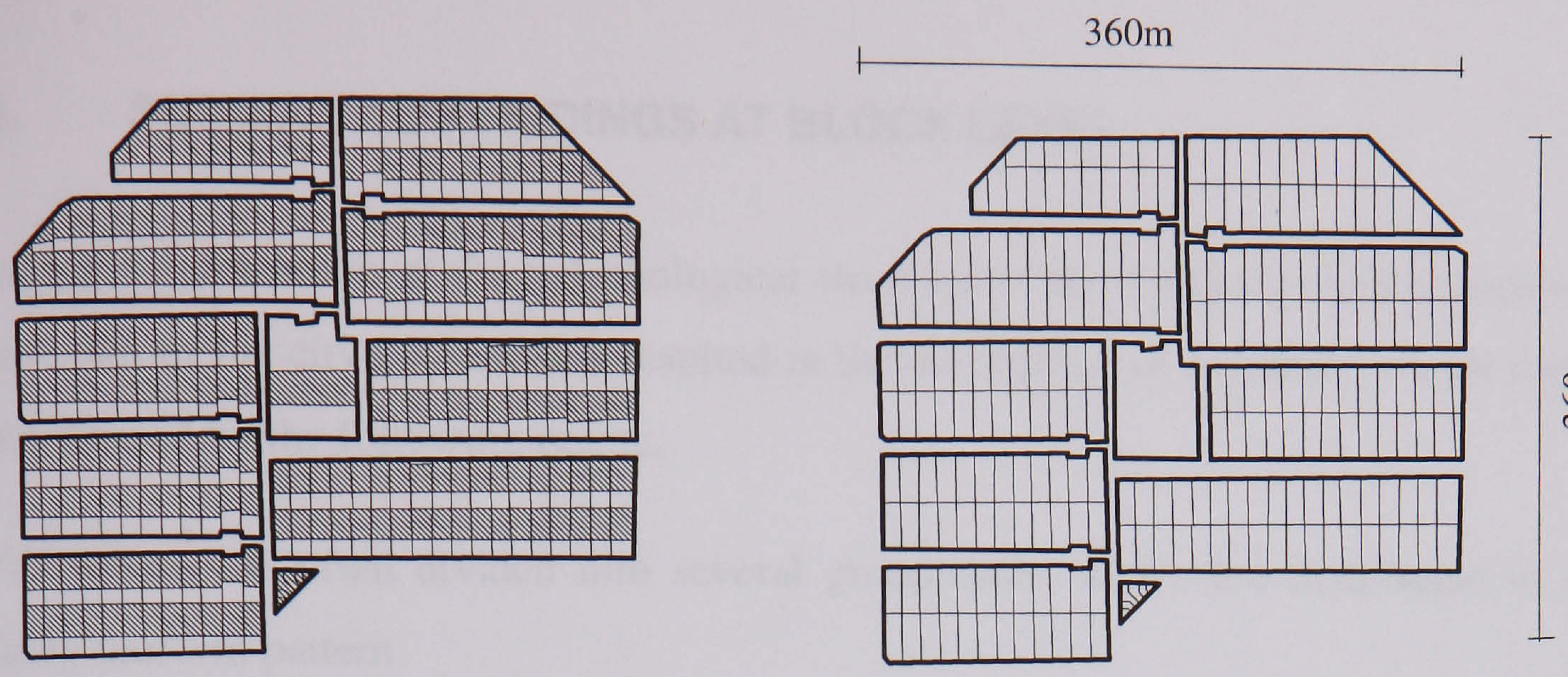
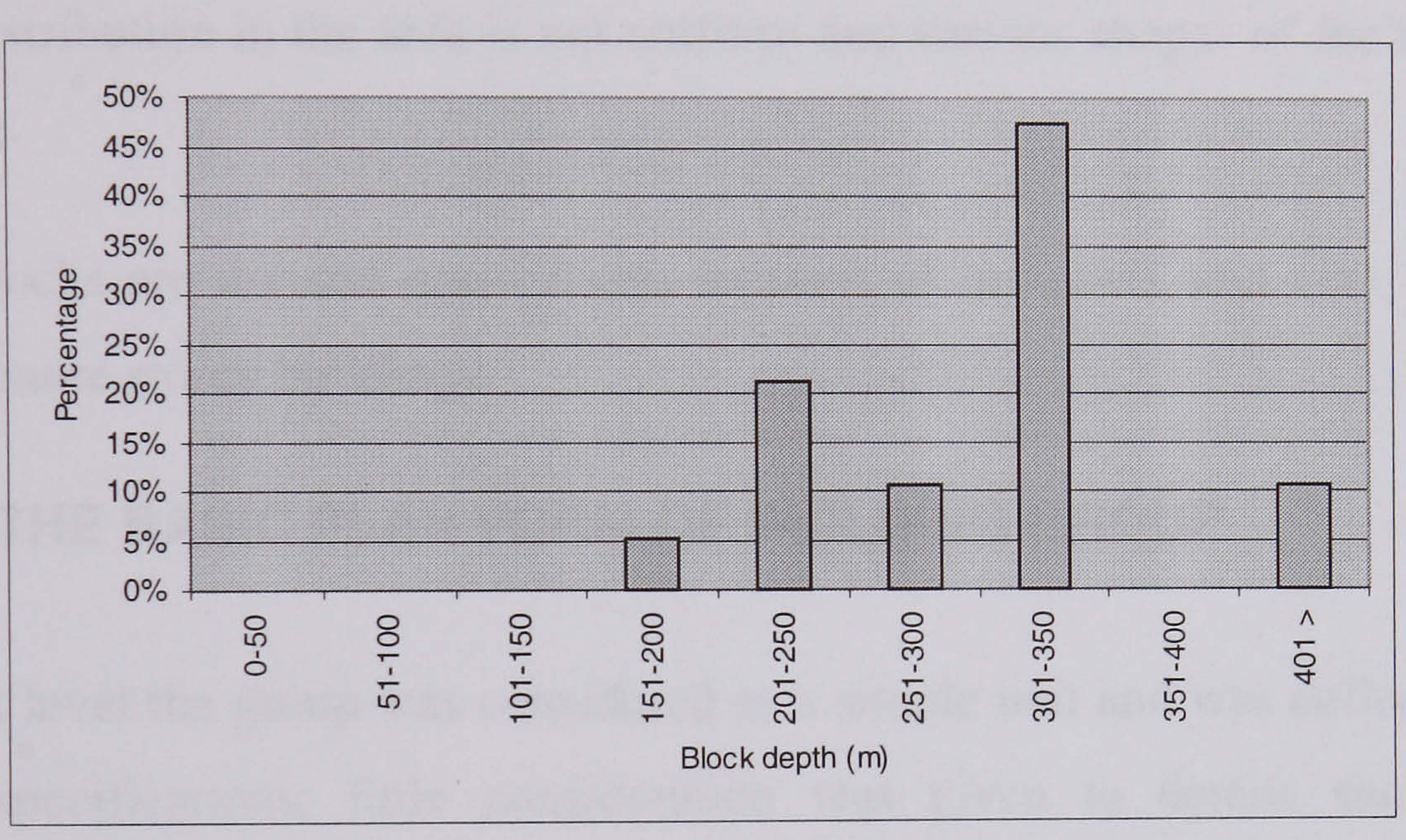
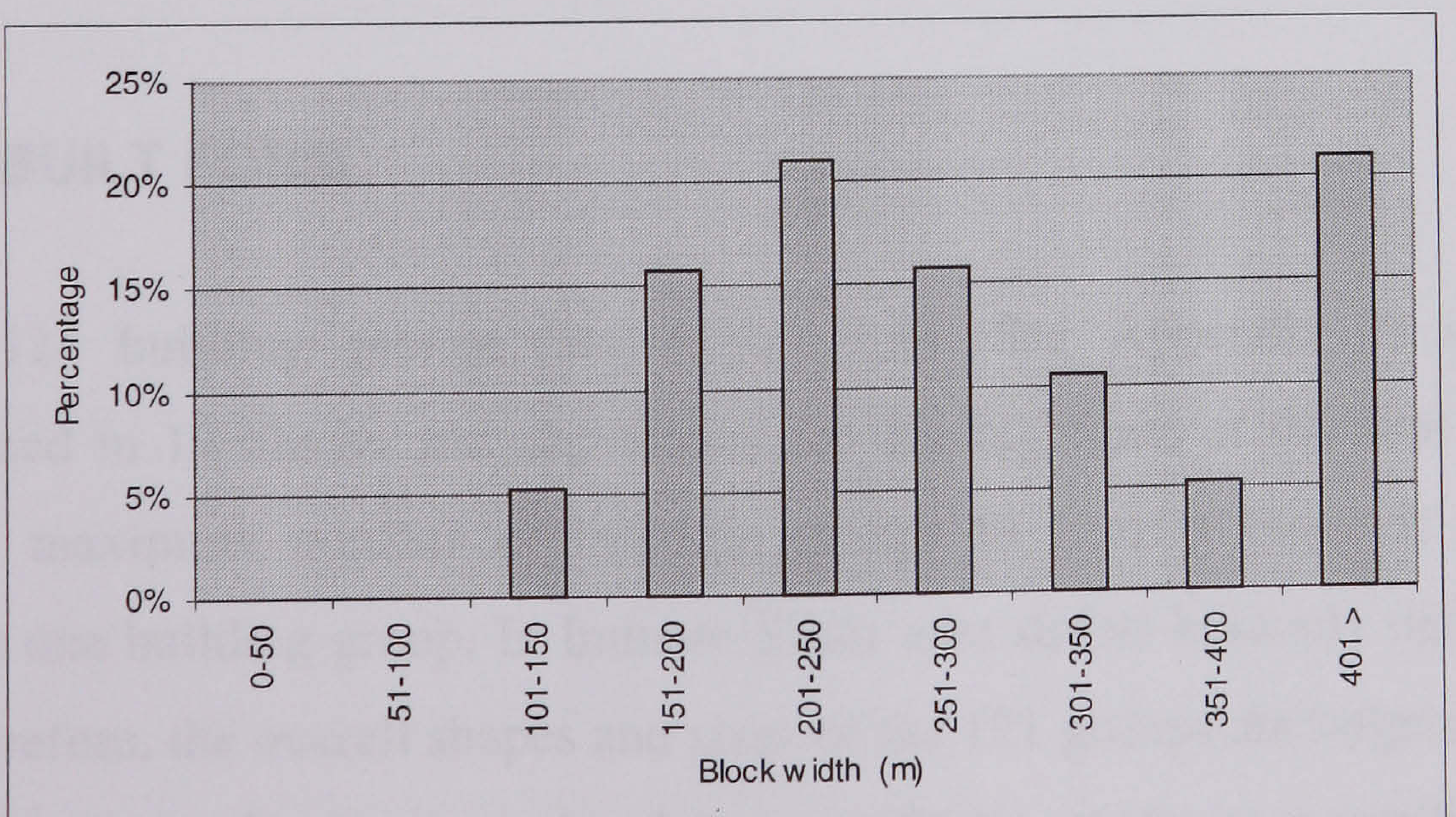


FIGURE 6.8: AN EXAMPLE OF A BLOCK IN THE IMMAM SHAHR AREA. THE BLOCK CONSISTS OF SEVERAL BUILDING GROUPS.



GRAPH 6.1: VARIATION OF BLOCK DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 18 BLOCKS IN THE IMMAM SHAHR AREA



GRAPH 6.2: VARIATION OF BLOCK WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 18 BLOCKS IN THE IMMAM SHAHR AREA

6.3.3. SUMMARY OF FINDINGS AT BLOCK LEVEL

The above consideration of the morphological structure of blocks of the typical area in the new part of the city of Yazd has resulted in the description of a pattern, which may be summarised by the following points.

1- The blocks are often divided into several group units, which are distributed in a fairly uniform pattern.

2- The minimum number of group units in a block varies from one to a maximum of 17.

3- Block distribution in the area is not uniform and various shapes of the blocks are in evidence.

4- Some blocks are divided into various sections of one, two, and very occasionally three or more storey buildings.

6.4. THE BASIC PLAN FORM OF BUILDING GROUP

At the block level the group was considered as a simple unit and was defined according to certain specifications; little consideration was given to details such as spatial arrangement and the access system. Attention now turns to the manner in which the blocks were divided into building groups, and how such groups relate to the minor streets as the main part of third street layer.

6.4.1. BUILT FORM

There are 121 building groups (See Figure 6.9) (See Appendix 3) in the area, accommodated in 19 blocks and surrounded by thoroughfares of the first and second layers. The maximum number of building groups to form a block is 17 and the minimum is one building group. In Immam Shahr area streets basically define building groups. Therefore, the overall shapes and sizes of the 121 groups are largely determined by the street system. In this way, the shapes are fairly regular as a result of the land subdivision imposed by areas of plots required for dwelling units and provision of access routes. At the building group of analysis, the building group may be treated as a single element, a 'mass' with three-dimensional form in contrast to the streets and the open spaces (See Figures 6.10 and 6.11). Each building group is composed of several dwelling units, which will be examined in a further level of analysis.

The building groups may be considered in terms of functional type and spatial characteristics. Some groups have a residential function. Some groups have a mixture of functions. The proportions of functions evident may produce three basic types of group: those in which there is only residential function, those where the residential function very much predominates but there are also some other functions, and finally those where some other function is present to a significant extent. In some examples of the third category, the proportion of some other function is more than 75 per cent of the total area of building groups or 21 groups. There are around 100 building groups in the area considered where the entire group or a significant proportion of it is in residential use. The remaining 21 groups has a somewhat lower proportion of residential land and therefore may consider as non-residential building groups.

In term of spatial characteristics, building groups can be examined in terms of their basic plan and their three-dimensional form. The pattern of building groups produces fairy similar dimensions in width (See Graph 6.4) (north-west to south-east direction) and a much broader range of dimensions in depth (See Graph 6.3) (north-east to south-west west direction). The great majority of building groups, 75 per cent, occurs within the width range of less than 90 meters. When building group depth is taken into account, a much greater spread of dimensions is encountered. The great majority of building groups, 70 per cent, occurs within the depth range of less than 150 metres. Regarding to the function of the building groups, almost the same variation is in evidence. The different range of variations in residential and non-residential building groups in the Immam Shahr area are shown in graphs 6.5 to 6.8. Building group subdivisions generally producing a depth/width ratio varies between 1:1 and 1:10. In building groups with non-residential uses and in mixed used groups, the built form of plots generally consists of structured located in the inner part of the plots.

The buildings in the district are rigidly rectangular with a much longer north-west to south-east dimension than the north-east to south-west dimension. They are generally linked together in a north-east to the south-west direction, though with alleys and streets occurring at intervals, as many as one to 135 building units forming a group.

Generally two types of building plot orientation are in evidence in the Immam Shahr area (See Figure 6.16). To the east and particularly in neighbourhood number 5311, the orientation of dwellings is likely to be north-east to south-west where in other parts of the area dwelling units are orientated in perpendicular direction. The average plot area of residential plots is around 410 sq.m where that of non-residential units is 4300 sq.m. Dwelling units are smaller to the north-west and western parts of the district. Buildings with shop-residential function are mostly constructed in two or more storeys. These buildings are located along the boundary streets and the main roads. At the centre of each neighbourhood a number of non-residential function are in evidence. These functions are mostly commercial or educational which are located alongside the first or second layer of the street system. These functions are situated close to some open spaces provided for children playground or green spaces.

In term of building's height building groups are generally constructed in single storey (See Figure 6.12). Some building within groups may be constructed in two storeys. These two storey buildings are spread in the whole study area.

6.4.2. OPEN SPACES

At the block level of study, the spatial arrangement between the building groups was consider in some detail. Figures 6.13 and 6.14 show some examples of the most common detail of open spaces arrangements, though other arrangements were also encountered. From an examination of such arrangements it appears that three types of spaces may be identified, namely open spaces, built spaces and margin space, the last occurring between the built and open space.

A minor street system penetrates some of the building groups or encircles them. In these groups, open space is often linear in the form of straight alleys provided for the use of both pedestrian and vehicular traffic. Most of these alleys are in the form of cul-de-sacs and vary in length from a minimum of 50 meters to a maximum of 125 meters. They are about 12 metres in width. These open spaces generally occur in an east-west direction. Alleys appeared in a fairly regular distance, about 50 meters far from each other. There is almost same alley system in multifunctional groups, though in addition there are generally some public open spaces such as parks or spaces in front of such as small shopping centres, which sometimes used as circulation routes. These open spaces are mostly rectangular in form and centrally located in some groups or at the margins of the others. From functional point of view these streets in section are simply divided into two portions. The middle part is provided for vehicular terrific where both side of them act as a margin space for pedestrian movements and some other functions

At the third layer of transportation, the provision and arrangement of streets in neighbourhood number 5311 is obviously different from the others. This is visible in direction and orientations of streets are provided for this neighbourhood.

Private open spaces may be classified into residential and non-residential courtyards. Often in residential plots almost 40 per cent of the plot area is available as open space, partly alongside the adjacent street (See Figure 6.11).

Open spaces may also be classified in two main categories, private and public (See Figures 6.13 and 6.14). At this level of study, public spaces mostly refer to streets and some open spaces, which act as such as children playgrounds, green spaces and pedestrian ways (See Plate 6.6). The private open spaces relate either to residential units or to governmental and public buildings, and access to them is limited.

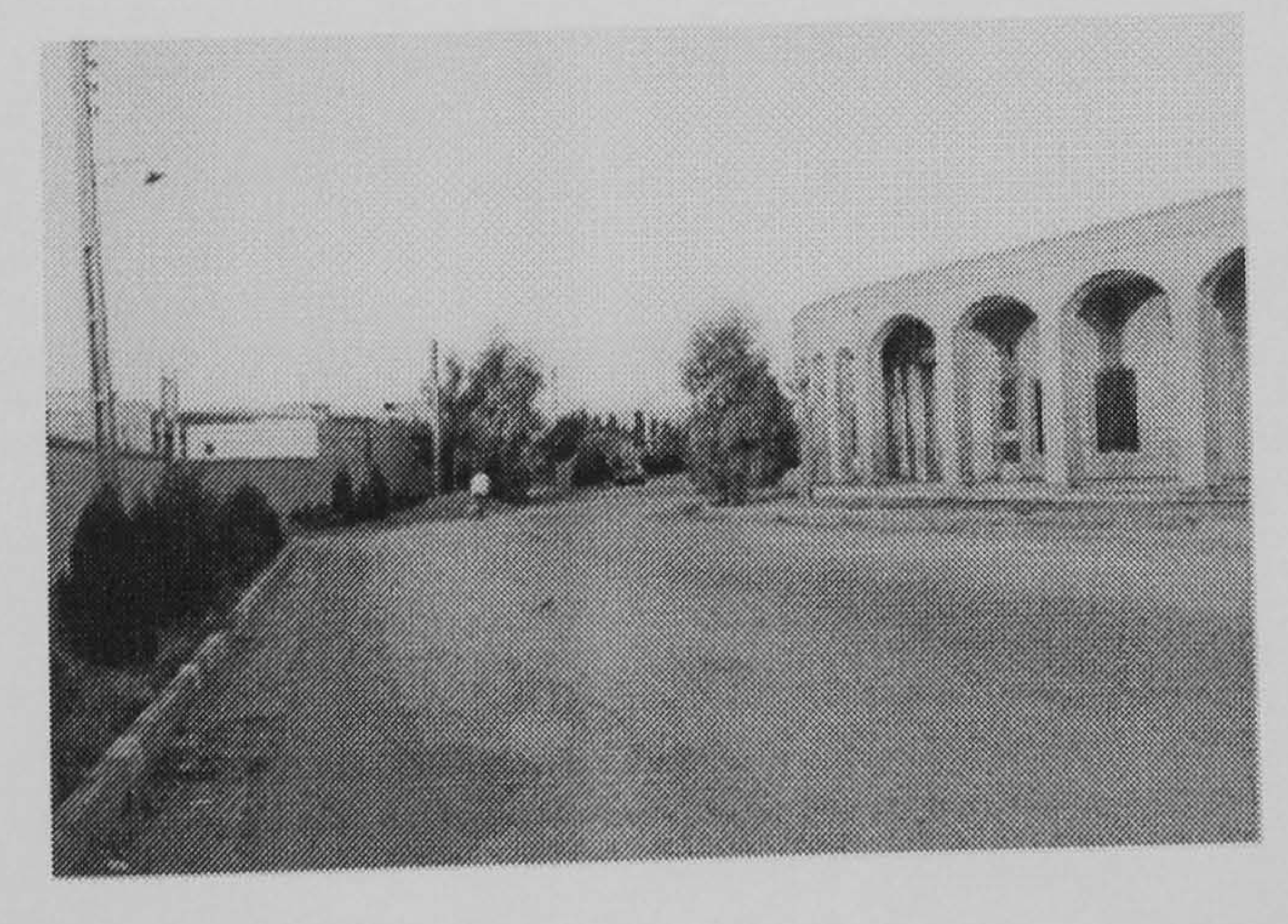


PLATE 6.6: EXAMPLES OF PUBLIC OPEN SPACES IN THE IMMAM SHAHR AREA.

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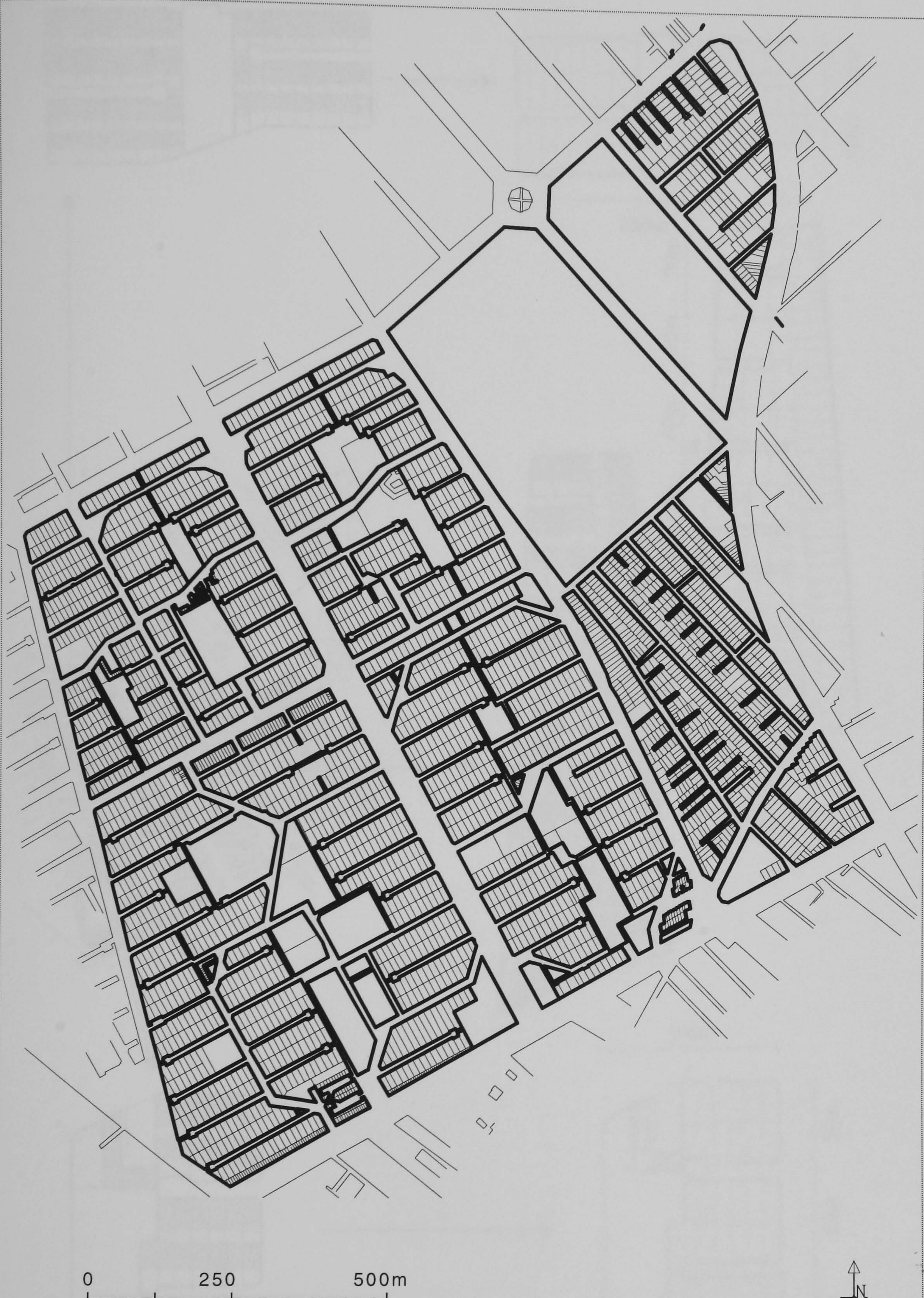


FIGURE 6.9: DISTRIBUTION OF 121 BUILDING GROUPINGS IN THE IMMAM SHAHR AREA. IN THIS AREA BUILDING GROUPS INCLUDE GENERALLY A CLUSTER OF SEVERAL DWELLING UNITS BUT MAY ALSO CONSIST OF A SINGLE NON-RESIDENTIAL UNIT

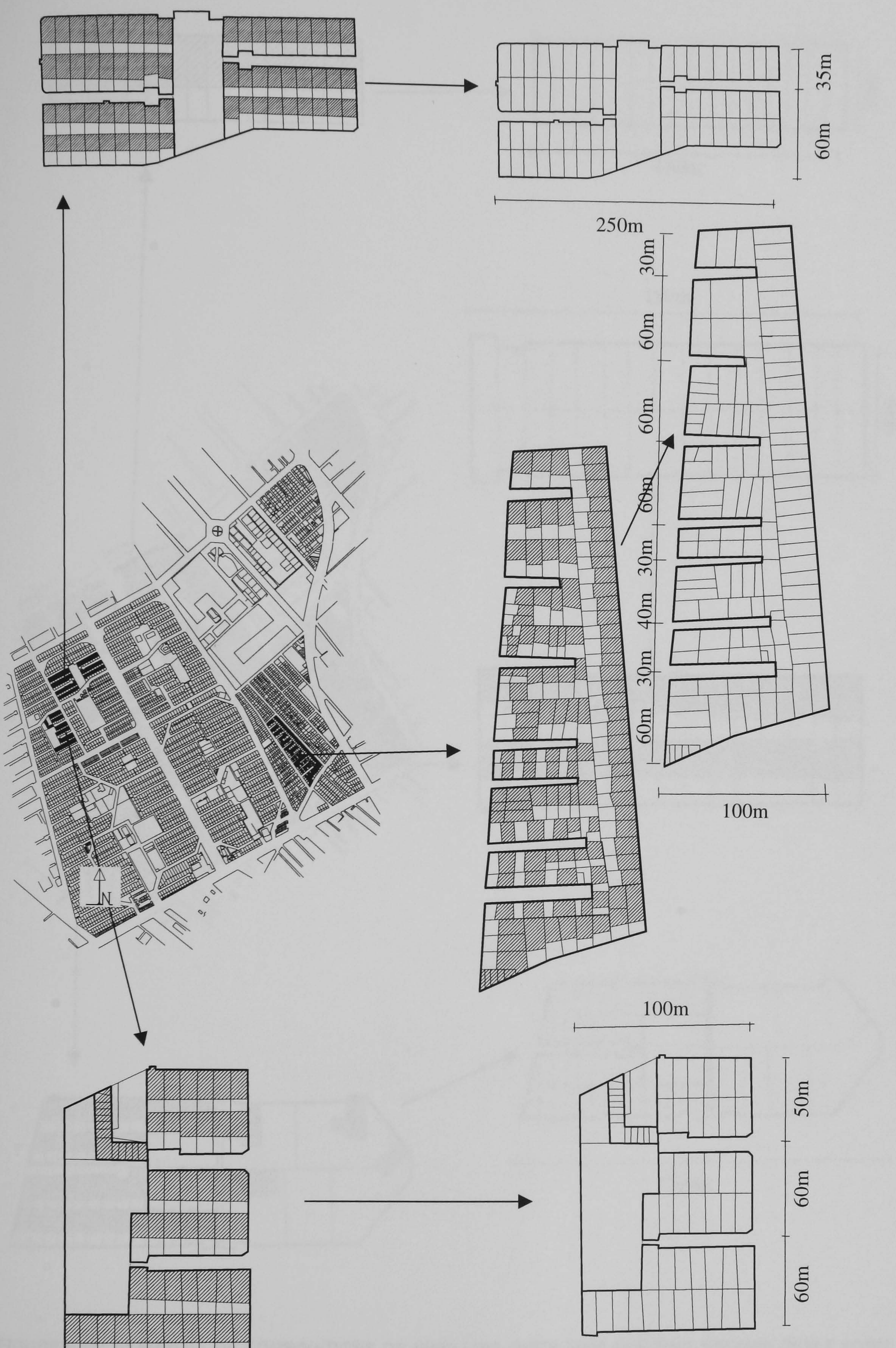


FIGURE 6.10: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)

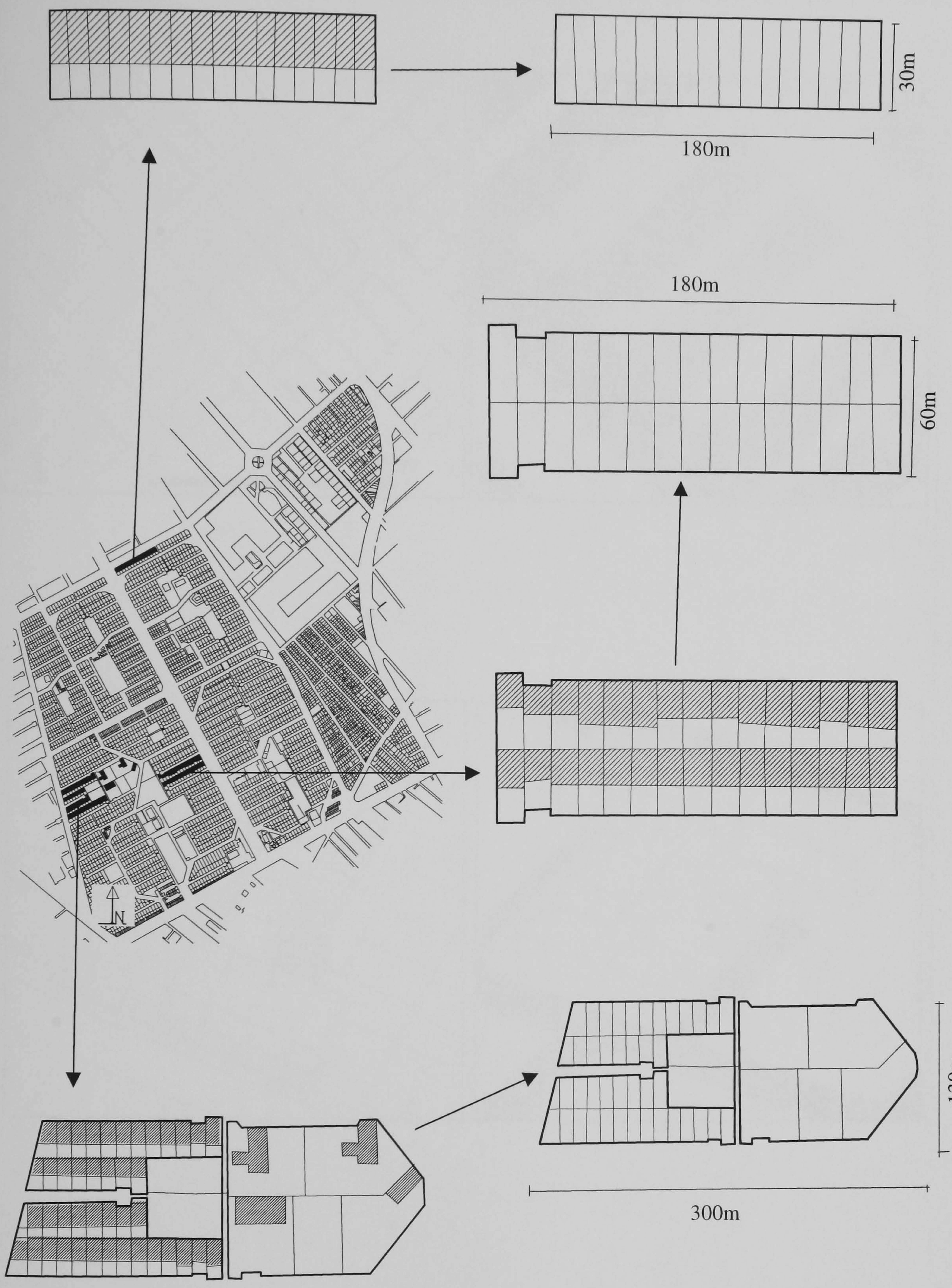


FIGURE 6.11: EXAMPLES OF COMBINATIONS OF DWELLING UNITS INTO BUILDING GROUPS (BUILT FORM AND LAND SUBDIVISION)

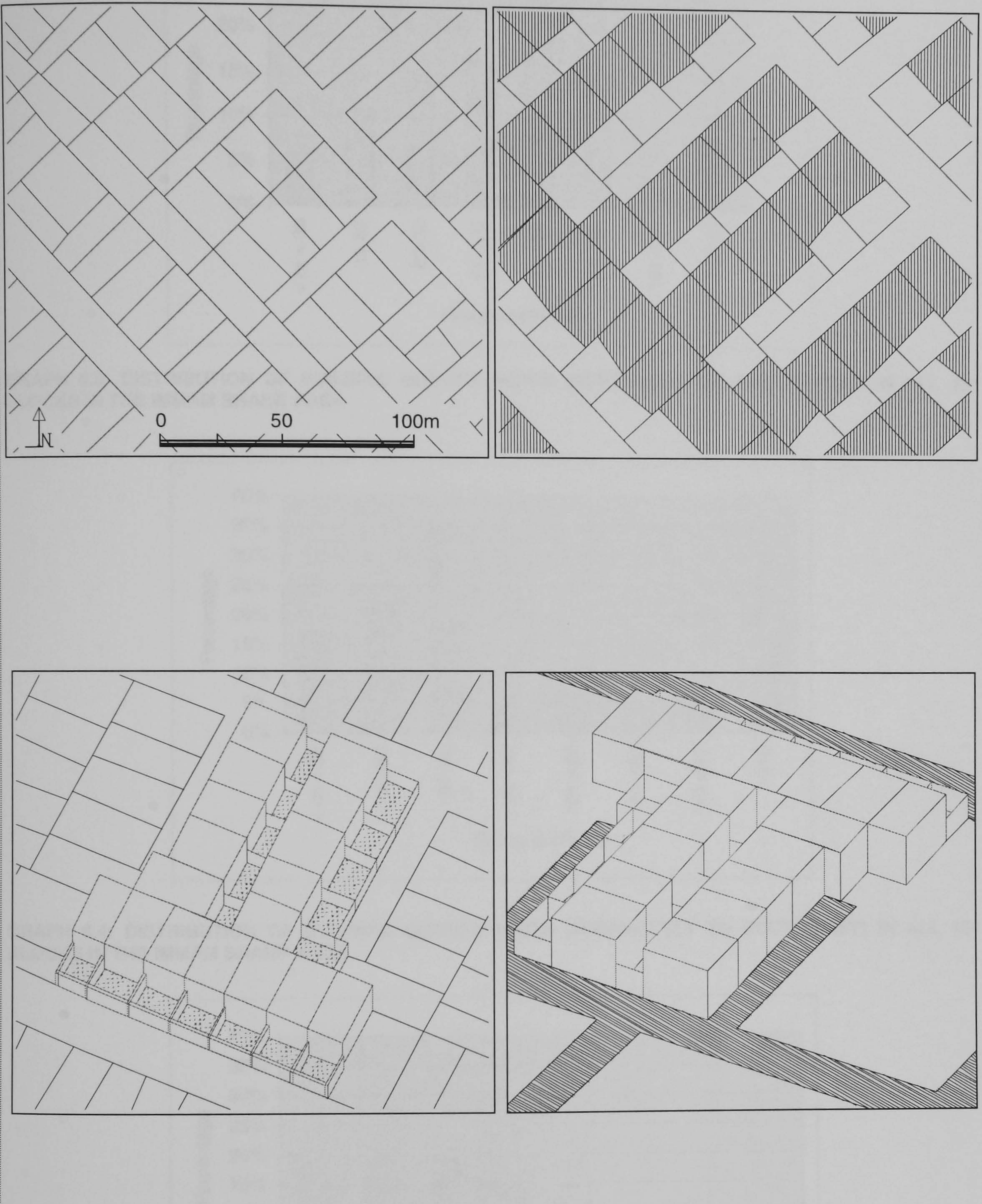
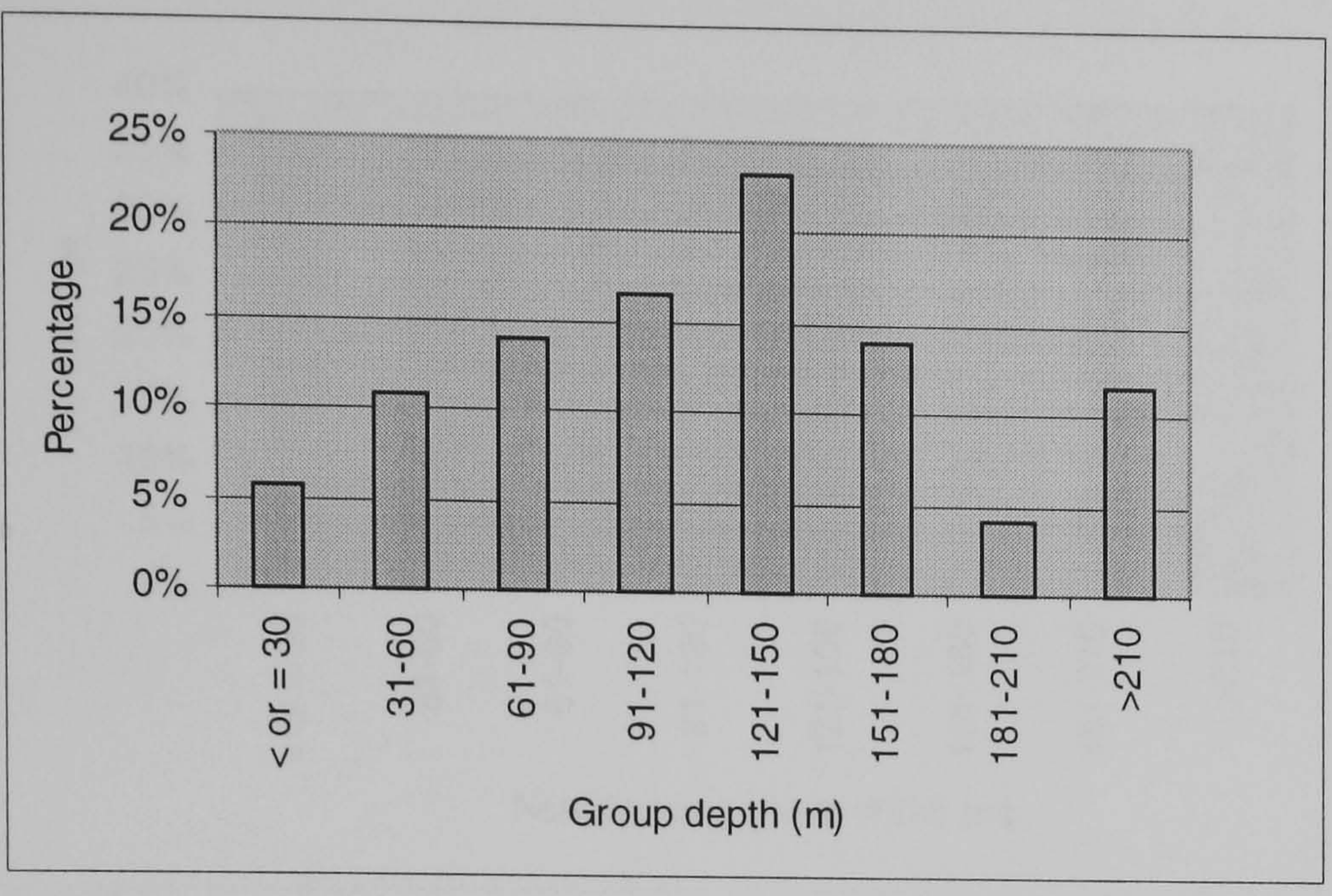
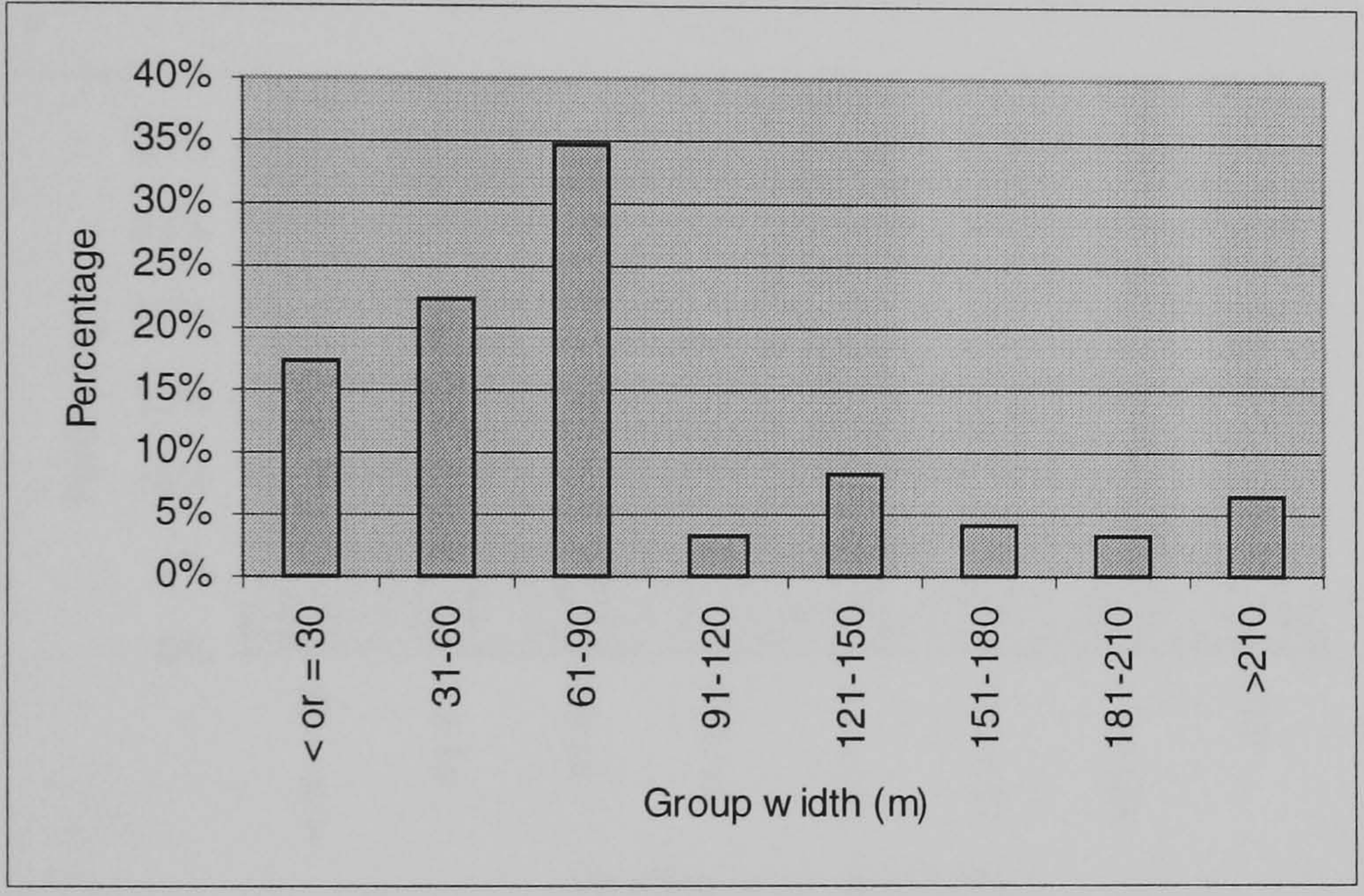


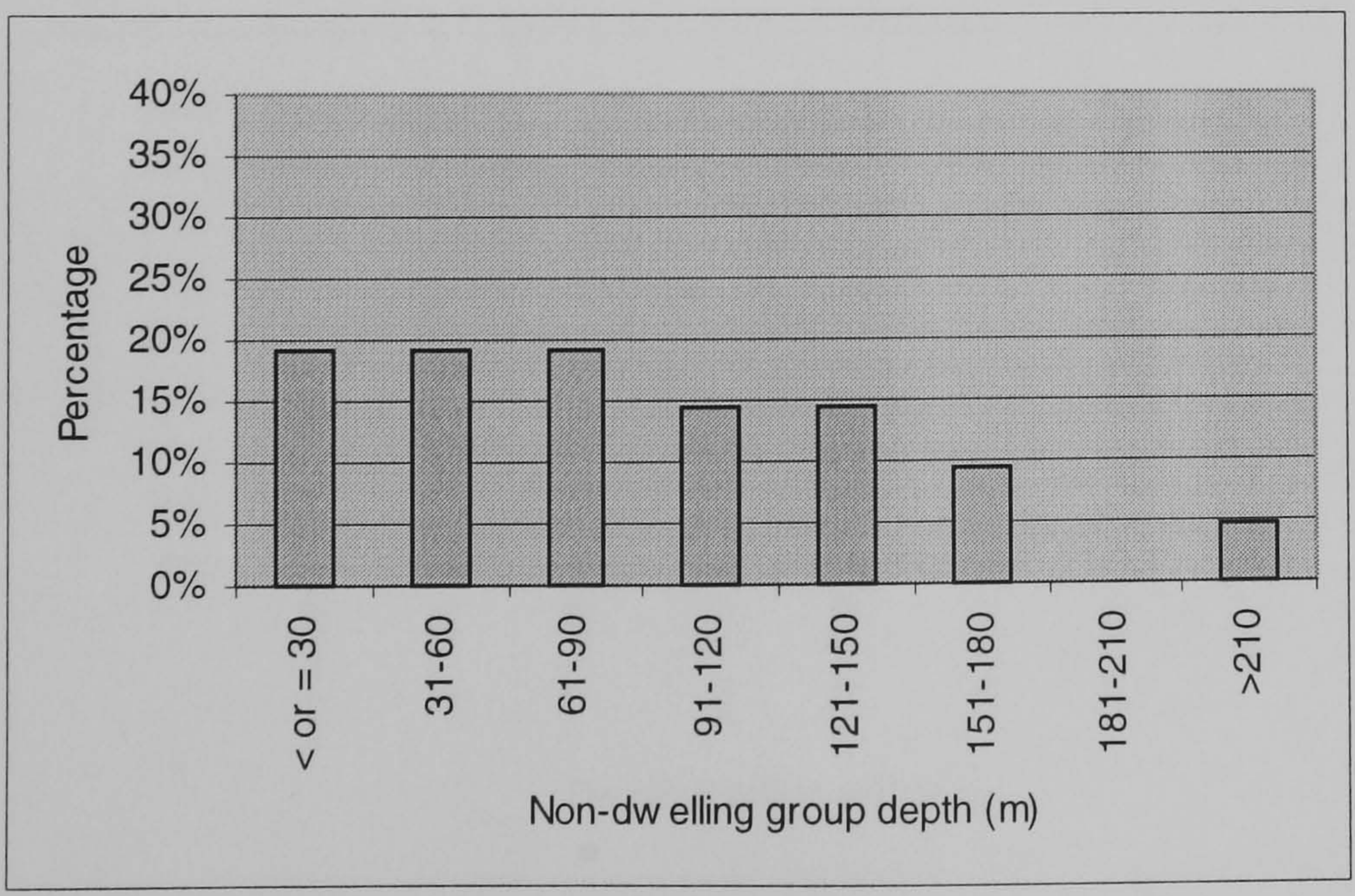
FIGURE 6.12: RESIDENTIAL BUILDING GROUPS IN THREE DIMENSIONS WITH GENERAL HEIGHT OF ONE STOREY ABOUT 4.5 METRES ABOVE THE GROUND LEVEL



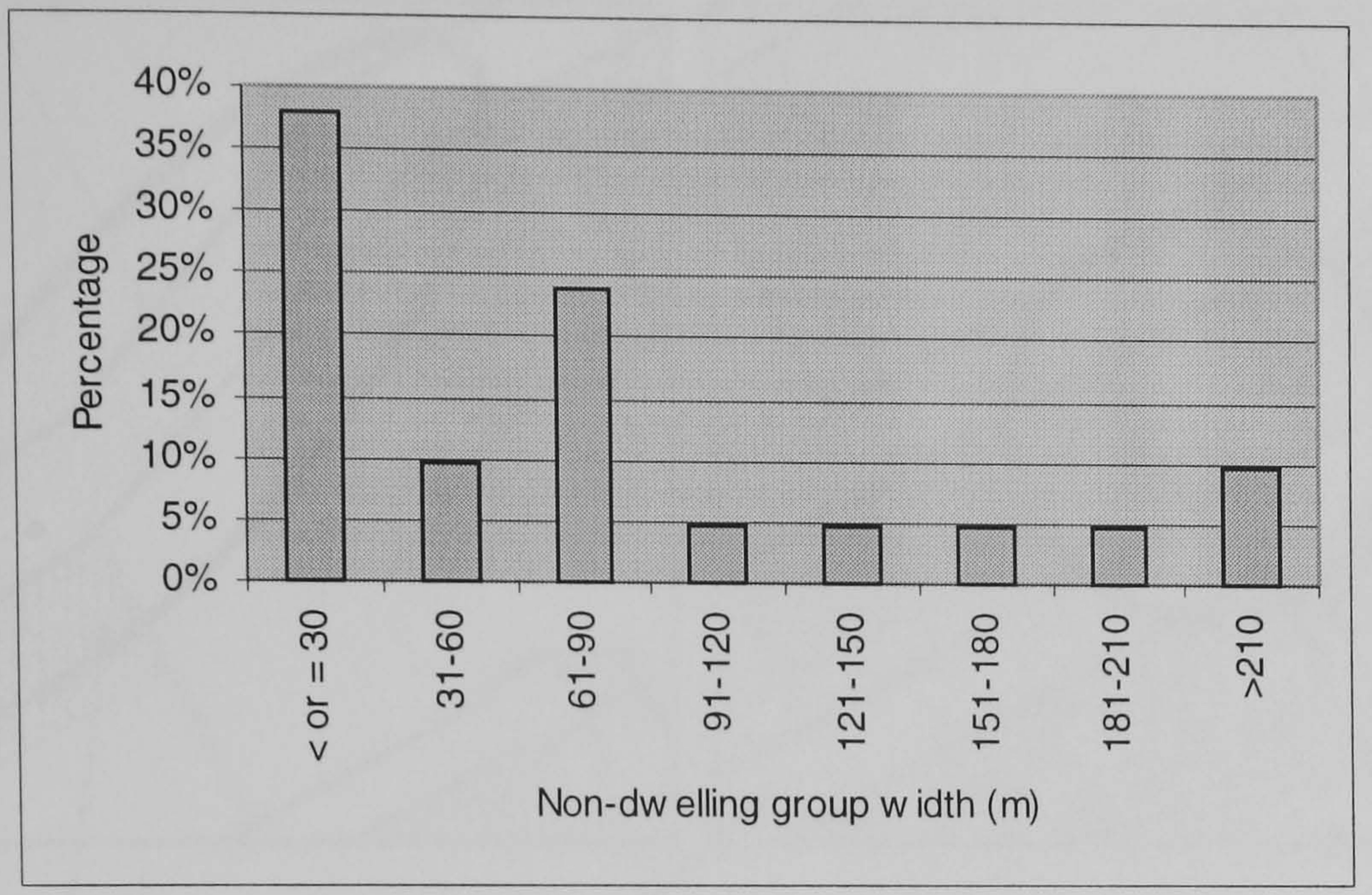
GRAPH 6.3: DISTRIBUTION OF BUILDING GROUPS DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 121 BLOCKS IN THE IMMAM SHAHR AREA



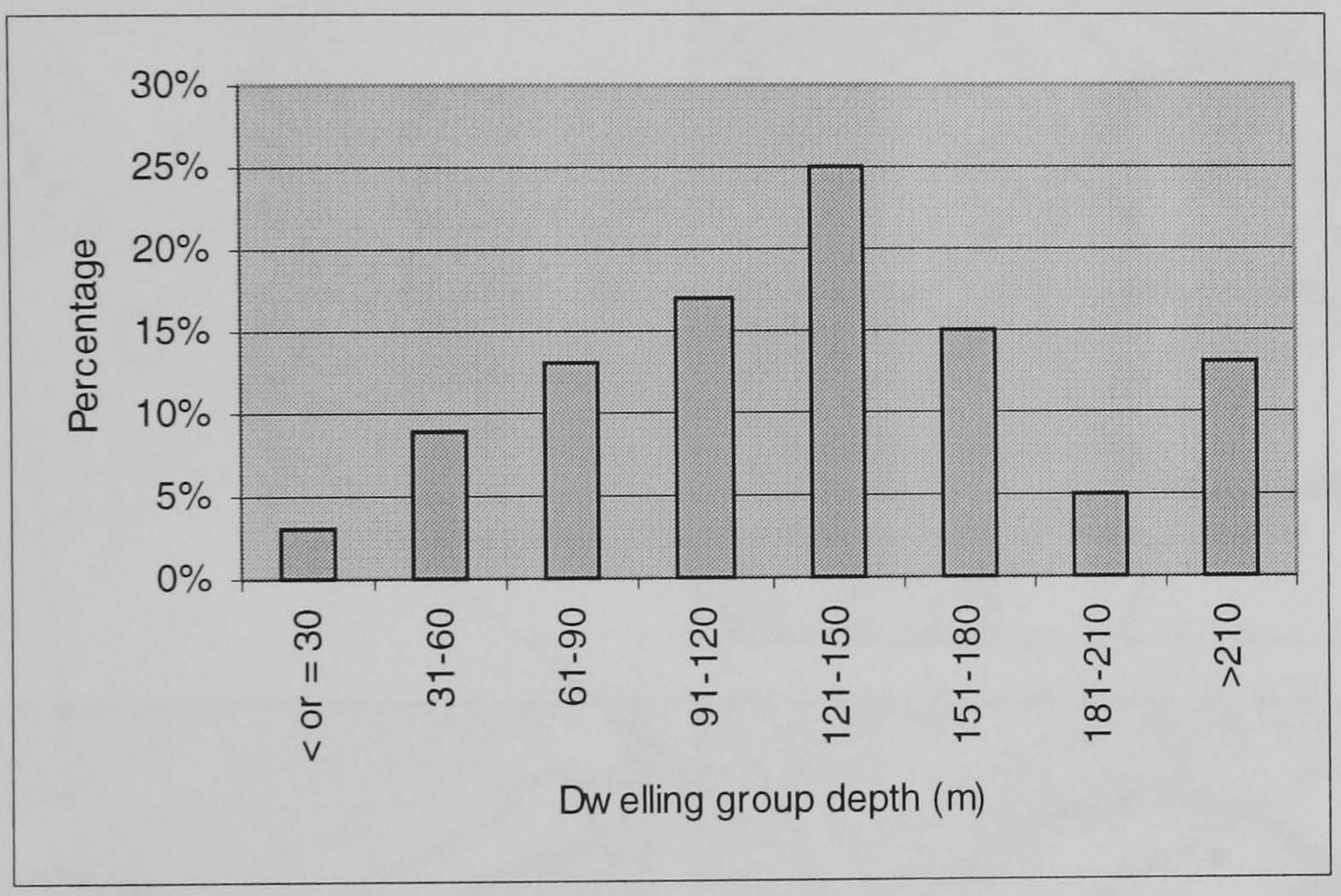
GRAPH 6.4: DISTRIBUTION OF BUILDING GROUPS WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 121 BLOCKS IN THE IMMAM SHAHR AREA



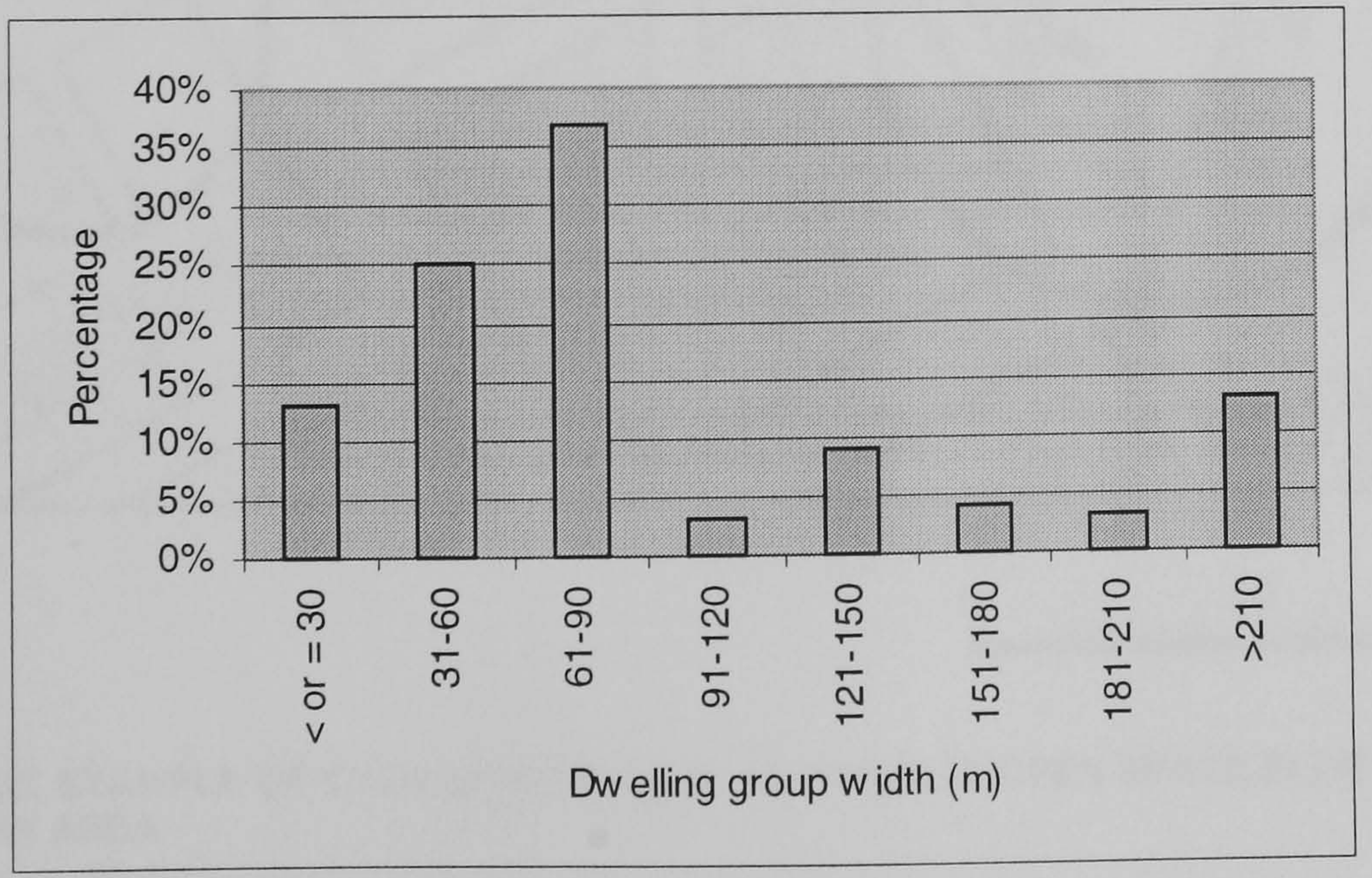
GRAPH 6.5: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN 21 NONE-DWELLING GROUPS IN THE IMMAM SHAHR AREA



GRAPH 6.6: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN 21 NON-DWELLING GROUPS IN THE IMMAM SHAHR AREA



GRAPH 6.7: VARIATION OF GROUP DEPTH (NORTH-EAST TO SOUTH-WEST) IN ALL 100 DWELLING GROUPS IN THE IMMAM SHAHR AREA



GRAPH 6.8: VARIATION OF GROUP WIDTH (NORTH-WEST TO SOUTH-EAST) IN ALL 100 DWELLING GROUPS IN THE IMMAM SHAHR AREA

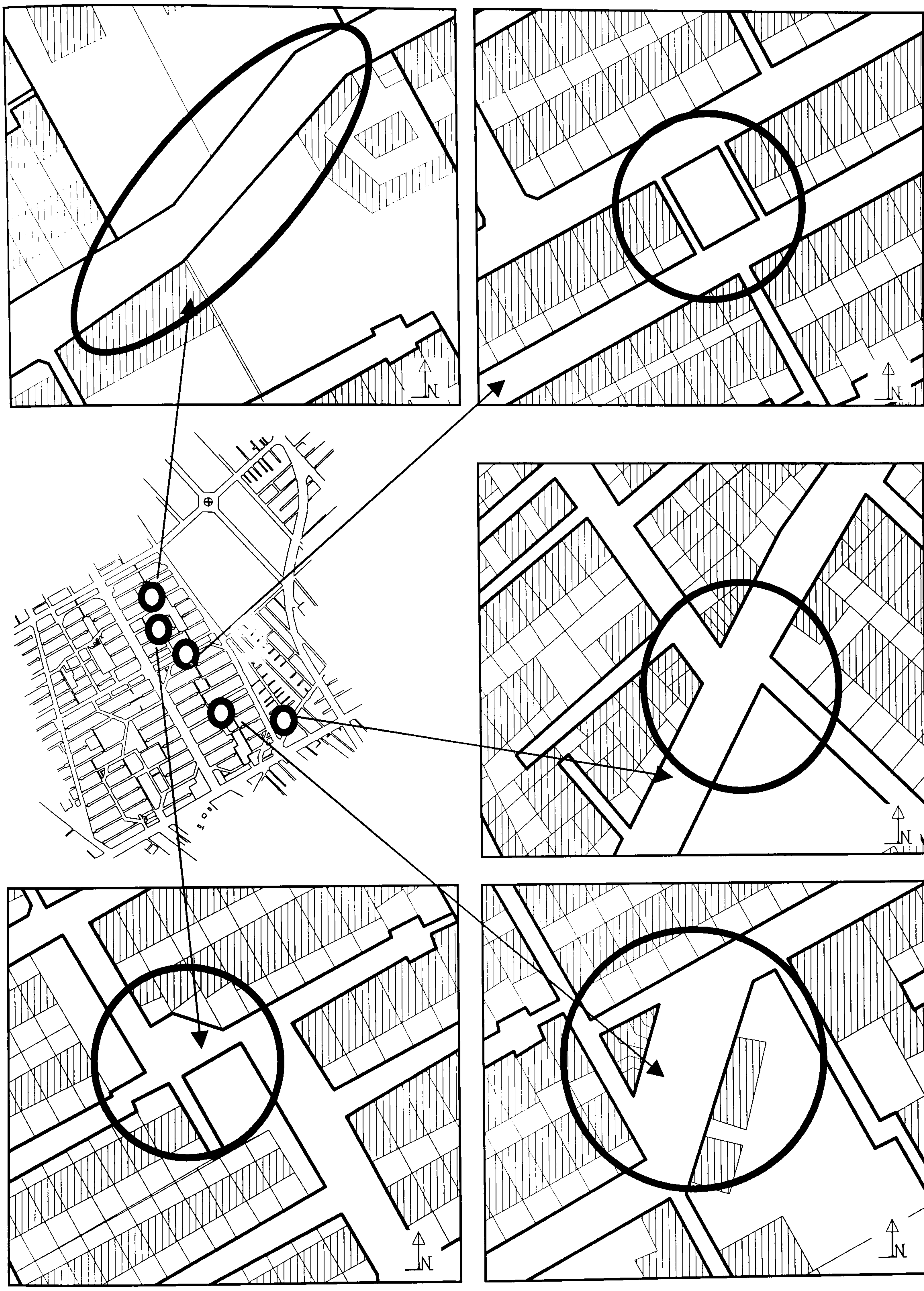


FIGURE 6.13: SOME EXAMPLE OF OPEN SPACES ACTS AS A PUBLIC OPEN SPACE IN DIFFERENT PART OF THE IMMAM SHAHR AREA

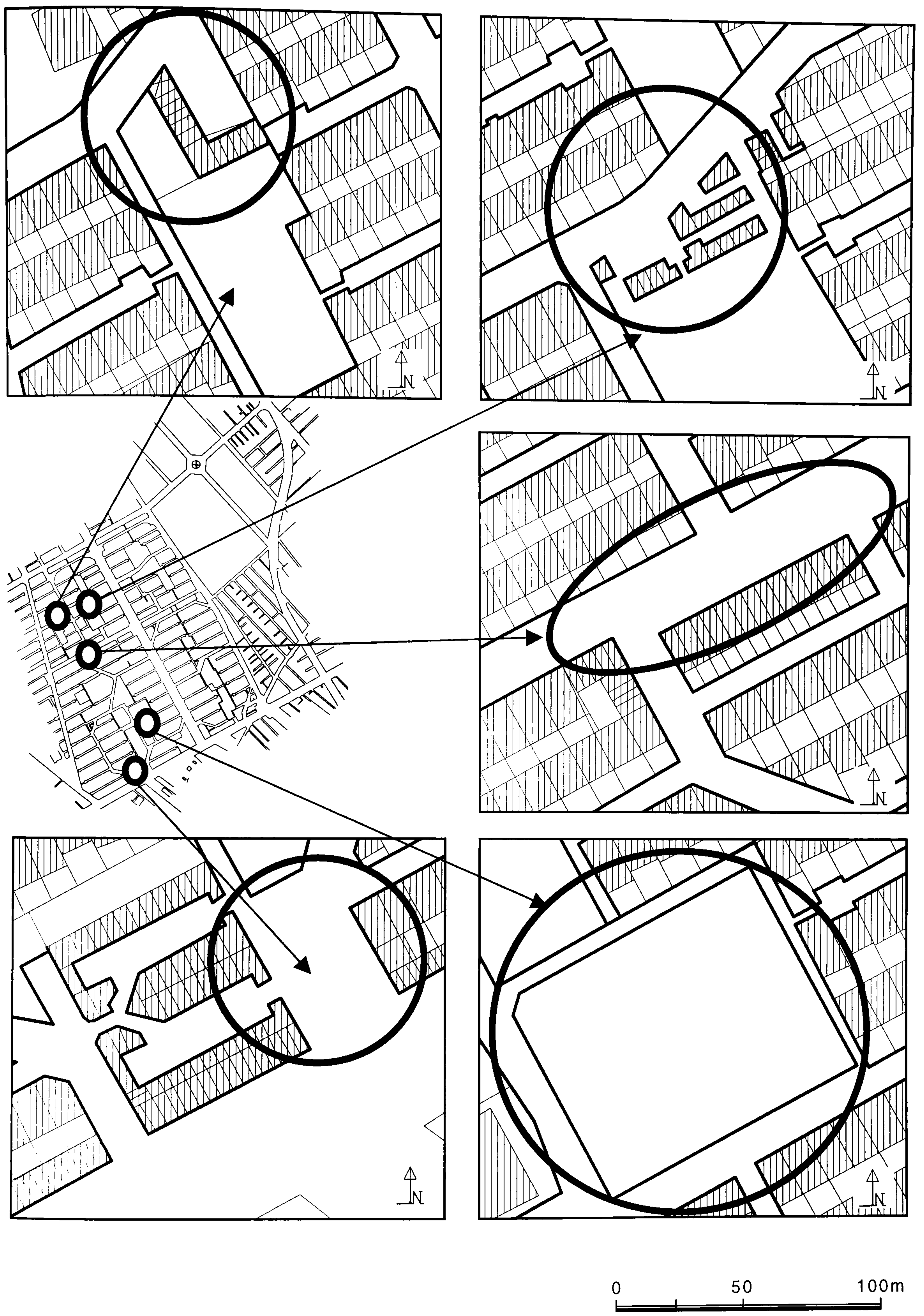


FIGURE 6.14: SOME EXAMPLE OF OPEN SPACES ACTS AS A PUBLIC OPEN SPACE IN DIFFERENT PART OF THE IMMAM SHAHR AREA

6.4.3. SUMMARY OF FINDINGS AT BUILDING GROUP LEVEL

The morphological structure at the group unit level of the typical area in the new part of the city of Yazd has resulted in the description of a pattern, which may be summarised by the following points:

1- Each group unit is in turn divided into several plots in a regular shape.

2- Plots are basically rectangular, with the average depth of 30 meters, substantially exceeding the width, which are generally 10 to 20 metres. They are normally combined with longer sides adjacent in an east-west direction to form building groups.

3- The dwelling plots contain private open areas in a fairly uniform pattern of a square open spaces located on one of the extreme side of the unit. These often have direct access to the adjacent streets. The location of these open spaces depends upon the orientation and placement of the plot within the building group.

4- Access to the units is normally gained directly from the streets through a courtyard to the building or directly to the building.

6.5. THE MORPHOLOGY AT BUILDING LEVEL

After a considerable detailed study of the area in the upper level of the study now the attention turn to the lowest level of morphology, that is the building unit. The aim of this part is to provide a description of the general pattern and characteristics of the building units within the building groups. To cover most units of the area the study continued in two subtitles one dwelling unit and the other non-dwelling unit. There are 2628 residential units in Immam Shahr. The average plot area of dwelling units in this area is about 340 sq.m (See Table 6.5).

6.5.1. TYPICAL HOUSE

The narrow and deep terrace house occupies a lot of 12 or 15 meters by 30 meters or sometimes more (See Figure 6.17). This type of plot is very common in new development areas of Yazd.

Generally four basic type of houses forms are identified (See Figure 6.15). This classification is according to the location of built space in the lot and the position of access to the plot. Most of buildings are orientated 30 degree toward south-east (See Figure 6.16). The dwellings, though subdivided, are rigidly rectangular with a much larger north-south dimension than an east-west dimension.

The larger part of the area consists of modern dwellings in single and in some part double storeys (See Table 6.6). There are only around 135 building which have more than two stories and are mostly located at the edge of the study area, close to the main roads or parameter streets. These building are instances of 'terrace' housing in the city of Yazd. Generally, however, the buildings are modern example of housing development erected in the locality since 1960s.

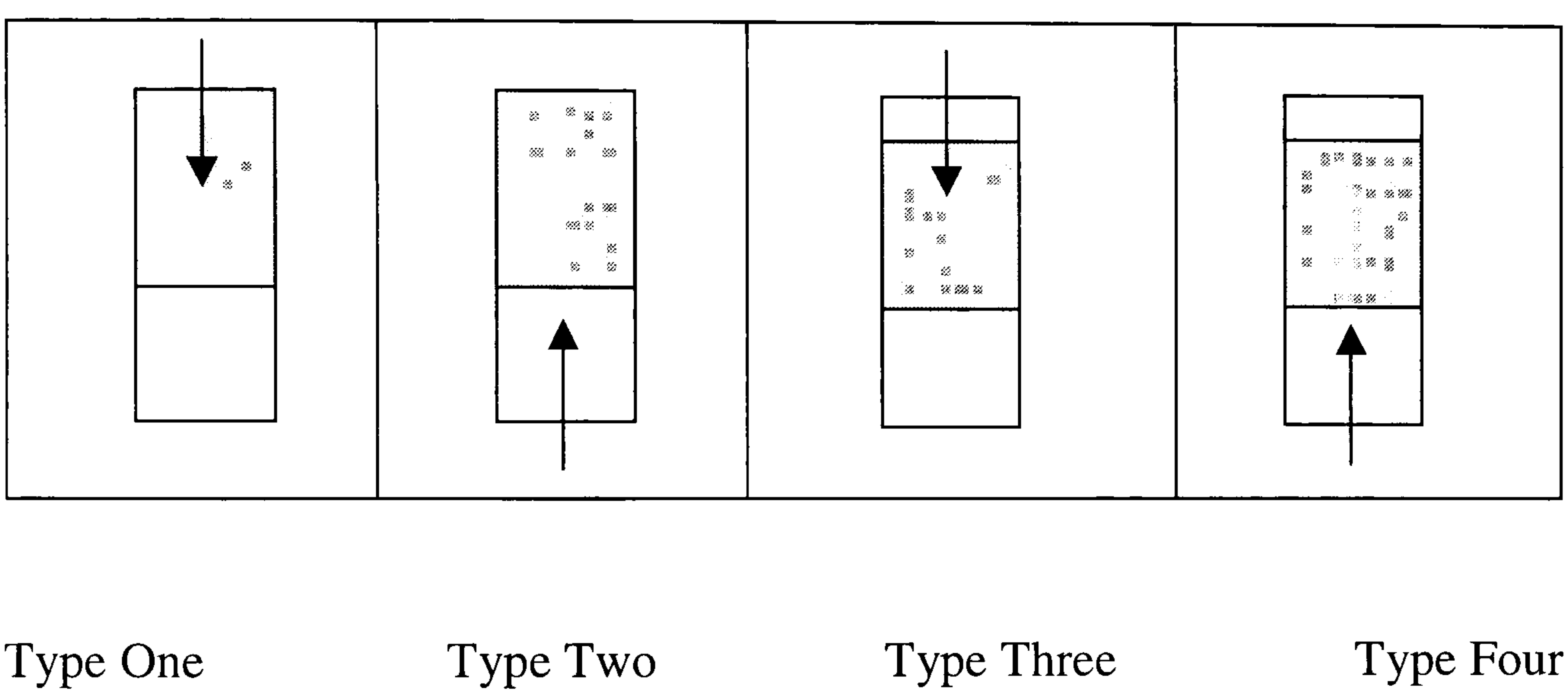


FIGURE 6.15: FOUR BASIC TYPES OF HOUSES AND LOTS IN THE IMMAM SHAHR AREA

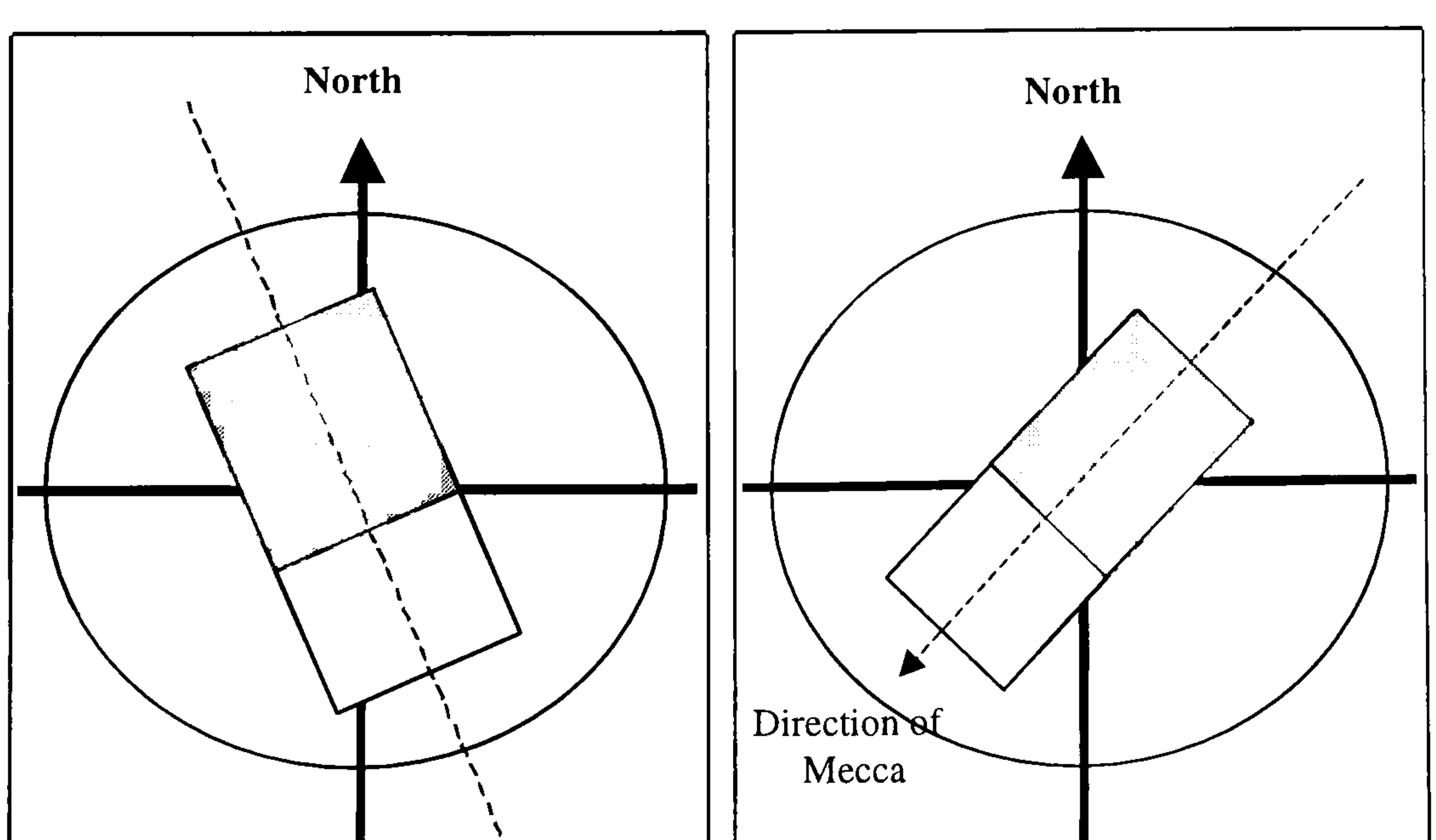


FIGURE 6.16: GENERAL ORIENTATION OF THE DWELLING UNITS IN THE IMMAM SHAHR AREA

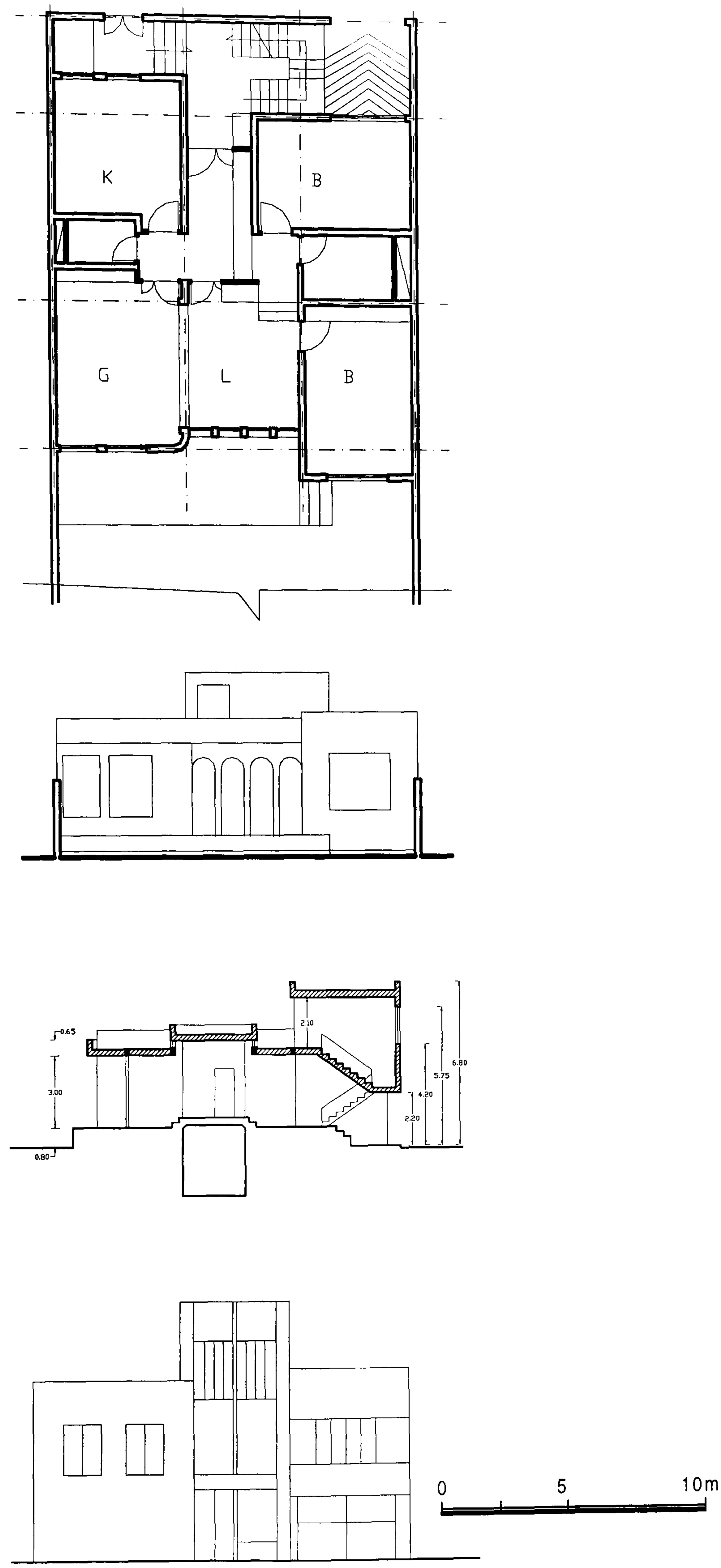


FIGURE 6.17: A TYPICAL EXAMPLE OF DWELLING UNIT IN THE IMMAM SHAHR AREA.

	5311	5312	5321	5322	5311	total
No of residential units	435	705	258	467	675	2540
Residential area m. sq.	137041	244608	105455	162002	209581	858687
Average	315	347	409	347	789	338

TABLE 6.5: LAND ALLOCATION OF DWELLING UNITS IN DIFFERENT PART (NEIGHBORHOOD) OF THE IMMAM SHAHR AREA.

No of floor	No of units
One	570
> one and <or = two	2479
More than two	135
total	3183

TABLE 6.6: DISTRIBUTION OF DWELLING UNITS IN THE AREA ACCORDING TO THE HEIGHT OF THE BUILDINGS

6.5.1.1. ACCESS SYSTEM

Access to the interior of the building unit is generally gained by means of the entrance on the street front. Therefore, all dwelling units have direct access to the linear streets provided to make vehicular and pedestrian access to the plots (See Figure 6.18). In types one and three there are mostly two doors one for pedestrians and another which is wider, called the garage gate. In types two and four, two doors are combined together for car and pedestrian access. In the latter types the access is through the courtyards, the former, it is through the building.

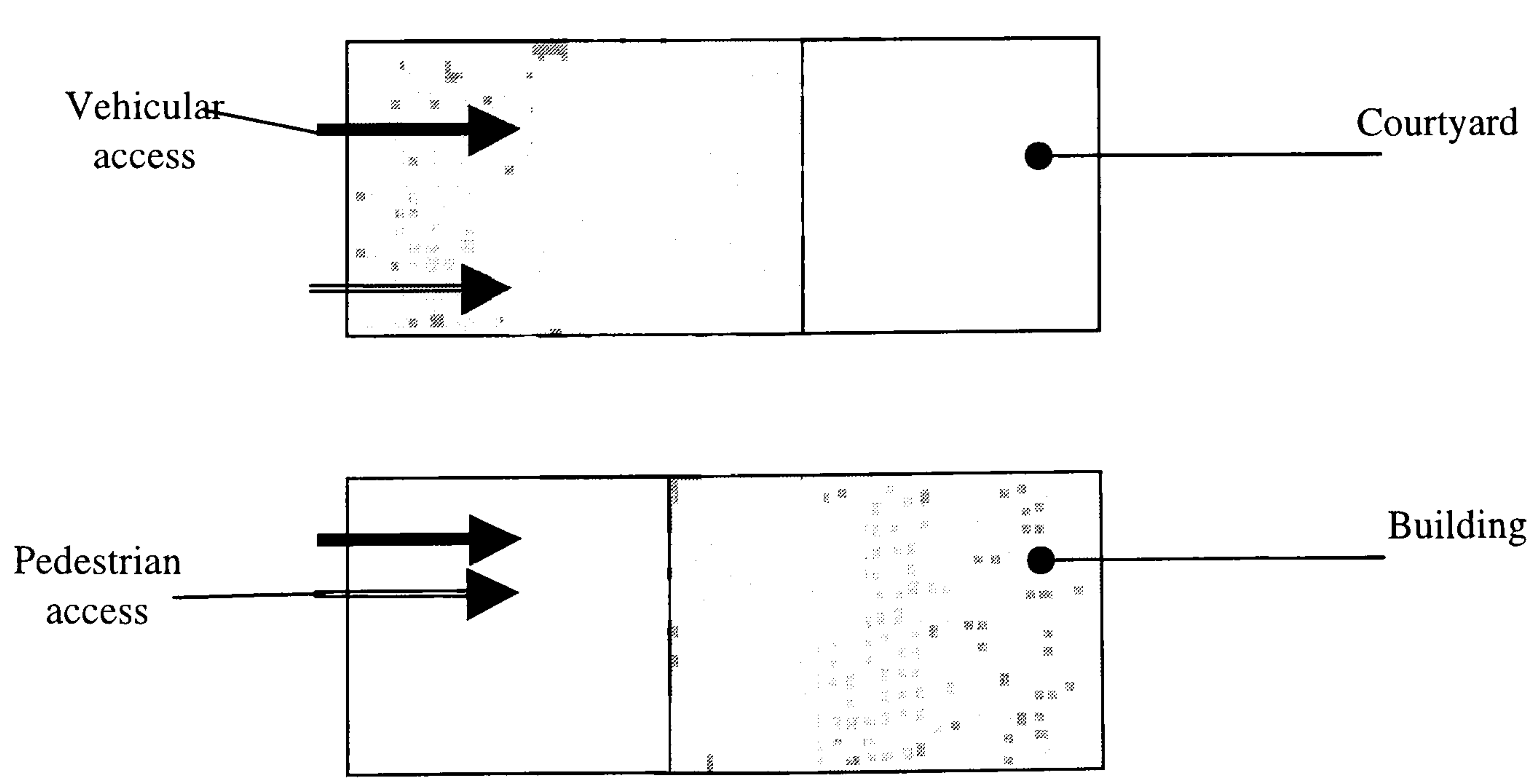


FIGURE 6.18: TYPICAL ACCESS SYSTEM TO THE DWELLING UNITS IN THE AREA.

6.5.1.2. THE MATERIAL OF WHICH THE HOUSE IS ERECTED

Building materials of all types are used in the building construction of the area, varying from what can be called strategic materials such as cement and structural steel to other structural materials including brick and blocks. Most of the single dwelling units are constructed with a load-bearing wall system. Buildings with more than two storeys are usually constructed with a steel frame system. All of the roofs are flat and are covered by mosaic tiles. The external walls of the building units are often made of bricks, which may on occasions be plastered. Flat roofs are normally covered with tiles.

6.5.2. NON-RESIDENTIAL UNITS

Non-residential plots are mostly in rectangular shape and have a range between 250 sq. meters to 6000 sq. meters (See Figure 6.19). These units are varied in function and located centrally in between dwelling units. There is very close relationship between the dwelling units and non-residential units. Access to the interior of the non-residential unit is generally gained by means of the entrance on the street front. The built part of these units exposed either centrally or to one side of the plot and therefore the built part has an external demonstration in which there are four elevations in evidence. Non-residential buildings are constructed in one and two storeys. There are 555 non-residential units in Immam Shahr. The average plot area of non-dwelling units in this area is about 960 sq.m.

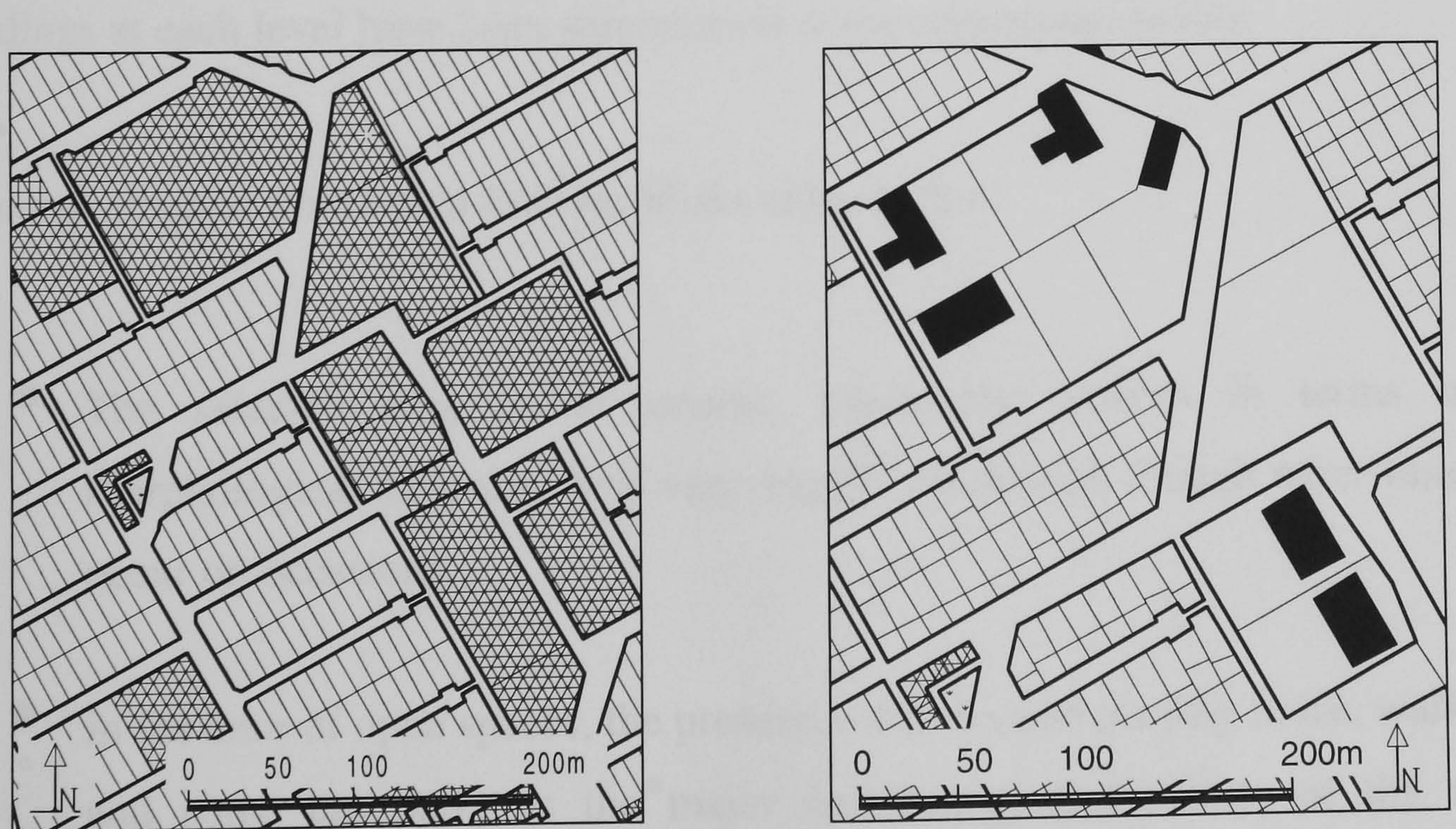


FIGURE 6.19: NON-RESIDENTIAL UNITS AREA ARE LOCATED CENTRALLY IN THE IMMAM SHAHR IN BETWEEN DWELLING UNITS

6.5.3. SUMMARY OF FINDINGS AT BUILDING LEVEL

The morphological pattern of the units may be summarised by the following points:

1- The plan form of dwelling units is a rectangular shape often around 340 sq.m and dimension of 12-meter width and around 30 meter deep.

2- The dwellings have two parts built-up portion, one, two and occasionally three storeys high, and a courtyard located close to the street or on the extreme part of the plot.

3- Dwelling units are generally oriented 30 degrees from South, toward the Southeast.

6.6. SUMMARY AND CONCLUSION

In this chapter the morphology of a typical new development part of the city of Yazd has been described at four levels, district, block, building group and unit, mainly in term of the built forms and open spaces, their disposition and relationship to each other. It addresses these questions: What is the essence of the built environment which has newly developed beyond the old city in terms of morphological character? What is the relationship and disposition of these elements with each other? The main characteristics of findings at each level have been summarised at the appropriate points.

The morphological findings in Immam Shahr indicate that:

- The selected area is, of course, essentially modern in terms of its morphological structure. It is very largely residential, though other functions occur on occasions.

- In the case of open spaces, the presence of parks and playing fields, walkways and some car park, as the major morphological elements of the newly developed area, are in evidence.

- The analysis of this particular part of Yazd shows how the traditional city of Yazd has undergone radical changes in its physical form, not only through internal physical transformations but also in its vast territorial expansion.

- The basic morphological pattern at four levels of study has been described in terms of the major characteristics. A degree of uniformity in the layout has been observed, with the primary elements occurring at comparatively regular intervals. There is a high uniform distribution of building groups in the area. The means of access have been a significant factor, first with regard to the building groups and then to the units.

- The direct relation between the street system puts emphasis on the importance of thoroughfares which introduced a very rigid shape of building groups and in turn a rectangular form of dwelling units.

- The morphological pattern of Immam Shahr is characterised by the repetition of a small number of particular features rather than by the presence of a few outstanding buildings. There is a major open space within the study area, the location of parks and playgrounds, which may be regarded as a singular element at this level of study.

The morphological analysis of a new area such as Immam Shahr has identified a set of new urban elements and typological transformations. Therefore it is suggested that for better understanding of the newly built environments and the elements which they include, in the case of Yazd, a set of revisions of morphological principle may be unavoidable.

In the last three chapters the detailed morphology of the three chosen areas of Yazd was explained. Attention in the next chapter will be given to certain characteristics of the building groups in all three areas.

Chapter Seven:

7. FURTHER MORPHOLOGICAL ANALYSIS OF THE BUILDING GROUPS

The study of urban morphology of Yazd has been described in the last four chapters. It has demonstrated the processes of formation and transformation in the various levels of morphological analysis. It has also shown that despite some alteration in the built form at different levels of morphology, the building groups which appeared in the historical and old parts of the city still remain in their original forms. They act as the principal component of the spatial arrangement of the built environment, not only in the historical and old parts of Yazd but also in the newly developed area. In this section, it is intended to give rather more attention to certain mainly statistical characteristics of the building groups identified in the previous three chapters.

7.1. GENERAL CONSIDERATIONS FOR FURTHER ANALYSIS

Whereas consideration was previously given to the general characteristics of building groups, there will also be made some comparisons, throughout this chapter, between various characteristics of the building groups developed in various stages of the development in Yazd. The study is based on the present situation of the building groups, although past situations may be taken into account if they are important concerning the development of the morphology. Particular consideration will be given to the general size of the building groups, spatial arrangements of the plots and access system.

In this chapter in addition to maps, scatter diagrams are used as a tool to demonstrate the degree of relationship between various spatial characters in building groups. These diagrams are useful aids to the understanding of correlation between various features of the building groups. As the nature of variables in this section is interval/ratio the most common measure of correlation used is Pearson's R. This measure of correlation allows demonstrating the strength and direction of linear relationship between variables. Pearson's R varies between –1 and +1. A relationship of –1 or +1 would indicate a perfect relationship, negative or positive respectively, between two variables. The coefficient of determination or R^2 is also used to define the relationship between different data. R^2 shows how far variation in one variable is accounted for by the others. It is also necessary to interpret both R and the significance level when computing correlation coefficients. The test of statistical significance tells us whether a correlation could have arisen by chance or whether it is likely to exist in the certain population.

7.2. BUILDING GROUPS IN THE WALLED CITY

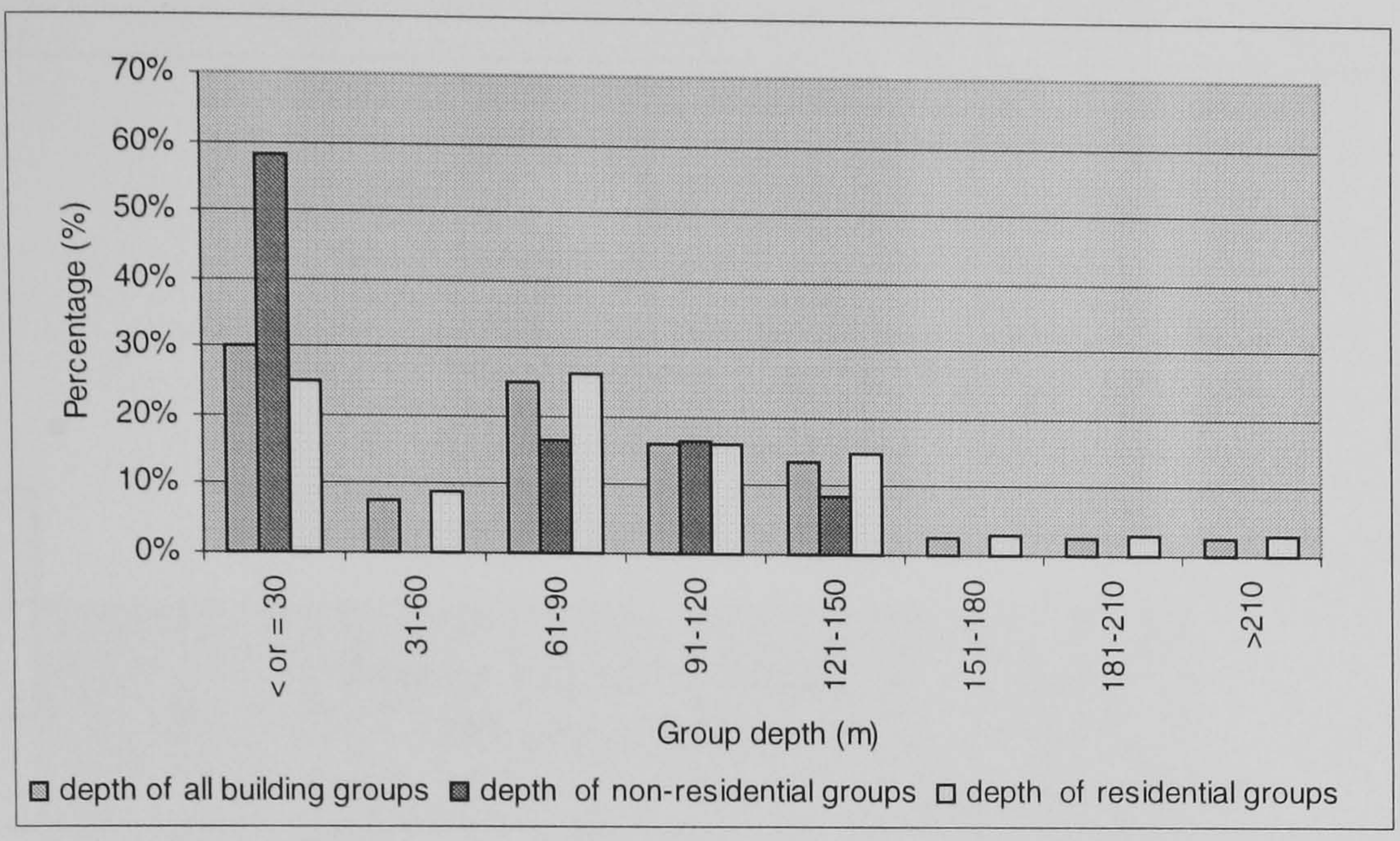
In Chapter Four the building groups which appear in the Fahhadan area have been described in some detail. In this section some more characteristics of the building groups has been examined

7.2.1. THE GENERAL SIZE OF THE BUILDING GROUPS

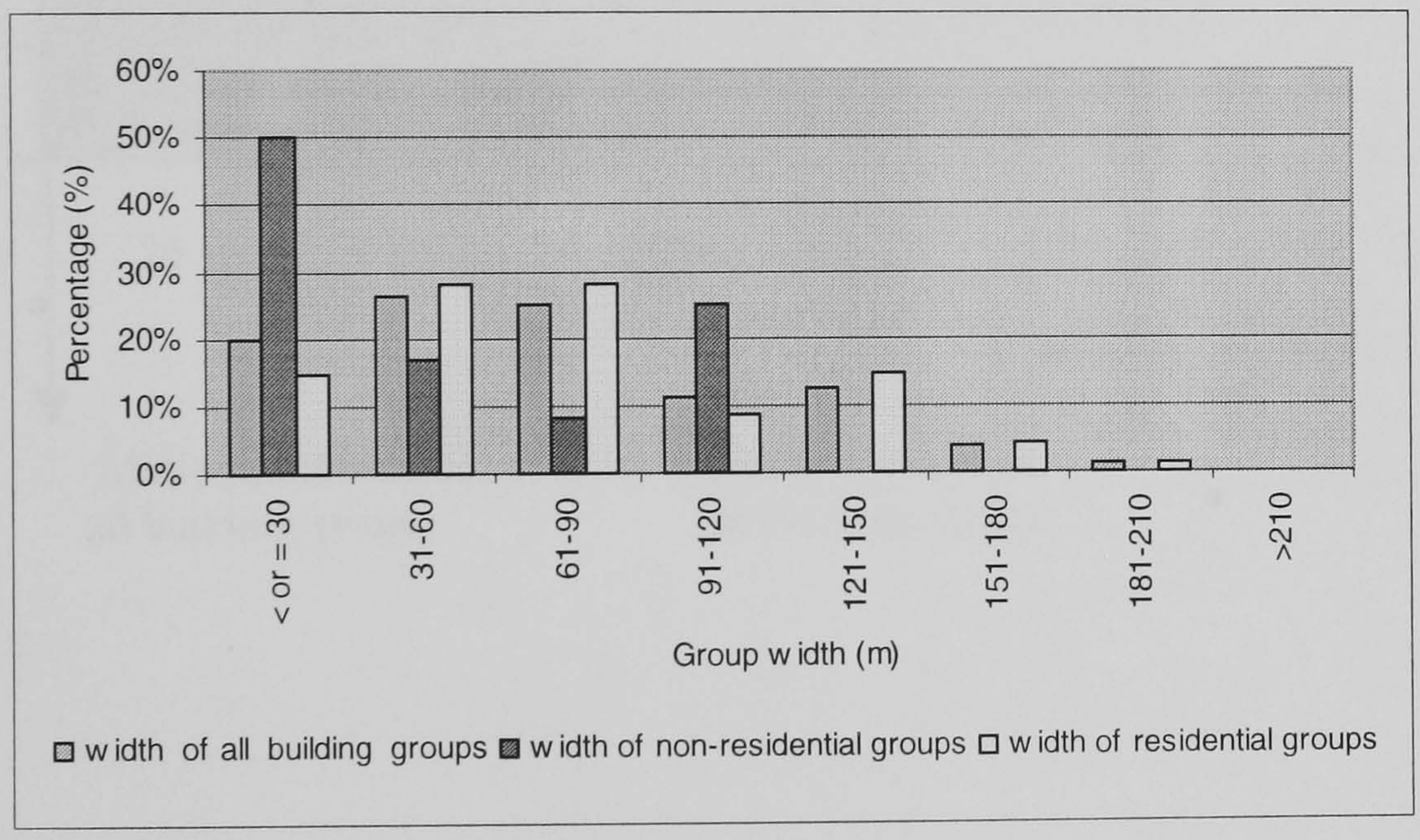
In Chapter Four, when all groups were considered, the majority of them, 63 per cent, occur within a depth range of less than 90 metres and another 30 per cent occur from 90 to 150 metres. While the largest proportion of non-residential groups, 58 per cent, have a depth range of less than 60 meters, the largest proportion of the residential groups, 60 per cent have a depth range of less than 90 metres (See Graph 7.1) (See Appendix 1).

When the width of all groups in the Fahhadan area was taken into account, a rather short spread of dimension was in evidence. Although around, 71 per cent of the groups occur within the range of less than 90 meters, 56 per cent of residential groups have wide ranges of from 30 to 90 meters. The non-residential groups were in general a little shorter than the residential groups and 56 per cent occur within ranges of from 30 to 60 metres (See Graph 7.2).

In this section, the relationship between the building group depth and width is another item to be considered. When all the building groups were considered, the depth/width ratio varied from 1:0.2 to 1:4.5. Although there is generally a perfect relationship between depth and width in all building groups appearing in the Fahhadan area (See Graph 7.3), when the depth/width ratios for non-residential building groups were considered comparatively a better relationship emerged (See Graph 7.4). In contrast, in that of residential groups even a weaker relationship was in evidence (See Graph 7.5). The summary of building group sizes in terms of building group depth and width is shown in Fig. 7.1



GRAPH 7.1: BUILDING GROUP DEPTH DISTRIBUTION IN THE FAHHADAN AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS



GRAPH 7.2 BUILDING GROUP WIDTH DISTRIBUTION IN THE FAHHADAN AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS

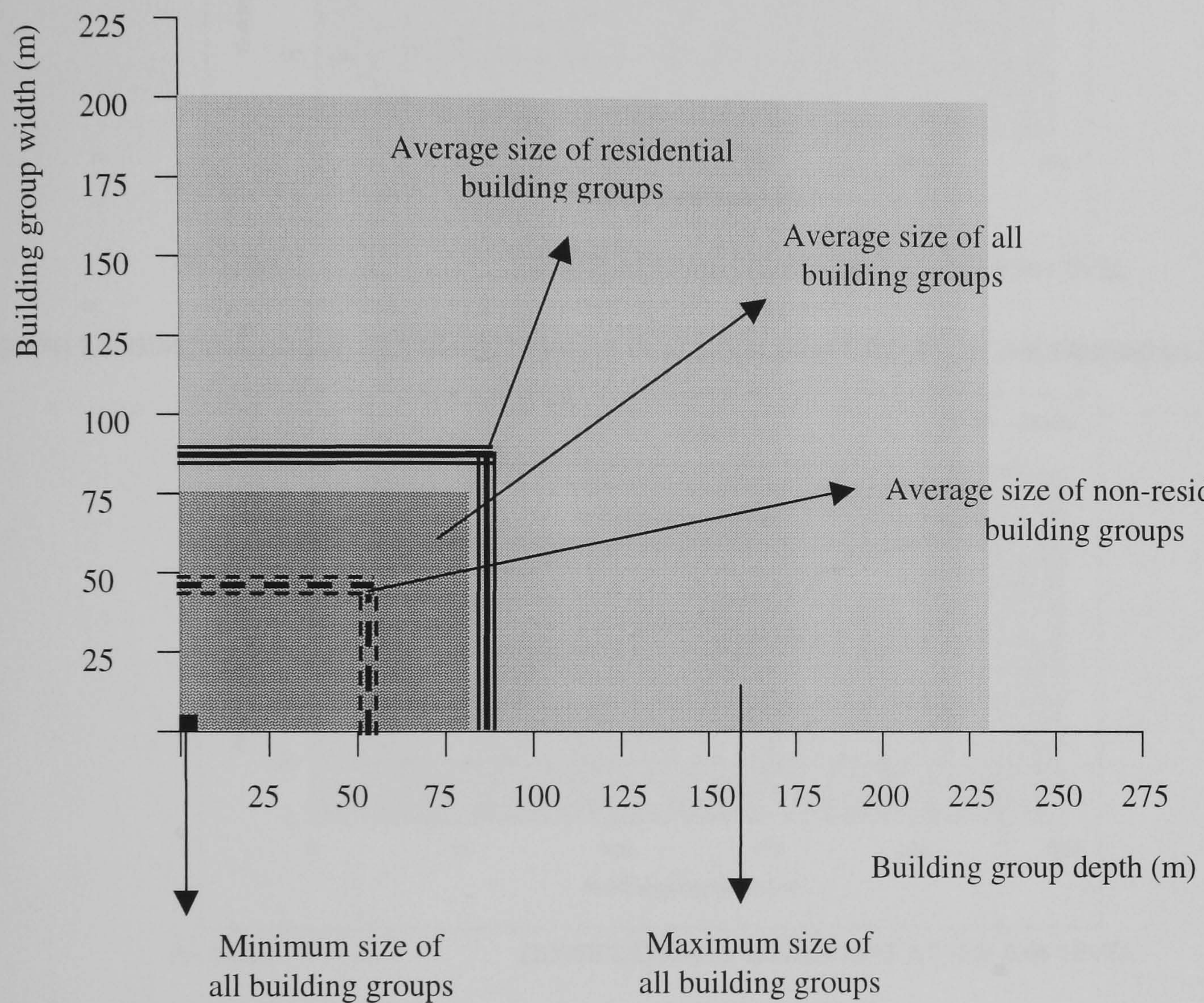
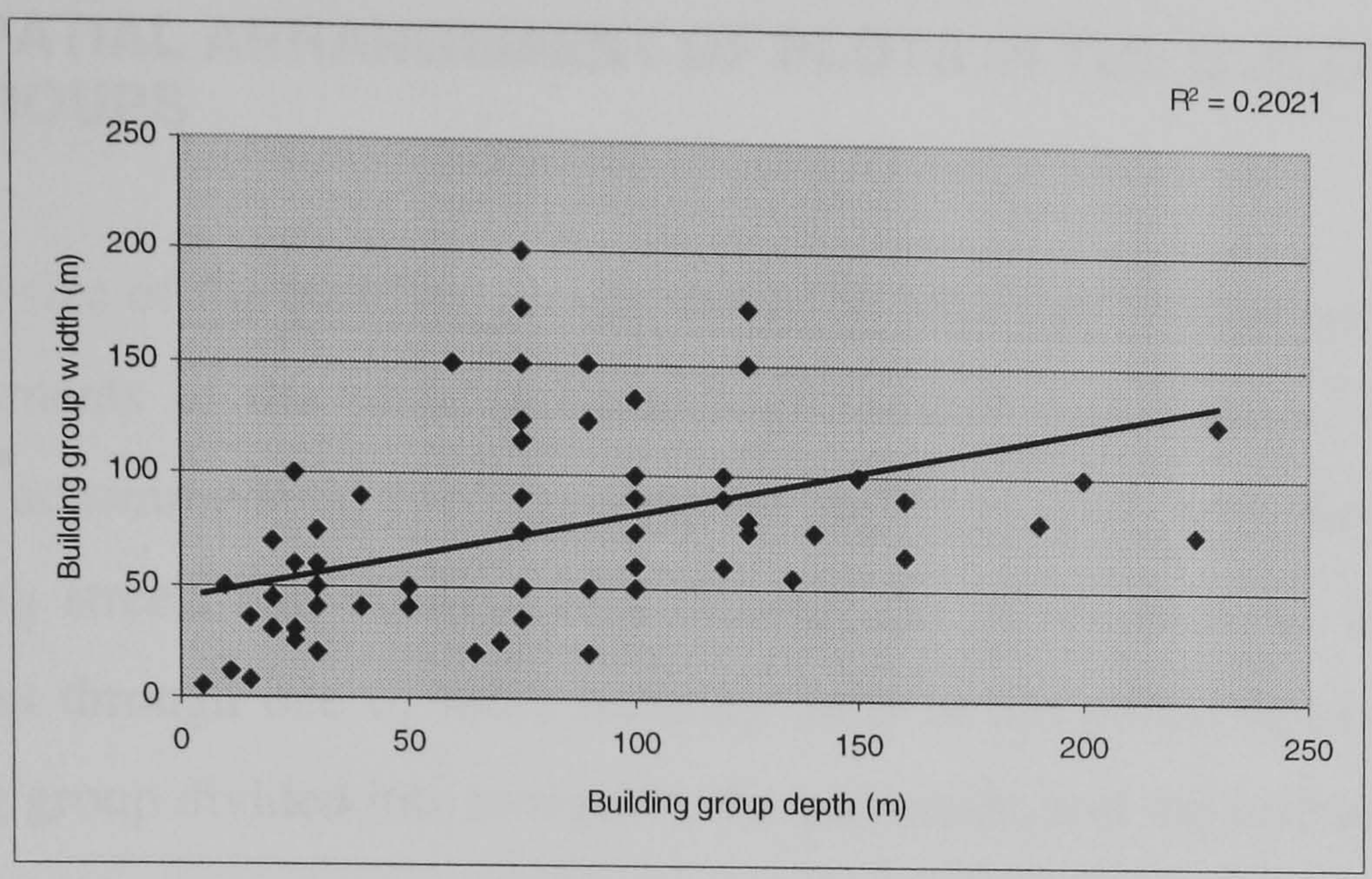
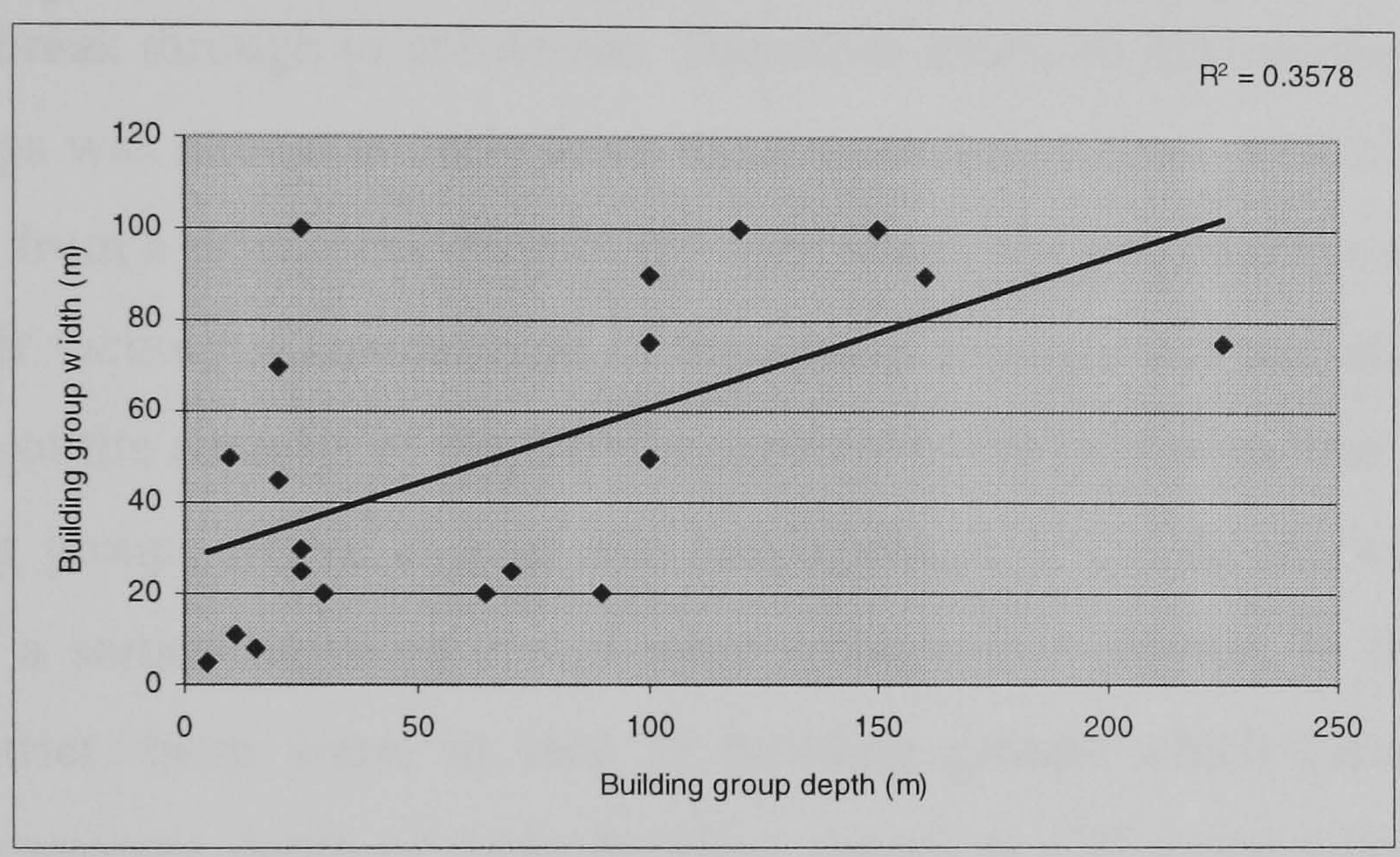


FIGURE 7.1: A SUMMARY OF BUILDING GROUP SIZES IN TERMS OF BUILDING GROUP DEPTH AND WIDTH IN THE FAHHADAN AREA



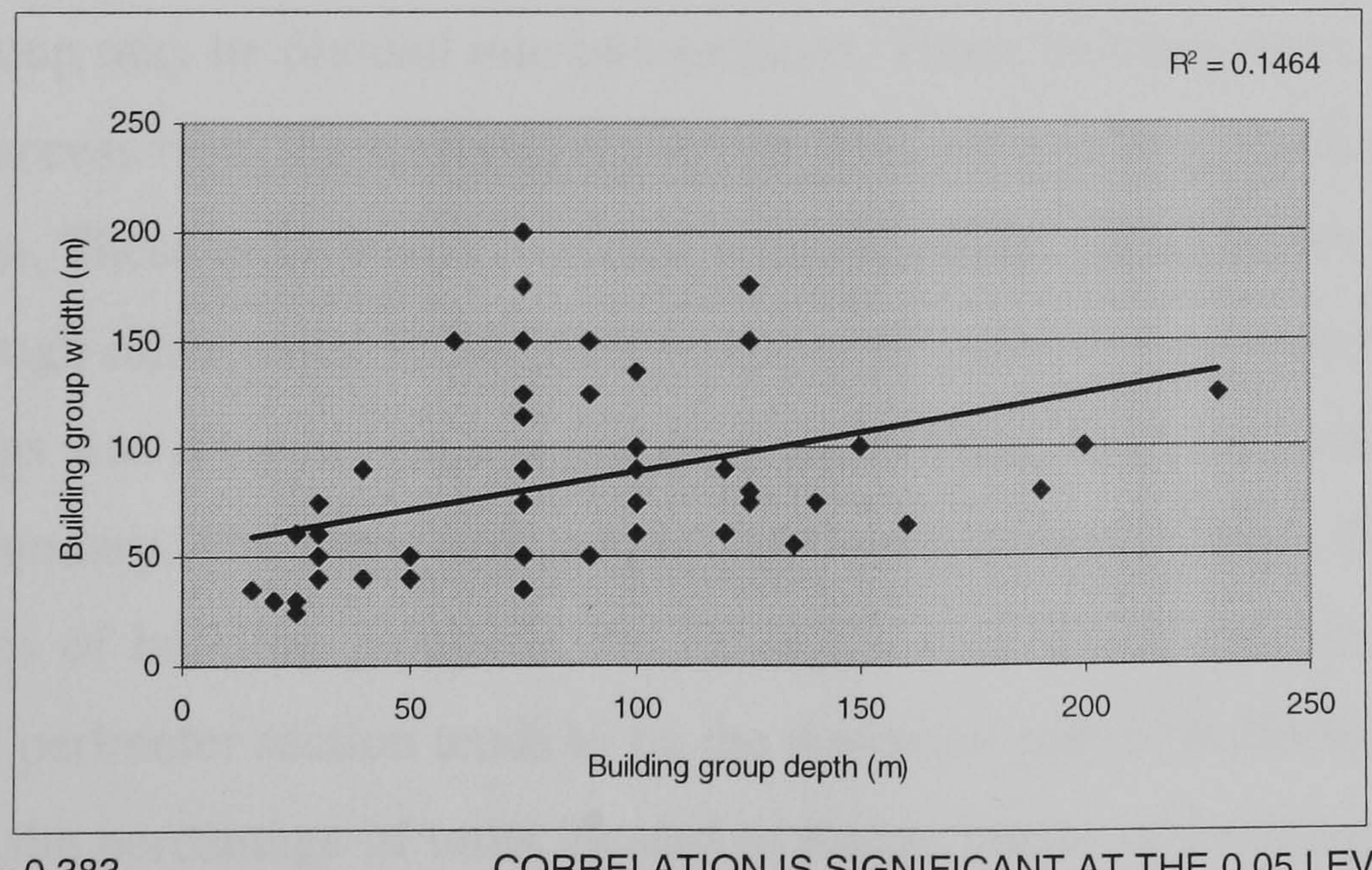
R= 0.450 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL

GRAPH 7.3: BUILDING GROUP DEPTH/WIDTH RATIO IN ALL BUILDING GROUPS IN THE FAHHADAN AREA



R= 0.598 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL

GRAPH 7.4: BUILDING GROUP DEPTH/WIDTH RATIO IN NON-RESIDENTIAL BUILDING GROUPS IN THE FAHHADAN AREA



R= 0.383 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL

GRAPH 7.5: BUILDING GROUP DEPTH/WIDTH RATIO IN RESIDENTIAL BUILDING GROUPS IN THE FAHHADAN AREA

7.2.2. SPATIAL ARRANGEMENT OF PLOTS IN THE BUILDING GROUPS

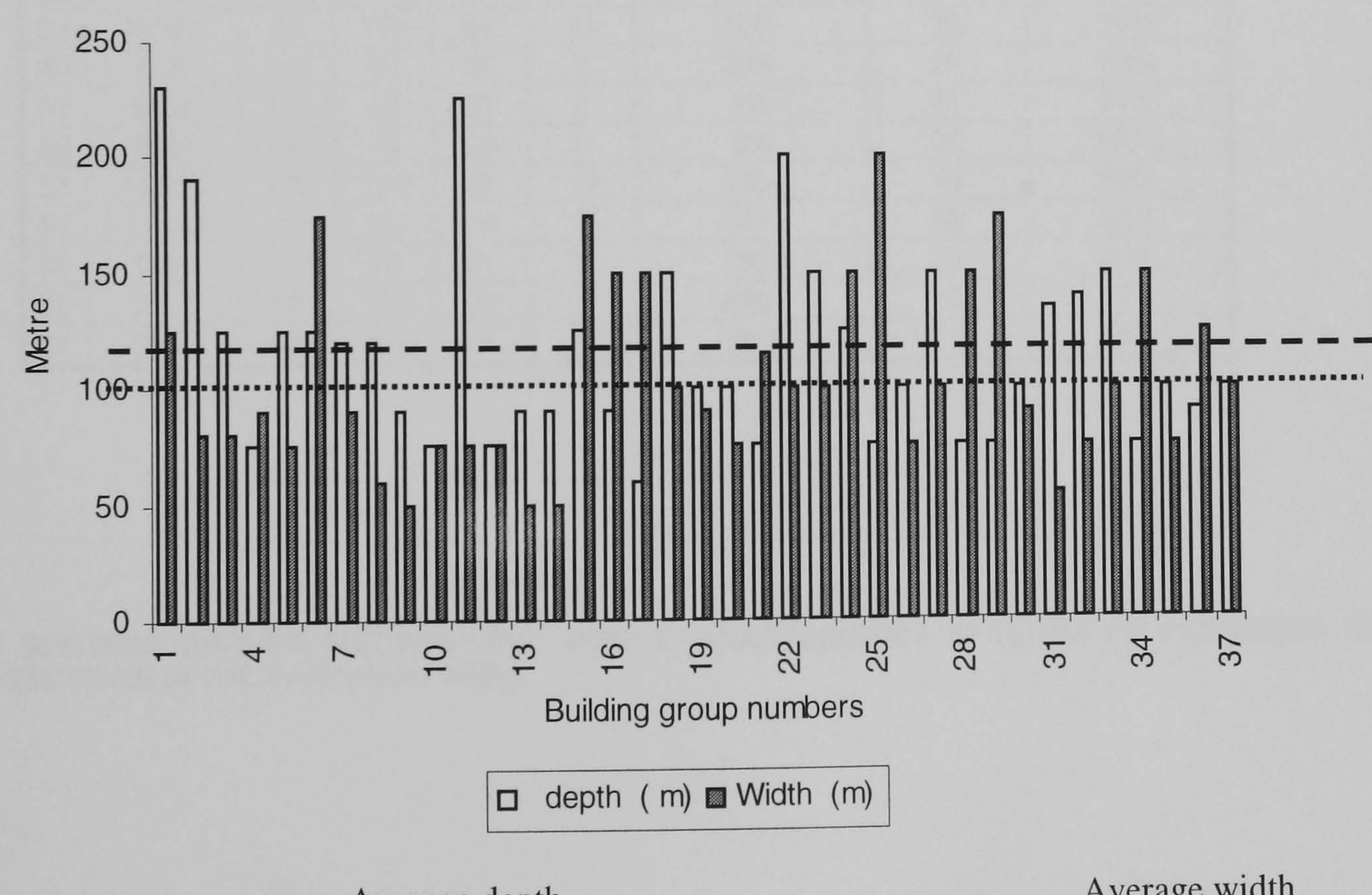
The shape and size of the building groups would be expected to bear some relationship to the arrangements of the plots and buildings located within them. Many building groups clearly accommodated two categories of buildings, each with direct access from the surrounding streets and either access through the cul-de-sacs off the surrounding alleys or access through one or more building units to the public open spaces. In this way a building group divided into two parts, the parimeter, and the interior section.

The great majority of building groups examined in the Fahhadan area, 53 per cent, did not have any break through or cul-de-sac. Therefore access to the building units in such building groups was almost entirely from the surrounding alleys, with a very few units having access from a private cul-de-sacs off such alleys or through other units which are located at their vicinity. Consideration of the spatial arrangement and access system in the remainder of the analysis of the building groups in the Fahhadan area was limited to those building groups where at least one breakthrough or cul-de-sac was in evidence and therefore a somewhat more complicated arrangement applied. In this way in the Fahhadan district, there were, in fact 37 building groups which came into such a category. The average depth of these building groups is 120 metre where the average width is around 100 metre (See Graph 7.6).

A building group may be divided into two sections. Those building units, which did not have a direct access from the surrounding streets were formed from the built parts of the interior section. These units were connected with the public spaces either through a cul-de-sac or through other units. In the great majority of cases the perimeter section of the building groups was divided into a series of plots, running from the surrounding alleys to an inner boundary. The shape and ratio of plot width to depth varied. Figure 7.2 show some examples of building groups in the Fahhadan area which may divided into two sections. The perimeter section tends to be the dominant part of building groups. Table 7.2 show that the percentage of units located in the perimeter of building groups varied from a minimum of 53 per cent and average of 83 per cent.

On occasions it was not always easy to identify which buildings, or parts of the buildings did not have direct access from the street or alley, therefore, looking firstly at the plan of the building group, an inside network of access routes was marked out. It was then possible to establish which buildings were served by these cul-de-sacs. The approximate boundaries between buildings were then observed, although it was not always easy to mark the division of peripheral and internal section of a building group. Where a building unit had accesses to both the surrounding network and a cul-de-sac, it was considered as a perimeter building unit.

Graphs 7.7 to 7.10 give an analysis of the relationship between both the number of perimeter and interior units with the depth and width of the building groups. According to these scatter diagrams, there is generally a weak relationship between them. However, there is a modest relationship between the width and number of interior units. Other relationships are not significant or the correlation is significant at 0.05 level, therefore, there appears to be no particular relationship with regard to the building group depth.



GRAPH 7.6: VARIATION OF BUILDING GROUP SIZE IN TERMS OF DEPTH AND WIDTH IN THE 37 BUILDING GROUPS WHICH HAVE AT LEAST ONE CUL-DE-SAC IN THE FAHHADAN

Number	Group area m sq.	Depth (m)	Width (m)	No of units	Interior section units	percentage of interior units	Perimeter units	Percentage of perimeter units
1	19562	230	125	87	11	13%	76	87%
2	14438	190	80	39	6	15%	33	85%
3	9363	125	80	36	11	31%	25	69%
4	4419	75	90	23	2	9%	21	91%
5	6598	125	75	23	4	17%	19	83%
6	11355	125	175	34	12	35%	22	65%
7	6786	120	90	18	1	6%	17	94%
8	6043	120	60	25	2	8%	23	92%
9	3472	90	50	11	1	9%	10	91%
10	5345	75	75	36	1	3%	35	97%
11	13415	225	75	15	7	47%	8	53%
12	3849	75	75	12	1	8%	11	92%
13	4560	90	50	17	3	18%	14	82%
14	3729	90	50	20	1	5%	19	95%
15	10271	125	175	30	9	30%	21	70%
16	8462	90	150	28	6	21%	22	79%
17	6273	60	150	23	1	4%	22	96%
18	11525	150	100	30	0	0%	30	100%
19	6301	100	90	25	1	4%	24	96%
20	5881	100	75	27	5	19%	22	81%
21	6766	75	115	32	8	25%	24	75%
22	8187	200	100	36	3	8%	33	92%
23	10632	150	100	38	11	29%	27	71%
24	8482	125	150	40	12	30%	28	70%
25	7936	75	200	31	5	16%	26	84%
26	5859	100	75	24	3	13%	21	88%
27	10974	150	100	15	1	7%	14	93%
28	7154	75	150	29	5	17%	24	83%
29	10100	75	175	37	11	30%	26	70%
30	7237	100	90	30	9	30%	21	70%
31	6136	135	55	23	2	9%	21	91%
32	6833	140	75	26	0	0%	26	100%
33	12700	150	100	55	10	18%	45	82%
34	11158	75	150	39	7	18%	32	82%
35	5186	100	75	21	2	10%	19	90%
36	7518	90	125	32	9	28%	23	72%
37	7695	100	100	27	6	22%	21	78%

TABLE 7.1 BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERMS OF PERIMETER AND INTERIOR SECTIONS IN THE FAHHADAN AREA

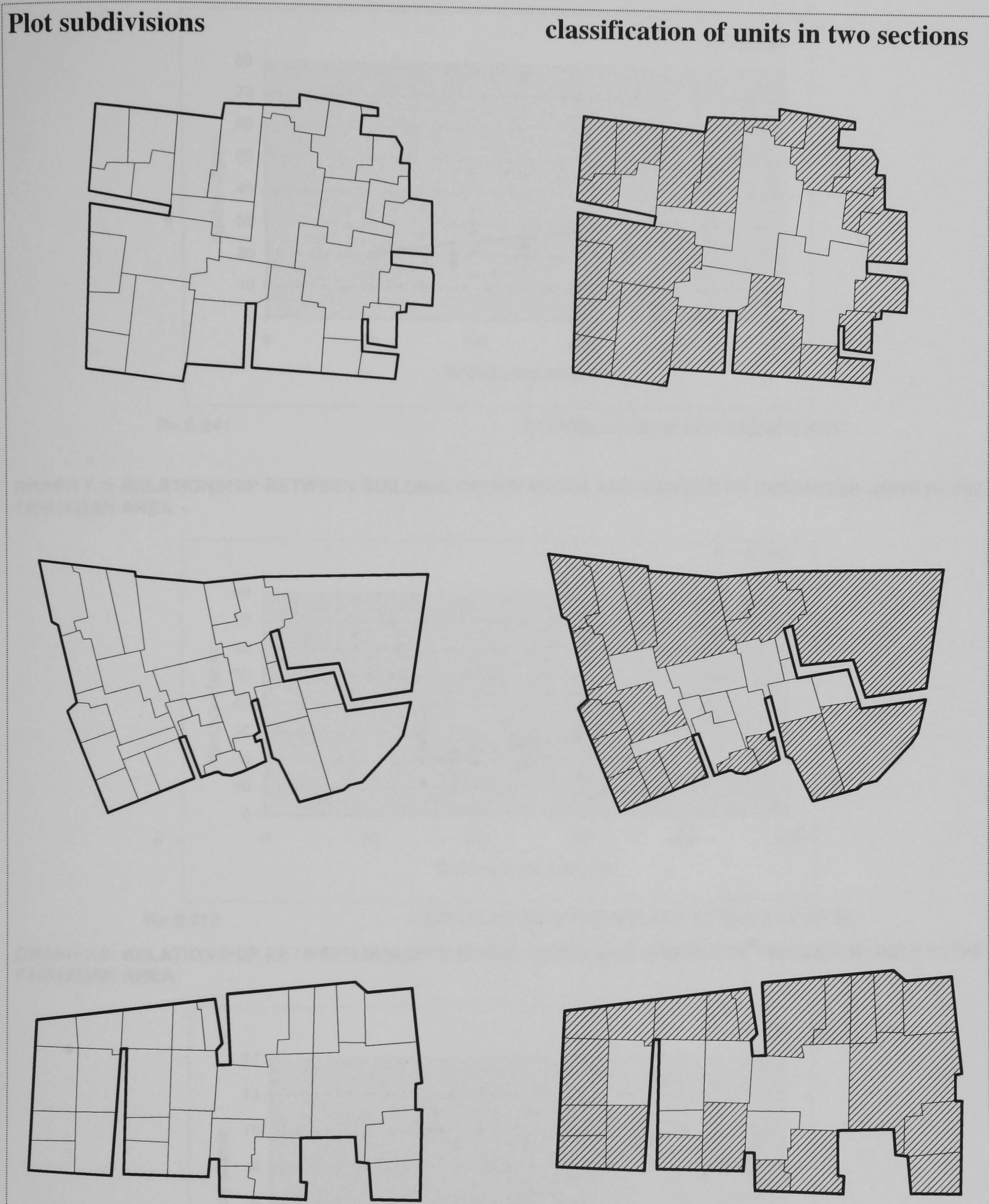
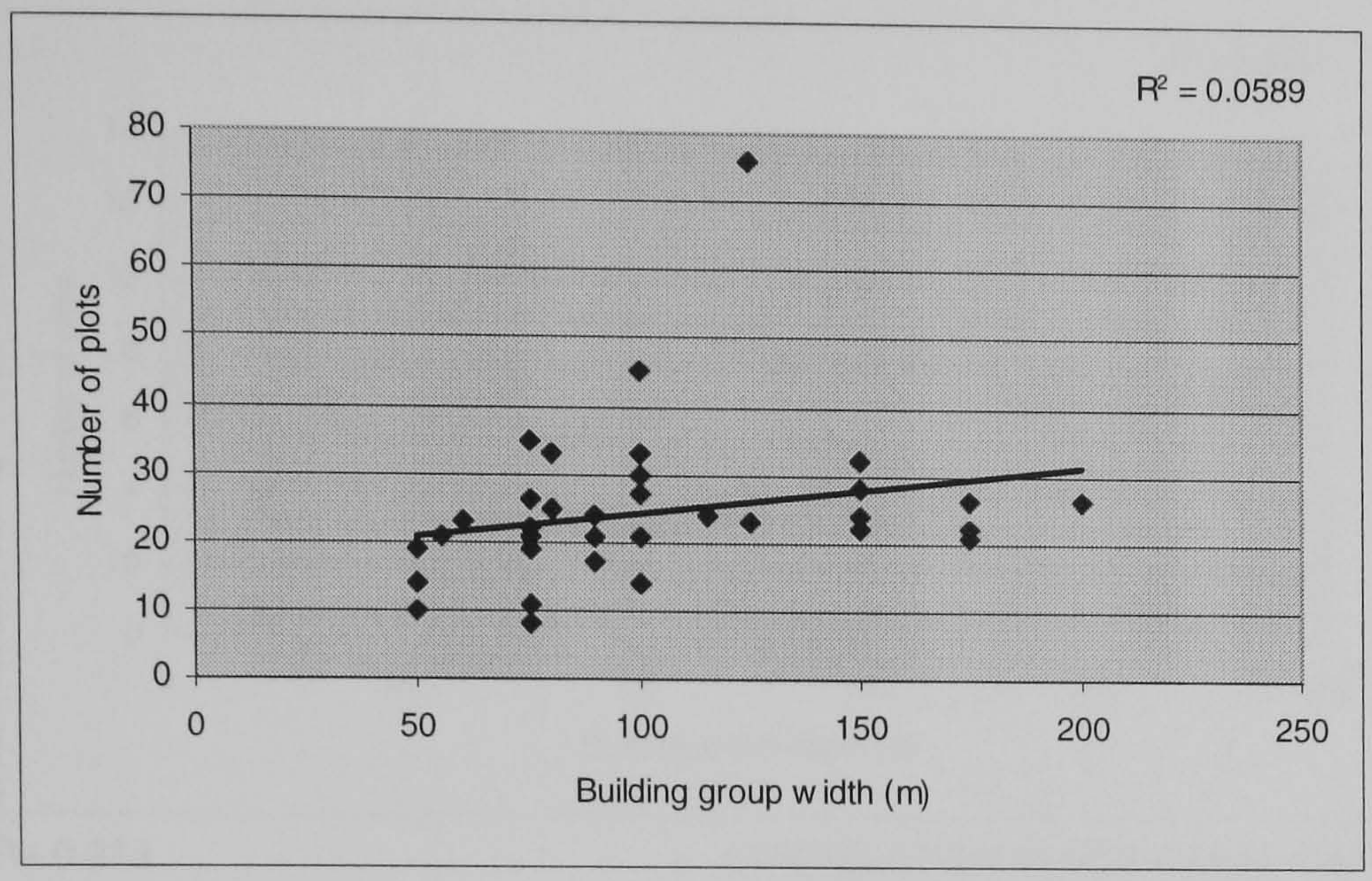
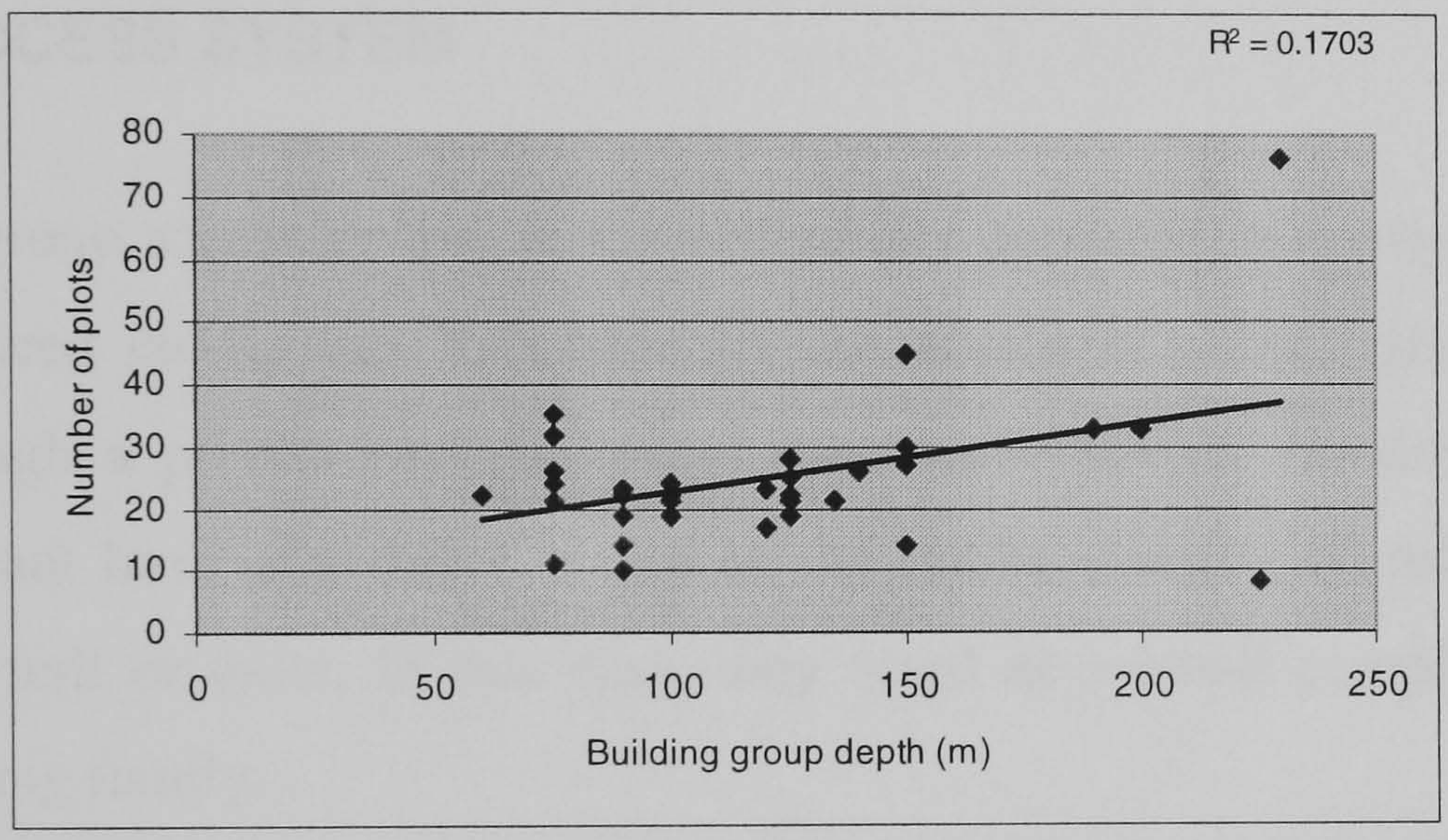


FIGURE 7.2: SOME EXAMPLES OF BUILDING GROUPS IN THE FAHHADAN AREA AND CLASSIFICATION OF INTERIOR AND PERIMETER BUILDING GROUPS. IN THE DIAGRAM, THE AREA WITH OBLIQUE LINES INDICATES THE PERIMETER UNITS.



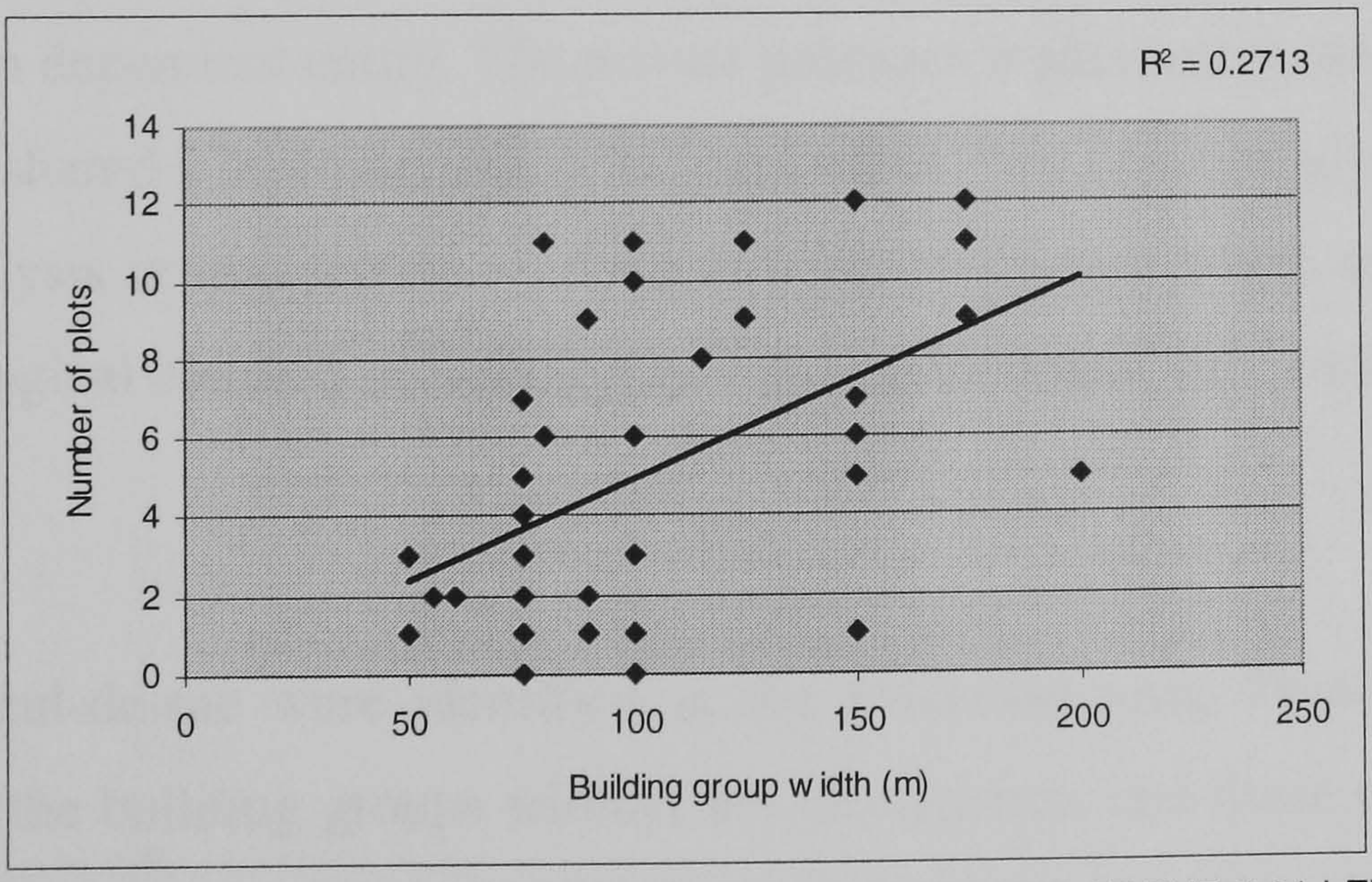
R= 0.241 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.7: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF PERIMETER UNITS IN THE FAHHADAN AREA



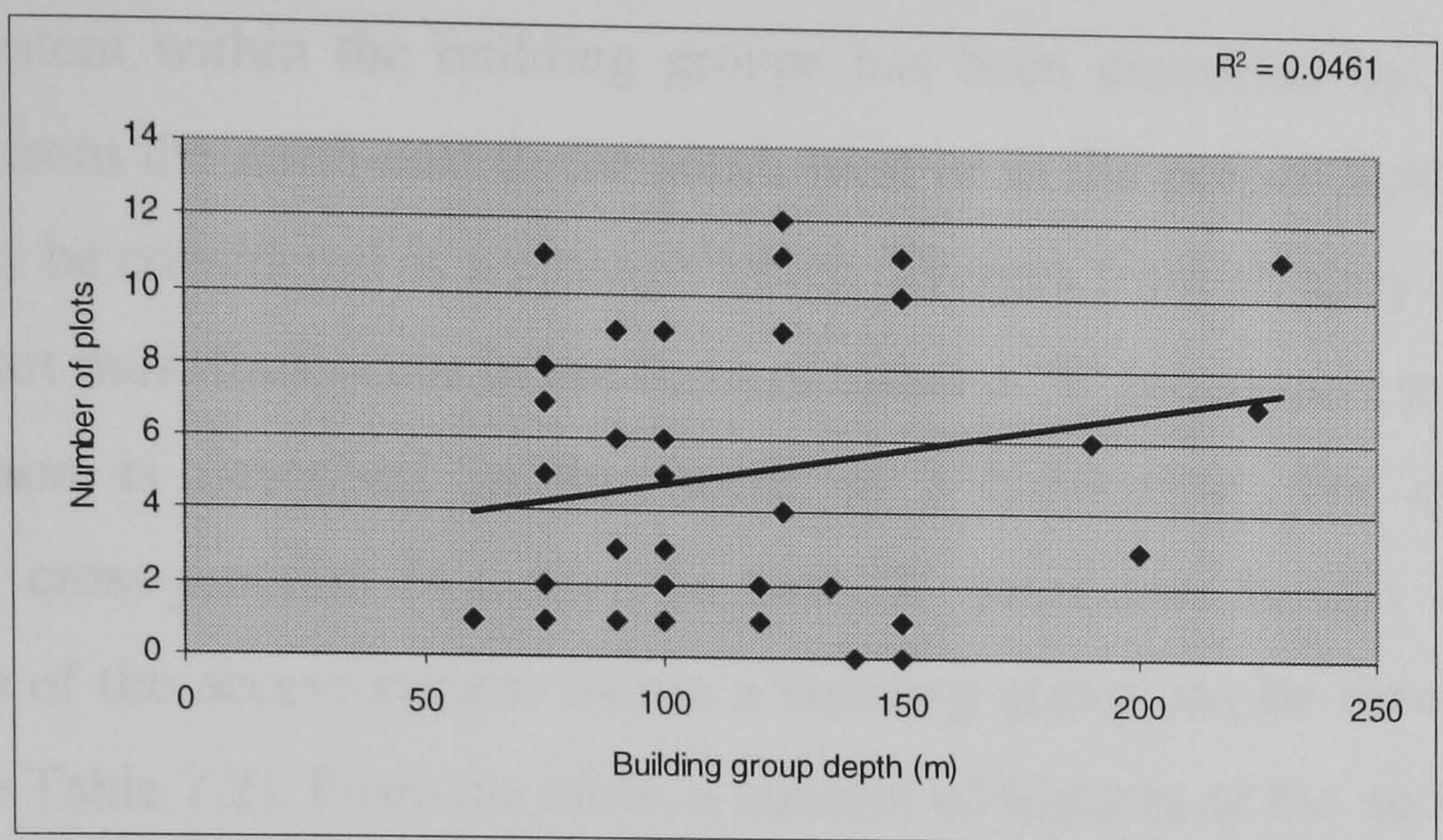
R= 0.413 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL

GRAPH 7.8: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF PERIMETER UNITS IN THE FAHHADAN AREA



R=0.521 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.9 RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF INTERIOR UNITS IN THE FAHHADAN AREA



R= 0.215 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.10 RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF INTERIOR UNITS IN THE FAHHADAN AREA

7.2.3. ACCESS SYSTEM

The building group access system in the walled city appeared to consist of a series of open and covered cul-de-sacs. Occasionally the access of some building units was provided through a private passage, which may serve several building units. Some buildings did not have any direct access to the public domain, therefore they serve through other unit or units. In this case, they acted as a small complex, which was occupied by a big family.

The private passages were a constituent part of a specific building units, where the cul-de-sac was an in dependent entity. The private passages were mostly used by a group of families which shared a building unit or in some cases, two or more adjacent buildings. The access analysis in this section referred only to cul-de-sacs which appeared to be a major morphological element of building groups and belonged very much to the public domain.

Two types of cul-de-sac were identified in the Fahhadan area. Those which simply penetrated into the building groups without any divergence, and those cul-de-sacs with one or more divergence occurred in building groups in various directions to serve the units which are located close to them. They serve the extreme units which are situated in the interior section of the building groups.

The access system within the building groups has been classified by their direction, generally run from the north-east to the south-west or in the perpendicular direction. A cul-de-sac may be considered as a passage which diverges from an alley or a cul-de-sac. A divergent part must thus occur in the form of either a 'T' junction or a cross-junction. Such a junction is described in this work as a breakpoint. For convenience of calculation, a cross-junction is treated as two 'T' junctions. In this way, the basic characteristics of the access system within a building group can be recorded by means of a table (See Table 7.2). From the table, a number of features of the access system as a whole can be considered, such as number of all breakpoints and the number of breakpoints in two directions.

The relationship between the number of breakpoints and the width of the building groups was examined (See Graphs 7.11 and 7.13). It seems that building group width is not related to the number of internal breakpoints. The examination shows that there is a modest relationship between the width and the both the number of internal breakpoint and the total number of breakpoints occur in building groups. Regarding building group depth there was no significant relationship (See Graphs 7.12 and 7.14). The correlation between perimeter breakpoints and both the width and the depth of the building groups were not significant.

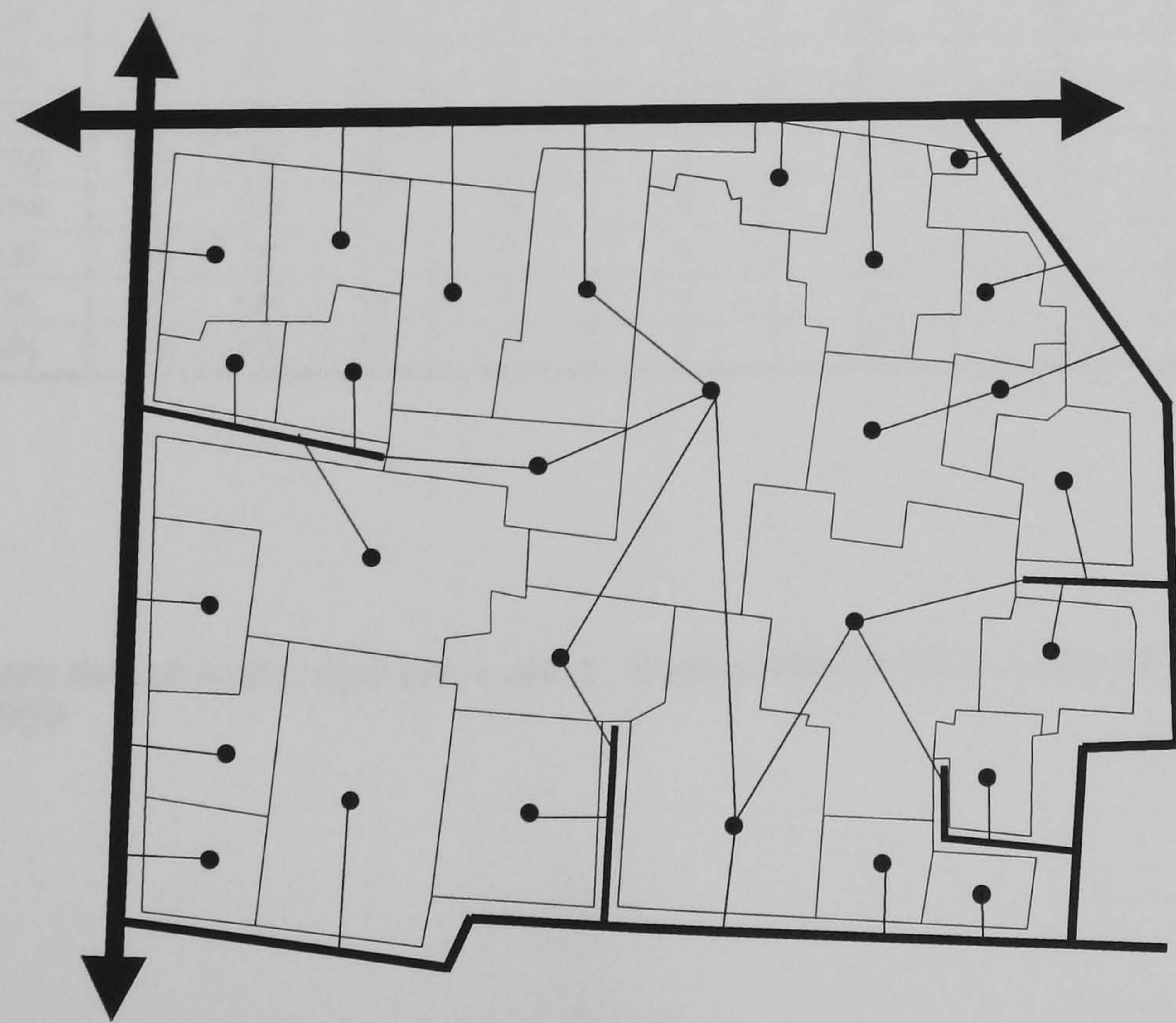
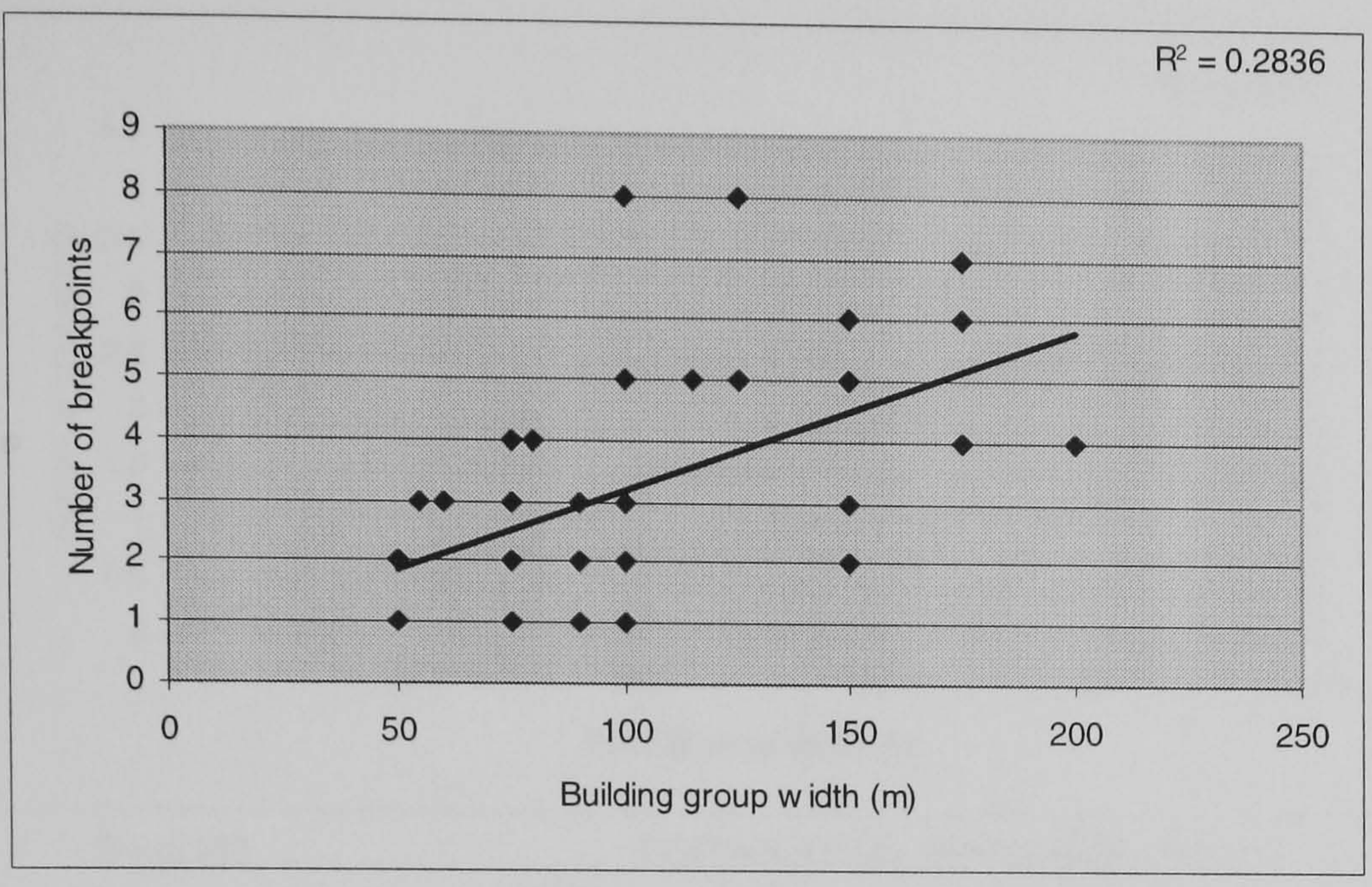


FIGURE 7.3: AN EXAMPLE ACCESS SYSTEM TO THE PLOTS IN THE FAHHADANAREA

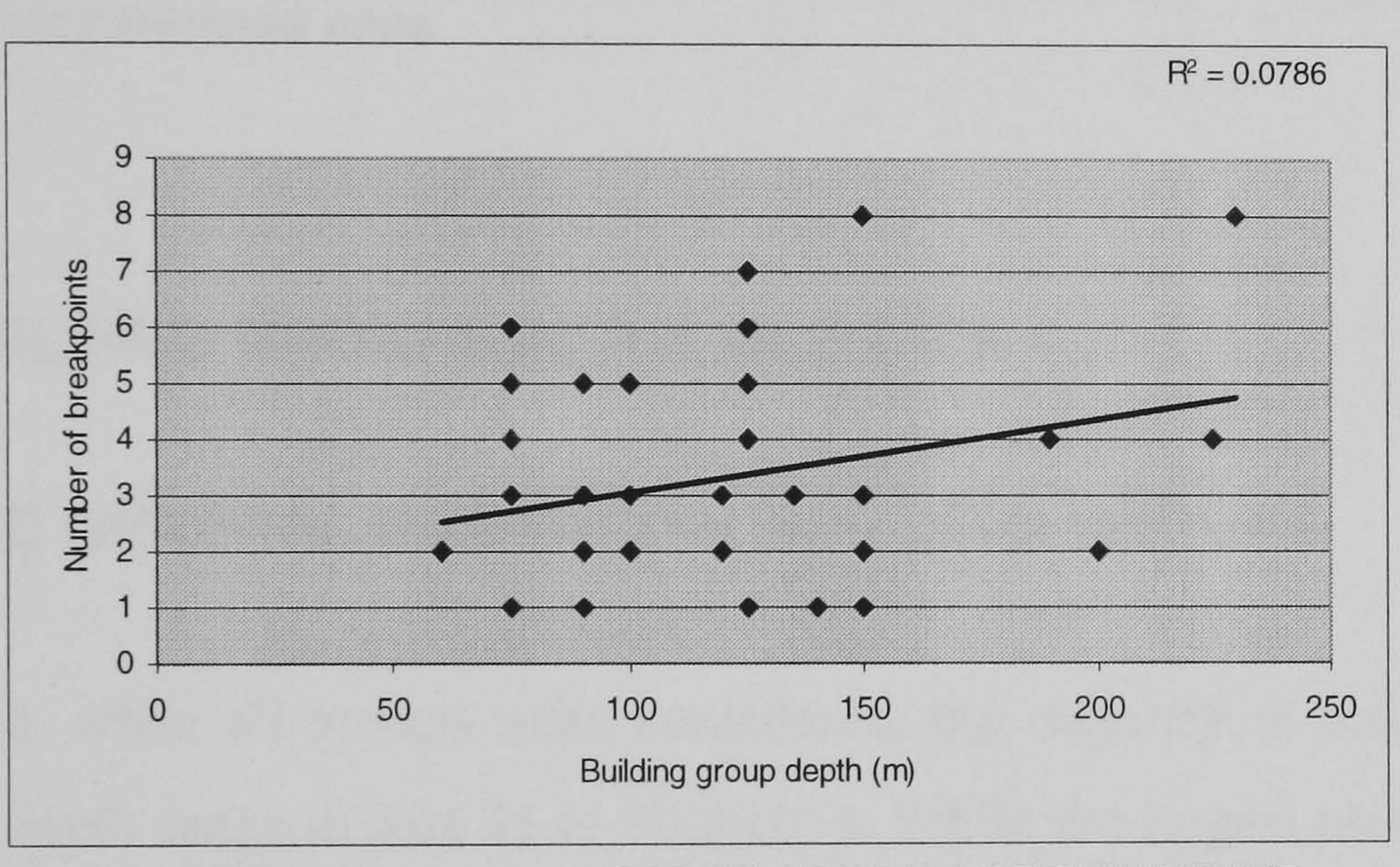
Number	Group area (m sq.)	Depth (m)	Width (m)	No of units	Breakpoints				
					Total	Inner break	Perimeter break	N-E to S-W	N-W to S-E
1	19562	230	125	87	8	4	4	4	4
2	14438	190	80	39	4	1	3	1	3
3	9363	125	80	36	4	0	4	2	2
4	4419	75	90	23	1	0	1	0	1
5	6598	125	75	23	1	0	1	0	1
6	11355	125	175	34	6	3	3	3	3
7	6786	120	90	18	2	0	2	0	2
8	6043	120	60	25	3	0	3	2	1
9	3472	90	50	11	1	0	1	0	1
10	5345	75	75	36	1	0	1	0	1
11	13415	225	75	15	4	0	4	0	4
12	3849	75	75	12	1	0	1	0	1
13	4560	90	50	17	2	0	2	1	1
14	3729	90	50	20	1	0	1	1	0
15	10271	125	175	30	7	4	3	4	3
16	8462	90	150	28	3	0	3	0	3
17	6273	60	150	23	2	0	2	1	1
18	11525	150	100	30	1	0	1	0	1
19	6301	100	90	25	2	1	1	1	1
20	5881	100	75	27	2	1	1	1	1
21	6766	75	115	32	5	2	3	2	3
22	8187	200	100	36	2	0	1	1	1
23	10632	150	100	38	3	1	2	2	1
24	8482	125	150	40	5	0	5	3	2
25	7936	75	200	31	4	3	1	2	2
26	5859	100	75	24	3	0	3	1	2
27	10974	150	100	15	2	1	1	1	1
28	7154	75	150	29	3	0	3	3	0
29	10100	75	175	37	4	1	3	2	2
30	7237	100	90	30	3	1	2	2	1
31	6136	135	55	23	3	1	2	2	1
32	6833	140	75	26	1	0	1	0	1
33	12700	150	100	55	8	3	5	3	5
34	11158	75	150	39	6	3	3	3	3
35	5186	100	75	21	3	1	2	1	2
36	7518	90	125	32	5	1	4	3	2
37	7695	100	100	27	5	1	4	2	3

TABLE 7.2: BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERM OF BREAKTHROUGH IN THE FAHHADAN AREA



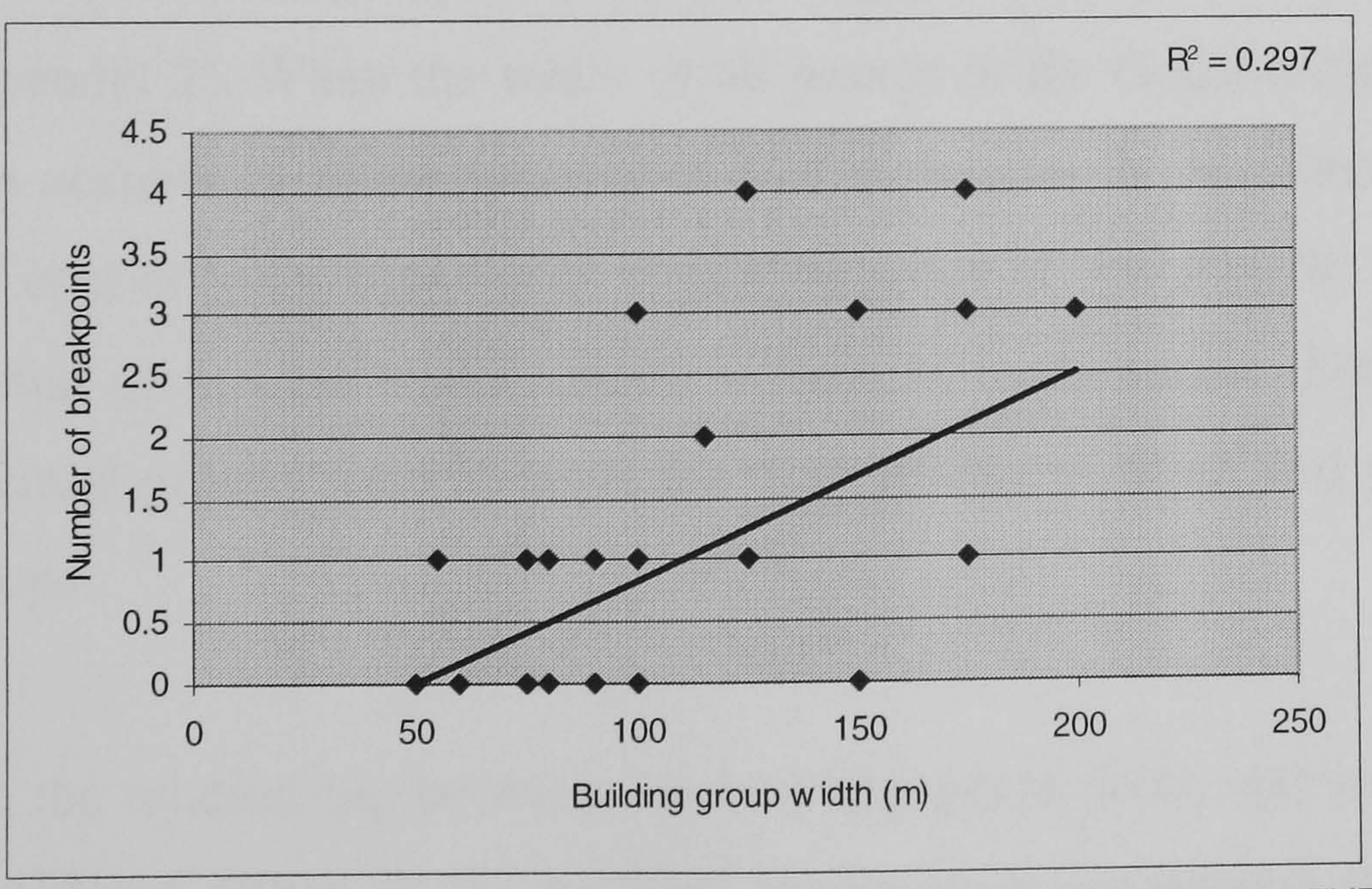
R=0.533 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.11: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF ALL BREAKPOINTS IN THE FAHHADAN AREA



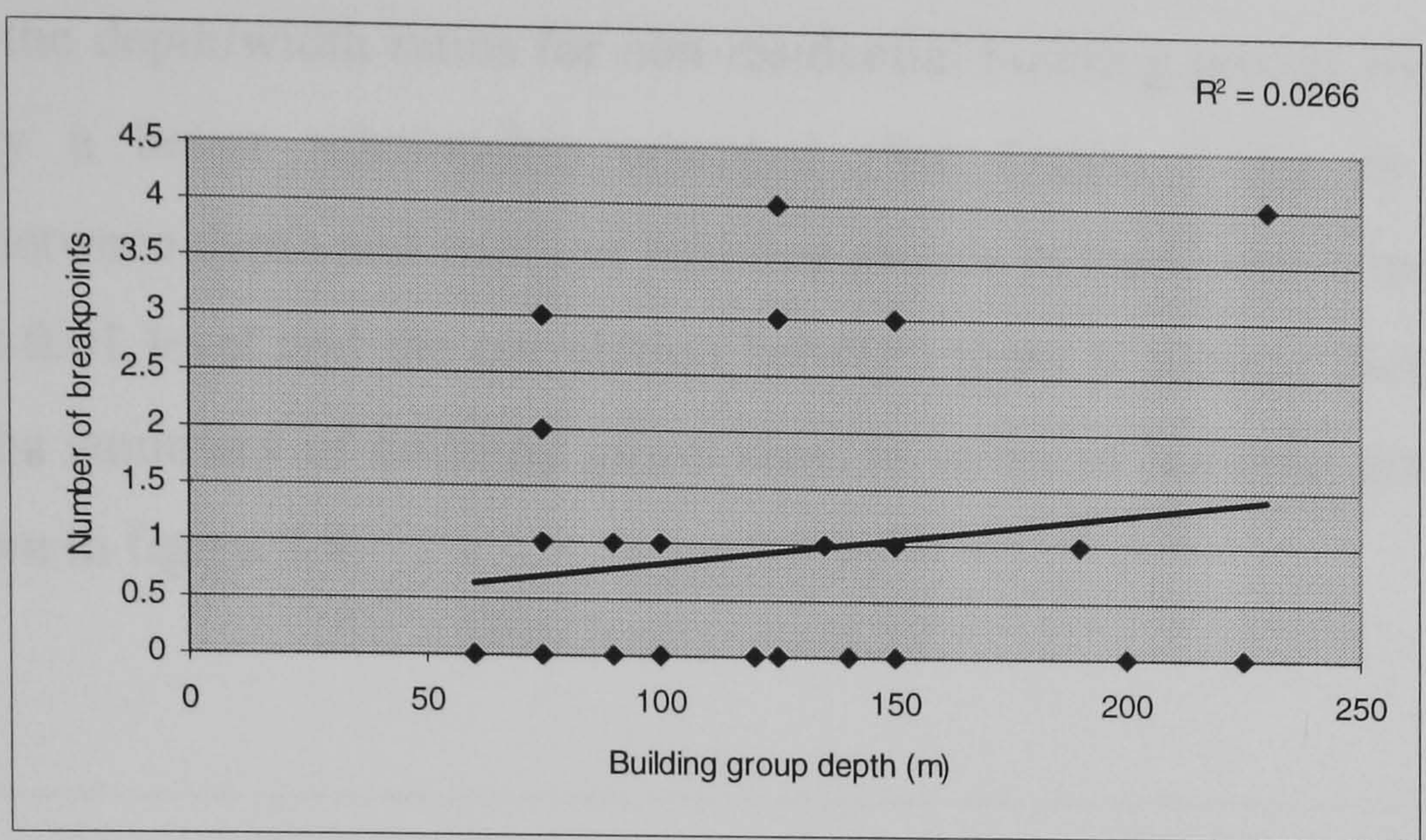
R= 0.280 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.12: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND ALL BREAKPOINTS IN THE FAHHADAN AREA



R=0.545 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.13 RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF INTERNAL BREAKPOINTS IN THE FAHHADAN AREA



R= 0.163 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.14 RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF INTERNAL BREAKPOINTS IN THE FAHHADAN AREA

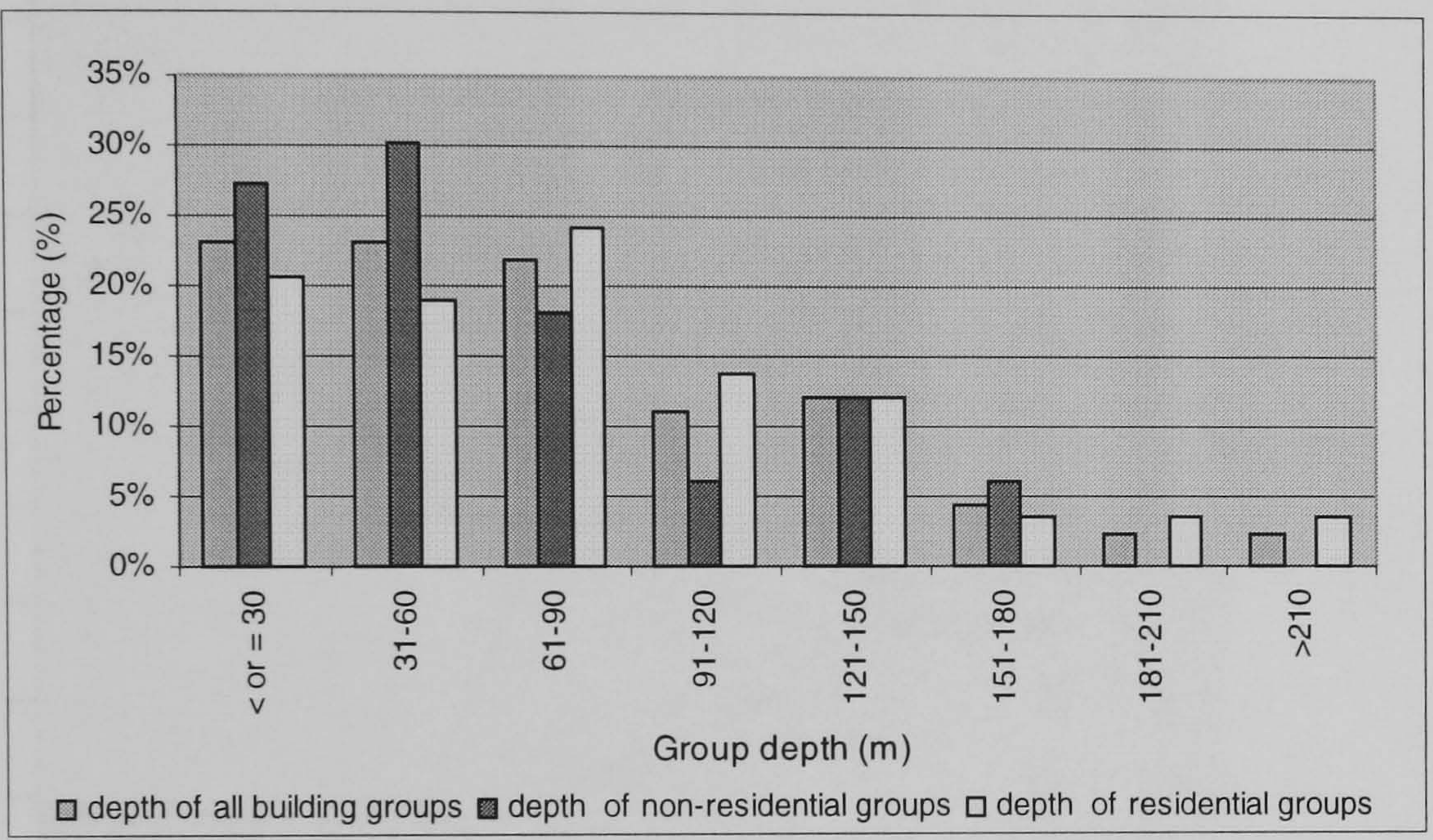
7.3. BUILDING GROUPS IN THE OLD CITY

7.3.1. THE GENERAL SIZE OF THE BUILDING GROUPS

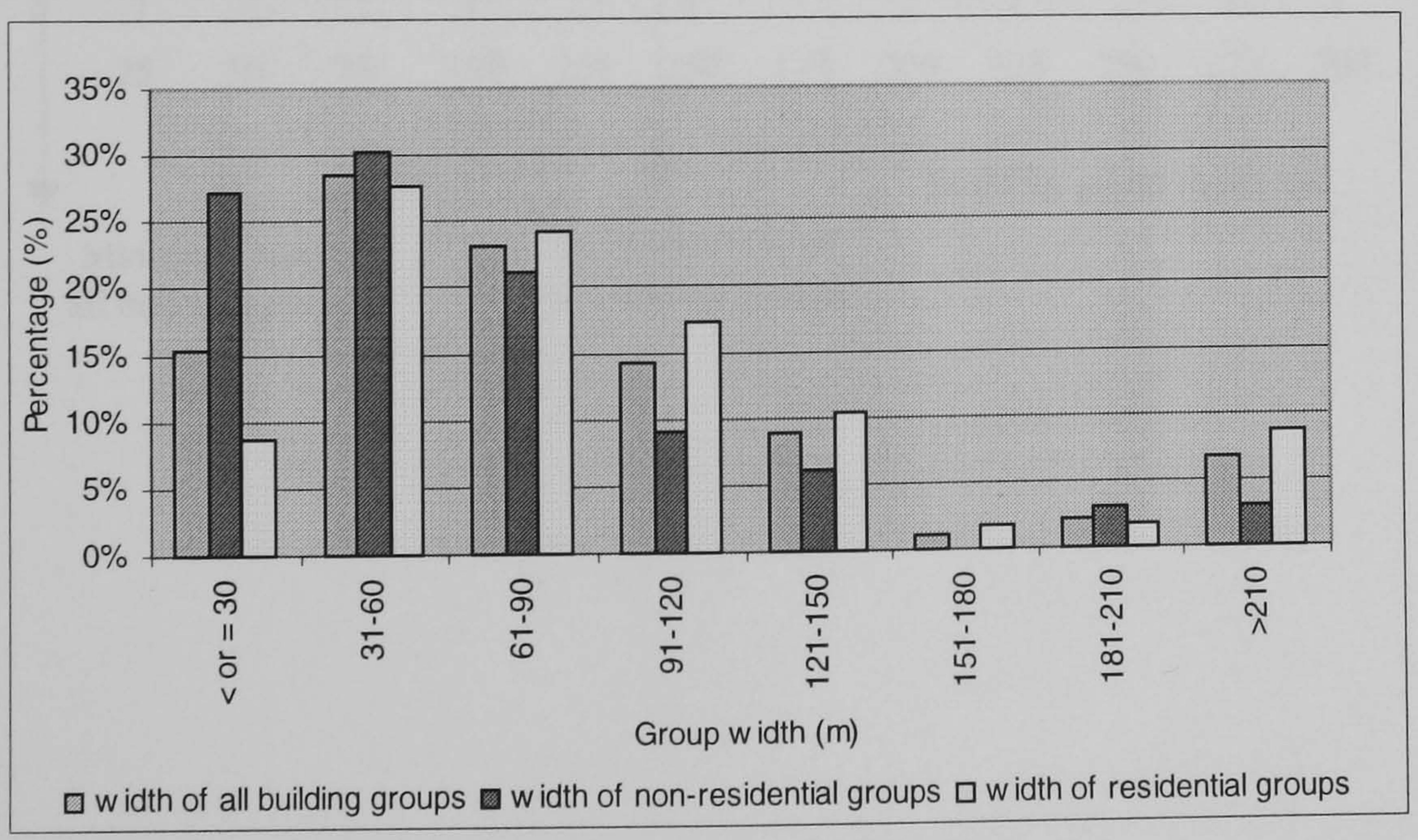
In Chapter Five, when all groups were considered, the majority of them, 53 per cent occur within a depth range of just 31 to 90 metres. While the largest proportion of non-residential groups 58 per cent had a depth range of less than 60 meters, the largest proportion of the residential groups had a depth range of less than 90 metres (See Graph 7.15) (See Appendix 2). When the width of all groups in the Godal-e-mosallah district was taken into account, a rather wide spread of dimension is in evidence. Although around, 67 per cent of the groups occur within the range of less than 90 meters, 52 per cent of residential groups had width ranges of from 30 to 90 meters (See Graph 7.16). The non-residential groups were in general a little shorter in depth and width than the residential groups

In this section, the relationship between the building group depth and width is another item to be considered. When all the building groups were considered, the depth/width ratio varied from 1:0.15 to 1:9.5. There is generally a perfect relationship between depth and width in all building groups appearing in the Godal-e-mosallah area (See Graph

7.17). When the depth/width ratios for non-residential building groups were considered comparatively a better relationship emerged (See Graph 7.18). In general, the relationship between depth and width of building groups in the Godal-e-mosallah area is significant at 0.01 level and the correlation between them is modest (See Graphs 7.18 and 7.19). The summary of building group sizes in terms of building group depth and width is shown in figure 7.4.



GRAPH 7.15: BUILDING GROUP DEPTH DISTRIBUTION IN THE GODAL-E-MOSALLAH AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS



GRAPH 7.16: BUILDING GROUP WIDTH DISTRIBUTION IN THE GODAL-E-MOSALLAH AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS

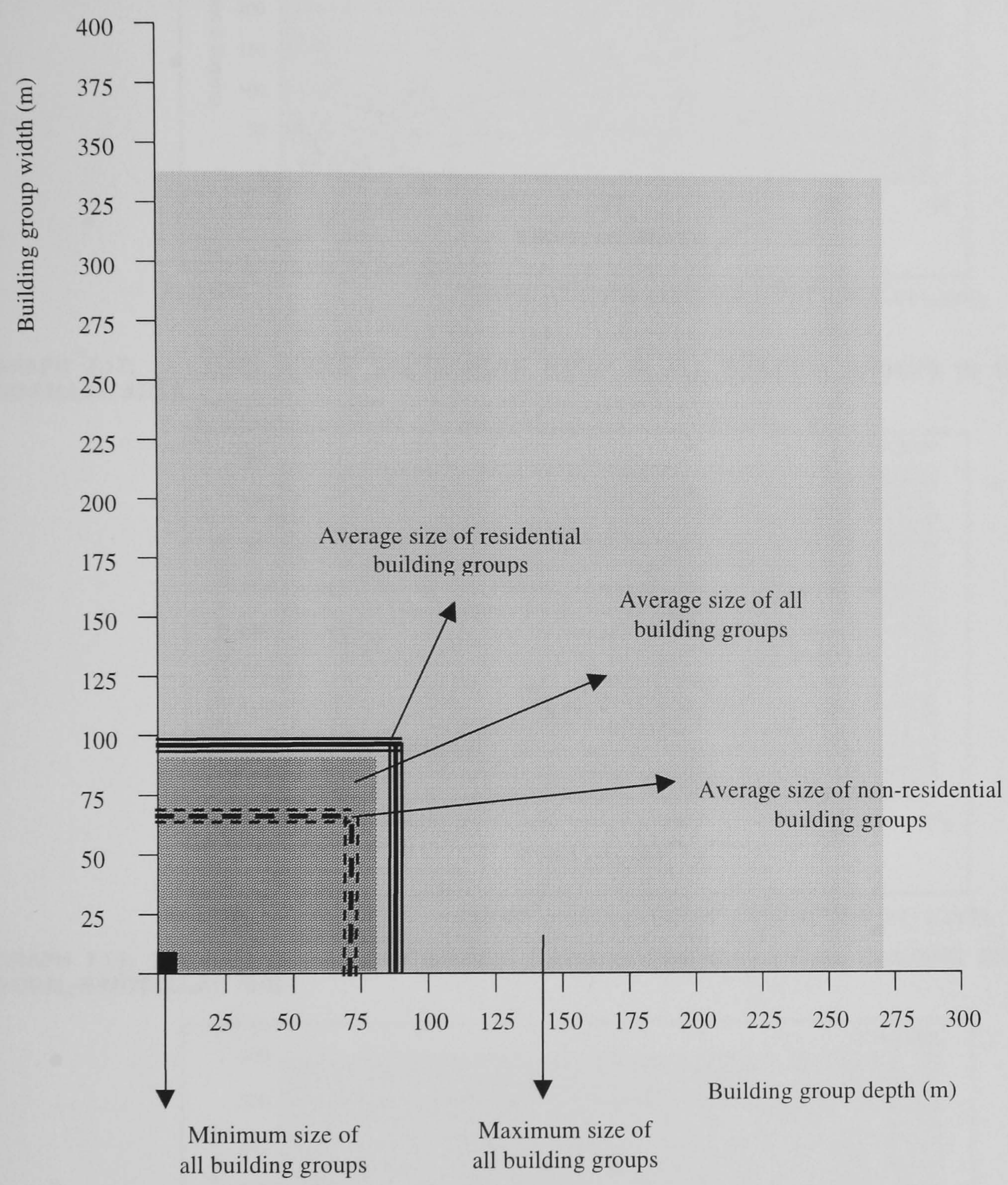
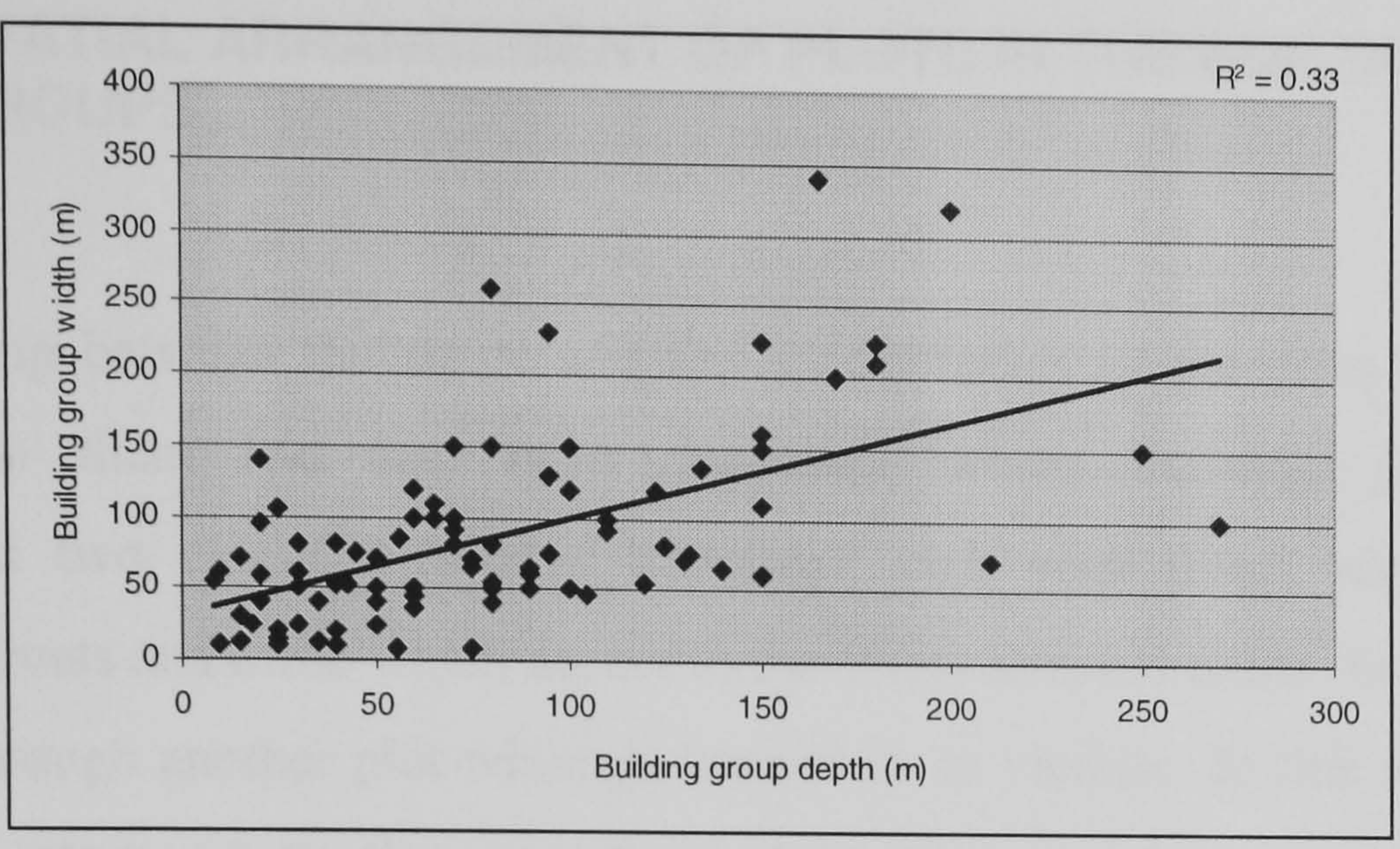
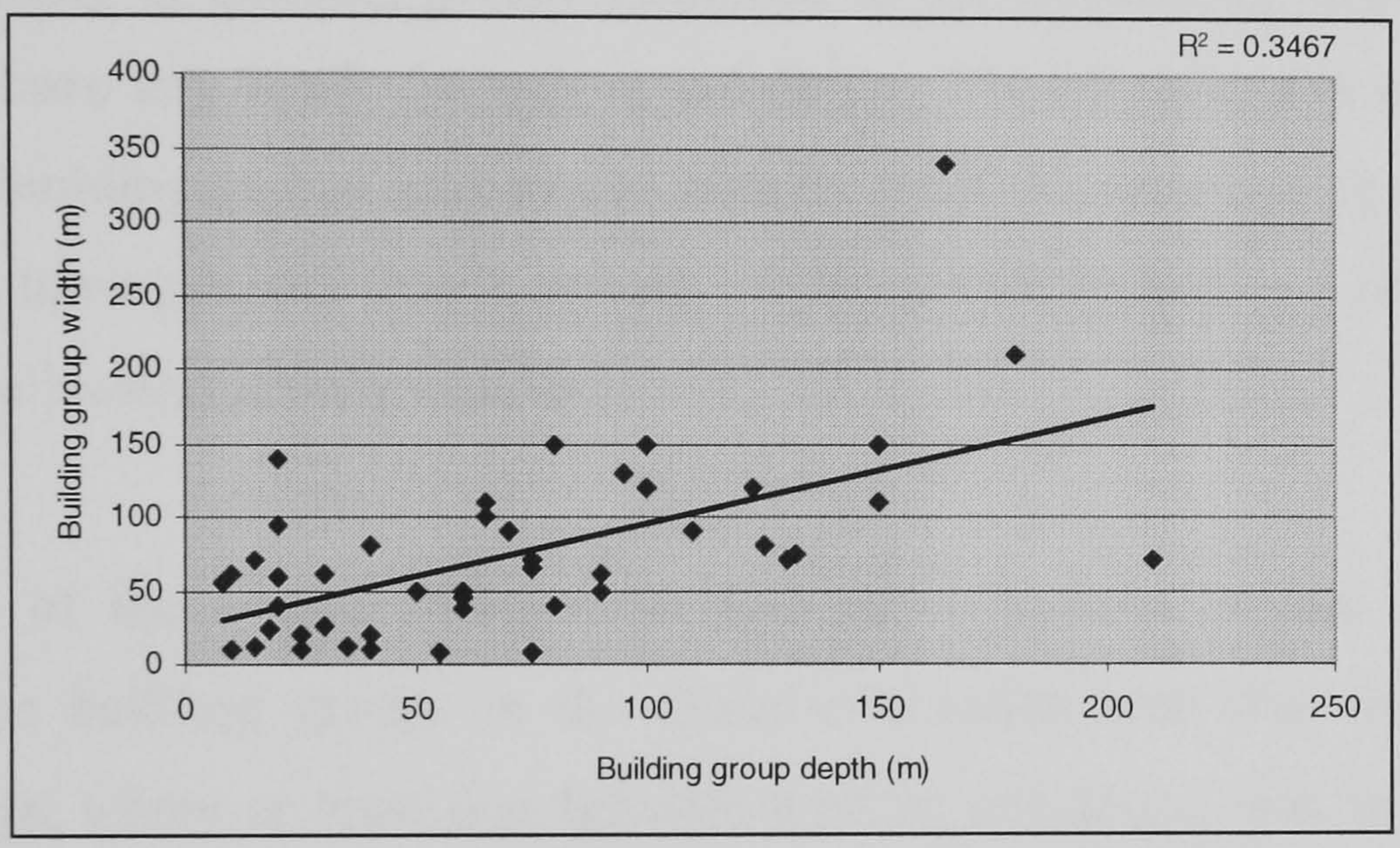


FIGURE 7.4: A SUMMARY OF BUILDING GROUP SIZES IN TERMS OF BUILDING GROUP DEPTH AND WIDTH IN THE GODAL-E-MOSALLAH AREA



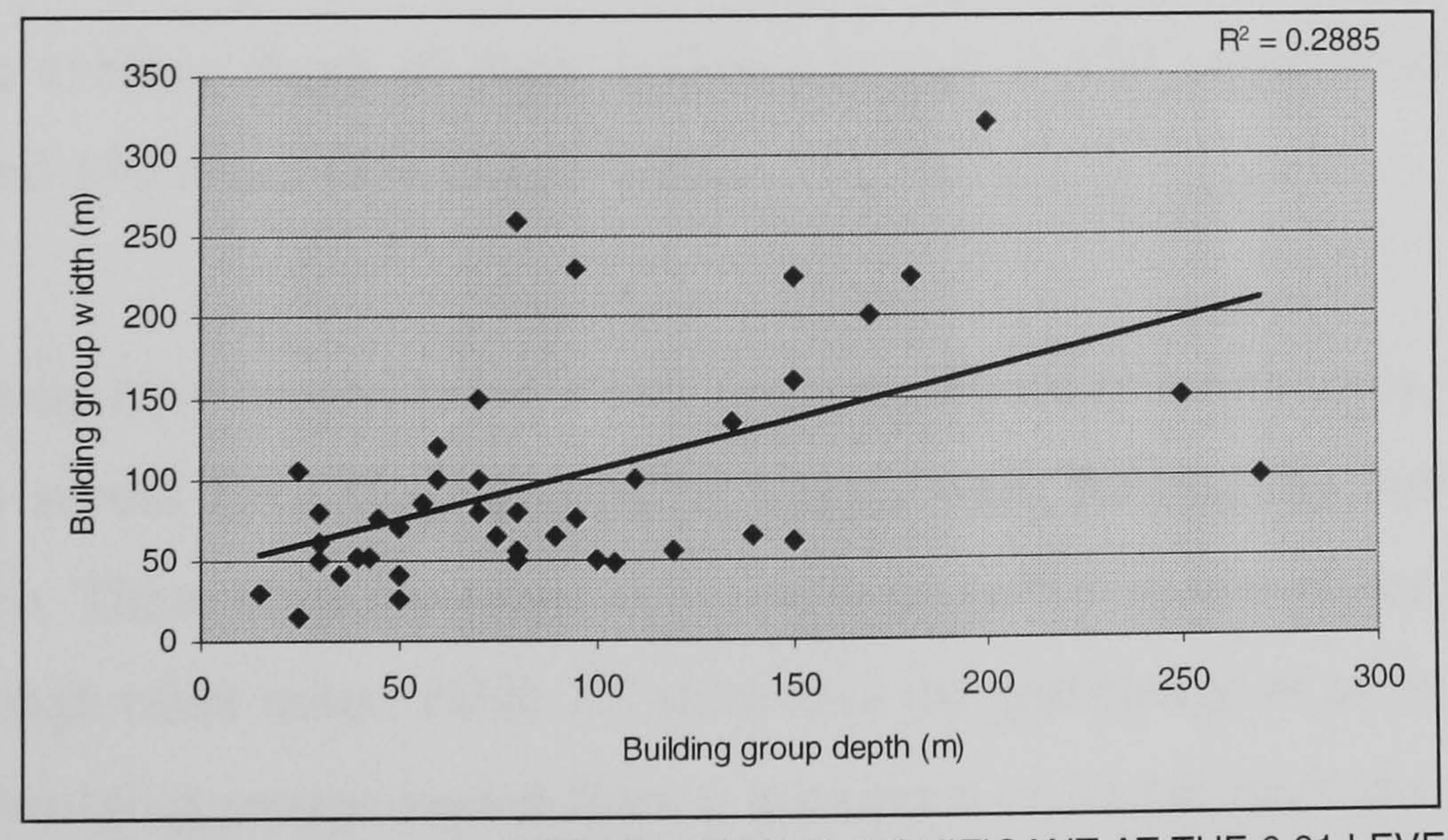
R=0.574 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.17: BUILDING GROUP DEPTH/WIDTH RATIO IN ALL BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA



R=0.589 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.18: BUILDING GROUP DEPTH/WIDTH RATIO IN NON-RESIDENTIAL BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA



R=0.537 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.19: BUILDING GROUP DEPTH/WIDTH RATIO IN RESIDENTIAL BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA

7.3.2. SPATIAL ARRANGEMENT OF PLOTS IN THE BUILDING GROUPS

The relationship between the shape and the arrangements of the plots and buildings located within them has also been examined. Many building groups clearly accommodated two classifications of buildings, each with direct access from the surrounding streets and those which access to the major alleys is either through a cul-de-sac or even through another plot which is located in its vicinity. In this way a building group divided into two parts, the parimeter, and the interior.

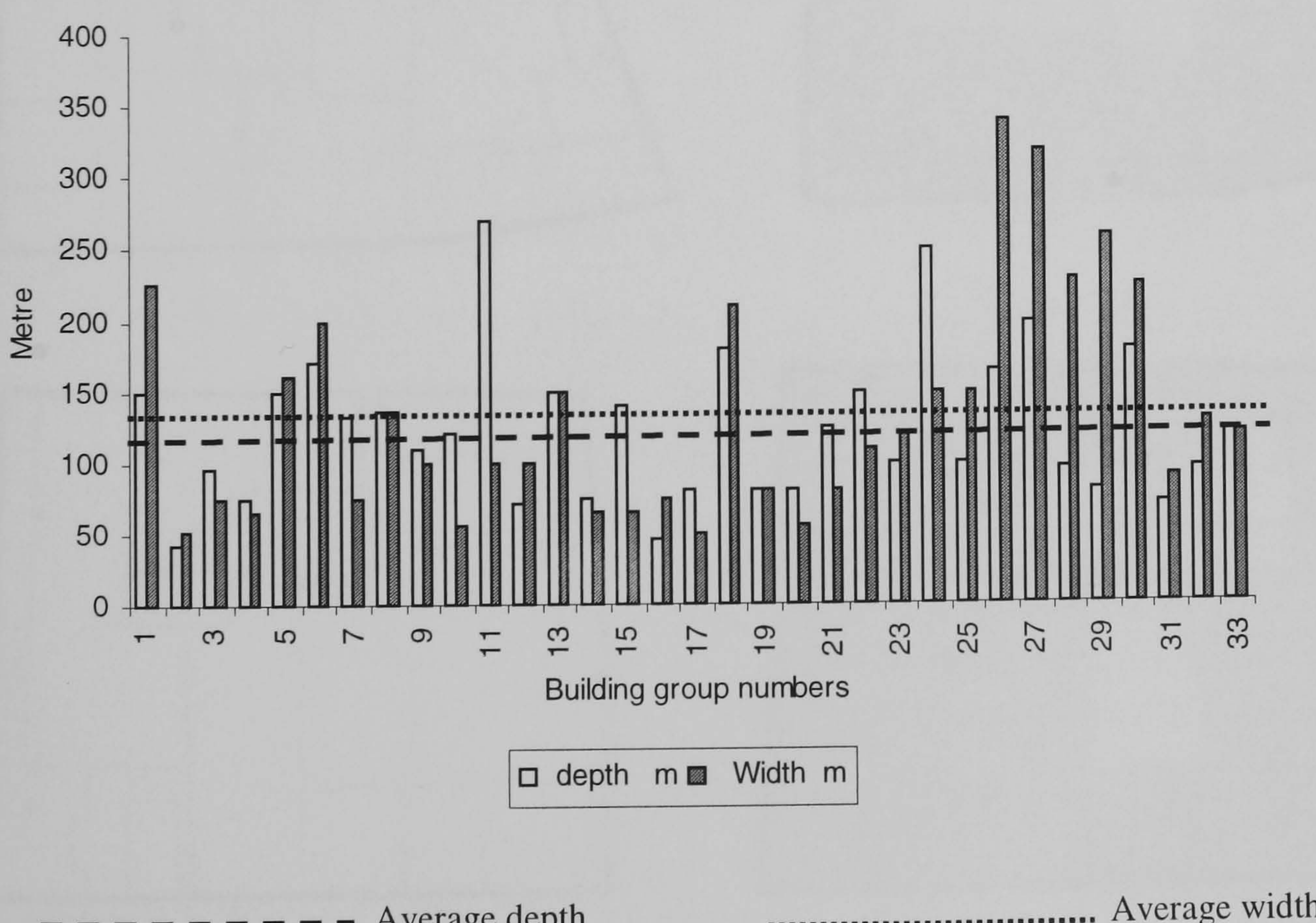
The great majority of building groups examined in the Godal-e-mosallah area, 64 per cent, did not have any break through or cul-de-sac. Therefore access to the building units in such building groups was almost entirely from the surrounding streets, with a very few units having access from a private cul-de-sacs off such streets or through other units which are located at their vicinity.

Consideration of the spatial arrangement and access system in this section of the analysis of the building groups in the Godal-e-mosallah area was limited to those building groups where at least one breakthrough or cul-de-sac was in evidence and therefore a somewhat more complicated arrangement applied. In this way in the Godal-e-mosallah district, there were, in fact 33 building groups which came into such a category. The average depth of these building groups is 120 metre where the average width is around 130 metre (See Graph 7.20).

A building group may be divided into two sections. Those building units, which did not have a direct access from the surrounding streets were formed the built parts of the interior section. These units were connected with the public spaces either through a cul-de-sac or through other units. Table 7.3 show that the percentage of units located in the perimeter of building groups varied from a minimum of 23 per cent and average of 78 per cent. Figure 7.5 shows some examples of how the extent of an interior section of Fahhadan area was identified.

On occasions it was not always easy to identify which buildings, or parts of the buildings did not have direct access from the street or alley, therefore, looking firstly at the plan of the building group, an inside network of access routes was marked out. It was then possible to establish which buildings were served by these cul-de-sacs. The approximate boundaries between buildings were then observed, although it was not always easy to mark the division of peripheral and internal section of a building group. Where a building unit had accesses to both the surrounding network and a cul-de-sac, it was considered as a perimeter building unit.

Graphs 7.21 to 7.24 give an analysis of the relationship between both the number of perimeter and interior units with the depth and width of the building groups in Godal-e-mosallah area. According to these graphs, there is a modest relationship between the number of perimeter units with the width and the depth of the building groups and number of interior units with the depth of building groups. However, the relationship between number of interior units and the width of the building groups was not significant.

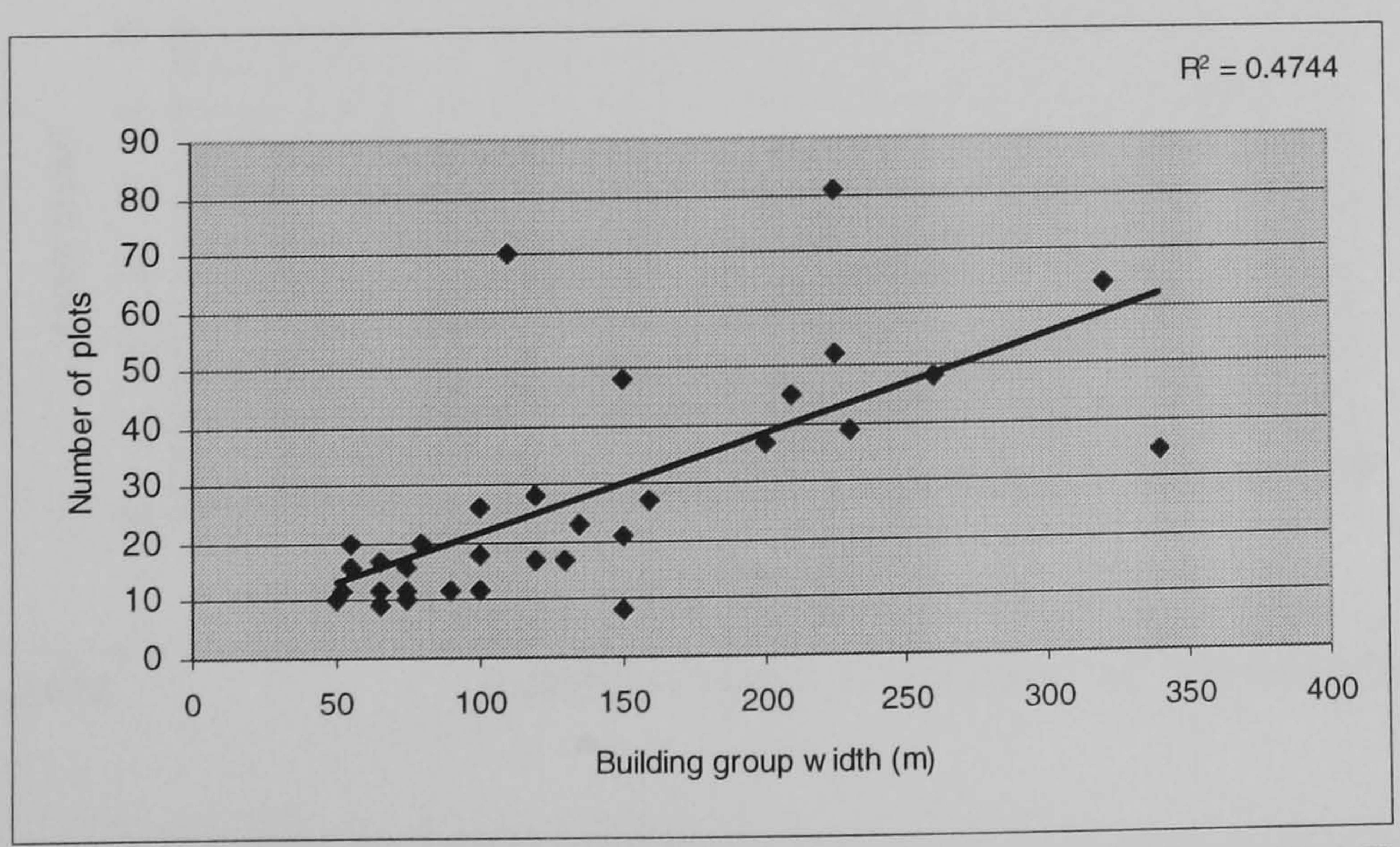


GRAPH 7.20: VARIATION OF BUILDING GROUP SIZE IN TERMS OF DEPTH AND WIDTH IN THE 33 BUILDING GROUPS WHICH HAVE AT LEAST ONE CUL-DE-SAC IN THE GODAL-E-MOSALLAH AREA

FIGURE 7.5: SOME EXAMPLES OF BUILDING GROUPS IN THE GODAL-E-MOSALLAH AREA AND CLASSIFICATION OF INTERIOR AND PERIMETER BUILDING GROUPS. IN THE DIAGRAM, THE AREA WITH OBLIQUE LINES INDICATE THE PERIMETER UNITS

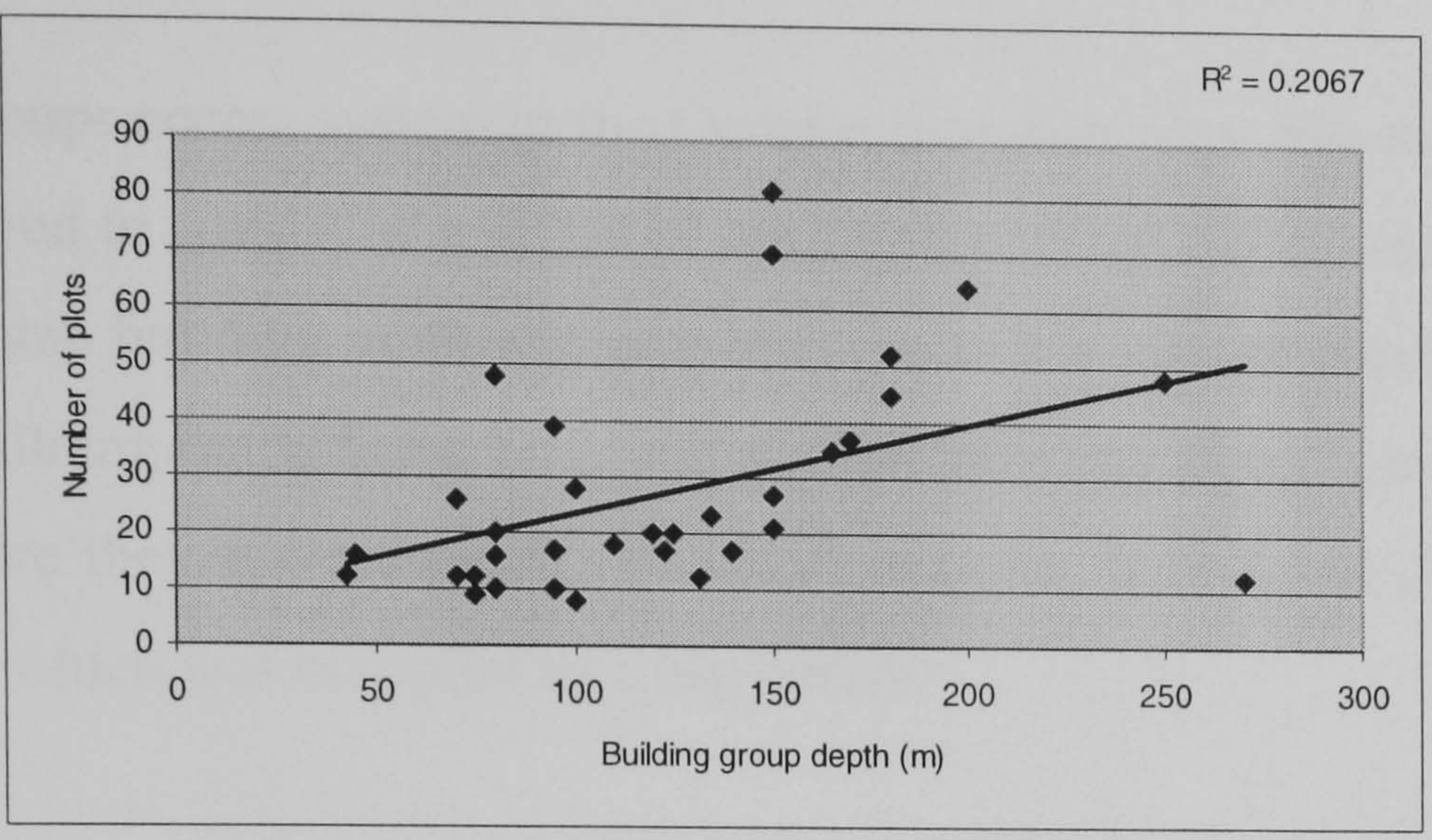
Number	Group area m sq.	Depth (m)	Width (m)	No of units	Interior section units	percentage of interior units	Perimeter units	Percentage of perimeter units
1	19560	150	225	86	5	6%	81	94%
2	1497	43	52	12	0	0%	12	100%
3	6931	95	75	28	18	64%	10	36%
4	3904	75	65	10	1	10%	9	90%
5	17280	150	160	68	41	60%	27	40%
6	25764	170	200	89	52	58%	37	42%
7	7907	132	75	14	2	14%	12	86%
8	14157	135	135	37	14	38%	23	62%
9	7724	110	100	19	1	5%	18	95%
10	5195	120	55	20	0	0%	20	100%
11	17145	270	100	53	41	77%	12	23%
12	5447	70	100	29	3	10%	26	90%
13	14478	150	150	22	1	5%	21	95%
14	3290	75	65	13	1	8%	12	92%
15	4708	140	65	22	5	23%	17	77%
16	3456	45	75	16	0	0%	16	100%
17	3609	80	50	11	1	9%	10	91%
18	22725	180	210	57	12	21%	45	79%
19	5471	80	80	22	2	9%	20	91%
20	3171	80	55	17	1	6%	16	94%
21	5054	125	80	25	5	20%	20	80%
22	15625	150	110	81	11	14%	70	86%
23	8885	100	120	33	5	15%	28	85%
24	30093	250	150	82	34	41%	48	59%
25	10348	100	150	20	12	60%	8	40%
26	40662	165	340	36	1	3%	35	97%
27	25525	200	320	83	19	23%	64	77%
28	13558	95	230	50	11	22%	39	78%
29	16235	80	260	61	13	21%	48	79%
30	26734	180	225	84	32	38%	52	62%
31	3485	70	90	13	1	8%	12	92%
32	7734	95	130	19	2	11%	17	89%
33	7945	123	120	18	1	6%	17	94%

TABLE 7.3 BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERMS OF PERIMETER AND INTERIOR SECTIONS IN THE GODAL-E-MOSALLAH AREA



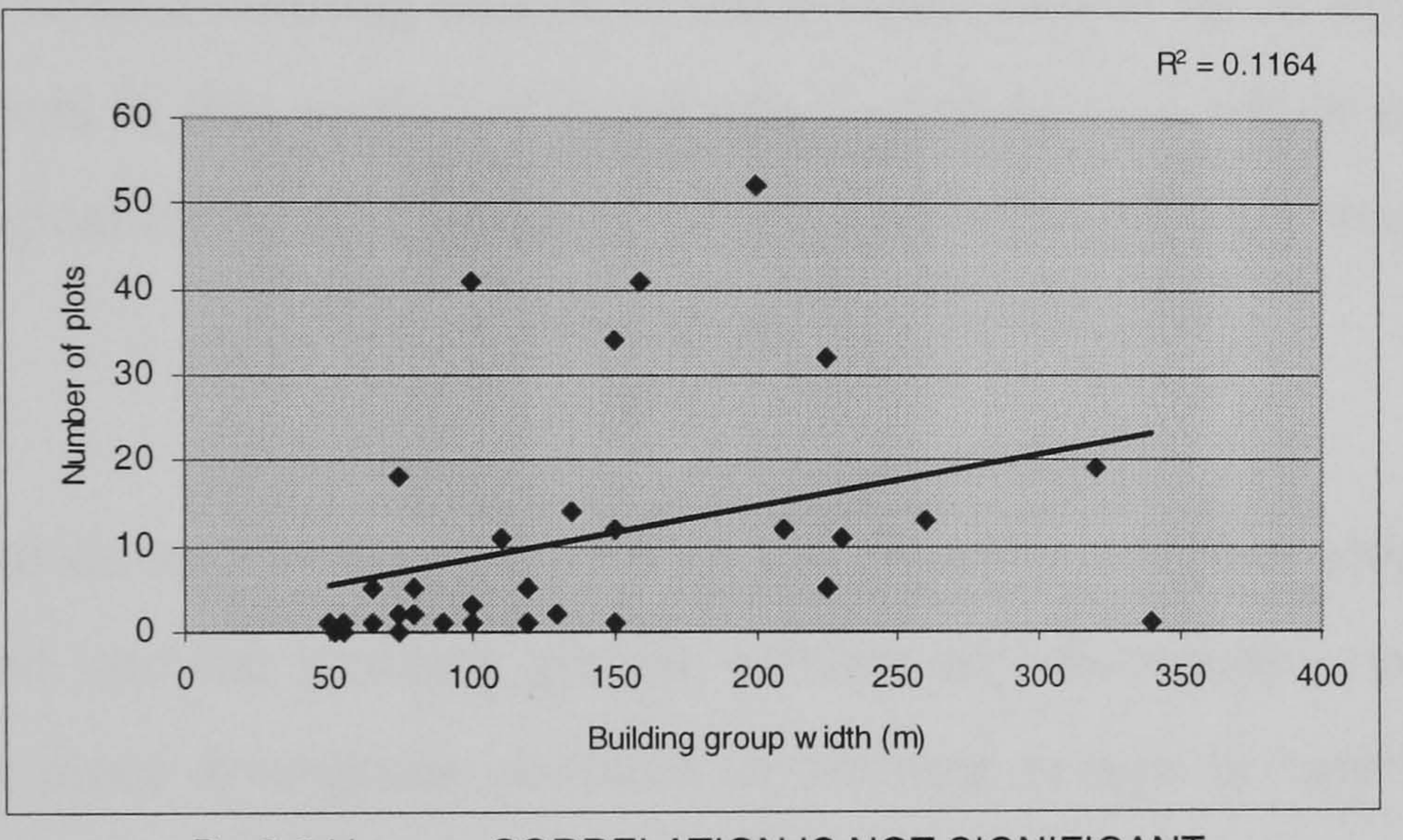
R=0.689 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.21: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF PERIMETER UNITS IN THE GODAL-E-MOSALLAH AREA



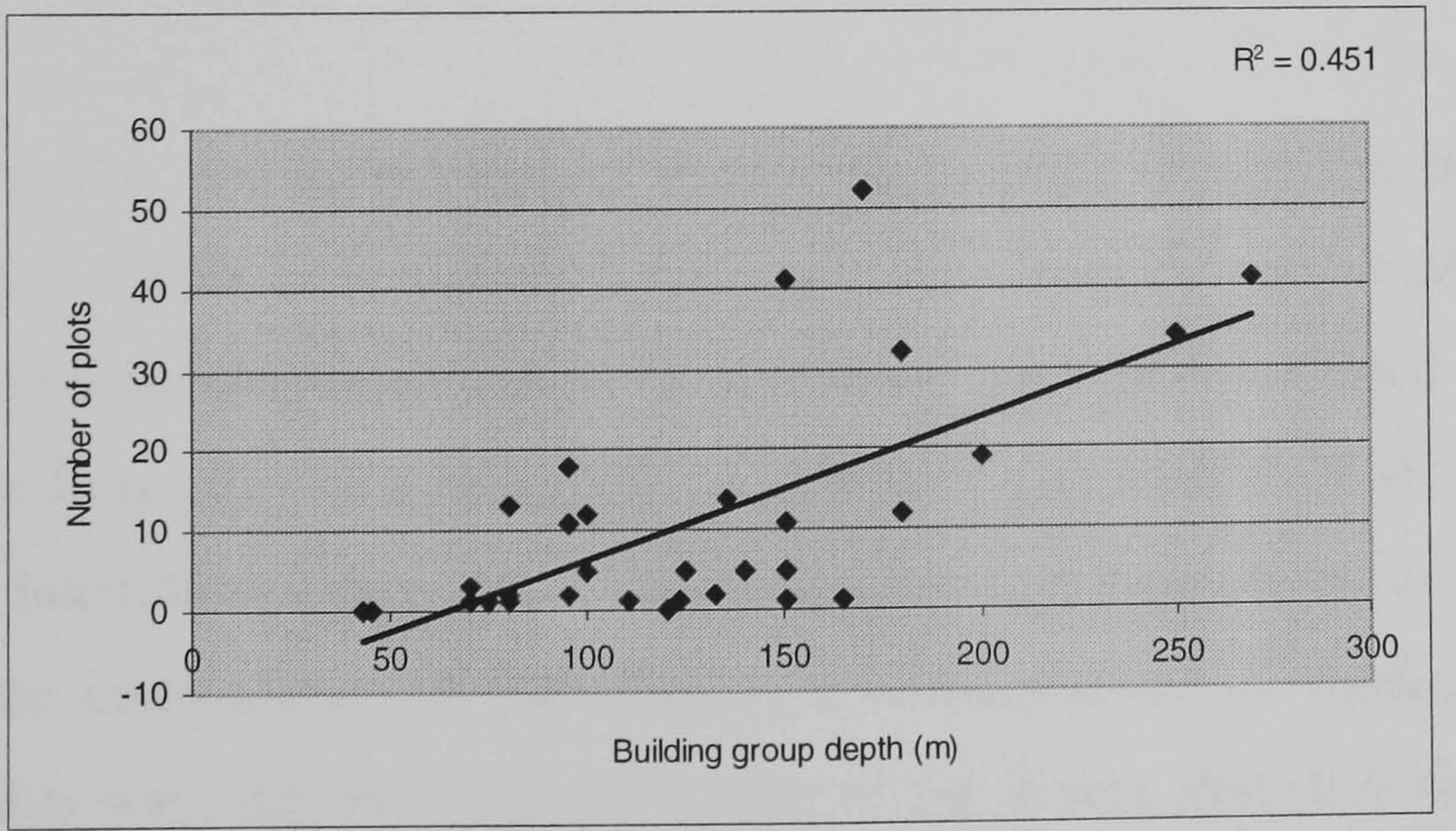
R=0.455 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.22: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF PERIMETER UNITS IN THE GODAL-E-MOSALLAH AREA



R= 0.341 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.23 : RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF INTERIOR UNITS IN THE GODAL-E-MOSALLAH AREA



R=0.672 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.24: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF INTERIOR UNITS IN THE GODAL-E-MOSALLAH AREA

7.3.3. ACCESS SYSTEM

The building groups access system in the Godal-e-mosallah area, like that of the walled city, also appeared to consist of a series of open and covered cul-de-sacs. Occasionally the access of some building units was provided through a private passage, which may serve several building units. Some buildings did not have any direct access to the public domain, therefore they serve through other unit or units. In this case, they acted as a small complex, which was occupied by a big family.

The private passages were a constituent part of a specific building units, where the cul-de-sac was an in dependent entity. The private passages were mostly used by a group of families which shared a building unit or in some cases, two or more adjacent buildings. The access analysis in this section referred only to cul-de-sacs which appeared to be a major morphological element of building groups and belonged very much to the public domain.

Two types of cul-de-sacs were identified in the Godal-e-mosallah area. Those which simply penetrated into the building groups without any divergence, and those cul-de-sacs with one or more divergence occurred in building groups in various directions to serve the units which are located close to them. They serve the extreme units which are situated in the interior section of the building groups.

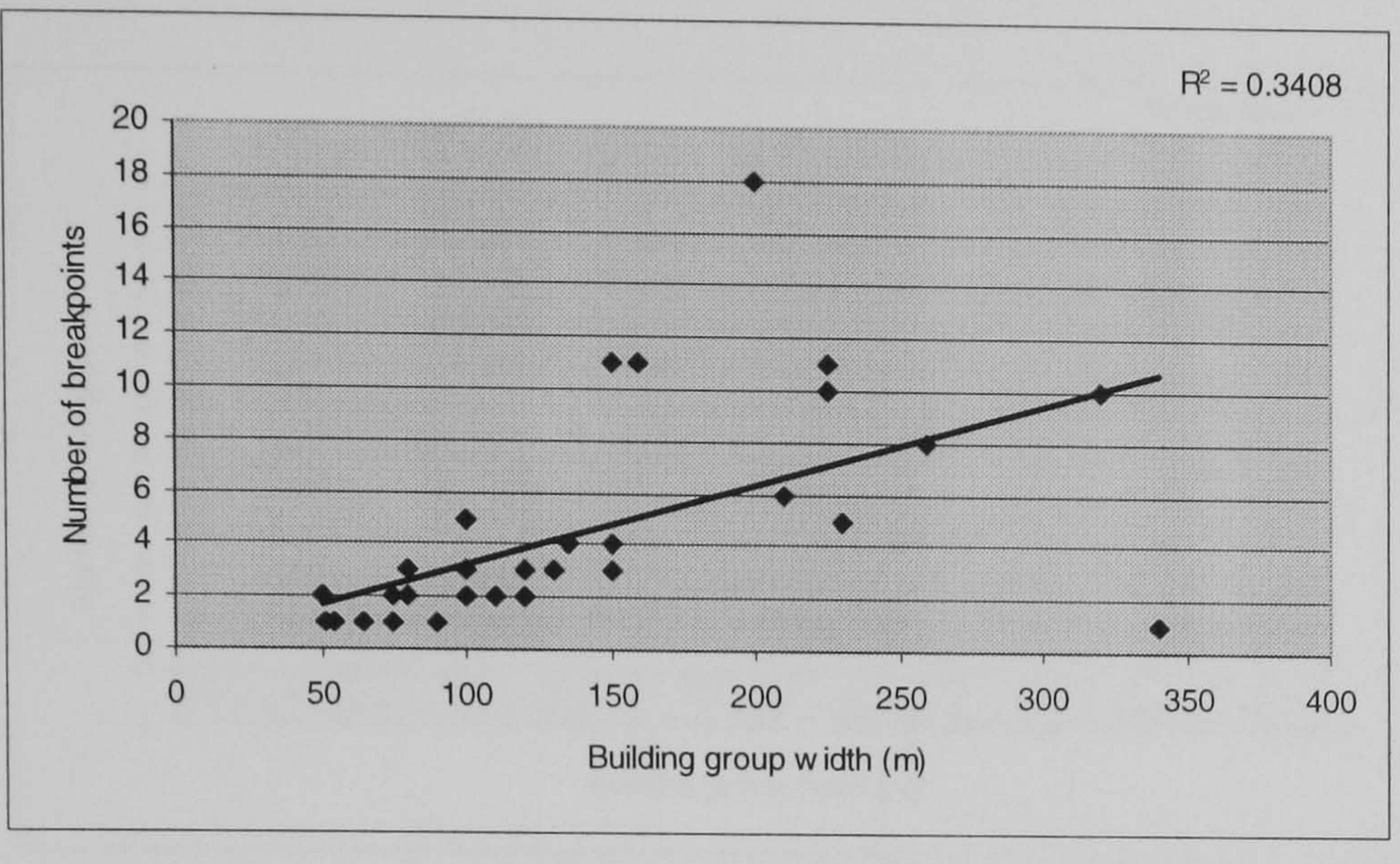
In Godal-e-mosallah, the access system within the building groups has been classified by their direction which, as in Fahhadan, generally runs from the north-east to the south-west or in the perpendicular direction. A cul-de-sac may be considered as a passage which diverges from alley or a cul-de-sac. A divergent part must thus occur in the form of either a 'T' junction or a cross-junction. Such a junction is described in this work as a breakpoint. For convenience of calculation, a cross-junction is treated as two 'T' junctions. In this way, the basic characteristics of the access system within a building group can be recorded by means of a table (See Table 7.4). From the table, a number of features of the access system as a whole can be considered, such as the number of all breakpoints and the number of breakpoints in two directions.

The relationship between the number of breakpoints and the width of the building groups was also examined. It seems that building group width to some extent is related to the number of internal breakpoint. The examination shows that there is a modest relationship between the width and the both number of internal breakpoint and the total number of breakpoints occur in building groups. Regarding to the building group depth there was also a significant relationship with the perimeter breakpoints and both the width and the depth of the building groups. In general the number of breakpoints is to some extent related to depth and width of the building groups in the Godal-e-mosallah area (See Graphs 7.25 to 7.30).

FIGURE 7.6: AN EXAMPLE OF ACCESS SYSTEM IN THE GODAL-E-MOSALLAH AREA

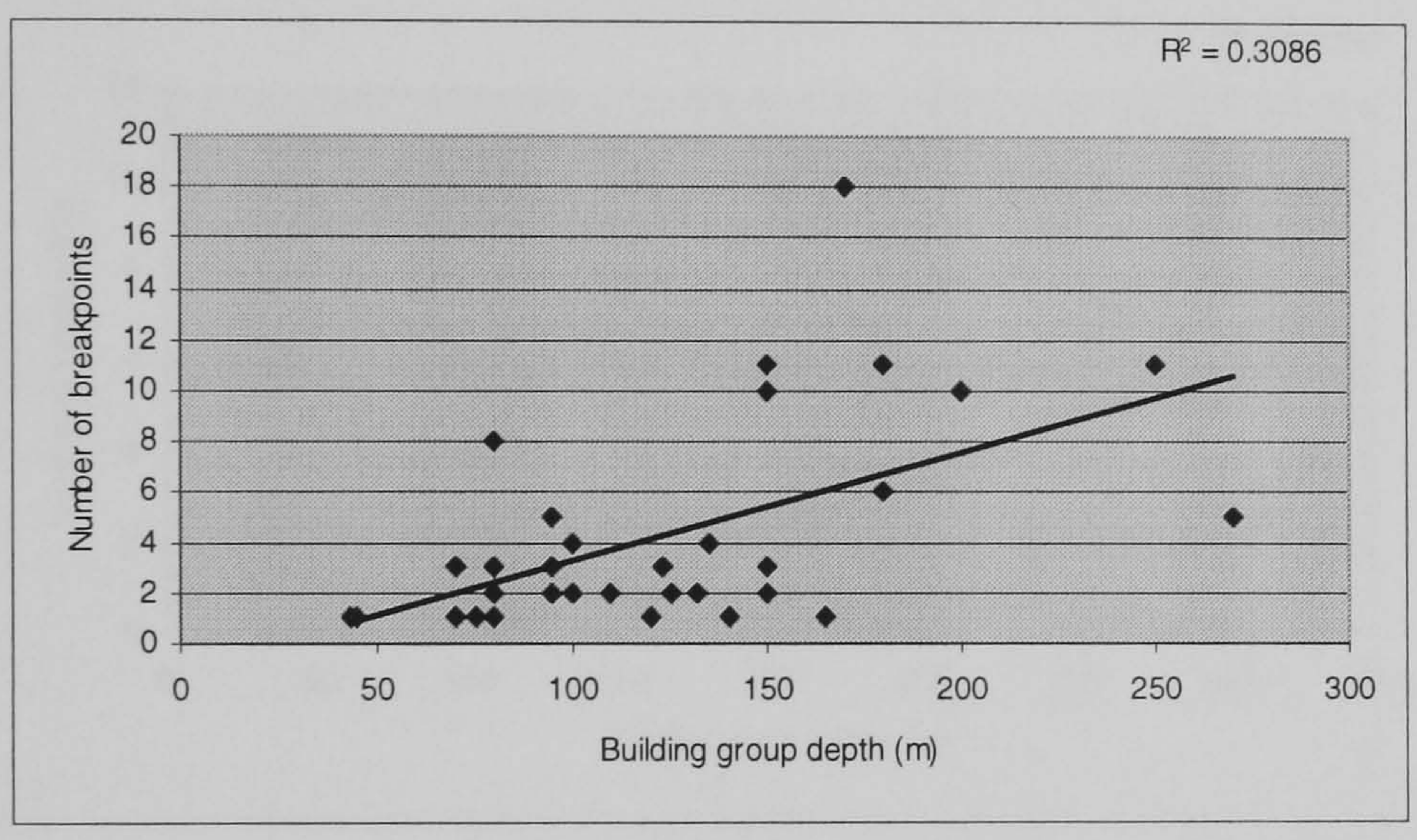
Number	Group area (m sq.)	Depth (m)	Width (m)	No of units	Breakpoints				
					Total	Inner break	Perimeter break	N-E to S-W	N-W to S-E
1	19560	150	225	86	10	6	4	6	4
2	1497	43	52	12	1	0	1	1	0
3	6931	95	75	28	2	1	1	1	1
4	3904	75	65	10	1	0	1	1	0
5	17280	150	160	68	11	5	6	3	7
6	25764	170	200	89	18	8	10	12	6
7	7907	132	75	14	2	0	2	1	1
8	14157	135	135	37	4	1	3	1	3
9	7724	110	100	19	2	0	2	0	2
10	5195	120	55	20	1	0	1	0	1
11	17145	270	100	53	5	1	4	3	2
12	5447	70	100	29	3	0	3	2	1
13	14478	150	150	22	3	0	3	3	0
14	3290	75	65	13	1	0	1	0	1
15	4708	140	65	22	1	0	1	1	0
16	3456	45	75	16	1	0	1	0	1
17	3609	80	50	11	2	0	2	2	0
18	22725	180	210	57	6	3	3	4	2
19	5471	80	80	22	3	1	2	1	2
20	3171	80	55	17	1	0	1	1	0
21	5054	125	80	25	2	0	2	2	0
22	15625	150	110	81	2	0	2	2	0
23	8885	100	120	33	2	1	1	1	1
24	30093	250	150	82	11	1	10	8	3
25	10348	100	150	20	4	3	1	3	1
26	40662	165	340	36	1	0	1	1	0
27	25525	200	320	83	10	6	5	8	3
28	13558	95	230	50	5	1	4	4	1
29	16235	80	260	61	8	0	8	8	0
30	26734	180	225	84	11	4	7	7	4
31	3485	70	90	13	1	0	1	0	1
32	7734	95	130	19	3	1	2	1	2
33	7945	123	120	18	3	2	1	2	1

TABLE 7.4: BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERM OF BREAKTHROUGH IN THE GODAL-E-MOSALLAH AREA



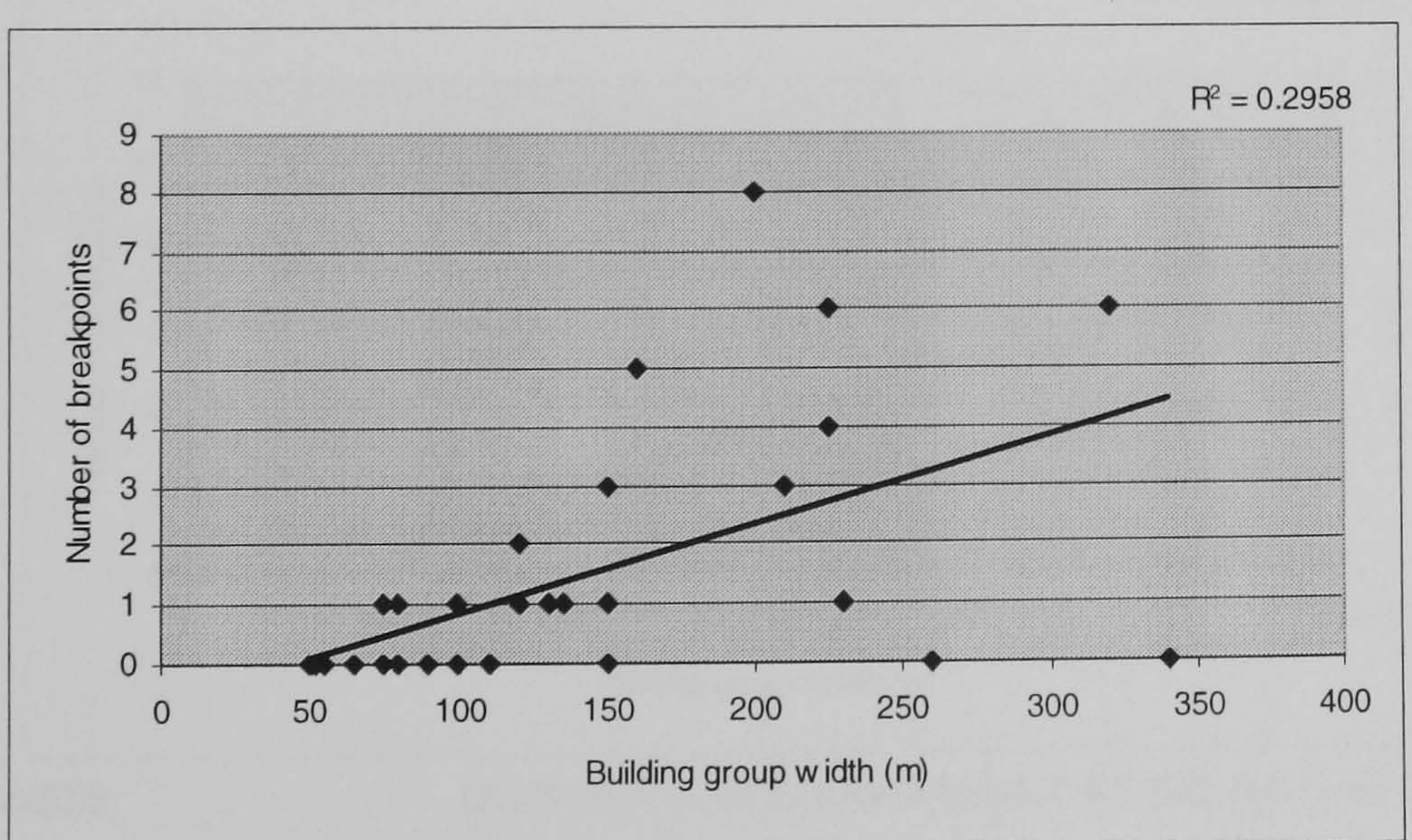
R=0.584 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.25: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF ALL BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA



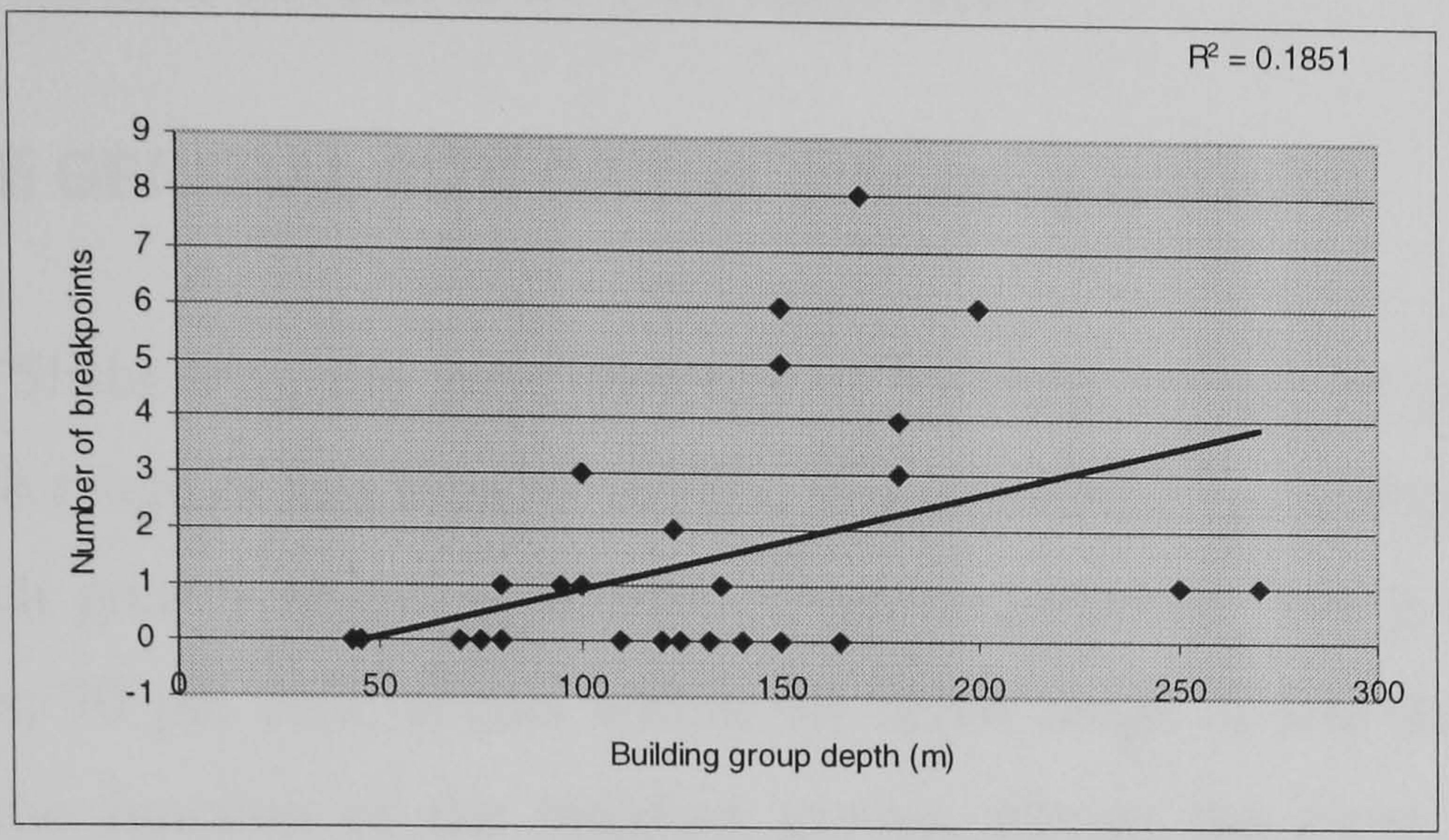
R=0.556 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.26: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF ALL BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA



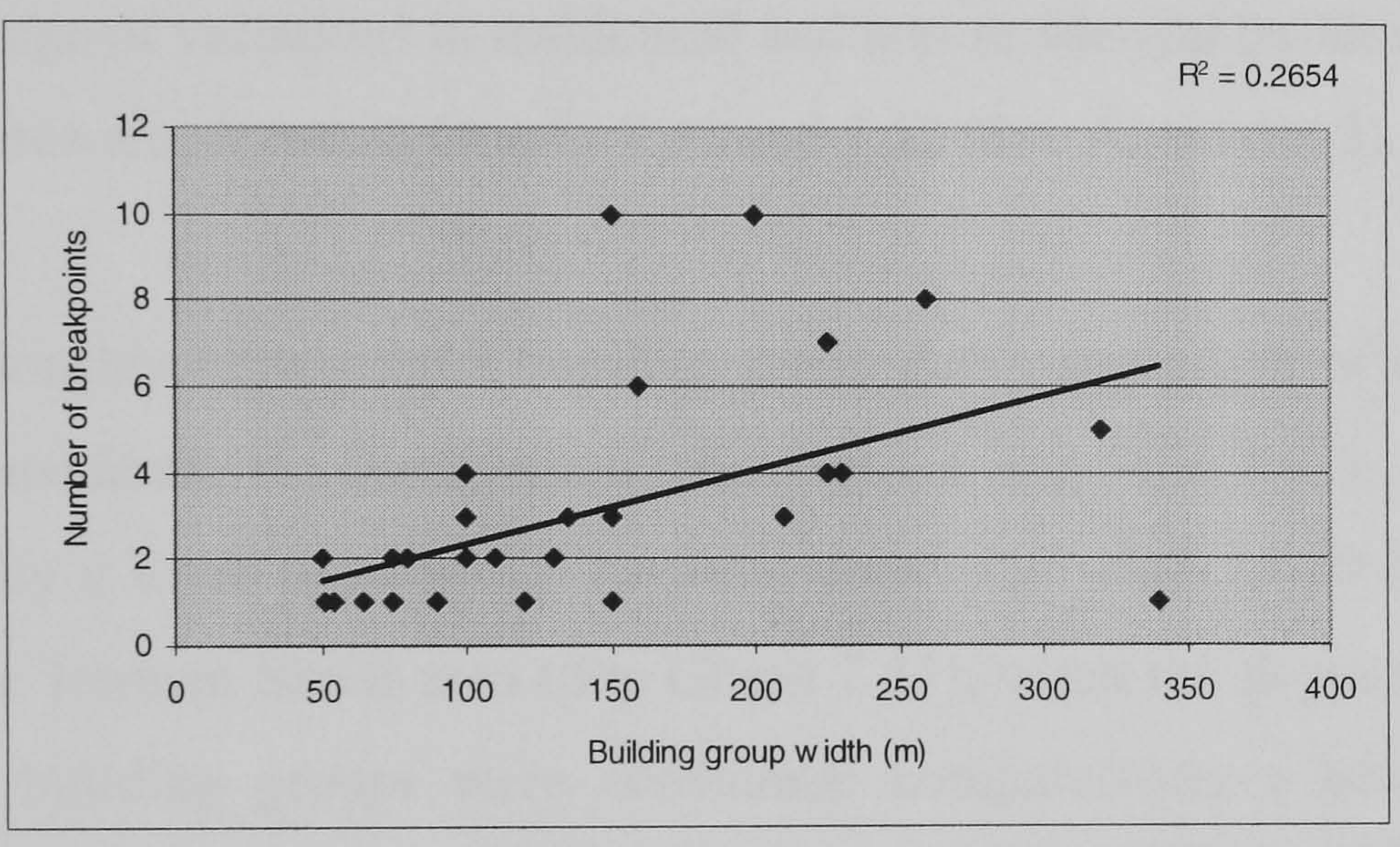
R=0.544 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.27: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF INNER BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA



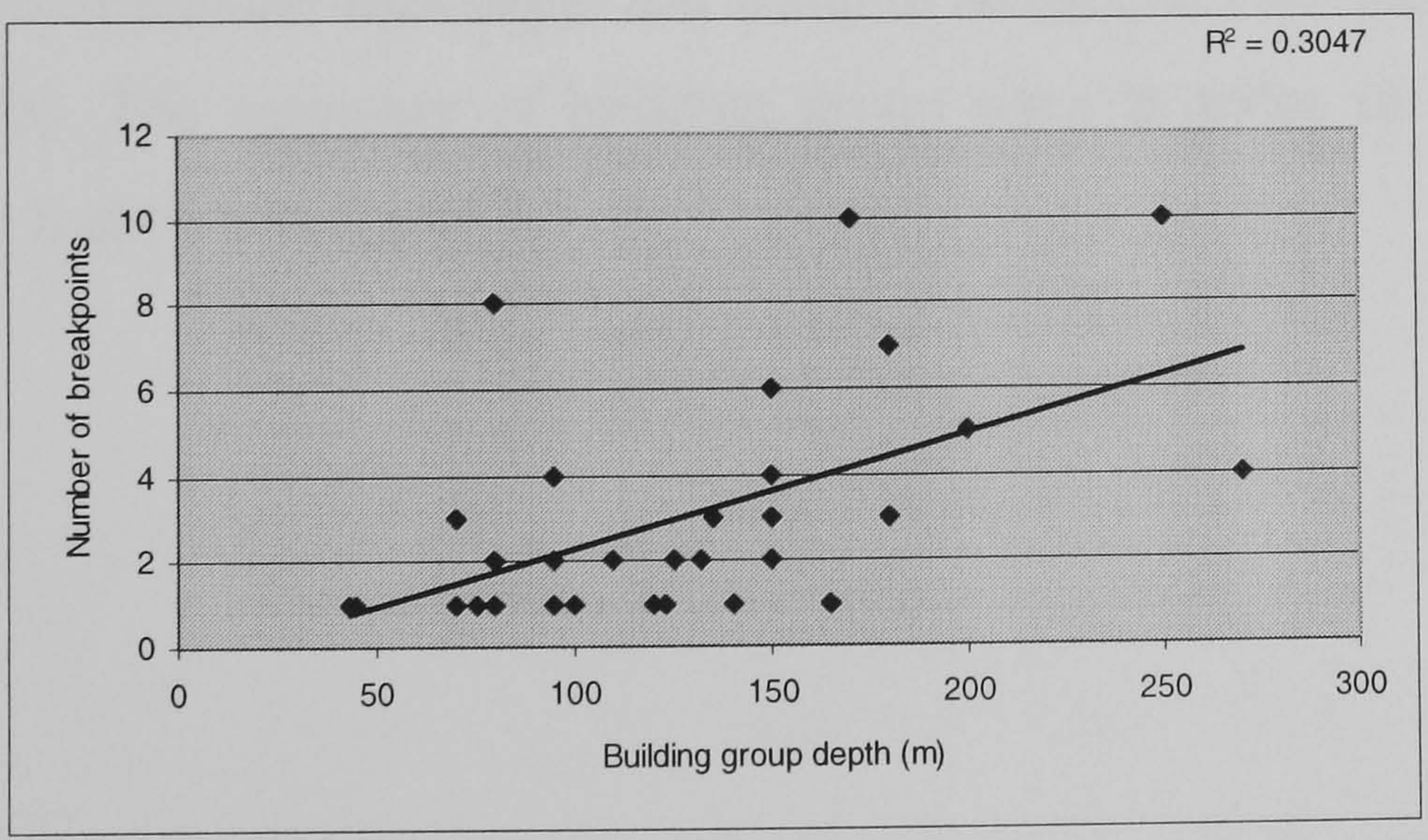
R=0.430 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL .

GRAPH 7.28: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF INNER BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA



R=0.515 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL .

GRAPH 7.29: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF PERIMETER BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA



R=0.552 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL .

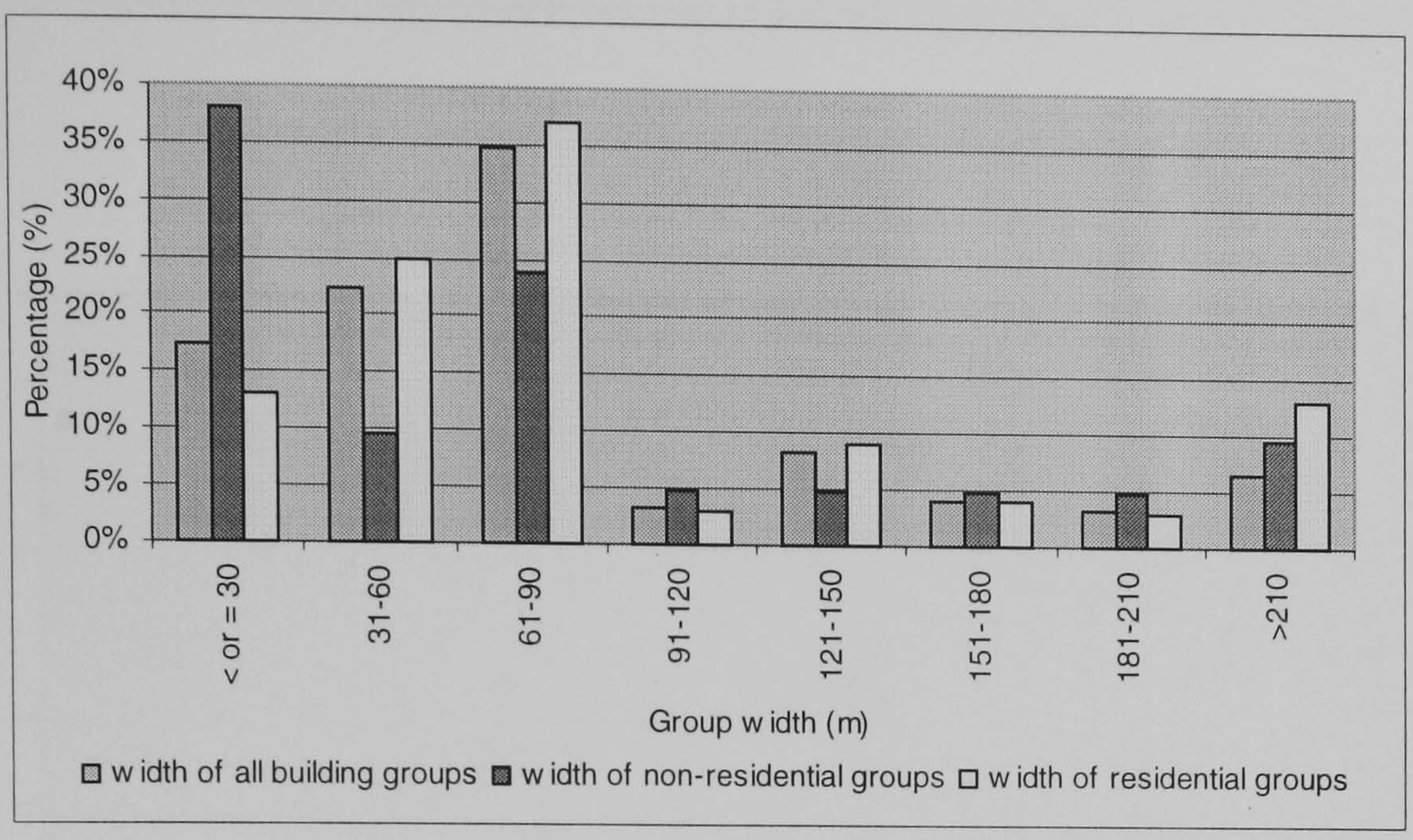
GRAPH 7.30: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF PERIMETER BREAKPOINTS IN THE GODAL-E-MOSALLAH AREA

7.4. BUILDING GROUPS IN THE NEW CITY

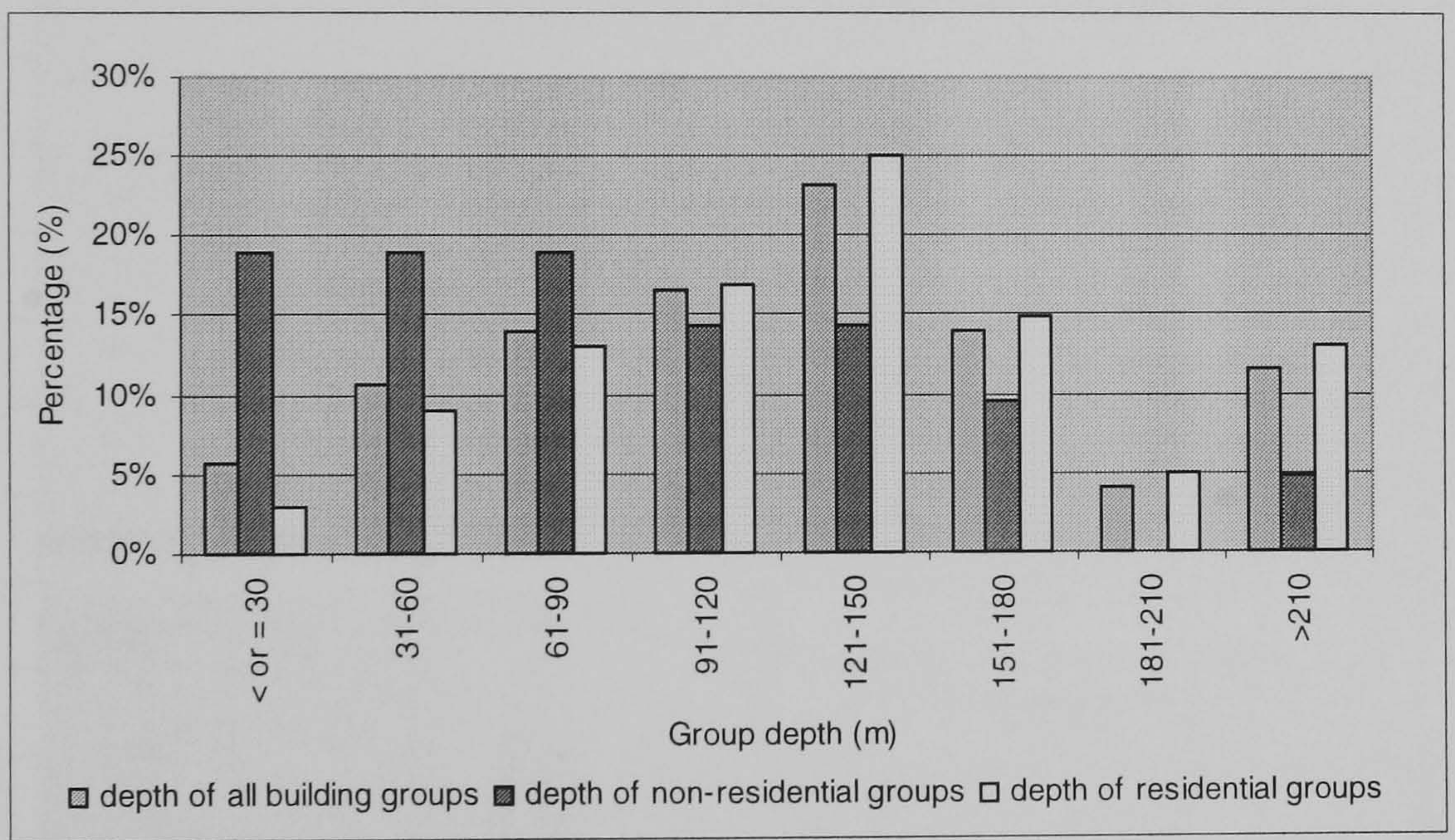
7.4.1. THE GENERAL SIZE OF THE BUILDING GROUPS

In the Immam Shahr area, the great majority of building groups, 75 per cent, occurs within the width range of less than 90 meters. When building group depth is taken into account, a much greater spread of dimensions is encountered. The great majority of building groups, 70 per cent, occurs within the depth range of less than 150 metres. Regarding to the function of the building groups, almost the same variation is in evidence. In building groups with non-residential uses and in mixed used groups, the built form of plots generally consists of structures located in the inner part of the plots. The different range of variations in residential and non-residential building groups in the Immam Shahr area are shown in Graphs 7.31 and 7.32 (See Appendix 3).

When the relationship between the building group depth and width of all the building groups were considered, the depth/width ratio was varying from 1:1 to 1:10. Although there is generally a weak relationship between depth and width in all building groups appearing in the Immam Shahr area (See Graph 7.33), when the depth/width ratios for non-residential building groups were considered comparatively a better relationship emerged (See Graph 7.34). In general, the correlation between the depth and the width of all building groups in the Immam Shahr area was significant at 0.05 with a low relationship. The correlation with depth and width in residential area was not significant (See Graph 7.35). The summary of building group sizes in terms of building group depth and width is shown in figure 7.7.



GRAPH 7.31: BUILDING GROUP WIDTH DISTRIBUTION IN THE IMMAM SHAHR AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS



GRAPH 7.32: BUILDING GROUP DEPTH DISTRIBUTION IN THE IMMAM SHAHR AREA CLASSIFIED AND COMPARED WITH THE RESIDENTIAL AND NON-RESIDENTIAL BUILDING GROUPS

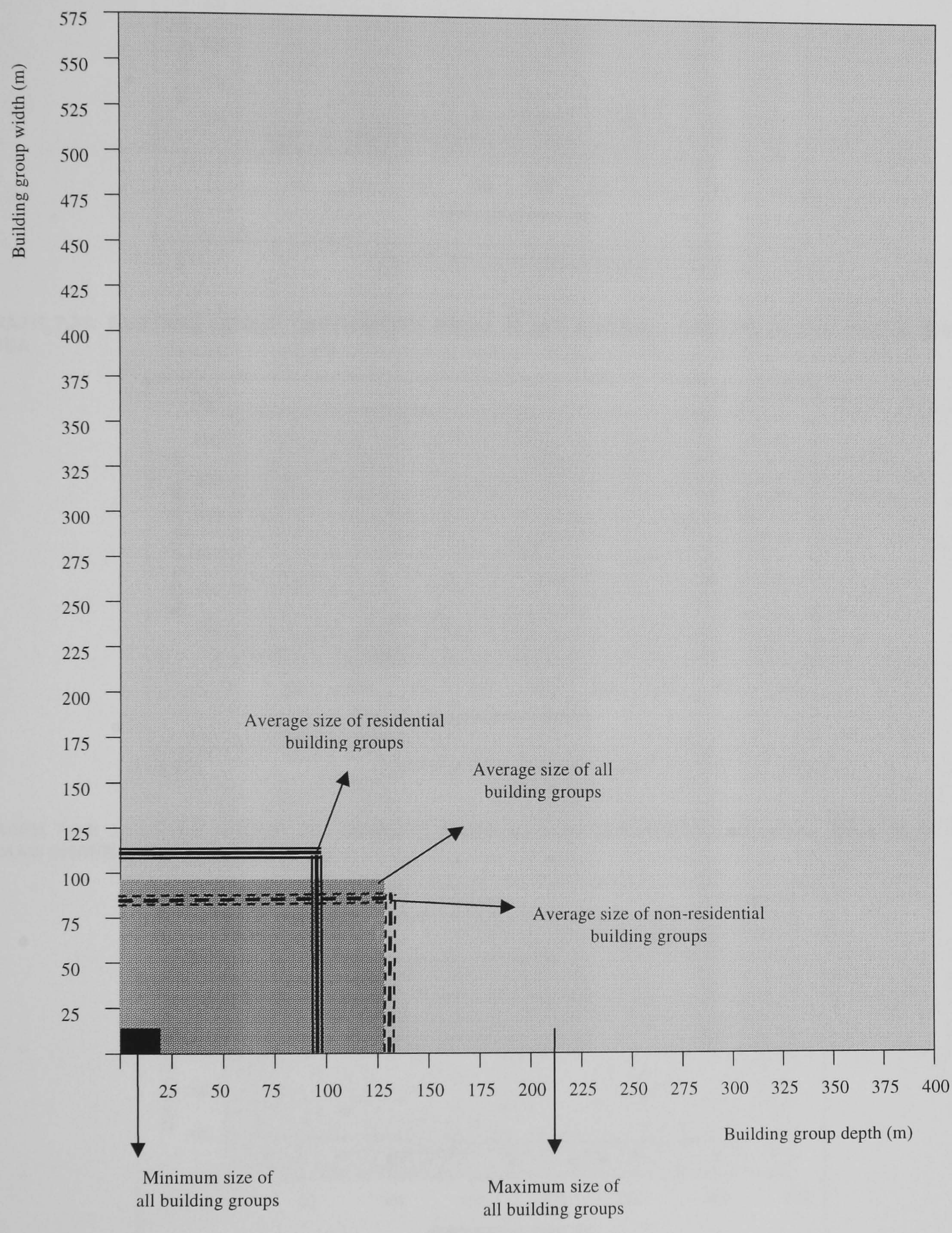
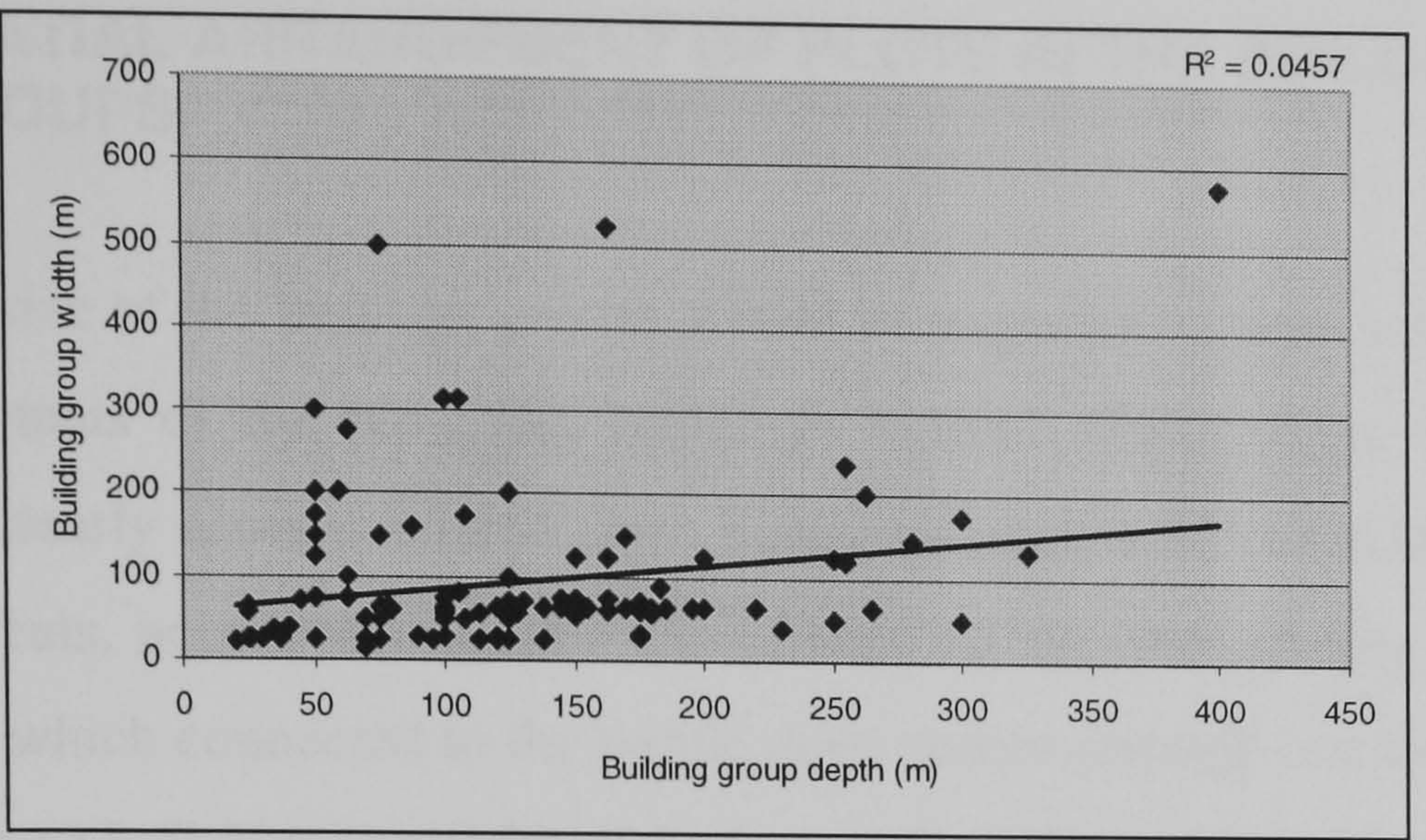
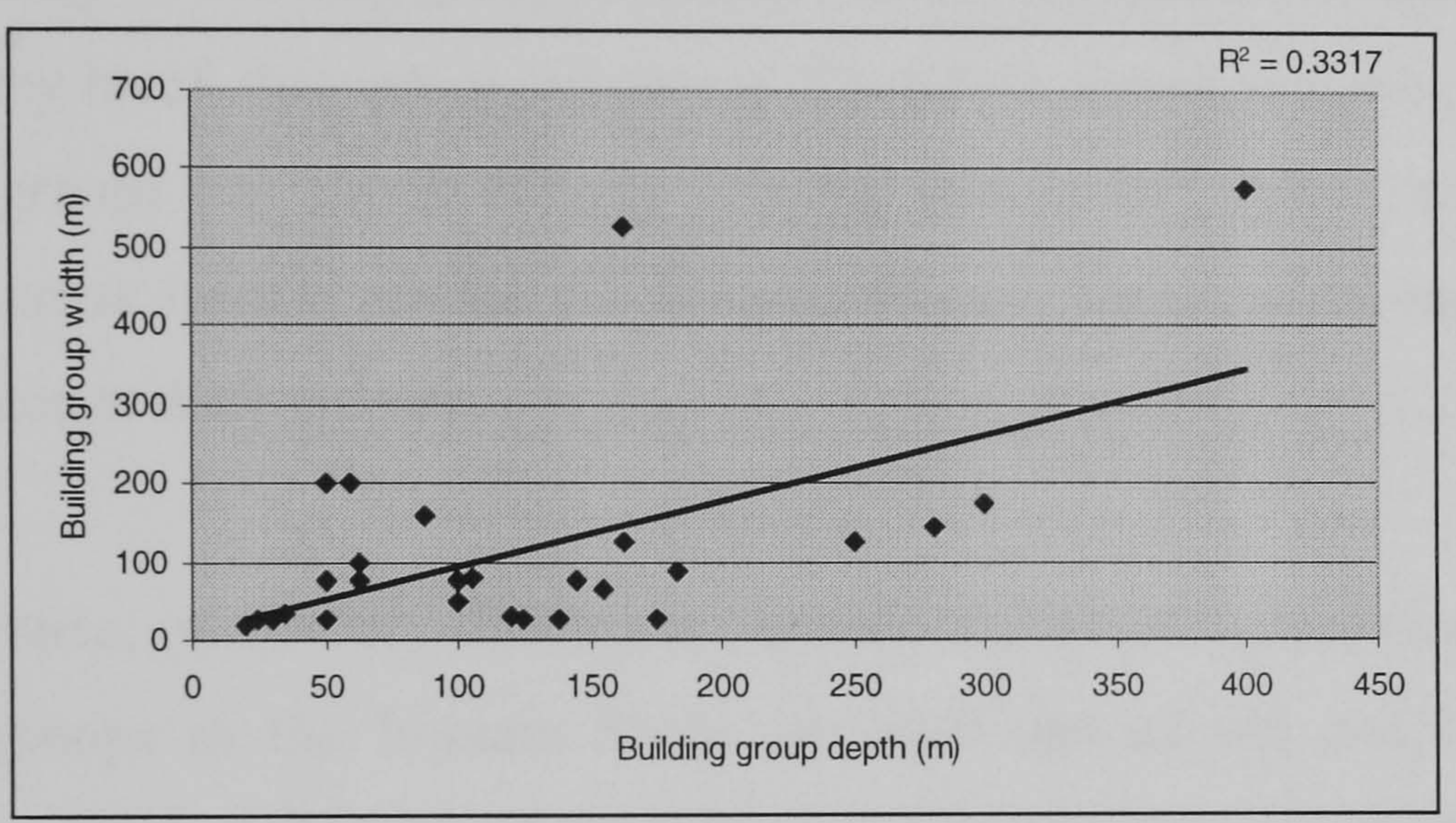


FIGURE 7.7: A SUMMARY OF BUILDING GROUP SIZES IN TERMS OF BUILDING GROUP DEPTH AND WIDTH IN THE IMMAM SHAHR AREA



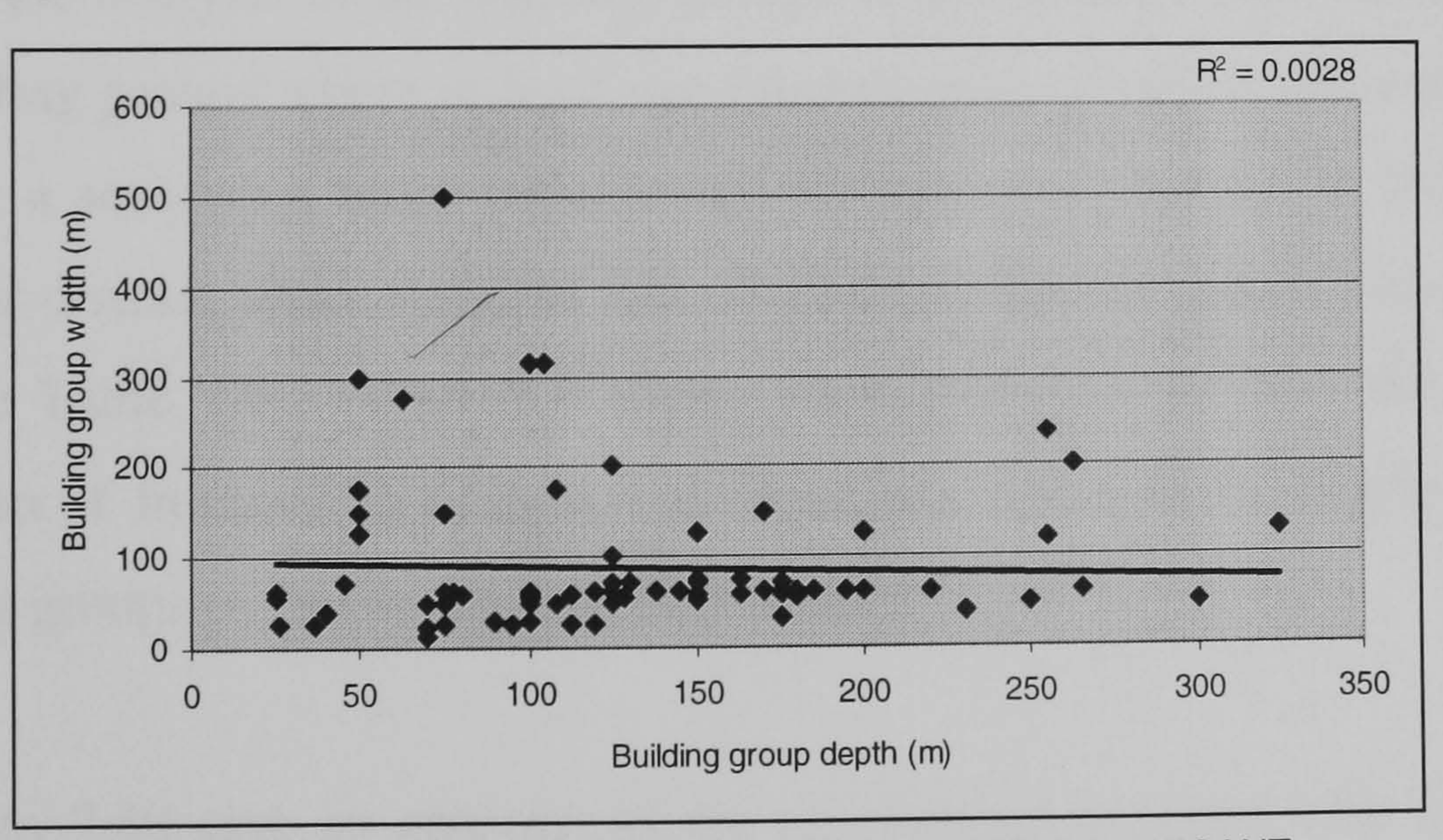
R=0.214 CORRELATION IS SIGNIFICANT AT THE 0.05 LEVEL

GRAPH 7.33: BUILDING GROUP DEPTH/WIDTH RATIO IN ALL BUILDING GROUPS IN THE IMMAM SHAHR AREA



R=0.576 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL

GRAPH 7.34: BUILDING GROUP DEPTH/WIDTH RATIO IN NON-RESIDENTIAL BUILDING GROUPS IN THE IMMAM SHAHR AREA



R= 0.053 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.35: BUILDING GROUP DEPTH/WIDTH RATIO IN RESIDENTIAL BUILDING GROUPS IN THE IMMAM SHAHR AREA

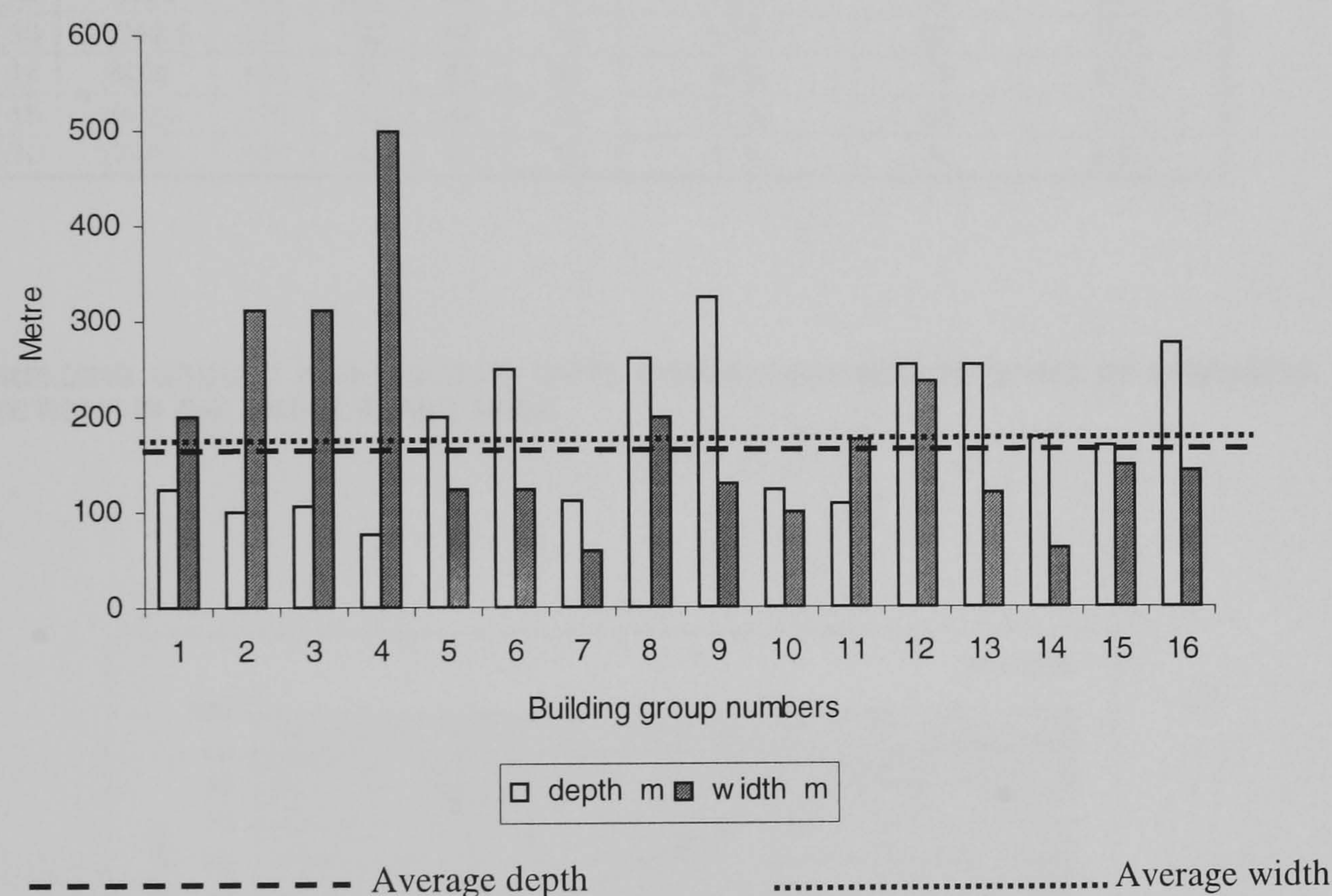
7.4.2. SPATIAL ARRANGEMENT OF PLOTS IN THE BUILDING GROUPS

The shape and size of the building groups would be expected to bear some relationship to the arrangements of the plots and buildings located within them. Many building groups depths clearly accommodated three buildings, each with direct access from the surrounding streets, access through the cul-de-sacs off the surrounding alleys, and an interior section which connected to the public open spaces through one or more building units. In this way a building group divided into two parts, the perimeter, and the interior.

The great majority of building groups examined in the Immam Shahr area, 86 per cent, did not have any break through or cul-de-sac. Therefore access to the building units in such building groups was almost entirely from the surrounding streets, with a very few units having access from a private cul-de-sacs off such streets or through other units which are located at their vicinity.

There is, of course, an obvious difference between the spatial arrangement of plots in the building groups in the Immam Shahr are with that of old and historical city. However, the method of analysis of the spatial arrangement was similar to the previous areas. Therefore, consideration of the spatial arrangement and access system in the remainder of the analysis of the building groups in the Immam Shahr area was limited to those building groups where at least one breakthrough or cul-de-sac was in evidence and therefore a somewhat more complicated arrangement applied. In this way in the Immam Shahr district, there were, in fact 38 building groups which came into such a category (See Table 7.5). Figure 7.6 shows some examples of how the extent of an interior section of Immam Shahr area was identified. The average depth and width of these building groups is 180 metre (See Graph 7.36).

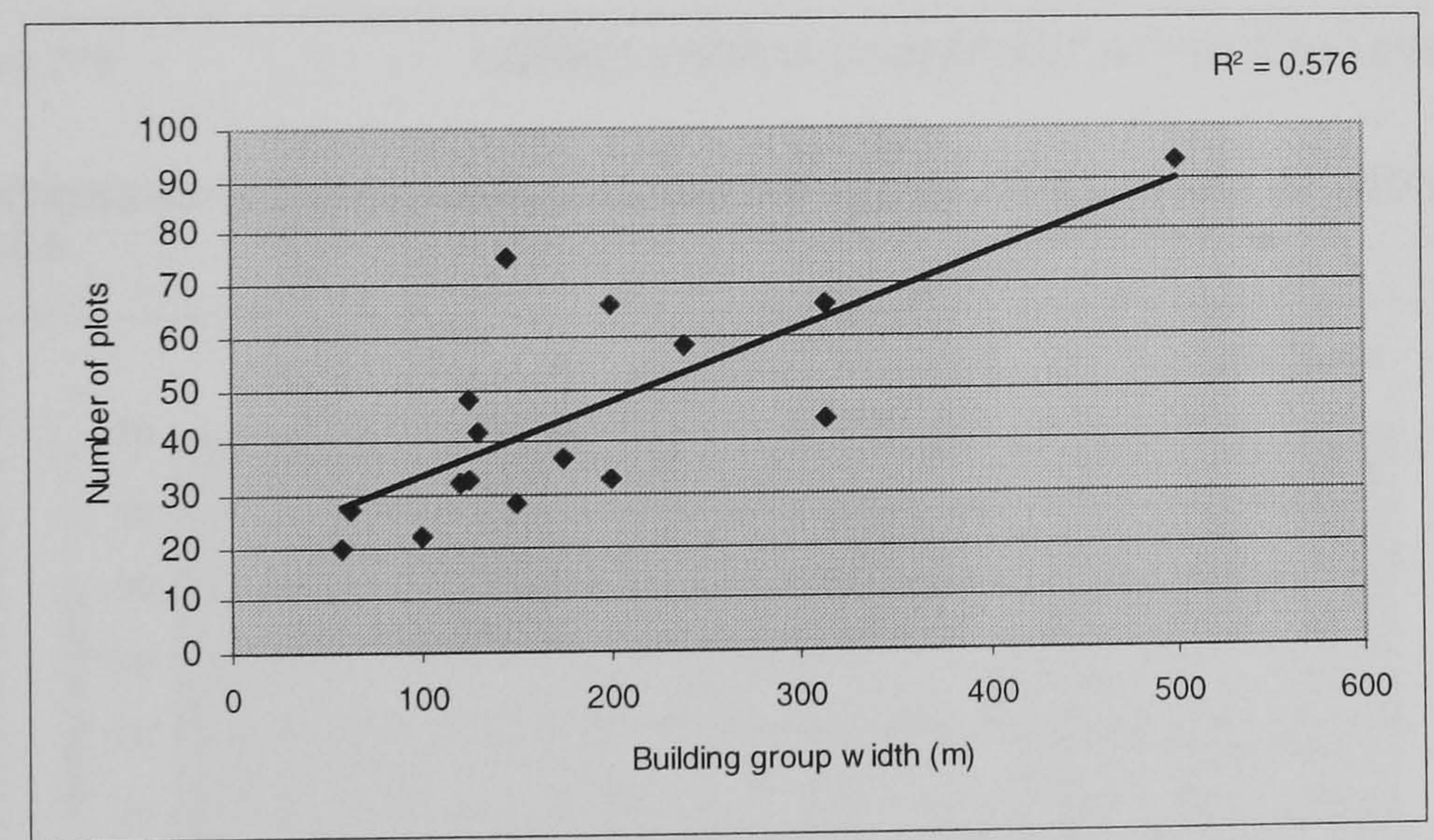
Graphs 7.37 to 7.40 give an analysis of the relationship between both the number of perimeter and interior units with the depth and width of the building groups in the Immam Shahr area. According to these graphs, there is only a high relationship between the number of perimeter units with the width of the building groups and number of the number of perimeter units with the width of the building groups and number of interior units with the width of building groups. However, the relationship between number of interior and perimeter units and the depth of the building groups was not significant.



GRAPH 7.36: VARIATION OF BUILDING GROUP SIZE IN TERMS OF DEPTH AND WIDTH IN THE 16 BUILDING GROUPS WHICH HAVE AT LEAST ONE CUL-DE-SAC IN THE IMMAM SHAHR AREA

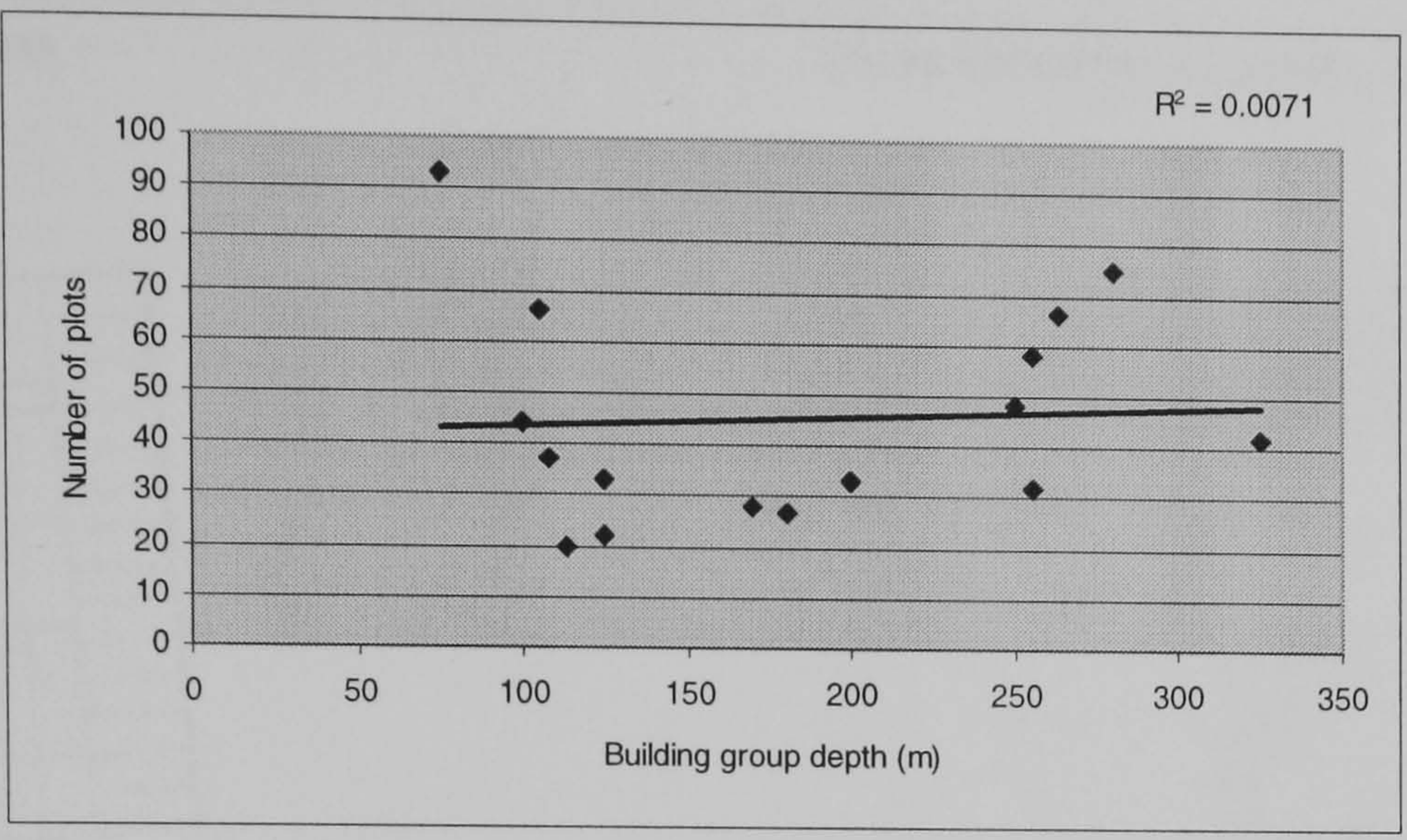
Number	Group area m sq.	Depth (m)	Width (m)	No of units	Interior section units	percentage of interior units	Perimeter units	Percentage of perimeter units
1	17859.2	125	200	54	21	39%	33	61%
2	22003.1	100	313	92	48	52%	44	48%
3	24670.2	105	313	124	58	47%	66	53%
4	33389.2	75	500	158	65	41%	93	59%
5	19568.5	200	125	45	12	27%	33	73%
6	42498.8	250	125	91	43	47%	48	53%
7	7147	113	58	20	0	0%	20	100%
8	40739	263	200	102	36	35%	66	65%
9	37043	325	130	68	26	38%	42	62%
10	12471.2	125	100	31	9	29%	22	71%
11	16491	108	175	57	20	35%	37	65%
12	40132	255	238	104	46	44%	58	56%
13	23042.5	255	120	64	32	50%	32	50%
14	8205	180	63	63	36	57%	27	43%
15	19234	170	150	44	16	36%	28	64%
16	27006	280	145	90	15	17%	75	83%

TABLE 7.5 BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERMS OF PERIMETER AND INTERIOR SECTIONS IN THE IMMAM SHAHR AREA



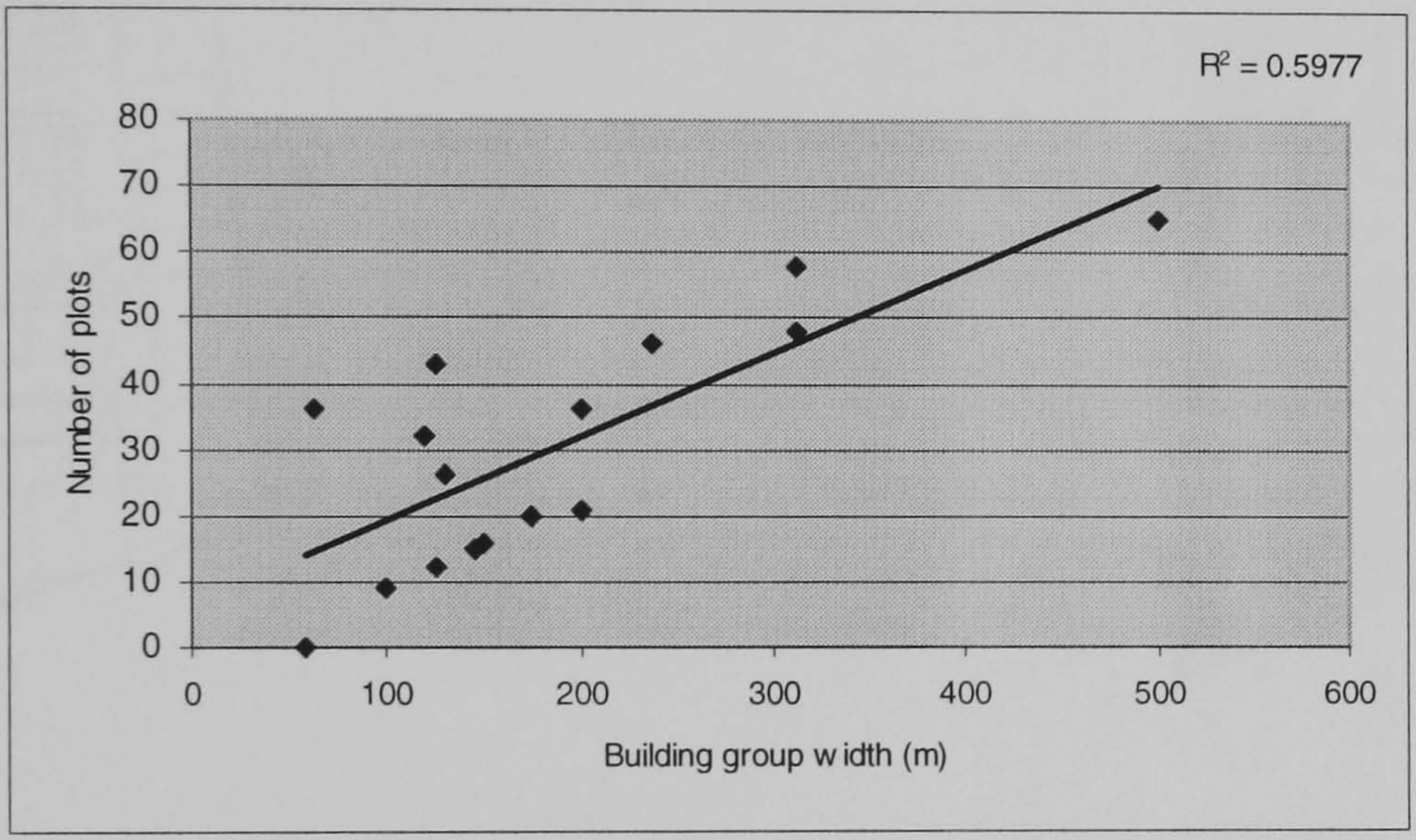
R=0.759 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL .

GRAPH 7.37: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF PERIMETER UNITS IN THE IMMAM SHAHR AREA



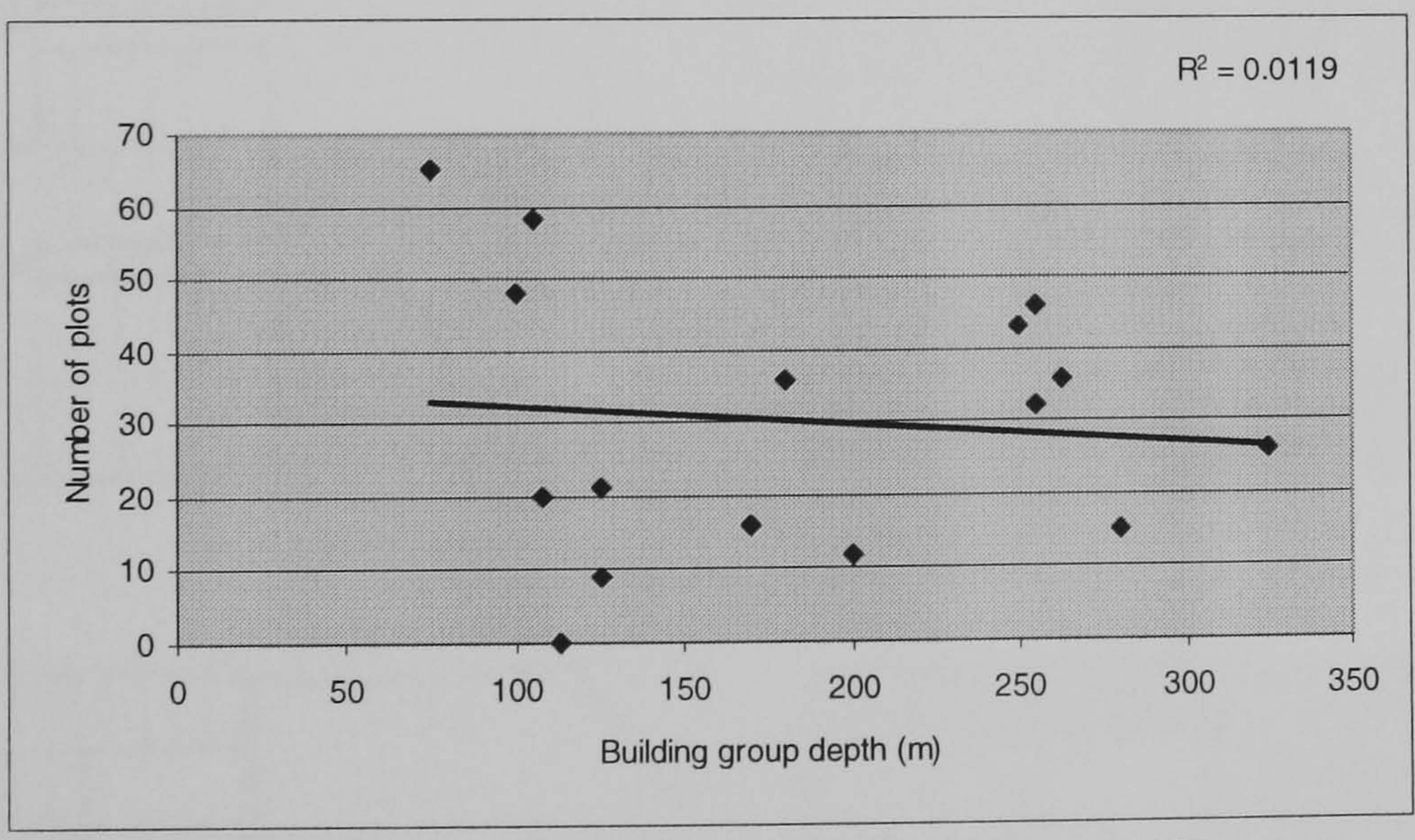
R= 0.084 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.38: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF PERIMETER UNITS IN THE IMMAM SHAHR AREA



R=0.773 CORRELATION IS SIGNIFICANT AT THE 0.01 LEVEL .

GRAPH 7.39: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF INTERIOR UNITS IN THE IMMAM SHAHR AREA



R= -0.109 CORRELATION IS NOT SIGNIFICANT

GRAPH 7.40 : RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF INTERIOR UNITS IN THE IMMAM SHAHR AREA

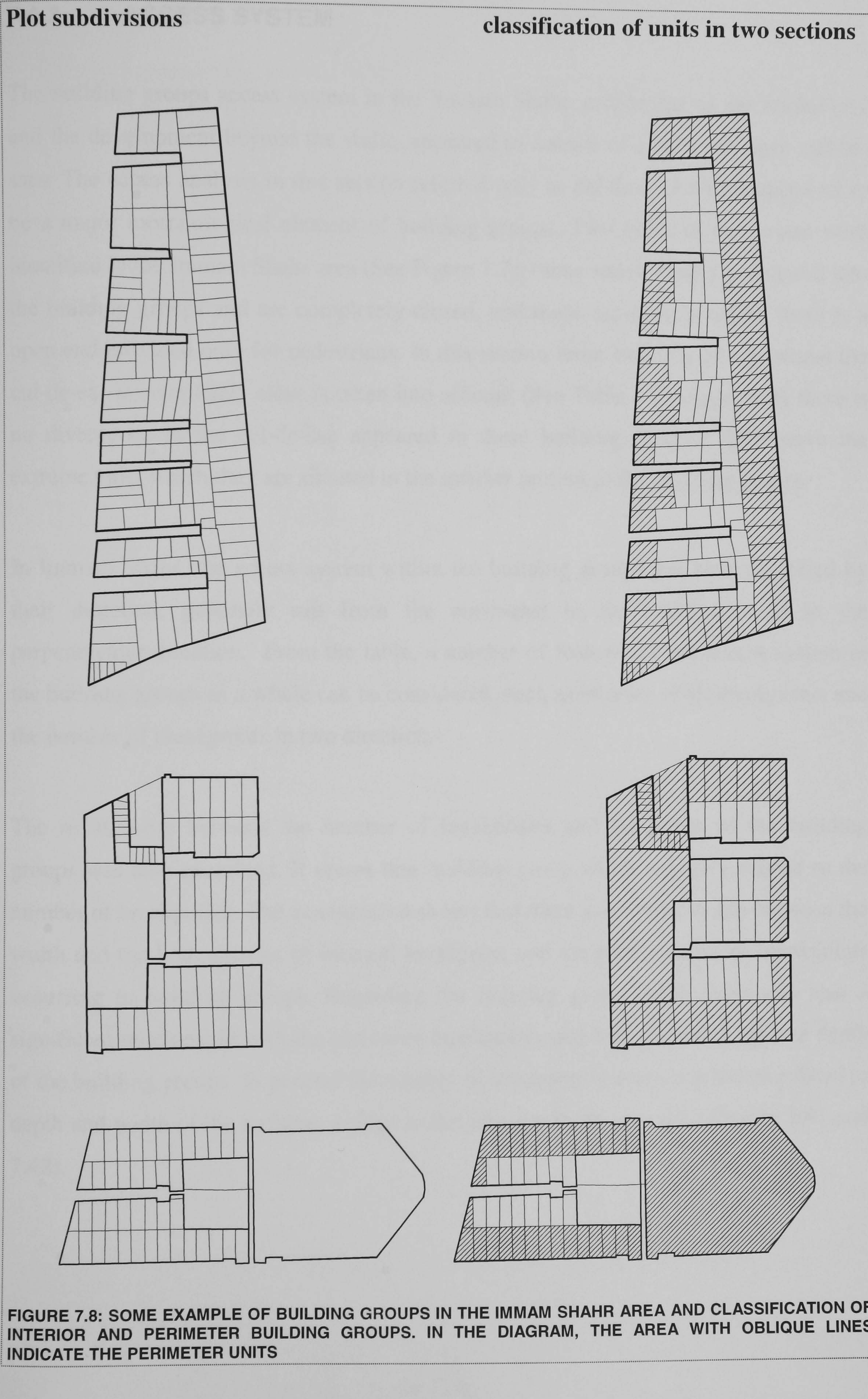


FIGURE 7.8: SOME EXAMPLE OF BUILDING GROUPS IN THE IMMAM SHAHR AREA AND CLASSIFICATION OF INTERIOR AND PERIMETER BUILDING GROUPS. IN THE DIAGRAM, THE AREA WITH OBLIQUE LINES INDICATE THE PERIMETER UNITS

7.4.3. ACCESS SYSTEM

The building groups access system in the Immam Shahr, unlike that of the walled city and the development beyond the walls, appeared to consist of a series of open cul-de-sacs. The access analysis in this section referred only to cul-de-sacs which appeared to be a major morphological element of building groups. Two types of cul-de-sac were identified in the Immam Shahr area (See Figure 7.7): those which simply penetrated into the building groups and are completely closed, and those cul-de-sacs which there is a open end provided only for pedestrians. In this section those building groups where the cul-de-sac is completely close is taken into account (See Table 7.7). Apparently there is no divergence in the cul-de-sac appeared in these building groups. They serve the extreme units which they are situated in the interior section of the building groups.

In Immam Shahr, the access system within the building groups has been classified by their direction, generally run from the north-east to the south-west or in the perpendicular direction. From the table, a number of features of the access system in the building groups as a whole can be considered, such as number of all breakpoints and the number of breakpoints in two direction.

The relationship between the number of breakpoints and the width of the building groups was also examined. It seems that building group width is highly related to the number of breakpoints. The examination shows that there is no relationship between the width and the both number of internal breakpoint and the total number of breakpoints occurring in building groups. Regarding the building group depth there was also a significant relationship with the perimeter breakpoints and both the width and the depth of the building groups. In general the number of breakpoints is to some extent related to depth and width of the building groups in the Immam Shahr area (See Graphs 7.41 and 7.42).

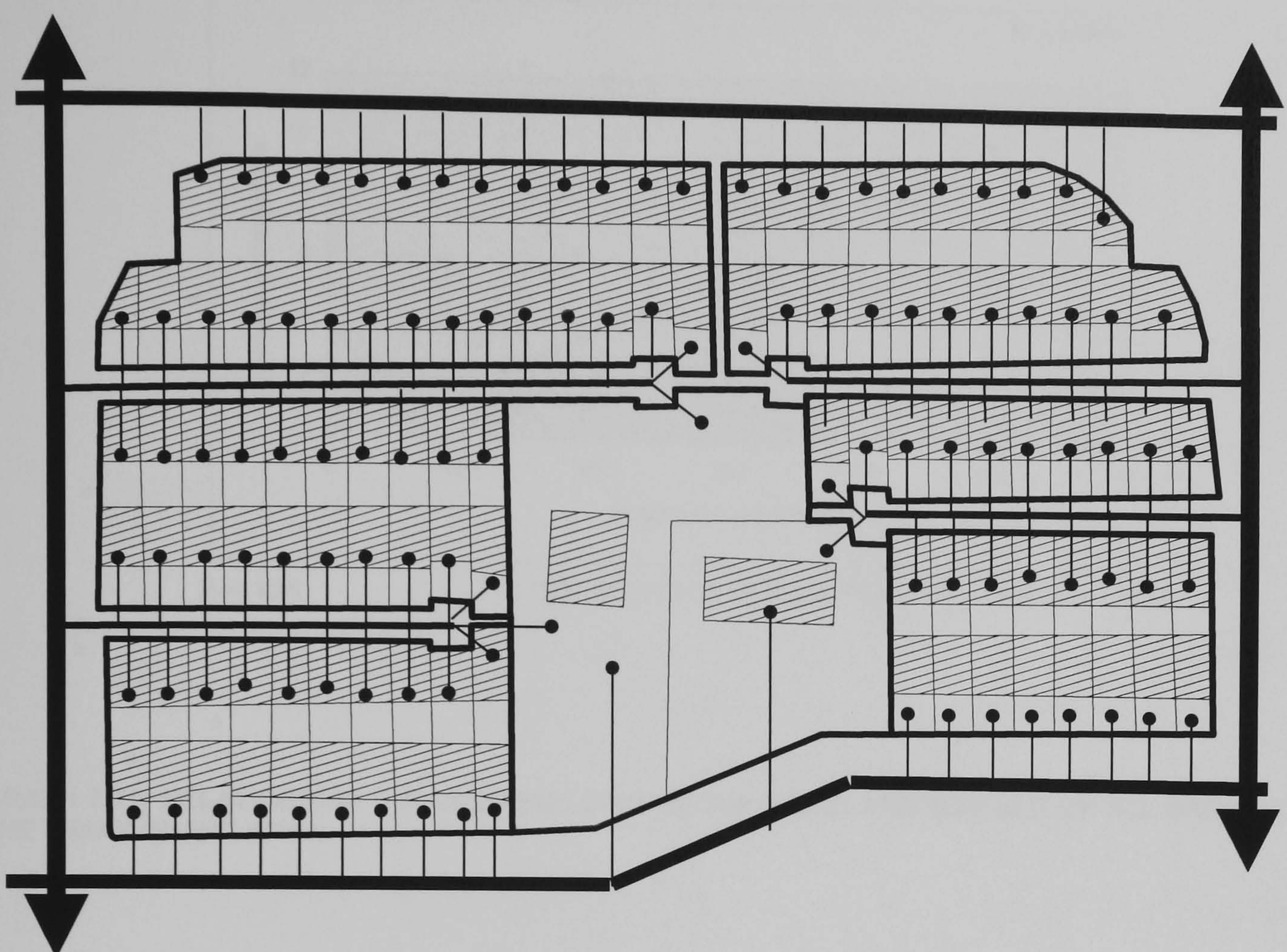
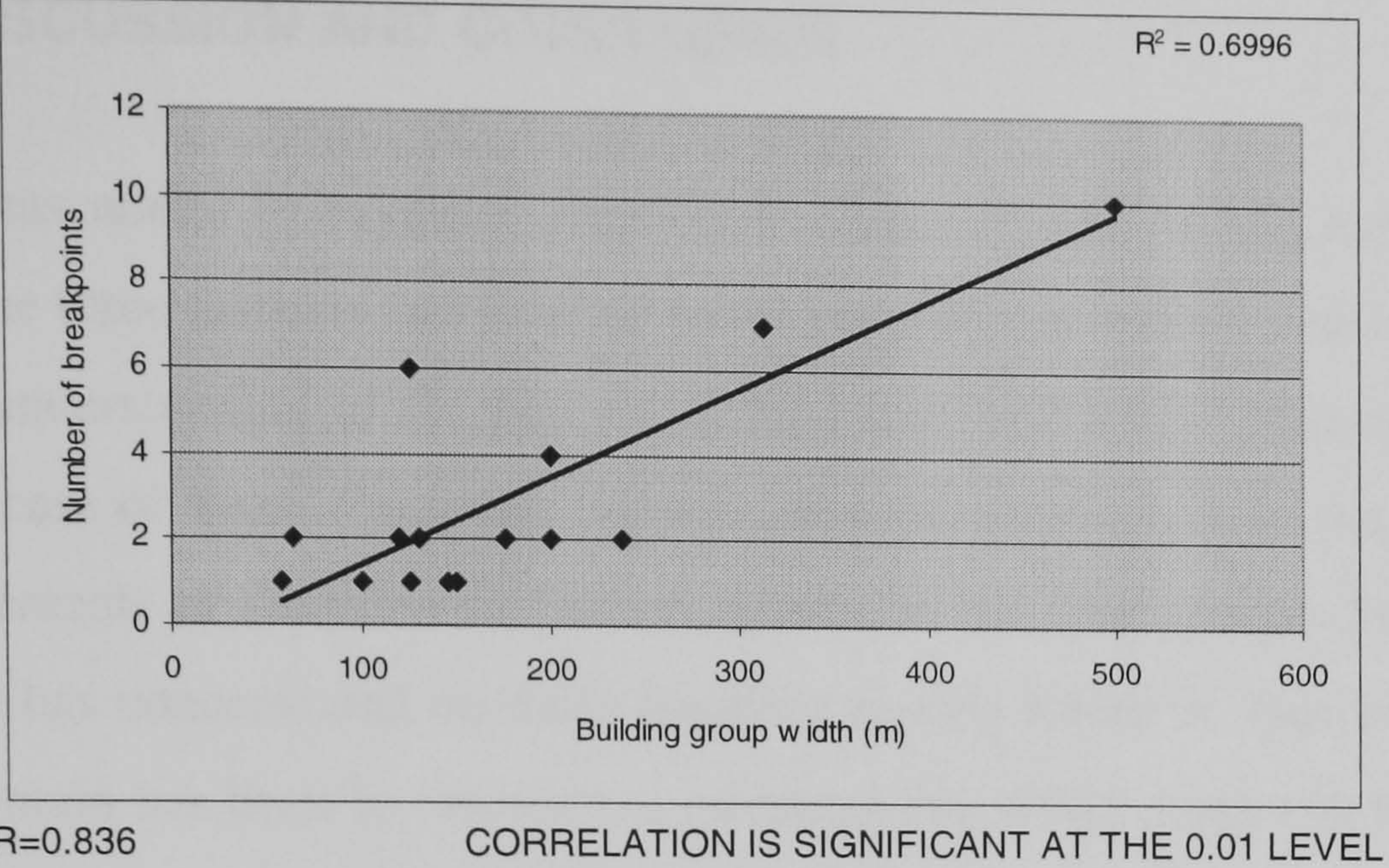


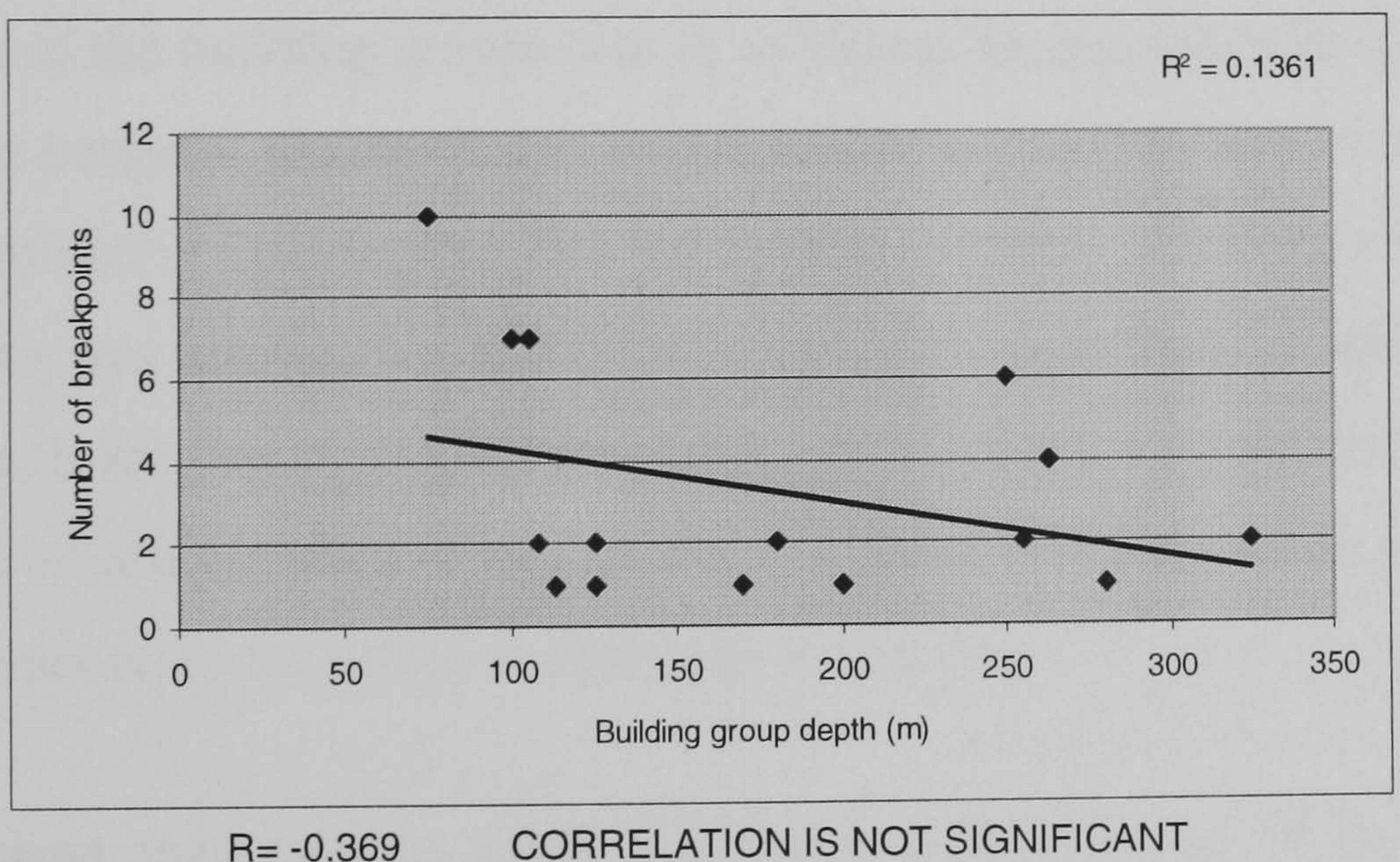
FIGURE 7.9: ACCESS SYSTEM TO THE PLOTS IN THE IMMAM SHAHR AREA

Number	Group area (m sq.)	Depth (m)	Width (m)	No of units	Breakpoints				
					Total	Inner break	Perimeter break	N-E to S-W	N-W to S-E
1	17859	125	200	54	2	0	2	2	0
2	22003	100	313	92	7	0	7	6	1
3	24670	105	313	124	7	0	7	7	0
4	33389	75	500	158	10	0	10	8	2
5	19569	200	125	45	1	0	1	1	0
6	42499	250	125	91	6	0	6	0	6
7	7147	113	58	20	1	0	1	0	1
8	40739	263	200	102	4	0	4	4	0
9	37043	325	130	68	2	0	2	2	0
10	12471	125	100	31	1	0	1	1	0
11	16491	108	175	57	2	0	2	2	0
12	40132	255	238	104	2	0	2	2	0
13	23043	255	120	64	2	0	2	2	0
14	8205	180	63	63	2	0	2	2	0
15	19234	170	150	44	1	0	1	1	0
16	27006	280	145	90	1	0	1	1	0

TABLE 7.6: BUILDING GROUPS AND BUILDING UNITS CHARACTERISTICS IN TERM OF BREAKTHROUGH IN THE IMMAM SHAHR AREA



GRAPH 7.41: RELATIONSHIP BETWEEN BUILDING GROUP WIDTH AND NUMBER OF ALL BREAKPOINTS IN THE IMMAM SHAHR AREA



GRAPH 7.42: RELATIONSHIP BETWEEN BUILDING GROUP DEPTH AND NUMBER OF ALL BREAKPOINTS IN THE IMMAM SHAHR AREA

7.5. DISCUSSION AND CONCLUSION

This chapter has aimed to examine some more characteristics of the building groups identified in the three districts and to draw some general conclusions which may help to give a better understanding of the process of formation and transformation in building groups in the case of Yazd. Particular consideration has been given to the general size, spatial arrangements of the plots and access system in building groups. The major part of the chapter has concentrated on those building groups where at least one cul-de-sac as a public domain has been in evidence, a circumstance which occurs in fewer than 40 per cent of the Fahhadan area (walled city), the Godal-e-mosallah area (immediately beyond the walls) and fewer than 15 per cent of the Immam Shahr area (newly developed area).

Those building groups, which are located in the three selected areas of Yazd, have had some common characteristics and many different features (See Graphs 7.43 to 7.48). While the building groups in the Immam Shahr area are often rectangular in shape, those of the old city are generally irregular with only a slight tendency to be rectangular. When the shape of building groups in the walled city was considered, more variation in size and shape of the building groups was in evidence. In general there is a relationship to some extent between the depth and width of the building groups in the three areas which are examined in this chapter. The relationship between the depth and width of the building groups was stronger in the Godal-e-mosallah area than in other parts of the city. Therefore, it may be concluded that, although there were some variations in shape and size of the building groups in various parts of Yazd, it should not be considered as a random phenomenon of the urban morphology in this city.

Some comparison may also be made for better understanding of the processes of formation and transformation of building groups in the three districts which were shaped in three periods of time (See Figure 7.10) (See Table 7.8). A comparison between general characteristics of building groups shows that building groups were generally increased in dimension from a relatively small size in the walled city to a comparatively larger one in the old and newly developed area. Building groups in the historical part of Yazd are smaller than those of the Godal-e-mosallah area and much smaller than those of Imam Shahr area. The average area of the building groups in the historical area is 5100 sq.m and it is 6100 sq.m and 11500 sq.m in the old and new area respectively. It also seems that building group depth is related to some extent to the building group width in both the historical and the old city of Yazd. However, this relationship was relatively weak when the depth/width relationship in the new area of Yazd was considered. When non-residential building groups were examined, it was found that there was a relatively stronger relationship between the depth and width of the building groups in all areas. The strongest relationship between the depth and width of the building groups was evident in the Godal-e-mosallah area, which is developed beyond the walls. A strong relationship has also emerged in both residential and non-residential building groups in this locality.

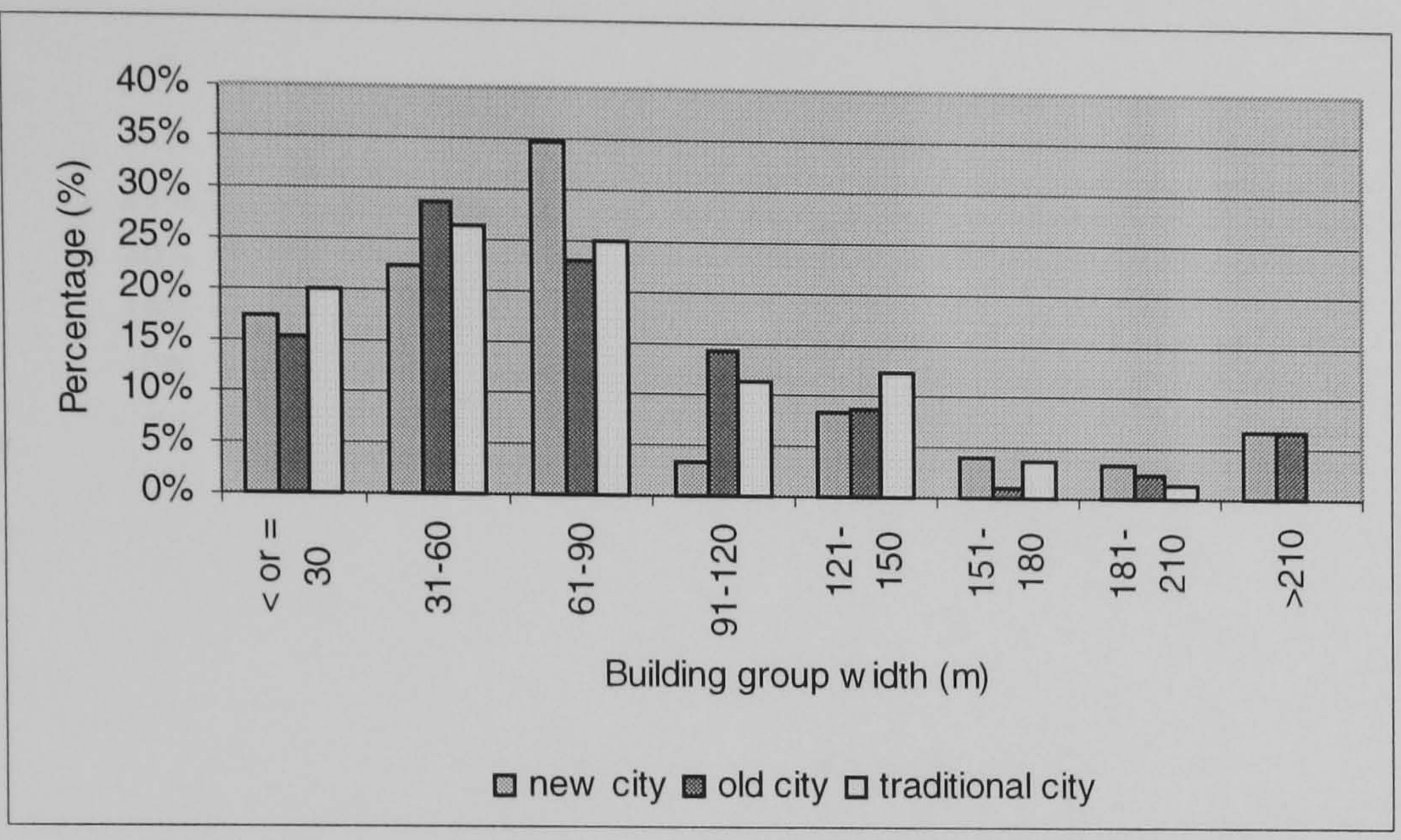
From the spatial arrangement point of view, building units are arranged in building groups somewhat similar in the historical and old parts of Yazd. Some differences emerged, as was expected, when the newly developed area was examined. There is only a modest relationship between the width and number of interior plots in the Fahhadan area, but other relationships were very weak. In contrast in Godal-e-mosallah, when the relationship between the number of interior and exterior plots was examined, there was generally a modest relationship between the arrangements of plots and the width and depth of building groups.

Although there are some obvious differences between the spatial arrangement of the plots in the Immam Shahr area with older parts of Yazd, there is a very strong relationship between the building group width and the number of perimeter and interior plots in the Immam Shahr area. However, the level of correlation between the spatial arrangement of buildings and the general dimension of building groups was either very weak or of no significant level.

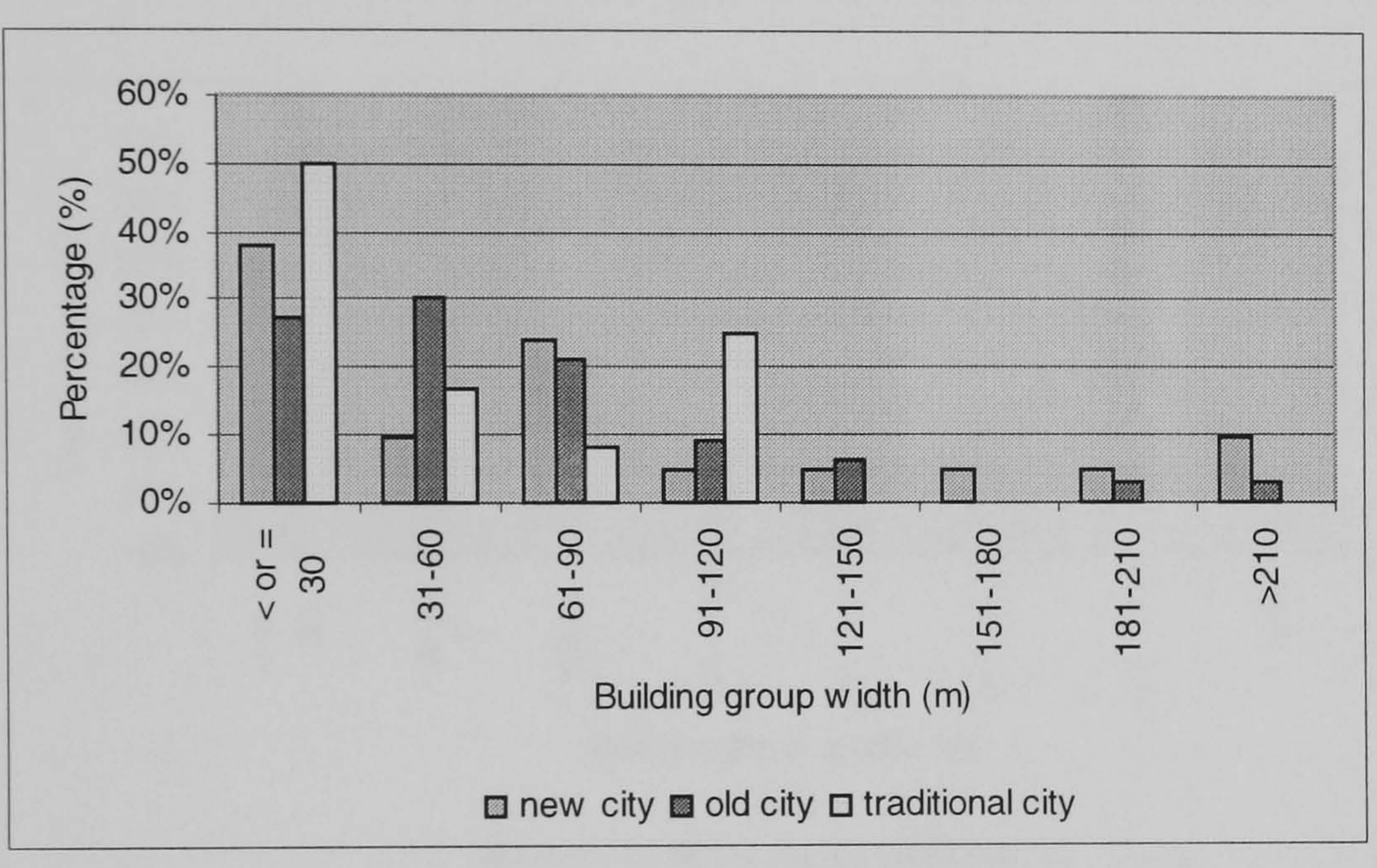
The analysis of the access system in each study area also demonstrated statistically and graphically a sense of logic behind the elements of the access system and the size and shape of building groups in the historical and the old parts of Yazd. However, this relationship varied when the relationship between the number of breakthroughs with the depth and width of the building groups was considered.

Where there is a relatively modest relationship between the number of breakthroughs and the width of the building groups in the Fahhadan area, there is a weak relationship or no significant relationship between the depth and the number of breakthroughs in the same area. In the Godal-e-mosallah area, there is generally a modest relationship between the number of breakthroughs and the width and depth of building groups. However, there is only a strong relationship between the building group width and the number of breakthroughs in the Immam Shahr area. Therefore, it may be concluded that in comparison generally there is a better relationship between the number of breakthroughs in the building groups which are located in the developments immediately beyond the walled city where non-residential functions are much more in evidence.

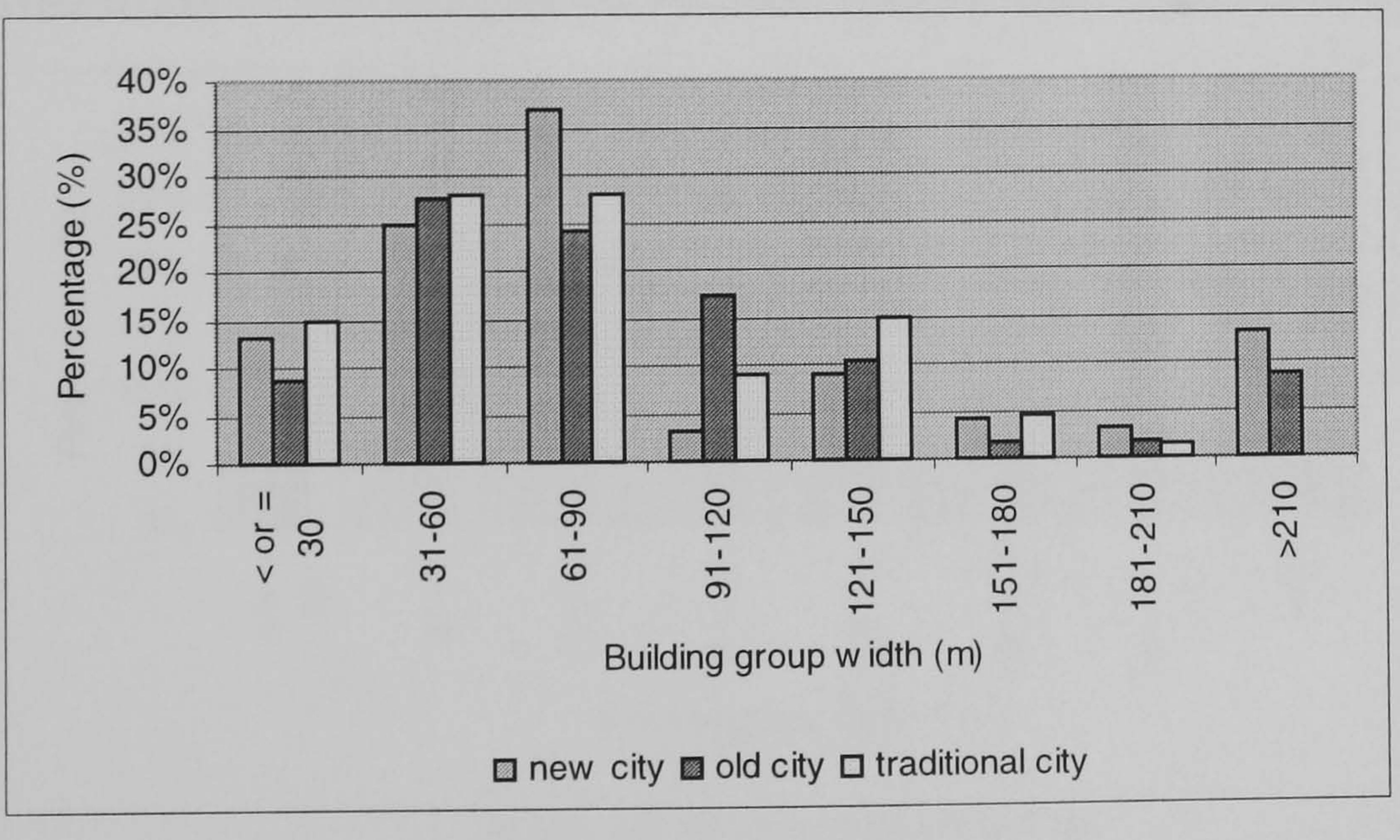
As a result it may be concluded that there is a better relationship, to some extent, between the depth and width of the building groups in the developments immediately beyond the walled city (Godal-e-mosallah) and that this relationship is stronger in those building groups where non-residential functions are predominant.



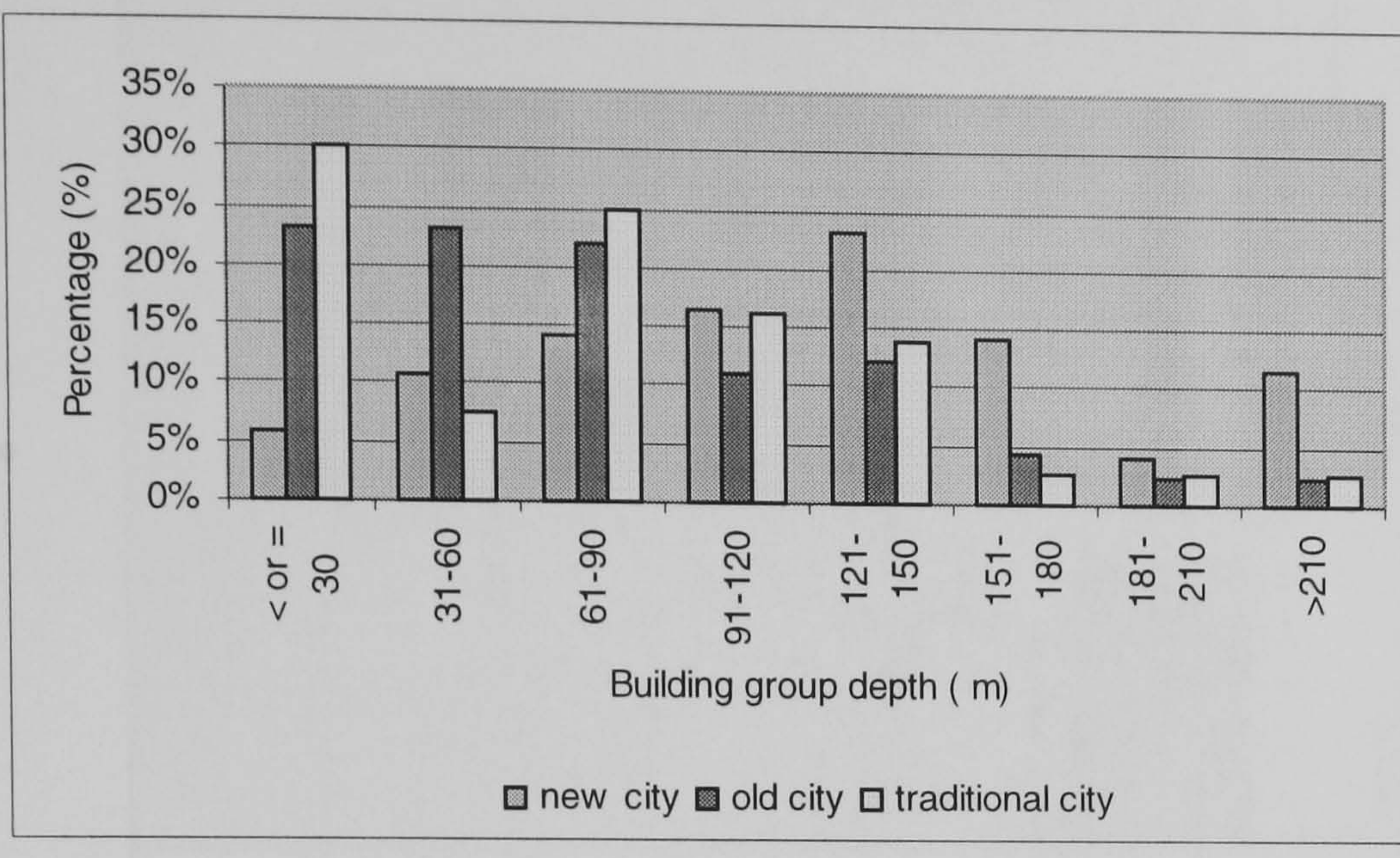
GRAPH 7.43: DISTRIBUTION OF ALL BUILDING GROUPS WIDTH IN THREE STUDY AREAS



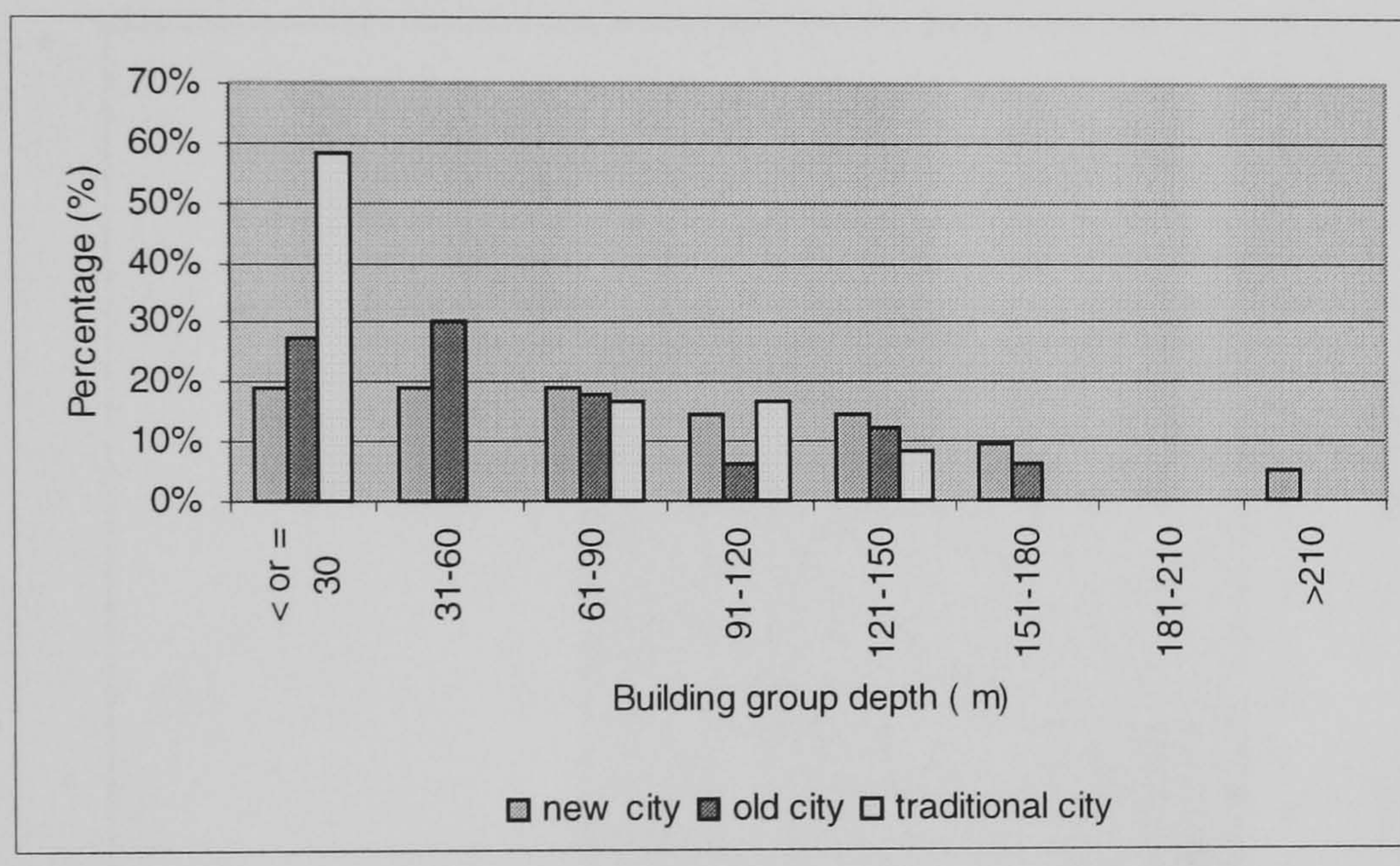
GRAPH 7.44: DISTRIBUTION OF NON-RESIDENTIAL BUILDING GROUPS WIDTH IN THREE STUDY AREAS



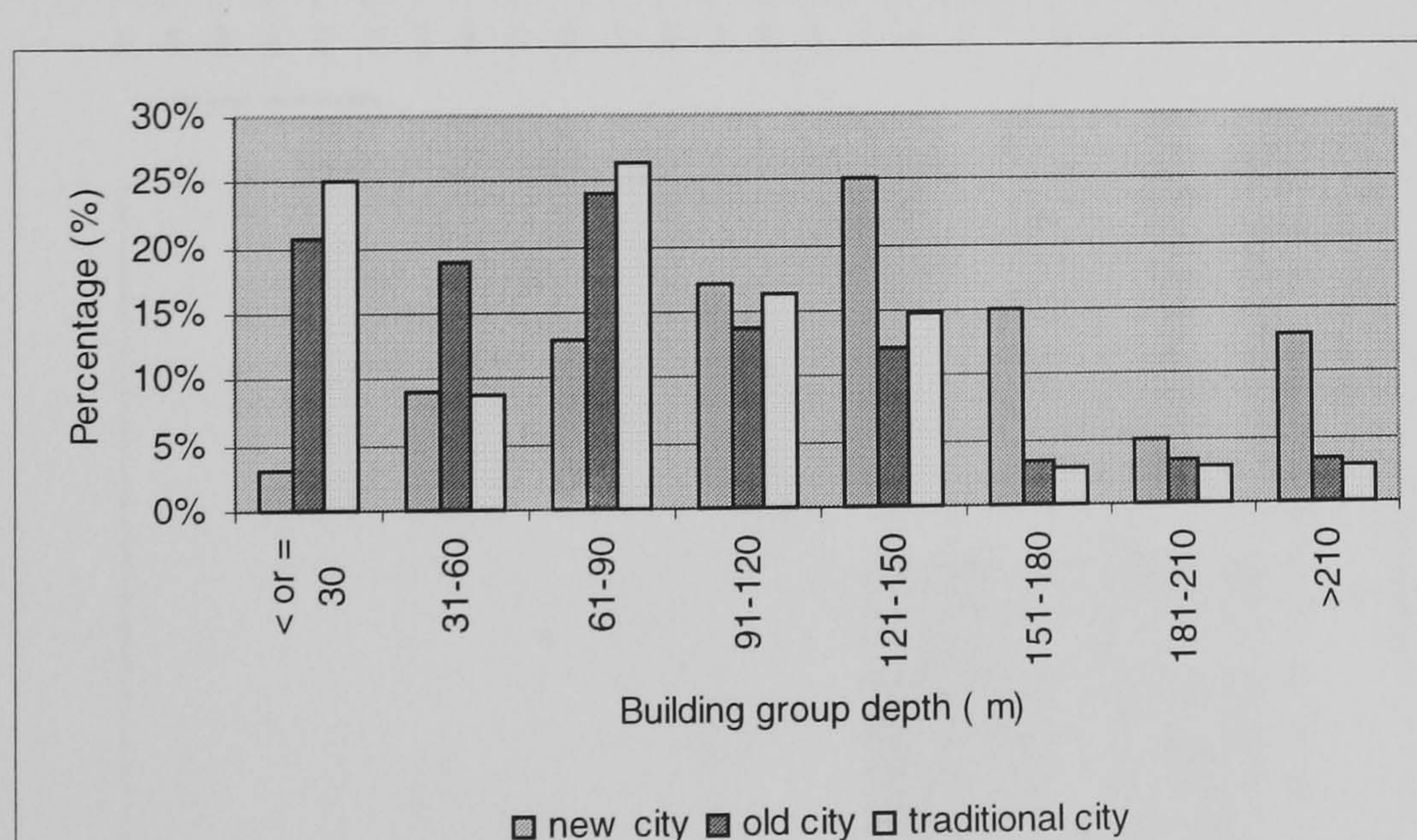
GRAPH 7.45: DISTRIBUTION OF RESIDENTIAL BUILDING GROUPS WIDTH IN THREE STUDY AREAS



GRAPH 7.46: DISTRIBUTION OF ALL BUILDING GROUPS DEPTH IN THREE STUDY AREAS



GRAPH 7.47: DISTRIBUTION OF NON-RESIDENTIAL BUILDING GROUPS DEPTH IN THREE STUDY AREAS



GRAPH 7.48: DISTRIBUTION OF RESIDENTIAL BUILDING GROUPS DEPTH IN THREE STUDY AREAS

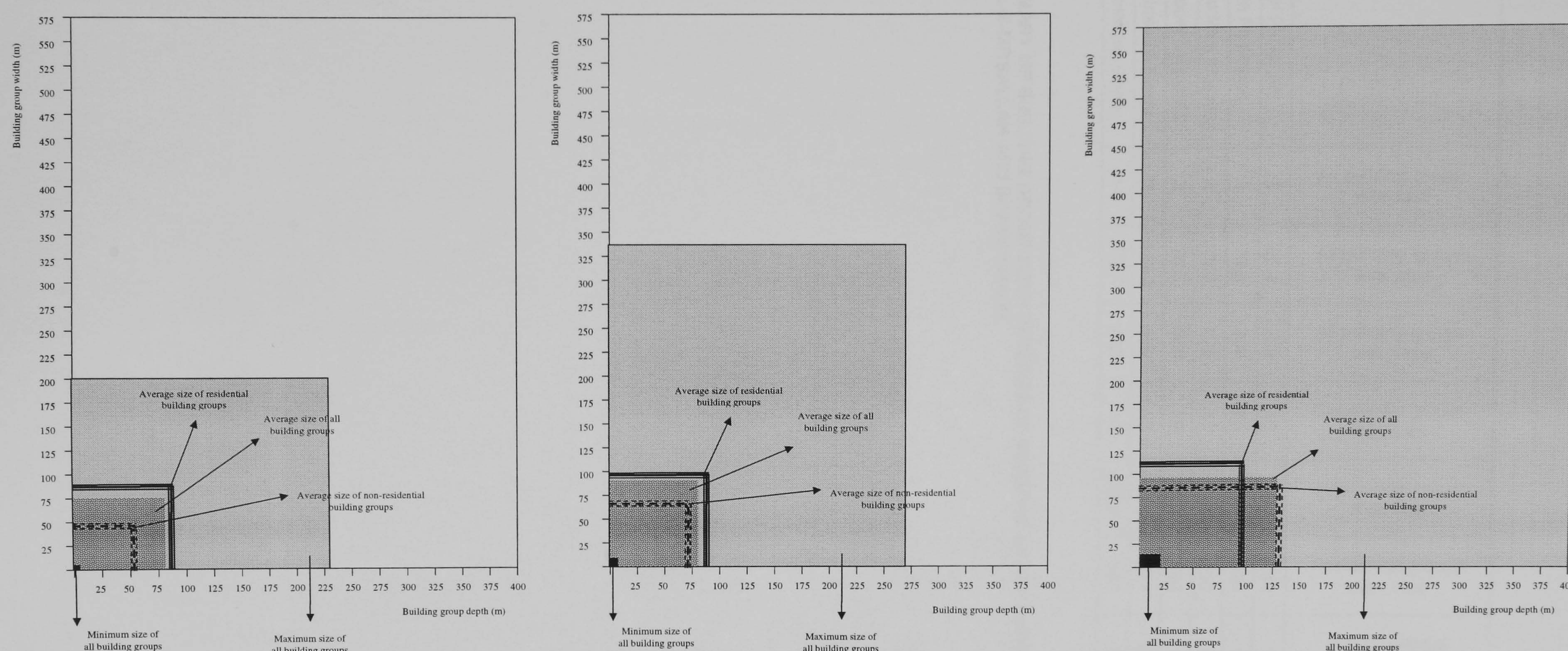


FIGURE 7.10: A SUMMARY OF BUILDING GROUP SIZES IN TERMS OF BUILDING GROUP DEPTH AND WIDTH IN FAHHADAN, GODAL-E-MOSALLAH AND IMMAM SHAHR

	All building groups min. size	All building groups Ave. size	All building groups max. size	Residential groups min. size	Residential group Ave. size	Residential groups max. size	non-residential groups min. size	non-residential groups Ave. size	non- residential groups max. size
Building group depth in Fahhadan	5	80.4	230	10	84.2	230	5	53.4	120
Building group Width in Fahhadan	5	75.3	200	25	84	200	5	46.2	100
Building group depth in Godal-e-mosallah	8	79.4	270	15	89.5	270	8	68.2	180
Building group width in Godal-e-mosallah	8	85.8	340	15	98.9	320	8	70.2	340
Building group depth in Immam Shahr	20	129.3	400	25	131.8	325	20	96.7	400
Building group width in Immam Shahr	14	92.7	575	14	86.6	500	20	111.9	575

TABLE 7.7: A SUMMARY OF BUILDING GROUP SIZES IN TERMS OF BUILDING GROUP DEPTH AND WIDTH IN FAHHADAN, GODAL-E-MOSALLAH AND IMMAM SHAHR.

Chapter Eight:

8. SUMMARY AND CONCLUSIONS

8.1. THE RESEARCH PROPOSITION

The overall aim of this research is a better understanding of the urban form of a typical traditional Iranian city, especially the way in which its morphology changes with time. The study is set against a background of uncertainty in the Iranian architectural and urban planning world about the nature of urban transformation. There is considerable discussion and some controversy; current practice appears often to be derived from conservative Western practices, not on knowledge of the Iranian city. In particular the search for ideas of urban space seems frequently to be limited to the concept of a few symbolic and historical building elements, and their immediate surroundings.

The study represents a sincere concern for the future of the urban environment in Iran. It is based on two assumptions: firstly, that achieving the continuity of a city depends on a sound understanding of the existing urban morphology; and, secondly, that knowledge gained by analysing one typical city, Yazd, in great detail might guide urban design for Iranian cities generally. The need for guidance is seen most when it is necessary, in planning, to assess whether existing traditional forms might assimilate modern elements.

Three specific objectives were stated: to identify the main morphological elements and their disposition in a traditional city; to analyse how these changed with time; and to develop morphological analysis as a practical tool for use in city planning, particularly for urban analysis in the Iranian context.

This chapter summarises the results and discusses them in relation to the three objectives. It begins with the outcome of the literature search, then reviews the principal morphological findings, the nature of change and continuity in urban morphology, and finally discusses the research methodology, its potential and limitations. Methodological modifications that occurred during the course of the research processes will also be considered.

8.2. LITERATURE REVIEW

Chapter Two described various approaches to urban analysis. There is a well-established body of work by the English School, the Italian and French Schools and also in practice by the SAR Group. There is, however significant variation in approach, mainly because each links morphological analysis other, different, fields of study of urban architecture and geography. In the approaches related to urban architectural studies, emphasis tends to be placed not only on the past but also on present-day urban form; they have also a focus on pattern principles or prototypes. Urban geography, on the other hand, tends to give primacy to the history of the settlement and places more emphasis upon the process of morphological development. The present study employs ideas and concepts from both approaches. The approach to analysis at different scale level was developed from techniques described in the literature.

8.3. MORPHOLOGICAL FINDINGS

In Chapters Three, Four, Five and Six, the formation and transformation of the spatial-organisation of Yazd was followed through three major periods, from early Islamic to the present time, and at five levels of analysis. It was shown that morphological characteristics of the present city are explicable in the context of their historical periods and modes of development.

8.3.1. CITY LEVEL

At the city level it is the basic structure that is examined. Knowledge of this is essential when considering any extension of the research to the general context of Iranian cities.

Yazd was initially surrounded by walls, which were reconstructed several times before the 14th century. Some parts of these walls still exist and it is in this area of Yazd that there is most evidence of the relationship between the culture of the people and the physical form of the built environment. The area has obvious cultural value and is often termed 'traditional'. It had very slow growth.

The main morphological elements were identified in three distinct but related morphological periods. In this way the city of Yazd may be physically divided into three main divisions: the traditional or historical (inner), the old (middle) and the new developed areas (outer). Each period was characterised by a certain pattern of street system and built form. The first period was belonged to the era from early Islamic periods up to the late 14th century. The traditional city or walled city is thus a consequence of a process of formation and transformation during a long period of time. The second part of the city belongs to the 15th up to the beginning of the 20th century. In comparison with the historical part of the city there was some evidence of rapid urbanisation and modernisation. The third section of Yazd generally belongs to the late decades of the 20th century and a city faced with rapid urbanisation.

The physical-spatial evidence of the walled city declares that there are two different street system patterns. One is located to the north of the walled city where the gridiron pattern of an alley system is clearly in evidence, with main straight alleys running from the north-east to the south-west. This part is the oldest section and could be considered an initial establishment of the city of Yazd. As a result of the construction of underground water channels (Qanat), agricultural lands and probably gardens developed in the vicinity of the city. These agricultural lands were situated to the south and south-east of the city. Later, gradually, they were used for construction. This process of development created an alley system mainly in the organic irregular shape of the agricultural lands, except in the western part of the walled city where the pattern changed to a regular shape of alleys. The underground water channel also influenced the appearance and orientation of alleys above it in the walled city. There is a very formal geometrical organisation in the arrangement of the elements of units and this regularity has changed to an irregular shape at the group level. This comparison reveals, on one hand, the influence of the pattern of agricultural land on spatial arrangement in building groups and, on the other hand, the importance of units within the walled city. A combination of an irregular pattern of alleys, which may considered as organic development, and a fairly regular pattern of alleys continued to the south and south-east.

The walled city consisted of some historical and new elements. Historical elements mostly included some public buildings which were located among dwelling units. There were some new open spaces which occurred along the old major alleys and some new streets comparatively wider than the old alleys were introduced to the walled city. The walled city, which was generally shaped and constructed on a pedestrian scale, impedes the flow of vehicular traffic in today's city.

The development of the city continued beyond the walls toward the south and south-east. These developments continued in the same direction including the south-west until the present day. Even though the city has undergone fairly rapid growth during the last 75 years, the old city consisted of the historical elements. The old city is still in evidence as a sample of the life of the people in the past and the present. The stability of form in the old city began to alter at the beginning of this century, but it has tended to change gradually. Despite a striking structural continuity, some dramatic changes have occurred from the early 20th century onwards mainly through an interaction with new concepts of city planning and lifestyle which is common in most Iranian cities.

Within the limitation of both the traditional and the old city as a whole, there are still many elements of the historical morphology in evidence. Although a large proportion of the old buildings, particularly dwellings, and a section of the city wall have been destroyed, other urban historical elements remain in position, beside a large area occupied by the old town including the walled city. Today, some of these buildings have changed their function, dwelling units becoming governmental offices, museums or even higher educational buildings like the school of architecture. In the process of functional transformation there is a basic concept that the internal physical composition of the buildings should not be changed; however, by the passing of time, some minor internal changes have occurred in such units.

The pattern of growth and development in Yazd from the beginning until 1973 was basically toward the south, south-west and the west. Since then there have been three stages of development in the city's transformation into the present comparatively large and thriving urban environment. The physical boundaries of the city have been enlarged considerably since the 1920s, dramatically since the 1970s, while many new elements and planning concepts have been introduced into both the new development areas and the old and historical parts.

8.3.2. DISTRICT LEVEL

The morphology at district level has generally been described with reference to the system of public open spaces, street system, and blocks in three selected parts of Yazd.

The growth and transformations within the walled city generally followed an irregular pattern of streets, with regular major alleys which ran from the north-east to the south-east. Although these major alleys were not straight, a state of continuity was in evidence. Blocks were formed between them and those alleys which ran from the north-west to the south-east. There was no regular form of alleys over the whole area although the north-east to south-west routes are found at fairly uniform distances from each other. Old squares were located alongside major alleys and surrounded by some publicly used land. When new squares formed they changed the general arrangement of open spaces and their relationship with the pattern of land use. Generally blocks are irregular and vary in shape, a factor which is obviously determined by the street pattern.

It is very clear that the alley system in the walled city was a direct result of the development of each individual building occurring within each block and building groups. In other words the shape and form of the blocks is influenced by the gradual formation of the elements of the urban form at the lower levels, such as building groups and individual units. However, the influence of land on the formation and transformation of the block and building groups could not be eliminated.

In the walled city, there was a hierarchy of open spaces within the alley system. Construction of new open spaces changed their scale and sequence, and the resulting relationships between morphological elements of open space at the district level were significantly different from those previously existing.

New streets changed the pattern of land use in development immediately beyond the walls. Generally, the old city is now punctuated by two separate patterns. The first is a new street layout, which acts as the first or upper layer of the system. The second is that of the major alleys, the old street system in the area, now acting as a subsidiary network. The main city streets, which encircle the area, are wider than the major alleys. The internal parts of the old city are defined by a hierarchy of major alleys, alleys and cul-de-sacs system remaining from the past. This system was connected to its surrounding area through some major alleys. In the analysis some major public open spaces were identified as a focal points for distributing major alleys, in contrast with the walled city where no such a formal open space on this scale was evident. As in the walled city the developments immediately beyond the walls initially followed the irregular pattern of alley system. However in the next developments the overall pattern tended to follow a loosely gridiron system. A fairly regular grid pattern of streets and major alleys is in evidence in the old city; the shapes of the enclosed blocks vary accordingly.

In those parts immediately beyond the walls where non-residential activities are more in evidence, the blocks tend to be regular. Construction of the bazaar and some other non-residential buildings, in addition to other public open spaces, may be considered as primary factors in the formation of the major alley system that developed there. The height of the blocks in the study area is fairly regular with an overall height being that of a single storey building. Non-residential buildings are relatively higher than dwelling units.

Beyond the walled city the street system was found to be straighter and wider by comparison with the walled city. There were also a number of non-residential developments in the old city. It is concluded that emergence of these new activities at a broader scale may have caused a wider and more regular pattern of street system in the immediate developments beyond the walls.

In the newly developed area, the street system may be divided into three basic layers. The area was generally divided into several blocks which are mostly rectangular in shape and served by a rectilinear system of straight intersecting streets. A block was simply defined as a piece or strip of land, surrounded by a first or second layer of the street system; it can therefore, be identified from the street pattern. The area shows three distinct planning patterns from successive periods of development. These are easily recognised from the layout of neighbourhoods and block subdivisions. There is usually but not always a distinction between the vehicular and pedestrian zones, marked by the use of different materials in spaces between groups. There are also some special spaces provided for pedestrians, and margins at the edge of open spaces.

8.3.3. BLOCK AND BUILDING GROUP LEVELS

In the walled city there are alleys surrounding a number of blocks in a rather free manner, their form and orientation were the result of the positions of individual buildings. Blocks were formed in different stages of the development of the walled city and vary in shape. Those that developed to the eastern parts tended to be irregular in shape. A system of secondary alleys for public use generally subdivided the blocks into several building groups. A system of central public open spaces like small squares, or 'Hosseinieh', is in evidence between the blocks in the older parts of the walled city.

Building groups in the walled city are generally irregular in shape and consist of a number of private open spaces. These spaces tend to be small in the building groups essentially in residential use and larger where non-residential uses predominate. Cul-de-sacs occur in building groups in various directions in different parts of the walled city, however they generally occur in a north-east to south-west direction. When the depth of the building group was not very large, the cul-de-sacs were much straighter than a winding route. The built form of building groups consisted of combinations of building units entirely spread over it with a system of central open spaces. In this way most units contain open courtyards, which occur in some sort of uniformity with variations in size. By contrast, in the eastern parts of the study area the basic form of the dwelling plots is much more irregular than in the western parts. The plot form of dwelling units is mostly irregular in the north-east part, with a trend to a rectangular shape in the eastern parts. The building groups consist of one, two and very occasionally three-storey buildings separated from each other by a system of open and covered alleys. The third layer of street system occurs in between groups which are relatively narrow. The building units appear to vary to quite an extent in size and the basic form of the plan, even in a single group.

In the developments immediately beyond the walls, blocks were formed in different stages of the development of the area and vary in shape. Those that developed during the late 19^{th} and early 20^{th} century tend to be rectangular in shape. There is a significant relationship between land use pattern and regularity of the basic plan form of a block. A system of secondary alleys for public use has generally subdivided the blocks into groups. The presence of secondary alleys in the older parts of the area is much more complicated than in the newer parts. A system of central public open spaces like small squares or 'Hosseinieh' in blocks which are situated in the older parts of the area is in evidence.

Building groups in the immediate developments are generally regular in shape. They consist of a number of private open spaces. Such spaces like in the walled city tend to be small in the building groups essentially in residential use and larger in the building groups where non-residential uses predominate. The building groups consist of one, two and very occasionally three storey buildings separated from each other by a system of open and covered alleys. The secondary alleys occur in between groups which are relatively narrow but wider than those in evidence in the walled city. Cul-de-sacs occur in building groups in various directions in different parts of the area, however they generally occur in a north-east to south-west direction. If the depth of the group is not very large, the cul-de-sacs are much straighter than a winding route. The presence of cul-de-sacs is comparatively rare in building groups which are located to the south of the area. There is generally less access of this type than in the walled city. These spaces are more straight and wider in the immediate developments beyond the walls. In this way the built form of groups consists of combinations of building units entirely spread over the building groups with a system of central open spaces. Similar to that of the walled city most units contain open courtyards, which occur in some sort of uniformity with variations in size. By contrast, in older parts of the area the basic form of the dwelling plots is much more irregular than in the newer parts.

In the newly developed area the blocks are often divided into several group units, which are distributed in a fairly uniform pattern. Block distribution in this part of the city is not uniform and various shapes of the blocks are in evidence. Some blocks are divided into various sections of one, two, and very occasionally three or more storey buildings.

Each group unit is in turn divided into several plots in a regular shape. Plots are basically rectangular, with the average depth of 30 meters, substantially exceeding the width, which is generally 10 to 20 metres. They are normally combined with longer sides adjacent in an east-west direction to form building groups. The dwelling plots contain private open areas in a fairly uniform pattern of a square open spaces located on one of extreme side off the unit. These often have direct access to the adjacent streets. The location of these open spaces depends upon the orientation and placement of the plot within the building group. Access to the units is normally gained directly from the streets through a courtyard to the building or directly to the building.

8.3.4. BUILDING LEVEL

The morphological pattern at the building or unit level initially involved the consideration of both the general pattern and arrangement of the units and their structural characteristics. In both the walled city and beyond the walls, dwellings have a single-storey living space and a basement for storage. They are mostly arranged around a courtyard. Various elements of the house are located around the four sides of the courtyard and faced inward to the open space. The position of each element has some relation with the climatic situation of the area. There is usually an intermediate space, the vestibule, between alleys and internal space of the dwelling units. This arrangement provides a degree of privacy within the dwelling unit. There are rarely openings on the external walls of the dwelling units. The plot form of dwelling units is usually irregular. The dwelling is usually organised in two parts, a private and a semi-private (reception area); both may be defined by a courtyard. The form of the main external door varies in relation to the size of dwelling units. The traditional system of construction, with mud as a basic material and a vaulted ceiling system, is a common method of construction. The external walls of some individual dwellings have been replaced by brick, while the concept of the entrance in some units have also been changed. Changes are in evidence also in the pattern of usage of the traditional units in both the walled city and the immediate developments beyond the walls.

In contrast to that of the historical and the old city, the plan form of new dwelling units is a rectangular shape often around 360 sq.m and dimension of 12-metre width and around 30 metres deep. The dwellings have two parts: a built-up portion, one, two and occasionally three storeys high, and a courtyard located close to the street or on the extreme part of the plot. Dwelling units are generally oriented 30 degrees from South, toward South-east.

8.4. THE PROCESS OF CHANGE AND CONTINUITY IN URBAN MORPHOLOGY

It was found that the transformations of Yazd occurred in two distinct ways. These are evident when the walled city is compared with the urban pattern beyond the walls and again, dramatically, with the newly developed areas:

1. *Transformations which were gradual and took place over a long period.* Most changes which occurred before this century did not contradict the traditional pattern; indeed, they tended to reinforce it.

2. *Changes which altered the established pattern within a short period.* The majority of the developments in this century were of this nature.

The changes which occurred during this century often involved the introduction of elements which were not in accordance with the established pattern and have seldom become integrated with it. At the city level, wide streets were cut through dense residential quarters; new streets and traffic roundabouts were established in the old fabric. The new network changed the scale of the street landscape and to some extent converted the original integrity of the city into a district-based form of 'super-blocks'. In addition, some multi-storey buildings altered the horizontal skyline of the walled and old areas of the city.

At district level, newly constructed streets changed the access system. They became lined with shops, which then tended to compete for customers with the bazaar. It is noted that throughout Yazd, rapid morphological changes at district level had a significant influence on land-use. Conversely, at building level, when other functions (commerce, education, governmental offices) were introduced into dwelling units, they tended at first to occur without changes to the original building form, particularly its external appearance. Then as the scale of re-use increased, dwellings were replaced by different architectural forms. Further changes in the street network changed the entrance system concept in some historical residential parts.

Despite all of this, many of the previous morphological elements have remained in place and the main framework of the old city is still in evidence. What emerges clearly is an overall relationship between the rate of change and extent to which new developments conform architecturally and morphologically with earlier work. There is an association between the speed of transformation and conformity, and it applies both ways: a major intervention causes rapid secondary effects; changes gathering pace within an area induce increasingly alien interventions. The faster the replacement of old with new, the more the disparity.

A further conclusion can be drawn: urban formation or transformation can begin independently at any scale level; but changes at one level bring about changes at higher and lower levels, and these then interact. In general, top-down diffusion of change appears to be faster than upward effects, but this can be explained by differences in the physical and economic scale of the intervention. Major physical developments have an immediate effect on both use and form of adjacent areas; changes of function at block and building levels tend to cause gradual morphological change at higher levels.

8.5. EVALUATION OF MORPHOLOGICAL ANALYSIS AS A METHODOLOGY

As an applied technique, morphological analysis has two outcomes: a very detailed description of the city at several different scales; and an overview of the processes of change. It is argued that both types of information are essential to planning practice and that there is a particular need for studies of this nature when (as in present-day Iran) the primary bases of urban planning are economic, demographic and political, but not architectural. The need for morphological analysis is not just at the building level, it exists at the scale of the master plans. While land-use plans and traffic schemes are necessary tools, they are too broad in scale and too limited in application to be helpful in the designing of urban form.

Morphological analysis, as used in this research, is intended to be used in studying the form of a settlement as it exists. Its limitations are two-fold and are the converse of this purpose:

1. The method is concerned with *physical* form and is not an analysis of social and economic factors, or documentary history. It is only part of any full study of a city. As earlier in this thesis, for the case of Yazd, a preliminary review of the written history is needed to inform and guide the process of analysis. Similarly, parallel reviews of economic and social factors are needed to analyse the reasons behind morphological change.

2. The method is time-consuming: the study of a major city requires many months of field work and analysis. Once done, however, it gives (a) a basis for urban renewal policy for that city and (b) a framework in which quick local studies within the city can take place when immediate developments are planned.

Some comments can be made about the particular research programme of this thesis:

- Few relevant maps and plans for this research were available in Iran, so data collection was predominantly by direct observation and site survey. Records made on-site -- photographs, sketches and drawings -- were the principal sources of information, especially for the detailed development processes.

- At the outset it was intended to examine the chosen settlement at four scale levels, the city, district, block and unit. However, after a preliminary site survey and collection of data it was realised that for more precise analysis and the nature of built environment it might to be altered into five scale levels.

- In the processes of analysis in five scale levels, it was realised that some significant elements might be neglected when moving from one level to another. The elements identified at each scale-level were influenced to a certain extent by bottom-up procedure. Thus if an element appeared to belong to a lower level morphology, it would be less likely to be identified as an element as a higher level.

8.6. LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FUTURE WORK

This research extends the concept of urban morphological analysis as a process to the case of Eastern cities. It is hoped that the results will lead to proposals for the appropriate treatment of urban spaces and design decisions in future developments in Yazd and similar settlements in Iran. In spite of some limitations, the thesis has attempted to show the need and importance of morphological studies in the Iranian context, and a possible way of carrying out such studies.

This has implications for research, education and practice. It illustrates an approach to urban analysis in the case of Iranian settlements which may be applied widely, and which, it is hoped, will advance our understanding of the traditional settlement pattern and its development. It also shows the value of urban morphological analysis as an apparatus; the interactive procedure employed here suggests itself as a useful means of investigating new design, as well as reconstructing the designs of earlier periods. But the particular limitations of the present project are:

- The work has concentrated on just one particular built environment in Iran.
- Although an overview of the history of Yazd provides a clear picture of its development, little detailed historical information was found on, for instance, the spatial arrangement and access system of blocks and building groups.

- The method has concentrated on the physical elements of Yazd. Although the socio-cultural and economic influences on the form of the settlement have been covered to some extent, this has been secondary to the main purpose.

Each of these suggests scope for extended future research. Investigation is required also into the best incorporation of morphological analysis in planning practice, Finally, in Iranian architectural schools, it would seem desirable to teach methods by which the formation and transformation of urban spaces can be analysed. The subject leads to an appreciation of the city as a systematic entity and an understanding of how its morphological elements interrelate.

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Appendix 1: Building groups characteristics in the Fahhadan area (walled city)

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	TOTAL CONSTRUCTION AREA OF GROUPS	PERCENTAGE	OPEN SPACES	GROUP PERIMETER m	NORTH-SOUTH DEPTH m	EAST-WEST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO N/E	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE PLOT AREA	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
1	23	318.2	282.9	0.89	35.3	108	10	50	500	1.6	0.2	10	31.8	229.9	0.72	8	0.80	28.7	88.3	28%	2	0.20	44.2	0	0	0	0	0
2	24	50.5	50.5	1.00	0	31	5	5	25	0.5	1.0	3	16.8	50.5	1.00	3	1.00	16.8	0	0%	0	0.00	-	0	0	0	0	0
3	25	4478	3031.9	0.68	1446	343	100	60	6000	1.3	1.7	21	213.2	113.9	0.03	2	0.10	57.0	4363.9	97%	19	0.90	229.7	0	0	0	0	0
4	26	19562	12232.2	0.63	7329	1241	230	125	28750	1.5	1.8	87	224.8	2190.8	0.11	19	0.22	115.3	17371	89%	68	0.78	255.5	8	4	4	4	4
5	27	764.4	538	0.70	226.4	105	20	30	600	0.8	0.7	1	764.4	0	0.00	0	0.00	-	764.4	100%	1	1.00	764.4	0	0	0	0	0
6	28	14438	7308.6	0.51	7130	716	190	80	15200	1.1	2.4	39	370.2	4782	0.33	18	0.46	265.7	9656.1	67%	21	0.54	459.8	4	1	3	1	3
7	29	9363	5072.1	0.54	4291	663	125	80	10000	1.1	1.6	36	260.1	829.9	0.09	7	0.19	118.6	8533.2	91%	29	0.81	294.2	4	0	4	2	2
8	30	429.8	362.2	0.84	67.6	99	30	20	600	1.4	1.5	9	47.8	305.2	0.71	8	0.89	38.2	124.6	29%	1	0.11	124.6	0	0	0	0	0
9	31	1300	1097.5	0.84	202.4	177	65	20	1300	1.0	3.3	7	185.7	1273.9	0.98	6	0.86	212.3	26	2%	1	0.14	26.0	0	0	0	0	0
10	32	4419	2759	0.62	1660	336	75	90	6750	1.5	0.8	23	192.1	1340	0.30	11	0.48	121.8	3079.4	70%	12	0.52	256.6	1	0	1	0	1
11	33	6598	3786.5	0.57	2812	435	125	75	9375	1.4	1.7	23	286.9	245.9	0.04	3	0.13	82.0	6352.1	96%	20	0.87	317.6	1	0	1	0	1
12	34	11355	6132.7	0.54	5223	698	125	175	21875	1.9	0.7	34	334.0	1920	0.17	2	0.06	960.0	9435.3	83%	32	0.94	294.9	6	3	3	3	3
13	35	6786	3722	0.55	3064	440	120	90	10800	1.6	1.3	18	377.0	173	0.03	2	0.11	86.5	6612.7	97%	16	0.89	413.3	2	0	2	0	2
14	36	6043	3822.7	0.63	2221	460	120	60	7200	1.2	2.0	25	241.7	141.8	0.02	6	0.24	23.6	5901.6	98%	19	0.76	310.6	3	0	3	2	1
15	38	905.5	676.4	0.75	229.1	125	25	30	750	0.8	0.8	14	64.7	380.2	0.42	10	0.71	38.0	525.3	58%	4	0.29	131.3	0	0	0	0	0
16	39	3472	2102.6	0.61	1369	316	90	50	4500	1.3	1.8	11	315.6	0	0.00	0	0.00	-	3472	100%	11	1.00	315.6	1	0	1	0	1
17	40	8054	4980.4	0.62	3074	514	160	90	14400	1.8	1.8	17	473.8	4616.5	0.57	6	0.35	769.4	3437.6	43%	11	0.65	312.5	0	0	0	0	0
18	42	122.5	122.5	1.00	0	46	15	8	120	1.0	1.9	1	122.5	122.5	1.00	1	1.00	122.5	0	0%	0	0.00	-	0	0	0	0	0
19	43	125.4	125.4	1.00	0	41	11	11	121	1.0	1.0	1	125.4	125.4	1.00	1	1.00	125.4	0	0%	0	0.00	-	0	0	0	0	0
20	441	5345	3207	0.60	2138	347	75	75	5625	1.1	1.0	36	148.5	725.9	0.14	3	0.08	242.0	3967.9	74%	33	0.92	120.2	1	0	1	0	1

Appendix 1: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	TOTAL CONSTRUCTION AREA OF GROUPS	PERCENTAGE	OPEN SPACES	GROUP PERIMETER m	NORTH-SOUTH DEPTH m	EAST-WEST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO N/E	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE PLOT AREA	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
21	442	13415	8049	0.60	5366	780	225	75	16875	1.3	3.0	15	894.3	2460.6	0.18	3	0.20	820.2	7741.3	58%	12	0.80	645.1	4	0	4	0	4
22	45	1998	1134.4	0.57	863.3	208	30	75	2250	1.1	0.4	10	199.8	59.3	0.03	1	0.10	59.3	1938.4	97%	9	0.90	215.4	0	0	0	0	0
23	46	3849	2246	0.58	1603	272	75	75	5625	1.5	1.0	12	320.7	745.5	0.19	1	0.08	745.5	3103.3	81%	11	0.92	282.1	1	0	1	0	1
24	47	4560	3057	0.67	1503	336	90	50	4500	1.0	1.8	17	268.2	0	0.00	0	0.00		4560.2	100%	17	1.00	268.2	2	0	2	1	1
25	48	3729	2402.4	0.64	1326	273	90	50	4500	1.2	1.8	20	186.4	872.4	0.23	8	0.40	109.1	2856.2	77%	12	0.60	238.0	1	0	1	1	0
26	49	10271	6388	0.62	3883	733	125	175	21875	2.1	0.7	30	342.4	1204.6	0.12	2	0.07	602.3	9066	88%	28	0.93	323.8	7	4	3	4	3
27	50	8462	5154	0.61	3308	610	90	150	13500	1.6	0.6	28	302.2	1565.2	0.18	1	0.04	1565.2	6897.2	82%	27	0.96	255.5	3	0	3	0	3
28	51	1492	1025	0.69	466.6	158	30	50	1500	1.0	0.6	4	372.9	0	0.00	0	0.00	-	1491.6	100%	4	1.00	372.9	0	0	0	0	0
29	52	1475	926	0.63	549.3	148	30	40	1200	0.8	0.8	5	295.1	0	0.00	0	0.00	-	1475.3	100%	5	1.00	295.1	0	0	0	0	0
30	54	2652	1606.8	0.61	1045	229	30	75	2250	0.8	0.4	11	241.1	319	0.12	2	0.18	159.5	2332.9	88%	9	0.82	259.2	0	0	0	0	0
31	55	6273	4080.5	0.65	2192	471	60	150	9000	1.4	0.4	23	272.7	924.5	0.15	2	0.09	462.3	5348.1	85%	21	0.91	254.7	2	0	2	1	1
32	56	622.6	467	0.75	155.6	120	25	25	625	1.0	1.0	7	88.9	338	0.54	6	0.86	56.3	284.6	46%	1	0.14	284.6	0	0	0	0	0
33	57	6004	4095	0.68	1909	478	100	135	13500	2.2	0.7	24	250.2	333.2	0.06	3	0.13	111.1	5670.6	94%	21	0.88	270.0	0	0	0	0	0
34	58	1304	875.5	0.67	428.5	144	40	40	1600	1.2	1.0	2	652.0	0	0.00	0	0.00	-	1304	100%	2	1.00	652.0	0	0	0	0	0
35	59	11525	8389.8	0.73	3135	515	150	100	15000	1.3	1.5	30	384.2	2001.3	0.17	7	0.23	285.9	9523.5	83%	23	0.77	414.1	1	0	1	0	1
36	60	6475	3779.8	0.58	2695	357	75	125	9375	1.4	0.6	24	269.8	353.3	0.05	5	0.21	70.7	6121.9	95%	19	0.79	322.2	0	0	0	0	0
37	61	6301	3538	0.56	2763	434	100	90	9000	1.4	1.1	25	252.0	45.5	0.01	1	0.04	45.5	6255	99%	24	0.96	260.6	2	1	1	1	1
38	62	5881	4189	0.71	1692	423	100	75	7500	1.3	1.3	27	217.8	411.1	0.07	4	0.15	102.8	5470.1	93%	23	0.85	237.8	2	1	1	1	1
39	63	6766	3717.5	0.55	3049	597	75	115	8625	1.3	0.7	32	211.4	238.8	0.04	4	0.13	59.7	6527.4	96%	28	0.88	233.1	5	2	3	2	3
40	64	786.8	574.3	0.73	212.5	106	15	35	525	0.7	0.4	5	157.4	138.3	0.18	2	0.40	69.2	648.5	82%	3	0.60	216.2	0	0	0	0	0

Appendix 1: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	TOTAL CONSTRUCTION AREA OF GROUPS	PERCENTAGE	OPEN SPACES	GROUP PERIMETER m	NORTH-SOUTH DEPTH m	EAST-WEST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO N/E	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE PLOT AREA	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
41	65	8187	5062.4	0.62	3125	674	200	100	20000	2.4	2.0	36	227.4	2035.6	0.25	15	0.42	135.7	6151.5	75%	21	0.58	292.9	2	0	1	1	1
42	66	10632	6622	0.62	4010	618	150	100	15000	1.4	1.5	38	279.8	525.9	0.05	2	0.05	263.0	10106	95%	36	0.95	280.7	3	1	2	2	1
43	67	2892	1910.4	0.66	981.3	251	40	90	3600	1.2	0.4	22	131.4	246.4	0.09	8	0.36	30.8	2645.3	91%	14	0.64	189.0	0	0	0	0	0
44	68	1577	1005.8	0.64	571.4	194	20	70	1400	0.9	0.3	15	105.1	695.8	0.44	10	0.67	69.6	881.4	56%	5	0.33	176.3	0	0	0	0	0
45	69	2120	1319.9	0.62	800.5	174	70	25	1750	0.8	2.8	9	235.6	1027.9	0.48	4	0.44	257.0	1092.5	52%	5	0.56	218.5	0	0	0	0	0
46	70	528.8	348.6	0.66	180.2	103	20	30	600	1.1	0.7	4	132.2	17.6	0.03	1	0.25	17.6	511.2	97%	3	0.75	170.4	0	0	0	0	0
47	71	1319	909.5	0.69	409.5	168	30	60	1800	1.4	0.5	7	188.4	0	0.00	0	0.00	-	1319	100%	7	1.00	188.4	0	0	0	0	0
48	72	8482	5192.6	0.61	3289	586	125	150	18750	2.2	0.8	40	212.1	0	0.00	0	0.00	-	8482	100%	40	1.00	212.1	5	0	5	3	2
49	73	645.3	400.4	0.62	244.9	106	25	30	750	1.2	0.8	4	161.3	0	0.00	0	0.00	-	645.3	100%	4	1.00	161.3	0	0	0	0	0
50	74	7936	4761	0.60	3175	643	75	200	15000	1.9	0.4	31	256.0	512	0.06	2	0.06	256.0	7424	94%	29	0.94	256.0	4	3	1	2	2
51	75	1939	1139.6	0.59	799.2	204	75	50	3750	1.9	1.5	9	215.4	576	0.30	1	0.11	576.0	1362.8	70%	8	0.89	170.4	0	0	0	0	0
52	76	18186	12894.5	0.71	5291	420	120	100	12000	0.7	1.2	26	699.4	17708	0.97	23	0.88	769.9	477.9	3%	3	0.12	159.3	0	0	0	0	0
53	77	1545	923	0.60	622	179	50	40	2000	1.3	1.3	6	257.5	220	0.14	1	0.17	220.0	1325	86%	5	0.83	265.0	0	0	0	0	0
54	81	758	345	0.46	413	115	25	25	625	0.8	1.0	3	252.7	0	0.00	0	0.00	-	758	100%	3	1.00	252.7	0	0	0	0	0
55	82	1445	867	0.60	578	177	25	60	1500	1.0	0.4	1	1445.0	0	0.00	0	0.00	-	1445	100%	1	1.00	1445.0	0	0	0	0	0
56	111	829	816.8	0.99	12.2	122	20	45	900	1.1	0.4	16	51.8	758.6	0.92	12	0.75	63.2	70.4	8%	4	0.25	17.6	0	0	0	0	0
57	112	4108	2956.5	0.72	1151	279	100	60	6000	1.5	1.7	31	132.5	780	0.19	19	0.61	41.1	3327.6	81%	12	0.39	277.3	0	0	0	0	0
58	113	5859	3897.8	0.67	1961	443	100	75	7500	1.3	1.3	24	244.1	884.2	0.15	5	0.21	176.8	4974.7	85%	19	0.79	261.8	3	0	3	1	2
59	114	1684	1462.1	0.87	221.7	218	25	100	2500	1.5	0.3	17	99.0	1465.3	0.87	15	0.88	97.7	218.5	13%	2	0.12	109.3	0	0	0	0	0
60	115	1120	694.8	0.62	425	171	50	50	2500	2.2	1.0	10	112.0	340.9	0.30	4	0.40	85.2	778.9	70%	6	0.60	129.8	0	0	0	0	0

Appendix 1: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	TOTAL CONSTRUCTION AREA OF GROUPS	PERCENTAGE	OPEN SPACES	GROUP PERIMETER m	NORTH-SOUTH DEPTH m	EAST-WEST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO N/E	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE PLOT AREA	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
61	116	1872	1018.3	0.54	853.4	191	50	40	2000	1.1	1.3	8	234.0	56.2	0.03	1	0.13	56.2	1815.5	97%	7	0.88	259.4	0	0	0	0	0
62	117	10974	5128.9	0.47	5845	602	150	100	15000	1.4	1.5	15	731.6	9345.5	0.85	11	0.73	849.6	1628.6	15%	4	0.27	407.2	2	1	1	1	1
63	118	7154	4739.3	0.66	2415	504	75	150	11250	1.6	0.5	29	246.7	44	0.01	1	0.03	44.0	7110.2	99%	28	0.97	253.9	3	0	3	3	0
64	119	10100	6543.5	0.65	3556	722	75	175	13125	1.3	0.4	37	273.0	342.2	0.03	2	0.05	171.1	9757.6	97%	35	0.95	278.8	4	1	3	2	2
65	120	7237	4862	0.67	2375	436	100	90	9000	0.0	1.1	30	241.2	3314.1	0.46	16	0.53	207.1	3923.1	54%	14	0.47	280.2	3	1	2	2	1
66	1211	4882	2929.2	0.60	1953	315	100	50	5000	1.0	2.0	25	195.3	2380.2	0.49	12	0.48	198.4	2501.8	51%	13	0.52	192.4	0	0	0	0	0
67	1212	6136	3681.6	0.60	2454	516	135	55	7425	1.2	2.5	23	266.8	100	0.02	1	0.04	100.0	6036	98%	22	0.96	274.4	3	1	2	2	1
68	1213	950.3	570.18	0.60	380.1	114	25	25	625	0.7	1.0	4	237.6	503	0.53	2	0.50	251.5	447.3	47%	2	0.50	223.7	0	0	0	0	0
69	1214	6833	4099.8	0.60	2733	492	140	75	10500	1.5	1.9	26	262.8	0	0.00	0	0.00	-	6833	100%	26	1.00	262.8	1	0	1	0	1
70	123	12700	7291.2	0.57	5408	874	150	100	15000	1.2	1.5	55	230.9	810.5	0.06	5	0.09	162.1	11889	94%	50	0.91	237.8	8	3	5	3	5
71	124	3096	1931.5	0.62	1164	238	75	35	2625	0.8	2.1	14	221.1	141.8	0.05	1	0.07	141.8	2953.8	95%	13	0.93	227.2	0	0	0	0	0
72	125	11158	7220	0.65	3938	798	75	150	11250	1.0	0.5	39	286.1	570.7	0.05	1	0.03	570.7	10587	95%	38	0.97	278.6	6	3	3	3	3
73	126	697.1	498	0.71	199.1	105	25	25	625	0.9	1.0	3	232.4	0	0.00	0	0.00	-	697.1	100%	3	1.00	232.4	0	0	0	0	0
74	127	6828	4330.1	0.63	2498	470	75	150	11250	1.6	0.5	28	243.9	224.5	0.03	4	0.14	56.1	6603.9	97%	24	0.86	275.2	0	0	0	0	0
75	128	7659	5113.6	0.67	2545	509	160	65	10400	1.4	2.5	37	207.0	1294.6	0.17	11	0.30	117.7	6364.4	83%	26	0.70	244.8	0	0	0	0	0
76	129	1746	1468	0.84	277.9	224	90	20	1800	1.0	4.5	8	218.2	1075.2	0.62	5	0.63	215.0	670.7	38%	3	0.38	223.6	0	0	0	0	0
77	130	571.7	460.5	0.81	111.2	103	25	30	750	1.3	0.8	5	114.3	61.2	0.11	3	0.60	20.4	510.5	89%	2	0.40	255.3	0	0	0	0	0
78	131	5186	2722.8	0.53	2463	393	100	75	7500	1.4	1.3	21	246.9	3196	0.62	13	0.62	245.8	1989.9	38%	8	0.38	248.7	3	1	2	1	2
79	132	7518	4543.4	0.60	2974	642	90	125	11250	1.5	0.7	32	234.9	1912.7	0.25	7	0.22	273.2	5605.1	75%	25	0.78	224.2	5	1	4	3	2
80	133	7695	4969.6	0.65	2725	593	100	100	10000	1.3	1.0	27	285.0	969	0.13	3	0.11	323.0	6725.7	87%	24	0.89	280.2	5	1	4	2	3

Appendix 2: Building groups characteristics in the Godal-e-mosallah area (old city)

GROUP NUMBER	GROUP AREA M SQ.	TOTAL CONSTRUCTION AREA OF THE GROUP	TOTAL OPEN SPACE IN THE GROUP	GROUP PERIMETER m	DEPTH m	WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY IN PLAN SHAPE	RATIO OF DEPTH/WIDTH	NO OF UNITS	RATIO OF TOTAL AREA/NUMBER OF UNITS	AREA OF NON-RESIDENTIAL M SQ	PERCENTAGE OF NON-RESIDENTIAL AREA	NUMBER OF NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE OF NONE-RESIDENTIAL PLOTS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF RESIDENTIAL AREA	NUMBER OF RESIDENTIAL UNITS	AVERAGE OF RESIDENTIAL PLOTS	RATIO OF UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
1	363	0	363	168	75	8	600	0.6	9	1	363	363	100%	1	100%	363	0	0%	0	-	0%	-	0	0	0	0	0
2	19560	11680	7880	1286	150	225	33750	0.6	1	86	227	6258	32%	46	53%	136	13303	68%	40	333	47%	333	10	6	4	6	4
3	476	0	476	77	25	15	375	1.3	2	1	476	0	0%	0	0%	-	476.1	100%	1	476	100%	476	0	0	0	0	0
4	119	119	0	43	15	12	180	0.7	1	3	40	81.1	68%	2	67%	40.55	38.2	32%	1	38	33%	38	0	0	0	0	0
5	1988	1156	832	185	60	37	2220	0.9	2	24	83	1249	63%	20	83%	62.43	739.3	37%	4	185	17%	185	0	0	0	0	0
6	3717	2191	1526	279	100	50	5000	0.7	2	15	248	624.3	17%	8	53%	78.04	3092.2	83%	7	442	47%	442	0	0	0	0	0
7	1497	744	752	209	43	52	2236	0.7	1	12	125	535.9	36%	8	67%	66.99	960.9	64%	4	240	33%	240	1	0	1	1	0
8	2214	1382	832	213	30	80	2400	0.9	0	10	221	261.1	12%	3	30%	87.03	1953.2	88%	7	279	70%	279	0	0	0	0	0
9	6931	4255	2676	477	95	75	7125	1.0	1	28	248	835	12%	4	14%	208.8	6095.8	88%	24	254	86%	254	2	1	1	1	1
10	3904	2628	1276	290	75	65	4875	0.8	1	10	390	1610	41%	2	20%	804.8	2294.4	59%	8	287	80%	287	1	0	1	1	0
11	6158	3330	2828	404	130	70	9100	0.7	2	6	1026	4789	78%	1	17%	4789	1368.4	22%	5	274	83%	274	0	0	0	0	0
12	17280	9695	7585	1213	150	160	24000	0.7	1	68	254	1561	9%	8	12%	195.1	15719	91%	60	262	88%	262	11	5	6	3	7
13	25764	15710	10054	1604	170	200	34000	0.8	1	89	289	5132	20%	8	9%	641.5	20631	80%	81	255	91%	255	18	8	10	12	6
14	7907	6382	1525	499	132	75	9900	0.8	2	14	565	4517	57%	2	14%	2258	3390.5	43%	12	283	86%	283	2	0	2	1	1
15	4513	2678	1835	270	56	85	4760	0.9	1	21	215	459.4	10%	4	19%	114.9	4053.5	90%	17	238	81%	238	0	0	0	0	0
16	961	647	315	134	20	58	1160	0.8	0	9	107	481.3	50%	7	78%	68.76	480	50%	2	240	22%	240	0	0	0	0	0
17	3418	1258	2159	255	75	65	4875	0.7	1	1	3418	3418	100%	1	100%	3418	0	0%	0	-	0%	-	0	0	0	0	0
18	14157	7760	6397	754	135	135	18225	0.8	1	37	383	175.9	1%	3	8%	58.63	13981	99%	34	411	92%	411	4	1	3	1	3
19	201	201	0	114	8	55	440	0.5	0	6	34	201.3	100%	6	100%	33.55	0	0%	0	-	0%	-	0	0	0	0	0
20	7724	4177	3547	440	110	100	11000	0.7	1	19	407	244.8	3%	1	5%	244.8	7479.5	97%	18	416	95%	416	2	0	2	0	2

Appendix 2: Continue

GROUP NUMBER	GROUP AREA M SQ.	TOTAL CONSTRUCTION AREA OF THE GROUP	TOTAL OPEN SPACE IN THE GROUP	GROUP PERIMETER m	DEPTH m	WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY IN PLAN SHAPE	RATIO OF DEPTH/WIDTH	NO OF UNITS	RATIO OF TOTAL AREA/NUMBER OF UNITS	AREA OF NON-RESIDENTIAL M SQ	PERCENTAGE OF NON-RESIDENTIAL AREA	NUMBER OF NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE OF NONE-RESIDENTIAL PLOTS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF RESIDENTIAL AREA	NUMBER OF RESIDENTIAL UNITS	AVERAGE OF RESIDENTIAL PLOTS	RATIO OF UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
21	5195	2880	2315	374	120	55	6600	0.8	2	20	260	1033	20%	8	40%	129.2	4162	80%	12	347	60%	347	1	0	1	0	1
22	4148	2794	1354	261	90	50	4500	0.9	2	18	230	1942	47%	12	67%	161.9	2205.7	53%	6	368	33%	368	0	0	0	0	0
23	3949	2168	1781	274	105	47	4935	0.8	2	15	263	262.8	7%	1	7%	262.8	3686	93%	14	263	93%	263	0	0	0	0	0
24	17145	9632	7513	966	270	100	27000	0.6	3	53	323	1961	11%	11	21%	178.3	15184	89%	42	362	79%	362	5	1	4	3	2
25	278	69	209	76	18	24	432	0.6	1	1	278	277.8	100%	1	100%	277.8	0	0%	0	-	0%	-	0	0	0	0	0
26	725	220	505	87	15	30	450	1.6	1	5	145	127	18%	2	40%	63.5	598.1	82%	3	199	60%	199	0	0	0	0	0
27	5447	3086	2362	419	70	100	7000	0.8	1	29	188	1237	23%	13	45%	95.12	4210.8	77%	16	263	55%	263	3	0	3	2	1
28	14478	9342	5137	670	150	150	22500	0.6	1	22	658	13056	90%	15	68%	870.4	1422.9	10%	7	203	32%	203	3	0	3	3	0
29	1180	246	934	129	50	25	1250	0.9	2	5	236	60	5%	1	20%	60	1120	95%	4	280	80%	280	0	0	0	0	0
30	5715	3714	2001	405	150	60	9000	0.6	3	28	204	1380	24%	14	50%	98.56	4334.9	76%	14	310	50%	310	0	0	0	0	0
31	295	238	57	70	25	20	500	0.6	1	3	98	294.6	100%	3	100%	98.2	0	0%	0	-	0%	-	0	0	0	0	0
32	5280	4028	1252	319	65	100	6500	0.8	1	41	129	3076	58%	31	76%	99.23	2203.6	42%	10	220	24%	220	0	0	0	0	0
33	1405	1017	388	171	60	45	2700	0.5	1	13	108	1405	100%	13	100%	108.1	0	0%	0	-	0%	-	0	0	0	0	0
34	3290	2070	1219	271	75	65	4875	0.7	1	13	253	941.3	29%	1	8%	941.3	2348.3	71%	12	196	92%	196	1	0	1	0	1
35	4708	2863	1844	406	140	65	9100	0.5	2	22	214	609.6	13%	4	18%	152.4	4098.1	87%	18	228	82%	228	1	0	1	1	0
36	1594	721	872	153	30	50	1500	1.1	1	8	199	322	20%	2	25%	161	1271.6	80%	6	212	75%	212	0	0	0	0	0
37	1392	593	798	135	35	40	1400	1.0	1	6	232	70.5	5%	1	17%	70.5	1321.2	95%	5	264	83%	264	0	0	0	0	0
38	1670	681	990	169	50	40	2000	0.8	1	5	334	0	0%	0	0%	-	1670.4	100%	5	334	100%	334	0	0	0	0	0
39	5460	3485	1975	307	60	100	6000	0.9	1	15	364	1062	19%	2	13%	531.1	4397.9	81%	13	338	87%	338	0	0	0	0	0
40	3716	2726	989	291	60	100	6000	0.6	1	16	232	676.1	18%	7	44%	96.59	3039.7	82%	9	338	56%	338	0	0	0	0	0

Appendix 2: Continue

GROUP NUMBER	GROUP AREA M SQ.	TOTAL CONSTRUCTION AREA OF THE GROUP	TOTAL OPEN SPACE IN THE GROUP	GROUP PERIMETER m	DEPTH m	WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY IN PLAN SHAPE	RATIO OF DEPTH/WIDTH	NO OF UNITS	RATIO OF TOTAL AREA/NUMBER OF UNITS	AREA OF NON-RESIDENTIAL M SQ	PERCENTAGE OF NON-RESIDENTIAL AREA	NUMBER OF NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE OF NONE-RESIDENTIAL PLOTS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF RESIDENTIAL AREA	NUMBER OF RESIDENTIAL UNITS	AVERAGE OF RESIDENTIAL PLOTS	RATIO OF UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
41	1394	765	629	149	30	50	1500	0.9	1	19	73	401.8	29%	15	79%	26.79	992.4	71%	4	248	21%	248	0	0	0	0	0
42	1608	918	689	164	30	60	1800	0.9	1	11	146	390.1	24%	6	55%	65.02	1217.6	76%	5	244	45%	244	0	0	0	0	0
43	2392	1158	1234	216	50	70	3500	0.7	1	9	266	0	0%	0	0%	-	2392.3	100%	9	266	100%	266	0	0	0	0	0
44	1256	782	474	186	40	52	2080	0.6	1	5	251	233.9	19%	2	40%	117	1022.5	81%	3	341	60%	341	0	0	0	0	0
45	3456	2177	1279	264	45	75	3375	1.0	1	16	216	196	6%	1	6%	196	3260.2	94%	15	217	94%	217	1	0	1	0	1
46	3609	2759	850	305	80	50	4000	0.9	2	11	328	1185	33%	2	18%	592.5	2424.2	67%	9	269	82%	269	2	0	2	2	0
47	4012	2506	1506	290	90	65	5850	0.7	1	18	223	1268	32%	9	50%	140.9	2743.4	68%	9	305	50%	305	0	0	0	0	0
48	22725	18251	4475	1197	180	210	37800	0.6	1	57	399	16469	72%	34	60%	484.4	6256.2	28%	23	272	40%	272	6	3	3	4	2
49	3696	2489	1207	303	60	120	7200	0.5	1	14	264	691.9	19%	7	50%	98.84	3004.5	81%	7	429	50%	429	0	0	0	0	0
50	5471	3747	1724	395	80	80	6400	0.9	1	22	249	1091	20%	9	41%	121.3	4379.4	80%	13	337	59%	337	3	1	2	1	2
51	3171	1694	1477	363	80	55	4400	0.7	1	17	187	259.6	8%	7	41%	37.09	2910.9	92%	10	291	59%	291	1	0	1	1	0
52	1782	1556	226	163	30	60	1800	1.0	1	13	137	1222	69%	11	85%	111.1	560	31%	2	280	15%	280	0	0	0	0	0
53	1166	776	390	130	10	60	600	1.9	0	18	65	605.6	52%	16	89%	37.85	560	48%	2	280	11%	280	0	0	0	0	0
54	5710	4756	954	256	90	60	5400	1.1	2	66	87	5430	95%	65	98%	83.53	280	5%	1	280	2%	280	0	0	0	0	0
55	389	0	389	84	30	25	750	0.5	1	2	194	158	41%	1	50%	158	230.8	59%	1	231	50%	231	0	0	0	0	0
56	1566	1466	101	190	60	45	2700	0.6	1	36	44	1566	100%	36	100%	43.51	0	0%	0	-	0%	-	0	0	0	0	0
57	620	604	16	81	35	12	420	1.5	3	19	33	619.8	100%	19	100%	32.62	0	0%	0	-	0%	-	0	0	0	0	0
58	444	0	444	121	55	8	440	1.0	7	1	444	444.1	100%	1	100%	444.1	0	0%	0	-	0%	-	0	0	0	0	0
59	637	637	0	64	25	10	250	2.5	3	14	45	636.6	100%	14	100%	45.47	0	0%	0	-	0%	-	0	0	0	0	0
60	5054	4402	652	445	125	80	10000	0.5	2	25	202	2486	49%	17	68%	146.2	2568	51%	8	321	32%	321	2	0	2	2	0

Appendix 2: Continue

GROUP NUMBER	GROUP AREA M SQ.	TOTAL CONSTRUCTION AREA OF THE GROUP	TOTAL OPEN SPACE IN THE GROUP	GROUP PERIMETER m	DEPTH m	WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY IN PLAN SHAPE	RATIO OF DEPTH/WIDTH	NO OF UNITS	RATIO OF TOTAL AREA/NUMBER OF UNITS	AREA OF NON-RESIDENTIAL M SQ	PERCENTAGE OF NON-RESIDENTIAL AREA	NUMBER OF NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE OF NONE-RESIDENTIAL PLOTS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF RESIDENTIAL AREA	NUMBER OF RESIDENTIAL UNITS	AVERAGE OF RESIDENTIAL PLOTS	RATIO OF UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
61	1567	1082	484	231	80	40	3200	0.5	2	15	104	1567	100%	15	100%	104.5	0	0%	0	-	0%	-	0	0	0	0	0
62	848	662	186	114	20	40	800	1.1	1	9	94	848.2	100%	9	100%	94.24	0	0%	0	-	0%	-	0	0	0	0	0
63	6166	5546	620	289	75	70	5250	1.2	1	53	116	6166	100%	53	100%	116.3	0	0%	0	-	0%	-	0	0	0	0	0
64	1348	1348	0	165	15	70	1050	1.3	0	35	39	1348	100%	35	100%	38.52	0	0%	0	-	0%	-	0	0	0	0	0
65	2152	2129	24	187	50	50	2500	0.9	1	44	49	2152	100%	44	100%	48.92	0	0%	0	-	0%	-	0	0	0	0	0
66	3669	2909	760	222	60	50	3000	1.2	1	44	83	3669	100%	44	100%	83.39	0	0%	0	-	0%	-	0	0	0	0	0
67	1057	1055	2	97	40	10	400	2.6	4	26	41	1057	100%	26	100%	40.65	0	0%	0	-	0%	-	0	0	0	0	0
68	1086	1076	10	114	40	20	800	1.4	2	30	36	1086	100%	30	100%	36.2	0	0%	0	-	0%	-	0	0	0	0	0
69	15625	12295	3330	662	150	110	16500	0.9	1	81	193	11002	70%	67	83%	164.2	4622.5	30%	14	330	17%	330	2	0	2	2	0
70	8885	5710	3175	536	100	120	12000	0.7	1	33	269	3873	44%	18	55%	215.2	5012.2	56%	15	334	45%	334	2	1	1	1	1
71	2365	1985	380	222	40	80	3200	0.7	1	12	197	1428	60%	8	67%	178.5	936.7	40%	4	234	33%	234	0	0	0	0	0
72	3720	2173	1547	300	70	80	5600	0.7	1	16	233	217.4	6%	2	13%	108.7	3502.6	94%	14	250	88%	250	0	0	0	0	0
73	30093	17389	12704	1617	250	150	37500	0.8	2	82	367	6157	20%	17	21%	362.2	23936	80%	65	368	79%	368	11	1	10	8	3
74	10348	7125	3223	795	100	150	15000	0.7	1	20	517	7071	68%	5	25%	1414	3277.5	32%	15	219	75%	219	4	3	1	3	1
75	9119	5068	4052	455	80	150	12000	0.8	1	21	434	4404	48%	4	19%	1101	4715.4	52%	17	277	81%	277	0	0	0	0	0
76	2257	2105	152	312	20	140	2800	0.8	0	17	133	1306	58%	13	76%	100.5	950.5	42%	4	238	24%	238	0	0	0	0	0
77	40662	19943	20719	988	165	340	56100	0.7	0	36	1129	36417	90%	30	83%	1214	4245	10%	6	708	17%	708	1	0	1	1	0
78	25525	14512	11013	1424	200	320	64000	0.4	1	83	308	8960	35%	31	37%	289	16565	65%	52	319	63%	319	10	6	5	8	3
79	13558	8676	4882	855	95	230	21850	0.6	0	50	271	340	3%	2	4%	170	13218	97%	48	275	96%	275	5	1	4	4	1
80	3018	1813	1205	252	25	105	2625	1.1	0	12	252	0	0%	0	0%	-	3018.3	100%	12	252	100%	252	0	0	0	0	0

Appendix 2: Continue

GROUP NUMBER	GROUP AREA M SQ.	TOTAL CONSTRUCTION AREA OF THE GROUP	TOTAL OPEN SPACE IN THE GROUP	GROUP PERIMETER m	DEPTH m	WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY IN PLAN SHAPE	RATIO OF DEPTH/WIDTH	NO OF UNITS	RATIO OF TOTAL AREA/NUMBER OF UNITS	AREA OF NON-RESIDENTIAL M SQ	PERCENTAGE OF NON-RESIDENTIAL AREA	NUMBER OF NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AVERAGE OF NONE-RESIDENTIAL PLOTS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF RESIDENTIAL AREA	NUMBER OF RESIDENTIAL UNITS	AVERAGE OF RESIDENTIAL PLOTS	RATIO OF UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
81	16235	10524	5711	972	80	260	20800	0.8	0	61	266	409.4	3%	2	3%	204.7	15825	97%	59	268	97%	268	8	0	8	8	0
82	26734	15677	11056	1449	180	225	40500	0.7	1	84	318	0	0%	0	0%	-	26734	100%	84	318	100%	318	11	4	7	7	4
83	5262	3526	1736	526	210	70	14700	0.4	3	28	188	2685	51%	19	68%	141.3	2576.9	49%	9	286	32%	286	0	0	0	0	0
84	135	47	88	38	10	10	100	1.3	1	2	67	57.1	42%	1	50%	57.1	77.6	58%	1	78	50%	78	0	0	0	0	0
85	4178	2883	1295	392	70	150	10500	0.4	0	11	380	280	7%	1	9%	280	3897.7	93%	10	390	91%	390	0	0	0	0	0
86	3485	2040	1445	325	70	90	6300	0.6	1	13	268	2666	77%	11	85%	242.4	818.6	23%	2	409	15%	409	1	0	1	0	1
87	7734	4182	3552	490	95	130	12350	0.6	1	19	407	3976	51%	5	26%	795.2	3758.2	49%	14	268	74%	268	3	1	2	1	2
88	7945	5138	2807	509	123	120	14760	0.5	1	18	441	4847	61%	8	44%	605.9	3098.1	39%	10	310	56%	310	3	2	1	2	1
89	10103	3571	6532	386	110	90	9900	1.0	1	19	532	10103	100%	19	100%	531.7	0	0%	0	-	0%	-	0	0	0	0	0
90	3981	2896	1085	308	65	110	7150	0.6	1	45	88	2108	53%	39	87%	54.04	1873	47%	6	312	13%	312	0	0	0	0	0
91	1752	1648	103	220	20	95	1900	0.9	0	43	41	1752	100%	43	100%	40.73	0	0%	0	-	0%	-	0	0	0	0	0

Appendix 3: Building groups characteristics in the Immam Shahr area (new city)

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
1	5311-1	9965	399	125	100	12500	1.3	1.3	5	1993.0	0	0%	0	0%	9965	100%	5	100%	1993	0	0	0	0	0
2	5311-2	14034.7	413	75	150	11250	0.8	0.5	32	438.6	2721	19%	12	38%	11314	81%	20	63%	566	0	0	0	0	0
3	5311-3	17859.2	825	125	200	25000	1.4	0.6	54	330.7	1677.2	9%	7	13%	16182	91%	47	87%	344	2	0	2	2	0
4	5311-4	22003.1	1572	100	313	31300	1.4	0.3	92	239.2	4166.1	19%	15	16%	17837	81%	77	84%	232	7	0	7	6	1
5	5311-5	24670.2	1547	105	313	32865	1.3	0.3	124	199.0	757	3%	6	5%	23913	97%	118	95%	203	7	0	7	7	0
6	5311-6	6595	440	50	200	10000	1.5	0.3	26	253.7	3861	59%	14	54%	2734	41%	12	46%	228	0	0	0	0	0
7	5311-7	2068.5	261	63	75	4725	2.3	0.8	19	108.9	1562	76%	15	79%	506.5	24%	4	21%	127	0	0	0	0	0
8	5311-8	7362.5	433	50	175	8750	1.2	0.3	12	613.5	1562.5	21%	11	92%	5800	79%	1	8%	5800	0	0	0	0	0
9	5311-9	11707.3	676	50	300	15000	1.3	0.2	30	390.2	3948	34%	2	7%	7759.3	66%	28	93%	277	0	0	0	0	0
10	5311-10	7957.3	412	50	150	7500	0.9	0.3	34	234.0	498.4	6%	2	6%	7458.9	94%	32	94%	233	0	0	0	0	0
11	5311-11	6650.9	347	50	125	6250	0.9	0.4	30	221.7	34.4	1%	1	3%	6616.5	99%	29	97%	228	0	0	0	0	0
12	5311-12	33389.2	1933	75	500	37500	1.1	0.2	158	211.3	1106	3%	3	2%	32283	97%	155	98%	208	10	0	10	8	2
13	5311-13	8442.3	456	50	175	8750	1.0	0.3	39	216.5	193.5	2%	1	3%	8248.8	98%	38	97%	217	0	0	0	0	0
14	5311-14	11855	626	63	275	17325	1.5	0.2	32	370.5	3298.9	28%	10	31%	8556.1	72%	22	69%	389	0	0	0	0	0
15	5311-15	211017	1856	400	575	230000	1.1	0.7	1	211017.0	211017	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
16	5311-16	81594	1312	163	525	85575	1.0	0.3	2	40797.0	81594	100%	2	100%	0	0%	0	0%	-	0	0	0	0	0
17	5311-17	3521.4	292	100	75	7500	2.1	1.3	18	195.6	1965.4	56%	11	61%	1556	44%	7	39%	222	0	0	0	0	0
18	5311-18	19568.5	867	200	125	25000	1.3	1.6	45	434.9	3373	17%	9	20%	16196	83%	36	80%	450	1	0	1	1	0
19	5311-19	5760	305	100	55	5500	1.0	1.8	14	411.4	0	0%	0	0%	5760	100%	14	100%	411	0	0	0	0	0
20	5311-20	7449.6	371	125	63	7875	1.1	2.0	24	310.4	2049.6	28%	9	38%	5400	72%	15	63%	360	0	0	0	0	0

Appendix 3: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
21	5311-21	42498.8	1672	250	125	31250	0.7	2.0	91	467.0	17352	41%	19	21%	25147	59%	72	79%	349	6	0	6	0	6
22	5321-1	3531.1	299	120	25	3000	0.8	4.8	12	294.3	699.1	20%	3	25%	2832	80%	9	75%	315	0	0	0	0	0
23	5321-2	7147	433	113	58	6554	0.9	1.9	20	357.4	2337	33%	4	20%	4810	67%	16	80%	301	1	0	1	0	1
24	5321-3	3840	278	75	63	4725	1.2	1.2	12	320.0	640	17%	2	17%	3200	83%	10	83%	320	0	0	0	0	0
25	5321-4	40739	1681	263	200	52600	1.3	1.3	102	399.4	15755	39%	33	32%	24984	61%	69	68%	362	4	0	4	4	0
26	5321-5	6036	330	100	63	6300	1.0	1.6	16	377.3	902	15%	2	13%	5134	85%	14	88%	367	0	0	0	0	0
27	5321-6	6640	351	100	58	5800	0.9	1.7	18	368.9	720	11%	2	11%	5920	89%	16	89%	370	0	0	0	0	0
28	5321-7	3613	241	70	50	3500	1.0	1.4	12	301.1	806.5	22%	2	17%	2806.5	78%	10	83%	281	0	0	0	0	0
29	5321-8	37043	1395	325	130	42250	1.1	2.5	68	544.8	13205	36%	2	3%	23838	64%	66	97%	361	2	0	2	2	0
30	5321-9	7651	393	138	63	8694	1.1	2.2	21	364.3	1996	26%	5	24%	5655	74%	16	76%	353	0	0	0	0	0
31	5321-10	9981	478	175	63	11025	1.1	2.8	28	356.5	1044	10%	3	11%	8937	90%	25	89%	357	0	0	0	0	0
32	5321-11	5357.2	417	175	28	4900	0.9	6.3	15	357.1	3197.2	60%	9	60%	2160	40%	6	40%	360	0	0	0	0	0
33	5321-12	4093	331	138	25	3450	0.8	5.5	11	372.1	3240	79%	9	82%	853	21%	2	18%	427	0	0	0	0	0
34	5322-1	7400.9	542	183	88	16104	2.2	2.1	14	528.6	3468.9	47%	3	21%	3932	53%	11	79%	357	0	0	0	0	0
35	5322-2	872.9	119	40	40	1600	1.8	1.0	1	872.9	0	0%	0	0%	872.9	100%	1	100%	873	0	0	0	0	0
36	5322-3	6151.3	345	125	63	7875	1.3	2.0	18	341.7	264	4%	1	6%	5887.3	96%	17	94%	346	0	0	0	0	0
37	5322-4	10112	501	180	55	9900	1.0	3.3	29	348.7	0	0%	0	0%	10112	100%	29	100%	349	0	0	0	0	0
38	5322-5	3320	244	63	75	4725	1.4	0.8	1	3320.0	3320	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
39	5322-6	784	153	70	14	980	1.3	5.0	1	784.0	0	0%	0	0%	784	100%	1	100%	784	0	0	0	0	0
40	5322-7	1620	210	70	23	1610	1.0	3.0	20	81.0	0	0%	0	0%	1620	100%	20	100%	81	0	0	0	0	0

Appendix 3: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
41	5322-8	948.5	144	37	25	925	1.0	1.5	11	86.2	138.5	15%	1	9%	810	85%	10	91%	81	0	0	0	0	0
42	5322-9	275	81	20	20	400	1.5	1.0	1	275.0	275	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
43	5322-10	660	94	25	25	625	0.9	1.0	1	660.0	660	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
44	5322-11	4726	281	78	63	4914	1.0	1.2	14	337.6	0	0%	0	0%	4726	100%	14	100%	338	0	0	0	0	0
45	5322-12	7415.5	386	120	63	7560	1.0	1.9	20	370.8	0	0%	0	0%	7415.5	100%	20	100%	371	0	0	0	0	0
46	5322-13	7580.6	393	125	63	7875	1.0	2.0	23	329.6	34	0%	1	4%	7546.6	100%	22	96%	343	0	0	0	0	0
47	5322-14	7126.9	454	88	160	14080	2.0	0.6	3	2375.6	7126.9	100%	3	100%	0	0%	0	0%	-	0	0	0	0	0
48	5322-15	12471.2	695	125	100	12500	1.0	1.3	31	402.3	1796	14%	1	3%	10675	86%	30	97%	356	1	0	1	1	0
49	5322-16	10109	494	175	63	11025	1.1	2.8	28	361.0	0	0%	0	0%	10109	100%	28	100%	361	0	0	0	0	0
50	5322-17	11520	442	145	75	10875	0.9	1.9	14	822.9	7200	63%	2	14%	4320	38%	12	86%	360	0	0	0	0	0
51	5322-18	8666	416	145	63	9135	1.1	2.3	24	361.1	1844	21%	5	21%	6822	79%	19	79%	359	0	0	0	0	0
52	5322-19	13143	555	220	63	13860	1.1	3.5	36	365.1	0	0%	0	0%	13143	100%	36	100%	365	0	0	0	0	0
53	5322-20	387	87	25	25	625	1.6	1.0	7	55.3	387	100%	7	100%	0	0%	0	0%		0	0	0	0	0
54	5322-21	8669.6	422	138	63	8694	1.0	2.2	24	361.2	718	8%	2	8%	7951.6	92%	22	92%	361	0	0	0	0	0
55	5322-22	9751	441	163	60	9780	1.0	2.7	28	348.3	0	0%	0	0%	9751	100%	28	100%	348	0	0	0	0	0
56	5322-23	4238	262	50	75	3750	0.9	0.7	1	4238.0	4238	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
57	5322-24	8676	414	145	63	9135	1.1	2.3	24	361.5	1080	12%	3	13%	7596	88%	21	88%	362	0	0	0	0	0
58	5322-25	10928.7	500	175	70	12250	1.1	2.5	30	364.3	0	0%	0	0%	10929	100%	30	100%	364	0	0	0	0	0
59	5322-26	10667	486	175	60	10500	1.0	2.9	30	355.6	0	0%	0	0%	10667	100%	30	100%	356	0	0	0	0	0
60	5322-27	8556	444	170	63	10710	1.3	2.7	25	342.2	882	10%	3	12%	7674	90%	22	88%	349	0	0	0	0	0

Appendix 3: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
61	5322-28	5532	348	125	50	6250	1.1	2.5	20	276.6	0	0%	0	0%	5532	100%	20	100%	277	0	0	0	0	0
62	5322-29	2527.2	206	45	70	3150	1.2	0.6	8	315.9	84	3%	1	13%	2443.2	97%	7	88%	349	0	0	0	0	0
63	5322-30	5396.8	426	175	33	5775	1.1	5.3	15	359.8	716	13%	2	13%	4680.8	87%	13	87%	360	0	0	0	0	0
64	5322-31	840	110	26	25	650	0.8	1.0	1	840.0	0	0%	0	0%	840	100%	1	100%	840	0	0	0	0	0
65	5322-32	6095.5	445	150	75	11250	1.8	2.0	11	554.1	2417.5	40%	1	9%	3678	60%	10	91%	368	0	0	0	0	0
66	5411-1	2704	267	113	25	2825	1.0	4.5	11	245.8	0	0%	0	0%	2704	100%	11	100%	246	0	0	0	0	0
67	5411-2	4789.9	295	100	50	5000	1.0	2.0	19	252.1	0	0%	0	0%	4789.9	100%	19	100%	252	0	0	0	0	0
68	5411-3	5540	324	108	50	5400	1.0	2.2	22	251.8	0	0%	0	0%	5540	100%	22	100%	252	0	0	0	0	0
69	5411-4	4021.2	275	80	60	4800	1.2	1.3	16	251.3	0	0%	0	0%	4021.2	100%	16	100%	251	0	0	0	0	0
70	5411-5	3225	239	75	50	3750	1.2	1.5	13	248.1	0	0%	0	0%	3225	100%	13	100%	248	0	0	0	0	0
71	5411-6	16491	809	108	175	18900	1.1	0.6	57	289.3	4991	30%	13	23%	11500	70%	44	77%	261	2	0	2	2	0
72	5411-7	10062.5	449	163	75	12225	1.2	2.2	25	402.5	3300	33%	1	4%	6762.5	67%	24	96%	282	0	0	0	0	0
73	5411-8	2848	211	25	63	1575	0.6	0.4	8	356.0	0	0%	0	0%	2848	100%	8	100%	356	0	0	0	0	0
74	5411-9	2855.2	214	25	55	1375	0.5	0.5	8	356.9	0	0%	0	0%	2855.2	100%	8	100%	357	0	0	0	0	0
75	5411-10	40132	1568	255	238	60690	1.5	1.1	104	385.9	3631	9%	24	23%	36501	91%	80	77%	456	2	0	2	2	0
76	5411-11	2919	261	100	28	2800	1.0	3.6	8	364.9	0	0%	0	0%	2919	100%	8	100%	365	0	0	0	0	0
77	5411-12	8268.8	403	138	63	8694	1.1	2.2	26	318.0	0	0%	0	0%	8268.8	100%	26	100%	318	0	0	0	0	0
78	5411-13	23042.5	1192	255	120	30600	1.3	2.1	64	360.0	851	4%	3	5%	22192	96%	61	95%	364	2	0	2	2	0
79	5411-14	7506	396	150	58	8700	1.2	2.6	28	268.1	280	4%	1	4%	7226	96%	27	96%	268	0	0	0	0	0
80	5411-15	6522.6	368	128	55	7040	1.1	2.3	25	260.9	0	0%	0	0%	6522.6	100%	25	100%	261	0	0	0	0	0

Appendix 3: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
81	5411-16	5971.6	303	125	63	7875	1.3	2.0	21	284.4	0	0%	0	0%	5971.6	100%	21	100%	284	0	0	0	0	0
82	5411-17	3567.3	296	120	30	3600	1.0	4.0	10	356.7	2847.3	80%	8	80%	720	20%	2	20%	360	0	0	0	0	0
83	5411-18	6453	384	100	30	3000	0.5	3.3	18	358.5	336	5%	1	6%	6117	95%	17	94%	360	0	0	0	0	0
84	5411-19	7216.4	368	125	63	7875	1.1	2.0	20	360.8	340	5%	1	5%	6876.4	95%	19	95%	362	0	0	0	0	0
85	5411-20	3960	321	125	25	3125	0.8	5.0	11	360.0	2520	64%	7	64%	1440	36%	4	36%	360	0	0	0	0	0
86	5412-1	9432	533	230	40	9200	1.0	5.8	73	129.2	2340	25%	52	71%	7092	75%	21	29%	338	0	0	0	0	0
87	5412-2	11687.8	593	220	63	13860	1.2	3.5	34	343.8	275	2%	1	3%	11413	98%	33	97%	346	0	0	0	0	0
88	5412-3	8205	580	180	63	11340	1.4	2.9	63	130.2	1331	16%	49	78%	6874	84%	14	22%	491	2	0	2	2	0
89	5412-4	10199	482	150	125	18750	1.8	1.2	28	364.3	0	0%	0	0%	10199	100%	28	100%	364	0	0	0	0	0
90	5412-5	8644	428	150	70	10500	1.2	2.1	24	360.2	0	0%	0	0%	8644	100%	24	100%	360	0	0	0	0	0
91	5412-6	8642	418	150	60	9000	1.0	2.5	23	375.7	0	0%	0	0%	8642	100%	23	100%	376	0	0	0	0	0
92	5412-7	9049	450	155	63	9765	1.1	2.5	17	532.3	3673	41%	2	12%	5376	59%	15	88%	358	0	0	0	0	0
93	5412-8	7920	401	150	60	9000	1.1	2.5	22	360.0	0	0%	0	0%	7920	100%	22	100%	360	0	0	0	0	0
94	5412-9	6954	379	125	70	8750	1.3	1.8	20	347.7	0	0%	0	0%	6954	100%	20	100%	348	0	0	0	0	0
95	5412-10	270	81	30	25	750	2.8	1.2	1	270.0	270	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
96	5412-11	10080	386	130	70	9100	0.9	1.9	28	360.0	0	0%	0	0%	10080	100%	28	100%	360	0	0	0	0	0
97	5412-12	2641.5	253	90	30	2700	1.0	3.0	8	330.2	0	0%	0	0%	2641.5	100%	8	100%	330	0	0	0	0	0
98	5412-13	432	159	35	35	1225	2.8	1.0	16	27.0	432	100%	16	100%	0	0%	0	0%	-	0	0	0	0	0
99	5412-14	9892.2	464	175	60	10500	1.1	2.9	28	353.3	0	0%	0	0%	9892.2	100%	28	100%	353	0	0	0	0	0
100	5412-15	6158	322	100	60	6000	1.0	1.7	17	362.2	0	0%	0	0%	6158	100%	17	100%	362	0	0	0	0	0

Appendix 3: Continue

GROUP NUMBER	GROUP ID. NUMBER	GROUP AREA m.sq.	GROUP PERIMETER m	NORTH-EAST/SOUTH-WEST DEPTH m	NORTH-WEST/ SOUTH-EAST WIDTH m	DEPTH * WIDTH m.sq.	RATIO OF IRREGULARITY	RATIO NE-SW / NW-SE	NO OF UNITS	RATIO AREA/UNITS	AREA OF NON-RESIDENTIAL m.sq.	PERCENTAGE OF AREA NON-RESIDENTIAL	NON-RESIDENTIAL UNITS	RATIO OF UNIT/NON-RESIDENTIAL UNITS	AREA OF RESIDENTIAL m.sq.	PERCENTAGE OF AREA RESIDENTIAL	RESIDENTIAL UNITS	RATIO UNIT/RESIDENTIAL UNITS	AVERAGE PLOT AREA	TOTAL NUMBER OF BREAKTHROUGH	INNER BREAKTHROUGH	PERIMETER BREAKTHROUGH	NE-SW BREAKTHROUGH	NW-SE BREAKTHROUGH
101	5412-16	19234	798	170	150	25500	1.3	1.1	44	437.1	5794	30%	6	14%	13440	70%	38	86%	354	1	0	1	1	0
102	5412-17	17805	529	163	125	20375	1.1	1.3	4	4451.3	17805	100%	4	100%	0	0%	0	0%	-	0	0	0	0	0
103	5412-18	11648	593	250	50	12500	1.1	5.0	39	298.7	745	6%	8	21%	10903	94%	31	79%	352	0	0	0	0	0
104	5412-19	11145.3	495	195	63	12285	1.1	3.1	39	285.8	840.7	8%	10	26%	10305	92%	29	74%	355	0	0	0	0	0
105	5412-20	2296	219	75	25	1875	0.8	3.0	14	164.0	0	0%	0	0%	2296	100%	14	100%	164	0	0	0	0	0
106	5412-21	2624	241	95	25	2375	0.9	3.8	16	164.0	0	0%	0	0%	2624	100%	16	100%	164	0	0	0	0	0
107	5412-22	2952	225	75	25	1875	0.6	3.0	18	164.0	0	0%	0	0%	2952	100%	18	100%	164	0	0	0	0	0
108	5412-23	17338	777	300	50	15000	0.9	6.0	45	385.3	1600	9%	1	2%	15738	91%	44	98%	358	0	0	0	0	0
109	5412-24	13946	678	265	63	16695	1.2	4.2	36	387.4	2140	15%	3	8%	11806	85%	33	92%	358	0	0	0	0	0
110	5412-25	19519.1	895	300	175	52500	2.7	1.7	52	375.4	10159	52%	26	50%	9360	48%	26	50%	360	0	0	0	0	0
111	5412-26	10698	501	150	53	7950	0.7	2.8	30	356.6	0	0%	0	0%	10698	100%	30	100%	357	0	0	0	0	0
112	5412-27	8985	501	200	63	12600	1.4	3.2	25	359.4	0	0%	0	0%	8985	100%	25	100%	359	0	0	0	0	0
113	5412-28	7209	370	145	63	9135	1.3	2.3	20	360.5	0	0%	0	0%	7209	100%	20	100%	360	0	0	0	0	0
114	5412-29	9700	394	105	80	8400	0.9	1.3	1	9700.0	9700	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
115	5412-30	7100	335	63	100	6300	0.9	0.6	2	3550.0	7100	100%	2	100%	0	0%	0	0%	-	0	0	0	0	0
116	5412-31	10698	487	185	63	11655	1.1	2.9	30	356.6	0	0%	0	0%	10698	100%	30	100%	357	0	0	0	0	0
117	5412-32	9882	468	175	63	11025	1.1	2.8	28	352.9	0	0%	0	0%	9882	100%	28	100%	353	0	0	0	0	0
118	5412-33	1250	150	50	25	1250	1.0	2.0	1	1250.0	1250	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
119	5412-34	4500	287	100	50	5000	1.1	2.0	1	4500.0	4500	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
120	5412-35	10500	485	60	200	12000	1.1	0.3	1	10500.0	10500	100%	1	100%	0	0%	0	0%	-	0	0	0	0	0
121	5412-36	27006	1126	280	145	40600	1.5	1.9	90	300.1	10980	41%	45	50%	16026	59%	45	50%	356	1	0	1	1	0