PRIVACY AND SEGREGATION AS A BASIS FOR ANALYZING AND MODELLING THE URBAN SPACE COMPOSITION OF THE LIBYAN TRADITIONAL CITY

CASE STUDY: THE CITY OF GHADAMES

FARAJ ABUBAKER EL-AGOURI

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CASE STUDY: THE CITY OF GHADAMES

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I certify that this thesis satisfies all requirements as a thesis for the degree of Doctor of Philosophy.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

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Faraj, A. EL-AGOURI

ABSTRACT

PRIVACY AND SEGREGATION AS A BASIS FOR ANALYZING AND MODELLING THE URBAN SPACE COMPOSITION OF THE LIBYAN TRADITIONAL CITY

CASE STUDY: THE CITY OF GHADAMES

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The study examines the spatial and visual privacy in different areas within the walled city of Ghadames, where different ethnic communities live in distinct localities. Conceptual and theoretical notions of privacy are tested, whose ultimate value is further refinement of privacy regulation conceptually and operationally. Complexities of privacy as a concept and its regulation are clarified through theory and extracted spatio-cultural information about physical settings created by these communities. The space syntax and isovist field analysis are applied as an integrated methodology. The study demonstrates usefulness and adaptability of this integrated approach, which provides a fairly definitive interpretation (i.e. understanding) of physical settings of the city that residents as well as visitors perceive as regulating privacy, and where privacy fits into the user’s perception.

The structure of the thesis can be understood as consisting of three parts. Part one includes literature about privacy definition, functions, regulating mechanisms, framework within the context of culture as well as the interface between private and public spaces. Second part introduces theory of space syntax and concept of visibility graph analysis (Isovist field). It also introduces the case study of Ghadames, field survey and observations. It illuminates the inhabitants' lifestyle, and show how they label spaces by function, gender and user identity. Part three analyses syntactically and visually the spatial structures for the whole walled city as well as the nine selected ethnic communities as embedded within the city and in isolation.

In brief, this study attempts to observe and quantify physical settings as privacy regulation mechanisms that operate within context of culture. Mechanisms are the physical elements that facilitate or impede privacy regulation in the city and/or enable users themselves to regulate privacy through their own locales. The elements are composed of field characteristics and barriers. Field characteristics regulate privacy by perceptually altering the physical context through shape, size, orientation, and environmental conditions. Barriers regulate privacy physically and symbolically through walls, screens, objects, and symbols.

Keywords: Privacy Regulation, Space Syntax, Visibility analysis, Traditional Cities

ÖZ

GELENEKSEL LİBYA KENTİNİN MEKÂNSAL ÖRGÜSÜNÜN ÇÖZÜMLENMESİ VE MODELLENMESİ İÇİN MAHREMİYET VE AYRIM TEMELLİ BİR ARAŞTIRMA

ÖRNEK ÇALIŞMA: GHADAMES KENTİ

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Bu çalışma, farklı etnik toplulukların ayrı yerlerde yaşadığı duvarlarla çevrili Ghadames kenti içindeki mekânsal ve görsel mahremiyeti incelemektedir. Mahremiyet kavramının kavramsal ve kuramsal çerçevesi sınanmış ve bireylerin özel yaşamlarının daha nitelikli kılınması için gerekli değerler tartışılmıştır. Mahremiyetin karmaşık yapıları ve bunların düzenleri, kentte yaşayan toplulukların ürettiği fiziksel çevrelere ilişkin mekânsal-kültürel bilgiler ve ilgili kuramlar açısından incelenmiştir.
Mekânın grameri (space syntax) ve eşgörsellik eğrilerine (isovist field) ilişkin çözümlemeler bütünleşik yöntemler olarak uygulanmıştır. Çalışma bu yaklaşımın kullanılabilirliğini ve uygulanabilirliğini göstermekte ve kentte yaşayanlarla ziyaretçilerin mahremiyeti nasıl algıladıklarına ilişkin tanımlar ve yorumlar getirmektedir.

Tez üç bölümden oluşmaktadır. Birinci bölüm mahremiyetin tanımlarına, işlevlerine, düzenleyici mekanizmalarına ilişkin çalışmaları kültür bağlamında özetlemekte, özel ve kamusal alanlar arasındaki arayüzleri tanımlamaktadır. İkinci bölümde mekânın gramerine ve eşgörsellik eğrilerinin grafik çözümlemelerine ilişkin kavramlar tanıtılmaktadır. Ghadames'e ilişkin alan araştırması ve gözlemler de bu bölümde yer almakta, kent sakinlerinin yaşam biçimleri verilmekte, ve kentsel mekânları işlev, cinsiyet ve kullanıcı açısından nasıl tanımladıkları betimlenmektedir. Üçüncü bölümde ise gramer ve görsel dil açısından tüm kentin mekânsal yapısı analiz edilmekte ve kentte varolan dokuz etnik topluluğun kentle ilişkileri, ya da yalıtılmışlıkları irdelenmektedir.

Özetle, fiziksel çevrenin mahremiyeti düzenlemek için nasıl kurgulandığı hem nicel olarak hem de kültür bağlamında incelenmiştir. Bu doğrultuda kent ölçeğinde mahremiyeti kolaylaştıran ya da engelleyen düzenekler ile kullanıcıların kendi mahremiyetlerini düzenlemek için geliştirdikleri fiziksel ögeler belirlenmiştir. Bu ögeler alanın özelliklerinden ya da yapılan engellemelerden oluşmaktadır. Kentin oluşturulmasında kullanılan yapay ve doğal ögeler algısal olarak biçim, boyut, yönlenme ve çevresel koşulların değiştirilmesi ile mahremiyeti sağlamaktadır. Duvarlar, perdeler, çeşitli nesneler ve simgeler ise hem fiziksel hem de simgesel olarak mahremiyetin gerektirdiği koşulları düzenlemektedirler.

Anahtar kelimeler: Mahremiyet, Düzenleme, Mekânın Grameri, Görsellik Analizi, Geleneksel Kentler

To My FAMILY

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SYMBOLS AND ABBREVIATIONS

SYMBOLS

I	Number of islands (rings) within the spatial system
C	Number of convex spaces
G^{convex}	Grid convexity measure of the spatial system
G^{axial}	Grid axiality measure of the spatial system
L	Number of axial lines within the spatial system
R^{convex}	Ringiness of convex space (the number of the rings in the system as a proportion of the Max. possible planar rings for number of spaces)
R^{axial}	Ringiness of the axial map
S	Shortest distance (or steps) far from the node
N_s	Number of nodes with the shortest distance s
m	Order of the vertices in terms of depth
k	Rank of Depth
$Ctrl_i$	Control value for i space or i line.
Ctrl2	Second degree of control measure
Ctrlb	Visual controllability measure of space
N	Number of axial lines
MD	Mean depth of a space or axial line
RA_i	Relative asymmetry of space or axial line i
D_n	Constant value used to relative MD for space n
Rn	Global integration (unrestricted radius) from all spaces to all others within the system.
$R3$	Local integration (restricted to 3 steps of depth)
RRA	Real relative asymmetry
Con	Connectivity of the axial line or space
Cc	Visual Clustering coefficient measure of space.
HH	Refers to Integration measure relativised by Hillier and Hanson method.
Tekl	Refers to Integration measure relativised by Teklenbourg method

SYMBOLS

Pde	Visual point depth entropy measure
Pde2	Visual relativised entropy measure.
MSD	Metric Shortest Distance measure
spa	Shortest path angle measure
γ_i	Clustering coefficient of i space
$E(\Gamma_i)$	Set of edges in the neighbourhood of the given vertex.
K_j	Number of vertices from the defined vertex as a neighborhood size.
VMD	Visual Mean Depth
VMD_n	Visual Mean Depth restricted to n steps of depth
VE	Visual Entropy
VE_n	Visual Entropy restricted to n steps of depth
VRE	Visual Relativised Entropy
VRE_n	Visual Relativised Entropy restricted to n steps of depth
IMI	Isovist Moment of Inertia
IMR	Isovist Max. Radial
MSLD	Mean Metric Straight-line Distance
MSPD	Mean Shortest-path Distance

CHAPTER 1

1.INTRODUCTION

1.1. PRELUDE

The research examines concept of privacy and its regulation through physical elements arranged or deployed by designers in buit environment i.e. traditional settlement that the users perceive as an implicit instrument for regulation privacy in the built environment .The attempt challenge evaluates the internal validity of the spatial correlates of privacy identified by Sundstorm, Town, and Brown, et(1982) through viewsheld (isovist) analysis and space syntax as an integrated methodology. The research expects that this integrated method will elicit information on spatial structures and physical elements enabling users themselves to regulate privacy through their own locals and culturally-conditioned social and behavior practices. However, while these variables will be identified, the research emphasizes primarily spatial and physical elements devised or deployed by designers to regulate privacy .

Field studies conducted in the research of Sundstorm ,et al (1980) and Town, and Brown, et al(1982) discovered that physical enclosure is correlated with privacy. Field studies also determined that privacy is correlated with satisfaction with urban environment. The researchers concluded that although privacy may contribute to an individual's satisfaction with surrounding environment, specific privacy needs associated with maximum satisfaction may vary with users' perception. The research affirms that series of field studies are not inclusive. The physical elements and spatial structures which will be analyzed include the buildings in terms of their size, shape, height, entances and its clustering as well as public open spaces as a spatial system include dead -end passages, streets,public squares , and the relation between both these masses and volumes. The physical and spatial elements investigated were predetermined by the researchers and may not exhaust the range of user's perceptions concerning the physical correlates of privacy.

1.2. THEORETICAL CONSTRUCT

The construct for privacy regulation holds that social, behavioral, and environmental mechanisms operating within the context of culture are employed to regulate privacy within built environments. These mechanisms are defined as following:

1- Environmental mechanisms

2- Behavioral mechanisms

3- Social mechanisms

These three mechanisms operating within the overall context of culture and are mediated by three cultural domains: Psychological processes, social legacy and adaptation to other groups.

(1) Environmental mechanisms are the physical elements that facilitate or impede privacy regulation in the designed environment. These mechanisms are devised or deployed by designers and /or enable users they to regulate privacy through their own locales. The elements are composed of field characteristics and barriers. Field characteristics regulate privacy by perceptually altering the physical context, through shape, size, orientation, and environmental conditions. Barriers regulate privacy physically and symbolically through walls, screens, objects, and symbols.

(2) Behavioral mechanisms are the cognitive and overt behaviors people use to “modify” themselves to conform to the environment. These behaviors regulate privacy through environmental screening, a cognitive behavior; and through overt behavior, nonverbal / verbal behavior, territorial behavior, and the use of personal space.

(3) Social mechanisms are policy and social supports governed by the cultural institution through accepted practices, morals, rules, and roles in the behavior setting. Settlement environment builds up the organizational climate within which privacy regulation takes place. They represent cultural communities as spatial organized systems. Policy and social supports facilitate or impede privacy regulation through structuring of activities in space and time.

These mechanisms operate within the overall context of culture, and are mediated by three cultural domains: psychological processes, social legacy, and adaptation to other groups. Behavioral mechanisms regulate privacy through psychological processes. Social mechanisms regulate privacy through accepted practices and social norms culturally patterned after social legacy and through adaptation to other groups.(adaptation of neighboring groups to accepted social practices, mores, rules, and roles in a behavior setting is patterned by how groups relate, adapting to different positions.)

Behavioral, social, and environmental mechanisms are further mediated by a subsystem of cultural and environmental elements ; emic values, beliefs; patterns of language; and material culture, in particular, the transformed physical environment. These elements evolve from and are simultaneously influenced by all the three cultural domains. Emic values and beliefs constitute the common core of consensus that a culture shares to communicate "meaning". Cultural contexting pattern that communicates contextual cues for privacy regulation are predicated upon emic values and beliefs. Patterns of language, as ways of communicating, condition verbal/nonvarbal behavior for privacy regulation through formal and informal education.

Material culture is an environmental outcome or reification of culture that appears in the transformed physical environment and in objects people interact with the silent messages communicated by physical environment, a major resource of material culture. The physical environment communicates the cultural meaning of environmental mechanisms as privacy regulators through mnemonic cues embedded within or encoded into environment. These cues are interpreted by the user. If the code is not decoded by the user, it is neither shared nor understood and the environment fails to communicate. Built environments that do not communicate lack compatibility in environmental meaning and can be perceived as disorienting and stressful (Rapoport,1983).

1.3. SPECIFIC AIMS OF THE RESEARCH

Specific objective of this research is to identify the physical and spatial elements of the traditional sattlement of Ghadames that devised or deployed by built environment or designers t hat users perceive as regulating privacy in this unique settlement. The range of these elements cover individual housing units, cluster of buildings, and the whole spatial form of the settlement. Becker(1985) argues that research to date on the physical setting of built environment has been largely atheoretical. The research trend has been problem-centred with less emphasis on refining or expanding theory. This research study, both problem-centred and theory-centred; has three research goals:

(1) To refine and extend theory on privacy as architectural and spatial correlates in built environment. Then, constructing overall privacy model including the social, behavioral, and environmental mechanisms operating within the context of Islamic culture.
(2) To investigate the effects of the different spatial structures as systems on facilitating or impeding privacy regulating mechanisms for both male and female users.
(3) To shed light on the hidden unique privacy regulation mechanisms that Arab, Barbar, and African cultures adopted to manage their privacy within the walled city of Ghadames.
(4) To demonstrate the usefulness of integrating isovist analysis and space syntax methodology in targeting user's need for privacy within the built environment.

1.4. SIGNIFICANCE OF PROBLEM

The importance of this problem can be clarified through the following points:

(1) For better privacy management within the built environment is an essential need for human satisfaction. How to successfully manage privacy in today's automated house and built environment is an urgent issue in design and management. Privacy is a rare commodity for most pedestrians and

dwellers. The inability to hold confidential conversations, lack of control over accessibility, the inability to avoid crowding, and lack of autonomy and distractions and interpretations can contribute to negative effects on pedestrian and dweller's satisfaction. In addition, there are economic ramifications due to neglecting privacy management for example; individuals pay high alteration costs in order to achieve their privacy using walls, screens, and partitions during building lifetime.

(2) Refinement of mechanisms for better privacy management. However, environmental mechanisms facilitate or impede privacy regulation is an integral part of the designed environment. On the positive side, the aesthetic quality of the physical and spatial environment can enhance the user's mood and morale, while the social environment can be source of interpersonal support and camaraderie. On the negative side, intrusive levels of noise, poor ventilation, and frequent distractions and interruptions can promote frustration and dissatisfaction with one's living environment.

(3) Targeting user needs and purposes through isovists and syntax integrated methodology. Research to date on the physical setting of Ghadames has utilized surveys targeting attitudes and preferences as well as post accommodation evaluation that assess user responses to living environments (Becker, 1985; Sundstorm, 1986). The research used to operationalize research questions on privacy indicate that the major limit of privacy research to date is its failure to expose the personal constructs of the research subjects, the users the environment examined. The typical survey is not in the user's language, so there may be little shared meaning of privacy as a concept: and the range of responses does not exhaust the user's perception of privacy, privacy needs, and privacy regulators.

The problem is magnified by the adoption of traditional positivist model to environment design research that is not capable of dealing with all issues central to the study of environment and behavior. The positivist model requires the researcher to make a sharp conceptual distinction between the knower(i.e. the researcher)and that which is known i.e.,"facts".(To the positivst, the "facts"of human behavior are empirically real and exist independently in the external objective reality (Bredo and Feinberg,1982; Eisenhart,1985).

The articulation of user needs and purposes is not amenable to positivist approaches(Patricics, 1987; Ventre,1986; Weisman,1983). Ventue(1986a). A constructionist, however, argues that because the quality of experience is subjective for user needs and purposes, knowledge is legitimized through authenticity-not whether or not it is verifiable. That is, human beings constitute or establish what counts as knowledge. "Facts" of human behavior are social constructions existing only by social agreement or consensus.

1.5. APPROACH: THEORY / METHOD

1.5.1 THEORETICAL FOUNDATION

The perception of privacy is dependent upon the accepted social practices, mores, and rules governing the behavior setting (Kira,1976). The usefulness of this methodology in targeting user needs and purposes becomes even more apparent when dealing with other cultures whose cultural meaning of social situations may not be the same. The meaning and clarity of privacy cues can be different across intra-settlement settings even within the same culture (Justa and Golan, 1977).

Behavioral and social scientists have advanced several definitions for privacy (see reviews by Altman,1976, 1977; Altman and Chamers,1980; Margulis, 1977; and Pennock and Chapman, 1971). Concepts of privacy have emphasized one of three central themes: retreat from people(Bates,1964); control over information(Westin,1967); and regulation of interaction (Altman,1975). Privacy within the built environment involves all three themes, but typically refers to the regulation of interaction or communication(Sundstrom,1986).

Altman (1975) definition of privacy is the most comperhansive encompassing the definations of Bates (1964) and Westin (1967). It is the "selective control of access to self or one's group"(p.18), with the central theme being the regulation of interaction. The present research, drawing upon the research of Altman (1975,1976,1977), Altman and Chemers (1980), and Sundstrom (1986), defines privacy as a psychological state associated with the regulation of interaction between the self and others and/or environmental stimuli.

Altman describes privacy as a boundary-regulating process that is dialectic in nature. Privacy is, for Altman, an interpersonal process, whose object is optimization. Westin(1967) theorizes that there are four psychological functions of privacy: the need for autonomy; the need for self-evaluation; the need for emotional release; and the need to allow for protected and limited communication with others. Altman argues that these functions are all in the service of the main psychological function of privacy, which is to maintain self-identity. Poor boundary definitions, according to Altman ,can lead to psychological problems. Blatt and Wild(1976) propose that the mental disorder, such as schizophrenia, is due to the patient's inability to separate himself / herself from others. The patient perceives that "they" are part of the world and do not perceive "themselves" as separate or distinct from others at any time. Kaplan(1977) utilizes Maslow's(1943) hierarchy of needs to examine privacy. Kaplan postulates that privacy falls under " safety and security", the second basic need after "psychological needs." This itself is a cue to importance placed on privacy in Islamic culture.

1.5.2 CULTURAL VARIABILITY OF PRIVACY REGULATION

Altman(1975) was the first to theorize that privacy is a cultural universal . Altman's cross-cultural research of privacy regulation in developing countries reveals that what differs is not that the need for privacy is present, but the ways in which that need is met, the ways that privacy is regulated. The cultural variability of standards indicates that such variability exists in the cities of developing countries as well, through no cross-cultural studies have empirically examined privacy regulation in this setting(Belcher,1985; Rapoport and Westin,1967-1968).

1.5.3 PRIVACY REGULATING MECHANISMS

Altman provides a conceptual framework of privacy regulating mechanisms used to withdraw from interaction or to seek it out(1975;Altman and Chemers,1980). These are environmental behavior(territoriality and personal space), nonverbal/verabal behavior and cultural practices. They operate in different combinations as a social system. Altman considers environmental mechanisms to another regulator, but does not include them in the conceptual framework.

Altman's theoretical framework is the most applicable to the investigation of privacy regulation in the built environment (Sundstorm,1986). Altman's concept is expanded in the present research to include environmental stimuli and additional privacy regulating mechanisms. The model depicted in Fig(1.1) conceptualizes a more holistic framework of privacy regulation than previously provided.

The model stipulatively identifies social, environmental and behavioral mechanisms operating within the context of culture that are employed to regulate privacy in built environment. It draws upon the research of Altman(1975, 1976, 1977), Altman and Chemers(1980),Hall (1966); Justa and Golan(1977); Rapoport(1976); Sundstorm(1982,1985,1986); Sundstorm,Town, and Brown,et al.(1982), and Zeisel (1984). The model is discussed at length in the next chapter.

1.6. METHOD

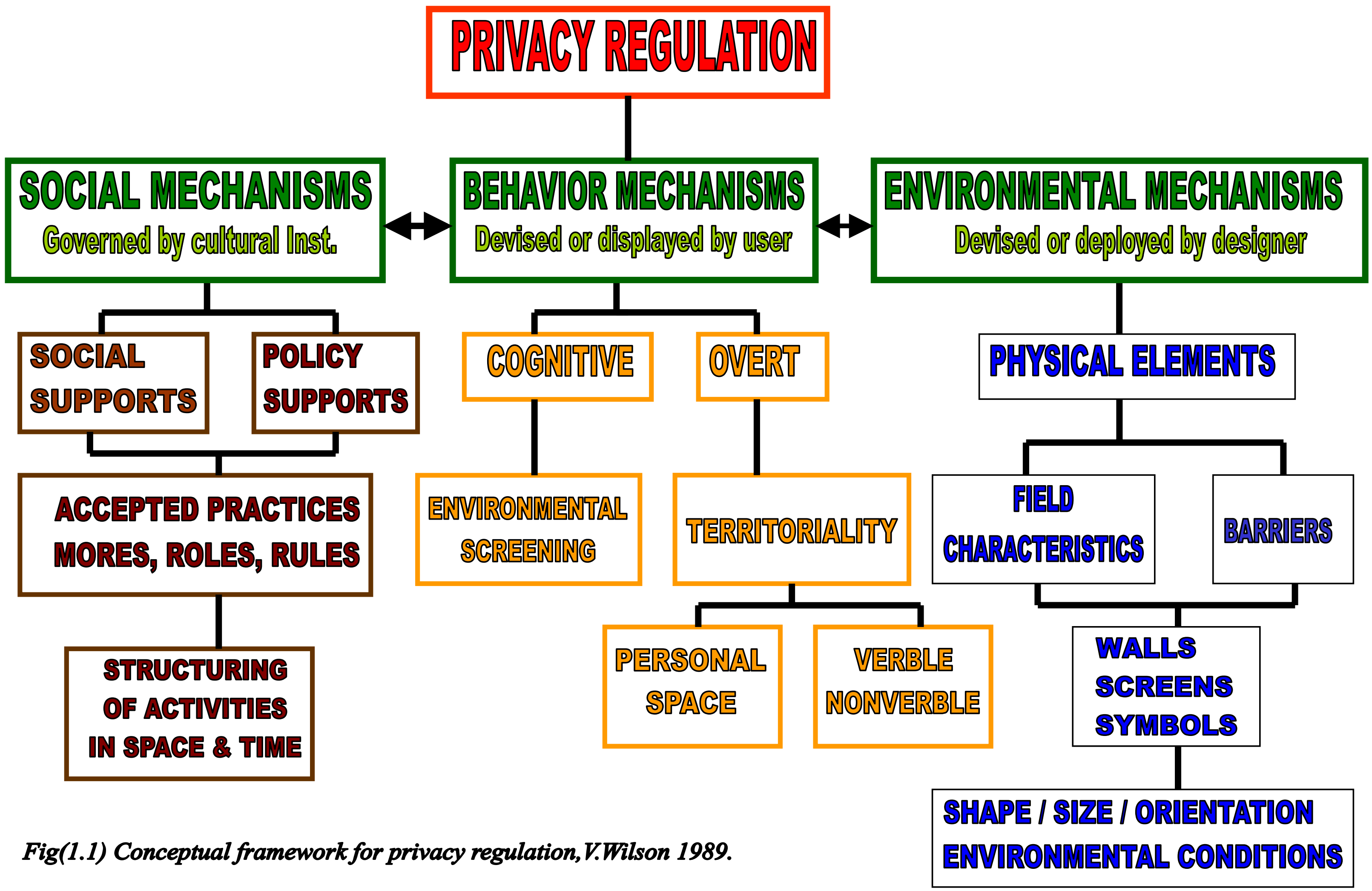
The specific objective is to identify physical and spatial elements devised or deployed by designers that users perceive as an instrument for regulating privacy. These will be approached using integrated method of Isovist Analysis and Space Syntax. This method is designed to analyze complex issues of space configuration, such as privacy regulation, by exhausting the range of the respondent's perceptions concerning the variable being examined and their relation with spatial structures, and to identify interrelationships among privacy issue. The underlying assumption is that it is possible to match particular items and attributes with particular cultural values (Harding and Livesay; 1984).

1.7 INTERIM CONCLUSION

Spatiality of privacy has been a neglected field at both academic and practical levels in the Libyan cities. However, the house and the city are seldom treated by researchers, architects, planners and decision' makers, as the socio-cultural artifact of their users. My prime conception of this study is that a city is a cultural phenomenon. Its form and organization are greatly influenced by the cultural (and sub cultural) milieu to which it belongs. Although, a small number of Libyan research projects concerning cities, have been done, just a few of them dealt with space as socio-cultural artifact, and none of them has comprehensively studied the city in urban traditional built environment.

The objective of this thesis is not only to refine privacy regulation mechanisms and study the traditional city but also to study the city in traditional environment where different ethnic communities live in distinct localities. The intention is to analyze a number of ethnic communities, located in a specific climatic and geographical context, having different cultural framework, and at a specific point in time.

The challenge here is to understand the built environment (spatial structure and lifestyle) by conducting and integrating ethnographical and topological information, and hence realized a research approach that enables eliciting cultural variables of value to environmental design issues. Learning from traditional city is only one way for architects, planners and decision makers, to avoid mistakes and guarantee harmony in the built environment. It is not necessary to copy traditional cities, but it is wise, in both academic research and design practice, to understand, modify and develop some of its principles and approaches and not simply discard and replace them. One of these principles is to think of the city in terms of its social and spatial meanings.



Fig(1.1) Conceptual framework for privacy regulation, V.Wilson 1989.

CHA PTER 2

CONCEPTUAL FRAMEWORK FOR ACCOMMODATING CULTURE AND ENVIRONMENT RELATIONS IN PRIVACY REGULATION

2.1. CULTURE AND ENVIRONMENTAL RELATIONS

2.1.1. CULTURE

Woods (1975) provides an overview of theoretical constructs of culture, pointing out that many of the early definitions attempted to cover too much, with little utility as a descriptive or explanatory concern. Later definitions were less general, but varied according to the orientation and intent of the definer. (See Kroeber and Kluckhohn who identify several hundred uses of the culture concept in their 1952-review of literature.)

Goodenough (1961) suggests that concepts often blur the distinction between culture as patterns of behavior and culture as patterns for behavior, and many times use the two senses of the term interchangeably. Culture refers to a way of life in the former case, and to the design for that way of life in the latter. Sole emphasis on the design for a way of life hints at cultural determinism, which excludes individual variability, voluntarism and autonomy. Woods (1975) stresses the importance of individual variability; summarizing Goodenough's 1961 description of culture:

> *The culture concept can best be utilized as a mental construct…a sort of cognitive map, which provides the individual with appropriate rules for behavior in various situational contexts. Some of these "rules" are idiosyncratic to the individual, some are shared with some members of the group, and others are shared with most members of the group. Those which are shared "with most members of the society lead to "behavior patterns characteristic of the group" and compromise culture in the traditional sense. So culture is shared but not completely. Individual variability can be recognized, (p. xii)*

Recent scholarship de-emphasizes the quest for a universally accepted definition of "*what culture really is*" and focuses instead on a particular range of social phenomena that is important for the purpose at hand (Cole and Scribner, 1994). The present research examines the interrelationship between culture and environmental relations as the pertinent social phenomena.

Fundamental cultural domains are displayed in Figure (2.1), reflecting the design need portion of the environment within the naturally occurring one (see Herskovits, 1952). Although the natural environment may play an important role in culture, it is not predetermining. Cultural practices often induce alterations of the natural environment, and diverse peoples in similar environments may affect totally different cultural practices (Rapoport, 1969). Culture can affect the natural environment, the natural environment can affect culture, or the two may be independent.

Altman and Chemers (1980) provide a slightly different configuration of culture and environmental relations. They identify five cultural domains: the natural environment (*topography, climate, flora, and fauna*); environmental orientations and world views (*cosmology, religion, values, and norms*); environmental processes and behaviors. (*Privacy, personal space, territoriality, and crowding*); environmental outcomes (built environment, homes, farms, and cities); and environmental cognitions (*perception, coding, memory, and judgments*). Each domain is examined on the same level of analysis.

The present research proposes that certain cultural and physical environmental identified by Altman and Chemers evolve as a subsystem and should be examined on a different level of analysis. *Ernie values and beliefs* and *environmental outcomes* as material culture are part of this subsystem, influenced simultaneously by three fundamental cultural domains. Altman and Chemers' framework also omits "adaptation to other groups," even though it is a vital component of culture.

The present research asserts that social legacy, adaptation to other groups and psychological processes are part of an integrated system in which each cultural domain is functionally interrelated with the other domains. The domains are mutually reinforcing.

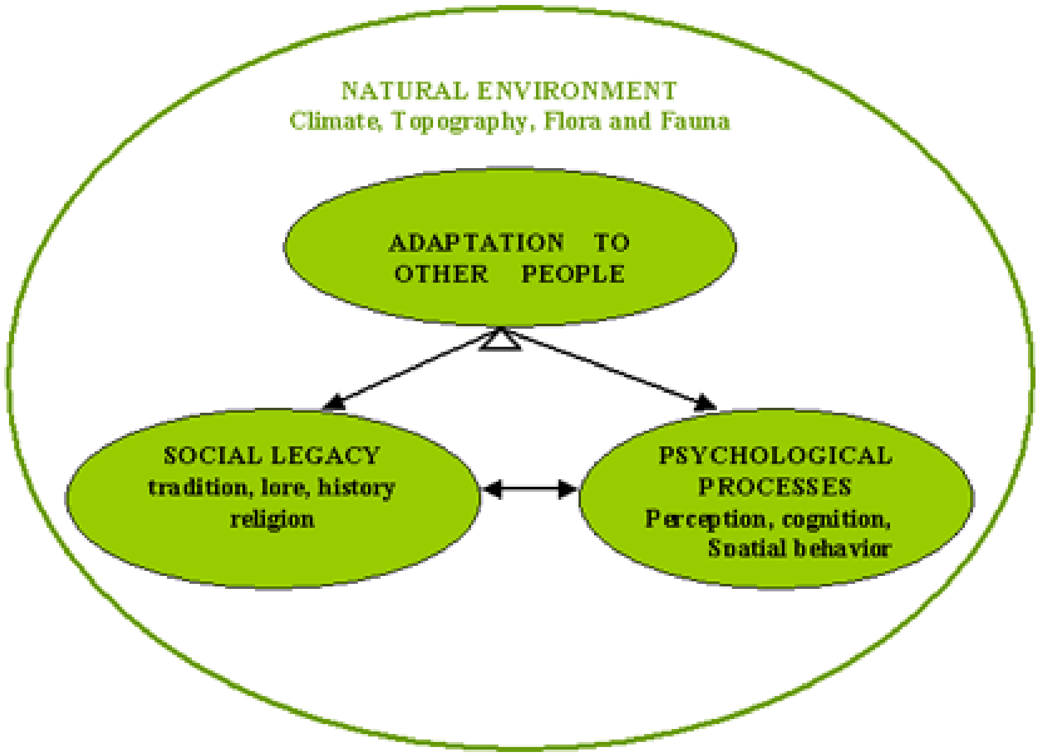


Fig (2.1) *Model of Culture and Environmental Relations.*

This orientation concurs with Altman and Chemers' (1980) perspective. It draws upon Berry's (1975) "weak" version of culture and environmental relations: These forces are part of an interdependent ecosystem in which cultural and environmental elements are interrelated in networks and patterns of dependencies. Hard and fast causal relations are not established.

Bennett (1982) criticizes Altman and Chemers' perspective for omitting the *"institutional imperative, economic compulsions, or power systems that shape the use of physical resources in modern society" (p.622)* . Bennett contends that the economic arrangement of people and resources in a group must be understood in order to understand culture. This is a positivist model, emphasizing the economic base as generating the social reality of a superstructure. Superstructures (i.e., cultural institutions) include institutional systems, education, the family and the church. Bennett's position stresses economic adaptation, indicative of social theory that incorporates a *structural approach.* The structural approach does not recognize individual variability, voluntarism, or autonomy. Researchers utilizing a structural approach rely on different cultural domains for analysis and explanation.

For instance, Kaplan and Manns (1972) in an overview of theoretical orientations, point out that Steward (1953) identifies technoeconomics, sociopolitical organization and ideology (*social legacy*) as the fundamental cultural domains in his structural approach. The structural approach focuses on the institution, a collectively organized phenomenon, and examines the structure of the social system as the central element of explanation. Focus on the institution is reflected in Steward's (1953) structural approach, described by Kaplan and Manns (1972):

> *While the core institutions of any culture may include ideological, sociopolitical, and technoeconomic elements, the technoeconomic factors figure most prominently in defining and forming the strategic features of any society, (p. 47)*

Harding and Livesay (1984) summarize this orientation:

> *As with any collectivist approach, there is a tendency to reify the structural model. One result is that the social structure sometimes comes to be viewed analytically as generating the social reality. The socio-cultural environment is seen as the result of the action of social forces on the group members. The goal of research is to seek put the basic dynamic, i.e., the social forces, and to explain the group life with reference to the character of its underlying structure. (p. 66}*

The present research, along with Altman and Chemers' perspective, emphasizes cultural theory that incorporates a perceptual approach. (This is not to be confused with environmental perception and structure of stimuli.) Harding and Livesay (1984) contrast the structural approach to this perspective:

> *The events and phenomena of social life are examined by researchers with this perspective not so much to reveal an underlying structure of social forces but to understand the dynamics of actors in social process. Analysts tend to assume a background of social factors as a context within which individuals' perceptions, motivations, and personal or social identities are the focus of interest.... The starting point of the analysis of social reality in this approach is reality as perceived by the actors, {pp. 66-67)*

The perceptual approach is an interpretivist model, interpreting culture through ideologies and meanings, cultural models, and cultural constructions. It recognizes individual variability and is concerned with the subjective (e.g., personal view) and intersubjective meanings that develop between people. Marriage is an example of a cultural model as a "meaning system." "Meaning" is a cultural construction, that is, a human way of categorizing or representing culture. Cultural constructions, according to Eisenhart (1987), accomplish four things:

1. They categorize reality (legitimized by social consensus).

2. They constitute reality, providing tools to understand how to organize one's life. (Choosing to get married versus living together is an example of this, constituting reality through meaning systems.)

3. They are a directive force. (Within cultural models, there are things that are considered to be right and wrong by the collective society.)

4. They are evocative. (Emotions are evoked when a cultural model is not adhered to, such as in divorce.)

Harding and Livesay's (1984) comparison of structural and perceptual approaches targets public policy, yet it is equally applicable to environmental design research and the investigation of privacy regulation. Theorizing on the impact of the physical environment typically emphasizes three levels of analysis, reflecting the perceptual approach: the individual; interpersonal relationships; and the structure of the community as a whole (see Sundstrom 1985, 1986). Harding and Livesay, for both theoretical and instrumental reasons, conclude that the analysis of a given social situation should begin at the perceptual and proceed to the structural aspects:

> *This movement is indicated by the nature of and relationship between these two dimensions of social reality. Subjective meaning and interaction*

are grounded in the autonomy of actors, but are conditioned by the pattern of social systems. This connectedness is apparent from the perceptual viewpoint, not only because it examines the process of the constitution of social relations, but because that perspective concerns the domain held by individuals that is explicitly about their social structure. That is, it reveals the structure of society as it most directly affects the actions and decisions of group members. One can only infer from the analysis of structure, as such, the subjective meanings of the population being studied.... Conventional structural models consist of indicators such as "income", "level of social services", or "socioeconomic status" which may identify elements of broader social forces . However, little attention can be given to a target community's specific perceptions. These perceptions and resulting actions lead to specific modifications of the group's particular variant of social life within the social system. By beginning policy-focused research with careful investigation of (a) the knowledge held by members of the group in the immediate situation and (b) the possible or actual reactions to change and its impacts; the perceived reality, patterns of action, and specific organization of the group can be positioned within the social structure, (p. 70)

The present research seeks to identify physical elements devised or deployed by designers that the user perceives as regulating privacy in the built environment. Once the user's perceived reality is understood, this information can be positioned within the social structure of society through culturally-sensitive space planning standards and design practices. Low (1986) proposes:

Designers are culture-makers in the sense that they give form to our cultural ideals, beliefs, and norms. They therefore are responsible for understanding the complex relationship of culture and place and culture and built form. (p.67)

2.1.2. SOCIAL LEGACY

Social legacy embodies tradition, lore, history, and religion. These attributes are institutionalized. Adaptation to other groups acknowledges how a group relates to other groups, adapting to different positions. Sundstrom (1985) argues that theories on the impact of built environments i.e. work environments have rarely emphasized adaptation, even though adaptation can modify the impact of many variables (collectively, or on individual and interpersonal levels). The following chapter discusses the impact of technology on individual and interpersonal adaptation; see also Dubos, 1980; Helson, 1964; Sundstrom, 1985; and Wchlwill, 1974.

2.1.3. PSYCHOLOGICAL PROCESSES

Psychological processes incorporate perception, cognition, and spatial behavior. Altman and Chemers (1980), taking a slightly different position than this, argue that privacy regulation occurs in the domain of "environmental processes and behavior," through spatial behavior. Cognition is placed in another domain. Their research findings reveal cultural differences in the nonverbal and verbal ways in which people communicate. The present project posits that privacy is also regulated through the cognitive means of environmental screening; this is examined in the following chapter. Spatial behavior refers to the output manifested in a person's actions and responses (Lang, 1974). It encompasses the ways that people use the environment in the course of social interaction. How we perceive behavior depends upon the conceptual framework of one's own culture. Lee (1959) summarizes:

> *when I throw a ball, do I perform an aggressive causal act, as my culture predisposes me to believe? Or does the ball leave my hand, as the Greenland Eskimo puts it, or do I merely actualize the ball's potential to move, as the Navajo would have it? (p. 2)*

A "layered" cultural analysis is provided in Figure (2.2), which displays the cultural and physical environmental elements that interrelate with all three cultural domains in networks and patterns of dependencies. These elements are examined on a different level of analysis. The present research posits that they evolve as a subsystem, influenced simultaneously by the three major cultural domains. Patterns of language, as ways of communicating, are culturally patterned through formal and informal education (Heath, 1983). Patterns of language are shaped by social legacy, adaptation to other groups, and psychological processes. Anthropologists have been intrigued for a long time by the parallels and possible relationship between the structure of language and the structure of cognitive thought, evidenced in the early major research of Sapir and Whorf. Structural linguists such as Levi-Strauss consider language as patterns for behavior, out of which other cultural domains evolve. Although the writings of Levi-Strauss, cited by Kaplan and Manns (1972), primarily emphasize language patterns, they demonstrate the interconnectedness of language patterns with cultural domains:

Language can be said to be a condition of culture and this in two different ways: First, it is a condition of culture in a diachronic way, because it is mostly through the language that we learn about our own culture [through informal and formal education].... But also, from a much more theoretical point of view, language can be said to be a condition of culture because the material out of which language is built is the same material out of which the whole culture is, built: logical relations, oppositions, correlations, and the like. (p. 163).

2.1.4. EMIC VALUES AND BELIEFS

Emic values and beliefs represent core elements that are fundamental to culture and are resistant to change (Rapoport, 1978a). They are resistant to change not only because they are so personally experienced, but because “people cannot act or interact at all in any meaningful way except through the medium of culture” (Hall,” 1969, p.188). A key component of culture is that people share common views of the world through their emic values and beliefs. This does not mean that they agree in all respects, but only that they share a common core of consensus (Goodenough, 1961; Rapoport,1978a}. Material culture, an environmental outcome, is a reification of culture that is also shaped by the cultural domains. Material culture appears in the transformed physical environment and in objects. The physical environment represents a major resource of material culture. Particular attention is given to this component of material culture, reflecting the research emphasis of the present topic.

2.2. ENVIRONMENTAL RELATIONS

2.2.1. PHYSICAL ENVIRONMENT

The transformed physical environment, or built environment, includes buildings, their interiors, and the surrounding outdoor areas. Sundstrom (1985) describes the physical environment as the “layout and appearance of buildings, the arrangement and properties of rooms (spatial system), characteristics of equipment and furniture, and the associated ambient conditions (sound, light, temperature, air)” (p.174). Zeisl (1984) categorizes these attributes of the physical environment as “field characteristics” and ‘barriers.” He asserts that field characteristics alter the physical context through shape, orientation, size, and environmental conditions. Zeisel further asserts that barriers keep people apart or join them together, physically and symbolically, through walls, screens, objects, and symbols. These environmental mechanisms provide resources for facilitating and impeding privacy regulation and are examined in the following chapter.

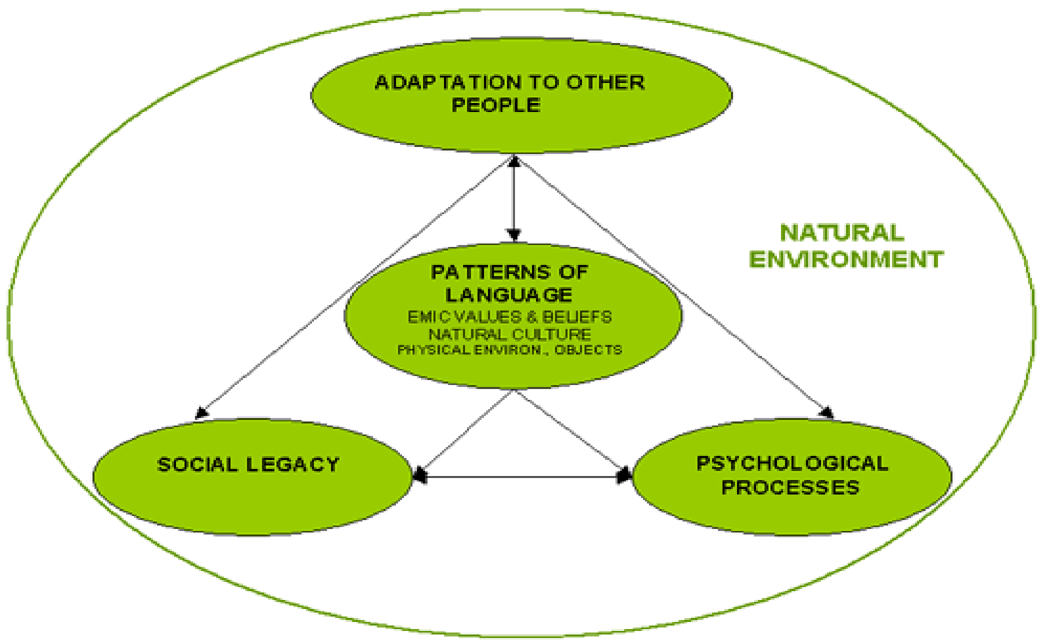


Fig (2.2): *Cultural and Physical Environmental Elements within Culture and Environmental Relations.*

Sundstrom (1985) extends Duffy's (1974a, b) general hypothesis that properties of the physical environment communicate dimensions of organizational (e.g., institutional) structure. Sundstrom proposes a more specific hypothesis regarding i.e. work environments, theorizing that properties of the physical environment communicate eight specific dimensions of organizational structure. For instance, standardization of procedures and specification. of tasks parallel rigidity of layout within buildings and subdivisions, formalization of roles (including role specification and emphasis on status and formal channels) parallels differentiation by rank of workspaces and uniformity of workspaces within ranks; interdependence (among work units and tasks, including work-flow) parallels proximity of work-units adjacent in the work-flow;

and so forth.

2.2.2. FUNCTIONS OF THE PHYSICAL ENVIRONMENT

Lang (1974) proposes that the physical environment functions in three ways: it helps to maintain the physiological states necessary to sustain life; it provides the necessary behavior settings; and it supports the psychological states through the use of symbols. Rapoport (1982) offers additional insight, proposing that the physical environment also provides cues for behavior; guides enculturation (and acculturation for that matter). And can help to maintain self-identity. *Enculturation* is defined as the cultural codes (emic values and beliefs) learned early in life. *Acculturation* is defined as the cultural codes learned later in life through rapid cultural contact and/or rapid change. (See Rapoport, 1982; also Woods, 1975).

2.2.3. PERCEPTION OF THE ENVIRONMENT

Contributions to the understanding of environmental perception increased rapidly during the 1970's. Representative overviews are provided by Downs and Stea, 1973; Ittelson, 1973; Lang, 1974; Lowenthal, 1972; and Proshansky, et al., 1970; 1976.

As early as 1950, Gibson argued that a detailed examination of the environment is necessary in order to understand perception. Gibson described the environmental dynamism of perception as a complete system. The environment, according to Gibson, contains information consisting of environmental stimuli that constitute basic, structural categories of perceptual experience. Ittelson (1973) describes Gibson's structural categories as a hierarchy of meaning levels, ranging from symbolic meaning (e.g., the ground to homeland); to activity-oriented meaning (e.g., the ground is something to be walked on); to concrete meaning (e.g., the ground itself). The environment is perceived not only in terms of stimuli, but in the structure of that stimulus. Congruently, Ventre (1986a) describes the environment as the "configuration of perceptual qualities in space and time." Garling (1976) expands the concept to include a cognitive aspect. He describes environmental perception as the classification and coding of the physical environment, acknowledging a perceptual/cognitive structure. This structure facilitates and impedes privacy regulation through stimulus screening. Mehrabian's (1976) theory of stimulus screening and its relationship to privacy regulation are discussed in the following chapter. Ittelson (1973) summarizes enduring qualities of actual and perceived environments:

1. Environments surround.
2. Environments are multi-modal, offering information through many senses.
3. Peripheral as well as central information is always present in environments.
4. Environments provide more information than can be processed.
5. Environmental perception involves action, it cannot be passively observed.
6. Environments provide symbolic meanings and motivational messages.
7. Environments have an ambiance (e.g., atmosphere) mediated through such things as social activity and aesthetic quality.

Perception of the environment also encompasses perceived adaptation and perceived user control. Individuals change "adaptation-levels" with continued exposure by adjusting their psychological standard of reference (Helson, 1964; Sundstrom, 1985). By so doing, they readjust perceived quality of life (QL) and quality of work life (CWL) standards. Sundstrom (1985) illustrates adaptation to the invasion of acoustical privacy:

> *for instance, an office worker may find an office noisy at first but after awhile his standard of reference may change as he comes to regard the office as less noisy, (p. 179)*

Additionally, the people such as workers may welcome the benefit of "masking noise" to keep his/her conversations private..; "learned" response to the environment. Wineman (1986) urges organizations to create environments that allow for individual choice and control, environmental diversity and participation. In perspective, Westin (1967) theorizes that the need for autonomy, or power to control and regulate one's life, is one of the psychological functions of privacy. (This includes both perceived and actual control.) Davis and Altman (1976) observe that perceived control and sense of responsibility "for the physical environment are lowest in places used by the greatest numbers of people, that is, the degree of perceive d lack of control over the environment can evoke stress (Frankenhaeuser and Gardell, 1976). Baum, et al. (1981) examine perceived control over environmental stressors. Baum, et al. (p.7), citing Wolf and Goodell (1968), argue that people not only respond to dangers or threats that have materialized; they are "equally affected by expectations of these events and by symbols of danger experienced previously."

2.2.4. ENVIRONMENTAL MEANING

The physical environment is a communication medium (Becker, 1977, 1981; Steele, 1973). Weaver (1986, p. 52) defines communication as the creation of common meaning." People interact with the silent messages communicated by the physical environment:

> *Nothing occurs, real or imagined, without a spatial context, because space (along with time) is one of the principle organizing systems for living organisms. (Hall, 1971, p. 24)*

The physical environment communicates meaning. But, to reiterate, environments are not predetermining. They may be facilitating to the extent of acting as" a catalyst for releasing latent behavior, but they cannot generate activities (Gans, 1968). Environmental determinism, now discredited, encouraged major misunderstandings such as the socio-environmental tragedies of Pruit-Igoe and "urban renewal" in Boston's Italian West End during the 1950's. The physical environment may facilitate, inhibit, or be neutral as a communication tool.

The environment is a nonverbal form of communication. Perception and structure of environmental stimuli are mediated through the symbolic interpretation of mnemonic cues. Meaning is imposed on the environment through mnemonic cues that are encoded into the built environment. Mnemonic cues reflect cultural practices, roles, rules, and mores. These cues are interpreted by the user (Rapoport, 1975). If the code is not decoded by the user, it is not shared nor understood, and the environment fails to communicate. It is for this reason that Rapoport '(1983) argues that built environments should be culturally specific in order for cues to be understood.

2.3. CULTURAL APPROPRIATENESS

Cultural appropriateness is used broadly here to refer to the compatibility of an introduced element with the socio—cultural patterns, goals, values, and circumstances (situational context) characteristic of the populations to which the element is introduced (Harding, 1979).

Culture shares a common code of communication in order for the environment to communicate it must have meaning. Singer (1984) argues that cultural differences are due to different meanings that people assign to the environment. Rapoport (1983), examining built environments in developing countries, observes that users frequently reject "copied" designs. He points out that imitating physical elements of design for new construction does not work; not only because the wrong physical elements are copied, but because they communicate inappropriate.(e.g., incompatible) meanings:

> *In copying, designers usually tend to copy the 'hardware'. Imitation leads to inappropriate results because it typically involves superficial appearance— the shape, geometry and the like rather than the principles and schemata behind the physical expression, the domains of which it consists, the spatial organization and its relation to lifestyle, social structure, and so on. (p. 251)*

The globalization of what were once national industries or firms has brought a crisis in corporate communication. People are dealing with other cultures continually. Yet culturally inappropriate structures continue to be built worldwide, especially in developing countries (see Rapport 1978a, b, c; 1983). Built environments that are not culture-specific lack compatibility in environmental meaning and can be perceived as disorienting and potentially stressful (Rapoport, 1983).

2.4. CULTURAL CONTEXT

Hall (1983) examines contexting patterns of culture, theorizing that information. Context and meaning are bound together in a balanced, functional relationship. Hall proposes that cultures enculturate their members to pay attention to different aspects of the environment with varying degrees of significance. He coins the term "contexting" to describe the perceptual and cognitive process of recognizing, giving significance to, and incorporating contextual cues in order to interpret the meaning of the behavior setting. Contextual cues refer to implicit and explicit messages that transmit information about the nature of the interpersonal relationship between communicators, nonverbal expressions, the physical environment, social circumstances and verbal communication that explicitly stands out against the background of implicit messages. More explicit information has to be transmitted in order to communicate when the context of the situation is not understood.

Hall applies the concept of contexting to the cross-cultural comparison of communication patterns. He theorizes that cultures with low contexting patterns rely more on environmental mechanisms to screen for privacy. These cultures also require the majority of information to be transmitted in explicit codes in order to understand meaning in environments. Cultures with high contexting patterns rely more on behavioral mechanisms to screen for privacy; most of the information transmitted is internalized in the individual or implicitly coded in the behavior setting. Hall (1966, 1983) organizes cultures on a continuum of high to low in their contexting patterns: Japanese, Chinese, French, and Mediterranean cultures are placed at the higher end of

the continuum; American, Canadian, English, German, and Swiss cultures are placed at the lower end of the continuum.

2.5. INTERIM CONCLUSION

The present research asserts that privacy regulation in built environments operates within the overall context of culture and is mediated by three cultural domains:

psychological processes; social legacy; and adaptation to other groups. Behavioral mechanisms regulate privacy through psychological processes. Social mechanisms regulate privacy through institutional policies and social norms patterned after social legacy and adaptation to other groups. (Adaptation of community groups to accepted social practices, rules, and roles in a behavior setting is patterned by how groups relate, adapting to different positions.)

Privacy is further mediated by the subsystem of cultural and environmental elements: emic values and beliefs; patterns of language; and material culture, in particular the transformed physical environment. These elements evolve from and are simultaneously influenced by all three cultural domains. Emic values and beliefs constitute the common core of consensus that a culture shares to communicate "meaning." Cultural contexting patterns that communicate contextual cues for privacy regulation are predicated upon emic values and beliefs. Patterns of language, as ways of communicating, condition verbal/nonverbal behavior for privacy regulation through formal and informal education.

People interact with the silent messages communicated by the transformed physical environment, a major resource of material culture. The physical environment communicates the cultural meaning of environmental mechanisms as privacy regulators through mnemonic cues encoded into the environment. These cues are interpreted by the user. If the code is not decoded, it is not shared nor understood and environmental mechanisms, employed to regulate privacy, fail to communicate. Privacy regulation operates in networks and patterns of dependencies, just as the cultural domains do. It is not a unidimensional concept with an easily identifiable class of empirical referents in current literature. This contributes to the complexity of privacy as a concept and to its regulation. The following chapter explores this complexity on another level of analysis, examining theoretical notions and ideas, and proposes a conceptual framework for privacy regulation.

CHAPTER 3

3.COCEPTUAL FRAMEWORK FOR STUDY PRIVACY HOLISTIC MODEL OF PRIVACY REGULATION

3.1. INTRODUCTION

This chapter examines current theory on privacy and its regulation in the built environment, in order to refine privacy as an intellectual construct and to shed light on misunderstandings. Misconceptions about privacy by corporate culture are compounded by conceptual and methodological conflicts inherent in interdisciplinary research. Wineman (1986) argues that progress toward integrative theory building in built environment continues to be limited due to the various disciplinary perspectives examining psychological, physiological, and architectural elements. This lack of integration is evident in privacy research. Conceptual frameworks for privacy regulation are not balanced. They are paradigm-specific from particular schools of thought. Regulatory mechanisms outside parent disciplines are vaguely represented.

A holistic model of privacy regulation is presented in this chapter, which attempts to integrate theory and further refine privacy regulation, conceptually and operationally. The model proposes a balanced conceptual framework for privacy regulation and suggests a more detailed method for classifying mechanisms based on their regulatory characteristics.

3.2. CONCEPTUAL FRAMEWORK FOR PRIVACY

The complexity of privacy as a concept is evident in the lack of agreement by theorists on exactly what privacy is: Is it a psychological state? A behavior? A goal? An attitude? The confusion and disagreement over privacy as a concept reaches global proportions. The first international comprehensive study of privacy was conducted by the International Commission of Jurists, held in Stockholm, 1967 (Mellors, 1978). The Commission could not agree upon a universal, definition for privacy…*only that it means different things to different societies at different times.*

3.3. PRIVACY DEFINITION

Privacy derives from the Latin words "privatus' (e.g., withdrawn from public life) and "privare" (e.g., to deprive). It acquires conventional opposition to public life during the sixteenth century and was considered to be a privilege, not a deprivation (Willians, 1983).

Behavioral and social scientists have advanced several definitions for privacy (see the reviews by Altman, 1976, 1977; Altman and Chemers, 1980; Margulis, 1977; and Pennock and,Chapman, 1971). Concepts of privacy have emphasized one of three central themes: *retreat from people*; *control over information*; *or regu1ation of interaction*. Privacy within the built environment involves all three themes, but typically refers to the regulation of interaction or communication (Sundstrom, 1986).

3.3.1. RETREAT FROM PEOPLE

Early definitions of privacy reflect Bates' 1964 definition as a "*person's feeling that others should be excluded from something which is of concern to him, and also a recognition that others have a right to do this*" (p. 429) Deliberate withdrawal by an individual or group from contact with other people is emphasized here, with the central theme being retreat from people. Privacy, under this definition, represents a situation in which the person achieves solitude. (This should not be confused with isolation, resulting from a perceived lack of environmental stimuli and/or other people.).

Bates, drawing on the research of sociologist Goffman, argues that the regulation of self/other boundaries is necessary in order to establish self-identity, which services self-esteem. Goffman (1969) examines overt role behaviors and the self as a monitoring system. He theorizes that the *"front*" and "*back*" regions of behavior are analogous to being "*on-stage*" and "*off-stage*." On-stage reflects overt role behaviors that people present to the world, and off-stage reflects the vulnerable side of the self when no social roles are consciously being played.

Comments

Bates' definition emphasizes *avoidance* of interaction with other people. This does not account for the dialectic nature of social exchange (see Simmel , 1950 translation by Wolff). Environmental stimuli are also not accounted for in the definition. Bates does not acknowledge that interaction and avoidance also occur between people and environmental stimuli. Hall (1966) explains that everything a person is and does is associated with his/her experience of space.

A person's sense of space is a synthesis of many sensory inputs. Sensory inputs are stimulated by attributes of the physical environment as mediated by culturally-conditioned perceptual faculties (Broadbent, 1973). These attributes, as environmental mechanisms, facilitate and impede privacy regulation.

3.3.2 CONTROL OVER INFORMATION

A widely accepted definition of privacy, first advanced by Westin (1967), is the "*right of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about themselves will be communicated to others*" (p.7), with the central theme being control over information.

Westin, who is frequently cited in discussions of electronic communications and documentary information whether generated in business or government, draws upon the research of Goffman and German sociologist, Simmel. Simmel (translation by Wolff, 1950) argued in the early 1900's that a person needs to be a part of other peoples' lives and also needs to establish his/her *own* distinctness in order to maintain self-identity. He described the dialectic nature of socia1 exchange and Proposed that privacy is an optimizing process.

Westin describes four states of privacy:

(a) Solitude. .Freedom from observation by others.
(b) Intimacy….involving pairs of people rather than one person.
(c) Anonymity….. Avoidance of identification in public places.
(d) Reserve….concealment of information about oneself to others.

Westin identifies four psychological functions of privacy:

(a) The need for autonomy …the power to control and regulate. One's life.

(b) The need for emotional release….to be able to relax from social roles "off-stage," thus protecting the vulnerable aspects of behavior.

(c) The need for self-evaluation…..to be able to experiment with various social roles "off-stage."

(d) The need to allow for limited and protected communication with others….to be able to secure confidential communication with others.

Comments

Westin defines the *right* to privacy, but not privacy. Privacy is, for Westin, basically a descriptive word, whereas the notion of claim presupposes that the problems of description have been resolved (Velecky, 1978). In order to make a claim, the grounds of that claim first need to be identified. Westin addresses the right to privacy in normative value terms, reflecting his background as a political scientist. Westin's emphasis on the right to privacy can be seen in the historical development of privacy within American law. Judge Coobey first defined privacy in 1888 as the right to be let alone (cited in Mellors, 1978). Lawyers Warren and Brandeis (1890-1891), using Cooley's definition, set a law precedent by defining privacy at length terms for the first time in the *Harvard Law Review*. They treated the right to privacy as a branch of law of libel dealing with truthful statements made for improper purposes. Their concern was with freedom from embarrassing publicity. Economist Young (1978) argues that increased interest in the right to privacy has been triggered by the bombardment of information technology, especially computers, population increase, increased government intervention; and changing moral and social attitudes.

This increased interest is reflected in *The Electronic Communications Privacy Act*, enacted during 1980s in America, which places for the first time strict limits on government and other intrusions into individual privacy by technological means (Sitomer, 1986). Sitomer points out that strong advocates of privacy such as the *American Civil Liberties Union* continue to lobby for new laws and restrictions on computer matching, and sharing computer files containing personal data, such as credit or health information. Sitomer concludes that an increasing number of questions relating to privacy invasion are being raised about the use of computers to monitor the efficiency and productivity of workers.

Interest in the 1egal right to privacy extends beyond U.S. boundaries. Article 12 of the *Universal Declaration of Human Rights*, *Article 17 of the United Nations Covenant on Civil and Political Rights*, and *Article 8 of the European convention for the Protection of Rights and Fundamental Freedoms*, all specify that there is a universal, human right to privacy (Mellors, 1978). This right may be universally accepted, but its specific application is largely culture-bound.

3.3.3.REGULATION OF INTERACTION

A third definition of privacy, first advanced by Altman (1975), is the most comprehensive, encompassing the definitions of Bates and Westin. It is the "*selective control of access to self or one's group*" (p.18), with the central theme being, the regu1ation of interaction. Altman, like Westin, draws upon the work of both Goffman and Simmel. Altman describes privacy as a boundary-regulating process that is dialectic in nature (i.e., open/closed; accessible/ nonaccessible). Privacy is, for Altman, an interpersonal process whose object is optimization.
Altman argues that the four psychological functions theorized by Westin are all in the service of the main psychological function of privacy: *to maintain self-identity*. Regulating self/other boundaries helps to maintain self-identity. Poor boundary definitions, according to Altman, can lead to mental problems. Blatt and Wild

(1976) propose those mental problems, such as schizophrenia are due to poor boundary definition. Patients with this condition are unable to separate themselves from others and see themselves as always being part of the world…never establishing their own distinctness.

3.4. PERCEIVED PRIVACY NEEDS

Altman theorizes that the most basic privacy need is to optimize social contact and to avoid crowding in order to maintain self-identity. Too much interaction leads to crowding. Crowding is subjective; the same number of people in the same size area is perceived differently depending upon the cultural context. Cultural context is mediated through a set of mnemonic cues that indicate what kind of setting it is (Rapoport, 1976) The psychological literature on the effects of crowding in face-to-face situations regarding stress, tension, discomfort, social interaction, and performance is voluminous. Altman (1975) and Baum and Epstein (1978) have summarized this research.

Kaplan (1977) stresses the importance of privacy needs by utilizing Mas1ow's 1943 Hierarchy of Needs. Kaplan postulates that privacy falls under "*safety and security*," the second basic need after "*physiological needs*." Sundstrom, Town, and Brown, et al. (1982) propose that there is a hierarchy of privacy needs for example, in work environment privacy depending upon job type. Their findings do not support the original hypothesis that activity complexity is positively related to perceived privacy needs. Rather, different activity may create different privacy needs. For instance, in one of their studies, clerical workers in walled offices reported less privacy than managers did in offices with equivalent enclosure.

The researchers theorize that at the most basic level, control over social contact and the ability to avoid crowding take priority. This corroborates Altman's assertion. Clerical job types are designated at this level. Once these needs are satisfied, the ability to concentrate by controlling distractions and interruptions take priority at the second level. Technical help, such as bookkeepers and accountants, are designated at this level. Once, these needs are satisfied, autonomy over supervision and audibility to co-workers take priority at the third level. This hierarchy of privacy needs is in the service of maintaining self-identity, as theorized by Altman, Sundstrom , et al., (1980) caution that sole concentration on creating an optimal level of social contact may be at the expense of under-emphasizing the link of privacy with identity.

3.5. PRIVACY REGULATION

Altman was the first to theorize that privacy is culturally universal (1975). Altman's cross-cultural research of privacy regulation in developing countries reveals that *what differs is not that the need for privacy exists, but the ways in which that need is met, the ways privacy is regulated.* The cultural variability of standards indicates that such variability exists in the built environment of deve1oped countries as well, though no cross -cultural studies have empirica1ly examined privacy regulation in this setting (Belcher, 1985; Rapoport and Watson, 1967-1968). Altman provides a conceptual framework of privacy regulating mechanisms used to withdraw from interaction or to seek it out.

These are environmental behavior (territoriality and personal space), verbal and nonverbal behavior, and cultural practices. They operate in different combinations as a social system. Altman considers environmental mechanisms to be another regulator, but does not include them in the conceptual framework. His primary interest in behavioral mechanisms reflects his background as asocial psychologist. A graphic representation of Altman's privacy regulating mechanisms is presented in Figure(3.1)

Comments

Altman's theoretical framework is the most applicable to the investigation of privacy regulation in the built environment (Sundstrom, 1986). Johnson (1991) expands Altman's framework of privacy and its regulation to include environmental stimuli in the definition of privacy and additional regulatory mechanisms. The model, illustrated in Figure (2.2) and presented in the "Introduction," conceptualizes a more holistic framework of privacy regulation than previously provided. It draws upon the research of Altman (1975, 1976, 1977); Altman and Chemers (1980); Hall (1966); Justa and Golan (1977); Rapoport (1976); Sundstrom (1982, 1985, 1986); Sundstrom, et al., (1980); Sundstrom, Herbert, and Brown (1982); Sundstrom, Town, and Brown, et al. (1982); and Zeisel (1984).

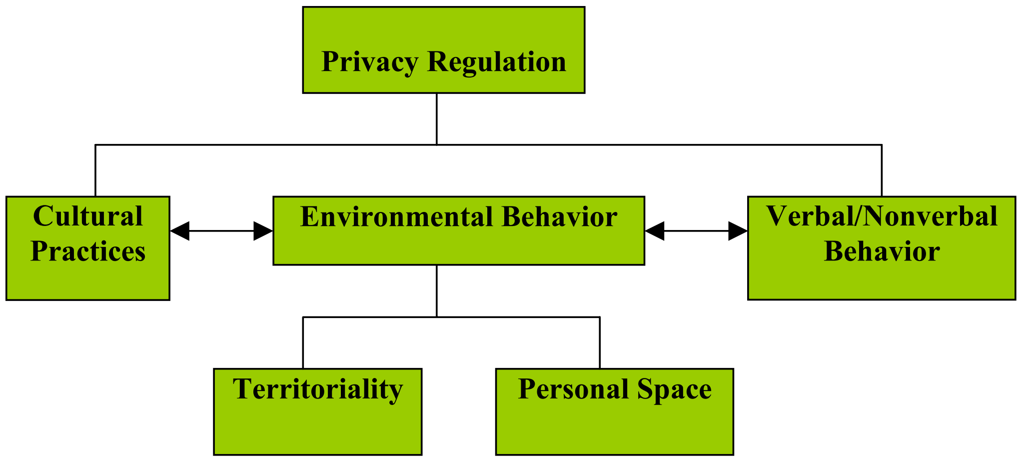


Fig (3.1) *Privacy Regulating Mechanisms identified by Altman*

Sundstrom (1986) describes privacy as a "*psycho1ogica1 state that accompanies a satisfactory retreat from, or regulation of, social interactions*" (p.177). Regulation between the self and others and/ or environmental stimuli is implicitly recognized. The present research defines privacy as *a psychological state associated with the regulation of interaction between the self and others and/or environmental stimuli.* This definition draws upon the research of Altman (1975, 1976, and 1977), Altman and Chemers (1980), and Sundstrom (1986).

3.6 HOLISTIC MODEL OF PRIVACY REGULATION

Bates, Westin, and Altman consider the experience of privacy being channeled through culture. Hall (1966) asserts that privacy is regulated through the structuring of space as a culturally patterned dimension. It is outside cultural awareness. The theoretical framework for the present research holds that social, behavioral, and environmental mechanisms operating within the context of culture are employed to regulate privacy within built environments. They operate in different combinations and are interrelated.

3.7. ENVIRONMENTAL MECHANISMS

The physical environment provides resources for regulating interpersonal accessibility, and for signaling desires for more or less social interaction (Sundstrom, 1985). Environmental mechanisms are the physical elements devised or, deployed by designers and/or, which enable users themselves to regulate privacy through their *own* locales. The physical elements are composed of field characteristics and barriers (Zeisel, 1984).

Zeisel asserts that field characteristics perceptually alter the physical context through *shape, orientation, size, and environmental conditions.* He further asserts that barriers are physical elements that keep people apart or join them together, physically and symbolically, through walls, screens, objects, and symbols. Field characteristics evolve from the layout of barriers.

An in-depth examination of environmental mechanisms is provided in this section, reflecting the research emphasis of particular issue. As stated earlier, Hall (1966) explains that everything a person is and does is associated with his/her experience of space. A person's sense of space is a synthesis of many sensory inputs. Sensory inputs are stimulated by attributes of the physical environment (Broadbent; 1973).

Kilpatrick (1961). echoing the eighteenth century empiricism of Berkeley, Locke and Hume summarized this: "*We can never be aware of the world as such, but only of….the importance of physical forces on the sensory receptors*" (p.1)... The statement pinpoints the importance of environmental mechanisms in constructing the different perceptual worlds that people inhabit within their culture.

3.7.1. FIELD CHARACTERISTICS

Zeisel proposes that field characteristics of a place can alter people's ability to be together or apart. They do this by altering the physical context within which perceptual relationships occur. Zeisel describes field characteristics as shape, orientation, size, and environmental conditions:

> ***The shape*** *of a setting affects primari1y visual and perceptual relationships.... Corners in a square area, for example, can be more easily seen as separate from one another than parts of a round place can. In a study of children playing in different rooms, groups of children quickly claimed as distinct territories the places in the leaves of clover-shaped rooms (Hutt,1969).* ***Orientation*** *of one place to another influences the behavioral relationship between people in them. Two places oriented so that people using them have a higher chance of casually seeing or meeting one another may be considered "functionally" closer than two equidistant places oriented to minimize chance .~.... (Festinger, et al., 1950) Possible distance between people is a major determinant of potential behavior relationships.* ***The size*** *of a setting offers opportunities for people to put distance between themselves or limits their options. A 4-meter-square conference room does not offer any of seven participants at a meeting the option to separate from the rest of the group....*
> *Loudness, light intensity, and air flow are* ***environmental conditions*** *that directly affect possibilities for behavior relationships by limiting and augmenting people's ability to hear, see, and smell other people and activities. (pp. 134—136)*

Loudness facilitates and impedes privacy regulation through background noise and conversational privacy. It is typically referred to as acoustical privacy (Sundstran, 1982). Extensive research has been conducted on acoustical privacy, beginning with the early research of Boyce, 1974; Brookes, 1972; Brookes and Kaplan, 1972; Huridert and Greenfield, 1969; Ives and Ferdinand, 1974; McCarrey, Peterson, et al., 1974; Nemecek and Grandjean, 1973; Rilarid and Falk, 1972; and Zeitlin, 1969. This research reveals that people in open-plan, compared to conventional, generally report experiencing less privacy. They spend additional time conversing, hear more noise, and experience more distractions. The intrusion of noise is emphasized in these studies. Conversely, loudness can also facilitate privacy regulation. This is evidenced in white noise introduced in open-plan. Goodrich (1982) gives an example of how *light intensity* relates to privacy regulation within the work environment. Task/ambient systems that provide higher light levels on the primary work surface, but reduce overall ambient light levels; create an unevenly lit space surrounding the workspace. Goodrich concludes:

> *This quality seems to increase informality, to reduce status distinctions, and to create a more relaxed climate, all of which increase their sense of perceived privacy. (p.365)*

Light intensity facilitates and impedes visual privacy. Sundstrom (1982) explains that visual privacy generally refers to the "*ability to work without unwanted surveillance and sometimes includes isolation from visual distraction, such as the sight of other people working or passing by*" (p. 383) ... The visual sensory system is the most powerful of all the sensory means of perceiving qualities and dimensions of the environment. Psychologists estimate that, for adults, as much as ninety percent of all sensory information is visually perceived data (Fitch, 1972). Kleeman (1981) gives an example of the olfactory relationship between privacy regulation and the quality of *air f1ow* within the environment:

> *Some people are very conscious of another kind of privacy--olfactory privacy. Some individuals are allergic to tobacco smoke or maybe they do not like the body odors of the people nearest to them. (p. 284)*

Empirical studies of olfactory privacy in built environments are minimal to nonexistent. Recent research, however, conducted in Europe indicates that olfactory context may have a mediating influence on perceptions of visual and acoustical privacy (Davis, 1990). That is, olfactory context appears to cause stimuli as visual and auditory, to be experienced and responded to differently. Ittelson's (1973) theory of environmental perception stated earlier, supports. the "*structuring*" of environmental Stimuli. He theorizes that the environment is perceived not only in of stimuli, but in the structure of those stimuli. (See also King, 1976; Mehrabian, 1976.) Caution is advised in generalizing from the European findings at the present time, as the structuring of environmental stimuli may not be equally salient across cultures.

The research of Sundstrom, et al. (1980) indicates a positive relationship between privacy and satisfaction. Congruent with this line of thinking, the Japanese Kajima Corporation has constructed a building in Tokyo using "*piped-in aromas*" to increase productivity and creativity of its employees (cited in "*Japanese Company Hopes Idea Makes Good Scents*," 1989). Perhaps taken to an extreme, this emphasis on quality of air f1ow does acknow1edge the multidimensional sensual reality of environmental conditions as privacy regulators.

3.7.2 BARRIERS

Zeisel (1984) describes barriers as walls, screens, objects, and symbols:

> ***Walls*** *separate people in places. The absence of walls allows people to be connected. The thickness, consistency, and the materials of walls influence the quality of separation. For example, walls with no soundproofing between bedrooms provide neighbors with aural opportunities (and inhibitions) that denser walls do not.* ***Screens*** *...glass panels, a garden hedge, doors, counters, windows…separate and connect people more selectively than complete walls. Glass can enable visual connection bit tactile separation; a shower curtain, the opposite….****Objects*** *form another class of barriers. Things placed in space may be perceived as space dividers or connectors: a piece of sculpture on a public plaza as a separator or as a place to meet; a couch in a living room; a tree in a garden. Finally,* ***Symbols*** *can be barriers. Color changes in the rug around a public telephone and change in ceiling height in a room (implicitly) signal that someone considers this space to be two separate places, perceptually. (pp. 132—134)*

Archea (1977) postulates that people position themselves around features of design, such as doors and partitions, in order to facilitate privacy regulation. These physical elements represent the barriers Zeisel describes. Mehrabian (1976) proposes that the amount of social interaction also depends upon the line of vision and positioning of fixed and semi-fixed patterns, such as raised floor areas, the angle of furniture and accessories. Sundstrom (1985) applies Altman's theory on the regulation of interaction to clarify this further:

> *Partners in conversation seek an optimal psychological distance, which is adjusted through interpersonal proximity, eye-contact, and others*

behaviors. App1ied to the work environment, this theory implies that conversants are more comfortable in seating arrangements that allow them to adjust their distance (or other cues of immediacy) to suit their preferences. (p.J84)

The literature on privacy regulation indicates that privacy is most consistently regulated through physical enclosure of the space by walls or partitions (BOSTI and Brill, et al., 1984, 1985; Ellis and Duffy, 1980; Hedge, 1982; Marans and Spreckelmeyer, 1982;, 1986; Sundstrom, et al., 1980; Sundstrom, Hertert, and Brown, 1982; Sundstrom, Town, and Brown, et al., 1982). This further substantiates Zeisel‘s description of barriers. Physical enclosure helps to regulate visual, olfactory and acoustical privacy.

3.7.3. PSYCHOLOGICAL FUNCTIONS OF PRIVACY REINFORCED BY THE PHYSICAL ENVIRONMENT

Designers use physical elements to reinforce the psychological functions of privacy, as outlined by Westin and Altman. Rapoport (1976) postulates that one of the functions of the environment is to maintain self-identify…the main psychological function of privacy theorized by Altman. The research of Hansen and Altman (1976) demonstrates that personalization of a space helps to maintain self-identity and commitment to place. Their research analyzed the relationship between territoriality and freshmen progress. Students who personalized their dorm rooms through artifacts, early on and most frequently, tended to perform better and remain in school longer than those who did not personalize their dorm rooms. Hansen and Altman concluded that personalization of a space reflects the degree of commitments to a place and helps to maintain self-identity.

3.7.4. SYMBOLIC VALUE OF PRIVACY: STATUS DEMARCATION REINFORCED BY THE PHYSICAL ENVIRONMENT

Steele (1973) asserts that people may prefer private spaces because they often signify status or importance particularly in work environment. Davis (1977) describes “status” as the value placed on an organization or social system by comparison to other members. It usually corresponds to an individual‘s formal rank in the social hierarchy. Higher ranks have acquired more privacy privileges Konar, et al. 1982 describe the process of status demarcation as one in which a person's position in the organizational hierarchy is symbolically indicated by the nature of his/her facilities.

Symbolic signs of status appear to be evident in most societies, and are believed to be reflected in certain environmental and social mechanisms. Steele (1973) points out that early research consisted mainly of anecdotal evidence regarding the role and nature of environmental status demarcation. Later studies have empirical substantiation, examining certain physical elements that designers deploy or devise, such as floor space, degree of enclosure (e.g., accessibility), layout, size and quality of furnishings and personalization (see Konar, et al., 1982).

This research confirms earlier general assertions that high-ranked people typically have more common status markers…. space, furnishings, capacity to personalize and privacy. Joiner's 1977 research reveals that spatial zones are demarcated through placement, and orientation of locales.

Criticality of environmental status markers, though seemingly lacking with regard to space allocation, may be influenced by other factors. The investigators note that in work environments legislative members are allowed to personalize their offices, and space allocation appears to be adequate across ranks.

3.7.5. PRIVACY AND SATISFACTION LINKED TO THE PHYSICAL ENVIRONMENT

Herzberg (1968; and Herzberg, Mausner, and Snyderman, 1959) and Locke (1983) point out that the physical environment is primarily associated with dissatisfaction--not satisfaction. Herzberg argues that the motivational factors influencing satisfaction are separate and distinct from those negative hygienic factors influencing dissatisfaction. Herzberg argues that eliminating negative factors, such as physical environmental features, will not create satisfaction.

The empirical research of Crouch and Nimran (1989) provides documentation that may refute this, pending further research. Their research reveals that the physical environment (including architectural privacy) has both positive and negative behavioral effects. Respondents in their study perceived the physical environment to facilitate and inhibit work performance.

Crouch and Nimran point out that a direct assessment of satisfaction with the physical environment cannot be made, as no measure of satisfaction was employed in the Australian study. Empirica1 research in the United States, however, indicates a positive relationship between privacy and satisfaction (Sundstrom, et al., 1980). Caution is advised in generalizing from the research of Crouch and Nimran at The present time, as positive and negative attributes of the physical environment may not be equa1ly salient across cultures.

3.7.6.CULTURAL VARIABILITY OF ENVIRONMENTAL MECHANISMS

No cross-cultural research that empirica11y examines privacy regulation in built environments from developed countries is reported. This includes physical elements devised or deployed by designers as regulatory mechanisms- the focus of the present research. Hall (1966) documents privacy regu1ation in certain developed countries, but does not hold behavior settings constant. Although Hall groups work with living environments, he nevertheless offers insight into culturally specific mechanisms regulating privacy. Hall theorizes that sensory input, stimulated by attributes of the physical environment, is molded and patterned by culture.

He lists culture-specific examples of physical elements and design practices that facilitate and impede privacy regulation. Hall holds that mechanisms used to regulate privacy depend upon cultural contexting patterns. Germans, a “1ow context” culture, primarily rely on environmental mechanisms, such as thick walls and double doors, to regulate privacy. They have difficulty if they must rely on their own power of concentration to screen out sound. Japanese, a “high context” culture, traditionally rely on behavioral mechanisms to regulate privacy; as reflected in thin sliding partitions used as acoustical screens in Japanese homes (See Kimura and Sine, 1986.)

The global impact of information technology may alter some of Hall's assertions regarding the dependency of privacy regu1atory mechanisms on the pattern of cultures (from high to low). For example, Japanese reliance on behavioral mechanisms to regulate privacy appears to be changing, even though they are considered to be a high context culture. Shoji Ekuan (1985), Director of the Japanese GK Institute, offers valuable insight**:**

> *Traditionally, Japanese do not pay attention to (architectural) privacy as much as Westerners do. Because of this, Japanese office workers prefer the shared space to cell-like, private rooms. Put into such a room, they would tend to feel more isolated than privileged. Things seem to be gradually changing... in favor of protecting (architectural) privacy.... In contract (sic), private rooms are favored by the designers and engineers. It is predicted that as the number of professionals increases with the advent of the information age, office space will likely be partitioned in one way or another. (p. 305)*

3.8. BEHAVIOR MECHANISMS

The user's role in the environment is not passive (Moore and Golledge, 1976) People active1y anticipate events so they can make decisions about behavior. They modify the environment (usually through semi-fixed features of design and personal space) or modify themselves to the environment (readjusting perceived QL and QWL standards). These exemplify the active role the user plays in the environment. See Hall (1966) and Rapoport (1976) for an in-depth discussion of semi-fixed feature space and personal space. Modifying the environment and modifying oneself to the environment facilitate privacy regulation through overt and cognitive behaviors.

3.8.1. OVERT BEHAVIOR

Extensive research has been conducted on personal space, territoriality, and verbal/nonverbal behaviors. (See Altman and Chemers, 1980 for a review.) Most of the research, however, does not specifically examine these overt behaviors as mechanisms used to regulate privacy. Altman and Chemers (1980) point out that the literature on personal space typically examines the effect of personal characteristics of people, intimacy of social relationships, and other variables on distancing behavior. Also, territoriality is usually examined as if it were a separate process, independent of privacy.

The limited empirical research that exists on these overt behaviors as privacy regulating mechanisms is provided predominantly by Altman. Altman (1975, 1976, 1977), Altman and Chemers (1980), Altman and Vinsel (1977), and Davis and Altman (1976) discuss these mechanisms. This research, primarily concentrating on personal space and territoriality, is briefly summarized in the following two sections with specific reference to Altman and Chemers.

3.8.2. NONVERBAL/VERBAL BEHAVIORS, PERSONAL SPACE, AND TERRITORIALITY

Altman and Chemers (1980) address nonverbal/verbal behaviors used to regulate privacy, but cite no empirical research. Paraverbal communication cues are described as "letting people know our feelings regardless of the content of what we say" (p.79). Nonverbal communication cues are defined as the body language used to communicate the desire for privacy: posture, head gestures, opening/closing of the arms, smiles/frowns, orientation of the body, and so forth.

Altman and Chemers emprical1y examined how personal space and territoriality are used to regulate privacy. They describe personal space, or interpersonal distancing, as a communication vehicle used to maintain an "appropriate" or "desired" level of contact. It is an important means of privacy regulation that continually changes with circumstances. Altman and Chemers stress that human territoriality, the process of establishing and controlling a territory, is extremely complex. It consists of many properties and dimensions, including.

1. Particular control and ownership depends upon the type of territory (e.g., primary/secondary/public).
2. The scale of territory may be small or large (e.g., objects/ rooms /homes /communities/nations).
3. Ownership may be by a person or group.

4. Territoriality primarily serves to maintain personal identity and to regulate social systems.

Territoriality, identified by Altman as a behavioral mechanism, is established and controlled through territorial markers that delineate boundaries. Environmental mechanisms are used as territorial markers, in addition to overt behavioral mechanisms. They are interrelated since both are used to delineate boundaries.

3.8.3.COGNITIVE BEHAVIOR

A more comprehensive perspective of how privacy is regulated requires a theoretical introduction to cognitive behavior as it relates to privacy regulation. A brief overview is given only, since this behavioral mechanism is outside the scope of the present research.

Minimal research exists in this area. Rapoport (1976) proposes that privacy is regulated by cognitive behavior through depersonalization. Depersonalization, however, emphasizes withdrawal and omits the dialectic nature of privacy regulation. Mehrabian (1976) theorizes that privacy is regulated through stimulus screening of environmental conditions a cognitive behavior.

8.3.4. STIMULI SCREENING

Mehrabian (1976) postulates that stimulus screening facilitates privacy regulation. He defines stimulus screening as "*how much a person characteristically screens out the less relevant parts of his environment, thereby effectively reducing the environmental load. and his arousal state*" *(p. 24)*. Mehrabian describes environmental load as the amount of information perceived in the environment in the form of stimuli. Of the three dimensions, the arousal/nonarousal dimension of emotional reaction is the most directly connected to the environment. The more environmental stimuli emotionally responded to, the greater the arousal state, and vice versa.

Individuals differ in their ability to screen environmental conditions, (Baum, et al., 1981; Becker, 1983, Mehrabian, 1976;Wineman, 1986). Mehrabian (l976) categorizes individual differences as nonscreeners and screeners. No screeners are those who are less selective in what they emotionally respond to in the environment. Screeners are described as those who are more selective in what they emotionally respond to, with less relevant stimuli screened out.

Mehrabian compares these differences in screening for acoustical privacy:

> *Supposing Mr. Jones, a screener, and Mr. Smith, a nonscreener, are in your living room having a quiet, relaxed conversation when.... . there is a sonic boom. Mr. Smith, the nonscreener, will startle, bolt upright in his chair, and possibly lose his train of thought. Mr. Jones, the screener, on the other hand, will at most turn his head in the direction of the sound. ... Mr. Smith's arousal level will shoot up whenever his environment gets loaded.., and will take a longer time coming down. Mr. Jones' arousal level will not go up as nearly as high and will come down more quickly. This does not necessarily mean that Mr. Smith is more nervous, anxious, or tense than Mr. Jones. Low levels of stimulus screening simply index less selectivity and therefore more amplified arousal responses to different situations….whether pleasant or unpleasant. However, we can say that nonscreerers have a more delicately or more finely tuned emotional "mechanism." They will thus be relatively sensitive to smaller variations in stimuli and may be put out of whack by relatively gross ones. (p. 25)*

Wineman (1986) recommends environmental diversity in design of built environments in order to compensate for individual screening differences. The unprecedented scale of new information technologies in the workplace has created new demands on faci1ity design and management. Designers and facility managers are confronted with the possible and probable repercussions of new technologies regarding spatial arrangements (see Goumain, 1989). Technological change and growth has impacted environmental overload, (i e., too much information perceived in the environment), arousal state, adaptation, fatigue, and stress. Concern with health factors, such as stress, is so paramount. In addition to indoor air pollution, and asbestos (see GAO, 1986; OTA, 1985**.** Sundstrom (1985) reviews prevailing theories on psychological/ physiological processes and their potential limitations regarding adaptation. He emphasizes the need for long-term research on the impact of technology on adaptation. Baum, Singer, and Baum (1981) caution that cumulative instances of stress have deceptive consequences. Regular and prolonged exposure to stress may require far more adaptive responses over time than temporary exposure to stress. Current research on stress is examining two key areas: (1) psychological and physiological stress caused by uncomfortable living conditions; and (2) increased actual and perceived control that has the potential to increase satisfaction and help decrease stress (see Baum, Singer, and Baum, 1981).

3.8.5. CULTURAL VARIABILITY

Cross-cultural research exists that empirically examines behavioral mechanisms used to regulate privacy in built environments from developed countries. The cross-cultural research of Altman (1975, 1976, and 1977) and Altman and Chemers (1980) examines overt behaviors used to regu1ate privacy in tribal environments. Their research offers scientific documentation that may apply to built environment in developed countries, pending further research. The research examines cultures appearing to have maximum and minimum privacy levels in exploring the hypothesis of privacy regulation as a cultural universal. In all cases, overt behaviors are identified that enable people to regulate their interaction with others.

The dialectic nature of privacy regulation (open/closed, accessible/inaccessible) was supported. Their examination also substantiated the second aspect of their thesis, which is the existence of culturally specific behavioral mechanisms used to regulate privacy. Altman and Chemers(1980) point out that the theory of privacy regulation as a cultural universal is in its formulated stage. This is due to the many complexities and difficulties in making inferences from the secondary data examined.

3.9. SOCIAL MECHANISMS

The present research asserts that social mechanisms are social and policy supports governed by the cultural institution through accepted practices, mores, rules, and roles in a behavior setting. Built environments constitute the organizational climate within which privacy regulation takes place. They represent a cultural climate as spatio-cultural system. Social and policy supports regulate privacy through the structuring of activities in space and time (see Rapoport, 1976.) Becker (1981) posits that we experience the environment by altering the ways in which we structure such things as time and movement patterns, a process of organizing that occurs continually in all societies.

Salancik and Pfeffer (1978) argue that social context provides cues appropriate behavior and attitudes. Steele (1973) directs attention factors outside both the individual and the physical environment:

> *One of the often overlooked functions of settings in an organization is the provision of means for social control: the application and enforcement of policies and social norms on the members of the system, so that there is some predictability or patterns to what people will and will not do there. (p. 94)*

Social norms affect the way the user identifies, interprets, and uses the physical environment and social aspects of the physical environment (Justa and Golan, 1977).

3.9.1. FORMAL AND INFORMAL POLICY SUPPORTS

Formal policy supports are explicit rules that outline activities (including job responsibilities) considered to be appropriate and inappropriate by the organization. Steele (1986) identifies several policy support types:

1. Policies that regulate use restrictions on certain facility spaces (i e., who can reserve conference rooms, use corporate exercise spaces, etc.).

2. Policies that regulate personal workplace elements, depending upon the employee's organizational hierarchy (i.e. status demarcation reinforced by design elements including floorspace, degree of enclosure or accessibility, layout, size and quality of furnishings, and personalization).

3. Policies that regulate the degree of personalization of the workplace for individual employees as well as groups (reflecting the character of the organization, in addition to status demarcation).

Informal policy supports are implicit rules that influence activities considered to be appropriate and inappropriate by the organization. They define levels of environmental ambiguity and flexibility (Becker, 1981). Steele (cited in Becker, 1981) observes informal policy support in the work environment:

> *A middle-level manager 'decided that his desk had faced the door of this office for too long. It was time for change, so he turned it around to face a side wall. The next day he found a memo on his desk from the president's assistant saying that it had been found that the most effective way for managers to arrange their offices was with the desk facing the door so others would feel welcome. He was instructed to return his desk to its old position, with the firm implied threat of no longer being considered an effective office manager if he did not. He later discovered that there was only one exception to the desk -toward-door rule: the president's office. (p.49)*

3.9.2. SOCIAL SUPPORTS

Social supports are informal social norms that implicit1y cue what people should and should not do in a given environment setting. Steele (1986) illustrates spatial behavior norms along with norms referring to specific items or setups in a environment, such as whether or not an home door should remain open or closed while the occupant is there.

Spatial behavior norms in a setting implicitly cue behaviors such as how loudly or softly one should talk on the telephone or to people in the public place, *and* when it is acceptable and not acceptable to stop ,move, enter other private or semi private spaces.

3.9.3. SOCIAL AND POLICY SUPPORTS USED TO REGULATE PRIVACY

Empirical research examining social mechanisms used to regulate privacy in the built environment is minimal to nonexistant. The research of Justa and Golan (1977) provides the most detailed documentation to date on policy and social supports that facilitate and impede privacy regulation, in addition to environmental mechanisms.

Policy supports that Justa and Golan identified in the study include: a well-defined access policy; ability to exercise control (over thermal and aural environments); and individual choice of décor. Social supports they identify include: Consensus on meaning of enclosed place as occupant's territory; low noise and low density from others (e g., "accepted" conversational and density levels); and discretion on the part of others.

Justa and Golan conclude that privacy cannot be achieved exclusively through the manipulation of environmental mechanisms alone. This has important implications for privacy regulation in the environment. Attempting to solve privacy-related problems exclusively through design elements is not sufficient. The research of Sundstrom, Town, and Brown, et al. (1982) discussed earlier, corroborates this. In one study, for example clerical workers in walled offices reported less privacy than managers did in offices with equivalent exposure. The investigators assert that this is because different activities create different privacy needs. Additionally, social and policy supports may not have been adequate to accommodate the particular privacy needs for that type of activity. The present research proposes that perceived privacy needs are achieved through the combined interaction of environmental, and social mechanisms..as privacy regulating mechanisms.

3.9. 4. CULTURAL VARIABILITY

Cross-cultural research examining social mechanisms employed to regulate privacy in tribal environments exists. Patterson and Chiswick (1981) investigated social mechanisms that appear to regulate privacy in the Iban of Sarawak, Borneo. In addition to certain behaviors mechanisms (personal space and territoriality), Patterson and Chiswick identify social mechanisms: intra-family group privacy; individual control of social ties; modesty; intra-family separation ; norms of social interaction; separation of sex roles; and exclusion of strangers. The researchers conclude that social mechanisms facilitate privacy regulation where the physical environment limits privacy regulation.

Altman (1975, 1977) and Altman and Chemers (1980) provide further cross-cultural examination of mechanisms used to regulate privacy in tribal environments. These studies analyze existing ethnographic accounts of social relationships. Descriptive accounts of mechanisms used to regulate privacy include social mechanisms, but are generally classified as “cultural practices.”

3.10 INTERIM CONCLUSION

This chapter provides the theoretical grounding for the present project in light of current theory on privacy. Answering the research question, “What physical elements deployed or devised by designers do users perceive as regulating privacy?” entails testing important conceptual/theoretical notions still in their formulative stage. The holistic model of privacy regulation presented in this chapter guides the research for the present project. The model’s ultimate value is the further refinement of privacy regulation, conceptually and. It posits a comprehensive conceptual framework of privacy regulation and suggests a more detailed method for classifying mechanisms based on regulatory characteristics.

CHAPTER 4

4. THE INTERFACE BETWEEN TWO WORLDS: PRIVATE AND PUBLIC SPACES

4.1. CULTURE AND METHOD

The interface between private and public domain i.e. between the interior spaces of a building and its surrounding external world is essential for space syntax methodology. In non-Weston dwellings (the Libyan house) h interface between these two worlds is rather complicated and usually adheres to some form of social-cultural codes. The argument of this study is that, the interface between the house and its surrounding is a universal phenomenon yet has local dimensions, which affects and determines the spatial configuration of the interior as well as the external spaces. The aim of this research is to achieve the correct syntactic application and interpretation for the traditional settlement of Ghadames in context of the Libyan Muslim Arab culture.

4.2. BETWEEN TWO WORLDS

The interface between private (the house) and public (the street) domains can be expressed spatially or symbolically, depending on the specific cultural and social principles (Rapoport 1969; Hanson and Hiller 1982). One uncommon and interesting approach to understand the traditional design is and usage is by studying the boundaries, the thresholds and the transitional spaces that link them in different ways (Lawrence 1984:261).

The above scene highlights two main points of significance of the study. The first one is the relationship between the public territory and the private territory of the premises. There is a complete separation between the premises and the street in the form of high external walls. Yet, the street serves a social function. The second one is the transition from the public domain to the private domain. There is more than one entrance that leads to different spatial domains. Each is used by a particular category of users.

The opening scene reflects certain socio-spatial codes that define the relationship between, and the passage from, public to private domain. The intention here to define the correct syntactic interpretation for this local dimension.

Moreover, space syntax method has been accused of reflecting Western views, and consequently new algorithms have been developed to overcome the bias. In this study, syntax analysis is applied to traditional Libyan settlement as an example of non-western settlement and Arab Muslim culture. These cases or examples represent both dwelling units and settlement as whole.

The expression" *the interface between two worlds*" has been applied differently at different instances. It is used as the interface between public and private, between inside (the house) and outside (the street), between inhabitants and strangers world, but also between cultures of Western and Eastern worlds (here represented by the Arab region), some of these concepts are elaborated upon in the following paragraphs, so as to clarify their use throughout the text of this research.

4.3. THE PUBLIC AND PRIVATE DOMAINS

Generally, the terms public and private in relation to residential space and everyday life have sometimes been explained by relating the concepts of public to street and private to dwelling unit. The logic of this general conception is therefore that public space encompasses the political, labour, neighbourhood or/and community spheres, which dominated by strangers, while the private space is symblised by the domicile or the interior residential space, which is the domain of inhabitants. However, these simple parallel terms (public/strangers and private/inhabitants) are questioned by many scholars of twentieth century. They argue that the dimensions between public and private, or users division of settlement space, are becoming eroded due to a number of reasons. This argument is, more o less, valid for different cultures and different societies, as we will experience throughout this part.

The architectural debate of interface between public and private domains started when scholars became interested in studying man-built environments during the last four decades of the 20th century (Gehl 1977:8). Chermayeff and Alexander (1963) in the Community and Privacy highlight the importance of defining the relationship between (the house) and the public domain (the street). The authors discuss the necessity of "protecting" the house environment from the urban constraints (noise and traffic).

They state that there is a need for some sort of barrier between the two domains. They illustrate how architecture and urban design cold be employed to define physical boundaries between public and private domains. The authors discuss a hierarchy of spatial domains, ranging from public circulation space to the private interior of the dwelling. They propose, what is so called, an" anatomy of privacy" in which different domains are linked yet retain their own clarity and autonomy in some sort of locks and barriers. Latter, in 1977, Alexander discussed what he labels as an "intimacy gradient" which is also adopted in the hierarchical approach. Adopting the concept of "hierarchy of space ", Newman (1972) proposes" hierarchy of defensible space". Many architects and planners have adopted Chermayeff and Alexander proposals and principles.

However, Lawrence (1990:75) argues that the Chermayeff and Alexander work discuss and illustrate the spatial characteristics of thresholds and transitions; yet the study presents a purely spatial interpretation with no analysis of the meaning of different spaces, including transition domain. Hanson and Hillier (1982:6) also claim that principle of the hierarchy of spatial domains as paradigm for design fails to include socio-spatial analysis. They say that this scheme of ideas seems:

> *". To offer the architect clear and unambiguous solutions to challenge of housing design. Its only serious disadvantage is that it completely fails to*

account for the findings of ethnographic studies of domestic space organization; which suggest that space features in our society in surprising, and often unexpected, ways as a means of social and cultural identification".

In the same article (Domestic space organization', 1982) Hanson and Hillier support their argument by analyzing the social behavior of two different socio-economic groups. These two groups inhabited the same fundamental buildings during two consecutive periods. The study is based on empirical observation, but draws upon novels, research reports, and historical and sociological studies. The study shows how the relationship between buildings and street change with regard to the social behavior of each group. In case of the first inhabitants, for whom the house was first built and who were traditional working-class families, the house was usually concealed from the street by net curtains. The curtains always remained closed, although the front door was kept ajar and there was a slight control over the back door.

The interior of the house became a manifested body to the street. Special efforts would be made concerning designing of the interior of the room, and hence walking down the Street "*is like visiting an exhibition of interiors*". Thus, on one hand, a visual contact was retained between inhabitant and the pass-by. On other hand, the front door always was kept closed as a sign of controlling permeability, thus no

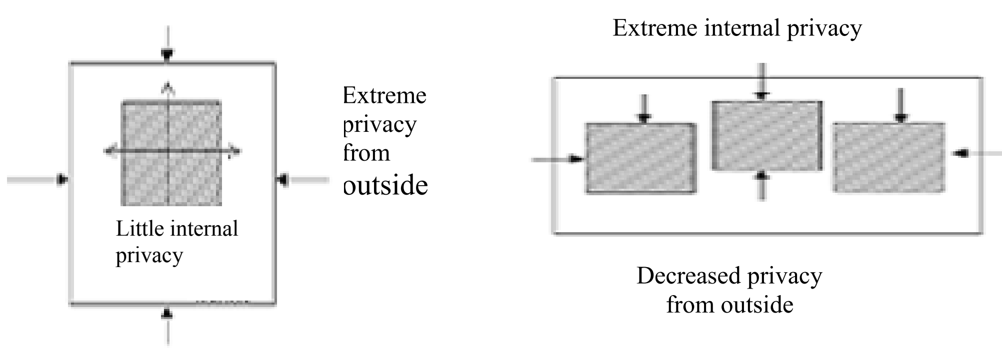


Fig (4.1) *Privacy realms in two different cultures, Japanese and Western(Anglo - American) From left to right after Rapoport(1969:68)* physical contact was allowed without permission.. Old people might be seen sitting in upright chairs on pavement. For the second group of the inhabitants, who were new Middle-class, the curtains were replaced by shutters or blinds. Hanson and Hillier write that" These will only shut late at night. Instead the interior of the room will be arranged so that the causal passer-by can look into the room". Instead of being concealed.

This relationship which links the life on the street and the domestic sphere is more than just spatial relationship. Rather it is based on socio-spatial principles, which are in some sense, the inverse of each other, and hence it cannot be constant for different users from different social backgrounds.

Moreover, Rapoport (1969:66-68) suggests that the spatial relation between house and the street can be seen as one form of desire for privacy, which differs from one culture to another. He discusses the separation of the two domains, public (the street) and the private (the house), for different cultures. He discussed Japanese, Indian and African attitudes towards the physical relationship between house and the street. For instance, he illustrates that the Japanese house turns a blank façade of high fence, he wrote" there is little concern with privacy and no worry if people can hear one another and the house can be seen right through" (68). He states that the separation between domains is one approach of defining privacy. He notes," although architects in our culture often refer to privacy as a basic need, it is really a complex and varied phenomenon" (68).

The topic of privacy has been of considerable interest to a wide variety of disciplines sociologist, political scientists and lawyers have focused on invasion of privacy. Philosophers have addressed ethical issues of privacy and architects have aimed to ensure privacy in their design. For most of these disciplines, according to Altman et al (1981:114)"it has been assumed that it is important, psychologically, for people to be able to avoid contact with others". The authors argue that this" traditional thinking" about privacy fits in with the hypothesizes underlying research on territoriality, personal space and crowding and contests with those implicit in social penetration theory (: 115).

They noted the philosophical debate and theory on privacy, personal space, territoriality, and crowding as one group, which emphasizes the virtues of interpersonal 'closed ness', while the social penetration theories emphasis 'openness' of people to another. However, the authors challenged the pure definition of each group as 'closed ness or' openness, i.e. as of each group as accessibility or inaccessibility to one other, which are both involved in social relationship. They, in referring to Altman (1975), state that there are times when people want to be alone and other times when they want to be heard and listened by others depending on different circumstances, Altman (1975:23).

> *"Thus, privacy is not solely a" keep out" or "let in" process; it involves a synthesis of being in contact with others and being out of contact with others. The desire for social interaction or noninteraction changes over time and with different circumstances. The idea of privacy as a dialectic process, therefore, means that there is a balancing of opposing forces-to be open and accessible to others and to be shut off or closed to others-and that the net strength of these competing forces changes over time."(After Altman et al 1981:115)*

The interpretation of privacy is very interesting, broad and complicated, yet it is necessary, particularly in relation to culture, to be understood by the designers to avoid failure in design and for the analyzer of the built environment to avoid misleading conclusions.

The above highlights the significant role of the social and cultural aspects and the meaning of privacy when discussing public and private. The following section aims to display certain concepts that are considered relevant to the relationship between house and the street i.e. boundary, barrier and territory.

In The Social Logic of Space, Hillier and Hanson (1984:143) state that the building interiors:"*are different in kind to settlement structure and not simply the same type of structure at a smaller scale"*. They suggest "*a traspatial system*". This system, they explain, “is a class of spatially independent but comparable entities which have global affiliations. Not by virtue of continuity and proximity, but by virtue of analogy and difference.”(:144). They argue that this attribute of the spatial relationship between the space interior and the “global” system lies in the very nature of a “boundary”.

Lawrence (1984, 1990) too considered the concept of a boundary essential for the study of the built environment and for the analysis of traditional space. Lawrence (1990:76-77) defines four kinds of boundaries, which can serve one or more purposes. First, physical barriers for communication of a visual or auditory kind, second, symbolic markers, often with a decorative or aesthetic value, expressing difference between domains; third, judicial borders defining the limits of legal possessions, and finally, administrative limits for the management and control of domains. He clarified those boundaries:

> *“. Have obvious spatial implications yet they do not inevitably have a dimension; the frontier between Swaziland and France, or the boundary between my house and that of my neighbor, can be defined by a line, whereas a fence serves only to occupy space than the boundary itself”(: 76).*

Moreover, he points that in the case of a symbolic boundary, accessibility and visibility between two domains is more dependent on social rules and conventions if we compare it to the case of a space enclosed by physical barriers. Hence, he argues, in the built environment study and in relation to boundary, it is necessary to examine how the behavior of different people is regulated by explicit norms and rules (e.g. in building regulations concerning the design and use of space) and implicit codes and conventions (e.g. in behavior protocols). He argued that the above four kinds of boundaries have” important implication for design and use of buildings, notably transition spaces and threshold”

Habra ken (1998:127-221) has observed the overlapping relationship between territorial and physical form. Territory might be expressed explicitly or might be understood implicitly, by building walls, making gates, and placing marker stones. Habraken (1998:126) states,

> *" Territorial control is ability to close a space and to restrict entry. It is perhaps the most instinctive way by which humans have learned to understand built environment."*

Habraken (1998:137-38) argues that the terms of privacy and public are relative, and the fact that 'private ness' and 'public ness' are not static conditions causes much confusion. He explains, "By observing a certain discipline in terminology, we can

avoid misunderstanding. Territory refers to a unit of spatial control. Private and public refer to space but not territory" (: 138).

He clarified that there is a clear difference between designation of space as private and the degree of privacy it provides. *"The first term is territorial, the second is not*". For instance, bedrooms without windows' curtains, or yards without a fence may afford privacy, but both are private, relative to the street. He defined the terms of private and public in relation to so called "Territorial Depth", which varies from one building or street to other. He defined territorial depth in this way:

> *" Territorial depth is measured by the number of boundary crossing needed to move from the outer space to the innermost territory." (: 137).*

These discussions highlight and Borden the significance and meaning of boundary and territory. When we think of the spatial interface between house and street. It helps us to think about the relation between territory and judicial border of the domestic building, between symbolic barrier and the implicitly understanding the territory.

The spatial transition zone between inhabited building (house) and the street, whether this zone is part of the private or public territory, is an interesting zone for the debate of the interface between house and street. The spaces within this zone, particularly in the case of Western domestic buildings, are defined as the front yards, porches, steps, and back yards; drive ways, sidewalks, alleys, and pedestrian pathways. Taylor and Brower (1985:183) explain that these spaces, which they define as exterior spaces adjoining the home:

> *" represent spaces where the two major types of setting in residential life-the private, personal, and owned versus the public, shared, and open to the community –interpenetrate. Consequently, these setting are of considerable interest for understanding the dialectic between individuals and local society."*

Many scholars find in the front yard, in particular, significant meaning and role for the built environment. Some of them had adopted field observation to investigate the use and meaning of this space.

4.4.TRANSITION ZONE: SEPARATING AND LINKING THE TWO DOMAINS

The interface between the private territories (the house) and public territories (the street) has been described, due to the existing or absence of transition zones, as either a soft interface or a hard interface (fig 4.1). According to Gehl, (1977:5) a soft interface is when a gradual transition between public and private territories is provided. The public 'street' blends into a 'semi-private' outdoor territory belonging to the house, the front yard. Here some sort of semi private area is induced. It is any space between the building and public part of the house and the street (e.g. the front yard, the garden etc.). A hard interface is defined as an abrupt confrontation between public and private. Here the relation is direct, without any semi-private buffer zone. The windows and the front door directly onto the street.

In the interface between public and private territories in the residential areas, Gehl(1977) has conducted empirical observations for a number of residential areas in Melbourne, Australia. The study highlights the use and meaning of the front yard. All along the study the author and his group attempt to investigate, explore and discuss the benefit of having such a soft interface. They prove that this area can be used for chatting, setting, watching, watering the garden, planting, gardening etc. The study argues that; such an area has many advantages where many activities can take place. It also provides chances for social interaction between the inhabitants and the neighbors and some sort of contact between inhabitants and the passers-by. They argue that by spending some time in this front yard, the inhabitants get opportunity to engage in various social activities, whether in a passive or active way.

The residents have the opportunity to greet their neighbors; exchange conversation while they are watering the garden, playing with their children collecting the mail, or just watching the world goes by. It is also provides opportunity to show some part of the inhabitants' personality (e.g. the way that they have planted and decorated this front passage etc. The study also claims that by having such a transition area, and so encouraging such activities and social interaction, the inhabitants will feel that this is *'their street* ', and hence the idea of the street as "*no man street*" will gradually disappear and hence thus limiting 'crime'.

Gehl states that there is a need for further empirical observation to study and compare, first, activity patterns in the streets in two cases of soft and hard interface. Empirical observation studying the activity patterns in houses which have private backyards, as well as semi-private front yards should also be conducted and compared to those houses which have only front yards. He writes,

> *"Studies involving a number of other factors which could be expected to influence the use of outdoor spaces, such as ethnic background, income level, traffic situation, local climate and orientation to the sun would also be useful contributions to the topic."*

Lawrence (1981) in his article" Connotation of transition spaces outside the dwelling" discusses the meaning and the use of the "space" outside the dwelling specifically the space in front of the house that is linked to the public domain, from sociological and psychological perspectives. His study investigates the ways in which residents of two different UK local authority house types have appropriated space in front of their dwellings. One of these house-types has "private" outdoor space as well as a backyard, while the other house-type, which also has a backyard, has no private outdoor space in the front. Here the houses are oriented to overlook a communal space, which has been landscaped by local authority.

The study was based upon observation of ways in which the residents had appropriated space outside the house in a physical sense. Interviews with the residents were also conducted in order to help understand what the residents felt about the space around their house. The study reveals that the space in the front of the house has an important symbolic value for the residents. The author sum-up that decision related to the liaison between the inside and the outside and between the front and the back of the dwelling unit, as well as the private gradient between the public and the private domains have both physical and symbolic connotations.

Thus to sum up, it is very clear that the spatial relation and the mediating space between house and the street is, more or less, well considered and appreciated by the inhabitants of non-Arab-Muslim culture. The discussion of the 'semi-private'zone, which is part of the private territory and which permits the visual connection between passer-by and the inhabitant, is an in significant issue. It is not typical, but is somehow found in the house in the Arab world.

4.5. ENTRANCES OPPORTUNITY FOR ENCOUNTER

An entrance is a space in which the physical connection between inside and outside of the building occurred. It is the 'passage room', which controls movement to, or from the house. It is a space where stranger, visitor and inhabitants are' identified' as users or passer-by. Hillier and Hanson (1984:19) state that

> *"The space outside the entrance constituted a potential interface between the inhabitant and the stranger; and the entrance was a means of converting a stranger into visitor".*

Pearson and Richards (1994:24) claim that entrances" serve to make transitions between domains such as inside/outside, sacred/profane, female/male, public/private, enemy/friend, elite/commoner or initiate/uninitiated." Lawrence (1981:203) also clarifies that many symbolic and physical customs are commonly associated with the passage between public and private domains. And before and after crossing the threshold. For example, the taking off hat or shoes or the putting on of a jacket are customs, which occur in the transition space. They also have physical and psychological meaning and interpretation.

Alexander et al (1977:625) suggest that when we pass from one domain to another, two" spaces" are involved. They are; first, the space found adjacent to the entrance door from inside the building territory or entrance room; and second space is the entrance transition or the space that is found adjacent to entrance door from outside the building.. The latter concerns access to inside of the buildings, while the former, focuses on the relationship between external spaces. In addition, Lawrence (1984) clarifies that these transition spaces between public and private domains can be considered as 'ambiguous zones' and that "such an interpretation enables both the spatial and the effective characteristics of dwelling to be understood".

Nevertheless, Rapoport (1969) examines the location of the" threshold' for three counties Fig (4.2). He showed that the location of the threshold changes in relation to the principle of private and public domains within different cultures. He locates the threshold in relation to the street, living domestic building and the juridical border (territory).

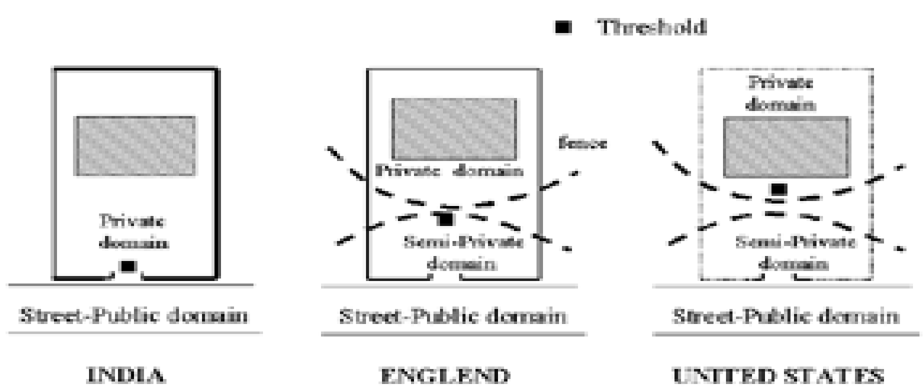


Fig (4.2) *Approximate location of threshold in three cultures, India, England and United States. (Rapoport 1969:80)*

Comparing these three models, the Indian model will be the closest model to a model of Arab culture, yet the threshold will be part of the public domain (street). Rather than the private domain as we will experience later.

The issue of the transition zones also covers the act of the entry or the crossing from domain to another, which embodies interesting customs and particular habits (Lawrence 1984:265). The three preceding sections show that the interface between public (street) and private (house) domains consists of different dimensions and involve interesting debates in the Western world. It will be interesting now to observe and compare some points of interest from the preceding discussions to the house and its exterior surrounding in Arab Muslim culture.

4.6. THE INTERFACE BETWEEN THE HOUSE AND ITS SURROUNDINGS IN THE ARAB-MUSLIM WORLD

The interface between the house and its surrounding in Arab-Muslim culture is complex and adheres to some form of restrict cultural codes. These codes determine a complete physical separation between the 'private' domestic life and the 'public' life in the street. This separation can be seen as means of acquiring privacy (khisosia), which is of paramount importance to the Muslim way of life. Guy T. Petherbridge (1987:195), who investigates the Muslim house and its society, clarifies,

> *"However closely the individual is associated with the life of his quarter, he also belongs to another unit: the family, the basic and irreducible unit of social life. The right and obligation of the family to live enclosed in its house has led to a clear separation between public and private life, perhaps the most significant social characteristic of Islamic culture".*

Privacy and the necessity of privacy has been generated by culture and regulated by religion. In one of the Prophet's sayings to the Muslim community, he warns, "He who looks into a house without the occupants' permission, and they puncture his eye, will have no right to demand a fine or ask for punishment" (after Hakim 1986:151).

The Prophet chides them to adhere to his warnings in order to help people to avoid misunderstanding and hence avoid contradiction and to guarantee privacy for the dweller. Most of laws regulating the built environment are based on the Prophet' command "Do not harm others or yourself, and others should not harm you or themselves" This harm has been interpreted as any intrusion into others' privacy. For instance, no one should open a window that exposes the domestic privacy of his neighbour. By law, the neighbour has the right to complain about this infringement harm and win. Another example, if someone builds a higher-storied house than his neighbour, thus blocking the wind flow for the latter, the neighbor has the right to complain (this harm) and win (Azab 1997:73-90).

The architectural interpretation of achieving visual privacy in the Arab Muslim region can be seen in the façade, the height of the external house-walls and the height of the external windows or openings, which are usually placed above eye level so the passer-by can not see inside the house. The intention is to conduct the everyday activities of the home without being observed and without fear of being observed by those outside the house (i.e. passers-by and neighbours), particularly, most of the domestic life that takes part in the open courtyard.

The necessity for privacy also extends to family domestic life from the visitors and the male visitors in particular. In this culture, the exposure of the female inhabitants to a male stranger is a very sensitive issue that varies in its sensitivity from one country to another.

In the Arab-Muslim house, particularly a traditional one, the design layout strengthens s the separation between the private domain and the public community domain. Or inside and outside the house by a complete physical barrier, which can be described as "a hard interface" (fig4.2). Here, the entry gate marks the house. In other wards, the territorial boundaries and the house's wall coincide. The design layout also confirms the separation between the domains where the daily domestic-life of the family takes place and that of the male- guests, the interior separation is determined from the entry gate (gates), One of the architectural solutions is by providing more than one entrance to the house in order to avoid the interaction between female members and male visitors.

4.7. "SOKAK OR FINA": TRANSITION ZONE

In the preceding section, I clarified that there is a complete physical separation between inside the house and the street, yet, the exterior space which is immediately adjacent to the walls of the house, is permitted for the temporary occupation of the male inhabitants. This space is defined, and known as *Fina*, which is a term used for open space. It is sometimes used to mean also courtyard. Here, it is used as a space on the street abutting a property that is used intensively and exclusively by the residents of the abutting properties, yet they do not have the right to sell or rent it.

Many scholars (Akbar 1998:107-110; Hakim 1986:27; Azab 1997:109) have written about this space. Hakim (1986:27) states that the width of fina is between one to one and halves matter width. While Akbar(1988:108) stated that there is no definitive answer in the legal system, but rather this has the potential of being answered by residing party.

Fina is one of the old architectural features of Muslim house and has been a part of it even before the Prophet's time. The Prophet orders the Muslim to behave in a particular way which gives the passer-by freedom of movement. The Prophet says;

> *"Avoid sitting on the thoroughfares"; they said it is difficult to avoid, as it is our gathering places where we spend time talking, "but if you insist then you should respect the right of the thoroughfares". What are the rights they asked, "Avoiding staring, do not create harm, salute back to those who forbid dishonor."?(Hakim 1986:147)*

Nowadays, It is still has the same use as in old times, particularly in the traditional environment. While in most of the modern newly planned areas, although it is still under the control of the owner of the house, it does not have the same use as it has in traditional areas. In the sense that the utilization of fina in most of the new planning and first class areas, is limited mainly to the parking of cars, and planting of trees.

4.8. SPACE SYNTAX: ITS ELEMENTARY THEORY AND METHOD

Space syntax, the analytical tool of this study, is a set of techniques for representation and quantification of spatial patterns of buildings. The main proposition of the theory is that social relations and events express themselves through spatial configuration. Configuration is the relationship between two spaces taking into account all other spaces in the complex (building or settlement).

Hillier and Hanson (1987:363) explain:" spatial configuration is thus a more complex idea than a pair of related spaces" The interface between the premises and its surroundings is essential for Space Syntax theory. In The social logic of space, and as prelude to the theory, Hillier and Hanson (1984:19) define the premises (building) as an elementary social-spatial element (cell), which consists of certain spatial elements that compound to certain social components. They explain that the cell, which normally contains several interrelated spaces, consists:

> *"..Of a boundary, a space within the boundary, an entrance, and a space outside the boundary defined by the entrance, all these spaces being part of a system which was placed in a large space of some kind which 'carried' it. All these elements seemed to have some kind of sociological reference: the space within the boundary establish a category associated with some kind of inhabitant; the boundary formed a control on that category, and maintained its discreteness as a category; the world outside the system was the domain of potential strangers, in contradistinction to the domain of inhabitants; the space outside the entrance constituted a potential interface between the inhabitants and the stranger: and the entrance was a means not only of establishing the identity of the inhabitant, but also a means of converting a stranger into a visitor."*

They argue that a building or premises is a domain of unitary control which is being expressed through two properties:" a continuous outer boundary, such that all parts of the external world are subject to some form of control; and continuous internal permeability, such that every part of the building is accessible to every other part without going outside the boundary" (: 147). Hillier and Hanson here make it clear that the relation should be within the sphere of inhabitant-visitors whether there is visual contact with the stranger in the street or not.

The analytical method is based on the transformation of floor plans into graphs and of the quantification of the relation properties of spatial nodes using mathematical formula. The method offers a simple objective procedure for describing, comparing and interpretation building patterns. The step towards quantification is achieved considering the space patterns a two-dimensional structure. This structure is then represented as a graph that can be organized as a justified graph.

The justified graph is a graph in which all the spaces in the complex are aligned above certain spaces (the root) in levels according to how many spaces one must pass through to arrive at each space from the root. The room is normally a space outside the cell, which normally stand for a building containing several rooms, and it is defined as the ’carrier of the system’ from the justified graph we obtain two configurational properties of spatial layouts. Two of which seem most important in articulating cultural ideas and social relations (Hillier et al 1987:364).

These properties are depth and ringness, which is choice that is the existence of alternative routes. Depth indicates how many steps one must pass through to arrive at certain space from any other space in the complex. We say that a space is at depth 1 from another space if directly accessible to it, at depth 2 if it is necessary to pass through one intervening space. From the depth (relative depth) we are able to calculate integration value for each space in the complex by using a special formula.

The justified graph represents the permeability of the system, whereas integration value extends these descriptions by expressing how the graph looks quantitatively” (Orhun, Hillier et al 1994). Other syntactic values are connectivity, control and ringness.

Since space syntax is based on the concept that social relations and events express themselves through spatial configuration, it will be interesting and fundamental to see if it is possible to interpret, syntactically, the socio-spatial codes of the interface between inside and outside concerning the traditional settlement of Ghadames in Libya. My ambition here is to develop an adequate quantitative analysis in observing the relationship between privacy as cultural specific and the spatial configuration of the settlement under study. I will test if space syntax techniques are relevant to traditional settlement in the Arab culture, hereby avoiding contradiction and misleading results when interpreting syntactically the underlying spatial structure of the whole settlement

4.9. INTERIM CONCLUSION

We find the relationship between the house in the Arab culture and street is generally manifested in a hard and sharp interface. The interface between communal (public) and private domains contains and embeds manifolds and deeply interesting nuances, which have been discussed and evoked by scholars. It brings to light many, implicit and explicit, social-spatial elements. This interface plays a vital role in configuration of the urban spaces into different domains and separates them.

From discussion throughout this chapter, it is very clear that the interface between communal and private domains as mediated by socio-cultural variations plays a crucial role in determining the spatial configurations and their effect on spatial interaction and on regulating the desired degree of privacy. These socio-cultural variations regulate privacy through accepted practices, mores, rules, and roles in behaviour setting.

They include also norms of social interaction, segregation of sex roles and exclusion of strangers. However, these socio-cultural mechanisms facilitate privacy regulation where the physical environment limits privacy regulation.

CHAPTER 5

5. THEORY OF SPACE SYNTAX AND VISIBLITY STUDIES

5.1. INTRODUCTION

Over the past two decades, space syntax has been proposed as a new computational language to describe spatial patterns of modern cities (Hillier and Hanson 1984, Hillier 1996). The notion of syntax, derived from linguistics, refers to relationships between different spaces, or interactions between space and society. These principles support the belief that spatial layout or structure has great impact on human social activities. From its origin in urban research, space syntax proposes a language of space that is of interest for many research and application areas involved in the description and analysis of spatial patterns in the city. Through the structural analysis of an urban environment, urban planners can derive a better understanding of the evolution of urban areas, and gain more insights to help with the design of new urban layouts. Using space syntax principles, human displacement patterns in the city can be analyzed, mainly by considering the degree to which urban spaces are integrated and connected.

Typical applications of space syntax include pedestrian modeling, criminal mapping, way-finding processes in complex built environments (Peponis et al. 1990, Hillier 1996, Jiang 1999) and other hidden socio-spatial dimensions in built environment. All these investigations tend to be based on the assumption that spatial patterns, or structures, have a great impact on human activities and behaviors in urban environments. Many empirical studies have demonstrated the importance of space syntax for the modeling and understanding of urban patterns and structures (Hillier 1997, Holanda 1999). These extend the conventional geographical frame of reference to large- and small-scale spaces. Large-scale space is beyond human perception and cannot be perceived from a single vantage point; while small-scale space is presumably larger than the human body, but can be perceived from a single vantage point. In a related work we illustrated how the concepts of large and small-scale spaces provide some modelling fundamentals for space syntax principles (Jiang et al. 2000). A large-scale urban space can be partitioned into a finite number of small-scale spaces. Using such a partition, the degree to which small-scales are interconnected or integrated can be analyzed.

5.2. LARGE-SCALE VERSUS SMALL-SCALE SPACE VIEW

From the point of view of cognitive perception, space can be considered at two scales, i.e., either large or small scale (Montello, 1993; Egenhofer & Mark, 1995). Large-scale space is beyond human perception and cannot be perceived from a single vantage point; while small-scale space is presumably larger than the human body, but can be perceived from a single vantage point. The perception of small-scale spaces while moving through a large-scale space provides a prerequisite for the perception of large-scale environment (in general, the geographic space). As human beings, we perceive a small-scale space throughout interacting objects that constitute the structure of the physical environment and the empty space that support its perception. For instance, a room may contain some furniture, such as a table and chair, but one can perceive the room's structure without any difficulty. Small-scale spaces are continuous (not discrete) and interconnected. For example, when we are walking along a street, at every moment we perceive our surrounding environment as a small-scale space.

Small-scale space perception is very important for reasoning in large-scale spaces. Downs & Stea (1977) assumed that "larger units must be built upon smaller units, that an 'atom' of experience must generate 'molecules' and so on". They further assumed that the cognition of small-scale spaces must inevitably precede the cognition of large-scale spaces. For instance, a child must fully comprehend his room before he can understand the surroundings of his house, and this spatial understanding must come before an understanding of his village, and so on. A similar assertion has been made based on empirical studies that judgment of whole spaces might be predicted from averaged judgments of their parts (Garling, 1969). When a tourist recalls a visit to a place, he/she will most likely present a sort of sketch map, something like a plan that includes, for example, his home and sights visited, which are all inter-connected in space and time. As such, a large-scale space can be represented as an infinite number of inter-connected small-scale spaces. Such a dynamic cognitive representation may be interpreted as a navigation-learning process in large-scale space. This cognitive environment offers scope for the application of space syntax to navigation knowledge representation.

These concepts and observations provide valuable insights into the space syntax model being elaborated in this chapter, *i.e. that* of a large-scale space being modeled as a set of individual small-scale spaces. The computational space syntax model that integrates the small-scale space perspective is based on a two-step approach.

The first step is the representation of the large-scale space as a finite number of small-scale spaces. The second step is to link these individual small-scale spaces to form a connectivity graph. For instance, Figure (5.6) shows various closed building plans, and their related connectivity graphs, with each room or corridor represented as a small-scale space.

A connectivity graph supports the computation of important spatial properties, e.g., how each node links to its immediate neighbours, and how each node links to every other node. Answers to these questions help us in understanding a large-scale space (here a building) from the perception of its small-scale spaces. In fact urban morphology, as applied through the theories and tools of space syntax, provides a computational representation of an urban space in which a graph decomposition of the so-called free space - the space within which human beings are able to move from one place to another in the city (a cognitive model of space in one sense) - gives a set of parameters that allows scientists to understand the basic functions and properties of an urban structure.

5.3. PRELIMINARY DEFINITIONS

5.3.1. DEFINITIONS

In order to help the reader to refer back as frequently as may be necessary, a number of analytical and technical ideas used in the section are defined here.

The *axial map* is the basis of settlement layout analysis. This represents the distance up to which observers can have an uninterrupted impression of visibility and permeability as they move about the town and-look in various directions. The map is derived by drawing the fewest and the longest lines of uninterrupted permeability necessary to cover the public open space of an area. When reference is made to particular 'spaces' I in fact mean 'linear spaces' or simply the lines on the map. The size of a settlement system is measured in terms of the number of lines.

The *convex map* of a settlement is the set of widest spaces that covers the open space structure of that settlement. It is a map of the open space broken up into the widest possible convex spaces. The convex spaces may be as long as the axial spaces of the system. If the system is regular, as in long straight roads, many axial lines may pass through a series of convex spaces. From these maps it is easy to see that urban space structures differ from one another according to the degree of axial and convex -extensions of their parts and according to-the relation between-these two forms of extension (Hillier and Hanson, 1984). Systems of axial and convex space can be discussed in terms of their internal configurations, in relation to each other, in relation to buildings that define the system, and in relation to the world outside the system.

5.3.2 THE ANALYSIS OF SETTLEMENT LAYOUTS

The postulates for applying syntactic analysis for a settlement are as follows:

(a) Every settlement, or part of a settlement, that we might select for study is made up of at least: A grouping of primary cells or buildings (houses, shops, and other such repeated elements), which we will call X; a surrounding space which is outside and not part of the settlement, whether this is inbuilt countryside or simply the surrounding parts of a town or city. Whatever this is, it will be treated as a single entity, the carrier of the system of interest, and referred to as Y; possibly some secondary boundaries (gardens, estate boundaries, courtyard boundaries, and so on) superimposed on some or all of the buildings, and intervening between those buildings and the unbounded space of the settlement. These secondary boundaries will be known collectively as x; a continuous system of open space defined by X or x, whose form and structure results only from the arrangement of those X or x. This open space structure will be known as y. Any configuration of, say streets and squares, would therefore be known simply as y; every settlement constructs an interface between the closed and open parts of the system; whether this is an X-y interface or an x-y interface (an X-Y interface being a fully dispersed set of buildings, and an x-Y interface, a fully dispersed set of secondary boundaries);

(b) Every settlement can therefore be seen as a sequence with all, or most of X-x-y-Y. This sequence can be seen as a 'bi-polar' system, with one pole (the most local) represented by X, and the other (the most global) by Y. The X-pole consists of many entities, all the buildings of the settlement, whereas the Y-pole can be treated for our purposes as a single undifferentiated entity, insofar as it represents the world outside the system of interest that contains or carries the system. The interface therefore comprises all the structure interposed between X and Y;

(c) The two poles of the system correspond to a fundamental sociological distinction between the two types of person who may use the system: X is the domain of the inhabitants of the settlement, whereas Y is the domain of strangers (those who may appear in the system from outside). The interface is therefore an interface for two types of relation: relations among the inhabitants of the system and relations between inhabitants and strangers. Every settlement form is influenced by both types of relation; and every kind of syntactic analysis can, and needs to be, made from both points of view. It would not be an exaggeration to say that the syntactic theory of spatial analysis depends on comparing these two points of view.

(d) The y-space of the settlement, the structure of public open space, needs to be considered not only from these two points of view, but also in the two ways mentioned ' earlier; that is, in terms of its axiality and its convexity, considered both separately and in relation to each other. Insofar as axiality refers to the maximum global extension of the system of spaces unified linearly, whereas convexity refers to the maximum local extension of the system of spaces unified two-dimensionally, the sociological referents of axiality and convexity follow naturally. Axiality refers to the global organization of the system. and therefore its organization with respect to Y, or in other words to movement into and through the system; whereas convexity refers more to the local organization of the system, and therefore to its organization with respect to X or, to put it another way, to its organization from the point of view of those who are already statically present in the system;

(e) Every convex or axial space in the system will have a certain description; that is, a certain set of syntactic relations to X, x, y and Y, which may be described and quantified in terms of its degree of symmetry-asymmetry, and distributedness-nondistributedness. These values indicate the degree of unitary or diffused control of that space; that is, the extent to which it participates in a system of ringy routes, and the degree of integration or segregation of that space with respect to the whole system, i.e. the extent to which a space renders the rest of the settlement shallow and immediately accessible.

(f) Each convex or axial space will have a certain synchrony; that is, the investment of a certain quantity of axial or convex space in that description. An increase in the quantity of space, making an axial line more extended linearly or a convex space significantly fatter, will always increase the emphasis given to that description. On the other hand, a large quantity of space invested in a market place with one kind of description will not be the same as a similar quantity of space invested in a parade ground, since the latter will have a different form of syntactic description. In general, a small quantity of space will be sufficient to constitute a description, a quantity of space will sufficient to constitute a description, whereas a large quantity of space will increasingly represent that description; that is, it will lend it symbolic emphasis;

(g) The more descriptions are symmetric (Always with respect to X and Y] then the more there will be a tendency to the integration 0/ social categories (such as the categories of inhabitant and stranger), while conversely the more they are asymmetric then the more there will be a tendency to the segregation of social categories; while the more descriptions are distributed (again with respect to X and Y), then the more there will be a tendency towards the diffusion of spatial control, while nondistributedness will indicate a tendency towards a unitary, super ordinate control;

(h) Finally, these descriptions of space can be related both to the everyday buildings that make up the system and to the various kinds of public building that may be located within the urban fabric. For example, the global organization of the system may be constituted throughout by the everyday buildings, with public buildings either hidden from the main axial system or related in the same way as the everyday buildings; or, at the other extreme, the everyday buildings may be removed from the global axial system, leaving it constituted only by the main public buildings.

5.4 A PROCEDURE FOR ANALYSIS

Within this framework, the analytic procedure can be set out by working through an example. In order to begin alpha-analysis accurate maps are required - the best are about the scale 1:1250, although the procedure has worked successfully on maps up to the scale 1:10,000 - preferably with all entrances to buildings marked. Without precise knowledge of the location of entrances, some but not all of the key syntactic properties can be analyzed. The example we will be working through is the small part of Ghadames, reproduced in Figure 5.3. The support of a photographic record is also helpful, but none of the following analytic procedures depend on such a record.

All can be carried out on the basis of the map alone. However, Some basic concepts related to axiality and convexity and its measures have to be explained before.

5.4.1. MEASURES OF CONVEXITY

Convex articulation can be measured by dividing the number of convex spaces by the number of buildings and the degree of *convex deformation* of the grid can be measured by dividing the number of convex spaces by the number of islands (defining an island as a block of continuously connected buildings completely surrounded by an open space). If *I* and *C* are the number of islands (or rings) and convex spaces, respectively, then the *grid convexity* (G^{convex}) of the system is given by:

$$G^{convex} = \frac{I}{C} \left(\sqrt{I} + I \right)^2 \qquad \textbf{(1)}$$

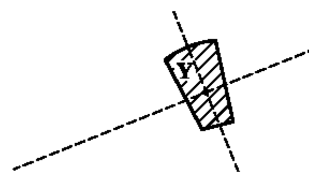


Fig (5.1) The point Y seen convexity and axiality

With the help of this formula it is possible to make a comparison of a convex map with an orthogonal grid in which convex spaces extend across the system in one direction, and in the other direction fit ladder fashion into the intersect ices. Since any point in space is part of two components, one direction (axaility) and two dimensions (convexity). (Fig5.1)

5.4.2 MEASURE OF AXIALITY

The degree of axial articulation can be measured by dividing the number of axial lines by the number of buildings. The degree of axial integration of convex spaces can be measured by dividing the number of axial lines with convex spaces. The grid axiality (G^{axial}) gives a measure of the comparison of an orthogonal grid with the number of islands.

$$G^{axial} = \frac{2}{L}\left(\sqrt{I}+1\right) \qquad \textbf{(2)}$$

Where L is the number of axial lines.

The ringiness of convex spaces(R^{axial}) is the number of the rings in the system as a proportion of the maximum possible planar rings for that number of spaces:

$$R^{convex} = \frac{I}{2C-5} \qquad \textbf{(3)}$$

The ringiness of the axial map(R^{axial}) is given by:

$$R^{axial} = \frac{I}{2L-5} \qquad \textbf{(4)}$$

As the axial map is nonplannar, this value will be higher than the convex value. From the relation between convexity and axiality in a space, we obtain two kinds of information about the space: through the convex organization we are given complete local information about the space we are in; and through the axial organization we are given partial global information about the spaces we might go to. In urban space, we are in effect given information about two scales at once.

The central concept of space syntax is integration. The technique allows one express integration in numerical values. As is the case with many other spatial structure, these values are dependent upon the size of the urban area.

The integration of space is a function of the mean number of lines and changes of direction that need to be taken to go from that space to all other spaces in the settlement system. Integration is therefore about syntactic not metric accessibility, and the word 'depth' rather than 'distance' is used to describe how far a space lies.

Every-line in a settlement layout has a certain depth from every other line. The integration value of a line is a mathematical way of expressing the depth of that line from all other lines in the system. These values will differ significantly from one line to the next but it is one of the most significant properties of architectural and urban spatial configurations. The integration of a system as a whole is indexed by real relative asymmetry (RRA) value—an expression used to indicate a complex mathematical index of depth—of all its lines. Smaller RRA values indicate greater integration. This value can be adjusted to eliminate the effect of size, giving a figure, which varies by one, with low values indicating shallow or integrated systems and higher values for deep or segregated systems. It is assumed that the distribution of integration across an urban area correlates with the movement pattern of an area. Urban areas can be distinguished by and compared in terms of different levels of integration. Integration is used as a measure of quality for urban areas. By calculating integrated and segregated parts of a settlement. It is also possible to know whether a new design proposal fits into the existing structure of an area. In this section, the integration values are used only to get information about the physical structure of the built space. The correlation between syntactic properties and pedestrian movement is not calculated.

Fig (5.2) a *: Convex space :no line drawn between any two points in the space goes outside the space,* ***b****: Concave space : a line drawn from A to B goes outside the space.*

The syntactic intelligibility of an urban system is defined as the degree of correlation between the connectivity and integration values of each line in the system. The term intelligibility is used because the stronger the correlation," the rosier it is to infer the global position of a space from its directly observable local connections (Hillier et 1983). This makes it possible to capture the way people can learn about large patterns from their experience of small parts or fail to do so when the correlation weak. Typical urban areas or towns will tend to have an intelligibility correlation of about 0.45 whereas unintelligible systems will have values of 0.2 or even less, where a value of 1 is strong and 0 is random.

5.5. SPACE REPRESENTATION IN SPACE SYNTAX: PRINCIPLES AND POTENTIAL

5.5.1. AXIAL LINE-BASED SPACE SYNTAX: PRINCIPLES

The initial idea of space syntax comes from an attempt to understand evolution and flows within the city: evolution by analyzing the way a built environment has developed as it has, flows by studying some social activities such as people displacements in the city. The axial line-based representation of an urban structure is the earliest approach of the space syntax (Hillier and Hanson 1984). Axial lines are used to represent directions of uninterrupted movement and visibility, so they represent the longest visibility lines in two-dimensional urban spaces.

Over the past two decades, this approach has been widely applied to solving various problems in urban systems such as prediction of pedestrian and vehicle flows, crime analysis and human way-finding process (of. Peponis *et al.* 1990, Hillier 1997, Holanda 1999). A set of axial lines, that mutually intersect and cover a whole free space, is called an axial map. According to Hillier's initial definition, an axial map constitutes the least number of longest axial lines (Hillier and Hanson 1984). We herewith briefly describe the axial line-based space syntax approach, and analyze the potential and limitations of axial lines technique. From the point of view of human spatial perception, we consider that an axial line is a vista space that is small enough to be perceived from a single vantage point of view (Jiang et al. 2000).

Through the representation of a large urban environment by a finite number of vista spaces, and how each vista space is connected or integrated to others, the spatial structure of the urban environment is analyzed. The derivation of an axial map for an urban space mainly relies on prior definition of a convex partition of free space. The "convex map" is said to consist of the least number of largest possible convex spaces needed to cover the entire area (Hillier and Hanson 1984). Thus the derivation is based on human judgment whose formalization is not a straightforward task.

The algorithm used can be described as follows: starting from the identification of the longest axial line, actually the longest visibility line, and then the second longest axial line and so on until the whole free space is covered by the intersected axial lines. To illustrate the main principles of this approach, Figure 5.3b represents a fictional urban system. The derivation of its axial map starts from line 11 then 17 then 23 then 16, and finally the resulting axial map consists of 27 axial lines as shown in Figure 5.3b. It should be noted that the example illustrated is a relatively simple one in which free spaces, i.e. streets, stretch linearly.

In terms of how each line intersects other lines, various morphological parameters can be derived for the analysis of an urban structure. These parameters include the *connectivity, control value, local* and *global integration.* The *Connectivity* of an axial line measures the number of lines that directly intersect that given axial line. It also denotes the number of immediate neighborhoods of an axial line. The *control value* of an axial line is given by the sum of the inverse *connectivity* values of the immediate neighborhoods of this axial line. Literately the *control value* shows the degree to which each axial line "controls" its immediate neighborhoods. In order to introduce the notion of integration, let us first define the notion of *depth.* The *depth* of an axial line is defined by me number of lines distant from a given number of steps to that axial, line. While connectivity considers immediate neighbors, depth considers k neighborhoods.

In order to introduce the calculation principles of *depth* and *connectivity,* let us assume some variables in the connectivity graph (Figure5.3c). The connectivity graph is the dual graph of an axial map, and it is derived by representing axial lines and line intersections from an axial map as nodes and links, respectively (Figure 5.l). For any particular node in the connectivity graph, the shortest distance (or steps) far from the node is denoted by *s (s* is an integer), the number of nodes with the shortest distance *s* is denoted by N_s, the maximum shortest distance is denoted by *I*. Using the expression, $\sum_{s-1}^{m} s \times N_s$ space syntax parameters are calculated as follows:

$$\sum_{s=1}^{m} s \times N_s = \begin{cases} Connectivity \quad iff \quad m = 1 \\ Local\ depth \quad iff \quad m = k \\ global\ depth \quad iff \quad m = I \end{cases} \qquad \textbf{(5)}$$

Where $1 < k < I$, usually we adopt three steps for the calculation of *local depth,* i.e. k is equal to 3 (this means that we consider those lines within three steps from an axial line). We can also note that *connectivity* is equivalent to *local depth* if k = 1. Let us take the example of the axial line identified as number eleven (equivalent to node eleven in the dual graph) in Fig 5.3d. This line intersects nine lines, s; the connectivity of the axial line eleven is 9. The immediate neighborhood of line eleven are lines 6, 7, 8, 12, 13, 14, 15,17 and 22, their respective *connectivity* values are 3, 4, 2, 2, 2, 1, 2,4 and 4. So the *control value can be measured according to expression:*

$$ctrl_i = \sum_{j-1}^{k} \frac{1}{C_j} \qquad \textbf{(6)}$$

Therefore, the control value of the axial line eleven is equal to $\frac{1}{3}+\frac{1}{4}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+1+\frac{1}{2}+\frac{1}{4}+\frac{1}{4}$. Overall this axial line number eleven has nine neighborhoods one step away, six neighborhoods two steps away, nine of neighborhoods three steps away, two neighbors four steps away (herein the concept Steps are equivalent to that of shortest distances). So *global depth* is equal to $9 \times 1 + 6 \times 2 + 9 \times 3 + 2 \times 4$ if $m = 4$. If $m = 3$, then local depth with three steps away is equal to $9 \times 1 + 6 \times 2 + 9 \times 3$.

Another notion related to local and global integration is the basic properties of symmetry and asymmetry. Mathematically, the relationship of two nodes *a* and *b* are said to be symmetric if the relationship of *a* to *b* is the same as the relation of *b* to *a.* For example, the relation of a and b to c in Figure 5.4a is symmetric. In contrast, the a to b with respect to c is not the same as the relation of b to a, and from a one must pass through b to c, but not vice versa.

$$RA_i = \frac{2(MD-1)}{(n-2)} \quad \text{And} \quad RRA_i = \frac{RA_i}{D_n} \tag{7}$$

Where n is the number of axial lines of an urban system. The value RA_i is then relativized by dividing by the RA_i of the" diamond shaped" graph with the same number of vertices (axial lines) in which the vertices are ordered so that there are m(>1) vertices whose distance from the root space is the mean depth of the system , m/2 vertices at the distance minus1, and so on (Figure5.5), Integration is a reciprocal of this value, which is given by the formula:

$$Integration = \frac{D_n}{RA} \quad \begin{cases} global\ (Rn) = \dfrac{D_n}{RA} \\ Local\ (R3) = \dfrac{D_3}{RA} \end{cases} \tag{8}$$

Where Rn is global integration and calculated based on unrestricted radius (from all spaces to all others within the system), and $R3$ is considered as local Integration calculated based on radius 3(three steps of depth away from all spaces) this radius could be 4,5,6…to n depending on local and global correlation and the purpose wanted.

$$D_n = \frac{2\{n(\log_2((n+2)/3)-1)+1\}}{(n-1)(n-2)} \tag{9}$$

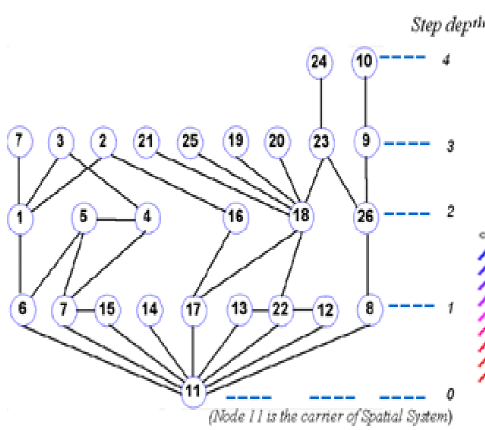
And this D-value gives the standardized value for the integration value from mean depth (MD) (Kruger 1989). The mean depth is given by the global depth (see Equation 1) divided by n — 1. In the following case study as well as in space syntax procedures is a reciprocal function of RRA. This relationship means that the bigger the integration value the more integrated the axial line is.

Table (5.1) *Syntactic measures of the area*

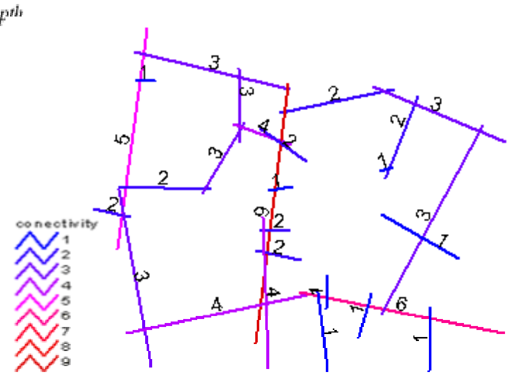
Index	Connectivity	Control	Integration	Total_Depth	Three_Depth	Integration_3
1	5	2.66667	1.22300	77.00	13.00	2.75009
2	2	0.53333	0.94505	92.00	10.00	1.27373
3	2	0.53333	0.89105	96.00	14.00	1.47842
4	3	1.08333	1.00602	88.00	11.00	1.72399
5	3	0.91667	1.00602	88.00	11.00	1.72399
6	3	0.64444	1.45054	69.00	29.00	2.25163
7	4	1.27778	1.29944	74.00	20.00	2.27320
8	2	0.44444	1.38607	71.00	22.00	1.81856
9	2	1.33333	0.83164	101.00	6.00	1.05603
10	1	0.50000	0.62373	126.00	3.00	0.21093
11	9	4.08333	2.07911	56.00	21.00	4.39336
12	2	0.36111	1.15506	80.00	16.00	1.57148
13	2	0.36111	1.15506	80.00	16.00	1.57148
14	1	0.11111	1.13406	81.00	17.00	1.37505
15	2	0.36111	1.22300	77.00	20.00	1.74102
16	3	0.95000	1.32709	73.00	15.00	1.83339
17	4	0.86111	1.89010	59.00	32.00	2.52434
18	6	4.58333	1.55933	66.00	16.00	3.13384
19	1	0.16667	0.95959	91.00	11.00	1.01899
20	1	0.16667	0.95959	91.00	11.00	1.01899
21	1	0.16667	0.95959	91.00	11.00	1.01899
22	4	1.36111	1.45054	69.00	18.00	2.23846
23	3	1.50000	1.13406	81.00	17.00	1.89681
24	1	0.33333	0.77966	106.00	5.00	0.50003
25	1	0.16667	0.95959	91.00	11.00	1.01899
26	3	1.33333	1.19948	78.00	11.00	1.72399
27	1	0.20000	0.82070	102.00	9.00	0.87259

(a) *Open and Closed spaces*

(b) *Axial map of the area*



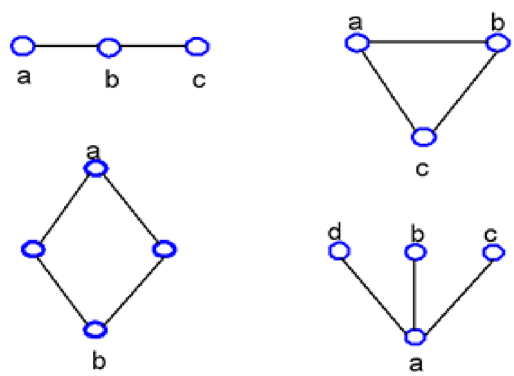
(c) *Justified graph of the spaces*



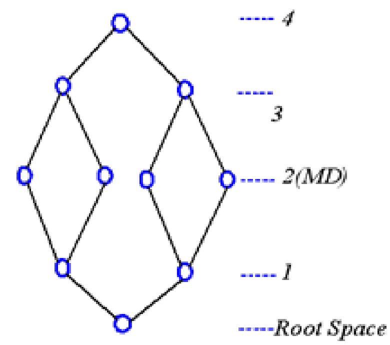
(d) *Connectivity of the spatial*

Fig (5.3) *Part of Ghadames walled city as system of spaces*

Depending on the *depth* used, that is, local versus global, the matching *integration* value is called *local* versus *global integration. Local integration* considers both immediate and non-immediate neighborhoods: that is, lines that intersect each immediate neighborhood and so on recursively up to a few steps away. *Global integration* considers both immediate and non-immediate neighborhoods up to *k* (all) steps away. Both connectivity *(*or *control value) and local integration* are local parameters, as they only consider immediate neighboring lines or lines within a few steps. In contrast, global integration considers all axial lines and



Fig(5.4) *Relational symmetry and asymmetry (Hillier and Hanson,1984)*



Fig(5.5) *Diamond Shape Graph for normalizing MD of Different graph sizes (Ayse Kubat,2004)*

is a global parameter. From the principles of the space syntax approach presented above, we can remark that the complexity of the derivation of an axial map is high from a computational point of view.

This is because, according to the sequential rule of deriving and drawing the axial lines, the derivation starts from the identification of the longest axial line, and then the second longest axial 'line, and so forth. Overall, the anal map provides the least number of axial lines. Based on human judgment, it seems possible to compare the axial map of an urban system, but the process is very time consuming for a large city Furthermore, no one can guarantee that axial maps created at different times are precisely consistent, not to mention maps created by different people. The requirement that an axial map consists of the least number of axial lines is hard to satisfy. In other words, there is no way to ensure that the axial maps created are made of the least number of axial lines.

On the other hand, a valid application of the space syntax approach has to be based on an axial map effectively composed of the least number of lines. Otherwise, the analysis is less meaningful, because the overall number of lines will not be representative of the urban structure. So far the derivation of an axial map still relies on human judgment to draw individual lines, so no automatic solution has been identified, particularly for large cities, within the space syntax research community (cf. Peponis et al. 1998).

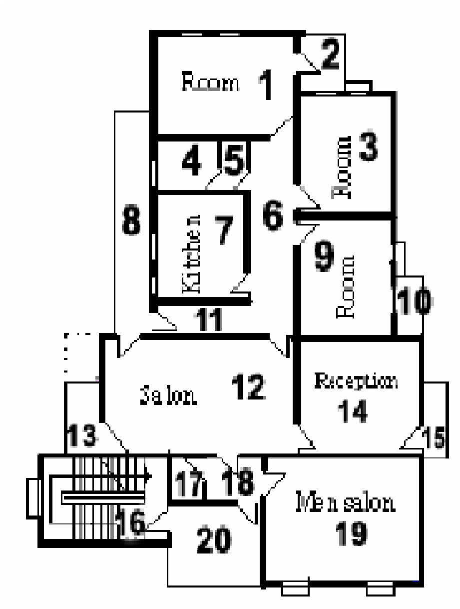
5.5.2. SPATIAL DECOMPOSITION AND REPRESENTATION:

An urban environment consists of two parts: spatial obstacles such as buildings, and free space within which human beings are able to move from place to place. The notion of free space, defined as the parts of an urban space available for movement of people (thus excluding by definition physical obstacles) is particularly important for space syntax approach. Space syntax focuses on free space and decomposes an entire area of free space into small pieces of space, each of which can be perceived from a single vantage point. As such, this representation constitutes the cognitive fundamental modeling reference of the space syntax approach. In other words, a visual distinction between different forms of the perceived space (free space versus physical obstacles). These modeling concepts differ from those generally used in modeling: *i.e., object*- versus field-oriented paradigms, since the concept of free space is not represented as such by these models.

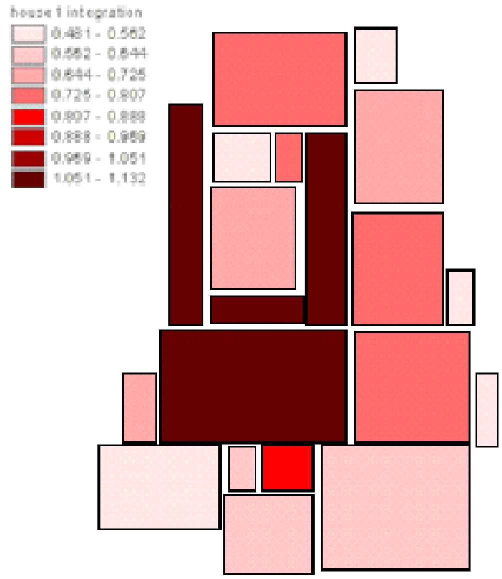
Several space syntax representations can be applied, depending on the degree of linearity of the free space. *The first* space-syntax representation is oriented toward environments, which are relatively linear. This linear property represents the fact that the built environment is relatively dense, so that the free space is stretched in one orientation at most points. Common examples of this type of urban environment are a city, a town, a village or a neighbourhood. When humans are walking in this type of free space, at most points (if not all) such a free space is perceived as a 'vista' that can be approximately represented as an axial line. The first representation, a so-called axial map, is defined as the least number of longest straight lines (Figure 5.3b). According to how each line intersects every other line, a connectivity graph, taking axial lines as nodes and line intersections as links, can be derived.

In contrast, *the second* representation is more oriented toward environments in which the free space is non-linear. A typical example of this type of environment is a building's internal layout, where most rooms are stretched in two ways, although corridors may have linear characteristics. Therefore, the second representation partitions the free space as a finite number of convex spaces, which is represented by a convex polygon in 2D maps. A polygon is said to be convex if no line drawn between any two points in that polygon goes outside the polygon. For a standard building layout, each room or corridor can be approximated as a convex space (Figure 5.4b). So the second representation, a so-called convex representation, should comprise the least set of the broadest spaces that covers the whole free space. A connectivity graph is derived by taking rooms as nodes and door connections as links.

The third representation is also oriented to non-linear free space, but with a more precise spatial representation. This representation is based on the notion of isovist, Which is defined as a visual field that is wholly visible from a single vantage point (Benedikt, 1979) (see Fig.5.5). As an observation point moves through the environment, the pattern of light reflected to that point changes continuously, creating an optic flow, which is the key concept in Gibson's direct perception theory (Gibson, 1979). Benedikt & Burnham (1981) made a claim based on an experiment, that isovists in some sense are a simplification of an optical flow that determines people’s movement behaviour in the environment.



a) Floor plan of a house

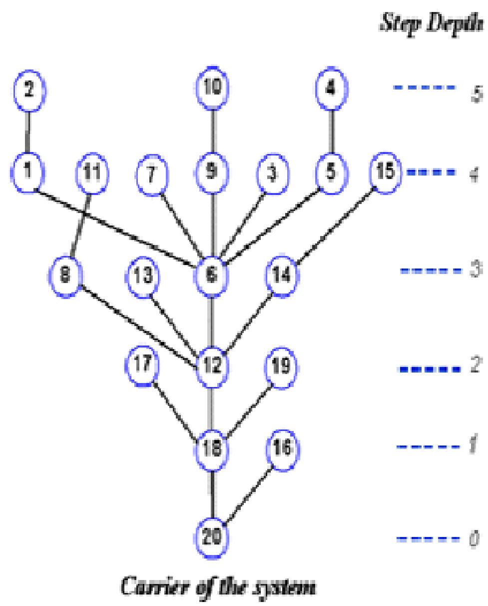


b) Integration graph

Note: dark brown presents highest integration and light red the lowest

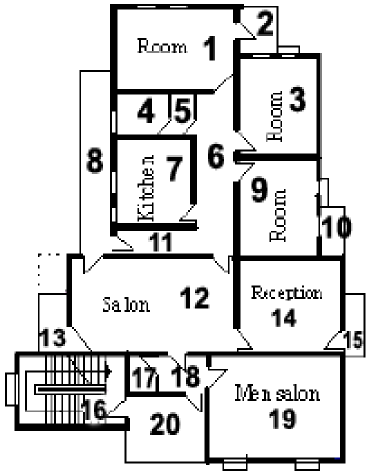
c) Table shows syntactical measures

Index	Connectivity	Control	Integration	Total_Depth	Three_Depth	Integration_3
1	2	1.16667	0.74020	71.00	12.00	1.37979
2	1	0.50000	0.54986	71.00	12.00	0.27083
3	1	0.16667	0.71279	89.00	3.00	1.07899
4	1	0.50000	0.54986	89.00	3.00	0.27083
5	2	1.16667	0.74020	73.00	11.00	1.37979
6	6	4.00000	1.08978	73.00	11.00	3.37767
7	1	0.16667	0.71279	89.00	3.00	1.07899
8	2	0.75000	1.13207	89.00	3.00	1.27973
9	2	1.16667	0.74020	71.00	12.00	1.37979
10	1	0.50000	0.54986	71.00	12.00	0.27083
11	2	0.66667	1.13207	55.00	14.00	1.47842
12	4	2.25000	1.08978	55.00	14.00	2.20007
13	1	0.25000	0.71279	73.00	11.00	0.70402
14	2	1.25000	0.74020	73.00	11.00	1.16346
15	1	0.50000	0.54986	53.00	10.00	0.27083
16	1	0.50000	0.48113	53.00	10.00	0.27083
17	1	0.25000	0.60141	71.00	12.00	0.70402
18	4	2.75000	0.80675	71.00	12.00	2.27763
19	1	0.25000	0.60141	89.00	3.00	0.70402
20	2	1.25000	0.62081	89.00	3.00	1.16346

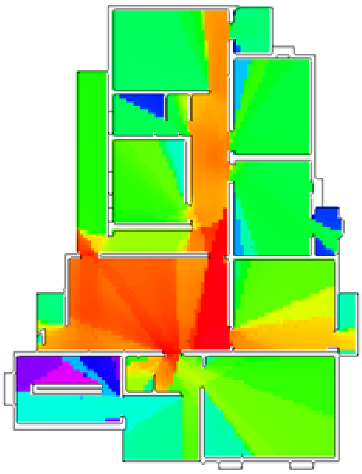


d) Justified graph

Fig (5.6) *Convex spaces within a house and space syntax representation of space as well as various syntactical measures.*

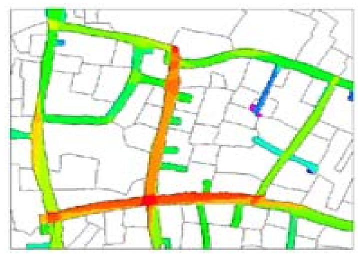


(a) *Floor Plan of typical house in new Ghadames*



(b) *Visual Integration graph based on Isovists*

(c) *Open and Closed spaces*



(d) *Integration graph based on Isovists within small part of Ghadames*

Fig (5.7) *Typical housing unit and part of the walled city of Ghadames with their representations of their spaces in form of Isovist integration graphs*

According to the representation, a building plan is partitioned into a finer grid [Turner & Penn, 1999], e.g., 100 × 100. Each cell at the finer level represents a single vantage point and its associated isovist. Then a connectivity graph can be created depending on how each isovist overlaps each other isovist. For the purpose of illustration, Figure 5.7d introduces a 3 × 3 grid with its associated isovist. Then a connectivity graph can be created depending on how each isovist overlaps each other isovist. For the purpose of illustration, Fig.5.5 introduces a 3 × 3 grid with its associated isovists. Theoretically the second and third representations are also applicable to the representation of a linear free space (first representation). However, due to the expense of computing large spatial configurations, so far they have only been applied to non-linear free spaces.

5.5.3. SPACE SYNTAX AND ISOVIST ANALYSIS

Isovists and isovist fields are of interest to space syntax in that they offer a way of addressing the relationship between the viewer and their immediate spatial environment, however, in the form described by Benedikt (Benedikt, 1979) they are essentially non-syntactic. All the measures he proposes and then plots as fields are locally defined, and are independent of the state of the field in other locations. This study applied Visibility Graph Analysis a new method introduced by Alasdair(2003). for integrating isovists, based on the connectivities of a set of isovists represented as a graph, and allows global relational measures to be developed which are attributable to each viewer location, but which are essentially relational and so syntactic in their definition. This section addresses more insights to the case study of Ghadames and its configurations by combing the axial line and convex space analysis with the isovist analysis using visibility Graph Analysis (VGA). However, the findings show that isovist local and global measures like visual integration, clustering coefficient, and entropy display excellent correlations with some observed phenomena in Ghadames, including a more detailed illustration of space usage than conventional space syntax analysis.

5.5.4. BRIEF INTRODUCTION TO ISOVIST

The concept of isovists was introduced into spatial analysis by Tandy for analysis of landscape however it was Benedikt (Benedikt, 1979) who first treated isovists fully as a method for analysis of architectural space. Benedikt's main contribution was to develop various measures of the properties of isovists, such as area, perimeter, occlusivity (the proportion of the perimeter lying on the solid boundary of the environment) and various measures of the distribution of the distance from the viewpoint to the perimeter. Benedikt calculated the properties of point isovists at a grid of locations in the open space of a configuration and then interpolated to give 'isovist fields'. He also developed the representation of a contour map of an 'isovist field' to describe the variation in these different isovist parameters through the environment. This work was one of the most thorough attempts to put the representation of the spatial environment, as opposed to built objects, on a firm quantitative footing, and is still widely referred to in the literature on analysis of urban and architectural space.

Isovists, in the guise of 'convex isovists' (the union of all point isovists within a given convex space) have been used for illustrative purposes in space syntax analysis since they provide a clear representation of the strategic views from (or of) a given location. However, their use has tended to rely on qualitative rather than quantitative assessment, and has tended to focus on the description of single isovists and the visual comparison; either of isovists from different locations or between Isovists (Fig 5.8) and empirical data on patterns of space use or behaviour (see for instance: HMSO 1994 and Peatross 1997 in their discussions of crime locations and control points in institutions respectively).

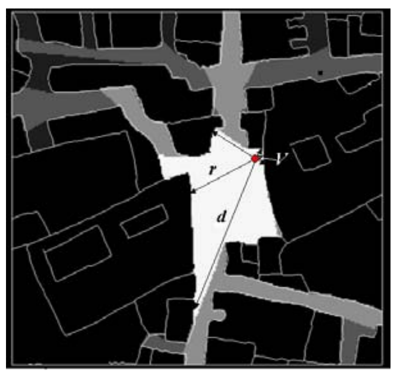


Fig (5.8) *Isovist field in white shows (a): View point,* ***(r):*** *diametric* ***(d):*** *distance to obstacles.*

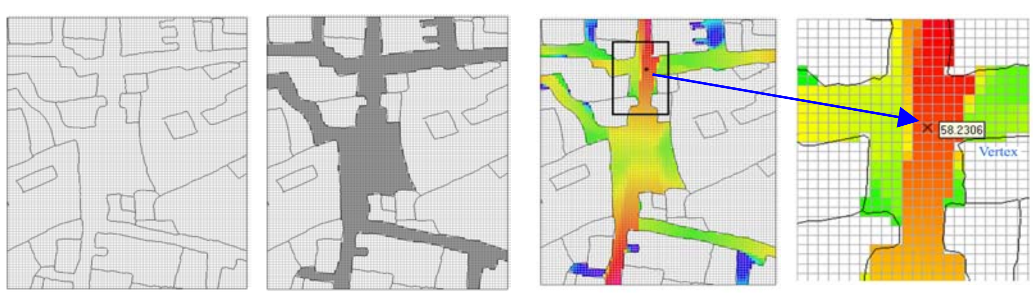
Although isovists seem to offer highly suggestive ways of interrogating spatial configuration, they have to date been of relatively limited application. We believe that there are two main reasons for this. First, the difficulty entailed in their production which has until recently been a time consuming procedure. Secondly, and possibly more importantly, that despite their sensitiveness to the shape of spaces isovists provide essentially 'local' measures of configuration, whilst the lessons of space syntax research suggest that it is the global properties of spatial configuration that are important in determining the functional consequences of design. Benedikt's measures of isovist fields are all local and capture the properties of a single visual field at a point in space, while both Peatross and the HMSO guide use isovists as a way of classifying observations of behaviour as being 'within sight' or 'out of sight' of a particular (single) location. This new method describes the development of a substantially different way of using isovist polygons. The axial or convex map from conventional space syntax is replaced with an isovist map constructed of point isovists at a grid of locations in open space in exactly the same manner as Benedikt. However, at this point the calculation of space syntax measures in a graph constructed by considering each isovist as a node and their relationship of intervisability / visual accessibility as links. In this way the method has developed a series of global measures in addition to local measures of isovist fields where a point in space can be given a mean depth value that quantifies its accessibility to all other points in space in the configuration, whether or not these are directly visible locally.

5.5.4.1.VISIBILITY MAPPING

In urban composition, a process of visualization of space as being potentially occupied by users and sequences of events is essential, though not necessarily conscious.(Hill. J, 1998):

> *"The architect and user both produce architecture, the former by design, the latter by inhabitation. As architecture is designed and experienced, the user has as creative a role as the architect."*

In this sense, the visibility graph is a tool with which we can begin consciously to explore the visibility and permeability relations in spatial systems as far as visual



(a) **(b)** **(c)** **(d)**

Fig (5.9) a :*main square filled with grids 70 by 70 Cm* ***b:*** *open space in black* ***c:*** *graph constructed shows Max. radail* ***d****: a point in Isovist Max. radial graph shows.value for Max. radial from that point.*

privacy is concerned. The relation between visibility and permeability is a vital component of how open spaces work spatially and are experienced by their occupants.

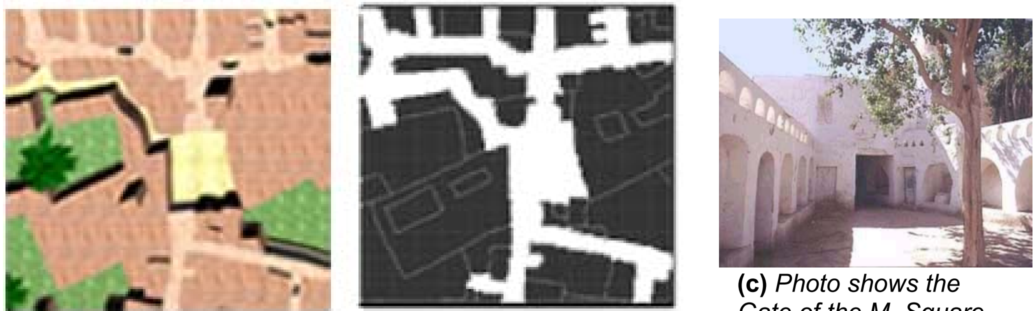
The VGA can help to investigate the configurational relationships of urban space through "depth map", a programme which is designed to perform visibility graph analysis of spatial environments. The program allows us to import a layout and to fill the open spaces of this layout with a grid of points(fig5.9). Once the graph has been constructed we may perform various analyses of the graph. The measurements of local and global characteristics of the graph for every analysed area are of interest from an urban and architectural perspective. In fact, these measurements can lead us to describe the city spatial configuration with reference to accessibility and visibility. The visibility graph properties may give clues to interpret manifestations of spatial perception, such as way finding, movement, and space use within city or a building.

Note that we have discussed a graph in terms of visibility, and therefore implicitly at eye level, taking an isovist at any height above the floor can form the visibility graph. As Hanson writes (1998):

> "*In moving around in buildings, people orientate themselves by reference to what they can see and where they can go. In looking at the visual and volumetric qualities of architecture, we need not be constrained by the pragmatics of everyday space use and movement. Indeed, we should not be, since architectural speculation almost invariably brings into play the relationship between visibility (what you can see) and permeability (where you can go).*"

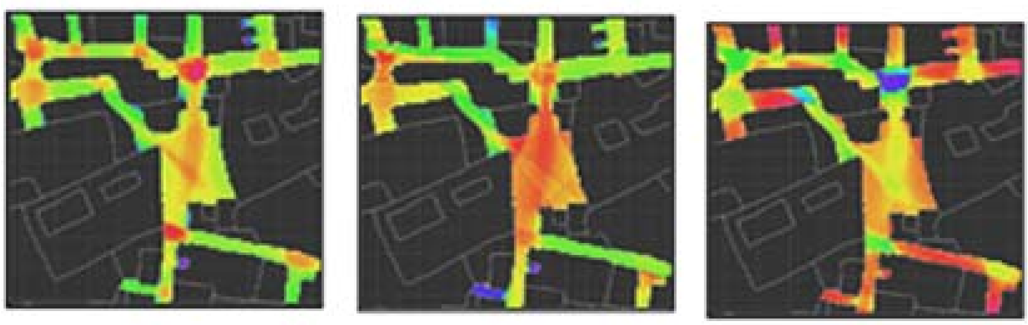
5.5.4.2. GRAPH CONSTRUCTION

The graph is made by Depth map. The programme attempts to find all the visible locations from each grid location in the layout one by one, and uses a simple point visibility test radiating from the current location to achieve this. As each location is Considered, a vertex is added to the graph for this point, and the set of visible vertices is stored. Depth map colours values by using a spectral range from indigo for low values through blue, cyan, green, yellow, orange, red to magenta for high values.

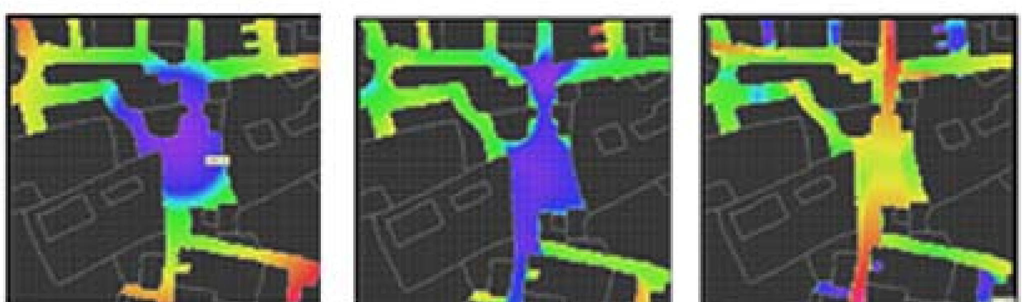


(a) *El katus Square* **(b)** Open space in white **(c)** *Photo shows the Gate of the M. Square*

(d) *Connectivity* **(*e*)** *Global integration* **(f *)*** *Entropy*



***(g*)** *Control* **(h)** *Controllability* **(i)** Clustering coefficient



(j *) Metric shortest path* **(k)** *Metric shortest angle* ***(l)*** *Max. Radial*

Fig (5.10) *El katus Square in Ghadames****:(a,b,c)*** *photo of El katus and its open space****(d,e.f):*** *graphs shows local isovist measures****;(g,h,i):*** *shows global measures****; (j,k,l)****: shows metric isovist measures.* ***Note:*** *colour range from indigo for low values through blue, cyan, green, yellow, orange, red to magenta for high values.*

For instance the measure known as *Point depth entropy* corresponds to how easy it is to traverse a certain depth within a system; low values correspond to low disorder, that means it is easy to move around and high values correspond to high disorder, which means that it is hard to move around. Concerning the clustering coefficient measure, low values occur where new areas of the system may be discovered so we tend to have high values at the corners, on the turning points i.e. the stairs or walls. In the current study, we consider each measure from the point of view of each vertex in the graph and we examine the pattern of their distribution across systems.

5.5.4.3 GRAPH MEASUREMENT

After producing a VGA for any given spatial environment we can analyse it by making use of some of the many measures developed for investigating graph properties. The analysis of the graph is split in two types: global measures (which are constructed using information from all the vertices in the graph) and local measures (which are constructed using information from the immediate neighbourhood of each vertex in the graph). In this study we will focus on both measures of graph structural properties. These are the local property, visual connectivity (*con*), clustering coefficient (*cc*), visual control (*ctrl*), controllability (*ctrl2*) and the global property visual integration (vhh), point depth entropy (*pde*), relativised entropy (*pde2*), metric shortest distance (*msd*), and shortest-path angle (*spa*).Once the measures have been calculated, these and derived measures will be used in a statistical package. However, in order to shed more light on these measures in detail, discuss their likely usefulness and implications, it is essential that we define them and describe their logarithms.

Global Measures:

They are all measures which are all based on preparing shortest paths from each node (location), through the visibility graph, to all other nodes (locations). These global measures are summarized as following:

-*Visual connectivity*: the visual connectivity of each node (location) is the total number of nodes (locations) that node can see in graph. It resembles the connectivity of an axial line as defined by Hillier(see previous section).

Mean depth: is calculated for each node much like the step depth. The shortest path (i.e., the fewest number of turns) through the visibility graph is calculated to each other node(location) within the graph. These are summed and divided through by the number of nodes in the graph (minus the node we are considering). This measure is a kerb stone for Space Syntax technique. It was discussed in detail in previous section..

Visual integration: is a measure, which has seen much mention in the space syntax literature; it is defined in Hillier and Hanson (1984). The measure is essentially a normalized version of the mean depth, and it is important because it has been found to correlate well with pedestrian movement.

`*Normalisation'* is a procedure to make different systems comparable with one another, typically by forcing a value in the range 0{1. Hillier and Hanson do this first, to produce what they call the *relativised assymetry*. However, they then divide through by a number called the d-value (see section for the calculation), which is meant to cater for the fact that as axial map graphs grow, they also become less integrated due to the way the lines intersect. Thus, a small system always looks more integrated than a large one.

Entropy and Relativised Entropy: entropy is a measure of the *distribution* of locations in terms of their visual depth from a node rather than the depth itself. Therefore, if many locations are visually close to a node, the visual depth from that node is asymmetric, and the entropy is low. If the visual depth is more evenly distributed, the entropy is higher. Relativised entropy takes account of the *expected* distribution from the node. That is, in most cases, you would expect the number of nodes encountered as you move through the graph to increase up to the mean depth and then decline afterwards. The technicalities of entropy and relativised entropy, which are based on Shannon's measure of entropy and information theory, are described in Turner (2001*b*).

However, the point depth entropy (pde) allows us to explore measures based on the frequency distribution of depths. Point depth entropy (pde) can give an insight into how ordered the system is from a location. Point depth entropy (pde) is the least number of edges that need to be traversed to get from one vertex to the other. Point depth entropy (pde) for a vertex is simply the average of the shortest path lengths from that vertex to every other vertex in the system, and so represents an average of the number of turns required for any journey within the system.

Local Measures

They are all based on the relationship between each node (location) and nodes directly connected to it. These can be summarized as following:

Clustering coefficient: is a measure introduced by Watts and Strogatz (1998) to help assess whether or not a graph is a `small world' or not. A `small world' is one that has tightly clustered groups of friends (though Watts and Strogatz's point was they may be much more generally applicable than just to people), but surprisingly low mean depth, that is, the number of steps to get from one person (e.g., a particular Australian sheep-herder) to any other person (including every Innuit as well as every Mexican) through links of mutual friends is surprising low. What, you are probably thinking, does this have to do with visibility graphs of spatial systems? The answer is that the clustering coefficient appears to give an idea of the `junction ness' of locations, and how the visual information is changing within systems, dictating, perhaps, the way a journey is perceived and where the decision points come within it (Turner et al., 2001). Clustering coefficient is defined as the proportion of vertices which are actually connected within the neighbourhood of the current vertex, compared to the number that could possibly be connected.

$$\gamma_i = \frac{|E(\Gamma_i)|}{Ki\ (ki = 1)} \tag{10}$$

where $E(\Gamma_i)$ is the set of edges in the neighbourhood of *vi* and *ki* is the neighbourhood size for a vertex.

Visual control and controllability: *control* is a measure, which again comes from Hillier and Hanson (1984), while *controllability* is a measure proposed in Turner (2001b). As the names suggest, control picks out visually dominant areas, whereas controllability picks out areas that may be easily visually dominated. For control, each location is first assigned an index of how much it can see the reciprocal of its connectivity. Then, for each point, these indices are summed for all the locations it can see. As should be obvious, if a location has a large visual field will pick up a lot of points to sum, so initially it might seem controlling.

However, if the locations it can see *also* have large visual fields, they will contribute very little to the value of control. So, in order to be controlling, a point must see a large number of spaces, but these spaces should each see relatively little. The perfect example of a controlling location is the location at the centre of Bentham's panopticon. This point can see into every cell, but the spaces inside each cell can see relatively little (back out to the centre and perhaps across it, but no more). By contrast, the cells themselves lack control, as they can see relatively little, but the locations they link to (in the centre) link out to many locations. *Controllability* is much easier to describe: for a location, it is simply the ratio of the total number of nodes up to radius 2 to the connectivity (i.e., the total number of nodes at radius 1).

$$c_i = \sum_{v_j \in V(\Gamma_i)} \frac{1}{k_j} \tag{11}$$

Where K_j is total number of vertices or neighbourhood size $V(\Gamma_i)$ is set of edges in the neighbourhood of V_i.

5.6. INTERIM CONCLUSION

This chapter discussed both space syntax and visibility graph analysis as relatively new techniques that describe spatial patterns of buildings and cities through computational language. First, principles of space syntax were introduced and various local and global syntactic measures were formulated. However, this technique is based on the realization that spatial arrangement and patterns of connections among convex spaces within a structure can be represented as nodes and connecting lines that comprise a graph. Through a graph syntactic properties of space are derived reflecting connectivity of spaces, their control, mean depth, local; and global integration, as well as their synergy and intelligibility. Then technique of visibility graph (isovist) was introduced as method for analysis of architectural and urban spaces. Various local and global measures were explained and their logarithms formulated reflecting various visual and metric properties of urban form.

These measures determine to a large extent the way people perceive urban form through movement and spatial experience. Both local and global measures were discussed. Visual local measures include clustering coefficient, control, controllability, and local integration, whereas visual global measures include visual entropy, relativised entropy, global integration, Max. radial, isovist moment of interia, and visual connectivity. Moreover, visual synergy and intelligibility as advanced measures were explained as revealing measures about the spatial experience that observer confronts during movement.

The both techniques are essential for representing space and understanding its configuration as far as spatial privacy regulation is concerned. The next step is to apply these techniques in the selected case study that we are going to deal with in the coming chapter.

CHAPTER 6

6. INTRODUCTION OF THE CASE STUDY"GHADAMES"

6.1. LIBYA: NORTHERN AND GHADAMES REGION

The old traditional settlements are prominent feature of the architecture scene of the urban morphology of Libya. The existence of such traditional settlements, housing a significant proportion of the population, ensures not only the preservation of traditional settlement and house form which is the dominant type, but also even the unique Libyan domestic lifestyle.

Nevertheless, no serious or comprehensive academic attention has been devoted to such settlement and its neighborhoods. Ghadames, the selected traditional settlement for the field observation is considered one of the oldest settlements of Tripoli region in Libya. Libya, the fourth largest state in Africa, is located in North Africa and lies between latitudes 33°N and approximately 20°N and longitudes 8°E and 25°E. It possesses a Mediterranean coastline of approximately 1820 Km in length. It is bordered by Egypt to the east, Sudan to the southeast, Chad and Niger to the south with Algeria and Tunisia to the west and northwest respectively.

Libya has an area of approximately 1,775,500 sq. km, 3 times the surface area of France, and a population of about 5500,000 (Census, 2000) is a cultural and geographic bridge firstly between Egypt and the Arabian lands to the East, the' mashreq' and the territory of the Arab W, the "maghreb'. Secondly, Libya acts as a link between the Mediterranean/Europe and Saharan Africa. Libya is also defined as one of the Middle East countries (Blake and Lawless 1980). From topographical perspective, the main contrast between narrow enclaves of fertile lowlands along Mediterranean coast and vast expanse of arid, rocky plains and sand seas to south.

Coastal lowlands separated from one another by predesert zone and backed by plateaus with steep, north-facing scarps; country's only true mountains, Tibesti, rise in southern desert. Country has several saline lakes but no perennial watercourses. Less than 5 percent of territory economically useful.

Due to the lack of natural barriers, the climate is greatly influenced by the desert to the south and the Mediterranean Sea to the north. The coastal regions have a Mediterranean climate with moderate temperatures and enough rain during the winter months for grain farming. In Tripoli, average temperatures are 30 deg C (86 deg F) in summer and 8 deg C (46 deg F) in winter; annual precipitation averages 380 mm (15 in) and falls mainly in winter.

The mountains of the Jabal Al-Akhdar attract considerably more reliable rainfall in winter and early spring, while in summer the heights are cooler than the surrounding plains. Semiarid conditions predominate in the Al Marj and Jaffara plains, and in the southern deserts, frequent periods of drought occur. A scorching wind called the "*Ghibli* " which is a hot, very dry, sand laden wind which can raise the temperatures in a matter of hours to between 40 deg C and 50 deg C, occasionally blows into the usually humid coastal towns. The wind is most noticeable in West of Libya and is often associated with the spring solstice.

6.2. SOUTH AND TRIPOLI REGION

Tripoli region Fig (5.2), which lies almost between latitude 33° and northwest of Libya, is has a strategic location on the Mediterranean Sea. It covers area of 374000sq. Km., which is about 22 % of the total area of the country, with population of approximately 3.6 million people, accounting for about 57% of the total population of Libya. (Formal Census 2001)

The region is made up of seven sub-regions known as Baladiyas, which are Tripoli, and Ghadames Fig (6.2). The Ghadames sub-region is located in south part of the region and has location along Tunisian and Algerian borders. This Baladyia covers 112200 sq.km. with total population of 0.4 million. The main settlements of this sub-region are Senoun, Dareg and Ghadames. The sub-region has arid hot climate and part of Great Sahara of North Africa. It exudes its own distinct character. Ghadames is considered as a capital of the Baladiya and its administrative and commercial center, with traditional style, residential and unique settlement form.

Fig (6.1) A map of Africa showing the size and location of Libya in relation to the rest of the continent.
Source: Polservice, 2000

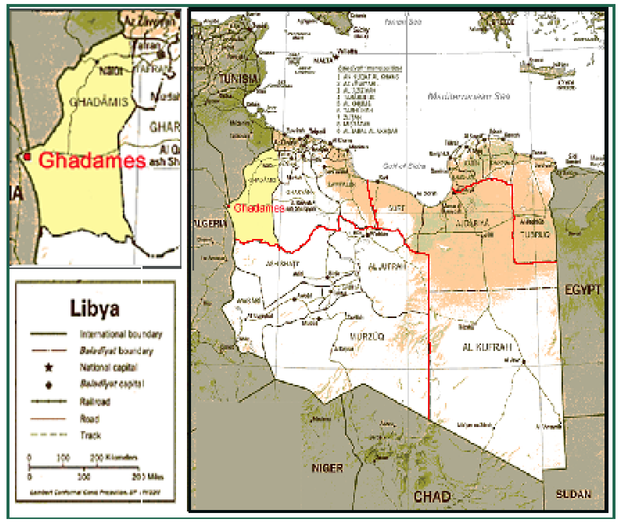


Fig (6.2) Map of Libya showing (i)Libya and neighbours,(ii)the capital region (iii)Ghadames subregion (iv) location of Ghadames. Source: Libyan Atlas, 1970

6.3. GHADAMES SETTLEMENT

The old settlement of Ghadames in Libya is considered one of the unique human settlements of North African desert. This uniqueness is due to its important role, which is historically played as a trade crossing point as well as culture center linking Mediterranean coast and central Africa.

The sustainability of this role related to inhabitants' deep understanding of basic human needs, scarcity of available natural resources, cruelty of prevailing environmental conditions and their capabilities to adapt and develop distinct technical systems through which they were able to invent effective technical solutions that made their settlement, architectural style, traditional building methods, and limited water to sustain more than fourteen centuries. However, Ghadames became a place of appreciation among visitors, academicians, and experts. Therefore, it was selected by the UNSICO, World Heritage Center, and Center of Human Settlements (HABITAT) in 1986 as one of the world settlements that have unique settlement form and global value in human heritage.

6.3.1 LOCATION OF GHADAMES

On the intersection of the 30.08 N and 09.30 E Ghadames city has its position. This position is on the northern part of Grezaa Desert on the northern part of Africa. It is about 600 Km far from the Mediterranean Sea coast. It is located about 300m over sea level and it has many sand-hills surrounding as a crescent from north and west side. “Between the Maghreb and the heart of Africa, Ghadames is at the intersection of Libya's border with Tunisia and Algeria, this oasis is situated on northern border of the Sahara in the Province of Fezzan.” (Rava Carlo Enrico, 1998). Ghadames is about 10 hectors surrounded by oasis of 215 hectors which includes farms and more than 30000 Palma trees. Fig (6.2).

6.3.2 HISTORICAL BACKGROUND

Historians record that Ghadames was habited (4,000) years ago. It is now an exciting settlement, which dearly indicates the presence of several civilizations that had lived on the settlement's streets and paths. These civilizations have left their prints on the rocks, in the caves, on ruins scattered on the dunes and in the curves of the valleys. Excavators in Ghadames have also found Greek carvings in a region to the northeast of the settlement went back to Paleolithic and Neolithic times (about10. 000 years). In addition, the mixture in tile city of Roman and Garamantes arts and architecture were found.

In the 3ed century B.C., there was also a castle built for Roman soldiers. In 4-5th centuries**,** Cydaus becomes an episcopate under the Byzantine Empire, and altogether four bishops served their mission.

In the 7th century A.D. 'Omar Ibn-al-As sent an Arab Muslim battalion to Ghadames in order to make it a foothold from which the Arab Muslim armies would spread throughout North Africa later on. He conquered it twice. It was a strategic position, which they sustained strongly. In 8th century, Ghadames is established as an important trading point for caravans. It linked the central Africa and Libyan coast to other Arab countries. The Italians reach Ghadames in 1914, three years after starting the occupation of the rest of Libya. They are met with strong resistance and after ten years. Italians finally get control over Ghadames. .

Afterwards, Ghadames is set under French control in 1940. Under World War 2, the old settlement is strongly damaged, after wards; the last French troops leave Ghadames in 1955. .

Ghadames population is composed of groups of people from Arab origin and other groups of ancient Libyan source. They speak Arabic which the Arab Muslim Leader Ugba ibn-Naafa' brought with him to the city when he conquered it in the 7th century A.D.). They also speak a sort of a vernacular language, which is common to day among the indigenous people of Ghadames.

It is worth noting that there is a legend about how the name of "GHADAMES" had been so framed. It is said that once upon a time a caravan passed through a valley where they had their own lunch. After they had packed their belongings and left the spot, one member of the caravan noticed the missing of the cooking utensils. Then he said, " we forget them at "GHADAMES" (He meant: We left them at Yesterday's lunch". i.e. where they had their lunch. .

In Arabic " GHADA" means hunch and "AMS" means in Arabic "Yesterday " Therefore, - GHA-DAMES - means yesterday lunch. However, it is by chance, the Roman name "Gyadamae" has been transformed to "Ghadames". However, there is no doubt that this story' is a pure legend for Ghadames to its name from a distortion of its original name, "Cydamus " and its present name has no relation with (Ghada'). (Arabic for lunch).

6.3.4. URBAN MORPHOLOGY:

The spatial configuration of Ghadames is unique. Its roughly circular plan is enclosed by the reinforced back-walls of the houses at the periphery. The street pattern consists of narrow and obscure corridors, which are integrated into the architecture of the dwellings at the ground floor level and mainly used by men. Women circulate at the level of the rooftops where they can move freely from one terrace to another.

The Ghadames region features full integration of the vegetation and cultivable land within the residential part of the town. Low-lying gardens line the streets in order to be closer to the water table. The settlement has two artesian wells. A sense of coolness given by the running water and the shade of the palm trees makes the heat bearable, even in the hot summer months.

Fig (6.3) *Tripoli Region, Ghadames and surrounding towns*
Source: History of Libya, 1970

Ghadames' architecture is Saharan in design and has been uniquely preserved. The local people have been able to use all the resources available in a poor environment to create perfect living conditions in a harsh climate. The local houses are built from mud, lime, palm tree trunks and leaves-- the only available building materials. The result, however, is most impressive. Elegant and Stylish it, the local homes are fittingly perfect into the harsh, desert environment.

6.3.5 FOUNDATION OF GHADAMES

According to historical background and spatial analysis of Ghadames and its foundation the selection of the site was not by chance or arbitrary or from vacuum, but the location was carefully selected by ancient tribes on purpose. This selection was based on several justified reasons that led to establishment of the early settlement. These reasons can be summarized in the following five points:

i. *Availability of water spring"Aen El Faras":* As water is essential element for living particularly in situation of Ghadames and its harsh desert environment. Therefore, existence of Aen El-Faras was the first reason for early tribes to settle down in this part of African desert.

ii. *Trade meeting point for caravans:* Most of Ghadames' population worked as traders because of Ghadames strategic location connecting African and Arab countries such as Chad, Niger, Tunis, and Algeria. This location made it easy for them to communicate other cultures

iii. *Natural advantage of the site:* Ghadames is considered as a natural protected site against harsh natural environment such as Southern hot winds "Gibili". On one hand the existence of the surrounding hill from South protects the site from undesired wind, and on other hand, Ghadamesians protected their settlement by planting forest of palm trees around the settlement which work as wind breakers as well as a source of food, building material, and furniture.

iv. *Construction materials availability*: the Ghadames is lush with mud brick, stones, and gypsum materials, which are as whole, form the main construction materials in addition to palm trees and its derivatives. Therefore, Ghadamesians did not import them, but have developed their own local materials, and their own traditional methods to deal with them.

v. *Surrounding agriculture areas*: As water is essential element for agriculture, and the water is available in reasonable quantities; in addition to fertility of Ghadames' land to some extent, the Ghadamesians confronted the harsh environment by their gumption and cooperation to overcome some difficulties related to hot arid zone where their settlement lies.

6.4. POPULATION AND SOCIAL STRUCTURE

The old Ghadames is populated by three known tribes. Each tribe is made up of number of families which constitute the over all frame of the tribe. These families are cohesive with each other. They are bounded by blood tie, alliance, mores and common tradition. However, All Ghadames streets were named according to the name of the family lives in. these tribes are Ben-Walid, Ben-Wizet and Tuarg. Both Ben-Walid and Ben-Wizet are considered as original inhabitants of Ghadames , whereas Tuarg and others came later to the settlement. Ben-Walid is made up of Darara, Tasko, and Mazeg. Ben-Wazet includes Tangazen, Tafarfra, Jarsan and Awlad billel, whereas Toarq made up of Aphogas and Awragen who lived on periphery of Ghadames before the foundation of the new settlement where this situation changed. The following table shows the population size in each tribe and male/female according to 2002 census.

Table(6.1) Male and Female tribal distribution

Tribe name	Males	Females	Total
Ben-Walid	1453	1520	2973
Wazet	1336	1326	2662
Aphogas	905	914	1819
Total	3694	3760	7454

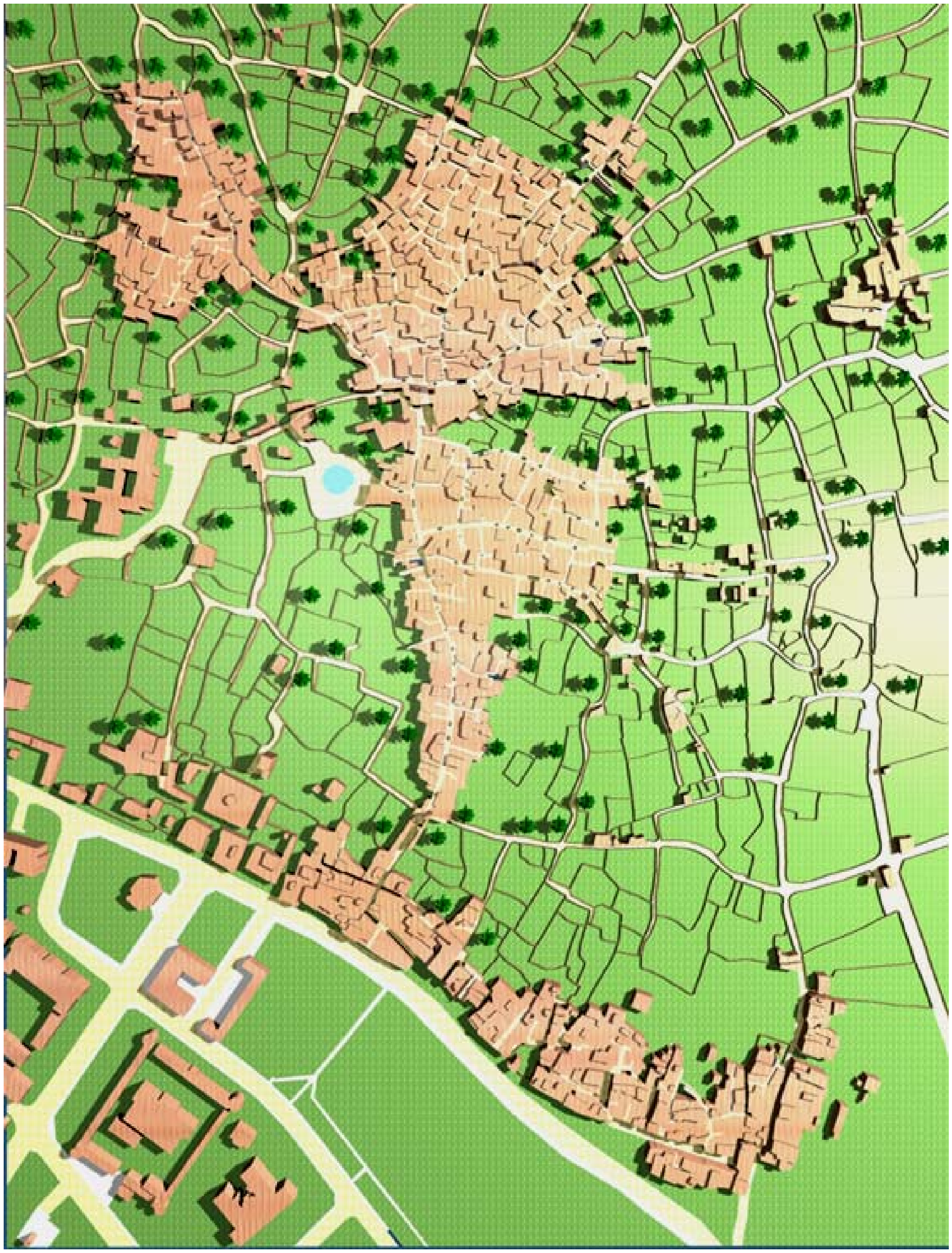
Source: Census, 2002

The population increase according to the last three decades is in the below table (6.2)

Table(6.2) population during 1980 to 2003distribution

Year	1980	1990	2000	2003
Pop. Size	5400	14700	20000	22100

Source: Estimated based on Census, 2003



Fig(6.4) Ghadames city, Top eye view for the whole settlement presented in 3d.

Table(6.3)Libyan and foreign population during 1980 to 2003

Years	Libyans	Non-Libyans	Total
1980	5100	300	5400
1990	13700	1000	14700
2000	19400	600	20000
2003	22500	460	23000

Source: Estimated based on Census, 2000

The total population of Ghadames according to Libyan/non-Libyan nationality is in the previous table (6.3)

Sex-age distribution of Ghadames population extracted from sensus, 2000.

Table(6.4)Sex/age distribution during 1980 to 2000

Age group	1980	1990	2000	%
0-17	2800	7400	10400	53.7
18-64	2100	5750	8300	42.1
>65	200	550	800	4.2
Total	5100	13700	19400	100

Source: Census, 2002

6.5. LAND-USE DISTRIBUTION

the existing distribution of land use in Ghadames as shown in land use plan Fig()and the following table() summarized the main uses and its percentage from both net and gross area.

Table (6.5) Land use of Ghadames in hectors, 2000.

Land-use	Area	%	Land-use	Area	%
1. Housing	**82.0**	**49.2**	**8. Transportation**	**13.5**	**8.1**
2. Education	**8.1**	**4.9**	**9. Public utility**	**4.5**	**2.7**
3. Health Service	**18.6**	**11.2**	***Total Net***	***166.8***	***100%***
4. Cultural and Religious	**24.9**	**14.9**	**10. Agriculture**	**5.4**	
5. Commercial and Recreation	**2.2**	**1.3**	**11. Open Space**	**245.3**	
6. Administrative	**1.5**	**0.9**	**12. Archeological**	**9.1**	
7. Industry and Warehouses	**4.9**	**2.9**	***Total Gross***	**489.3**	

Source: Poly Service Company, 2000

6.6. HOUSING TYPOLOGY

The housing area within built Ghadames is about 820 hectors. This housing zone can be classified into three main categories; first, the traditional houses within the old settlement, which is about 11% of total residential zone. Second, scattered houses in the whole settlement that forms about 15%. Third, new modern houses built recently from concrete that form 74%. The common height of these houses is 2 or 3 floors surrounded by agriculture land.

6.7. GENERAL CLIMATE DATA FOR GHADAMES LOCATION

These circumstances mentioned above team together to give the city a desert, hot days and very cold nights in general. The climate in Ghadames during winter is warm, because the desert sand it is affected directly and quickly by the sunrays and it is known that sands are quickly warmed and quickly become cold. In the summer period, the day times are unbearably very hot, but in the night, they are moderate, suitable and comfortable. Its has been observed from all plentiful data about temperature degree that the difference in temperature is regular throughout the year as a curved line with a rise and fall in the direction of temperature difference only with monthly periodical.

Following figure 6.4 shows the mean maximum temperature for Ghadames settlement. This Figure shows the temperature for 5 years. However, it explains that about Seven months have temperature more than 35° and up to 41.7° according to the Temperature survey. The following schedule showing the temperature degree interval year seasons it's calculated as mean temperature from 1943 to 1979 based upon D.B.T. (Ahmed S., 1985. P. 20)

It is necessary to say that the rise and fall in temperature depends on the wind direction, atmospherically pressure and humidity. The location of Ghadames on this point and under the effect of this climate has compelled the Ghadames inhabitants to overcome all this discomfort and to solve all the factors that conditioned the city and houses shape. But in that time all the technological possibility were compelled to overcome all this discomfort and to solve all the factors that conditioned the city and

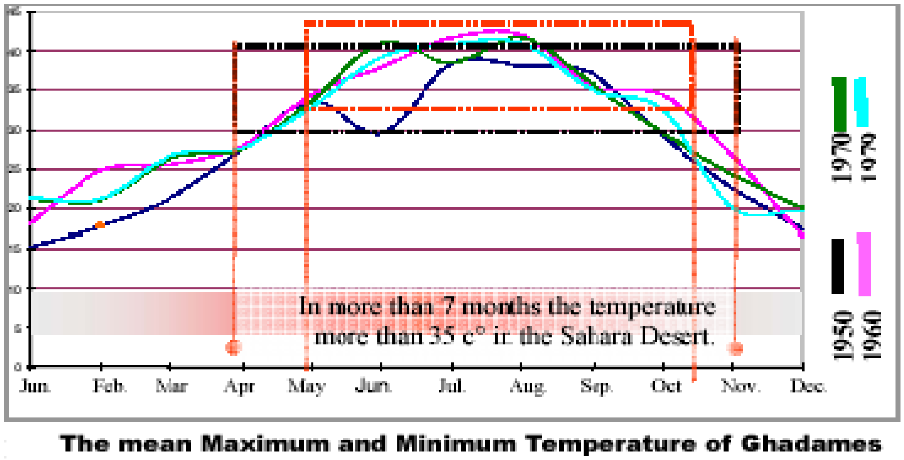


Fig (6.5) *Shows Max. and Min. Temperature of Ghadames*

houses shape. But in that time all the technological possibility were compelled to solve and to overcome all climate circumstances with a natural solution (Ahmed S., 1985- p.7).

6.7.1 TEMPERATURE OF GHADAMES ZONE

6.7.2. RAINFALL IN GHADAMES

Because Ghadames has a location in hot dray zone between the latitude lines 29º 30' and 31º 15' to the north and to longitude lines 9º 23' and 11º 30' to the East, Moreover, it is located in a desert zone, it benefits of a very little rainfall, only Sometimes when there is a NW wind.

- The max. Rainfall was in 1976 (about 182.9 mm)
- The max. Monthly rainfall was in March 1974(about 65.8 mm)
- The daily max. Rainfall was in March 1974 (about 44.0 mm) (Ahmed S.1985)

6.7.3 RELATIVE HUMIDITY IN GHADAMES

In general, the relative humidity in Ghadames is in the human convenience range. Sometimes it is less than 17.0%; which is the minimum level of required human humidity. (Ghadames humidity tables located in appendix D) - The max humidity was recorded in Jan. 1950 (about 67%). It was in the human zone. The Minimum. humidity was recorded in July 1962 and July 1977 (about 13%). It was out of human zone (Ahmed S. 1985). *Note* the main relative humidity in Ghadames equals 30%, and that means it is in the human comfort zone when the temperature between 20.3Cº and 27.7Cº.

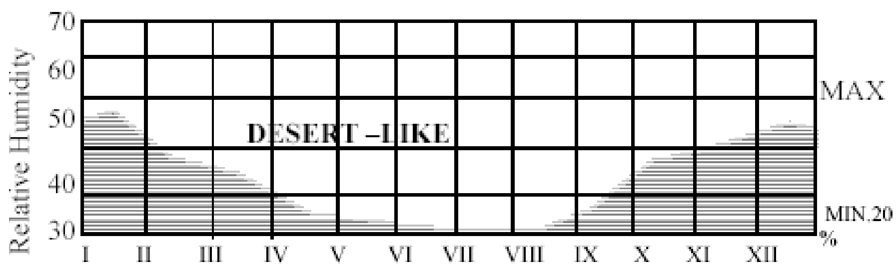


Fig (6.6.) *The mean relative humidity in Ghadames, (Ahmed S. 1985. p. 27)*

6.7.4 MEAN VAPOR PRESSURE IN GHADAMES

The vapor pressure in Ghadames is normal compared with other cities. It rises in Summer from May to October to be lowered in winter between November and April.

- The Maximum was in August 1965 about 13.2mbs
- The Minimum was in March and April 1967 about 3.9mbs (Ahmed S. 1985)

6.7.5 MEAN ATMOSPHERIC PRESSURE TO THE SEA LEVEL IN GHADAMES (MEAN M.S.L IN MBS.)

In addition, the atmospheric pressure in Ghadames is normal because the humidity there is Normal and human. Its rises in winter from October to March to be lowered in Summer from April to September.

- The Max. was in December 1974 about 23.9mbs.
- The Min. was in May 1971 about 7.6mbs. (Ahmed S., 1985)

6.7.6 WIND SAND DUST

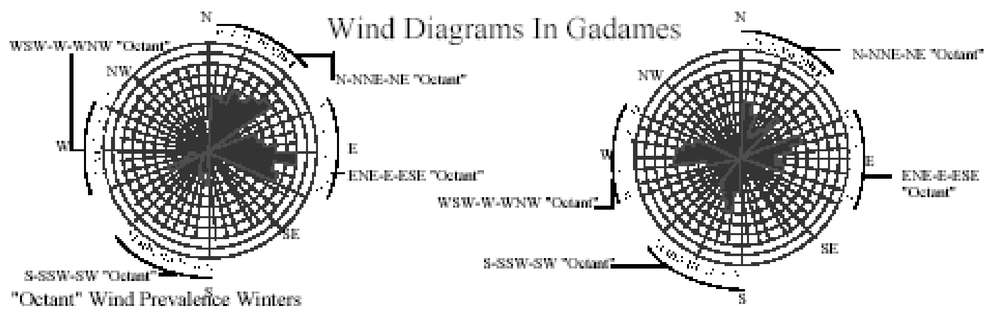
The local wind in Libyan Desert called "Geipli" it came in the summer season; moreover, it generally is very hot and has dust. The following figures show the wind Case in Ghadames area. The Wind Analysis Yearly Ghadames According on the followed tables are:

1. East winds are most dominant with 14% prevalence. There are followed by NW-NE-NNE and ENE with 10.1, 9.0, 6.6, 6.1 and 6.0 respectively.
2. The average wind speeds are 8 to 12 knots/hr.
3. The mean vector for V-XI May through November. 15 E-NE octant.
4. Wind speeds 50 to 75 knots/hr experienced during II, IV, V and II, speeds over 25konts/hr. prevalence through out the year.

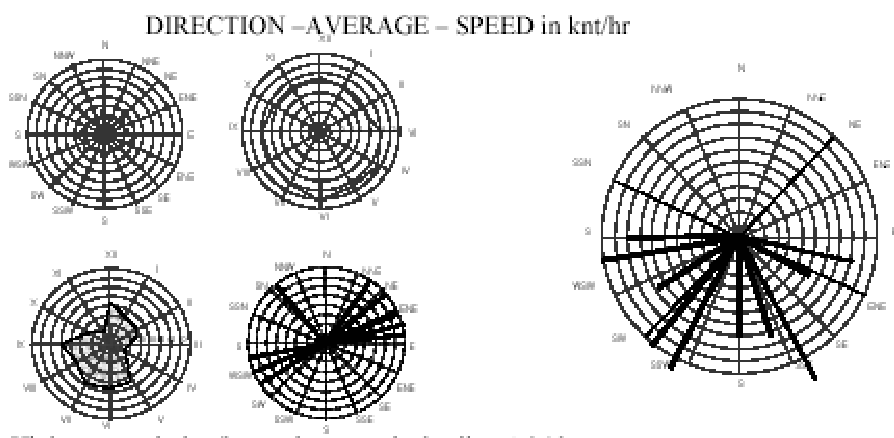
6.8. INTERIM CONCLUSION

The traditional walled city of Ghadames as a case study selected, consists of ground floor (male domain) and upper floor (female domain). The case also represents three ethnic communities from Arab, Barbar and Tuarg (African) origin. However, the walled city is located in Libyan Sahara where hot-arid climate is dominant.

The residents of this unique settlement accommodated the surrounding environment by utilizing plama trees and mud brick to built architectural complexes that form this unique structure. The strategic location of the settlement near Tunisian and Algerian borders, as trade point linking Mediterranean coast and trade centers in Chad and Niger, geographically makes the settlement play main commercial function. Historically, the early Barbar tribes settled down the city about 3000 years ago, and then Arab tribes came into the city where they shared Islam as a new religion in 7th century. Whereas, Tuarg as African tribes settled the city recently, hence they were Shelterless rangers.



Monthly "Octant" prevalence	Yearly prevalence
1- ENE-E-ESE Octant	25.7%
2- N-NNE-NE Octant	24.8%
3- WSW-W-WNW Octant	18.5%
4- S-SSW-SW Octant	15.2%



Highest a pot in knt/hr one kont nautical-mile =1.86 km
One kont/hr = 30m/min =0.5/sec.

Fig (6.7) *Wind diagrams (direction and speed) in Ghadames*

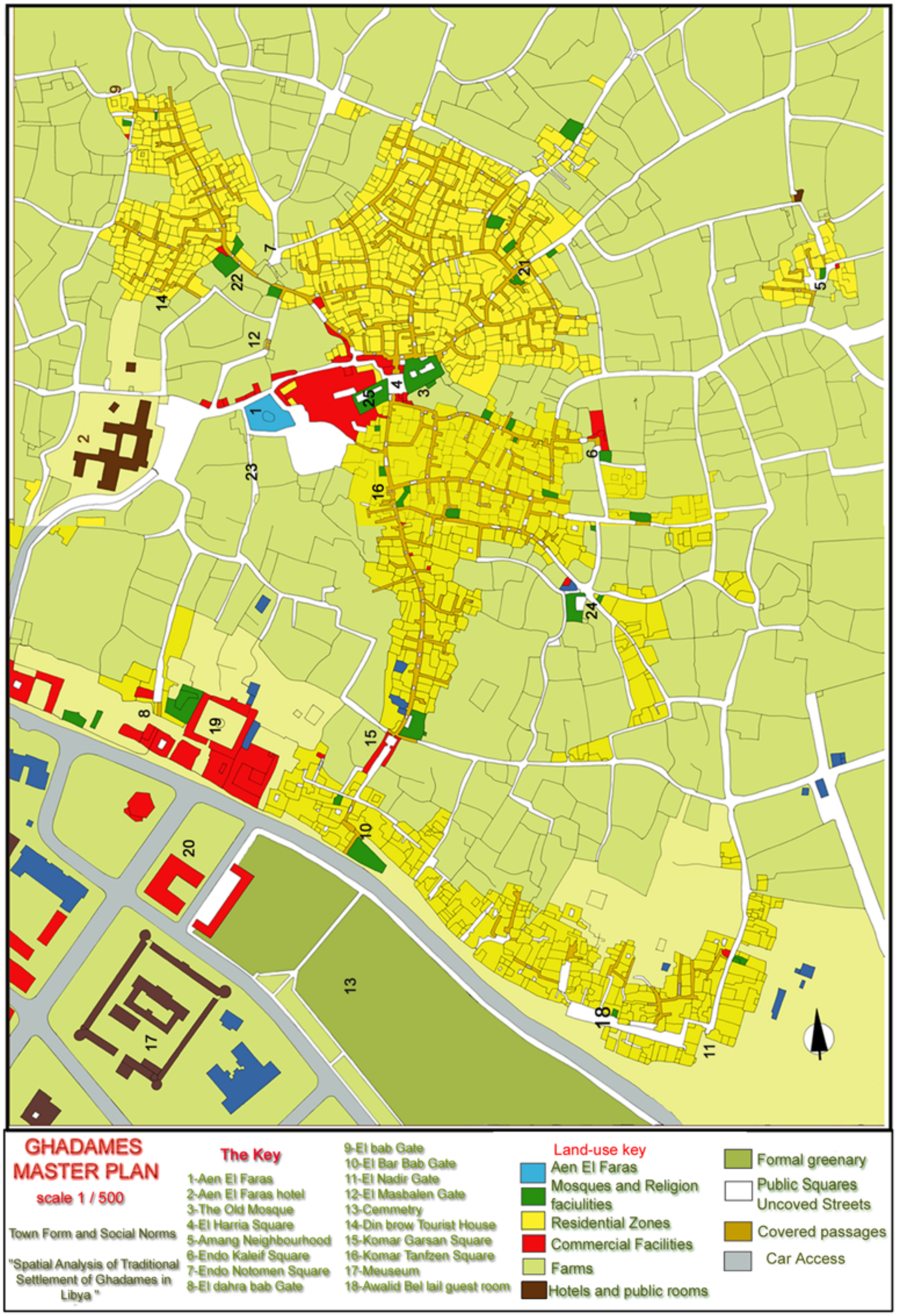
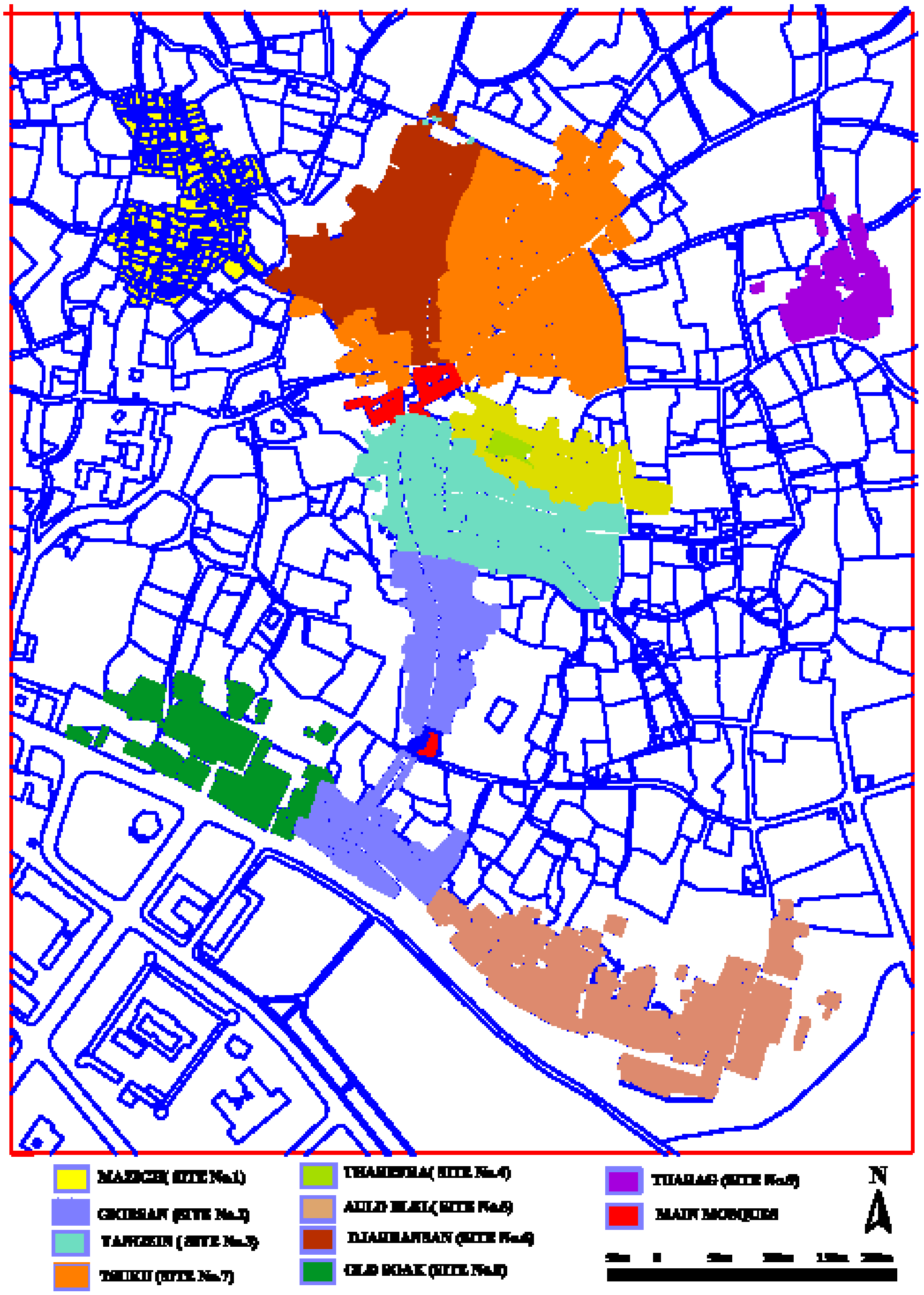


Fig (6.8) *shows Ghadames land use plan. Source, Ghadames Baladyia 2002.*



Fig(6.9) shows the axial map for the walled city of Ghadames

CHAPTER 7

7. SYNTACTIC AND VISUAL PROPERTIES OF GHADAMES

Having introduced both the basic concepts and methods of the descriptive theory of space, known as Space Syntax (Hillier, 1986) and visibility graph analysis (V.G.A) method, this chapter attempts to apply these techniques in the walled city of Ghadames as a selected case study (See chapter 5). The aim is to establish a systematic relationship between these syntactical and morphological measures of Ghadames' spatial system in one hand and various privacy constructs measured in terms of interaction between inhabitants and visitors, control over space, enclosure, territory, proximity and other relevant aspects.

In this framework, the analysis is conducted on two levels of detail. Level of the whole Ghadames including three unconventional axial maps representing ground floor (male domain), upper floor (female domain), and the whole spatial system with entrances of buildings embedded. The second level of analysis covers nine sites representing three different cultural communities within Ghadames. These community areas are analyzed as embedded within the city (embedded model) and as separated (cut out model). The later level of analysis will be addressed in detail next chapter.

7.1. SYNTACTICAL PROPERTY OF GHADAMES

Two strategies are adopted to prepare the three mentioned syntactic maps (convex, axial, and interface maps) in order to overcome couple of problems associated with applying the conventional maps. The first the problem of representing segregated systems of space for ground floor and upper floor, which are dominated by male and female respectively.

The adopted strategy is to prepare two axial maps and its related convex maps representing these two domains of users. Each of them is analyzed separately to determine its spatial properties. The second problem is that Ghadames has been uninhabited settlement since 1998. It is under restoration and rehabilitation and work is going on under supervision of committee assigned by UNISCO. Therefore, It is impossible in this case to conduct survey for counting pedestrian movement across the walled city. Instead entrances of building were marked and used to prepare separate axial map for the whole walled city that sheds more light on the pattern of movement generated from each building. This strategy enables us to overcome such a problem and to measure spatial properties of street configuration.

7.1. SYNTACTIC AND MORPHOLOGICAL PROPERTY OF GROUND FLOOR (MALE DOMAIN)

To give clear picture of the socio-spatial configuration of ground floor as male domain, it is necessary to investigate and interpretate the results derived from both the convex and axial maps (fig 7.1a,b) which are abstract representation of the space structure. These results, which include morphological and syntactic measures, are summarized in table 7.1.

7.1.1. MEASURE OF CONVEXITY:

The spatial system of the ground floor shows low value of convex articulation (0.76), which indicates a great break up of open space and therefore less synchrony. The properties of convex spaces Fig(7.1a) reflect a great variety in the length and width of the segments of the settlement. This type of convex space structure is property found in Islamic organic city. Looking at the value of degree of convex deformation – comparing the number of the existing convex spaces with the minimum that could exist for a regular grid with the same number of islands- it is 12.43, which shows high irregularity in Ghadames texture. It is also an informative to measure grid convexity value – comparing the convex map to an orthogonal grid in which convex spaces extend across the spatial system in one direction, while in other direction, the convex spaces fit ladder - fashion into the interstices- we found this measure is very low and equals 0.0979. This value reveals that Ghadames has a very deformed grid, shows irregularity and non-angular developmen.

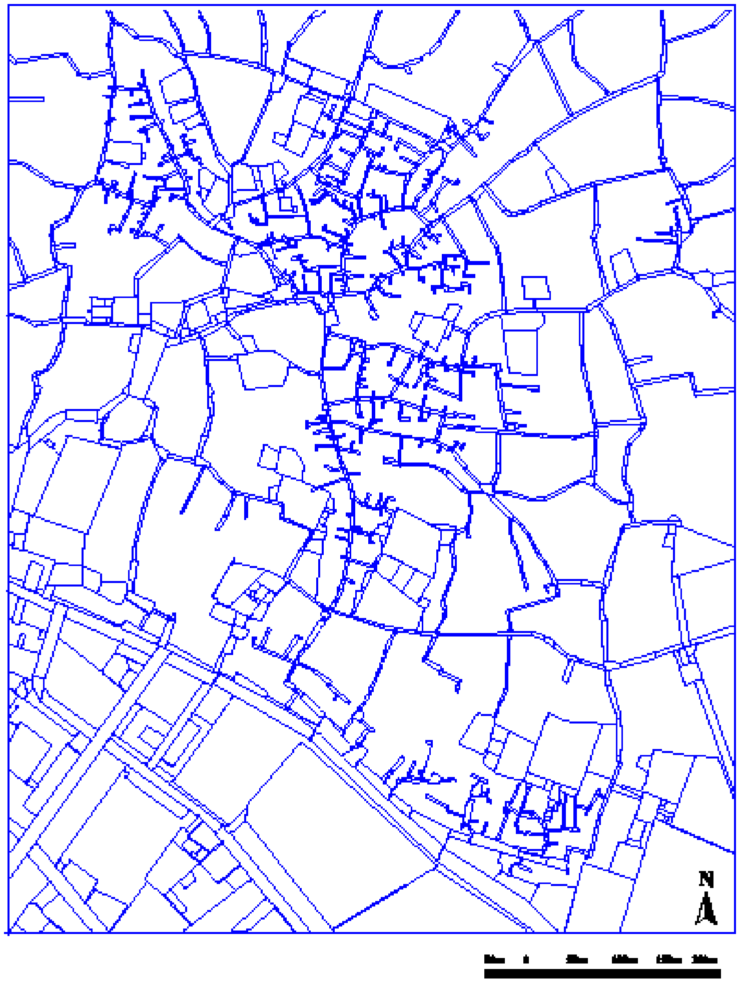
7.1.2. MEASURE OF AXIALITY:

Based on the prepared axial map of Ghadames ground floor illustrated in Fig (7.1b) three main measures are calculated that explain nature of Ghadames axiality. These measures are axial articulation, axial integration of convex spaces, and grid axiality as listed in Table 7.1. Looking at axial articulation - the number of axial lines compared with the number of buildings - Ghademes ground floor has non-axial articulation since the value 0.48 is low which indicates that the streets and cul-due-sacs of the walled city have a great break ups development in their system.

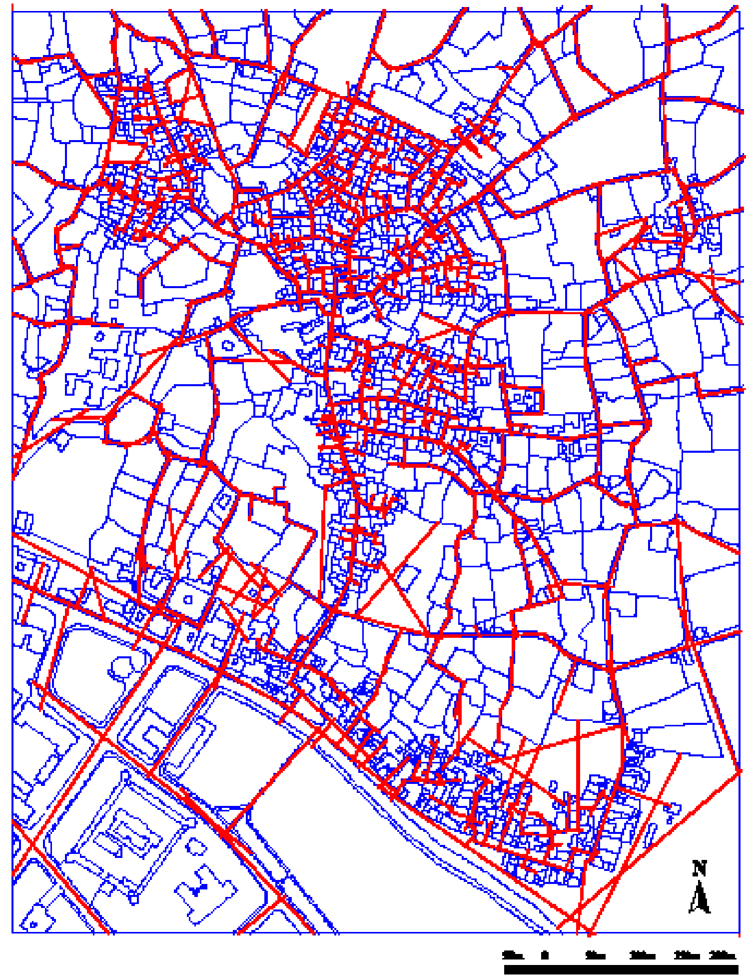
An other informative measure is the axial integration of convex spaces. The value is 0.57 shows low degree of axial integration in Ghadames convex spaces. In addition, the value of grid axiality -comparing the number of axial lines to an orthogonal grid with the same number of islands- is too low 0.032 that reflects very weak approximation of a grid. This fact can be seen throughout non-axial and deformed public squares. An other interesting feature of Ghadames is that both convex and axial ringiness is too low 0.04 and 0.06 respectively which confirms that the walled city has non-distributness system of spaces. In fact, this property is a common phenomenon in almost organic cities.

7.1.3. MEASURE OF SYNTACTIC PROPERTIES

Syntactic analysis was conducted based on the axial map of the ground floor as a male domain. Both the base convex and axial map is illustrated in fig (7.1a,b) and numeric results are summarized in table7.1. These results represent the average value for each of the 15 syntactic measures that cover various aspects of open space configuration.



Fig(7.1a) shows transcription of open spaces in Ghadames into a convex map



Fig(7.1b) shows the axial map for the walled city of Ghadames

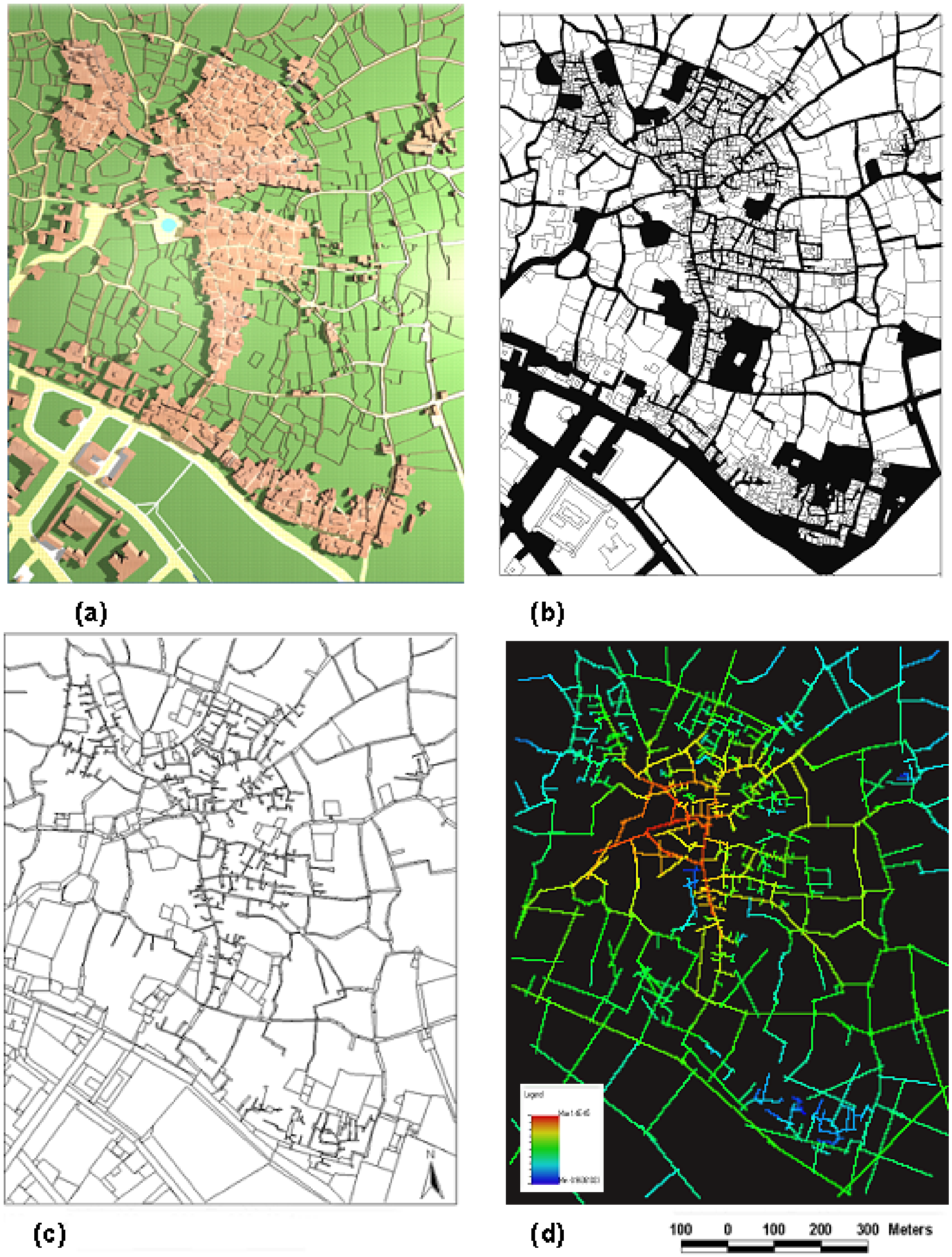


Fig (7.2) *The walled city of Ghadames: (a) Top eye of the city(b) open space map(open space structure in black; (C) transcription of the plan into a convex map; (d) transcription of the plan into an axial map.*

However, like most cities across the world, the pattern of the walled city of Ghadames has central integration core and axis, with high integration value connecting the center to the main street of the city. (See fig7.2d) Globally, Ghadames ground floor has a mean global integration-unrestricted radius-value of 0.56, which is below Arab cities index (see table 7.5).

However, The axial map strictly picks the actual center of the walled city very precisely, that is, the distribution of the high-integrated lines (the most accessible routes) are colored red, then orange, yellow and green, through to blue and dark blue for the least accessible routes in the axial map. It is obvious that the high-integrated lines extend in the heart of the center where two central mosques Younis and El Ateg are located in opposite sides to El katous central square (Maddan). An other interesting feature of these high-integrated lines is that they are clustered around the Ghadames water spring, which is thought to be a crucial element beyond Ghadames foundation and its survival up to present moment.

Locally, Ghadames local integration- restricted to three steps of depth- is 1.6, which is roughly similar to that of Arab cities. The most locally integrated lines, which are a few, in this case, are locally distributed in wide manner around the residential communities within Ghadames. All of them are found separated from each other and constitute part of internal islands within the residential areas. An other local measure, which is informative about Ghadames, is the connectivity value. It is found that each line connects on average 3 other lines within system. This low value of connectivity is distinct property of Arab cities due to short broken dead end streets (cul-de-sacs) that reflect higher mean depth of space and the inhabitants' tendencies toward privacy. The average length of the axial line (viewshield or isovist radial) is about 40m, when compared with that of Libyan cities is too short. This fact implies that the walled city has very short lines of sight and a great change in direction of visual axes within its open space. An other interesting and an informative measure about how deep the space is in Ghadames, is the maximum depth from the carrier of the system

(Maximum turns in direction needed to move from one part to another within spatial system of the walled city). It is found 26 steps of depth, which reflects that the structure of spaces in the system is much far deeper relative to female spatial system (upper floor as a female domain). However, if this measure for Ghadames is compared with a large city like Tripoli, which has roughly the same number of steps than it is obvious, that Ghadames has a distinct depth property. Moreover if it is compared with that of Benghazi we can discover that Benghazi has shallower spaces since the maximum depth is 22. (See table 7.5)

Looking at control value (see table7.2) measured in terms of standard deviation (Std) –conventionally mean control value for the systems equal 1 see chapter 5 for more information - as a local syntactic measure (table 7.1), it is clear that the ground floor (male domain) system has Std 0.838 whereas the upper floor (female domain) has 1.114 which reflects two main facts about control over the spaces. First, the male spaces have generally stronger control than female spaces, which are unexpected, feature if we look at a strict tree-like pattern of the female. Second, the reduction in Std values from 1.114 for upper floor to 0.838 for ground floor indicates that with more connections among spaces, it is less likely that one or a few spaces will dominate access to other spaces in the spatial system of Ghadames.

It is also informative to measure the intelligibility for the male spatial system by investigating the correlation between global integration and connectivity. This measure clarifies how intelligible the ground floor is for the male users of the system. The value of correlation is 0.1221(fig 7.2), which indicates weak intelligibility of the spatial system for the user. This implies that male users confront difficulty in capturing the whole structure of the city from their experience of the small parts.

Moreover, the correlation of Global and local integration, which is known as synergy measure, is 0.23. This measure reflects the nature of the male space configuration as a product of both the inhabitants and the visitors this implies that local areas of male are globally separated, even in the case of residential areas close to integration core (centre).

Table (7.1) *illustrated various syntactic measures of the three maps of Ghadames*

	Ground floor "Male Domain"	Upper floor "Female Domain"	Ghadames With entrances
Morphological properties			
Convex spaces	1168	448	2640
Axial lines	744	371	2139
Mean length (m)	39.52	11.41	16.52
Buildings	1535	835	1535
Islands	94	16	94
Thoroughfares	434	212	434
Dead ends	233	154	1705
Thoroughfares / Dead ends ratio	1.8627	1.3766	0.2545
Area of open space (esq.)	125484.7813	18848.5594	-
Perimeter (m)	36644.7813	12290.6508	-
Measure of convexity			
Convex articulation	0.7609	0.5365	1.7198
Convex deformation of grid	12.4255	28	28.085
Grid convexity	0.0979	0.0558	0.0433
Measure of axiality			
Axial articulation	0.4847	0.4443	1.3934
Axial integration of convex spaces	0.5711	0.2318	22.7553
Grid axiality	0.0321	0.02695	0.01
Numerical properties			
Convex ringiness	0.0403	0.018	0.0178
Axial ringiness	0.0634	0.0217	0.022
Syntactic measures			
Integration (Rn) global	0.5577	0.5824	0.5917
Integration (R3) local	1.6078	1.4877	1.648
Connectivity	2.7	1.84	2.35
Intelligibility (Rn vs.Con)	0.1221	0.116	0.0423
Synergy (Rn vs. R3)	0.2267	0.211	0.0891
Max depth	26	20	34

Source: *results derived from the three axial maps using space syntax Webmap package and data manipulated using SPSS statistical package.*

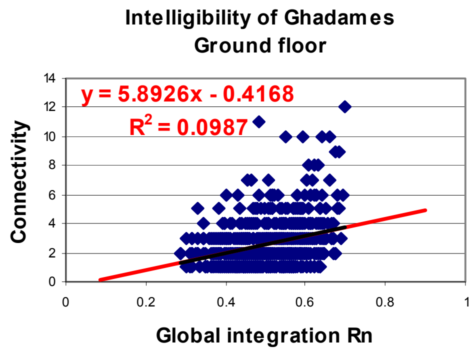
7.2. SYNTACTIC PROPERTIES OF GHADAMES UPPER FLOOR (FEMALE DOMAIN):

Having analyzed Ghadames ground floor (male domain), this section will focus on investigating the syntactic and morphological properties of the upper floor (female domain). However, the upper floor is analyzed as an independent spatial system dominated by female users. First, both convex and axial maps are constructed and deeply analyzed. The relevant results are summarized in table 7.1. These results include morphological and syntactic measures illustrated numerically and graphically in form of tables and relevant maps (See Append A1). These measures represent various properties that reflect the female spatial system and can be discussed in detail under the following aspects:

Table (7.2) *Descriptive Statistics for Ghadames Ground Floor "male domain"*

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Total step depth	744	7553	15544	7690659	10336.91	1450.80
Total count	744	745	745	554280	745.00	.00
Total r3 depth	744	3	48	10419	14.00	8.45
Total r3 count	744	3	30	6959	9.35	4.83
Connectivity	744	1.00	12.00	2011.00	2.7030	1.6953
Control	744	.08	7.50	743.01	.9987	.8380
Integration	744	.3504	.7617	411.2178	.552712	8.14959E-02
Integration 3*	744	.2109	4.5464	1196.1732	1.607760	.798303
Fractional ra	744	.0093	.0200	9.6538	1.29755E-02	1.87974E-03
Max depth*	744	20	34	19641	26.40	2.71
Integration X*	744	.33	1.36	715.45	.9616	.1803
Fractional X	744	.05	.25	124.41	.1672	5.873E-02
Fractional count	744	1.00	1.00	744.00	1.0000	.0000
Un justified length	744	.63	879.75	74598.22	100.2664	101.5180
Length (m)	744	.25	346.79	29405.51	39.5235	40.0169

Source*:* *results derived from the ground floor axial map using space syntax Webmap package and data manipulated using SPSS statistical package.*



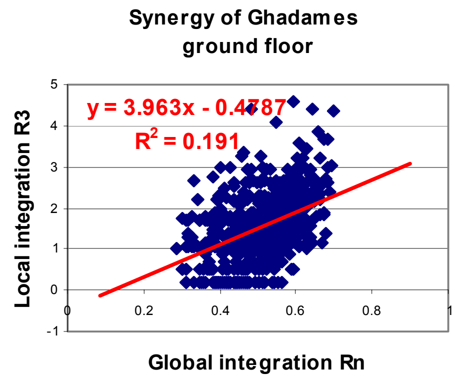


Fig (7.3) : *Scatter gram for two syntactic measures in Ghadames ground floor shows:(a) intelligibility (global integration vs. connectivity): (b) synergy (global integration vs. local integration).*

7.2.1. MEASURE OF CONVEXITY

The general investigation of the female convex map (fig 7.3) shows many similarities to that of the male discussed in previous section except for a few measures. These measures can be investigated in detail and compared with that for the male spatial system. The female convex articulation as a local variation is 0.536, which is lower than of the male. This obviously indicates that the female open spaces are less break up and more spatial synchrony. However, looking at an other informative measure, which is the degree of open space deformation, it is found 28 higher than for the male open spaces. This fact reflects that the female convex spaces have non-geometrical and more deformed grids in the urban texture. The grid convexity measure of the female is 0.056 lower than of the male and this confirms more irregularity and more deformation of the grid structure of female spatial system.

7.2.2. MEASURE OF AXIALITY

Generally, the axial measures of the female open spaces are lower in their values than that of the male. These differences reflect to some extent the distinctive properties of the female open spaces. The axial articulation value of the female is much lower than of the male. Therefore, it shows female open spaces as more axial and less break up than male open spaces. Moreover, the axial integration value of the female open spaces is also lower (0.23) which reveals that the male open spaces have high axial integration relative to that for the female. This can be observed through the long linear routes in Ghadames ground floor. The grid axiality measure- comparing an orthogonal grid with the same number of islands in the spatial system- for female is 0.026 which nearly similar to that of the male. This fact reflects very low approximation a grid with non-axial organization of female spaces.

Measuring the distributidness of the female spatial system through both convex and axial ringiness reveals that it has an organic and tree-like structuring open spaces. Both convex and axial ringiness has lower values than of the male confirming more irregularity of the female spatial system.

7.2.3. MEASURE OF SYNTACTIC PROPERTIES

Having analyzed both the axial and convex properties, this section will discuss the interface between axiality and convexity of the female open spaces through the syntactic measures. These measures illustrated in table 7.3 reflect both local and global structuring properties of the female spatial system.

Globally, the integration value- unrestricted radius- for the spatial system is 0.58 higher than for the male. The global integration map fig (7.3) shows very precisely the most integrated and segregated parts of the system. The integration core of the system is clearly located in the central area where most of female activities took place. These activities include the religious facilities located in the upper floor of the central mosque (Younis), shopping activities a round the main square (El kadus) of the settlement and probably the only public link to ground floor for female through the mosques' staircases.

However, the form of integration core confirms the importance of the main square and the surrounding activities for Female activities. The segregated areas within female spatial system are located in the edges of the system where the dead-end streets (cul-de-sacs) of the residential areas are found. However, looking at the maximum depth measure for female spaces (20 steps of depth), it is shallow system compared with that for the male (26). Therefore, the female move within the system with less change in their direction and pass through smaller number of spaces in their journeys than the male do.

Locally, the integration measure-restricted to radius 3- for female spatial system is 1.48 and the most integrated and segregated local spaces is illustrated in fig (7.3e). The general distribution of this local measure shows clear uniform distribution of the integration values throughout female open spaces. This distribution resembling the hierarchy of the street system with locally segregated spaces in dead-end streets and integrated along the main street of the system. This reflects social logic of female spaces hence the most integrated spaces create spatial opportunity for gathering small groups of females belonging to the same ethnic community. However, looking at the property of control for female spaces, it is clear from the control map(Append.A) and the value of standard deviation (1.114) for the system that female spatial system has generally less control over space compared with the male spatial system. At first glance, this fact seems illogical if we observe the strict tree-like structure of female spaces but if the control value calculated for each space we can recognize that 37.73 % of spaces has strong control (greater than 1) compared with about 43.4% spaces in the male spatial system. (See chapter 5 for more about control). An other fact is that the distribution of control value for female system ranges from 0.1 to 8.4 whereas in the male spatial system ranges between 0.1 and 7.5. This confirms that some female spaces within the system have stronger control value than the male system.

An other local informative measure worth discussing in this context is the connectivity measure. This measure sheds more light on the degree of accessibility within the system since the intensity of social interactions and encounters in spatial setting depend on degree of accessibility both at local and global level of the system.

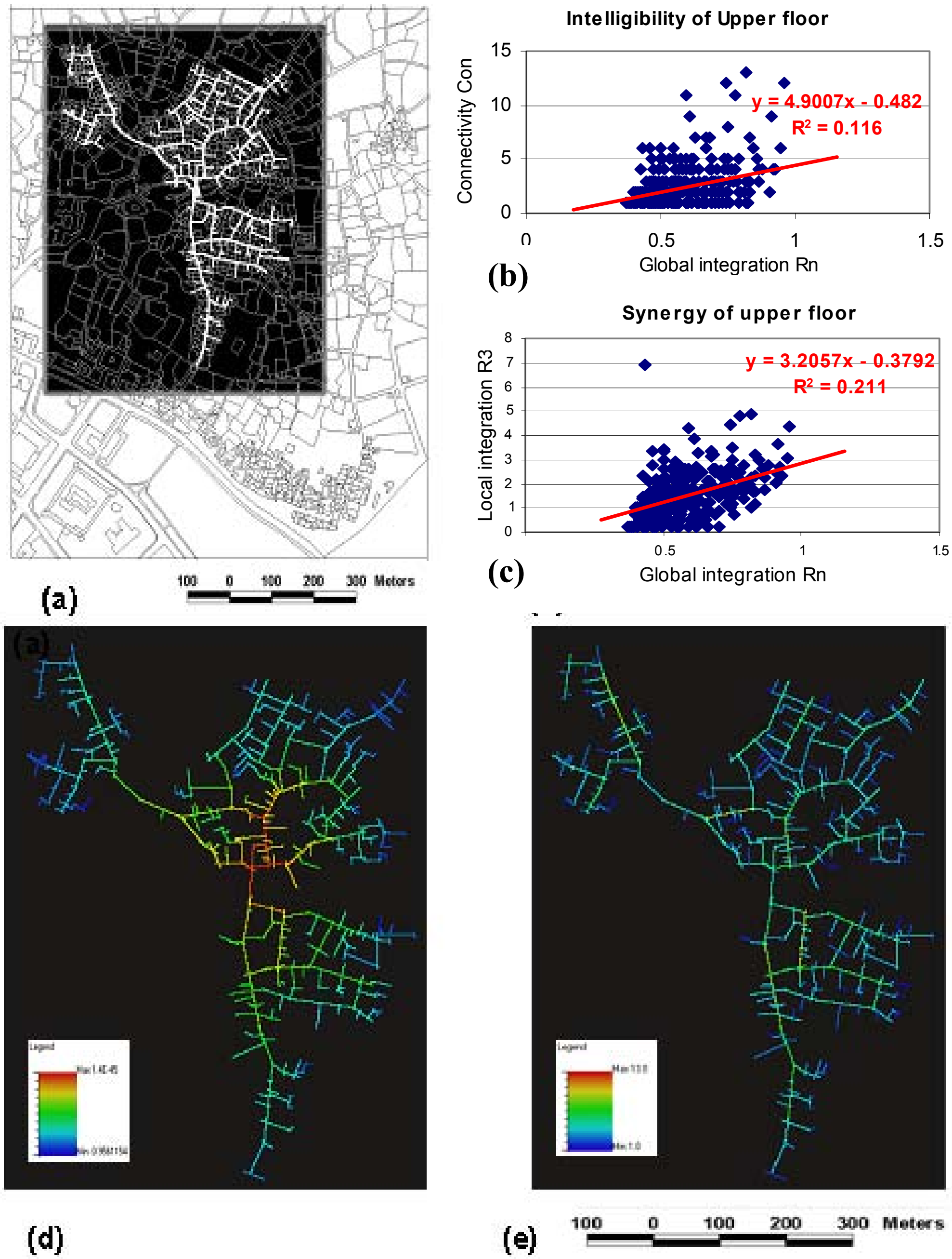


Fig (7.4) *Ghadames upper floor 'female domain'* ***:(a)*** *open space map with female spaces in black* ***:(b)*** *and* ***(c)*** *diagrams shown intelligibility and synergy:* ***(d)*** *axial map shows global integration:* ***(e)*** *axial map shows local integration.*

However, the average connectivity value of female spatial system is 2.37, which is lower than that for the male system (2.7). This reflects restricted accessibility in the female spatial system and confirms sense of boundary, which increases with decrease in accessibility of an individual or group of female in spatial setting. It is may be difficult to sustain a group identity due to intrusions with increase accessibility. However, in such a system female individual may very well find its own territory, which, however, is better defined as privacy than territoriality. Furthermore, the average length of the female axial line or visual axis is 11.5m, which is nearly quarter length of the male axial line. This visual property confirms that the female spatial system restricts long visual axes and protects visual privacy for the system users.

The correlation of global integration to connectivity (fig 7.3b) known as intelligibility for female spatial system (0.116) is found to be nearly similar to that for the male system. This low correlation is due to density and broken axial lines that distinguish generally most of Islamic organic cities. The correlation between local and global integration (inhabitant / visitors) which is known as synergy (fig7.3c) was also found very low (0.211) and nearly similar to that of the male.

7.3. SYNTACTIC ANALYSIS OF GHADAMES WITH ENTRANCES OF THE BUILDINGS EMBEDDED

Having shed light on both male and female domain in the walled city of Ghadames, this section attempts to give more insight about Ghadames internal structures considering both visibility and movement from the building entrances. However, all entrances of the buildings in Ghadames were marked and comprehensive axial map prepared of the whole Ghadames. However, to give clear picture about grids and natural movement in Ghadames from individual block or building, it is useful to provide quick overview to four known theories that are helpful in understanding the syntactic analysis and the relevant measures. The four theories are: the theory of “natural movement”, the theory of “movement economy”, the theory of "centrality as a process” and the theory of "the city as object" (Hillier, 1984, 1996,2000, 2001). They provide the theoretical basis for analysis.

Table (7.3): *Descriptive Statistics for Ghadames Upper floor" Female domain*

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Total step depth	744	7553	15544	7690659	10336.91	1450.80
Total count	744	745	745	554280	745.00	.00
Total r3 depth	744	3	48	10419	14.00	8.45
Total r3 count	744	3	30	6959	9.35	4.83
Connectivity	744	1.00	12.00	2011.00	2.7030	1.6953
Control	744	.08	7.50	743.01	.9987	.8380
Integration	744	.3504	.7617	411.2178	.552712	8.14959E-02
Integration 3*	744	.2109	4.5464	1196.1732	1.607760	.798303
Fractional ra	744	.0093	.0200	9.6538	1.29755E-02	1.87974E-03
Max depth*	744	20	34	19641	26.40	2.71
Integration X*	744	.33	1.36	715.45	.9616	.1803
Fractional X	744	.05	.25	124.41	.1672	5.873E-02
Fractional count	744	1.00	1.00	744.00	1.0000	.0000
Un justified length	744	.63	879.75	74598.22	100.2664	101.5180
Length (m)	744	.25	346.79	29405.51	39.5235	40.0169

Source: *results derived from the Ghadames axial map (upper floor) using space syntax Web map package and data manipulated using SPSS statistical package.*

also argues that while we may find movement and attractors (land-use or functional types which benefit greatly from movement and by themselves are capable of generating movement, such as retail shops) highly related to each other, we cannot assume that movement can be explained by attractors until we can be sure that the configuralional properties of the grid have not influenced both the presence of movement and the presence of attractors (Hillier, 1984). The key here is that while the grid configuration can directly influence both the patterns of movement and attractor distribution, movement and attractors cannot directly influence the grid parameters.

The theory of 'movement economy' explains the mechanism, which generates the common strong association between movement and attractors. According to this theory, it is the grid structure that initially influences the pattern of movement, and they then affect the distribution of attractors, which in turn attracts more movement into the grid, creating the multiplier effect on movement (Hillier, 1996).

The theory of "centrality as a process" concerns the mechanism, which generates the spatial characteristics of a functional land-use type of areas, which benefits highly from movement. The key to this process is the minimization of mean trip length in order to generate movement economy within the local grid (Hillier, 2000). Mean trip length is minimized through “metric integration”, that is, the minimization of both the configurational distance (the topological distance to go from A to B) and the metric distance (the specific distance to go from A to B).

The theory of “the city as object” suggests that there is a generative process, which has a dual characteristic working through socio-cultural and micro-economic forces, and which gives rise to the variation and invariants of area structure across cities (Hillier, 2001). The socio-cultural process generates the variation in urban grids across cities, mostly seen in residential areas and influenced by variety in tastes, norms, standards, etc, through the degree to which movement economy is controlled. The micro-economic process generates the invariants, i.e., the deformed-wheel shape of the global city structure and the compact and integrated local grid Structure of a functional area, which benefits highly from movement in order to promote movement economy. Accordingly, the study hypothesized that spatial structure is the primary factor influencing functional development across and within areas, through its ability to influence the pattern of movement, and so facilitate different land-use specialization in different areas, with different spatial structures to accommodate these functional differences.

Having introduced these theories, it is better to investigate the axial map for further insights. However, The syntactic analysis of the detailed axial map was carried out and the findings are graphically and statistically presented to give a clear and precise picture of these internal structures. However, from the syntactic measures summarized in table (7.3), it is clear the maximum depth from entrances of the buildings (34 step) is extremely deep relative to the both previous axial maps. This fact reveals that the inhabitant of the walled city turn on average 34 times in their movement from their building entrances to the carrier of the system. This very deep structure of spaces (or entrances) is a common feature in tree-like pattern which emphasizes tendency to strain access to buildings and therefore, creating high level of privacy.

Table (7.4): *Descriptive Statistics for Ghadames" with building entrances embedded"*

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Total step depth	2139	63721	5	63726	34022.87	7070.18
Total count	2139	2137	4	2141	2138.00	79.99
Total r3 depth	2139	106	3	109	20.00	15.71
Total r3 count	2139	63	3	66	12.17	8.78
Connectivity	2139	24.0000	1.0000	25.0000	2.350164	2.605198
Control	2139	17.9131	.0400	17.9531	1.000283	1.722169
Integration Rn	2139	.6254	.2948	.9202	.591747	.111402
Integration 3*	2139	6.7393	.2109	6.9502	1.647985	.946158
Fractional ra	2139	.2932	.0032	.2963	5.52832E-03	1.05956E-02
Max depth*	2139	45	2	47	33.76	5.05
Integration X*	2139	1.2323	.4721	1.7044	1.147774	.206706
Fractional X	2139	.2215	.0000	.2215	1.03539E-04	4.78861E-03
Fractional count	2139	0	1	1	1.00	.00
Length "m"	2139	324.1973	.9805	325.1778	16.525011	26.332780

Source: *results derived from the Ghadames axial map (entrances embedded) using space syntax Webmap package and data manipulated using SPSS statistical package.*

Looking at the global integration map (Fig 7,6) it is striking that the most integrated lines or integration core picks out precisely and more defined than those of male and female axial maps. Hence, the most integrated line extends toward the center where the mosques, public square, and main market place (El Katus) are located (see land use in chapter 6). It seems that when the entrances of building are included in the axial map, the distribution of global and local integrated lines become more informative about movement within the city. Moreover, global integration map shows that the three residential areas (Auld Blel , Mazigh, Tuarg) are partially segregated and deeper relative to other residential areas.

The local integration measure (see fig7.7) reflects the fact that the most integrated spaces are locally distributed in almost regular pattern. This pattern resembles the order of the street system with deep cul-de -sacs (marked in blue), feeder streets (light green) and main streets (dark green). Looking at the connectivity measure (2.35) of the axial map, it is lower than that of Arab cities (2.97) which shows how the accessibility is restricted in Ghadames to create the desire level of interaction a among the inhabitants. This also can be seen through the short length of the axial lines (view shields or isovist radial), which is on average (16.5 m) lower than what we have seen in Libyan cities (141.2m). This again confirms high degree of enclosure that people of Ghadames confront in their spaces.

However, the correlation value between global integration and connectivity, which is known as intelligibility, is found too low (0.037) even lower than that of the Libyan cities (0.204). This luck intelligibility is due to the fact that Ghadames grids are constructed of tiny streets, broken axial lines, often covered, straight for short sections but generally turning, twisting, and opening into each other and into obviously private dead-end streets.

Synergy is an other informative measure that gives more insight about the correlation of global and local integration value mentioned, it is found 0.08 that is a very low value compared with that of Libyan cities (0.375). This reveals that the local areas of Ghadames is globally segregated and again confirms strong tendency to manage their desire level of privacy.

7.4. SYNTACTIC PROPERTIES OF GHADAMES IN COMPARISON TO CITIES IN LIBYA AND SOME CITIES AROUND THE WORLD

Enough syntactic studies have been done to show that although cities around the world share many spatial characteristics (Hillier, 1996); there are significant differences in the syntactic and geometrical structures of their spaces. Some of these differences are likely to be the results of cultural differences between them; for example, cities in the Arab world are on average much less connected and integrated. (Locally and globally) than European cities (see below table 7.5)

However, looking at the syntactic properties of the walled city of Ghadames, it was necessary to compare them in the first place with those syntactic measures of the Libyan cities. However, the space syntax enable us to compare different cities regardless of their size which is a great advantage of this technique- the impact of the size is eliminated by using normalizing mean depth concept (see chapter 5 for normalizing mean depth concept). In the recent Libyan studies there were not any syntactic measures based on space syntax technique that we could compare with, therefore, it was essential that axial maps of some Libyan cities be constructed and then syntactically analyzed to establish some general syntactic measures for the Libyan cities.

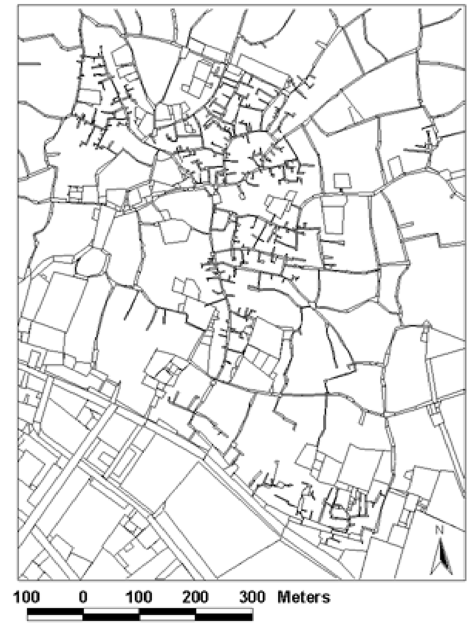
Table (7.5) *Comparison of syntactic values of Ghadames to that of rest of the world*

	K cases	Axial size	Connectivity (Con)	Local Integration	Global Integration	Intelligibility Rn vs. R3	Synergy Rn vs. R3
USA	12	5420	5.835	2.956	1.610	0.224	0.559
Europe	15	5030	4.609	2.254	0.918	0.137	0.266
U.K	13	4440	3.713	2.148	0.720	0.124	0.232
Arab	18	840	2.975	1.619	0.650	0.231	0.160
Libyan*	6	1416	3.53	2.061	0.904	0.192	0.369
Ghadames*	1	744	2.7	1.608	0.558	0.122	0.227

Source: *Average syntactic measures of 6 Libyan cites prepared by the author The other cases extracted from paper A Theory of the city as Object by Bill Hillier, 3rd space syntax Symposium, Atlanta, 2001.*

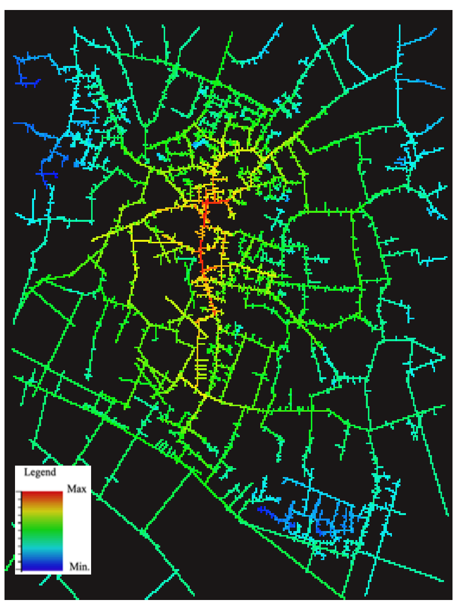
However, the axial maps of five elected Libyan cities are prepared in addition to Ghadames. These cities are different in their size include Tripoli, Benghazi, Ghat, the old Tripoli, and the old Benghazi. The two former cities are Capital city and the second largest city in Libya (formal planned) and the three later cities are Ghat, old Tripoli town, and old Benghazi town (informal planned). The city of Ghat is similar to Ghadames in many aspects like size, function, and climatic conditions, located in the same region and populated by tribal communities.

They are syntactically analyzed and various axial maps and numeric measures are derived from the base maps. These general measures of Libyan cities are the overall average values derived statistically from the measures of these cities.



Fig(7.6) *Ghadames open spaces tran-scripted in black colour*

Fig (7.7) *Ghadames open spaces tran-scripted into convex map.*



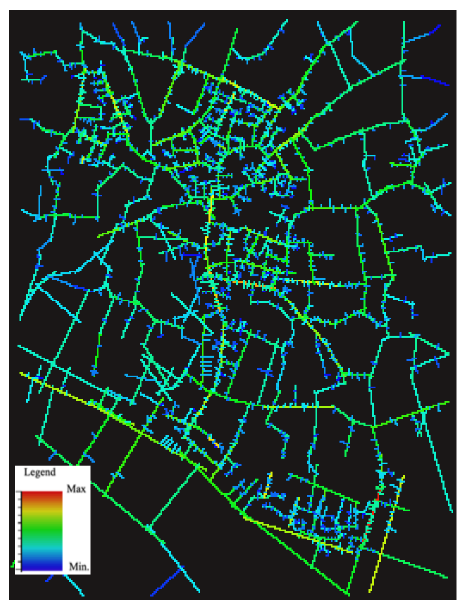


Fig (7.8) *Ghadames axial map shows: global integration of its spatial system with entrances of the building embedded.*

Fig(7.9) *Ghadames axial map shows: Local integration of its spatial system with entrances of the building embedded.*

They are syntactically analyzed and various axial maps and numeric measures are derived from the base maps. These general measures of Libyan cities are the overall average values derived statistically from the measures of these cities.

The syntactic properties of Libyan cities (see table 7.6) indicate that the average global integration is 0.9, which is higher than the Arab and UK cities and closely matches the European cites. This measure would be 0.87 if the formal planned cities (Tripoli and Benghazi) were excluded with a very slight change. This confirms that structure of spaces in Libyan cities is likely to be globally integrated.

An other informative measure of the Libyan cities is the local integration (R3) which shows that the Libyan cities are locally integrated to extent that most of Arab cities. Hence, the local integration (1.6) is closely matches the Arab cities even if the formal cities are excluded. However, The average connectivity measure of Libyan cities is 3.53, which is comparable to that of UK cities and more than that of the Arab cities. If the two formal planned cities are excluded, the connectivity value deceases to 3.2, which is slightly higher than Arab cities.

An other general interesting syntactic measure for the Libyan cities, is the intelligibility of its structures as measured in terms of the correlation between connectivity and global integration, the measure shows that Libyan cities are more intelligible in terms of their structures than both UK and European cities, but less intelligible than Arab cities.

The Libyan cities have also on average high synergy value (0.369) which shows the co relation between local and global integration (Table 7.6), this value when compared with that of UK and European cities is much more higher, but less than US cities. This fact reveals that local structures of the Libyan cities are globally integrated.

Table (7.6) *Syntactic measures of six Libyan cities including Ghadames with its three spatial system.*

	Conn= ctivity	Average Length (m)	Max depth	Integ- ration X	Local integration (R3)	Global integration (Rn)	Intelli- gibility Rn / Con	Synergy Rn / R3
Tripoli	3.82	238.69	26.27	1.346	2.229	0.948	0.1976	0.4456
Benghazi	4.46	201.02	21.79	1.463	2.528	0.992	0.1565	0.3204
Ghat	3.06	76.50	15.61	1.12	1.809	0.898	0.2134	0.3563
Tripoli old town	2.77	72.80	17.31	1.113	1.691	0.9317	0.2626	0.4938
Benghazi old town	4.36	218.56	14.72	1.45	2.5	1.15	0.219	0.4041
Ghadames(ground)	2.55	39.52	26	0.919	1.518	0.5037	0.0987	0.191
Ghadames (upper)	2.37	11.41	20.17	0.922	1.4877	0.5824	0.116	0.211
Ghadames (entrances)	2.35	16.52	33.74	1.148	1.648	0.5917	0.0423	0.0891

Source: *prepared by the Author using intensive statistical manipulation based on formal maps Tripoli and Benghazi master plans, Poly service Ltd, 2002; Ghat formal plan by Doxiads, 2000; Ghadames layout by UNSICO, updated 2003.*

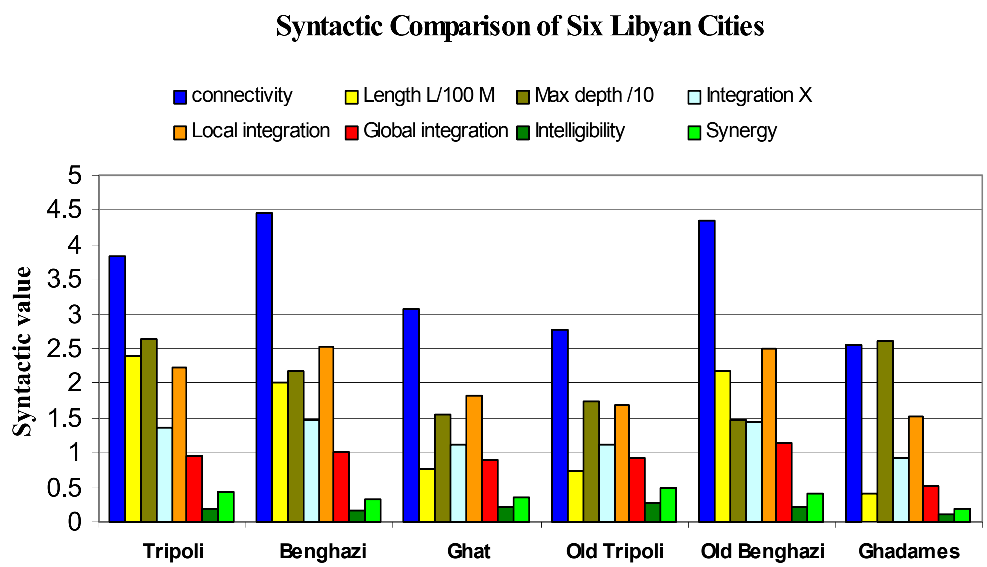
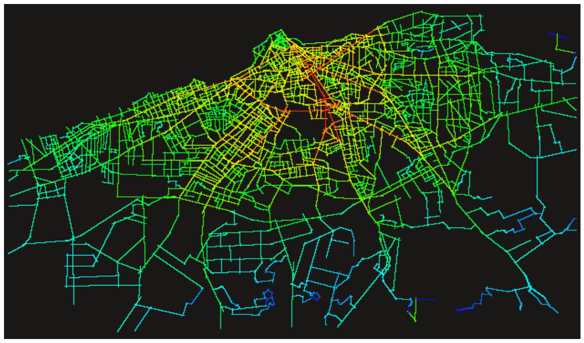
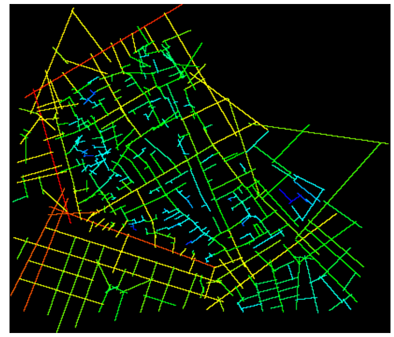


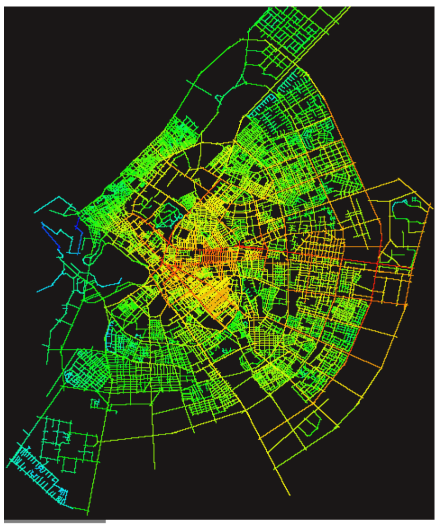
Fig (7.10): *Bar chart shows syntactic measures of six Libyan cities.*



(a) Tripoli, Capital city

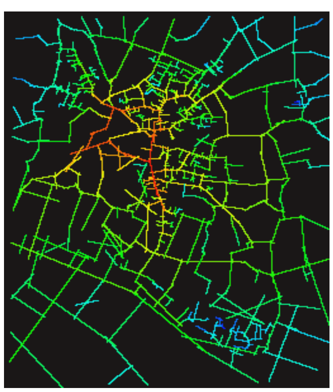


(c) Tripoli, old town

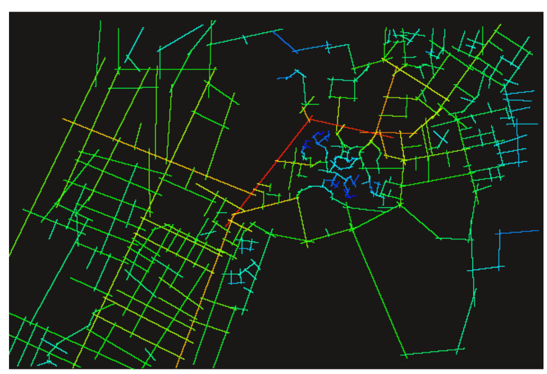


(b) Benghazi, second

(d) Benghazi, old



(e) Walled city of Ghadames



(f) Ghat, traditional

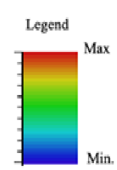


Fig (7.11) *axial maps of six Libyan cities show Global Integration measure (see Append 1c for various axial maps)*

7.5. SYNTACTIC COMPARISON OF MALE AND FEMALE DOMAINS

Having analyzed in detail both the ground floor (male domain) and the upper floor (female domain), this section attempts to summarize the space characteristics of both domains as well as to more insight interpretation of their space structure and use. However, Ghadames ground floor as male domain characterized by deep structures of spaces with little control over them, long visual axes, high level of accessibility between spaces, non-intelligible and users are not able to recognize the whole structure of Ghadames by experience of the small parts.

However, this section has as its objective the investigation of how the urban spatial characteristics concerning syntactic and morphological measures such as accessibility, integration, control, visibility and others, specifically influence both male and female residents' perception of privacy within their open spaces. This syntactic analysis is carried out in a comparative study of two spatial systems, which are dominated by male and female discussed in the pervious section. However, Ghadames is strongly affected by privacy in form of tendencies toward spatial partitioning, gender segregation, strong enclosure, and high spatial depth in the urban setting. It is verified in these specific urban contexts how far greater segregation and depth, and less control determine open spaces perceived by residents as more vulnerable to privacy.

Accessibility, which means access to a certain space and has implication for potential movement, presence of people, and use of spaces, is one of the configurational characteristics which has been identified as directly related to the communication and spatial interaction, mainly by studies involving syntactic analysis (Hillier & Shu, 1999; Shu, 1999). The degree of accessibility and consequently potential of movement and presence of people in the urban space would affect the choice of path to be followed by pedestrians, since people would be attracted by spaces with people and would tend to avoid deserted spaces (Gehl, 1987).

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Table (7.7) *shows comparative measures of male and female domains in terms of morphological and syntactic properties.*

Positive criteria			Negative criteria
Synchrony	FE	MA	Asynchrony
Regular	MA	FE	Irregular
Angular	FE	MA	Organic
Axial	MA	FE	Nonaxail
Distributedness	MA	FE	Nondistributedness
Symmetry	FE	MA	Asymmetry
Cul-de -sacs	FE	MA	Thoroughfares
Strong Rn integration	FE	MA	Weak Rn integration
Strong R3 integration	MA	FE	Weak Rn integration
Strong control	FE	MA	Weak control
High connectivity	FE	MA	Low connectivity
Spatially shallow	FE	MA	Spatially deep
Accessibility	MA	FE	Inaccessibility
Long visual axes	MA	FE	Short visual axes
High synergy	MA	FE	Low synergy
H. Intelligibility	MA	FE	L. intelligibility

Comparing the values of global integration (Rn=0.55) and local integration (R3=1.61) in male spatial system (ground floor) and in female spatial system (Rn=0.58 and R3=1.49), It can be seen on one hand that the slight higher global integration value in female spatial system than male reflects the less level of segregation of upper floor (female domain) configuration, which tend to reinforce the movement and control by the visitors. In detriment of the movement and control by the resident (Table7.7). On other hand, the value of local integration is lower than that of the male, which indicates that female spaces are locally far more segregated than male spaces, therefore, the female residents tend to reinforce the movement and control locally rather than the visitors do.

This fact reveals that female spaces are globally integrated whereas the male spaces are globally segregated. This fact can be confirmed in Ghadames spatial setting, hence the most three integrated lines globally in female spatial system (Rn=0.95, 0.94,0.93) constitute the only nuclei of the system where the female religious school, main shopping area, an the only common link to ground floor are located. This services and facilities enhance a great deal of interaction among the female residents within the whole system rather than three steps away from their spaces.

There is clear central distribution of accessibility in the grid of female spatial system, existing the only nuclei where most of the integrated lines are found, the others are more segregated lines located away from the integration core (Fig7.4a), where 0.96 is the maximum value of global integration and 0.37 is the minimum value. Hence, it is possible to define two distinct areas in female spatial system, based on the values of global integration: one located along and around the integration core of the grid, and characterized by integrated spaces, where the global spatial organization predominates, reinforcing the movement and control by the visitors; and the other situated away from the centre of walled city, where three axes establish the most segregated areas of the urban pattern of Ghadames, giving priority, in this way, to the global organization of space, and to the movement and control by the residents(Fig7 4).

In the analysis of the axial map of global integration of male spatial system (Fig7.3), there is only one integration nucleus (deformed wheel) in the system, with all the other spaces tending to segregation, as they extend away from this axis, as a consequence of the proposed "cul-de-sac" layout, which accentuates the asymmetry. Hence, the main access route to the Ghadames centre, as its surroundings, reinforces the movement and control by the visitor, with such control being transferred to the resident as one penetrates into the interior of the city. The maximum value of global integration is 0.76 while the minimum is 0.35, both far inferiors to those in female spatial system (Table 7.1), reflecting the greater global segregation of the configuration in ground floor (male domain) when compared to upper floor (female domain).

Analyzing the axial map of local integration of upper floor (female domain), considering the limit of three steps of depth, it is observed that there is a relative equilibrium in the distribution of integration levels and consequently accessibility, predominantly highlighting many axes, mostly feeder streets, as the most integrated in the system (Fig7.3c). The values of local integration in upper floor (Append A), show a maximum local integration value in female spatial system 6.9 and a minimum value of 0.22, far superior to those in ground floor (maximum = 4.5; minimum = 0.22), therefore, reflecting two interesting properties of female spaces: first they are more locally segregated than those of the male. Second property is that female spatial system has some spaces more locally integrated than that of the male has. Moreover, both domains has the same minimum local integration value- the difference is only in number of those spaces within the system- in another wards both of them has the most locally segregated spaces, but generally, female spaces are far more locally segregated as a configuration than the male spaces.

The analysis of the degree of control in ground floor (male domain), considering all the 774 lines which constitute the grid of the ground floor, confirm the tendency to segregation of the spaces in the city, as a function of `no exit' streets (cul de sacs), with a central axis connecting the two central mosques, water spring, and retail activity area, constituted by a highly controlled line, with the degrees of control tending to diminish as spaces are located further away from this axis. Examining the degrees of control of those lines which constitute the ground floor (male domain), the highest control value is 7.5 (), the lowest value is 0.1 (line 15) and the standard deviation (std) is 0.84(control is a local measure and all systems of space has mean control value equals one, therefore, using Std is essential measure for measuring general control value). It is 43.4% of the ground floor axial lines (744 line) that has high control value (greater than 1) whereas the remain (421 line) has low control value. In upper floor (female domain), the highest control value is 8.5 (line 1), the lowest value is 0.1 (line 32), and the Std is 1.12. It is about 37.7 % of female spaces that have high control value.

Comparing both axial maps in terms of control property, it is obvious that the ground floor (male domain) has generally strong control over its spaces than the upper floor. Moreover, the most controlled spaces are found in upper floor (female domain) rather than in ground floor, hence the degree of control changes for female spaces in wider range (8.4) than that for the male (7.4). It seems that, there are only a few spaces far more controlled in female spatial system but there is also many spaces far less controlled than the male spaces. In general, the ground floor spaces are much more controlled.

The analysis carried out allows for the conclusion that the male and female spaces have very dissimilar syntactic properties and accessibility characteristics, with the latter presenting a far more globally integrated and shallow configuration, making more easy the movement and control by the visitor. Therefore, these results suggest that the problems related to lack of privacy in the Ghadames should be greater in ground floor than in upper floor.

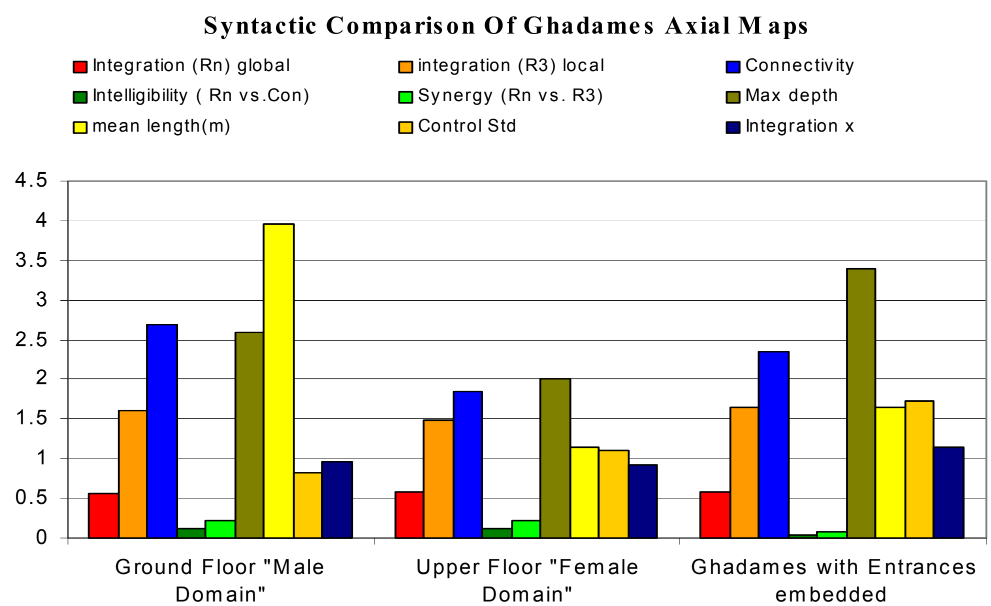


Fig (7.12): *Bar chart shows syntactic measures of three axial maps in the walled city of Ghadames in comparison with each other.*

7.6. SYNTACTIC PROPERTIES OF MALE/FEMALE SPATIAL SYSTEMS IN CONTEXT OF THE WALLED CITY "EMBEDDED MODEL"

Having established the general properties of the walled-city of Ghadames with both independent male/female spatial systems (cut-out model) and how they compare with Libyan cities as well as cities around the world, the next set of analyses looked at the relation of the ground floor (male domain) and upper floor (female domain) spatial systems with each other, as well as to the city as a whole. This type of analysis namely embedded model analysis has been found very useful in showing similarity and difference, as well as the relationships of male/female spaces to the city as a whole. However, the two spatial systems (ground floor and upper floor) of Ghadames are linked by means of the existing communal vertical circulation system (public staircases whreas private staircases within houses excluded) found in Younis mosque near the main square (El katus) and in Komar Giorsan square in south. Therefore, combined axial map for the whole Ghadames was prepared and syntactic analysis was conducted covering both mentioned systems. However, the summary of findings is listed in bellow table (7.8). It shows interesting characteristics of both dependent systems, which ought to be discussed.

Table(7.8) *Shows syntactic properties of ground floor and upper floor in both models as well as a city as a whole*

	Ground Floor "Male Domain"			Upper Floor "Female Domain"			Whole Ghadames
	Embed.	**Cut-out**	**Spatial Diff.**	**Embed.**	**Cut –out**	**Spatial diff.**	
Global integration	0.5369	0.5577	-0.0208	0.5257	0.5824	-0.0567	0.5333
Local Integration R3	1.6067	1.6078	-0.0011	1.5937	1.4877	0.106	1.5992
Connectivity	2.7	2.7	0	2.57	2.37	0.2	2.66
Intelligibility	0.0669	0.1221	-0.0552	0.079	0.116	-0.037	0.0765
Synergy	0.145	0.2267	-0.0817	0.1415	0.211	-0.0695	0.1484
Max depth (step)	17	26	-9	30	20	10	29
Control Std	0.893	0.83	0.063	1.112	1.114	-0.002	0.94

Note: *Embed.: means embedded model, Cut-out: means cut-out or independent model Spatial Diff.: means the difference in syntactic properties of both models for a particular spatial system i.e. ground floor system.*

Looking at ground floor as a male domain in both spatial models in detail, syntactical differences as illustrated in figure (7.13) shows generally that most of syntactic measures in embedded model change slightly but this difference is found not to be significant. For example, syntactic difference in the global integration (unrestricted radius) measure of ground floor is 0.0208, which indicates that ground floor loses a bite of global integration due to its connection to upper floor (female domain).

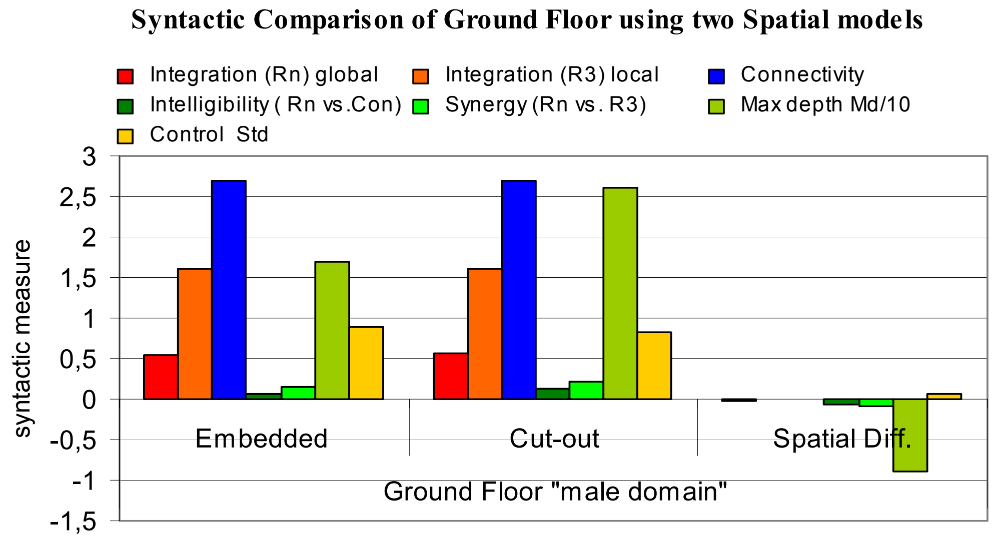


Fig (7.13) *illustrates the ground floor syntactic properties a subsystem embedded and disembedded within the whole city.*

In contrast, the ground floor gains local integration (restricted to 3steps of depth), and gains average maximum depth value as embedded within the whole system. One point is ought to be mentioned here, the difference in maximum depth (Max. number of turns) is very significant (9 steps of depth) which reveals that the impact of upper floor makes the male spaces is too deep within the whole Ghadames. Hence, in cut-out model the max depth is 17 steps of depth whereas in embedded model is 26. In other wards the male users of the system make on average 26 turns in order to traverse from one space to another within the whole city.

Moreover, control measure (a local measure) over ground floor spaces as measured in terms of standard deviation increased slightly in embedded model which reflects that with more connections among spaces in ground floor is less likely that one or a few of these spaces will dominate access to other spaces in the whole spatial system of Ghadames.

Looking at the upper floor of Ghadames as a female domain again in both spatial models of space, it is evident that syntactic difference in properties of the upper floor

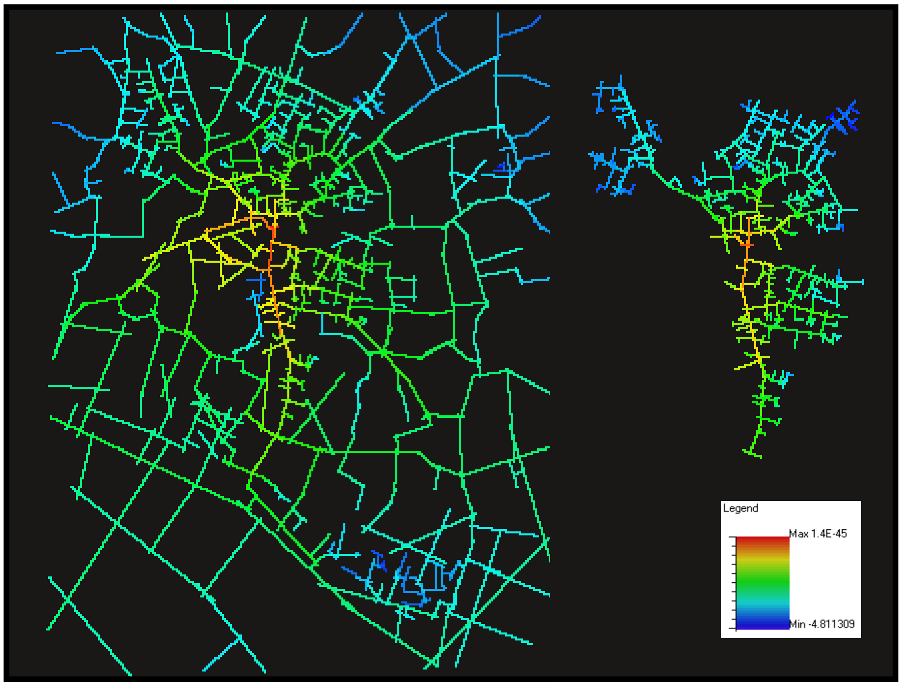
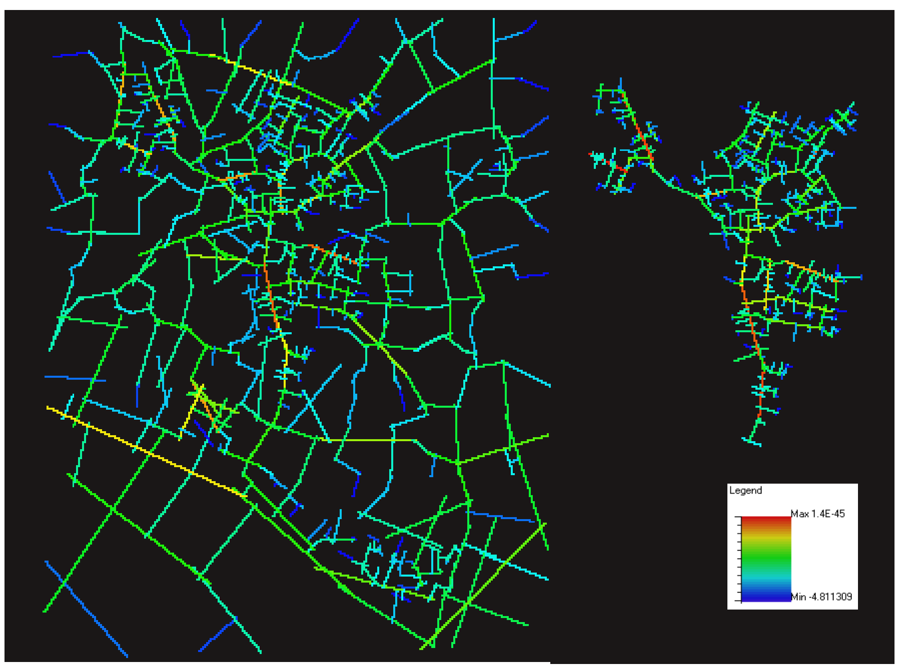


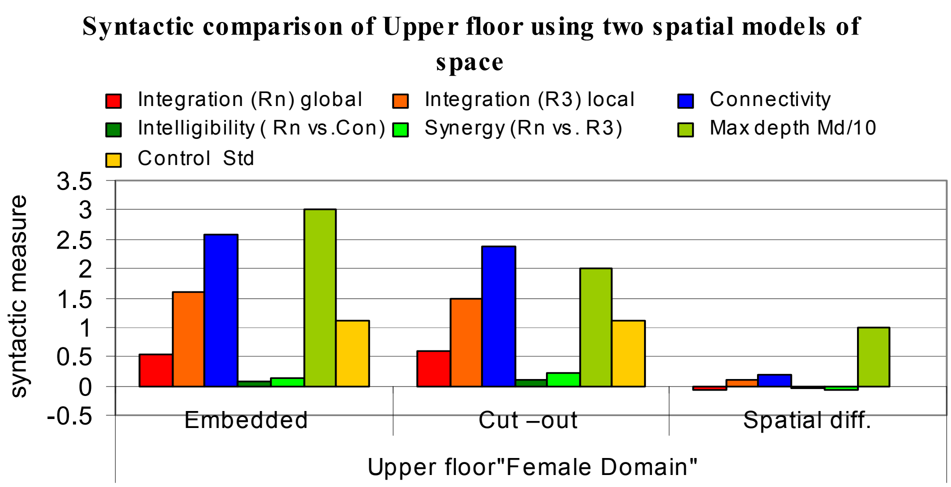
Fig (7.14): *Axial map of the whole Ghadames spatial system –both Ground floor and Upper floor are embedded – shows distribution of global* integration.



Fig(7.15): *Axial map of the whole Ghadames spatial system –both ground floor and upper floor are embedded – shows distribution of Local integration.*

as embedded within the city and as an independent system is quite significant. For example, the average maximum depth (number of turns) within embedded system is far deeper (10 steps of depth) than that of the independent system. This reconfirms that female spatial system embedded within the whole city requires on average 30 turns for female users to traverse from one space to anther. An other interesting point is that the global integration measure of female spaces within the embedded model is lower than that of the independent system, which means the ground floor system impact on female spaces is globally negative for female movement.

This fact is in contrast to local Integration (see fig 7.16) measure, which is much higher within embedded model than that of independent system. The syntactic difference is quite significant (0.106) which means that female spaces are more locally integrated as a positive impact of the male spaces in the ground floor. In another wards, the existing of ground floor as male domain contributes to make female spaces more locally accessible and therefore female social interaction is more likely to occur among female.



Fig(7.16) *illustrates the Upper floor syntactic properties a subsystem embedded and disembedded within the whole citv.*

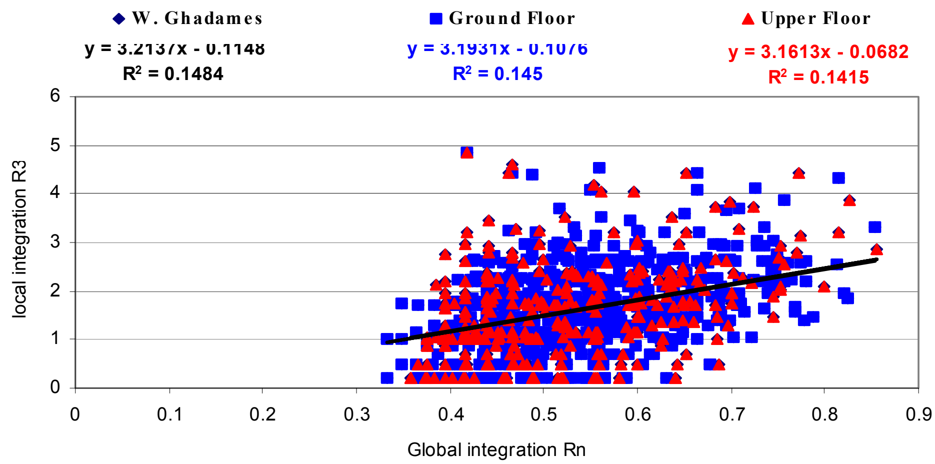
Table (7.9) *Descriptive Statistics for Upper floor " embedded model"*

	N	Min	Max	Sum	Mean	Std.	Var
total step Depth	371	11150	25105	6710743	18088.26	3308.09	10943445.348
total count	371	1133	1133	420343	1133.00	.00	.000
total r3 depth	371	3	60	5638	15.20	10.24	104.931
Total r3 count	371	3	35	3668	9.89	5.79	33.533
Connectivity	371	1	13	956	2.58	1.99	3.969
CONTROL	371	.1	9.1	375.9	1.013	1.112	1.236
Integration	371	.35751	.85553	195.03738	.5257072	.1063634	1.131E-02
Integration 3*	371	.21093	4.83559	591.24974	1.5936651	.8938350	.799
Fractional ra	371	.00618	.01495	3.75941	1.013319E-02	1.815968E-03	3.298E-06
Max depth*	371	22	37	11102	29.92	3.64	13.227
Integration X*	371	.35867	1.50844	367.24997	.9898921	.2025245	4.102E-02
Fractional X	371	.05612	.25000	69.22371	.1865868	5.789709E-02	3.352E-03
Fractional count	371	1	1	371	1.00	.00	.000

Another two interesting key syntactic measures of the embedded male/female spatial system is intelligibility (correlation between global integration and connectivity) and synergy (correlation between local and global integration). First, both male and female spatial systems as embedded model of space are less intelligible than that when they are independent from the whole system of the city. Therefore, the impact of combing both systems leads the whole system of the city to lower value of intelligibility. In other wards, low intelligibility impedes to capture the way users of

Table(7.10) *Descriptive Statistics for Ground Floor " embedded model"*

	N	Min	Max	Sum	Mean	Std. D	Var.
Total step Depth	744	11170	26896	13096791	17603.21	2890.05	8352395.097
Total count	744	1133	1133	842952	1133.00	.00	.000
Total r3 depth	744	3	50	10406	13.99	8.57	73.432
Total r3 count	744	3	31	6954	9.35	4.91	24.092
Connectivity	744	1	12	2014	2.71	1.73	3.010
Control	744	.1	9.1	750.8	1.009	.893	.798
Integration	744	.33266	.85382	399.41856	.5368529	9.652605E-02	9.317E-03
Integration 3*	744	.21093	4.83559	1195.35125	1.6066549	.8093437	.655
Fractional ra	744	.00612	.01463	7.14665	9.605715E-03	1.550631E-03	2.404E-06
Max depth*	744	20	37	20108	27.03	3.13	9.819
Integration X*	744	.32838	1.40456	714.80635	.9607612	.1851149	3.427E-02
Fractional X	744	.04568	.25000	124.72248	.1676377	5.898354E-02	3.479E-03
Fract. Count	744	1	1	744	1.00	.00	.000



Fig(7.17) *shows Synergy measure (local and global correlation) of the whole city in comparison to male and female spatial systems*

the system can learn about large patterns of the city from their experience of local spaces. This is not surprising considering the complexity of the Ghadames pattern, which has an inward-looking structure, scarce open spaces on streets, and a unique cul-de-sacs system. Second, looking at synergy value (correlation between local and global integration) in both male/ female spatial systems, it is clearly that the both systems have lower synergy values as embedded model than that as independent systems.(See tables7.9; 7.10). Unlike intelligibility, the synergy value of the whole Ghadames is higher than that of the male and female spatial systems in embedded model. The better correlation between local and global integration suggesting a city encourages (stimulates) the natural movement.

Fig(7.18) *photo shows the main street" El Jarsan" with main mosque at the end of vista*

Fig(7.19) *photo shows one of the gates to the city centre from west*

Fig(7.20) *photo shows the one of gates to the main square" El Katus" from South part.*

7.7. VISIBILITY GRAPH ANALYSIS

Having analysed the walled city of Ghadames using axial lines concept of space syntax, the next attempt is to look at the walled city of Ghadames from isovist concept using visibility graph analysis (see chapter 5). However, in order to establish an actual correspondence between the configuration of the settlement and the morphology of its open spaces, we then proceeded to analyse the selected case study by mean of the methods of visibility graph analysis. In other words, the public space of each spatial configuration within the settlement has been reduced into a spatial system not by the introduction of the lines connecting its convex spaces, but by its filling up with a uniform grid of points, and then studying the visual relations connecting each of them with all the others (Turner et al., 2001). The mesh of the grid has been dimensioned so that each single path of the settlement and open space would be covered with at least a row of vertices, fitting as narrow as possible the articulation of the urban space; therefore, on the basis of the selected cases we've chosen a grid with a 2.20 meter mesh: every street, even the narrowest of the most restricted historic center and cul-due-sacs get hence represented by a set of vertices, as well as every other significant urban element can be said to be sufficiently reproduced.

On this regard, it is worth noticing that processing a visibility graph (by Depthmap software) is obviously far heavier than working on an axial map (by Webmap software), because it involves the processing of a much larger number of elements: the visibility graph of the small settlement of Ghadames, for instance, consists of around 42.000 vertices, which composes an enormous system when compared with the 1015 lines of the corresponding axial map.

Obviously, the fundamental elements resulting from the previous configurational analysis remain substantially unchanged: still the integration core of each spatial system of ground floor" male domain", upper floor "female domain", and the settlement as a whole remains clearly hinged around the centre where major activities take place and the street which was previously identified as its main integrator. All the same, this kind of analysis allows a more fluid extension of the results so far: it is possible to appreciate the distribution of integration value all over the extension of all the convex spaces, and not only with reference to the line which connect them to each other (Batty, 2001). It is worth specifying that the convex space is here assumed as the composition element of the urban grid, since it is the only a real element that configurational analysis does actually provide. The convex space does hence emerge, as composed of a set of vertices, characterised by their own configurational values. It will then be possible to appreciate the configurational value of the convex space, as the mean value of the configuration of its inner points. Even the square, therefore, seen as a particularly." fat" convex space, can be analysed from a configurational point of view.

7.7.1. VISIBILITY GRAPH ANALYSIS OF GHADAMES:

Having introduced concept of isovist and the related global and local measures in chapter five, this section attempts in the first place to analyse the whole Ghadames spatial system and then looking at both ground floor "male domain" and upper floor" female domain" spatial systems as visually embedded and disembedded model of space within the whole spatial system. Seeking to shed more light on these configurations as far as some properties like patterns of enclosure, contiguity, containment, subdivision, accessibility, and visibility is concerned.

However, looking at visual characteristics of the walled city as summarized in table (7.11), it is obvious from the findings that these descriptive measures indicate more insights to space configuration within Ghadames than that of the axial line analysis mentioned in previous section. Globally, although the visual integration-unrestricted radius- value (1.3788) is higher than that of axial integration (0.55), the distribution of the most visually integrated spaces (fig7.21) are almost similar to that of the axial integration map of the city. Hence, the most visually integrated spaces are found in and around the Ghadames centre where most intensive activities and the water spring(Aen Alfaras) take place. This fact reconfirms that the form of the centre has a great potential of movement for connecting every part in the city to another. However, the most globally segregated area is mainly residential (Mazigh neighborhood as shown in blue).

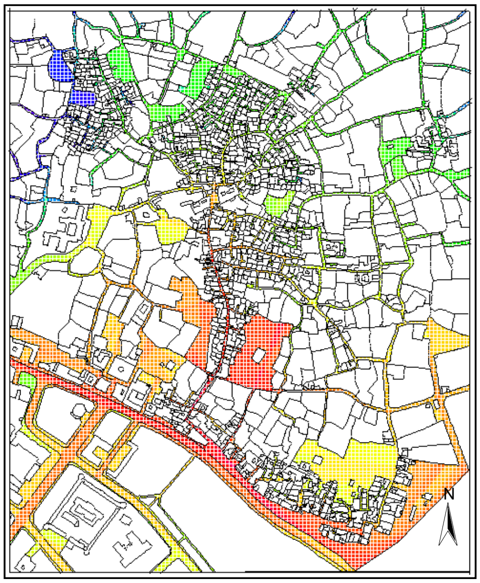


Fig (7.21) *Ground floor "male" shows visual global integration in cut-out model of space.*

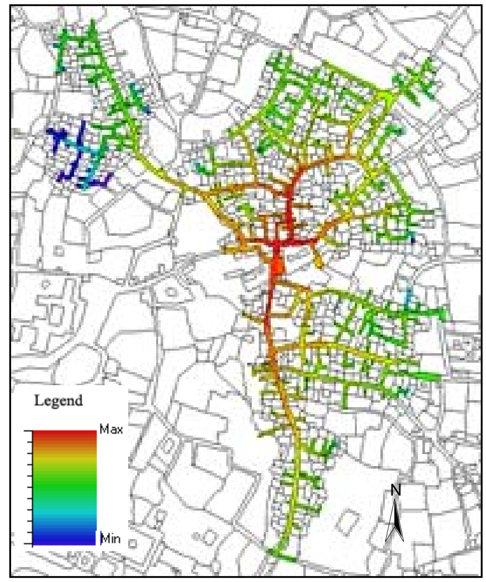
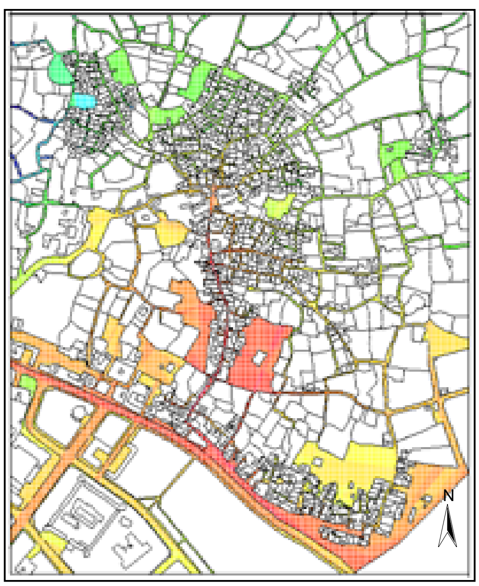
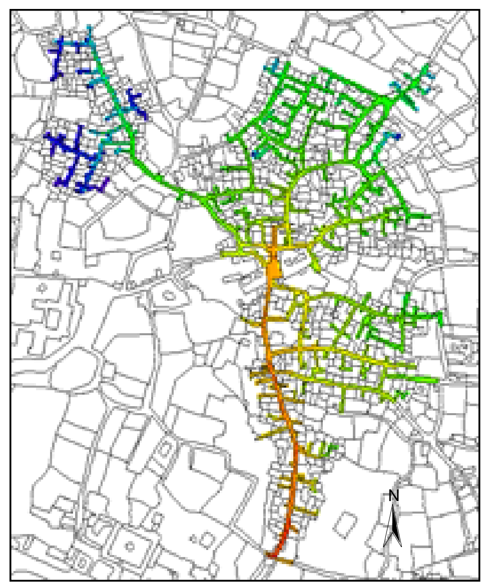


Fig (7.22) *Upper floor "female" shows visual global integration in cut-out of space.*



Fig(7.23) *Ground floor "male domain" shows visual global in embedded model of space.*



Fig(7.24) *Upper floor "female domain" shows visual global integration in embedded model of space.*

100 0 100 200 300 Meters

100 0 100 200 300 Meters

The visual integration graph as illustrated in fig (7.23 and 7.24) indicates that the most globally integrated spaces are along the main street of the city (Gorsan) connecting both the main gate of the settlement (Komar) to the main square (El katus Madan) of the settlement; whereas in upper floor connecting the two public connections (Staircases) of the two mosques located at both ends of the main street.

Table(7.11) *Visual comparison of both ground floor and upper floor visual characteristics in context to the whole city*

	Ground Floor " male domain"			***Upper floor* "female domain"**			**Whole Ghadames**
	Embed.	**Cut-out**	**Visual Diff.**	**Embed.**	**Cut-out**	**Visual Diff.**	
Visual Clustering Coefficient	0.795958	0.79613	-0.000172	0.76214	0.76214	0	0.7929
Visual Control (Std)	0.275521	0.275503	1.8E-05	0.35610	0.35610	0	0.283793
Visual Controllability	0.377948	0.380396	-0.002448	0.27015	0.27015	0	0.368143
Visual Entropy	3.924243	3.857573	0.06667	3.421389	3.62480	-0.203415	3.878505
Visual Entropy r3	1.300277	1.300682	-0.000405	1.282112	1.29450	-0.012397	1.298625
Visual Integration (HH)	1.407996	1.456371	-0.048375	1.086691	1.30606	-0.219372	1.378771
Visual Integration (HH) r3/10	0.7103189	0.7102537	6.52E-05	3.826651	3.83028	-0.003629	6.805166
Visual Integration (Tekl)	0.413528	0.414231	-0.000703	0.405211	0.40301	0.002199	0.412771
Visual Integration (Tekl) r3	0.486756	0.486765	-9E-06	0.468622	0.46903	-0.000412	0.485106
Visual Mean Depth/10	1.0555602	1.0213178	0.0342424	13.477808	8.48960	4.988203	10.821397
Visual Mean Depth r3	2.2895	2.289	0.0005	2.458737	2.44712	0.011617	2.3049
Visual Node Count/10000	4.1853	3.8048	0.3805	41853	3807	38046	41853
Visual Node Count r3/1000	3.09443	3.09538	-0.00095	345.69	322.31	23.38	2844.41
Visual Relativised Entropy	3.975225	3.955232	0.019993	4.068427	3.27050	0.79792	3.983703
Visual Relativised Entropy r3	2.479885	2.479305	0.00058	2.616315	2.59726	0.019046	2.492294
Visual Synergy	0.1126	0.1164	-0.0038	0.2018	0.2397	-0.0379	0.1126
Visual intelligiblity	0.2349	0.256	-0.0211	0.2297	0.2146	0.0151	0.2349

Note: *Embed. Means the subsystem of space embedded within the whole visual system; Cut-out: means the particular system is independent from the whole visual system. Integration(HH): means normalization using Hillier and Hanson method; integration(Tekl) means normalization using Teklenberg method.*

Looking at the global measure of visual entropy in Ghadames, which is informative about how order the spatial system is, it is found to be high (3.88) ranging between 3.2 and 4.3, which reflects very disorder system of spaces. The most disorder spaces are found around the central area in both ground floor and upper floor of the city. These spaces have main function of joining various residential areas where different ethnic communities live.

The visual entropy graph (Append A) picks out these spaces confirms that they are structured on random manner. The users of such system confront difficulty in terms of permeability and visibility fields to traverse from one space to another. The geometry of these spaces tends to be irregular in shape which helps to create many junctions and turning points within the spatial structure, leading to a loss of visual fields and thus, clustering most of spaces. Locally, the visual entropy within three steps of depth shows that local spaces have low value (1.3) and therefore less disorder and the users of local residential areas traverse local spaces easily. That is to say, the local areas are easily accessible. It also demonstrates that in the residential areas the visual fields change continuously with movement, as surfaces disappear and others come into view. However, both global and local visual entropy as explained confirm the fact that the residential areas are locally well organized.

Taking into account the expected visual distribution of locations in terms of their visual depths as visual relativized entropy measure, it is obvious that the value is too high (3.98) which indicates that the users would expect a large number of locations (nodes) encountered as they move through the system (graph) to in crease up to the mean depth and then decline afterwards. These spaces of high values are only found in one segment in the main streamlined street (Garsan) as illustrated in Append.A. In local context, the distribution of visual relativized entropy across the system is even and mainly found in large open spaces of the city.(see Append A.) The local measure of visual clustering coefficient (fig7.25; 7.26) indicates that Ghadames spaces offer multidirectional fields of view and therefore low clustering coefficient value (0.79). The spatial system of Ghadames can be considered according to this measure as a small world where spaces are tightly clustered encouraging social interaction. This junction ness of locations in Ghdames give an idea about how the visual information is changing within the system, dictating, perhaps, the way a journey is perceived and where the decision points come within it. The clustering coefficient graph as illustrated in fig 7.25 and 7.26 show even distribution of those spaces with a great tendency to partition large spaces into small convex spaces, which can be seen as informationally stable entities.

In addition to clustering coefficient, the visual control and controllability are also informative measures about the structure of spaces in Ghadames. The visual control measure picks out visually dominant areas as illustrated in Append A. As it can be seen, the visual control is evenly distributed across the system (Std=0.28) with only a few spaces in dead end streets that lack visual fields and therefore contribute little to the value of control. It is unlikely that one or more spaces will domain access to the overall system of spaces. Moreover, visual controllability is another local informative measure (see chapter 5) that gives more insights about the visual property of Ghadames. It is much easier to describe for a location, it is simply the

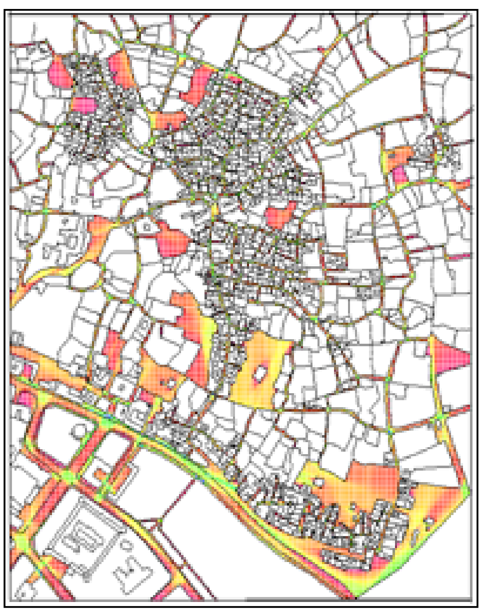
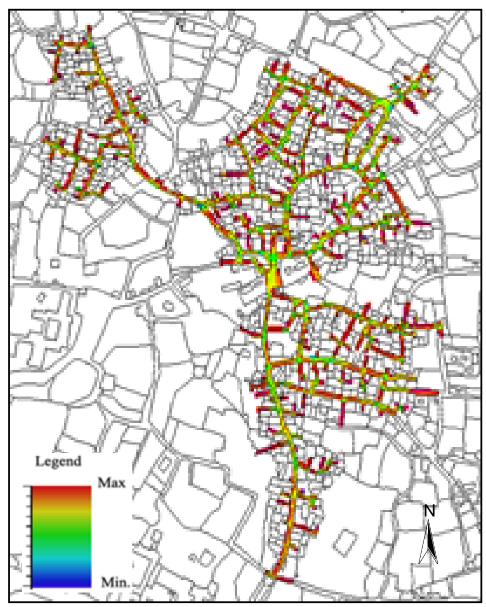


Fig (7.25) *visibility graph for ground floor shows visual clustering coefficient "embedded model"*



Fig(7.26) *visibility graph for Upper floor shows visual clustering coefficient "embedded model"* ratio of the total number of nodes (locations) up to radius two to visual connectivity (i.e. total nodes at radius 1).

It was found to be very low (0.368) which implies that most of linear spaces i.e. streets generally lack this visual property. However, the most controllable spaces are those large fat spaces such as public squares where multidirectional visual fields are dominant. The visual controllable graph picks out those spaces and highlighted them in red as controllable spaces using conventional space syntax spectrum of colours. These controllable spaces are easily visually dominated in the city.(see Append.A)

Looking at property of the visual connectivity in the city, it is found to be very low (0.39) which reveals that Ghadames lacks interconnected visual fields. This system with its visually inaccessible spaces indicates some how tendency to support sense of enclosure and segregation. It seems the irregular organic structure of spaces impede visual fields. Comparing the visual connectivity of the walled city of Ghadames to that of Tripoli and Benghazi old towns (fig 7.27) it is far less connected than both of them.

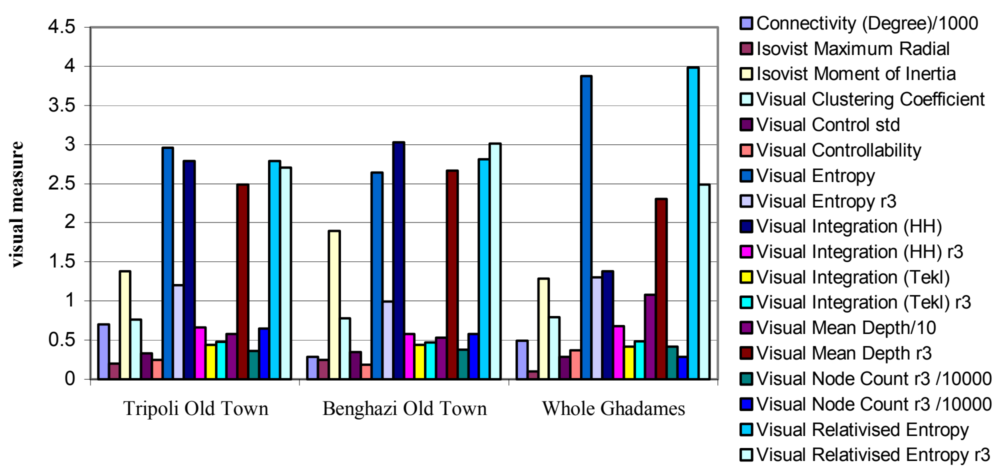


Fig (7.27) *Bar chart shows visual comparison of three old Libyan cities*

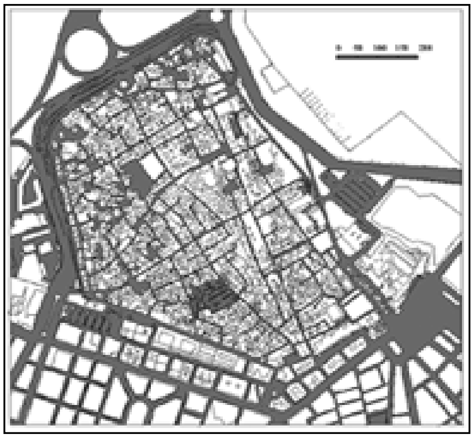


Fig (7.28) *Tripoli old town, open spaces shown in black*

Fig (7.29) *Benghazi old town, open spaces shown in black*

Fig (7.30) *visibility graph for Tripoli old town shows visual integration (global)*

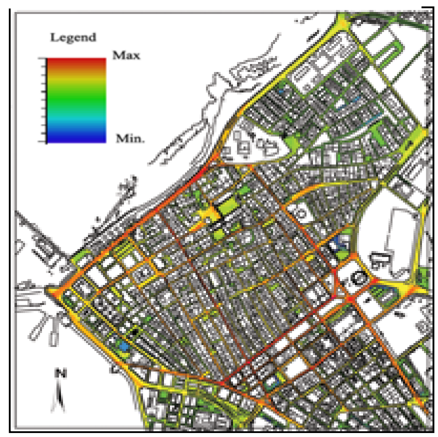


Fig (7.31) *visibility graph for Benghazi old town shows visual integration (global).*

Fig (7.32) *visibility graph for Tripoli old town shows visual integration (local)*

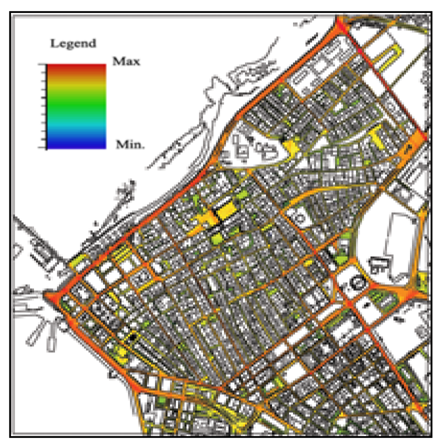


Fig (7.33) *visibility graph for Benghazi old town shows V. integration (local)*

This fact can be confirmed by looking at visual intelligibility measure of the city, which is too low (0.2349) compared with that of Tripoli and Benghazi old towns. However, this less intelligible structure of spaces in Ghadames can be accounted for the fact that the local residential areas are globally segregated, even in the case of those areas very close to integration core (centre of activities) in addition to the existing of fewer visual connections among spaces.

In terms of visual synergy, the walled city of Ghadames has low value (0.2349), which reveals lack of correlation between local and global visual integration. This value of visual synergy is found to be less than that of Tripoli (0.35) and Benghazi (0.29) old towns. Therefore, spaces of Ghadames seem to intrude strangers (visitors) from penetrating to the various parts of the city except in limited central zone (integration core).

It is also helpful to measure isovist maximum radial (distance to furthest visible point location from each node or location) in which case low values will indicate short sight of vision and therefore high degree of enclosure and vise versa. The isovist maximum radial in Ghadames is 105m, which is nearly half of that in Tripoli (202m) and Benghazi (217m) old towns. This implies high degree of enclosure as well as multidirectional and changing visual fields within the city.

The distribution of isovist maximum radial in both ground floor and upper floor of Ghadames shows that ground floor" male domain" offers much longer sight of vision on average 105m particularly in south road as well as in the main street (El Katus) than that of the upper floor (24m) where there is only a few secondary streets in residential areas have reasonable sight of vision. In addition to this informative measure, the isovist moment of inertia (see chapter 5) provides another interesting measure which reveals about how easy an object or pedestrian is to span within the system. However, looking at this measure in Ghadames, The value seems to be very low which reflects the fact that it is very easy for users of the system to span from one space to another. This surprising visual property property may be accounted for

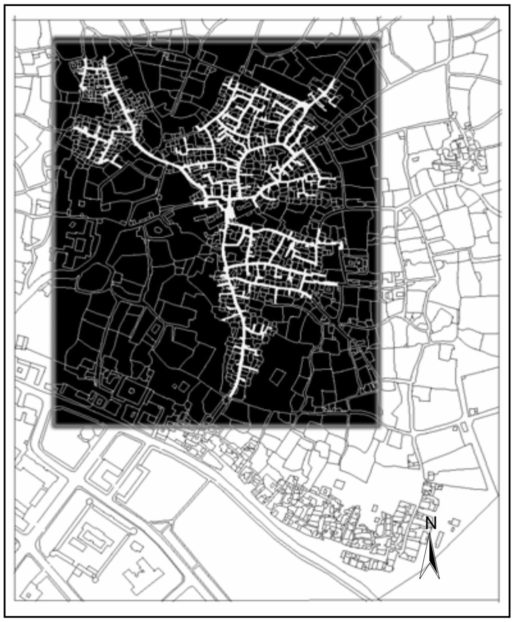


Fig (7.34) *Ghadames map shows area of interest in black and upper floor open spaces in white as female domain*

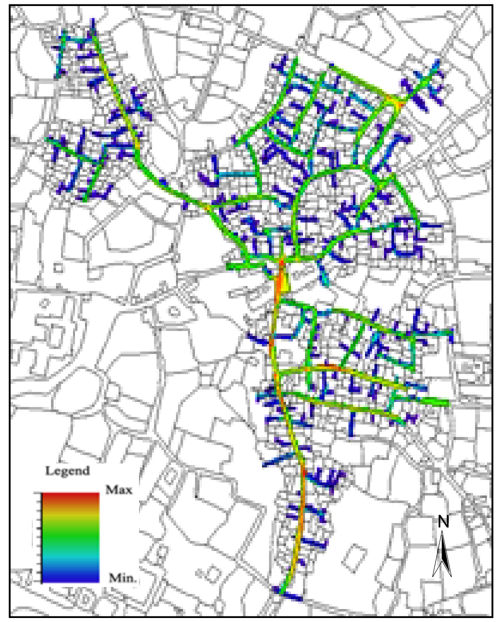
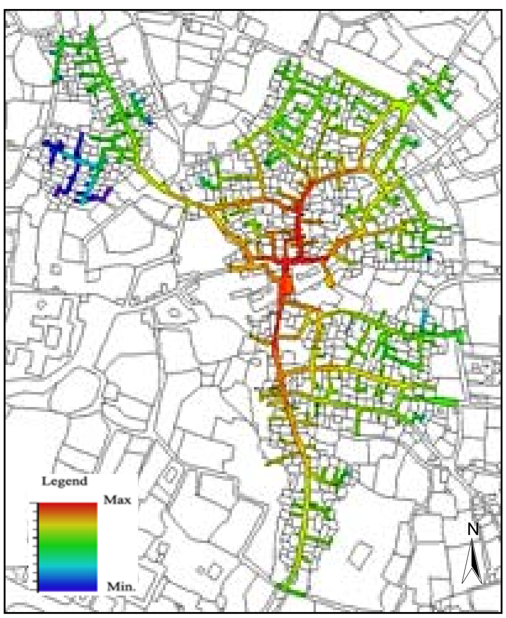
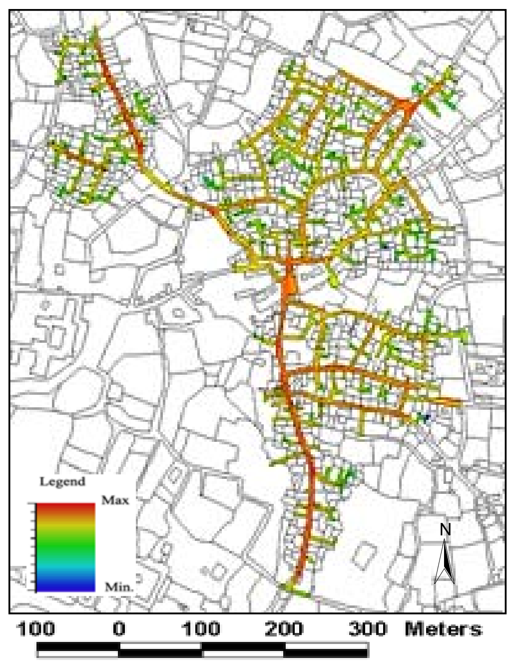


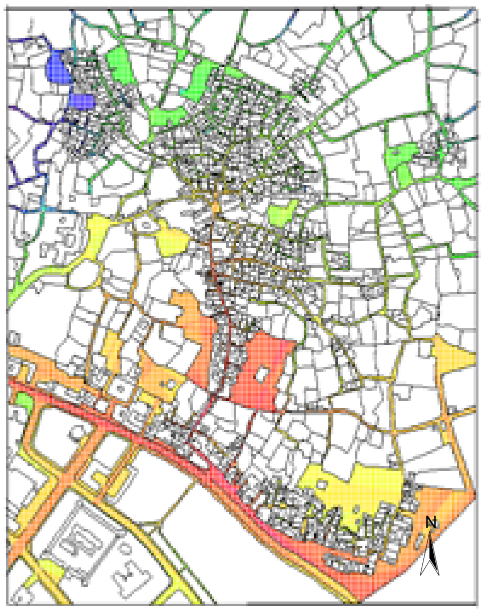
Fig (7.35) *Visibility graph of the upper Floor shows visual connectivity*



Fig(7.36) *Visibility graph of the upper Floor shows visual integration (global).*



Fig(7.37) *Visibility graph of the upper Floor shows visual integration (local)*



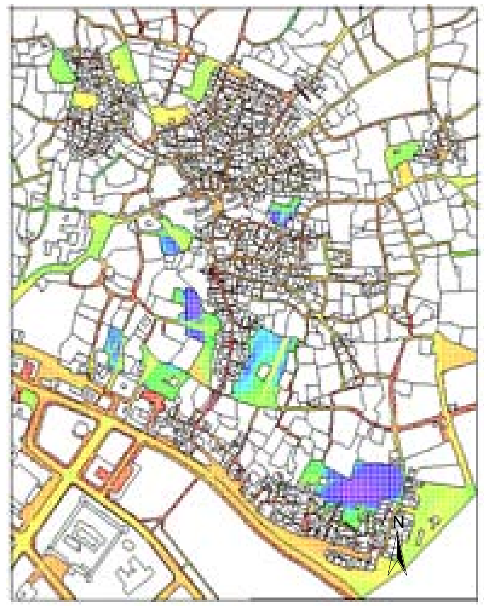
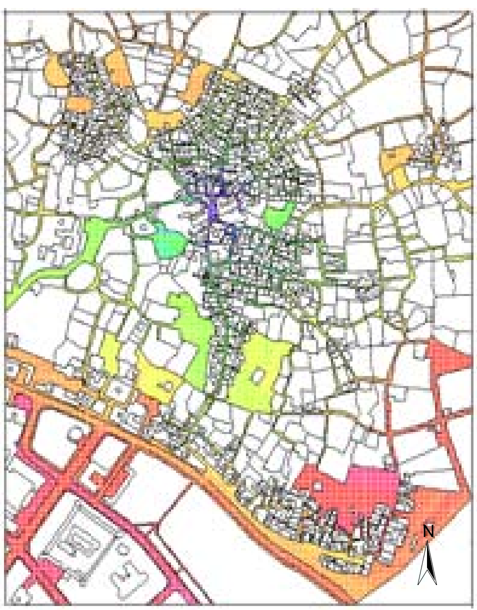
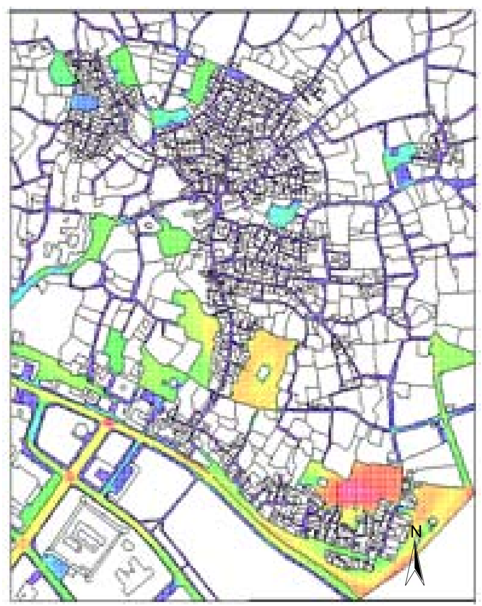


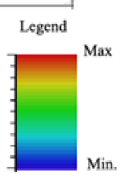
Fig (7.38) *Ground floor "male domain" shows visual global*

Fig (7.39) *Ground floor" male domain" shows visual Local mean depth*





Fig(7.40) *Ground floor "male domain" shows visual Entropy*



Fig(7.41) *Ground floor" male domain" shows visual connectivity*

the streamlined and irregular forms of spaces, which can be interpreted as a potential movement. However, comparing it to that of Tripoli and Benghazi old towns the value seems to be very low.(Table 7.6)

7.7.2. COMPARISON OF THE TWO DOMAINS:

Looking at both ground floor ”male domain” and upper floor “female domain” in embedded and disembedded model of space, they show some similarities and differences ought to discussed in detail.

7.7.2.1 EMBEDDED MODEL:

In visual embedded model of space the upper floor” female domain” has higher values in terms of visual synergy, entropy, mean depth, and control measures than that of the ground floor (Fig7.38). Regarding visual synergy, the female spaces in upper floor shows visual correlation between local and global integration. In context of the whole system. This implies existing more balance in visual fields that female users have in their system. However, the case in ground floor is reversed , hence visual synergy is lower and ground floor lacks consistent visual fields.

The visual entropy reveals that the visual depths in upper floor are more evenly distributed throughout the system and therefore, more disorder than that of the ground floor. In terms of visual mean depth, the upper floor as female domain is deeper(13 steps of depth) than that of the ground floor(10 steps of depth). This deep system of space in upper floor may be accounted for the tree-like structure of spaces. This visual measure is also informative about the female tendency to partition their spaces toward privacy and segregation.

Concerning the visual control, the results also show that the spaces in upper floor seem to have higher value (Std=0.36) than the ground floor(0.28). Hence, the most visually dominant area is found in the upper floor even though the ground floor

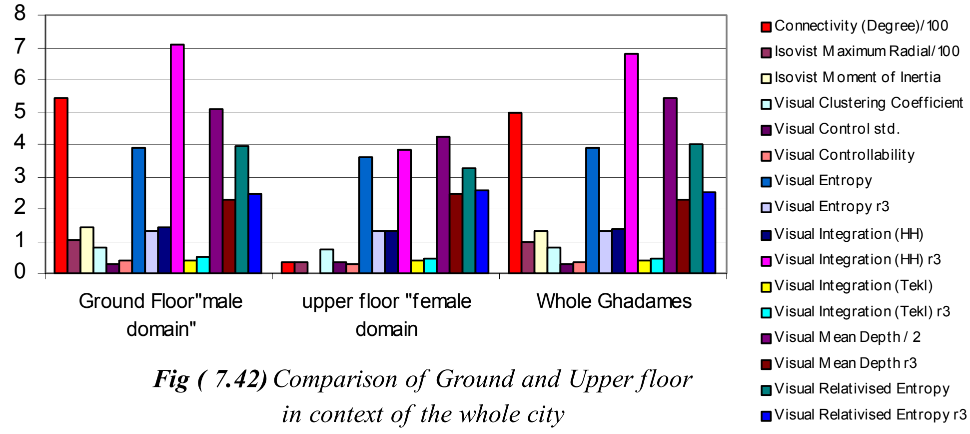
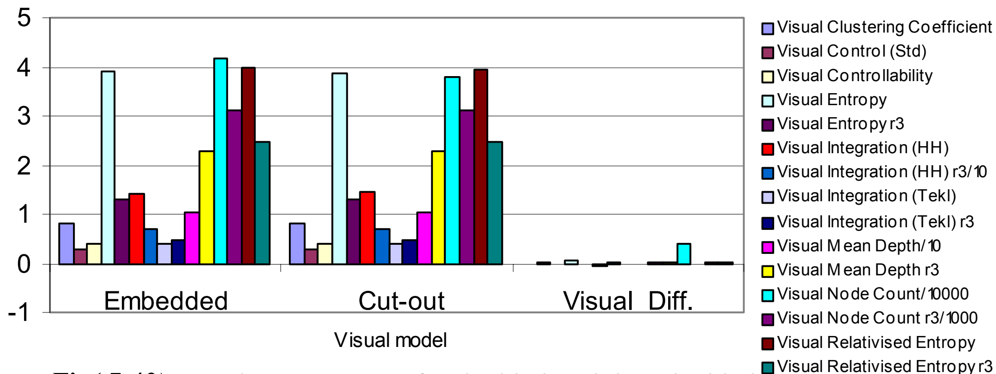
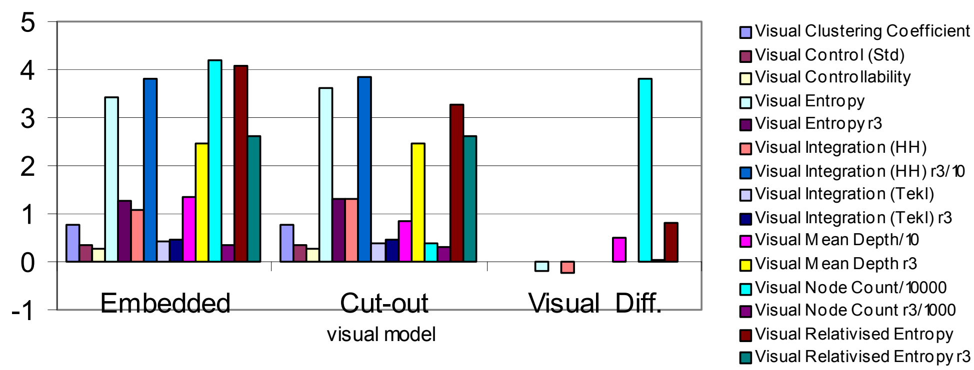


Fig (7.42) *Comparison of Ground and Upper floor in context of the whole city*



Fig(7.43) *Visual Comparison of embedded and disembedded models for Ground Floor*



Fig(7.44) *Visual comparison of embedded and disembedded models for upper floor* generally have more visually dominant areas. The range of visual control in ground floor is wider whereas in upper floor is restricted to some extend. more visually dominant areas. The range of visual control in ground floor is wider whereas in upper floor is restricted to some extend.

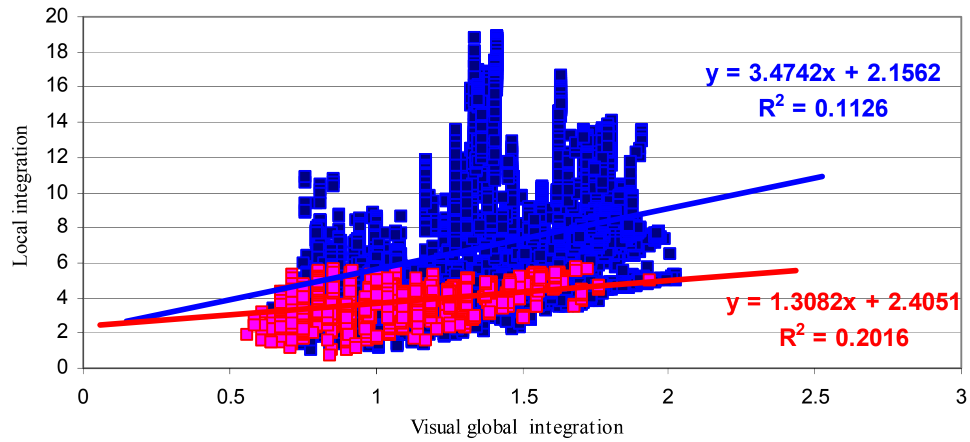
7.7.2.2. CUT-OUT MODEL:

It is also informative to analyse both systems of Ghadames as disembedded (independent) system of space. This will enable us to determine some visual properties that distinguish each system from another. It will also shed light on some similarities and differences that may or may not contribute to overall visual properties of the city. However, the results of both male and female independent systems are summarized in table (7.8) and illustrated in fig (7.43) and (7.44).

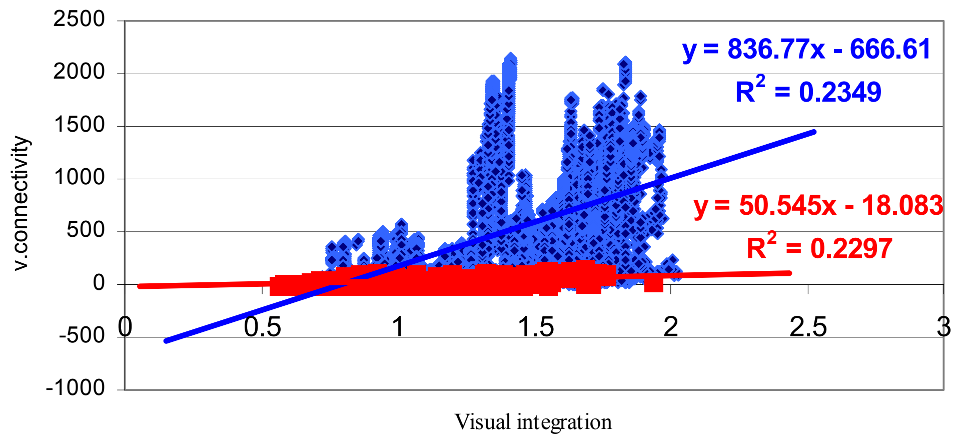
Globally, three visual property measures (mean depth, entropy, intelligibility) show significant differences between ground floor "male domain" and upper floor " female domain" in cut-out model. Hence, the spatial system of upper floor seems to have shallower visual mean depth (8 steps of depth) that that of the ground floor (10 steps). This reveals that structure of female spaces require less number of turns for users in order to traverse from one space to another within upper floor. In contrast, looking at visual mean depth three steps from each space as local measure, the upper floor seems to be deeper (2.45) than that of ground floor (2.29). This fact implies that structures of upper floor spaces are globally shallow and therefore female users of the system confront less visual barriers to navigate the system. However, the local visual mean depth of the same system implies the opposite and upper floor seems to be locally deeper than that of the ground floor and male users confront less visual barriers in navigating their system of spaces.

The global measure of visual relativised entropy or the expected distribution of spaces in terms of their visual depth shows that the ground floor value is higher than the upper floor which reflects more disorder visual fields within ground floor than that of upper floor.

Another very important global measure ought to be discussed is the visual intelligibility (correlation between global visual integration and visual connectivity). Looking at both independent systems, the ground floor seems to be more intelligible (R^2= 0.256) than that of upper floor(R^2=215).



Fig(7.45) *Visual Synergy of ground Floor and upper Floor"embedded model"*



Fig(7.46) *Visual intelligibility of Ground Floor and Upper floor "embedded model"*

7.8. INTERIM CONCLUSION

The entry and penetration of visitors to local residential streets in the Arab Muslim culture, is regulated by certain socio-religious codes, these codes identify the visitors a long gender and kinship lines (as muharim and non-muharim). This identification determines the domain and space which imposes the desired degree of privacy needed for male and female users, it is also determines the interface between inhabitants and strangers (visitors), as it is the case in the walled city of Ghadames.

The intimacy gradient (Alexander 1977) which may be found in each culture at varying degrees, in the case of Ghadames where different ethnic communities and gender segregation took place within these distinct localities, such gradient involves other dimensions than simply front to back, or formal; semi-private to the most intimate spaces, for above reasons.

The case study presents a unique settlement of Ghadames where two separate systems of space are dominated by male and female users. One system represents the ground floor as male domain, while the other represent the upper floor as female domain. The two systems of space are analysed syntactically and visually as in isolation from each other and as embedded within the whole city. Various syntactic and visual measures have been calculated in order to explore the configuration of male and female spaces in terms of permeability and visibility. The results show that female spatial system is characterized by higher degree of enclosure, restricted and controlled spaces and shorter sight of vision than that of the male.

CHAPTER 8

8.THE SELECTED CASES: SYNTACTIC, VISUAL AND METRIC ANALSES

8.1. PRELUDE

Having analyzed the walled city of Ghadames and compared its morphological, syntactic and visual properties with that of Libyan cities and cities around the world, the next set of analyses will investigate nine selected area within the walled city which are dominated by three ethnic communities, namely Arab, Barbar and Tuarg (African). The aim is to shed light on some similarities and differences in their syntactic, visual, and metric characteristics as the context of these distinct cultural settings as far as privacy regulation mechanisms in these localities are concerned.

The analysis was carried out by using both space syntax and isovist techniques. Nine different localities within the walled city were studied both as they were embedded within the city (embedded model) and in isolation (cut-out model). This was done in order to find differences in their organization of spaces and their relation to immediate neighbourhoods, as well as to help us understand the ways by which a spatial community with strong internal bonding organizes, uses and defines the spaces within its neighbourhood.

However, streets, squares and pols in the walled city have distinct Arabic or Barbar or African names, which reflect the residents of the communities. After verifying the accuracy of this by identifying community areas through survey and land property map (Append.D), each community area was mapped by identifying well-defined blocks formed by large clusters of streets with Arabic, Barbar and African names (see Append.D). Arab community occupy five distinct neighbourhoods inhabited by Giorsan (site No2.), Tangzin (site No.3), Tharafra (site No.4), Auld Blel (site No.5)

Fig(8.1a) shows location of the nine selected areas and axial map of the whole city and Old Soak (site No.8). These localities are located in South part of the walled city and extend linearly to the main square within the centre of the settlement (fig8.1) The Barbar communities (Aphogas and Oragin) occupy only one neighbourhood, which is called Amnesh (site No.9) in the periphery of the settlement. However, the nine sites were analyzed in terms of their morphological, syntactic and visual characteristics. The findings were summarized in table (8.1) and will be discussed in the next sections.

8.2. THE SELECTED CASES: MORPHOLOGICAL CHARACTERISTICS

Examining various morphological measures of the selected cases in Table (8.1), it is informative to compare them and to find clear similarities and differences between these communities. However, measuring the convexity and axiality of their spaces provide grounds for informative comparison.

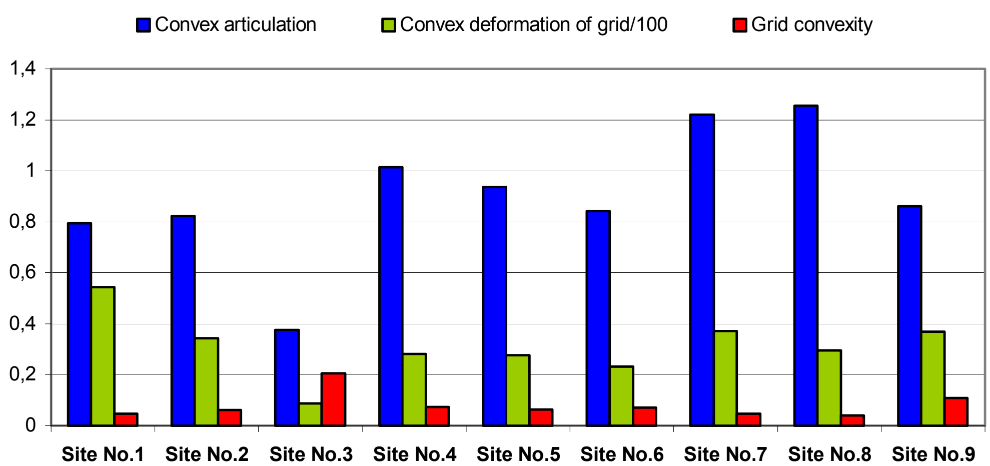
8.2.1. MEASURE OF CONVEXITY

Convex maps for the nine selected areas within the walled city of Ghadames were prepared and their open spaces structures were examined in terms of three indicative measures, namely convex articulation, deformation of grid and grid convexity measure. These three measures for the cases were illustrated in Fig (8.3). Generally, most of examined areas show sort of similarities between them except in case of Tangzin (site No.3). This area shows the lowest value of convex articulation measure and therefore the least break up and Pthe most synchrony in its spaces. In contrast, Old Soak(site No.8) shows the highest value (1.26) where spaces are the most broken up due to discontinuities of edges and corners of their shapes. Another interesting measure is the degree of convex deformation within the areas; it shows that Mazigh (site No.1) has the highest value. This implies non-geometric grid and more organic pattern of open spaces. Unlike Mazigh neighbourhood, the other cases show lower values, which reflect more regularity in their urban texture. Tangzin (site No.3) spaces can be considered the least deformed and more geometrically organized. This fact can be confirmed from the lowest value (8.66) it has.

Table (8.1) *shows morphological and syntactic measures of the nine selected areas within the walled city of Ghadames.*

Morphological	**Site (1)**	**Site (2)**	**Site (3)**	**Site (4)**	**Site (5)**	**Site (6)**	**Site (7)**	**Site (8)**	**Site (9)**
Axial lines	113	87	98	72	105	187	196	26	24
Average length (m)	21.87	28.81	24.89	23.3	41.66	21.68	19.54	56.92	31.38
Buildings	205	209	208	139	295	330	304	47	43
Islands	3	5	9	5	10	12	10	2	1
Thoroughfares T*	79	63	73	53	87	135	141	24	19
Deadens D*	34	24	25	19	18	52	55	2	5
T/ D ratio	2.323	2.625	2.92	2.789	4.833	2.596	2.564	12	3.8
Total area Of the site	5.8535	7.2398	4.9185	2.7376	14.781	5.6384	7.1725	3.397	1.78
Area of open space	0.6693	2.3094	0.8858	0.4495	3.3834	1.239	1.1331	1.141	0.28
Open space %	11.43	31.8	18	16.42	22.89	21.97	15.88	33.59	15.89
L. of O.S boundaries	0.4098	0.4794	0.4429	0.2692	0.6763	0.6236	0.6781	0.154	0.111
Area / perimeter ratio	1.63	4.8173	2	1.67	5	1.99	1.67	7.37	2.55
Measure of convexity									
Convex articulation	0.795	0.823	0.375	1.014	0.936	0.842	1.22	1.255	0.86
Convex deform. of grid	54.338	34.4	8.667	28.2	27.6	23.167	37.1	29.5	37
Grid convexity	0.048	0.0609	0.2051	0.0743	0.0628	0.0717	0.0467	0.0409	0.1081
Measure of axiality									
Axial articulation	0.5512	0.4163	0.4712	0.518	0.356	0.5667	0.6447	0.5532	0.55
Axial integ. of con. S	0.6933	0.5058	1.2564	0.5106	0.3804	0.6727	0.5283	0.4407	0.64
Grid axiality	0.0484	0.0744	0.0816	0.0899	0.0793	0.0477	0.0424	0.1857	0.167
Numerical properties									
Convex ringiness	0.0093	0.0147	0.0596	0.0181	0.0183	0.0218	0.0136	0.0177	0.0145
Axial ringiness	0.0135	0.0296	0.0471	0.034	0.4878	0.0325	0.0258	0.0425	0.0233
Syntactic measures									
Max depth	11.78	13.34	12.23	9.79	13.16	13.55	17.28	9.08	7.75
Connectivity	2.05	2.46	2.57	2.67	2.5	2.64	2.43	2.62	2.42
Integration (Rn) global	0.856	0.7845	0.9648	0.9756	0.717	0.799	0.73	0.7066	0.7818
integration (R3) local	1.5583	1.5346	1.6142	1.6274	1.4258	1.6118	1.4734	1.5019	1.346
Intelligibility	0.183	0.1653	0.3331	0.4254	0.4531	0.2407	0.207	0.4035	0.6499
Synergy	0.3562	0.2883	0.5446	0.573	0.5921	0.4605	0.3116	0.5184	0.7399

The grid convexity measure of the nine cases shows again that Tangzin (site No.3) has the highest degree of grid convexity, which means little deformation in the grid structure and more angular urban blocks. The other sites show lower values, which imply more deformed spaces and less angular pattern of streets. The lowest value is found in Tuarg (site No.9), which looks as the most deformed area.



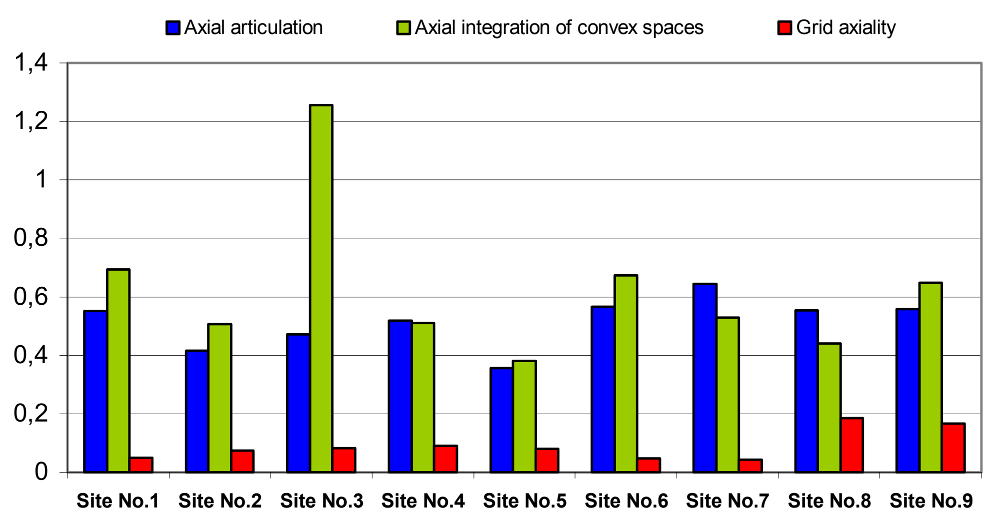
Fig(8.3) *Comparison of Convexity of Spaces in the Nine Sites*

8.2.2. MEASURE OF AXIALITY

Axial maps of the nine areas were prepared and numerically analyzed(table 8.1). Three axial measures, namely axial articulation, axial integration of convex spaces and grid axiality were used for comparing the nine distinct localities. A low value of axial articulation indicates a high degree of axiality. Looking at Tsuku community which shows the highest axial articulation value, it is obvious from its axial map that it has greater break up in axial lines and non-axial pattern in its urban fabric compared with that of the other selected areas. The value is too low for Auld Blel (site No.5),Giorsan (site No.2) and Tangzin(site No.3) which seem to have more continuity in their axial lines and less break up space structure. The other areas are approximately the same, when the means are compared, as the values for Mazigh and Old Soak(0.55), Tuarg(0.56), Djarrasan(0.57) and Tharefra(0.52). They reflect more axial development and less break ups in their spaces.

It is also informative to calculate the axial integration of the convex spaces within the selected areas. Hence, this measure compares the number of axial lines with the number of convex spaces, in which case low values will indicate a high degree of axial integration in the convex spaces. The highest value is calculated for Tangzin(site No.3), which shows poor axial integration, and broken up structure of its convex spaces. This is because the area lacks geometrical order and has organic street pattern. However, Auld Blel shows the least value of axial integration measure and therefore reflects uniform pattern of spaces and strong correlation between them.

In terms of grid axiality of the selected areas, two areas, namely Old Soak(site No.8) and Tuarg (site No.9) show the highest values of grid axiality which indicate strongest approximation of a grid. Hence, the measure allows us to compare an orthogonal grid with the same number of islands in the urban layout. Therefore, the two sites imply grid-like characteristics rather than organic ones. The other areas almost show low values for this measure, which reflect non-axail organization of their spaces. This can be seen in irregular form of squares and the organic-like structure of spaces.

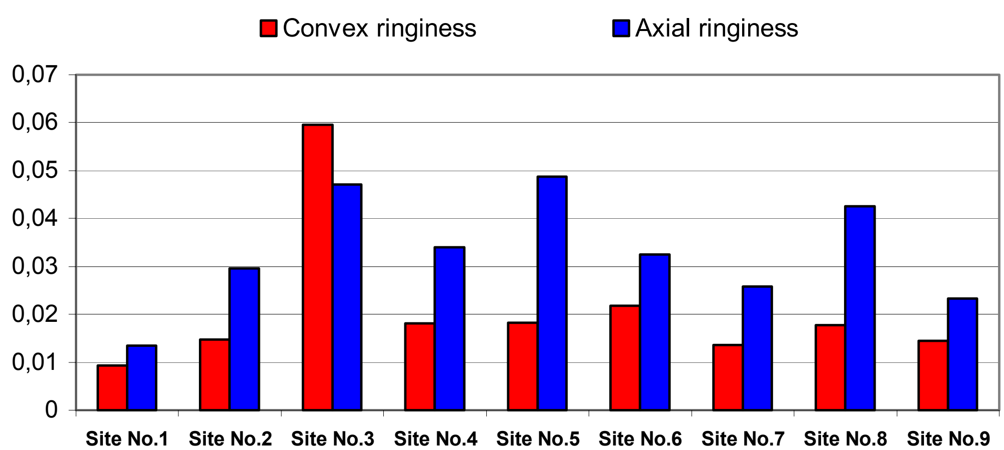


Fig(8.5) *Comparison of Space Axiality in the Nine Sites*

8.2.3. MEASURE OF RINGINESS

Looking at convex ringiness of the selected areas, it is obvious from numeric analysis that Tangzin (site No.3) is found to be the highest in terms of distributedness of spaces, and therefore, existence of grid-like urban texture in the area. The other areas are found to be relatively lower and therefore have organic-like structures. The lowest value is found for Mazigh (site No.1), which shows the most organic structure of convex spaces. Ethnic comparison shows that convex spaces of Arab communities are more distributive than that of Barbar and Tuarg communities.

Regarding axial ringness of the areas, it is clear that the values of axial ringiness are higher than that of convex ringiness, This fact generally implies that spaces in the selected areas are more axially connected and linearly extended. The highest value of axial ringiness is found in Auld Blel (site No.5), whereas the lowest value is found in Mazigh (site No.1). Generally, Arab communities seem to have higher values in both convex and axial ringiness than Barbar and Tuarg.



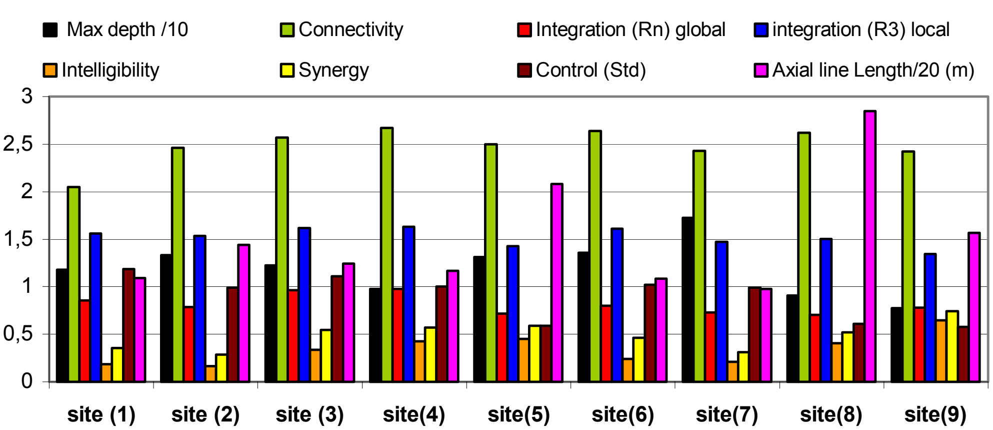
Fig(8.5)*Comparison of Convext and Axial Ringiness of the Nine Sites*

8.3. SYNTACTIC PROPERTIES OF THE SELECTED CASES:

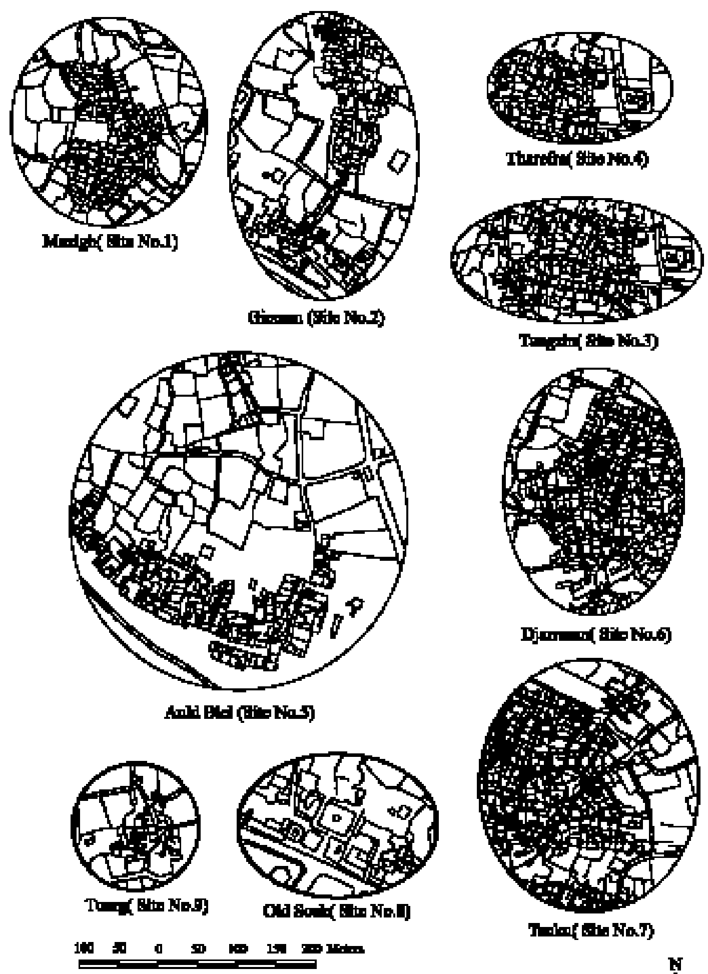
Having investigated the convexity and axiality of the selected areas, this section attempts to investigate the syntactic characteristics of the nine cases. However, axial maps for the selected areas were prepared and analysed using two models of space. First, the nine areas were analysed independently (cut-out model) or in isolation. Second, they were analysed in context of the whole system of the city where the selected areas are embedded within the whole city (embedded model). The aim is to understand configurations of space in these selected through their syntaxes and to construct a cross-ethnic comparison in this vernacular settlement. Moreover it aims at tracing the impact of syntactic properties of each selected area on the other as well as their impact on the whole spatial system of the walled city.

8.3.1. SYNTAXES OF INDIVIDUAL CASES (CUT-OUT MODEL)

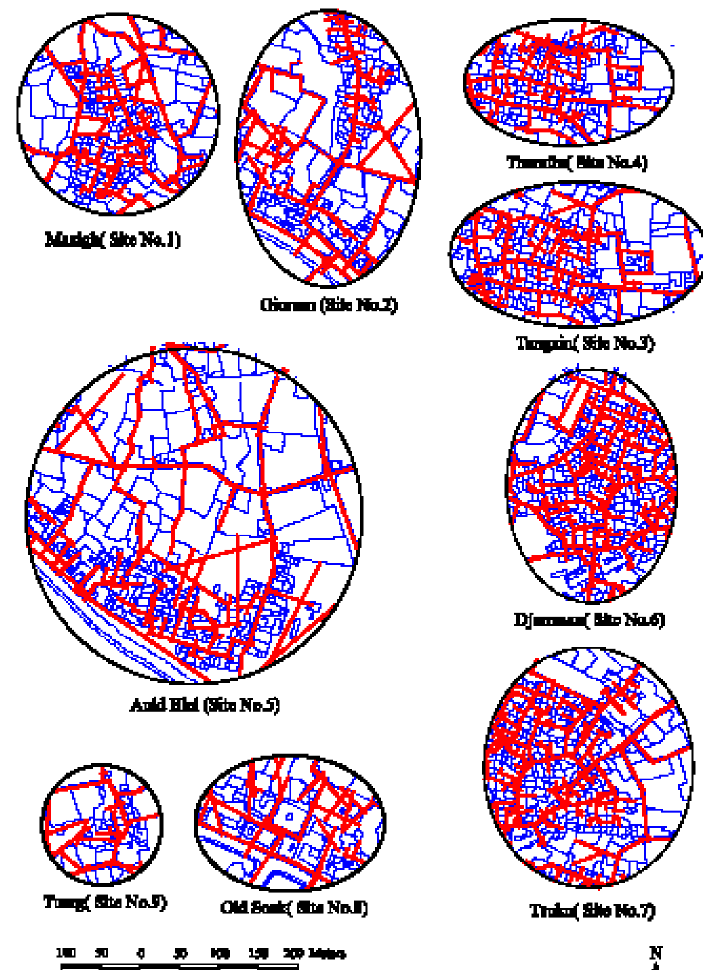
Axial maps for each selected area were constructed and numerically analysed independently from the whole city. The findings were summarized in table (8.1). Eight syntactic measures of local and global interest were used to explain the spatial properties of the selected cases. In terms of maximum depth within the each area (number of turnings for people to traverse from one space to another within its territory-see chapter 5), the deepest spaces (17 steps of depth) are calculated in Tsuku (site No.7), whereas the shallowest spaces (8 steps) are found in Tuarg (site No.9). The average of this measure for all areas is 12 steps of depth which shows extremely deep structure of spaces compared with that found in Tripoli and Benghazi old towns (see chapter 7).



Fig(8.7) *Syntactic Comparison of the Nine areas"cut-out model"*



Fig(8.8a) shows maps for the nine selected areas within Ghadames



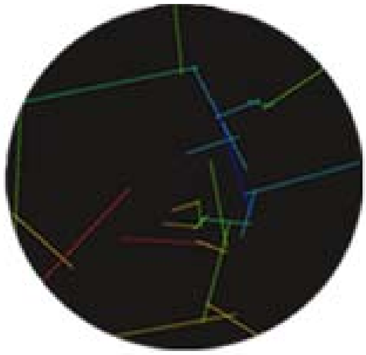
Fig(8.8 b) shows axial maps for the nine selected areas within Ghadames

Looking at the three domain ethnic communities within the walled city, the spaces in Barbar communities are generally on average deeper than that of Arab and Tuarg communities (14 steps). This accounts for nature of space organization in Barber communities where three-like pattern of streets and short broken lines are dominant features.

The connectivity of the selected areas is another revealing measure; the axial maps of the nine cases show that the areas have axial lines connecting on average 2.48 other lines or spaces, which are too low, compared with that of Arab cities (2.975). This low connectivity accounts for short bent broken axial lines of the areas. However, the highest connectivity value is calculated for Tharefra (2.67) and the lowest in Mazigh (2.05). Generally, axial lines of Arab communities are more connected (2,57) than that of Barbar (2.37) and Tuarg (2.42), which implies greater opportunities to support social interaction among the Arab residents.

Looking at global integration values of the selected areas, they generally indicate that the spaces within the areas are globally integrated, hence the average value is 0.81, which is higher than that spaces in Arab cities (Rn=0.65) and in UK cites (0.72). The most globally integrated area is Tharefra (0.98), whereas the most globally segregated is Old Soak (0.71). In general, the spaces in Arab communities are more globally integrated (0.82) than that of Barbar (0.79) and Tuarg (0.78) communities. The pattern of in the most integrated and segregated spaces within the selected areas these can be seen in integration maps. (See Append. A).

The local integration measure is another revealing measure, which shows nature of space organization in local context of the areas (three steps away from each space). The selected areas seem to be locally segregated according to the calculated average value(R_3=1.52). When this value is compared to that of Arab cities (1.619) shows lower local integration value for the spaces. This difference seems to be not significant, whereas it is found to be significantly different from those of UK. cities. The highest value is again calculated for Tharefra (1.63), which shows distinctively the most locally and globally integrated spaces of all areas. This implies that strong



Fig(8. 9) Tuarg, Max. Depth

Fig(8.12) Photo shows the main gate to Tuarg community in the peripherial zone.

Fig(8. 10) Tsuku, Max. Depth

Fig(8.13) shows main loop street in Tsuku where visual fields change continuously.

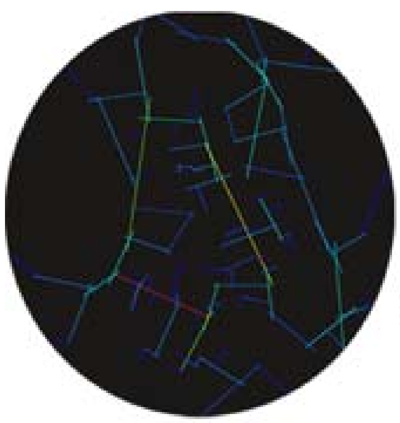
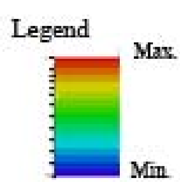
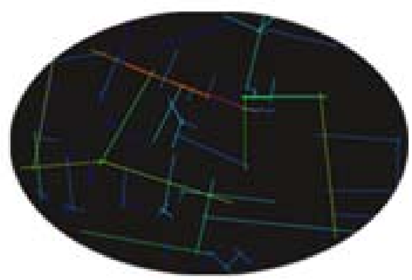


Fig (8.11) Mazigh, Connectivity





Fig(8.14) Tharefra, Connectivity

social relations between neighbors as well as residents and visitors within the community. The lowest value is calculated for Tuarg (1.35), which has the most locally segregated spaces. However, spaces within Barabr communities seem to be more locally integrated than that of both Arab and Tuarg communities (1.55). Therefore, spaces in Barbar communities encourage and support social interactions among the neighbors within the community.

Another import local measure ought to be discussed in this context is the control value of the selected areas; it is measured in terms of standard deviation (see chapter 5) in order to investigate this property. The average value is calculated for the spaces within selected cases and found to be very high (Std=0.896) which can be justified according to low connectivity value mentioned before, hence control is a reciprocal of the connectivity as fully explained in chapter five. Both Mazigh (site No.1) and Djarrasan (site No.6) show both the strongest and the lowest controlled spaces; hence the Max. Control values are 8.44, 8.04, and the Min. values 0.07 and 0.08 respectively.

Spaces of both Tuarg and Old Soak show limited range of control values (1.9 and2.2) which implies far less controlled spaces and constrained level of control reflecting dead-end street pattern and the tree-like structure of spaces. Looking at a cross-ethnic comparison of the areas, it is obvious that Barbar communities do have stronger degree of control over their spaces than do Arab and Tuarg communities. The distribution of the control value within the cases is illustrated in control maps in Append A.

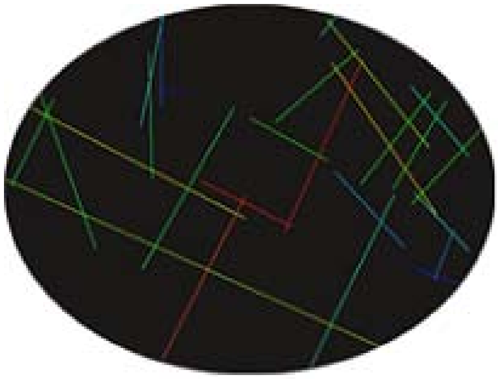
T*able (8.2)* *shows the range, minimum and maximum values of control in Cut-out model*

	Site (1)	Site (2)	Site (3)	Site (4)	Site (5)	Site (6)	Site (7)	Site (8)	Site (9)	Sum	Mean
Range	8.37	6.2	5.69	4.54	2.92	7.96	7.5	2.22	1.9	47.3	5.255556
Min.	0.07	0.08	0.09	0.1	0.167	0.087	0.09	0.2	0.33	1.214	0.134889
Max.	8.44	6.3	5.78	4.6	3.08	8.04	7.6	2.42	2.2	48.46	5.384444
Std.	1.18	0.98	1.107	0.999	0.59	1.02	0.99	0.61	0.58	8.056	0.895111

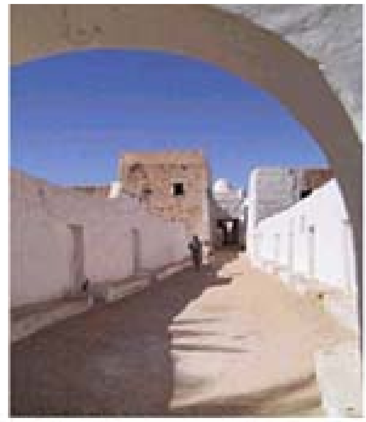
Intelligibility as a global measure is also informative about the selected areas; hence, it shows the correlation between global integration and connectivity of the areas. It is clear from the average value that the selected areas are very intelligible($R^2 = 0.34$) compared to that found in Arab cities (0.231) and in UK (0.124). However, the most intelligible area seems to be Tuarg (0.65), whereas the least intelligible is Mazigh (0.183). Comparing the ethnic communities of the walled city, Arab areas seem to be more intelligible than that of Barbar. This implies that Arab residents easily capture the whole structure by their experience of the small parts. The space organization in other areas, namely Tharafra, Auld Blel, Old Soak and Tangzin, suggest almost the same syntactic values, as the mean intelligibility value for them is 0.43. Mazigh, Giorsan, Djarrsan and Tsuku communities show lower syntactic measures than mean intelligibility measure of the nine areas, which are almost Barbar communities.

Looking at the correlation between local and global integration which is known as synergy (see chapter 5), shows that the mean value ($R^2 = 0.48$) for the selected areas is higher than that of Arab cities($R^2 = 0.16$). Tuarg community (site No.9) seems to have the highest value for this measure (0.74), whereas the lowest is calculated for Giorsan(0.29). This low value for Giorsan accounts for short broken line structure in its axial map, which reflects organic-like pattern and large number of dead-end streets within the area. Ethnic comparison reveals that spaces within Arab communities in general have higher synergy value (0.51) than that of Barbar communities (0.37). Therefore, spaces in both Tuarg and Arab communities encourage visitors' movement within their communities unlike that of Barbar.

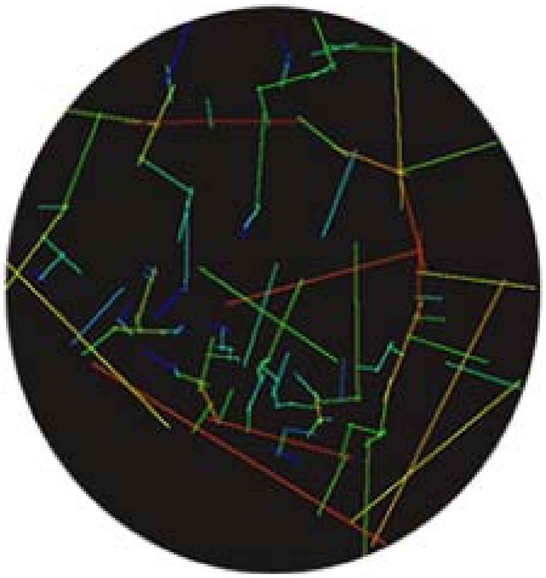
It is also informative to measure the mean length of the axial lines in each selected area under study. This allows us to investigate how long the sight of vision is within each ethnic community. The mean length of the axial lines is calculated in total for the selected areas, it is about 30m, which is much shorter than that for old Tripoli and Benghazi ($L \approx 210$m). This implies that residents of the walled city confront high degree of enclosure and limited areas of visual fields in their spaces. However, Tsuku community seems to have on average the shortest line of vision (L=19.5m), whereas Old Soak community has on average the longest line of vision (L=51m).



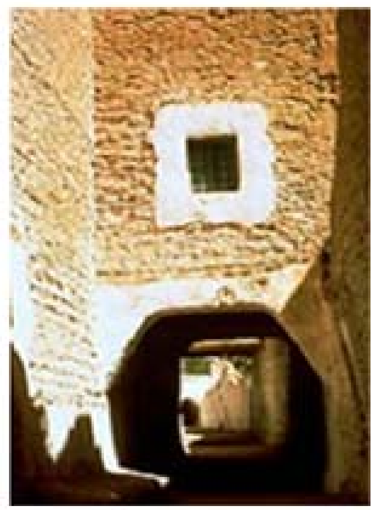
Fig(8.15) Distribution of Global Integration in Old Soak



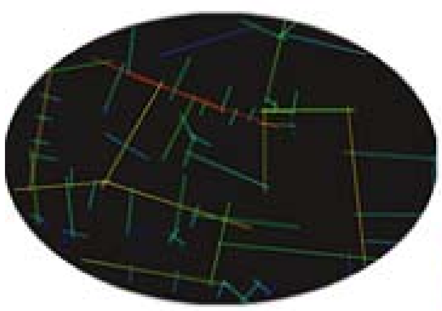
Fig(8.18) Main Street of Giorsan with religious building in the middle as a gate to public square.



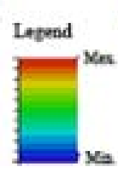
Fig(8.16) Distribution of Local Integration in Auld Blel

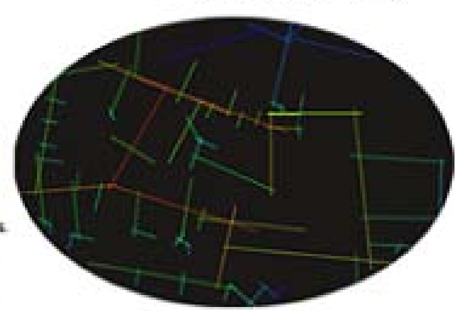


Fig(8.19) covered passage within Auld Blel Community



Fig(8.17) Distribution of Global integration in Tharefra





Fig(8.20) Distribution of Local Integration in Tharefra

Comparing the three ethnic communities within the walled city, the spaces within Barbar communities seem to provide the shorter lines of vision than that of Arab and Tuarg communities (L=31m). Therefore, spaces within Barbar areas seem to close visual fields and encourage sense of enclosure among their residents. It is ought to be mentioned that average length of axial lines in Arab and Tuarg communities are too close to overall mean line length for the nine areas. This again confirms significant difference between Barbar areas from one side and Arab and Tuarg areas from another in terms of visibility within their spaces.

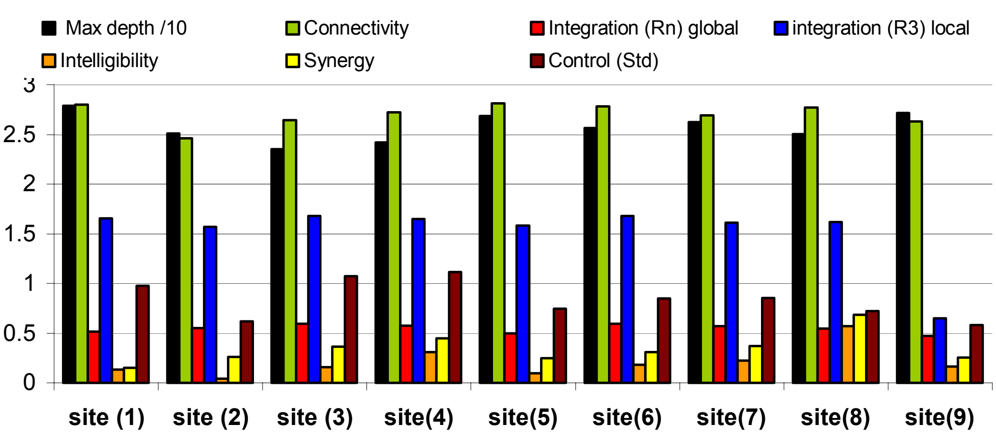
8.3.2. SYNTACTIC PROPERTIES OF THE NINE AREAS WITHIN CONTEXT OF THE WALLED CITY "EMBEDDED MODEL"

Having investigated the syntactic properties of the selected areas in isolation ”cut-out model “, the next set of analyses investigates the areas as subsystems embedded within the whole city ”embedded model”. Seven syntactic measures were calculated for the selected cases, which represent various spatial properties of the ethnic communities. These measures were summarized in table (8.3) and discussed in detail in the following paragraphs.

Looking at a global measure of maximum depth, the overall mean value for the areas is about 26 step of depth, which is extremely deep structure of spaces. This fact can be confirmed by comparing this mean value with that of old Tripoli and Benghazi (20 steps). The difference in mean Max. depth between the nine cases was found to be insignificant; hence, the highest value is 27 steps in Tuarg, whereas the lowest is 24 steps in Tangzin. Spaces of Arab communities within the walled city seem to be shallower (25 steps) than that of Barbar communities (27). Therefore, residents of Arab communities generally traverse from one space to another in the city with the least number of turnings or changing direction in their journeys. In contrast, residents of Tuarg community traverse city spaces with greatest number of turnings. This deep space structure in Tuarg community can be justified by looking at the Tuarg neighbourhood in context of the whole city where Tuarg users occupy peripheral location from core of minimum depth or central area.

The mean connectivity value of the selected areas is 2.7, which is too low compared with that of Arab cities (2.975). This low connectivity accounts for short broken axial lines found in the walled city in general. The highest connectivity value is calculated for Mazigh (2.8), whereas the lowest value is found in Giorsan (2.46). The difference in connectivity values between the selected areas seems to be insignificant. Looking at the measure across the three ethnic communities, the spaces of Barbar communities are more connected (2.757) than that of Arab (2.68) and Tuarg (2.63). This again is not significant difference, which conforms similarities in which spaces of nine communities are embedded within the whole system.

Looking at key global measure of integration (unrestricted radius) for the nine selected areas, the overall mean value shows that their spaces are globally segregated (Rn=0.546). This can be confirmed by comparing this global measure with that of Arab cities (0.65). Lack global integration is natural consequence of the broken short axial lines found almost in all Arab cities. This is a cultural trait of Arab cities, by which they restrain a stranger's movement through the residential streets.



Fig(8.21) Syntactic Comparison of the Nine areas"embedded model"

However, spaces of Tsuku (site No.7) seem to be the most globally integrated (0.593), whereas spaces of Tuarg (site No.9) are the most globally segregated

(0.471). Generally, the syntactic differences between the selected areas seem to be insignificant compared with the overall mean value. In the three ethnic communities of Ghadames, spaces of Barbar communities are slightly more globally integrated than that of Arab communities (0.558). The pattern distribution of this value for the nine communities is illustrated in Append A.

The mean local integration value for the selected areas is 1.521, which is slightly lower than that of Arab cities (1.619). Hence, spaces within these areas are locally segregated which implies the organic development and short broken axial lines. Excluding Tuarg neighbourhooh as the most segregated area, the mean local integration value would be1.66, which is similar to that found in Arab cities. It is clear from table (8.3) that Tuarg community seems to be the most locally segregated area, whereas Barbar communities are the most locally integrated (1.64). The pattern of local integration distribution of the areas is illustrated in append A.

Another revealing global measure of intelligibility shows that the selected areas generally less intelligible(R^2=0.209) than that of the Arab cities (0.231). This low intelligibility accounts for low connectivity values for the areas. The differences in their syntactic values are quite significant.

Table (8.3) Syntactic measures *of the nine selected areas in embedded model.*

	Site (1)	Site (2)	Site (3)	Site (4)	Site (5)	Site (6)	Site (7)	Site (8)	Site (9)	Sum	Mean
Max depth	27.86	25.1	2.3.51	24.19	26.87	25.63	26.26	25.03	27.17	208.11	23.12
Connectivity	2.8	2.46	2.64	2.72	2.81	2.78	2.69	2.77	2.63	24.3	2.70
Integration (Rn) global	0.514	0.5543	0.5933	0.5775	0.498	0.592	0.5668	0.546	0.471	4.91	0.546
integration (R3) local I	1.652	1.571	1.679	1.6474	1.581	1.679	1.6099	1.616	0.651	13.69	1.521
Intelligibility	0.131	0.0435	0.1579	0.3063	0.0945	0.182	0.2268	0.5709	0.166	1.88	0.209
Synergy	0.154	0.2592	0.3651	0.4461	0.246	0.3061	0.3705	0.682	0.256	3.08	0.343
Control (Std)	0.973	0.619	1.07	1.116	0.748	0.851	0.857	0.724	0.583	7.54	0.83 9

The most intelligible area is Old Soak (0.571), whereas the least intelligible is Giorsan (0.044). Looking at the three ethnic communities, spaces of Arab communities are generally the most intelligible (0.23), whereas spaces of Barbar communities are the least intelligible (0.18). However, density and length of axial lines have strong influence on intelligibility value, which was argued to be the reason why naturally grown cities like those in the UK become less intelligible as they grow bigger, while modern cities like Benghazi and Tripoli with long lines, increase connectivity.

Synergy is another key global measure, which is, ought to be investigated in the selected areas. Hence, it shows the correlation between local and global integration values for the selected cases. The mean synergy value of the areas is much higher than that of Arab cities(R^2=0.343). This implies that spacess of Ghadames generally support and encourage visitors' movement within the communities. The highest value is calculated for Old Soak (0.682), whereas the lowest in Mazigh (0.15). However, Arab communities within Ghadames show the highest synergy value (0.40), which reflects the fact that Arab spaces are locally and globally well organized for facilitating both resident and visitor movement.

It is also informative to measure control value of the selected areas (Table8.). Control is a measure of the extent to which a given space controls access to the spaces that are adjacent (immediately connected) to it. In general, control for a space in inversely proportional to the connectivity of the adjacent spaces (see chapter 5). It is calculated in terms of standard deviation (Std). However, the findings as summarized in table (8.4) show that Tangzin (site No.5) and Tharefra (site No.4) communities have both the strongest controlled spaces (8.0) and the least controlled spaces (0.1) as well as a similar range values.

The difference in control between both communities can be seen in pattern of control value distribution where Tharefra shows a higher Std. (1.12) than Tangzin (5.4). This implies spaces with less control and limited dispersion of distribution (1.07). This implies that Tharafra community has a slight wider dispersion of control values from the mean. The most restricted control values are calculated for Tuarg community where spaces confront limited range of control (2.3). Considering all nine selected areas, the mean Max. Control value is 5.2, whereas the Min. is 0.13. Generally, Spaces of Arab communities seem to have the strongest control (8) with Max. control value of 0.56, whereas spaces of Barbar communities seem to have the lowest control value (0,1) with lower range of control distribution

T*able (8.4)* *shows the range, minimum and maximum values of control in embedded model*

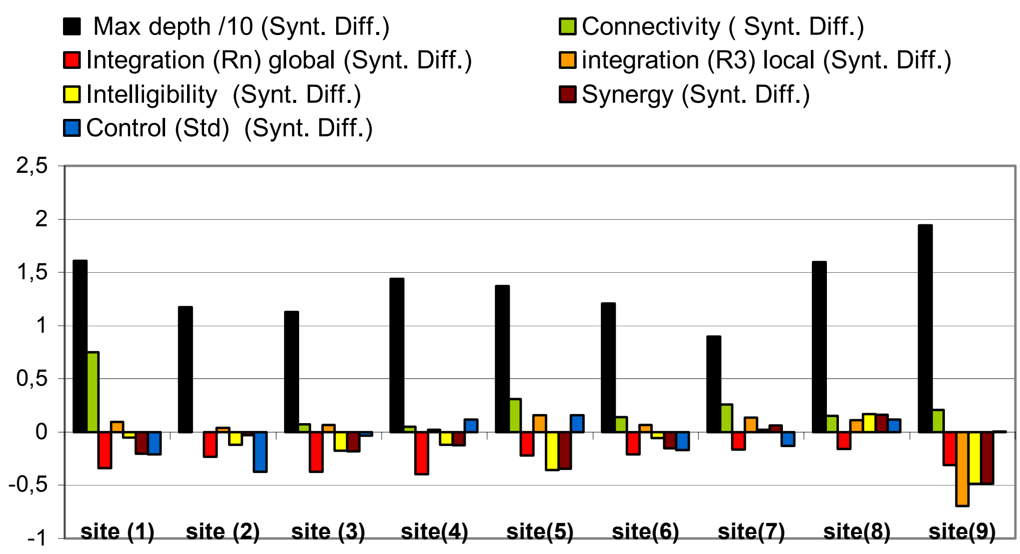
	Site (1)	Site (2)	Site (3)	Site (4)	Site (5)	Site (6)	Site (7)	Site (8)	Site (9)	Sum	Mean
Range	5.8	3.2	7.9	7.9	5	5.2	5.2	3.1	2.3	45.6	5.067
Min.	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	1.2	0.133
Max.	5.9	3.3	8.0	8.0	5.2	5.3	5.3	3.3	2.5	46.8	5.20
Std.	0.97	0.619	1.07	1.118	0.75	0.851	0.58	0.724	0.86	7.542	0.838

8.3.3. SYNTACTIC DIFFERENCES IN THE NINE SELECTED AREAS:

Having analysed the selected areas as embedded within the city ” embedded model” and in isolation ”cut-out model”. This section attempts to investigate the spatial properties of the areas in terms of their syntactic differences between both presented models of space. The syntactic values that show those syntactic differences are summarized in table (8.5). It is clear that Auld Blel, Djarrarsan and Tuarg communities show more significant differences than that of other ethnic communities. Seven syntactic measures are used to demonstrate the spatial differences of the nine selected areas. Generally, two syntactic measures, namely, maximum depth and connectivity, show that the selected areas gain increase in both of them as the areas embedded within the whole city. The mean increase in Max. depth of the area is14 steps of depth. The largest increase is calculated for Tuarg community (19 steps), which is accounted for its peripheral location within the city (see Append A). The smallest increase in Max. depth is calculated for Tsuku(9 steps), which reflects central location of the area within the city. This implies that residents of Tsuku confront on average the least number of turnings or changing directions in traversing from one space to another within the city.

The other syntactic measure of connectivity shows slight increase in space connections for the all areas. The average increase is 0.216 with the largest in crease in Mazigh(0.75) and the Least in Giorsan (0.1). This reveals that all communities gain more connections for their spaces as result of the impact of surrounding areas. However, it can be observed that Giorsan community as central areas shows very slight insignificant increase in its connectivity. This again implies no considerable impact on the areas from surrounding communities. Looking at the three ethnic communities in a comparison, spaces of Barbar communities seem to gain more connections (0.383) that that of Arab (0.118).

The syntactic difference in global integration of the nine selected areas show that spaces of each community seems to be more globally integrated in isolation ”cut out model” than in embedded within the city. The difference is quite significant for all the areas, which implies that connecting these areas leads to decrease the global integration value. This reduction is on average is 0.31 reflecting the way in which these areas are connected within the city. Spaces of Old Soak show the smallest change in this measure (0.161), whereas spaces of Tharefra show the largest change (0.398). Generally, Arab



Fig(8.22) *Syntactic Difference of the Nine Areas " embedded-cut out models"*

Generally, Arab communities seem to be more influenced by the neighbour communities in terms of this measure than Barbar communities are.

Difference in local integration is another informative measure about to spatial properties of the nine selected areas. On average Arab communities lose 0.27 of the global integration value, whereas Barbar communities lose 0.23. Generally, all Ghadames communities show higher local integration measure as their spaces are embedded within the whole city. Tuarg community is the only area that shows reduction in this measure (-0.695). This may accounts for the impact of the surrounding areas within three steps of depth as well as the extended axial lines and therefore more connections linked with them that make the area locally segregated. However, the other areas show on average a slight increase (0.085), which is generally insignificant increase. Auld Blel, Tsuku and Old Soak demonstrate significant increase in their local integration values as the result of neighbour communities. Looking at the three ethnic communities, spaces of Barbar communities on average seem to gain more local integration value (0.49) than that of Arab communities (0.36).

Looking at a key global measure of intelligibility, it can be seen from Fig (8.22) that seven areas seem to lose their intelligibility values, whereas two areas gain a slight increase of their intelligibility because of the good correlation of global integration values and space connections in embedded model. Generally, mean intelligibility difference in the nine areas under study tends to decrease in embedded model. The overall average of this reduction is 0.48. Tsuku and Old Soak are the only areas that gain intelligibility advantage; hence, their syntactic difference is positive. The largest increase is calculated for Old Soak (0.167) and the lowest in Tsuku (0.0198). This significant increase in Old Soak spaces is due to sound correlation between global integration and number of space connections (0.571). However, spaces of Arab communities show considerable decrease in their intelligibility within embedded model with average reduction of 0.12 of their values, whereas spaces of Barbar

T*able (8.5)* *shows syntactic Differences in the range, minimum and maximum values of control in Nine Selected Areas.*

	Site (1)	Site (2)	Site (3)	Site (4)	Site (5)	Site (6)	Site (7)	Site (8)	Site (9)	Sum	Mean
Max depth	16.08	11.76	11.28	14.4	13.71	12.08	8.98	15.95	19.42	123.66	13.74
Connectivity	0.75	0	0.07	0.05	0.31	0.14	0.26	0.15	0.21	1.94	0.216
Integration (Rn) global	-0.342	-0.2302	-0.3715	-0.3981	-0.219	-0.207	-0.163	-0.1606	-0.3108	-2.402	-0.267
integration (R3) local	0.0937	0.0364	0.0648	0.02	0.1552	0.0672	0.1365	0.1141	-0.695	-0.0071	-0.001
Intelligibility	-0.052	-0.1218	-0.1752	-0.1191	-0.3586	-0.0587	0.0198	0.1674	-0.4839	-1.1821	-0.131
Synergy	-0.2022	-0.0291	-0.1795	-0.1269	-0.3461	-0.1544	0.0589	0.1636	-0.4839	-1.2996	-0.144
Control (Std)	-0.212	-0.371	-0.037	0.116	0.155	-0.169	-0.133	0.118	0.007	-0.526	-0.058

communities seem to sustain their intelligibility regardless of being disembedded or embedded within the city; hence the mean difference in this syntactic value is insignificant (0.04) which is nearly the third of what we have seen in Arab communities.

It is also informative to measure control value of the selected areas (Table8.). Control is a measure of the extent to which a given space controls access to the spaces that are adjacent (immediately connected) to it.

In general, control for a space in inversely proportional to the connectivity of the adjacent spaces (see chapter 5). It is calculated in terms of standard deviation (Std). However, syntactic difference in control values show that the average Std. reduction for nine areas is 0.057. Four areas only show a slight increase, namely Tharefra (0.12), Auld Blel (0.16), Old Soak (0.11) and Tuarg (0.28) which reveal that spaces in these areas gain more controlled spaces and wider range (degree) of control from their surrounding areas.

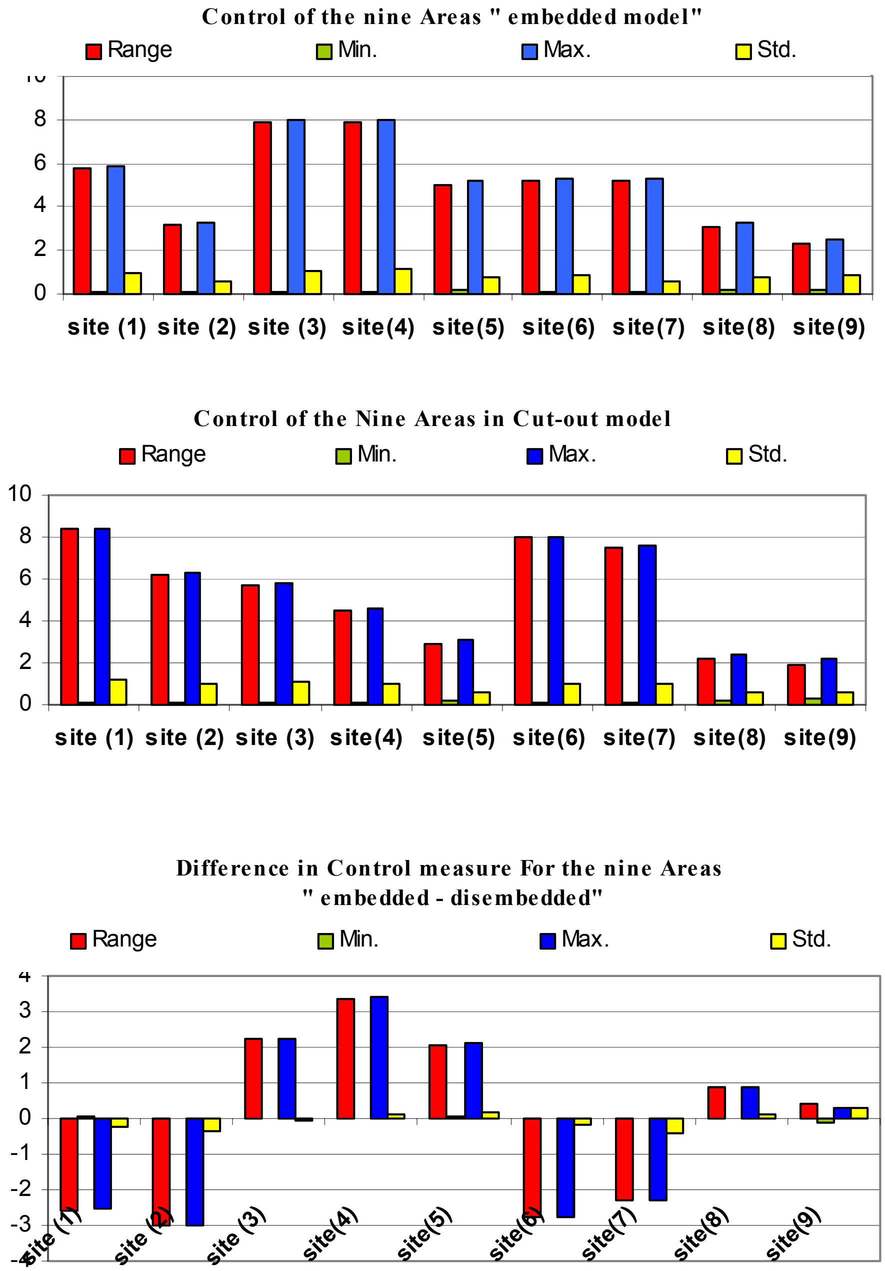
The other five remaining areas show a slight decrease in Std values, which is on average 0.24. The highest decrease in Tsuku (0.41) and the lowest in Tangzin (0.04). This decrease implies that spaces are more constrained and have lower range of control for them. The reduction in the standard deviation of control values reflects the fact that with more connections among spaces, it is less likely that one or two spaces will dominate access to the others. The most controlled spaces are found in Tangzin and Tharefra (8.0) in embedded model, whereas the least controlled spaces are found almost in all other areas (0.10) except Auld Blel, Tuarg and Old Soak (0.2).

T*able (8.6)* *shows syntactic Differences in the range, minimum and maximum values of control in Nine Selected Areas.*

	Site (1)	Site (2)	Site (3)	Site (4)	Site (5)	Site (6)	Site (7)	Site (8)	Site (9)	Sum	Mean
Range	-2.57	-3	2.21	3.36	2.08	-2.76	-2.3	0.88	0.4	-1.7	-0.18889
Min.	0.03	0.02	0.01	0	0.033	0.013	0.01	0	-0.13	-0.014	-0.00156
Max.	-2.54	-3	2.22	3.4	2.12	-2.74	-2.3	0.88	0.3	-1.66	-0.18444
Std.	-0.21	-0.361	-0.037	0.119	0.16	-0.169	-0.41	0.114	0.28	-0.514	-0.05711

8.4. VISUAL AND METRIC ANALYSIS OF THE SELECTED AREAS:

In order to establish an actual correspondence between the configurations of the selected areas and the morphology of their open spaces, we then proceeded to analyse the selected case studies by means of visual and metric methods of graph analysis. In other wards, the public space of each area has been reduced into a spatial system not by axial lines as introduced in pervious section, but by distribution of a uniform grid of points, and then studying visual and metric relationships connecting each of them with all others. This mesh of grid covers each convex space with at least a row of vertices, on basis of the selected areas a grid of 2.2 m mesh is chosen based on reasonable level of resolution for practical capacity of computation as well as similar to that used in analyzing the whole settlement. On this regard, the nine selected areas are analysed visually and metrically in order to extract the unique characteristics of these areas as far as some aspects of privacy regulation are concerned.



Fig(8.23) *Shows control values for the selected areas as embedded model and in isolation as well as the difference in control value between them.*

8.4.1 VISIBILITY GRAPH ANALYSIS FOR THE NINE CASES

Visibility analysis. Conducted to a cross-sectional sample of Ghadames communities, clarifies the internal structure of these nine areas. However, In addition to three elementary measures: visual connectivity, isovist maximum radial, and isovist moment of inertia the key global measures of visual mean depth, integration, entropy and relativised entropy are calculated. Moreover, the key local measures: visual clustering coefficient, control, and controllability are also calculated. Other two advanced visual measures: visual intelligibility and synergy are derived for the selected cases. The summary of the findings in terms of these measures is summarized in table (8.7) and can be discussed in detail under the following headings:

8.4.1.1 PRELIMINARY RESULTS

Having constructed the visibility graphs for the nine selected areas, three immediate available measures, namely visual connectivity, isovist Max. Radial and moment of inertia show general visual properties of the cases.

Visual connectivity measure (how many locations each node can see) shows that the overall average value of this measure is about 305 with highest visual connectivity value 1152 for Auld Blel, whereas the lowest is 44 in Tharefra. This fact reflects the compact structure of spaces in Tharefra, which restrain visual fields and create high degree of enclosure in contrast to that of Auld Blel. However, comparing the measure a cross the three ethnic communities of the city, spaces of Tuarg seem to be the least visually connected (78), whereas spaces of Arab communities are the most connected (456). In this regard, spaces of Arab communities seem to reinforce visual interaction among the observers in opposite to that seen in Tuarg community.

B

Table (8.7) *Shows summary of the visual and metric measures of the nine selected communities manipulated using SPSS*

	Mazigh Site No.1	Giorsan Site No.2	Tangzin Site No.3	Tharefra Site No.4	Auld Blel Site No.5	Djarrasan Site No.6	Tsuku Site No.7	Old Soak Site No.8	Tuarg Site No.9	Mean
Connectivity	159.54	639.14	53.097	43.99	1151.91	131.55	91.93	393.9024	77.699	304.7509
Isovist Max.Radial	48.52	84.29	38.757	38.17	132.63	41.71	39.16	88.4294	37.02	60.96516
Isovist Moment of Inertia	700494.8	6773044	153840.4	127841.4	31326257	528937.6	265286.4	4651191	147776.3	4963852
Clusteing Coefficient	0.8098	0.795	0.7749	0.7722	0.7863	0.7768	0.7925	0.8063	0.8189	0.792522
Visual Control (Std)	0.2853	0.2456	0.34	0.3337	0.284	0.3025	0.305	0.28323	0.2844	0.29597
Visaulcontrollability	0.4391	0.5259	0.321	0.3027	0.425632	0.3777	0.3571	0.4661	0.4115	0.40297
Visual Entropy	3.135	2.59	2.7755	2.5778	2.591509	3.1165	3.4752	2.3631	2.538	2.795845
Visual Entropy R3	1.3131	1.3396	1.3031	1.3584	1.407343	1.3011	1.3102	1.39	1.4384	1.351249
Visual integration HH	1.549	3.056	2.08	2.2688	4.06771	1.72339	1.4684	3.6606	2.5883	2.4958
Visual integration HH R3	6.3889	9.9048	4.304	4.1124	8.1559	5.9769	4.9693	8.4744	5.1267	6.379256
Visual integration Tekl	0.4087	0.4392	0.4216	0.4261	0.4512	0.4142	0.4072	0.4488	0.434	0.427889
Visual integration Tekl R3	0.4947	0.511	0.4744	0.4739	0.4914	0.489	0.4806	0.5038	0.4891	0.489767
Visual Mean Depth	6.561	4.372	5.0278	4.3968	3.8595	6.3875	7.4675	3.5582	3.7751	5.045044
Visual Mean Depth R3	2.1468	1.946	2.391	2.3761	2.1841	2.2314	2.3168	2.032	2.1726	2.199644
V. relativised Entrop	3.5343	2.7118	2.6873	2.5583	2.3841	3.0425	3.2157	2.4342	2.4145	2.775856
V. relativised Entrop R3	2.3581	2.177	2.5563	2.4916	2.3165	2.4256	2.4906	2.23	2.2747	2.368933
Visual intelligiblity (R Sq)	0.003	0.273	0.03	0.498	0.66	0.003	0.002	0.053	0.044	0.174
Visual Synergy (R Sq)	0.006	0.003	0.031	0.498	0.006	0.006	0.001	0.008	0.02	0.064333

Looking at isovist maximum radial measure cross the nine selected areas, the findings reconfirm the fact regarding Tharefra, which has the shortest isovist Max. radial of 38m, whereas the longest is calculated for Auld Blel (133m). The overall average value for the selected areas is 61m which is low value compared to what we have seen in old Tripoli, Benghazi and Ghat (see chapter 7). Three communities are found to have higher values than overall average, namely Giorsan (84m), Old Soak (88m) and Auld Blel (133m). It is ought to be point that the correlation between visual connectivity and isovist Max. radial a cross the nine areas is extremely strong(R^2=0.95) which is very interesting reflecting the fact that with an increase in number of space connections within the areas it is the most likely that their average isovist Max. radial increases. This fact implies nature of the axial development for spaces within these communities. However, the average of the isovist Max. radial values in Arab communities is 76m which is the greater than that of Barber communities (43m).

Third revealing measure of isovist moment of inertia (how easy an object or pedestrian is to spin) for the nine areas shows that residents of Tharefra seem to spin within their spaces much easier than residents of other communities; hence, the lowest value is calculated for their spaces. In contrast, residents of Auld Blel confront more difficult system of spaces in order to spin from space to another. The overall average value for the nine areas is too high revealing in general that it is not easy for residents to spin within their communities. This high value accounts for two extreme values in Giorsan and Auld Blel where spaces do not support easy movement for their residents. Comparing the three ethnic communities, it is obvious that space of Tuarg community is the easiest for pedestrian to spin, whereas space of Arab communities reveal the opposite situation, hence Arab residents confront difficult sequences of visual fields.

8.4.1.2 GLOBAL VISUAL PROPERTIES OF THE SELECTED AREAS

The key global measures of visual mean depth, integration, entropy and relativised entropy are calculated for the nine cases. They demonstrate various visual properties of space configuration. However, visual mean depth or the fewest number of turns through the visibility graph is calculated for each community. The overall average value for the areas is 5.05 steps of depth. The shallowest spaces are found in Old Soak (3.56), whereas the deepest is in Tsuku (7.47). Therefore, resident of old Soak make the fewest number of turns in their journeys whereas residents of Tsuku confront many spaces and turns in order to traverse from one space to another. This deep structure of spaces can be interpreted as residents' tendency toward a high degree of privacy. Distribution of mean depth values within the nine communities shows generally high values are found in the feeder streets connecting residential dead-end streets. A cross ethnic comparison of the communities' shows that spaces of Barbar communities are deeper (6.81 steps) than that of Arab (4.24) and Tuarg (3.78) communities. Therefore, residents of Barbar communities on average make the largest number of turns to change direction within their journeys, whereas residents of Tuarg make the fewest ones.

However, if mean depth restricted to three steps away from each space within the communities as a local mean depth, the overall average value for the areas is 2 steps. Comparing the restricted mean depth (local depth) in all areas, the difference seems to be not significant, hence the difference ranges from 1,9 steps in Giorsan and 2.4

steps in Tangzin.This implies greater potential for social interaction between neighbours in Giorsan than in other communities. Comparing the three ethnic groups, all the same, restricted or unrestricted mean depth, residents of Tuarg community make the fewest number of turns (2.17), whereas residents of Arab communities make larger number (2.19) .The residents of Barbar communities make the largest number of turns (2.23) as their spaces are the deepest. However, looking at restricted and unrestricted mean depth for the areas, Tuarg communities seem to offer the greatest potential for social interaction between neighbours as well as between neighbours and visitors. This fact can be interpreted as consequence of their isolated area, which may encourage neighbours to interact with each other as well as with visitors.

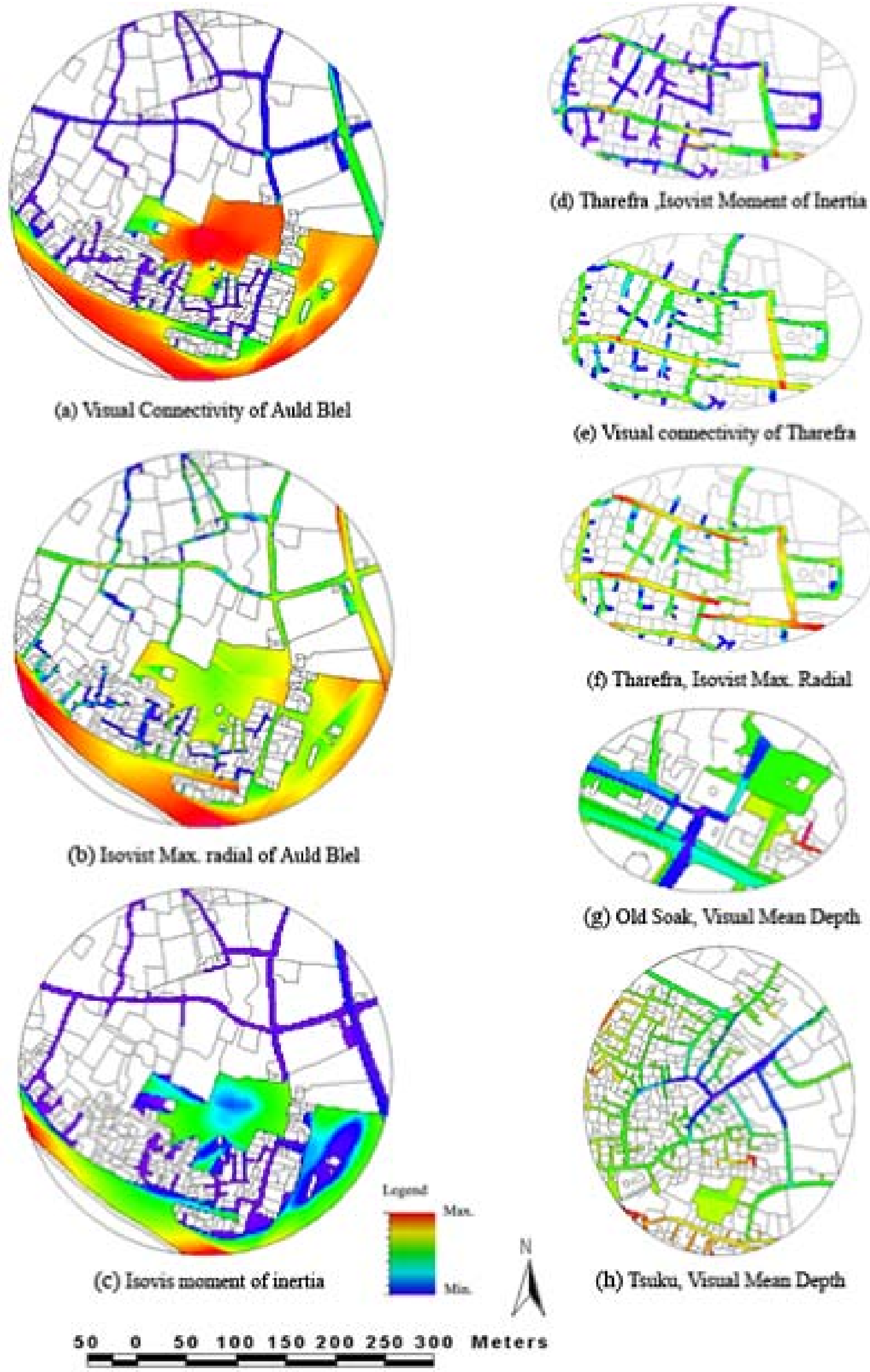


Fig (8.24) *Visibility graphs shows visual connectivity, Isovist Max. Redial, moment of inertia and visual mean depth for communities that have Min. and Max Values.*

Another key global measure of visual integration (HH) for the nine selected areas, demonstrates that the overall average is 2.5, which reflects high degree of global integration between the spaces. Hence, this level of integration is higher than that of Arab and UK cities. The most globally integrated spaces are found in Auld Blel (4.07), whereas the lowest value is in Tsuku (1.47). However, comparing the three ethnic communities in average spaces of Arab communities seem to be more visually integrated (3.01) than that of Barbar (1,58) and Tuarg (2.59) communities. This implies that Arab communities reinforce movement of visitors within their spaces unlike that of Barbar communities where their residents seem to be more conservative and inward looking. The distribution of globally integrated spaces within these nine communities is shown in Append B.

Restricting the visual integration into three steps of depth (local integration) shows on average that spaces of the communities are locally integrated (6.4). The most locally integrated spaces are calculated for Giorsan (9.9), whereas the most locally segregated spaces are in Tharefra (4.1). Therefore, spaces of Giorsan support social interaction between neigbours unlike that of Tharefra. However, spaces of Arab communities are in general the most locally and globally integrated of all and potential for social interactions between neighbours and between neighbours and visitors is greater than that of other communities.

The key global measure of visual entropy (distribution of locations in terms of their visual depth), which reveals about how order the spatial system is, shows that the average value of the nine communities is 2.78. This level of visual entropy implies disorder system of spaces. However, the least disorder system of spaces seems to be in Old Soak (2.36), whereas the most disorder system is in Tsuku (3.48). Generally, the spatial system of Barbar communities indicates more disorder configuration of spaces than that of Arab (2.58) and Tuarg (2.54) communities. Spatial system of Tuarg turns out to have the lowest value, which means the least disorder system of spaces that the residents traverse from one space to another easily, that is to say, their spaces are easily accessible in terms of permeability as well as of visibility fields. It is also demonstrates that the visual fields change continuously with movement, as surfaces disappear and others come into view.

Looking at visual relativised entropy (the expected distribution of locations in terms of their visual depth), the average value for the nine communities is 2.78 reflecting slightly less disorder systems of spaces in general, that is to say, the frequency of the expected distribution of visual depths is less disorder than the actual. The lowest value is calculated for Auld Blel (2.38), whereas the highest is in Mazigh (3.53). Therefore, residents of Auld Blel confront visually less disorder sequence of visual fields for traversing from one space to another. Comparing the three ethnic communities, Barbar communities show the highest value, which implies the most disorder system of spaces. The lowest value is calculated for Tuarg communities with the least disorder of spaces. One point ought to be mentioned here, the rank of the three ethnic communities in terms of relativised entropy is the same rank of visual entropy, which confirms that the expected and actual distribution of location in terms of visual depths is nearly the same.

8.4.1.3 LOCAL PROPERTIES OF THE NINE SELECTED CASES

Three key local measures, which are based on the relationships between each convex space and spaces directly connected to it, are calculated for the nine selected areas. These measures are clustering coefficient, visual control and controllability (see chapter 5). However, Looking at clustering coefficient cross the areas, the overall mean value is 0.79. This shows quite high value, which implies that when residents of these communities move from one space in any direction do not cause any great loss of their visual information. Hence, this measure relates to the convexity of the isovist at the generating location. If the isovist being considered id almost a convex polygon, then almost all point locations within neighbourhood will be able to see each other, and therefore clustering coefficient will tend to one. If, on the other hand, the isovist is very spiky(not at all convex) then many points within isovist will not be visible from each other, and clustering coefficient will tend to zero.

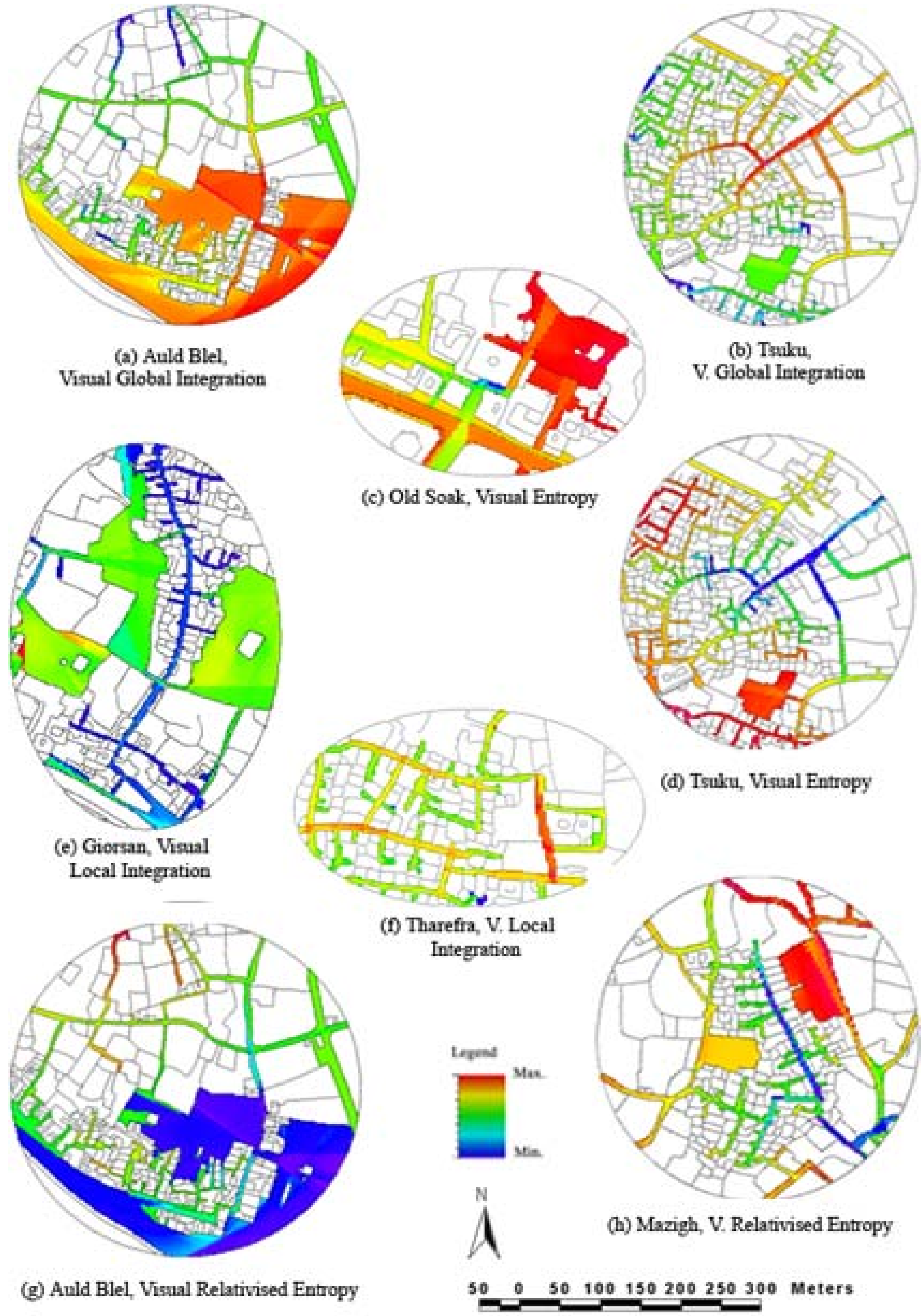
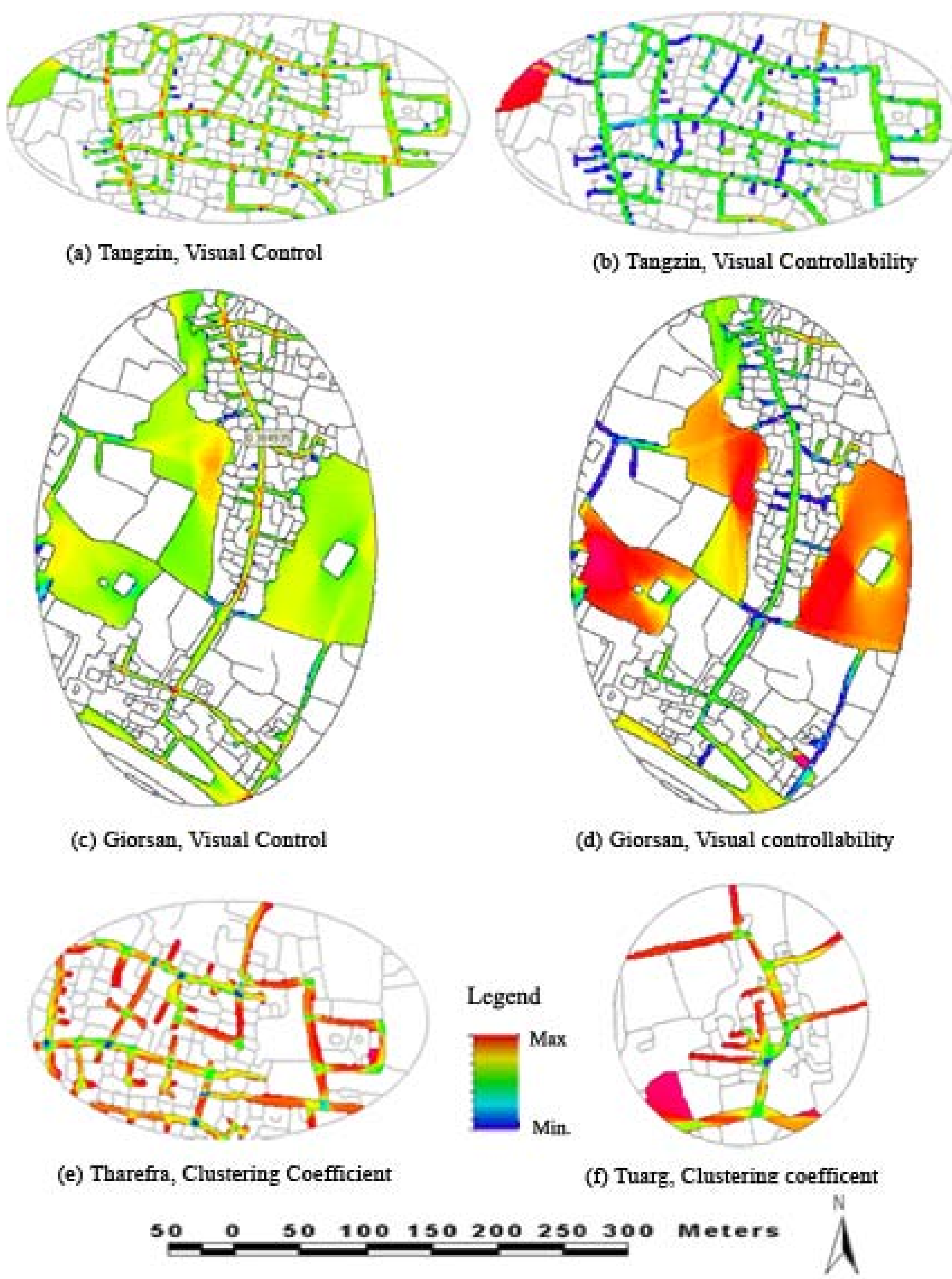


Fig (8.25) *Visibility graphs: shows visual global and local integration, visual entropy and relativised entropy for the communities that have minimum and maximum values.*

The lowest value is calculated for Tharefra (0.77), which reflects to some extent spiky isovist, and therefore observers within this community tend to lose much of visual information during their journeys. In contrast, residents of Tuarg community tend to lose little of their visual information; hence, the clustering coefficient is the highest (0.82). Comparing the three ethnic communities, it is obvious from the average value that Arab communities show the lowest clustering coefficient (0.7869), which confirms a great potential of their spaces for generating multidirectional visual fields. Hence, visual fields change continuously for observer when he or she moves away from one space to another. However, Barbar communities show a slight higher value (0.793) than that of Arab communities. This indicates that residents of Barbar communities generally lose little visual information in their movement within the community.

Another key local measure of visual control as measured in terms of standard deviation indicates that the overall mean value for the nine selected areas is 0.296. This generally reveals that spaces within these communities are unlikely to allow more visual permeability. Moreover, This low value also indicates that the visual control values of spaces are constrained in limited range of diversity. The highest value is calculated for Tangzin (0.34), whereas the lowest value is in Giorsan (0.25). Looking at the visual control values in the three ethnic communities, it seems to be that spaces of Arab communities are the highest (0.36). Hence, Arab spaces are the least constrained in terms of visual control. However, spaces of Tuarg community show the lowest value (0.28), which reflects the most constrained visual control property.

Concerning the local key measure of visual controllability, the results also show that the average value of the selected areas is 0.4. This implies that spaces of communities are slightly controllable, as the area of visual field is larger compared to the area visible from the centre to which it connects. The highest value is calculated for Giorsan (0.53), whereas the lowest is in Tangzin (0.32). This means that residents of Giorsan spaces are subject to visual observation from surrounding large visual



Fig(8.26) *Visibility graphs show visual local measures: visual control, visual controllability, and clustering coefficient for the communities that have the Max. And Min. values.*

fields available to other people within the community. Comparing the ethnic communities, spaces of Arab communities seem to be the least controllable (0.408), whereas spaces of Tuarg community are the most controllable (0.412), hence spaces are likely to reinforce observation through large visual fields.

8.4.1.4 ADVANCED VISUAL MEASURES

Visual intelligibility and visual synergy are two informative measures about the visual properties of the selected areas. As visual intelligibility value helps to capture the way people can learn about large patterns from their experience of small parts. Whereas, Visual Synergy as measure of correlation between local and global integration demonstrates to what extent the visual interactions between residents and visitors occur.

However, the mean intelligibility value for the areas is 0.17, which indicates less intelligible areas. Therefore, observers in these areas confront visual difficulty to understand the whole visual fields of the areas from observing small parts. The high values are calculated for Auld Blel (0.66), Tharefra (0.5) and Giorsan (0.27), which show high intelligible spaces. The other communities lack intelligibility property with the lowest value for Mazigh and Djarrasan (0.003). Ethnic comparison shows that Arab communities seem to be the most visually intelligible of all (0.30). The second highest value is calculated for Tuarg (0.044), whereas the lowest is in Barbar (0.007) which lacks the intelligibility property.

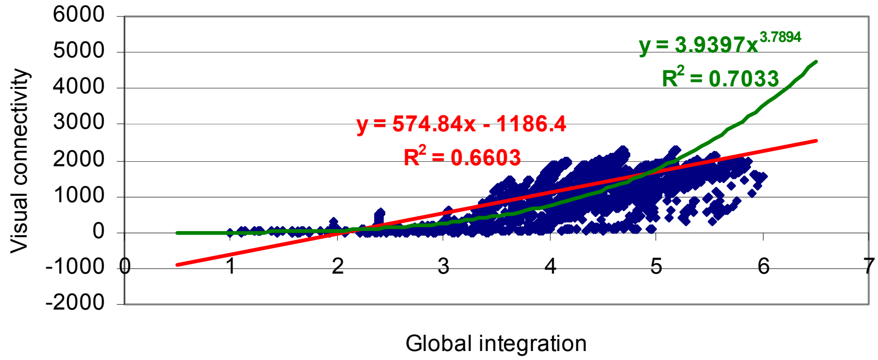
The second advanced visual measure of synergy (correlation between local and global integration) is calculated for the nine selected areas. It shows that the overall average value is too low(R^2 = 0.064) compared with that seen in Arab cites (0.16). Tharefra is the only community that distinctively shows extremely strong synergy value of 0.49 as illustrated in Fig (8.28) as well as a high visual intelligibility. This implies that observers are easily captured and understand the visual picture of the community from just navigating a few visual fields. Moreover, a great potential for visual interaction is likely to be found between neighbours as well as neighbours and visitors. The lowest synergy value is calculated for Tsuku (0.001), which reveals that spaces of this community are unlikely to offer potential for visual interaction among the members. Comparing the three ethnic communities, spaces of Arab communities generally show higher visual synergy value than that of Barbar (0.006) and Tuarg. (0.02) Communities.

8.4.2 METRIC PROPERTIES OF THE SELECTED AREAS

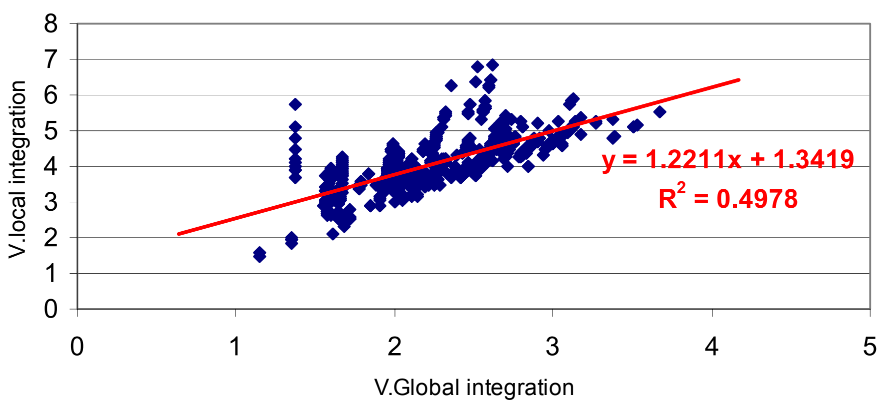
Having analysed the selected areas using topological measures based on step mean depth, the next set of analysis attempts to investigate the nine areas from metric relationships prospective. Three essential measures are metrically calculated for the areas reflecting different metric properties of the communities. These measures are mean shortest path distance, mean shortest straight-line distance, and mean angular deviation of the shortest paths.

Looking at the key metric measure of mean shortest path distance (metric mean depth) shows that the overall average distance is 168m for the areas. The highest value is calculated for Auld Blel (226m), whereas the lowest value is calculated for Tuarg (98m). This reflects to some extent the nature of human interaction matrix in Tuarg community, as residents require the least action of movement in order to traverse from one space to another within the area.

The situation is reversed in Auld Blel where more physically effort is needed for residents to execute action of movement. Comparing the three ethnic communities, Arab communities shows lower mean shortest path distance (116m) than that of Barbar (202m). Therefore, more effort is needed to move within the Barbar spaces than in Arab spaces. Another point ought to be stated, the focus of this measure is the central parts of these communities where may or may not counter with visual mean depth of the areas.

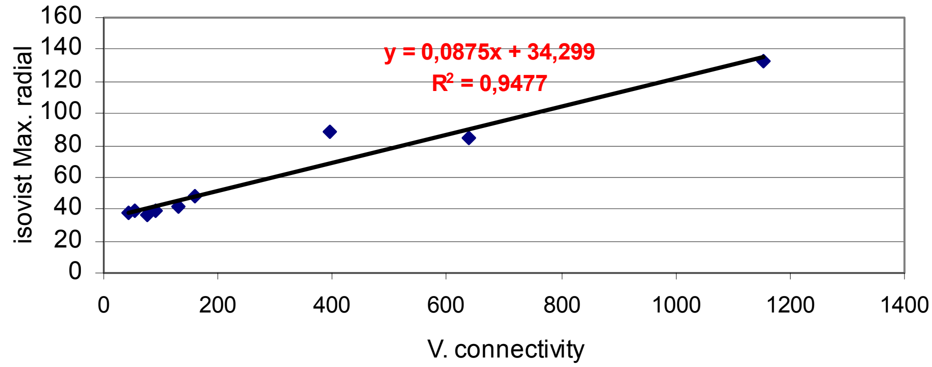


Fig(8.27) Visual intelligibility of Auld Blel

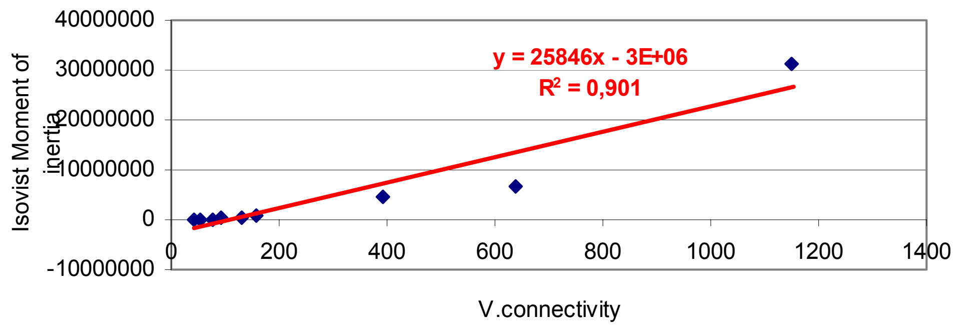


Fig(8.28)Visual synergy for Tharefra Community

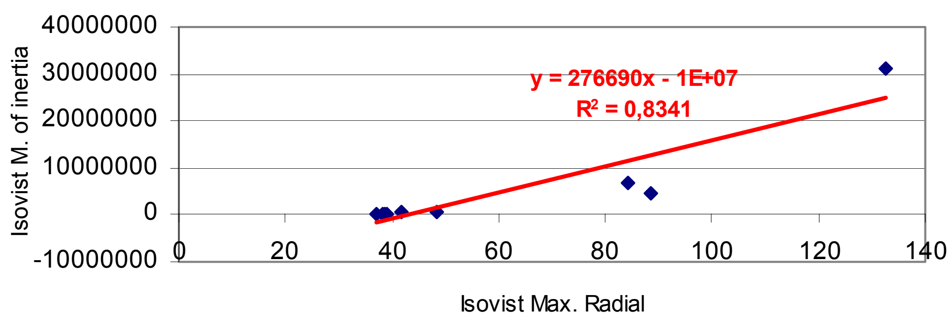
Metric mean straight-line distance is another interesting measure which reveals about the Crow's fly distance from one point to another within the system. The overall average value for the nine selected areas is 110m. The longest straight-distance is calculated again for Auld Blel (172m), whereas the shortest straight-line distance is calculated again for Tuarg community (68m). Looking at the ethnic communities, spaces of Arab communities seem to have the longest straight-line distance (116m) than that of Barbar (114m) and Tuarg (68m) communities. The difference in this measure between Arab and Barbar communities seems to be insignificant, but it is highly significant in case of Tuarg communities. The last key metric measure of mean shortest path angle, which reveals about the mean angular deviation encountered on each of the shortest paths shows that the mean average value for the



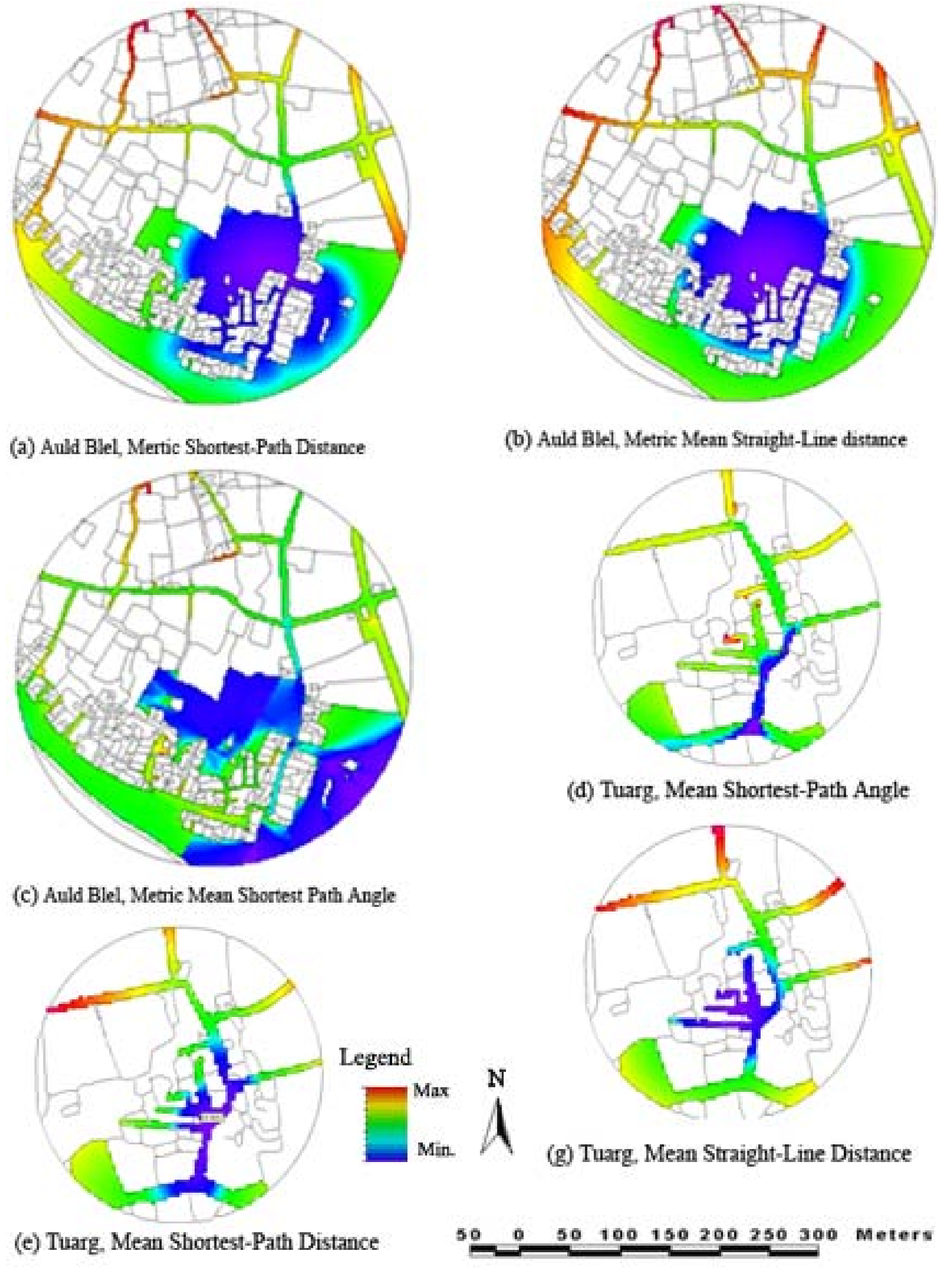
Fig(8.29) *Shows Correlation between visual Connectivity and Isovist Max. radial Correlation*



Fig(8.30) *Correaltion between V. connectivty and Isovist Moment of Inertia*



Fig(8.31) Correlation Between Isovist Max. Radial and Moment of Inertia



Fig(8.32) *shows metric visibility graphs for Auld Blel and Tuarg communities with three main measures: mean shortest-path distance, mean straight-line distance and mean shortest-path angle.*

nine areas is 2.6 (the angles are recorded in range 0-4 for 0^0 to 360^0). The highest angular deviation is calculated for Tsuku (3.99), whereas the lowest is calculated for Tuarg community.

8.5. PRELIMINARY FINDINGS

8.5.1. COMMUNITIES: VISUAL AND METRIC PROPERTIES

Visual and metric analyses of the nine selected communities demonstrate some important concluding points that ought to be addressed.

1. Auld Blel community shows the most visually connected spaces, whereas Tharefra shows the most visually segregated spaces. The low connectivity value of Therefore implies that spaces restrain visual fields and reinforce high degree of enclosure. Ethnic comparison shows that Tuarg is the most visually segregated community, whereas Arab communities show the most accessible spaces and more visual interaction is likely to be found.

2. Tharefra shows the shortest Isovist Max Radial, which confirms spaces that encouage and degree of enclosure, whereas Auld Blel shows the Longest Isovist Max. Radial that implies spaces reinforce open visual fields and less tendency to visual privacy. However, Barbar communities seem to show shorter sight of vision and more enclosure than those spaces of Arab communities.

3. Spaces of Tharefra seem to show the least Isovist Moment of Inertia that people can span much easier within the community than in any other community. Space of Auld Blel community show the opposite and people confront more difficulty traversing from one space to another. Ethnic comparison shows that spaces of Tuarg community are the easiest for people to span, whereas spaces of Arab communities show the opposite.

4. The shallowest spaces are found in Old Soak, whereas the deepest are in Tsuku community. This show that users of Tsuku spaces tend to make large number of turns in order to traverse from space to another. Generally, spaces of Barbar communities are deeper than that of Arab and Tuarg communities. This implies residents of Barbar on average make the largest number of turns in their journeys, whereas Tuarg residents make the fewest ones.

5. Locally, the mean depth of Giorsan seems to be the shallowest of all which reveals a greatest potential for spatial interaction between neighbours. Tuarg spaces are the shallowest both in restricted (local) and unrestricted (global) mean depth. This implies that people within Tuarg community make the fewest number of turns in traversing from one space to another.

6. Auld Blel is the most globally integrated community, whereas Tsuku is the least globally integrated. Therefore, spatial interaction is likely to take place in Auld Blel than Tsuku community.

7. Spaces of Arab communities are visually more integrated than that of Barbar and Tuarg community. This implies that Arab communities reinforce movement of visitors within their spaces unlike that of Barbar and Tuarg community.

8. Giorsan community shows visually the most locally integrated spaces, whereas Tharefra shows the least locally integrated spaces. Stronger spatial interaction between neighbours is likely to be seen in Tharefra community. In general, spaces of Arab communities are the most locally and globally integrated of all, whereas Tuarg community shows the most locally segregated spaces.

9. Old Soak community seems to have the lowest visual entropy value, which reflects the least disorder system of spaces. In contrast, Tsuku community shows the most disorder system of spaces that residents of Tsuku confront

visual difficulty in traversing from one space to another. Generally, Barbar communities turn to show more disorder system of spaces than that of Arab communities, wheras Tuarg community shows the least disorder system of spaces. This means that Tuarg spaces are easily accessible in terms of visibility and permeability.

10. Tharefra community shows the lowest value for clustering coefficient, whereas Tuarg shows the highest value. Therefore, Tharefra residents tend to lose much of their visual information during their journeys. Since clustering of the spaces is more related with decision points for observers in way finding. In contrast, residents of Tuarg tend to lose little of their visual information. Arab communities turn to have the least clustered spaces that generate multidirectional visual fields. So, Arab residents tend to lose much of visual information during their journeys. Barbar communities show slightly higher values, which implies that Barbar residents generally lose little of visual information in their movement within the community.

11. Tangzin community shows the most controlled spaces, whereas Djarrsan community shows the least controlled spaces. Therefore, spaces of Tangzin tend to impede multidirectional visual fields and restrict open sight of vision, whereas spaces of Djarrsan community tend to reinforce visual fields and support visual interaction. Spaces of Arab communities are less restricted than that of Barbar community ,but more restricted than that of Tuarg community.

12. The Giorsan community shows the most controllable spaces, whereas Tangzin shows the least controllable spaces. This implies that Giorsan spaces are subject to visual observation from the surrounding large visual fields. Arab communities show the least controllable space of all, whereas Tuarg community shows the least controlled and controllable spaces.

13. Auld Blel, Tharefra and Giosan are the most intelligible communities within the walled city. Residents of these communities easily capture the whole structure of communities by their experience of small parts. Mazigh and Djarrsan are the least intelligible communities, which implies that residents of these communities confront difficulty in understanding the whole structure of their communities. In general, Arab communities are the most intelligible of all, whereas Brbar communities are the least intelligible.

14. Tharefra community distinctively shows both the highest synergy and intelligibility values. This fact reveals that the community reinforces visual interaction between visitors and neighbours and that the residents are able to capture the structure of the community from experience of fewer visual fields. Tuarg community shows the lowest synergy values, which intrudes strangers from penetrating into the community. Generally, Arab communities seem to offer greater potential for visual interaction between visitors and residents their Barbar and Tuarg communities.

8.5.2. VISUAL COMPARISON OF THE NINE COMMUNITIES WITH THE WHOLE CITY

Comparing the visual properties of selected communities with that of the whole city using least square method shows the following concluding points:

1. The lowest value for the sum least square differences in the visual measures was calculated for Tsuku community (Table 8.8), which implies that the community closely represents the visual properties of whole city. However, Auld Blel has the highest value for the sum square differences, which implies that the visual properties of the community are too far from visual properties of the city.

2. Comparing the three ethnic communities, Barbar communities, namely Tsuku, Djarrsan and Mazigh show the lowest values for the sum of square

differences of all other communities. These interesting visual properties of Barbar communities closely reflect almost visual properties of the whole city.

3. Tuarg community shows extremely far visual properties from that of the whole city, hence the sum of square differences in the variables is very high.

4. In Tsuku community five visual measures show the least sum square differences from that of the city.(Table 8.8),whereas Tuarg and Auld Blel Do not show any visual measure closely relate to the overall properties of the city.

Looking at syntactic and visual comparison between each community with another shows the following remark points:

1. Considering all syntactic and visual variations (26 measures), the degree of relationships between the communities were measured in terms of correlation coefficient (R^2) and listed in table 9.3. They show generally strong correlations between them confirming the unity of Ghdames' structure.

2. The strongest correlation was found between Tsuku and Djarrsan (Barbar) communities, whereas the weakest correlation was found between Old Soak and Tsuku (Arab and Barbar) communities.

3. Barbar communities, namely Mazigh, Djarrsan and Tsuku, show the higher correlation coefficients between them than that of Arab communities. This implies that syntactic and visual properties of Barbar communities resemble each other.

4. Old Soak is the only community that shows poor correlation with all other communities, which reflects extreme structure of spaces and different syntactic and visual properties from the rest of the communities.

5. Tuarg community shows the second weakest correlation coefficients as it can be seen from table 9.3 reflecting different syntactic and visual structure of spaces.

8.5.3 COMMUNITIES: METRIC PROPERTIES

1. Metrically, Auld Blel community shows the highest mean shortest path distance or metric depth. This implies that the residents have to move long metric distances within their community. Spatial interaction among neighbours is unlikely to be strong as a consequence of far distances. Tuarg community shows the lowest metric depth, which implies that Tuarg residents make the least action of movement in order to traverse from one space to another.

2. Arab communities metrically show shallower spaces than that of Barbar community; hence, Barbar residents confront long travel distances and limited potential for spatial interaction.

3. Auld Blel community shows the longest mean straight –line distance of all, whereas Tuarg shows the shortest mean straight-line distance. This implies to some extent the degree of visual enclosure; hence, the short walking distances in Tuarg community reflect multidirectional physical movement for the residents and therefore, more restricted visual fields.

4. Arab communities show longer straight-line distances than Barbar and Tuarg communities. It is more likely that residents of Arab communities walk relatively longer distances with fewer numbers of turns than that Barbar and Tuarg residents.

5. The highest angular deviation of the shortest paths is found in Tusku, which implies soft angles are likely to be found in community paths; therefore residents confront less difficulty in changing direction. The lowest angular deviation is found in Tuarg which implies relatively sharp restricted angles

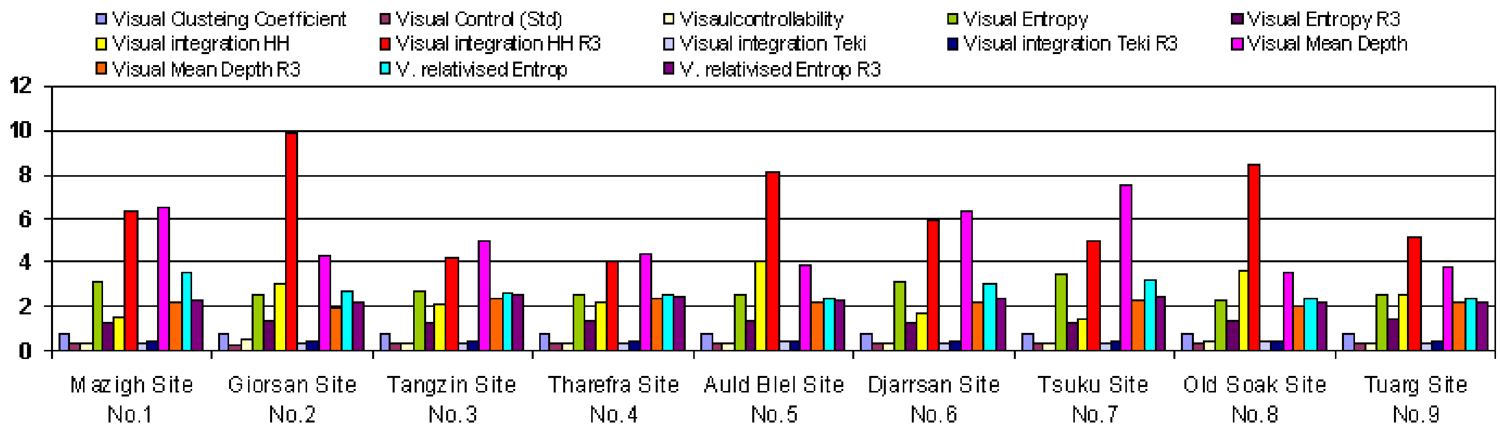
throughout Tuarg paths and residents confront difficulty in changing directions from one street to another.

6. Angular deviation of shortest paths in Barbar communities turns to be higher than that in Arab communities, but lower than that in Tuarg . This implies that residents of Barbar communities change their direction through softer angles from street to another than in Arab communities. In other words, soft angles have considerable influence on pedestrian in terms of path choice and way finding.

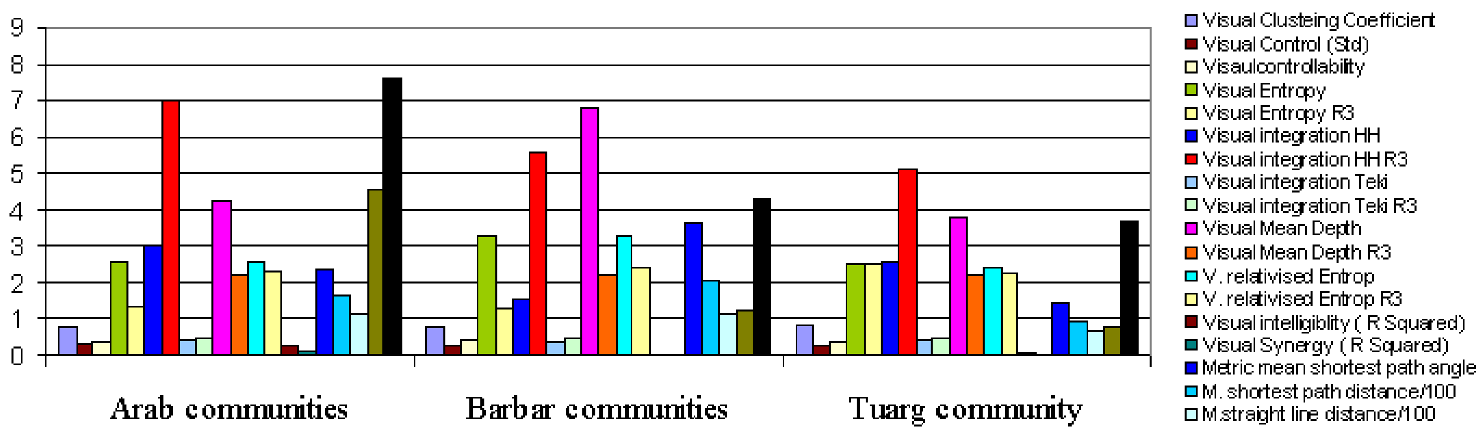
8.6. INTERIM CONCLUSION

Spaces of each ethnic community are usually distinguished in terms of their syntactic and visual properties. They show significant differences in their permeability and visibility reflecting these distinct localities of Arab, Barbar and Tuarg communities. Each community has its own self-organised mechanism, which is culturally specific to create and manage the desired level of privacy for members of the community.

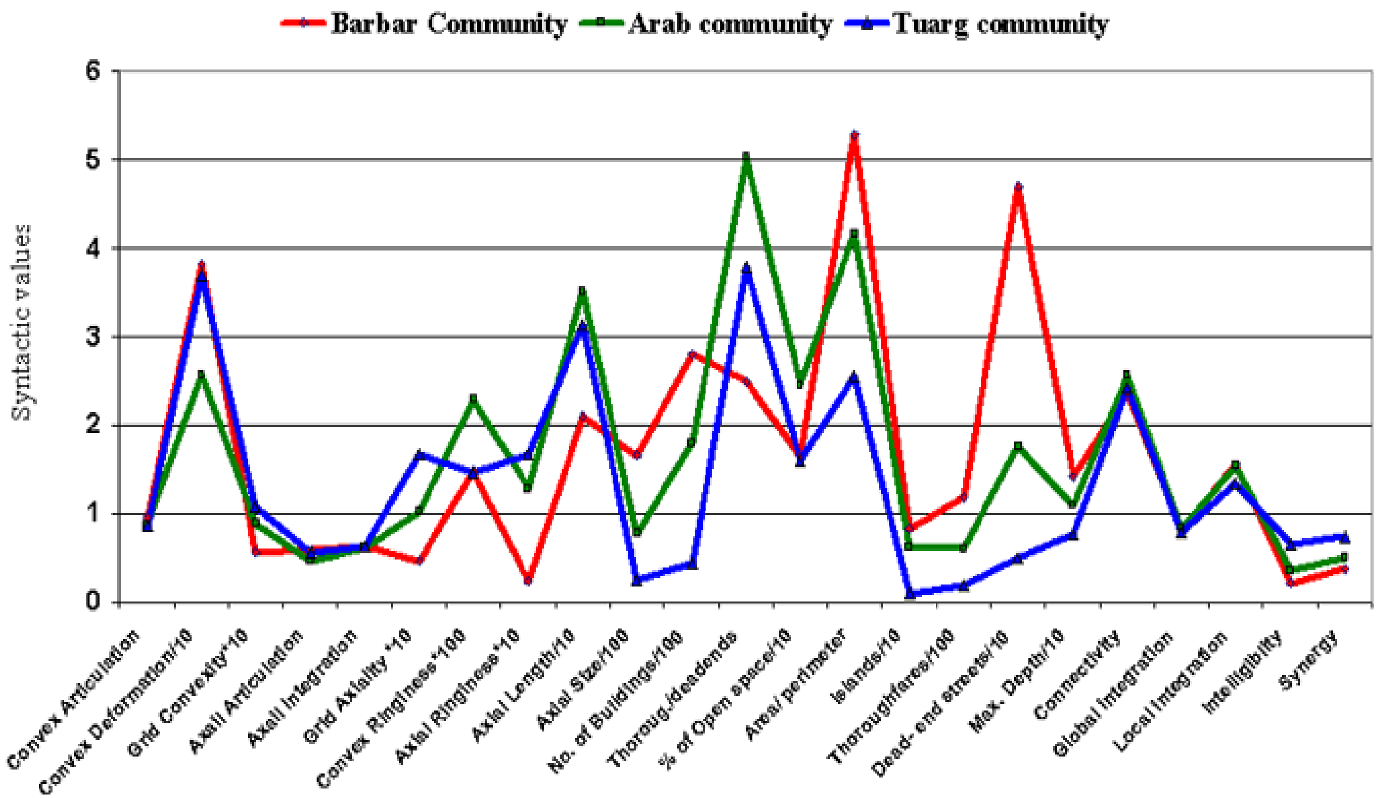
However, examining the syntactic and visual properties of the nine selected cases, it is obvious that although there are strong cultural variations in different ethnic communities of the walled city, there are also powerful invariants. Socio-cultural factors generate the differences by imposing a certain local geometry on the local construction of settlement space, while mico-economic and environmental factors, coming more and more to play as the walled city expands, generate the invariants (Hillier, 2001). This fact can be confirmed by looking at the syntactic and visual differences of these communities in isolation and in embedded model of space. However, Tharefra community provides a very illustrative example of this case where spaces are extremely intelligible and their synergy values are very significant.



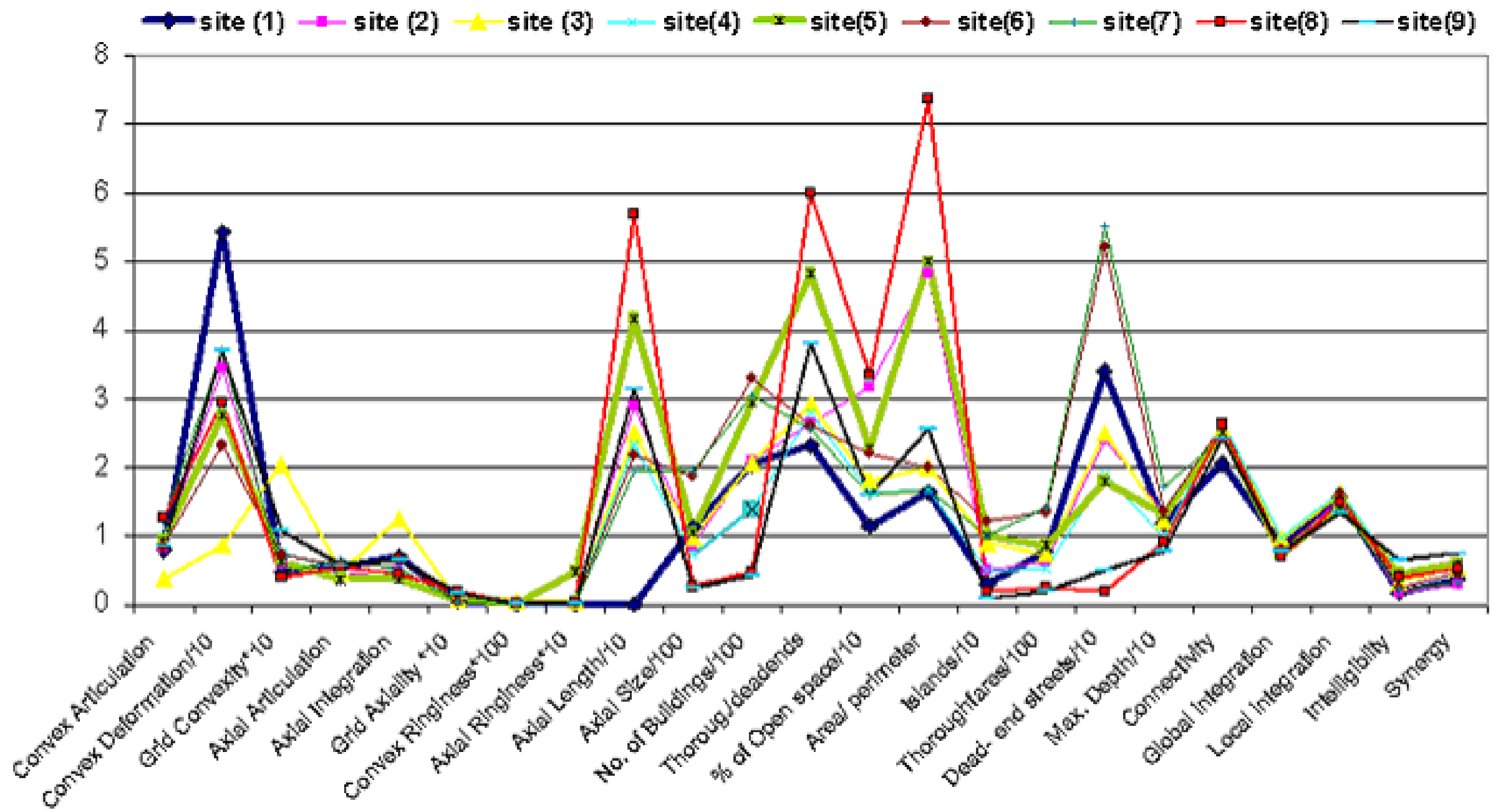
Fig(8 33)Visual comparison of the Nine selected Areas



Fig(8.34)Comparison of the three ethnic communities



Fig(8.35) Comparison of the Three Ethnic Communities



Fig(8.36) Syntactic Comparison of the Nine Communities

Table(8.8) Syntactic Correlations among the nine selected communities using axial analysis

		MAZIGH	GIORSAN	TANGZIN	THAREFRA	A.BLEL	DJARRSAN	TSUKU	OSOAK	TUARG
MAZIGH	Pearson Correlation	1.000	.983**	.978**	.995**	.970**	.985**	.987**	.667**	.815**
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000	.000	.000
	N	26	26	26	26	26	26	26	26	26
GIORSAN	Pearson Correlation	.983**	1.000	.989**	.993**	.993**	.976**	.967**	.701**	.807**
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000
	N	26	26	26	26	26	26	26	26	26
TANGZIN	Pearson Correlation	.978**	.989**	1.000	.989**	.991**	.994**	.983**	.646**	.741**
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000
	N	26	26	26	26	26	26	26	26	26
THAREFRA	Pearson Correlation	.995**	.993**	.989**	1.000	.983**	.987**	.985**	.709**	.824**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000
	N	26	26	26	26	26	26	26	26	26
A.BLEL	Pearson Correlation	.970**	.993**	.991**	.983**	1.000	.974**	.958**	.672**	.769**
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000
	N	26	26	26	26	26	26	26	26	26
DJARRSAN	Pearson Correlation	.985**	.976**	.994**	.987**	.974**	1.000	.997**	.613**	.729**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.001	.000
	N	26	26	26	26	26	26	26	26	26
TSUKU	Pearson Correlation	.987**	.967**	.983**	.985**	.958**	.997**	1.000	.612**	.740**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.001	.000
	N	26	26	26	26	26	26	26	26	26
OSOAK	Pearson Correlation	.667**	.701**	.646**	.709**	.672**	.613**	.612**	1.000	.926**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.001	.001	.	.000
	N	26	26	26	26	26	26	26	26	26
TUARG	Pearson Correlation	.815**	.807**	.741**	.824**	.769**	.729**	.740**	.926**	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.
	N	26	26	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed). measured in terms of R squared

CHAPTER 9

CONCLUSION

The theoretical construct of this study holds that social, behavioral and environmental mechanisms operating within context of culture are employed to regulate privacy within the urban environment. Figure1 presented in the introduction presents the model for this conceptual framework and guided the identification of morphological, syntactic, visual and metric variables relating to privacy regulation in the detailed analyses. These analyses substantiate the regulatory mechanisms classified in the model and presented in this chapter.

Organization of spatial system and related features associated with privacy regulation in open spaces are more important to male and female users to sustain their desired degree of privacy than any other features not associated with such privacy regulation. Literature examining positive and negative effects of physical setting in urban environment suggests that privacy is important to user of place.

The syntactic and visual analyses indicated that barriers (such as partitions, gates, and doors) and field characteristics (such as orientation or position in space) associated with privacy regulation are the most important variables for determining physical enclosure and degree of privacy. Literature on privacy regulation, as stated previously, indicates that privacy is most consistently regulated through physical enclosures of space by walls and partitions.

The visual property associated with a wall or partition is perceived by the female user as more important in regulating privacy than by male users. The research reveals that users across ethnic communities gain their greatest perceived privacy in places enclosed by floor-to-ceiling walls as the case seen in covered passages or partitions and accompanied by gates or doors. Certain inconsistencies discovered during the domain definition and identified through visibility graph analysis investigation these findings. Female users, particularly in the walled city of Ghadames, seemed to prefer low partitions of walls or curtains rather than the floor-to-ceiling solid walls (or covered passages). Having covered passages, doors and gates between their spaces did not appear to be an important issue; hence, most of their spaces are open from ground to open sky. However, male users appeared to perceive the visual property associated with the partition of walls and covered passages as more important in regulating privacy than the particular thickness or material of the partition, an acoustical property. Farm hedges, soft fences and gates in the ground floor connect male users more selectively than complete walls or hard high fences found in the upper floor where female users are dominant.

9.1. GENERAL SYNTAXES OF GHADAMES

The study reveals the following key differences and similarities of the three axial maps (ground and upper floor and entrances embedded).

1. The shape of integration core is quite similar in these systems: follow the logic of territory.

2. In these layouts, the underlying spatial structure has a strengthening effect on territoriality.

3. Spatial hierarchy based on accessibility reflects functionally distinct spatial locations in all these layouts. In general, public areas are more accessible than private residential areas, and residential areas with loop system of streets are more accessible than the areas of dead-end streets.

4. The structure of space and location of common spaces within the city are consistent in these layouts depending on the importance given to interaction and enclosure in each floor.

5. The relationship between the underlying spatial order and the geometric order of the layout is slightly different in these layouts, which affects male and female privacy constructs in several ways.

6. Global accessibility and direct interact vary among male and female layouts depending on the demands of control in local residential spaces.

7. The number of axial lines in upper floor (female domain) is fewer and shorter in length that encourage social interaction than it is in the ground floor (male domain) spaces that do not encourage interaction. This is because for a given number of spaces in layouts, the fewer the number of axial lines the higher the potential for spatial and visual interaction.

8. The shorter length of axial lines in female spaces than that in the male spaces reinforce spatial interaction among female users of the upper floor rather than male spaces, which show longer axial lines. This is because the length of axial lines per floor the lesser the travel distance and the higher the potential for interaction. Put it another way, female users of the system do follow law of shortest distance and least effort to traverse from one space to another.

9. The interconnectedness of the axial line structure is higher in the ground floor that encourages interaction than it is in the upper floor, which does not encourage interaction. This is because the degree of interconnectedness of a spatial structure relates to potential choice for movement and opportunity for more interaction.

10. The higher the privacy requirements of a space in these spatial systems the lower the integration and connectivity values of the axial line on which the space is located and the fewer the number of axial lines cutting across the space. This is because an axial line with low connectivity and integration is locally and globally less accessible, and the amount of movement across a space may depend on the number of axial lines cutting across the space.

11. The residential communities of Ghadames generally occupy spaces on segregated axial lines because these spaces are less accessible and therefore, discourage frequent interaction between residents and visitors as it can be seen in ground floor. Conversely, the spaces of the upper floor (female domain) of the walled city encourage frequent interactions between female residents and visitors within the spatial system. The female spaces occupy locations on the most globally integrated axial lines because these locations of spaces are more accessible.

12. Structure of Ghadames spaces is generally very deep. Deepening the spaces decrease social control level of perception and social interaction, increasing the depth of these spaces in the city leads residents to stay apart from each other.

9.1.1. GHADAMES: SYNTAXES OF FLOORS AND COMMUNITIES

From this intensive study for the walled city of Ghadames a number of conclusions can be drawn. Configurations in each cultural community seems to show some variations especially when the pattern of visibility and permeability are concerned. Significant differences one to another are seen during the observation. This possibility related to socio-cultural variations as well as gender segregation of spaces, which varies considerably in each community.

In respect of spatial permeability in ground floor (male domain) and upper floor (female domains), the spatial system of female spaces has higher permeability to strangers than that of male spaces which scores lower. This implies more potential for spatial and visual interaction among female users in upper floor than that of the male users in ground floor.

Integration of spatial pattern and syntactic properties of the nine selected areas revealed many similarities between them. It emerged that in Ghadames a strong cultural pattern of distinct groups is trying to overcome the similarities of spaces, which were adopted by them. However, an in depth analysis showed some interesting differences between these areas.

1. The way these areas are related to the walled city as a whole differences were mainly due to the position of areas within the whole city.

2. The communities themselves were found to be independent and self-contained, i.e. spatially linked to one another.

3. The nine selected areas are not spatially as different as expected, even though they were comparable in terms of their syntactic measures, morphologically they have different spatial structures and geometries.

4. Two main differences between the spatial morphological and these measures were in their local integration core, Tuarg and Arab communities have centrally-located local integration cores, while Barbar communities have their local integration core on their edges.

5. Arab communities were found to be better connected with other Arab communities, but analysis showed very weak spatial linkages between the areas of Arab and Barbar communities.

9.1.2. VISUAL AND METRIC PROPERTIES OF THE GHADAMES

In terms of visual and metric analyses of the walled city of Ghadames and its selected communities, some remarked conclusions could be drawn.

1- The global integration core for the whole city remains clearly hinged around the centre where major activities take place. The outcome of visibility graph analysis substantially confirms the results of axial analysis providing mean depth value that in each case (ground floor, upper floor and entrances embedded) approximate the previously obtained values of axial integration.

However, the most globally segregated area is a residential located in Mazigh neighbourhood.

2- The distribution of visually local integrated spaces within the walled city is found to be even and almost uniform a cross the spaces with a slight more local integrated spaces in both Auld Blel and Giosan and neighbourhoods. This implies that local areas are more accessible and therefore a greater potential for visual and spatial interaction is likely to be found among neighbors.

3- Ground floor (male domain) seems to be more locally and globally integrated than that of Upper floor (female domain). Moreover, spaces of ground floor are more visually connected than the upper floor, which reveals that greater possibility in route choice for the users of ground floor. Their movement from one pace to another is less restricted than that of the female in upper floor.

4- Structure of spaces in Ghadames is generally very disorder, hence the city lack s geometric order and uniform grids as organic tree-like structure. This fact can be confirmed through observing the very low visual entropy measure for the city. The most disorder areas are found around the edges of neighborhoods where various residential areas match each another. This confirms that these neighborhoods are independent and self-contained and evolved according to self-organized local mechanisms dictated by each cultural community. This can also be reconfirmed by examining the local entropy measure, which is very low value and therefore less disorder spaces within three steps away of depth. In this context, it is obvious that spaces within these communities seem to reinforce and encourage spatial and visual interaction among residents rather than residents and visitors.

5- Distribution of spaces in Ghadames in terms of their visual depth (visual relativised entropy) reveals that users would expect a large number of spaces (locations) encountered as they move through the system. This fact can be seen in the streamlined street of Giorsan where spaces vary considerably in terms of their visual depth and therefore have the highest values of the visual relativised entropy measure.

6- Locally, the distribution of spaces in terms of visual depth in range of three steps of visual depth reveals that spaces are almost evenly distributed with only a few spaces that are found in large open spaces such as public squares that vary slightly in terms of their visual depths.

7- In general, spaces of the walled city offer to a great multidirectional fields of vision and users of the system confront continuous changing of visual information in their movement. This fact may interpretat their attractiveness to both visitors and residents.

8- Spaces of the walled city are controlled evenly throughout the system with only spaces that found in the dead-end streets that are overcontrolled because they lack visual accessibility and contribute a little to the value of control.

9- Regarding visual controllability property of Ghadames spaces, the most controllable spaces are found in the linear and dead-end streets, whereas the least controllable are mainly found in large spaces such as public squares where multidimensional visual fields are dominant.

10- Visitors and inhabitants of the walled city confront difficulty to capture the while structure of the city from their experience of small parts. In other words, the city lacks intelligibility property as a consequence of two main reasons. First reason, the local residential areas are globally segregated even near the the most integrated core of the city. Second reason, spaces of the city show very low visual connections among them. Therefore, very weak correlation is found between their integration values and their visual connectivity.

11- The interface between inhabitants and visitors is unlikely to be seen throughout city spaces, as visual synergy measure is too low. This fact reveals that city spaces seem to extrude strangers from almost all parts of the city if the integrated core is excluded. Therefore, inhabitants and visitors confront difficulty to contact one another and visual and spatial interaction is not likely to be found. Looking at the two floors, female spaces (upper floor) seem to show higher visual synergy values than male spaces (ground floor), which imply more spatial and visual interaction among female users than that of male spaces.

12- Ghadames spaces are generally characterized by offering shorter sight of vision compared with that found in Libyan cities. This property reflects high degree of enclosure in these spaces and lack open visual fields for the users. However, The spaces of upper floor (female domain) is even more clustered and offering far shorter sight of vision for the female users.

13- Another interesting property of Ghadames spaces is that users of the system are easily to span within various parts of the city. The Isovist Moment of Inertia is too low that reconfirms this fact. This is because the pattern of street network of the city structured according to law of shortest links and least effort for pedestrian movement. It is clear from natural connections and streamlined streets throughout the city that users are likely to make least effort in traversing from one space to another.

9.2. SYNTAXES OF THE NINE COMMUNITIES

The findings of the detailed analyses of the nine selected communities of the city are summarized in table (8.1) that drew some concluding remarks about their syntactic, visual and metric properties.

1. Regarding convexity measures, spaces of Old Soak and Tsuko communities show the highest values. This implies the most broken up spaces and the most synchrony, whereas Tangzin community shows the least broken up structure of

spaces and therefore the least synchrony. Spaces of Arab communities seem to show the least broken up spaces and the least deformed grids.

2. Axial measures of the convex spaces within these communities show that spaces of Tangzin community are the most axially integrated, whereas spaces of Auld Blel are the least integrated. This fact reveals that Tangzin spaces demonstrate a strong approximation of a grid and the least angular structure of spaces, whereas spaces of auld Blel show the opposite property.

3. Tangzin community also shows the highest values of convex and axial ringiness which indicates the greatest potential of accessible spaces within the community. Users of this community are most likely to interact with each other and structure of their spaces encourages such spatial interaction.

4. The deepest structure of spaces is found in Tsuku community, whereas the shallowest spaces are found in Tuarg. This depth property for spaces reflects to some extent nature of spatial interaction and degree of enclosure among users of these communities. The highest Max. Depth in Tsuku community implies tendency to segregation, enclosure and privacy, whereas the shallowest spaces in Tuarg encourage interaction and least tendency to segregation and privacy. Spaces of Barbar communities are generally deeper than that of Arab and Tuarg, which implies higher degree of enclosure and tendency to privacy.

5. Spaces of the nine selected communities show very low connections among them which accounts for short bent broken axial lines within the areas. Tharefra community has on average the most connected spaces of all, whereas Mazigh has the least connected spaces. This implies that with more connections among spaces it is most likely more interaction and less tendency to spatial privacy. Generally, Arab communities are more connected than that of Barbar and Tuarg communities.

6. Regarding global integration, spaces of the nine communities are globally integrated which implies strong interface between their inhabitants and visitors. The most globally integrated community is Tharefra, whereas the most globally segregated community is Old Soak. In general, Arab communities are more globally integrated than that of Barbar and Tuarg communities.

7. Locally, most of the Ghadames communities show spaces that are locally segregated. The most locally integrated spaces are again in Tharefra community, which has the most locally and globally integrated spaces. This fact implies strong interaction between neighbours and between visitors and inhabitants.

Table (9.1) *Syntactic measures of the three ethnic communities*

Morphological and Syntactic measures	Ethnic Communities		
	Barbar	Arab	Tuarg
Convex Articulation	0.952	0.881	0.86
Convex Deformation	3.82	2.5673	3.7
*Grid Convexity*10*	.0555	.0888	.1081
Axial Articulation	0.588	0.463	0.55
Axial Integration	0.631	0.619	0.64
Grid Axiality	.0461	0.102	0.167
*Convex Ring.*100*	1.49	2.3	1.45
Axial Ringiness	.023	0.1282	0.167
Axial Length	21.03	35.116	31.38
Axial Size/100	165.33	77.0	24.0
No. of Buildings/100	280	180	43
Thoroug./deadends	2.494	5.0334	3.8
% of Open space	16.427	24.54	15.89
Area/ perimeter	5.29	4.171	2.55
Islands	8.33	6.2	1
Thoroughfares/100	1.1833	0.6	0.19
Dead- end streets/10	4.7	1.76	0.5
Max. Depth/10	1.42	1.092	0.775
Connectivity	2.37	2.564	2.42
Global integration	0.795	0.83	0.78
Local integration	1.547	1.54	1.346
Intelligiblity	0.21	0.356	0.6499
Synergy	0.3761	0.50328	0.7399

8. Spaces of the nine selected communities are highly controlled as a direct consequence of their low connectivity as well as their tree-like structure. The most controlled and least controlled spaces are found in Mazigh and Djarrsan communities. This implies flexible range of control property in these communities and therefore less restricted way of movement. They offer a great potential for spatial interaction among users. The most restricted spaces are found in Tuarg and Old Soak, which reflect dead-end street pattern and their low connectivity. Over controlled spaces are seen in Barbar communities, whereas the least controlled in Arab communities.

9. The study reveals that Ghadames communities are very intelligible in general. The most intelligible community is Tuarg, whereas the least intelligible is Mazigh. This implies that inhabitants of Tuarg are easily capturing the whole structure of their community by experience small parts, opposite to that of Mazigh inhabitants. Ethnic comparison shows that Arab communities are more intelligible than Barbar communities. This is because spaces of Barbar are extremely deep, less connected and globally segregated.

10. Synergy measure demonstrates that the selected communities have on average high mean synergy value, which shows significant correlation between their global and local integration values. Therefore, community spaces reinforce strong interface between inhabitants and visitors of the communities. Tuarg community seems to show the highest value for this measure, whereas Giorsan shows the lowest value. This lowest value in Giorsan accounts for sort broken axial lines and organic-like structure of its spaces. Ethnic comparison shows that Arab communities have higher mean synergy value than Barbar communities. In other words, Arab spaces seem to reinforce stronger spatial interaction between their inhabitants and visitors of the communities.

11. Mean axial line length of the selected communities is too short compared with that seen in Arab and Libyan cities. This accounts for the compact structure of spaces and organic growth of the city. So, short sight of vision is dominant feature in these communities. The shortest axial lines are calculated for Tsuku,

whereas the longest axial lines are found in Old Soak. This implies that residents of Tsuku confront higher degree of enclosure and limited visual fields in their community. Ethnic comparison shows that Barbar communities have shortest axial line length than that Arab and Tuarg communities have.

9.3. COMMUNITIES: EMBEDDED AND DISEMBEDDED MODELS OF SPACE

Syntactic analyses of the nine selected communities in isolation as well as embedded within the whole city indicate the following concluding remarks:

1. In embedded model of space, spaces f Tuarg community shows the highest Max. depth, whereas Tangzin shows the lowest value. This accounts mainly for the their positions within the whole structure of the city as well as their nearness from the integration core of the city.

2. Arab communities show lower Max depth than both Barbar and Tuarg communities. Therefore, residents of Arab communities generally traverse from one space to another within the city with the least number of turnings or changing of directions.

3. Mazigh community shows the most connected spaces of all, whereas Giorsan shows the least connected and therefore the most segregated spaces. Although Barbar communities are the least connected in disembedded model of space, they gain better connections in embedded model from their positions within the city. So, the impact of the surrounding communities has a positive influence on their connectivity.

4. Tsuku is the most globally integrated community of all, whereas Tuarg is the most segregated community in the city. This shows that structure of spaces in Tsuku is very shallow and accessible from integration core of the city. The most integrated spaces in Tsuku community are around the central mosque of the city. This feature implies that visitors can easily penetrate into various parts of

the community and therefore, less tendency to spatial segregation. However, Spaces of Tuarg community show the opposite case and show a greater tendency to segregation and privacy. This feature is very obvious from the peripheral location of Tuarg community and the least number of connections to surrounding streets.

5. Tuarg seems to be the least locally integrated community of all in both models of space. This reflects to how far Tuarg spaces impede spatial interaction among neighbours of the community. Tharefra and Djarrsan are the most locally integrated communities of all that reflects spaces that encourage spatial interaction among their neighbours.

6. Old Soak is the most intelligible community that inhabitants can easily capture the whole structure of the community from their experience of a fewer spaces. However, Giorsan community shows the opposite case and inhabitants confront difficulty to understand the whole structure of their community.

7. Old Soak shows the highest synergy value implies strong interface between neighbours of the community and visitors, wheras Mazigh community shows spaces that impede spatial interaction between neighbours and visitors.

8. Spaces of Tangzin and Tharefra communities seem to show both the most controlled and the least controlled spaces, which offer a great, potential in impeding and disimpeding movement within communities. The most restricted spaces are calculated for Tuarg community, which again reconfirms deep structure of spaces that impede flow movement of people.

9. The nine communities show some spatial differences in their syntactic measures in isolation and in embedded models of space. Tuarg community seem to be the most negatively impacted in terms of four syntactic measures as the community embedded within the whole city. The community loses global and local integration, intelligibility, and synergy values as direct impact of surrounding

communities. Old Soak community in embedded model shows better syntactic values for most of the measures except global integration property, which is negatively impacted.

10. Tharefra shows the largest syntactic differences between both models of space in terms of global integration measure. spaces of community are more globally integrated in isolation than in embedded model. This accounts mainly for the surrounding street connections. However, Old soak community shows the smallest syntactic difference regarding global integration measure. This difference shows to be insignificant compared with syntactic differences in other communities.

11. Syntactic measure of local integration shows that spaces of eight communities are more locally integrated in embedded model of space than in cut-out model. Tuarg community is the only community that shows reduction in local integration value. This reduction is quite significant reflecting the strong impact of the surrounding communities on connectivity values.

12. Six communities tend to lose their intelligibility when they are embedded with the whole city. Tsuku and Old Soak are the only communities that show a slight increase in their intelligibility values. This can be understood as a result of the gained connections for their spaces as well as their better global integration values.

13. Tharefra, Auld Blel, Djarrsan and Old Soak communities show an increase in their control values in embedded model of space, whereas the other communities seem to lose their control values. Auld Blel shows the highest increase in control value, and therefore shows the most restricted spaces that impede spatial interaction, whereas Giorsan shows the highest decrease in control value and therefore reinforces the interaction within the community.

9.4. SHORTCOMINGS OF SPACE SYNTAX

There are some problems that remain unsolved with the syntactic methods regarding convex partitions and in preparing axial lines. These problems can be summarized in the following points:

1. There are some technical problems that remain unsolved with many attempts to divide open space or building or city plans into convex spaces. However, a space syntax, is more than that other methodologies for the analysis of cities or buildings, has proposed that plans can be represented as set of interrelated convex spaces, we may take it as a starting point. Hillier and Hanson (1984,P.92) originally proposed that the convex representation of a plan should comprise "the least set of the fattest spaces that covers the system". Subsequently, they proposed that if visual distinctions are difficult the map can be derived by locating the largest possible circles that can be drawn without interesting a wall and then by expanding each circle to largest space possible without reducing the fatness of any other space (P.98). A number of questions are raised by the degree of completion and rigor of the definition. Not only are we not always sure how to balance rigorously the research for large spaces against the requirement that we preserve fatness, but it is also unclear how the requirements of size and fatness should interact with the requirement that we break the system into as small a number of spaces as possible given our other requirement.

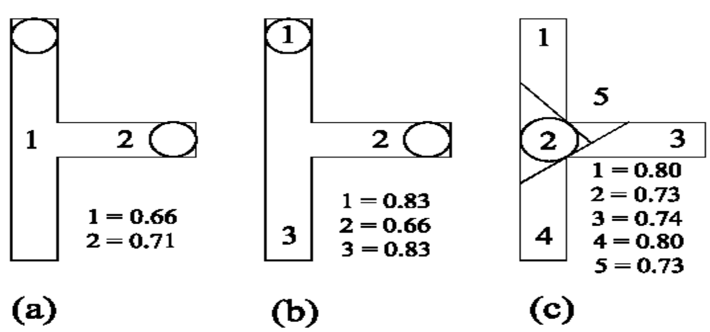


Fig (9.1): *Alternative attempts to partition a shape into the least set of fattest convex spaces (fatness values of individual convex spaces are indicated alongside)*

Some of these difficulties are illustrated in Fig (9.1). In discussing the example we interpret fatness to mean the area/ perimeter ratio. However, we relativize this ratio to allow comparisons between spaces of different areas. We do this by comparing a given space to a circle of the space under consideration by the perimeter of that space. In Fig (9.1) we start with two equal circles and end up with two convex spaces. In fig (9.1a) we start with two circles and end up with three spaces. Even choosing between those two solutions is not as easy as it seems because the solution with three spaces gives us higher fatness values. In Fig (9.1c) we start with the largest single circle and end up with five spaces. It seems that, if we want to minimize the number of spaces, we can not always start drawing the largest possible circle.

2. One of the shortcoming of space syntax is the notion of axial lines are quite fuzzy, although we attempt to regard it as the representation of vista space in research. However, Hillier and Hanson (1984) argue that the partition of space should meet an implicit of enclosure that they assume is met by geometrically convex subspaces. They define a convex map as: "… the least set of fattest spaces that covers the system …" (1984; page 92), and they continue by suggesting an algorithm for manually constructing such a convex map: "Simply find the largest convex space and draw it in, then the next largest, and so on until all the space is accounted for." (1984, page 98). However given the continuity of space, such partitioning is not well defined. Even if there is a minimum number of subspaces which are convex, these cannot be found and in any case, the criterion for what is a 'fat' convex space is never defined. In fact although space syntax has largely ignored these considerations of convexity in practical applications, some progress has been made in defining what Peponis et al. (1997) call 'informationally stable spaces' which do meet conditions of convexity. They demonstrate that there is no partition which gives a minimum number of subspaces whose convexity is unique as we illustrate in Figure 1(a).

3. Generation of axial maps for an urban area system is still manual, and there is no efficient completely automatic way to do it even through what they call it all axial map produced using Depth map software. Although there are some

principles to draw axial line, it hard to guarantee the consistency of axial maps. For instance, the claim (Hillier and Hanson 1984) that an axial map is the least set of longest axial lines is not proven as mentioned in the first point.

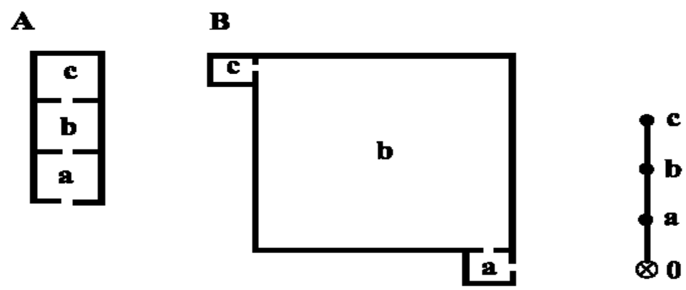


Fig (9.2) *Two buildings have the same interconnected spaces illustrated in form of justified graph*

4. Many authors have recognized problems with Space Syntax method and have proposed new ideas to overcome them (see Foster 1989 and Brown 1990). Space Syntax fails to take into account interaction, where walls, doors, stairs, windows, and space all interact to create a building or a city. Syntax Analysis deals with two dimensional vector analyses where rooms or spaces are plotted as dots and lines connecting these dots. However, buildings or spaces with the same graph can be vastly different, this type of analysis does not integrate the differences between buildings or spaces, nor does it take into account where buildings have grown as a result of environmental constraints rather than social factors (Brown 1990). As can be seen in Figure 9.2, these two buildings are spatially different, however the justified map is the same for both buildings (Brown 1990: 95). Therefore, this type of analysis is only useful for examining the access patterns of the building not the spatial organization and layout. The nature of the technique that this 2D-analysis employs causes difficulty in dealing with multi-story buildings, where stairs may connect rooms. An access map may then indicate that the fastest route may be by stair, nevertheless it may not be the most convenient. Assumptions are also different game levels represent different aspects and historical contexts of the building. As a result one can skip levels rather that loading an entirely new virtual world, thus allowing one to know a structure extremely quickly.

5. There are other two issues make space syntax controversial. First the definition of its basic elements is left entirely to the user with little guidance as to how to generate axial lines. Thus there is always the suspicion that each example cannot be replicated by a different user in a different time at a different place. This breaks the logic of science. Desyllas and Duxbury (2001) make the point when they say:

" …the axial map cannot provide researchers with reliable and comparable results … " (P.27.6). As Peponis et al. (1998) argue, objectivity in the process of generating axial lines can only arise "… from the rigor and repeatability of the procedures used to generate them." (P.560). Second, the twist that is occasioned by treating lines as nodes is counter to the way social physics and transportation analysis have developed where density and volume of movement is intrinsically associated with point locations, not geometrically artificial lines defined by users where length, hence cost and travel time are ignored.

9.5. A NEW PARTITIONING: ASSUMPTION/INNOVATION

Regarding the problem of partitioning space into relevant elementary units, J. Peponis (1997) proposed three convex space partitions including one based on the thresholds at which edges, corners and surfaces appear into field of vision of a moving subject, or disappear outside it. His proposal is to overcome space partition problem and to quantify descriptions of space or building shape and spatial configurations.

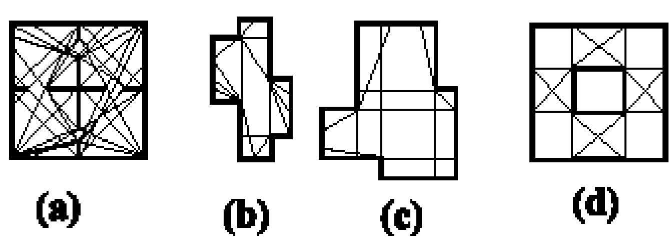
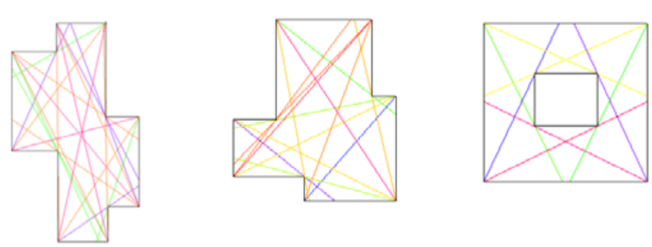


Fig (9.3) *e-partition of four hypothetical plans*

1. The three space partitions are minimum partition (m-partition), surface partition (s-partition) and end-point partition (e-partition). These partitions are illustrated in Append d4. First, m-partition is based on partition of a plan into minimum number of convex spaces that are needed to cover all its area. It is the simplest representation of spatial structure by using Min. lines. This partition is not found to be specified uniquely in all cases.

   The second is s-partition, which is based on extending surfaces of built shape. This partition does not provide informationally stable convex spaces since information about shape changes while a moving observer remain within the same s-space. Finally, e-partition on end-point partition based on considering all diagonals that can be drawn in a shape and their extensions (see Peponis,1997). This partition has two interesting properties, first every line we cross a demarcation line, a discontinuity either appears into or disappears from our field of vision. Second, the convex subshapes defined by this partition are informationally stable. The significance of this partition can be highlighted if we relate it to the idea of isovists as we have tried in this research.

2. The all-line axial map first defined and thence published by Penn et al. (1997) but used extensively by Hillier (1996) in his second book, consists of all possible lines that link vertices defining differences in orientation between faces as well as all extensions of faces to meet other faces, with the added constraint that such lines must pass freely through space which is unobstructed. These all begin with the all-



(b) **(c)** **(d)**

Fig (9.4) *All axial maps generated automatically based on Peponis logarithm Shows connectivity measure.*

lines map illustrated in Figure 9.4 and in each case, they reduce the number of lines in this map while meeting different criteria for covering the convex spaces. One of these methods is particularly straightforward being based on ranking the number of diagonals in the all-lines map with respect to the number of s-partitions that each diagonal crosses. The diagonal with most crossing points becomes the first axial line. This and the associated s-partitions are then removed, the remaining diagonals re-ranked, the largest chosen, the set of diagonals and s-partitions reduced further, and so on until all partitions have been crossed. This method leads to the axial map which is closer to but still somewhat different from the first map. These methods show promise but as they depend on the vertex geometry of the original plan or layout, they remain restrictive in terms of where lines can be drawn.

9.6. RESEARCH CONTRIBUTION

The contributions of this intensive research are summarised in the following points:

1. Complexities of privacy as abstract notion are further refined conceptually and operationally. The regulation mechanisms for privacy are clarified through theory and systematic information generated through integrated methodology of space syntax and visibility graph analyses.

2. The research is the first attempt to study privacy regulation in multi-cultural environments syntactically, visually and metrically that enables us to shed more light on different physical settings and related elements of privacy regulation.

3. The role of the physical environment for fostering and impeding privacy regulation is explained according to cultural variations as well as gender variations.

4. Syntactic, visual and metric properties of Arab, Barbar, and African (Tuarg) communities are measured and their differences and similarities are compared in overall context of Libyan cities as well as cities from the rest of the world.

5. The adopted methodology provides a fairly definitive interpretation (i.e. understanding) of physical elements created by Ghadames builders that users perceive as regulating privacy, and where privacy fits into the users' perception.

6. The research draws attention to the relationship between culture and space, as well as the potential of space for fostering the culture of distinct communities. The culturally sensitive design adopted in the illustrative case study of Ghadames reveals that cities should enable different cultures to coexist, while still helping each community to keep its cultural identity and so avoid conflicts and tensions arising from it.

7. The spatial analysis using both space syntax and visibility graph analyis as a distinct field of research is strong in describing and analyzing behavior, demonstrating and describing patterns and relating these to socio-demographic characteristics of population, has been largely effectual when environment is conceived less as a social space and more as a physical setting or system.

9.7. FUTURE RESEARCH

The privacy theories presented in this thesis were developed earlier in the field of privacy regulation and enclosure. Here, they were used to form holistic privacy model considering social, behavioral and environmental mechanisms operating within the context of culture. There is surprising little empirical research for studying these mechanisms in urban level. Specifically, The environmental mechanisms as the physical elements of privacy regulation are not studied on field of urban design. Therefore, most of the observations lack empirical validation in the field of privacy regulation in urban context.

In this research I tried to emphasize the role of physical elements to create or impede the desired level of privacy in multi-cultural environments. The physical elements investigated were predetermined by researchers and may not exhaust the range of user perceptions concerning the physical correlates of privacy. However, preferences and patterns of behavior as mediating factors for privacy regulation have not been studied in urban level. It would be valuable to validate the results of how patterns of behavior and preferences affect the desired level of privacy. It is also known that in person-to-person or ethnic group to ethnic group relationships the intimacy gradient increases as the sense of community grows. Therefore, the development of privacy regulation as a function of time would be an interesting topic of study, as well as the development of accepted level of privacy that reflects

9.8. A FINAL REMARK

Throughout the thesis I have drawn my discussions on theories, which show that the physical environments influence the perceived level of privacy in significant way. I argue that privacy regulation, as a culturally specific need in urban environment, is crucial for the general quality of the city. What I have found that there is a need in urban design to direct attention to both the visual and the hidden features of architecture and urban design to facilitate privacy need.

The interest in the appearance of the buildings and places should be accompanied by an interest in how these buildings and places are combined with other urban elements – buildings, streets, and open space – and how they relate to the underlying privacy requirement of the configuration of space. The design of urban interfaces and spatial relations is an important key to good urban environments. This is where the conditions for interaction are set. An urban environment that is designed to support exchange and encounters is also well suited to sustain a wide range of social, cultural possibilities. This is essentially what privacy is about, and the challenge for architects and urban designers is to facilitate the best spatial conditions for it.

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APPENDIX A: DESCRIPTIVE STATISTICS OF THE SELECTED SITES

Descriptive statistics for the nine communities shows summary of their syntactic properties through the various measures and their axial maps.

Table (A.1) Descriptive Statistics for Mazigh (site No.1)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step	113	631.00	487.00	1118.00	79936.00	707.3982	145.9201	21292.670
Total count	113	.00	113.00	113.00	12769.00	113.0000	.0000	.000
Total r3 depth	113	45.00	3.00	48.00	1728.00	15.2920	10.7035	114.566
Connectivity	113	13.00	1.00	14.00	280.00	2.4779	2.0489	4.198
CONTROL	113	8.37	.07	8.44	113.00	1.0000	1.1847	1.403
Integration Rn	113	.8070	.4796	1.2865	96.7259	.855981	.194677	3.790E-02
Integration 3*	113	4.5586	.2109	4.7695	176.0851	1.558275	.887226	.787
Fractional ra	113	.0442	.0281	.0724	4.7482	4.20195E-02	8.59336E-03	7.385E-05
Max depth*	113	7.00	9.00	16.00	1331.00	11.7788	1.6406	2.692
Integration X*	113	.9735	.5126	1.4861	111.7437	.988882	.212722	4.525E-02

Table (A.2) Descriptive Statistics for Giorsan (Site No.2)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step	87	680.00	335.00	1015.00	48376.00	556.0460	146.7868	21546.370
Total count	87	.00	87.00	87.00	7569.00	87.0000	.0000	.000
Total r3 depth	87	48.000	3.000	51.000	1162.000	13.35632	10.59286	112.209
Connectivity	87	12.00	1.00	13.00	214.00	2.4598	1.8414	3.391
CONTROL	87	6.2326	.0769	6.3095	87.0000	1.000000	.985161	.971
Integration	87	.9980	.3655	1.3635	68.2479	.784458	.214459	4.599E-02
Integration 3*	87	4.688	.211	4.899	133.513	1.53463	.85408	.729
Max depth*	87	8.00	9.00	17.00	1161.00	13.3448	1.8161	3.298
Integration X*	87	1.263	.448	1.710	83.470	.95942	.25020	6.260E-02

Table (A.3) Descriptive Statistics for Tangzin (Site No.3)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step Depth	98	755.000	346.000	1101.000	52698.000	537.73469	126.10481	15902.424
Total count	98	.00	98.00	98.00	9604.00	98.0000	.0000	.000
Total r3 depth	98	49.00	3.00	52.00	1544.00	15.7551	10.3914	107.981
Connectivity	98	10.00	1.00	11.00	252.00	2.5714	2.0609	4.247
CONTROL	98	5.69	.09	5.78	98.00	1.0000	1.1069	1.225
Integration	98	1.2043	.3972	1.6015	94.5488	.964784	.230345	5.306E-02
Integration 3*	98	4.1851	.2109	4.3960	158.1906	1.614190	.915879	.839
Max depth*	98	8.00	9.00	17.00	1199.00	12.2347	1.9782	3.913
Integration X*	98	1.3713	.3284	1.6997	102.5715	1.046648	.247202	6.111E-02

Table (A.4) Descriptive Statistics for Tharefra (Site No.4)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step Depth	72	362.00	238.00	600.00	25786.00	358.1389	79.3623	6298.375
Total count	72	.00	72.00	72.00	5184.00	72.0000	.0000	.000
Total r3 depth	72	44.00	3.00	47.00	1058.00	14.6944	9.6876	93.849
Total r3 count	72	24.00	3.00	27.00	698.00	9.6944	5.5453	30.750
Connectivity	72	9.00	1.00	10.00	194.00	2.6944	1.9975	3.990
CONTROL	72	4.5444	.1000	4.6444	72.0000	1.000000	.998897	.998
Integration Rn	72	1.073	.495	1.569	70.236	.97551	.24520	6.013E-02
Integration 3*	72	3.8187	.2109	4.0297	117.1713	1.627379	.893842	.799
Fractional ra	72	.0622	.0412	.1034	4.4460	6.17500E-02	1.43207E-	2.051E-04
Max depth*	72	6.00	7.00	13.00	705.00	9.7917	1.3935	1.942
Integration X*	72	1.2333	.4474	1.6807	74.1537	1.029913	.257759	6.644E-02

Table (A.5) Descriptive Statistics for Auld Blel (Site No.5)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step	105	700.00	507.00	1207.00	78494.00	747.5619	151.8894	23070.402
Total count	105	.00	105.00	105.00	11025.00	105.0000	.0000	.000
Total r3 depth	105	27.00	3.00	30.00	1162.00	11.0667	6.3477	40.294
Total r3 count	105	16.00	3.00	19.00	817.00	7.7810	3.6951	13.653
Connectivity	105	5.00	1.00	6.00	262.00	2.4952	1.3165	1.733
CONTROL	105	2.9167	.1667	3.0833	105.0000	1.000000	.593384	.352
Integration Rn	105	.6889	.3966	1.0855	75.2740	.716895	.164023	2.690E-02
Integration 3*	105	2.8200	.2109	3.0309	149.7140	1.425848	.728091	.530
Fractional ra	105	.0584	.0357	.0941	5.5125	5.25004E-02	1.18685E-	1.409E-04
Max depth*	105	8.00	9.00	17.00	1382.00	13.1619	1.8766	3.522
Integration X*	105	.8385	.3789	1.2174	89.2377	.849883	.186449	3.476E-02

Table (A.6) Descriptive Statistics for Djarrasan (Site No.6)

	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step Depth	187	1344.00	986.00	2330.00	260070.00	1390.7487	225.8098	50990.082
Total count	187	.00	187.00	187.00	34969.00	187.0000	.0000	.000
Total r3 depth	187	47.00	3.00	50.00	2754.00	14.7273	9.1467	83.662
Total r3 count	187	26.00	3.00	29.00	1811.00	9.6845	5.2139	27.185
Connectivity	187	11.000	1.000	12.000	494.000	2.64171	1.82426	3.328
CONTROL	187	7.958	.083	8.042	187.000	1.00000	1.02452	1.050
Integration Rn	187	.7301	.4346	1.1647	149.4898	.799411	.143844	2.069E-02
Integration 3*	187	4.3109	.2109	4.5218	301.4121	1.611829	.800759	.641
Fractional ra	187	.0294	.0195	.0488	5.4801	2.93053E-02	5.53100E-	3.059E-05
Max depth*	187	8	9	17	2534	13.55	1.85	3.432
Integration X*	187	1.0859	.3333	1.4193	185.0955	.989815	.171700	2.948E-02

Table (A.7) Descriptive Statistics for Tsuku (Site No.7)

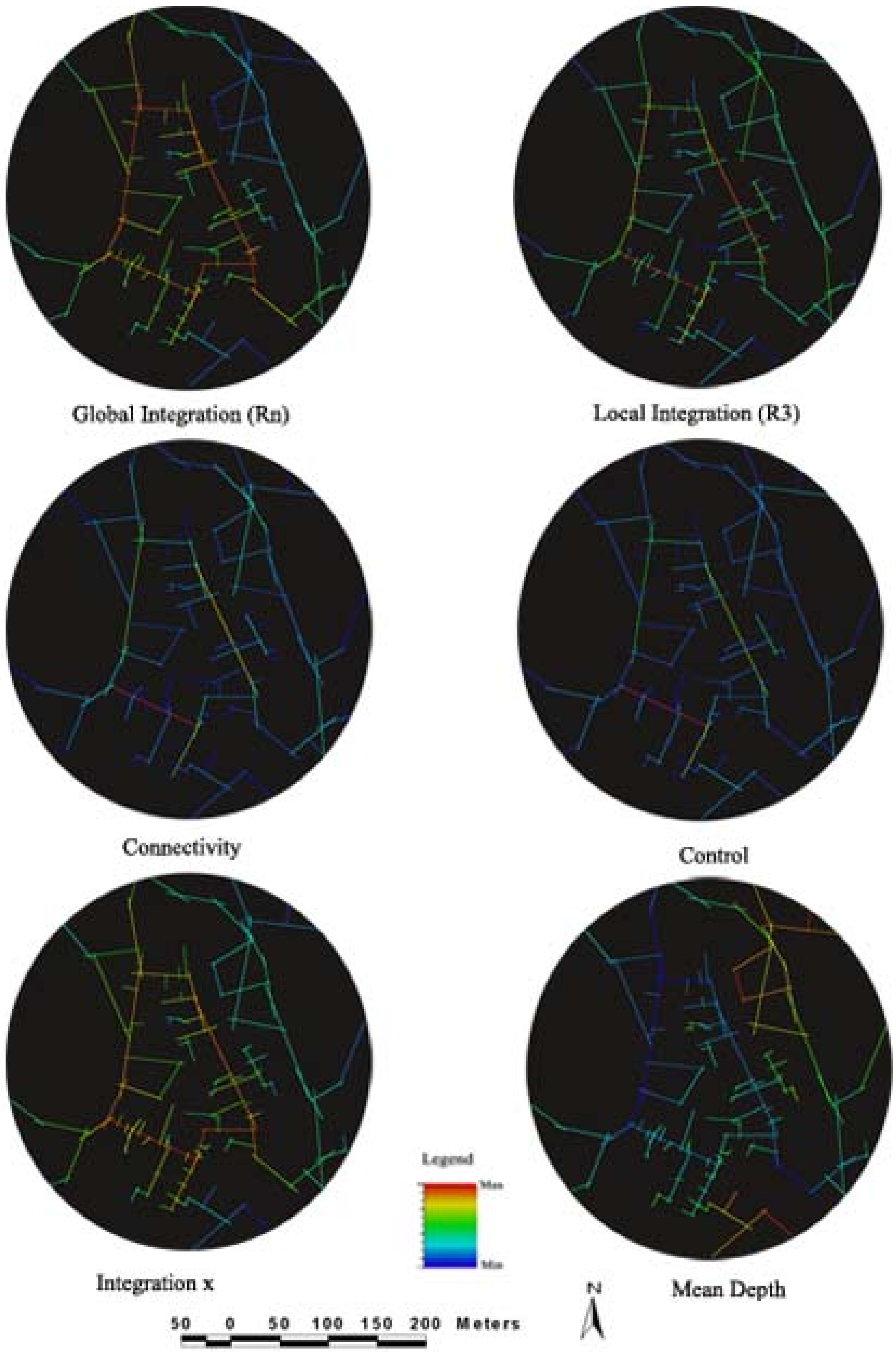
	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step Depth	196	2072.00	1042.00	3114.00	323588.00	1650.9592	382.5633	146354.675
Total count	196	.00	196.00	196.00	38416.00	196.0000	.0000	.000
Total r3 depth	196	40.00	3.00	43.00	2484.00	12.6735	8.2042	67.308
Total r3 count	196	23.00	3.00	26.00	1676.00	8.5510	4.7103	22.187
Connectivity	196	10.00	1.00	11.00	476.00	2.4286	1.6733	2.800
CONTROL	196	7.5281	.0909	7.6190	196.0000	1.000000	.993893	.988
Integration	196	.8294	.3391	1.1685	141.5031	.721955	.169345	2.868E-02
Integration 3*	196	4.2126	.2109	4.4236	288.7878	1.473407	.815898	.666
Max depth*	196	11.00	12.00	23.00	3386.00	17.2755	2.5891	6.703
Integration X*	196	1.015	.399	1.414	178.948	.91300	.20695	4.283E-02

Table (A.8) Descriptive Statistics For Old Soak (Site No.8)

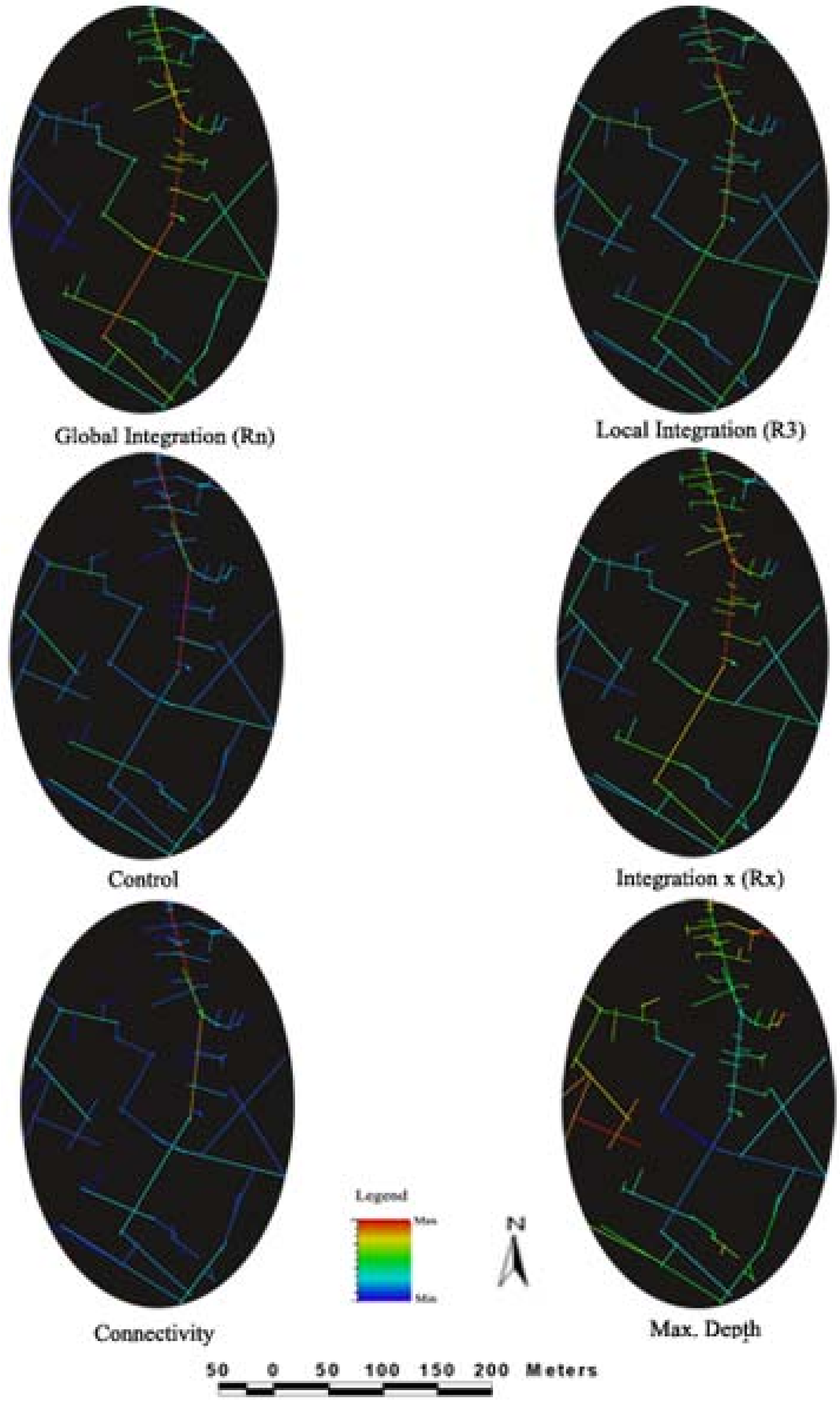
	N	Range	Min.	Max.	Sum	Mean	Std.	Variance
Total step	26	96.00	80.00	176.00	2974.00	114.3846	25.5485	652.726
Total count	26	.00	26.00	26.00	676.00	26.0000	.0000	.000
Total r3 depth	26	13.00	3.00	16.00	256.00	9.8462	3.9567	15.655
Total r3 count	26	8.00	3.00	11.00	188.00	7.2308	2.4545	6.025
Connectivity	26	4.00	1.00	5.00	68.00	2.6154	1.2985	1.686
CONTROL	26	2.22	.20	2.42	26.00	1.0000	.6059	.367
Integration Rn	26	.6795	.3893	1.0688	18.3722	.706625	.187884	3.530E-02
Integration 3*	26	2.7459	.2109	2.9568	39.0512	1.501970	.776001	.602
Max depth*	26	6.00	6.00	12.00	236.00	9.0769	1.4401	2.074
Integration X*	26	.6555	.4133	1.0688	19.4992	.749967	.177735	3.159E-02

Table (A.9)Descriptive Statistics for Tuarg (Site N0.9)

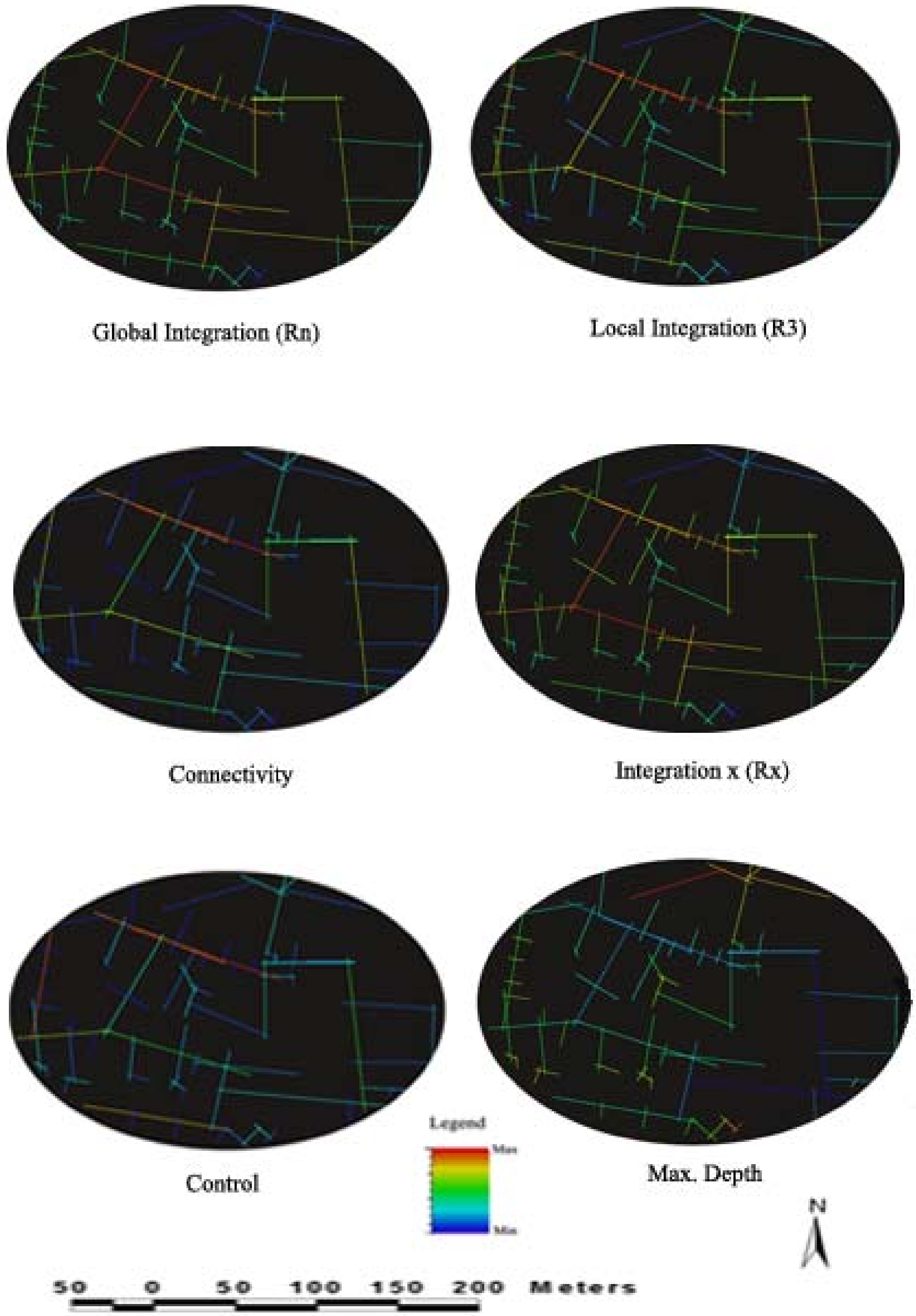
	N	Range	Min.	Max.	Mean	Std.	Variance
Total step Depth	24	83.00	65.00	148.00	94.8333	21.10361	445.362
Total count	24	.00	24.00	24.00	24.0000	.00000	.000
Total r3 depth	24	16.00	3.00	19.00	9.2500	4.45509	19.848
Total r3 count	24	10.00	3.00	13.00	6.8333	2.76101	7.623
Connectivity	24	4.00	1.00	5.00	2.4167	1.28255	1.645
Control	24	1.8667	.3333	2.2000	1.000000	.5756324	.331
Integration	24	.8185	.4142	1.2327	.781796	.2279735	.052
Integration 3*	24	2.7459	.2109	2.9568	1.346908	.7837023	.614
Max depth*	24	5.00	5.00	10.00	7.7500	1.39096	1.935
Integration X*	24	.7991	.4336	1.2327	.804980	.2193448	.048



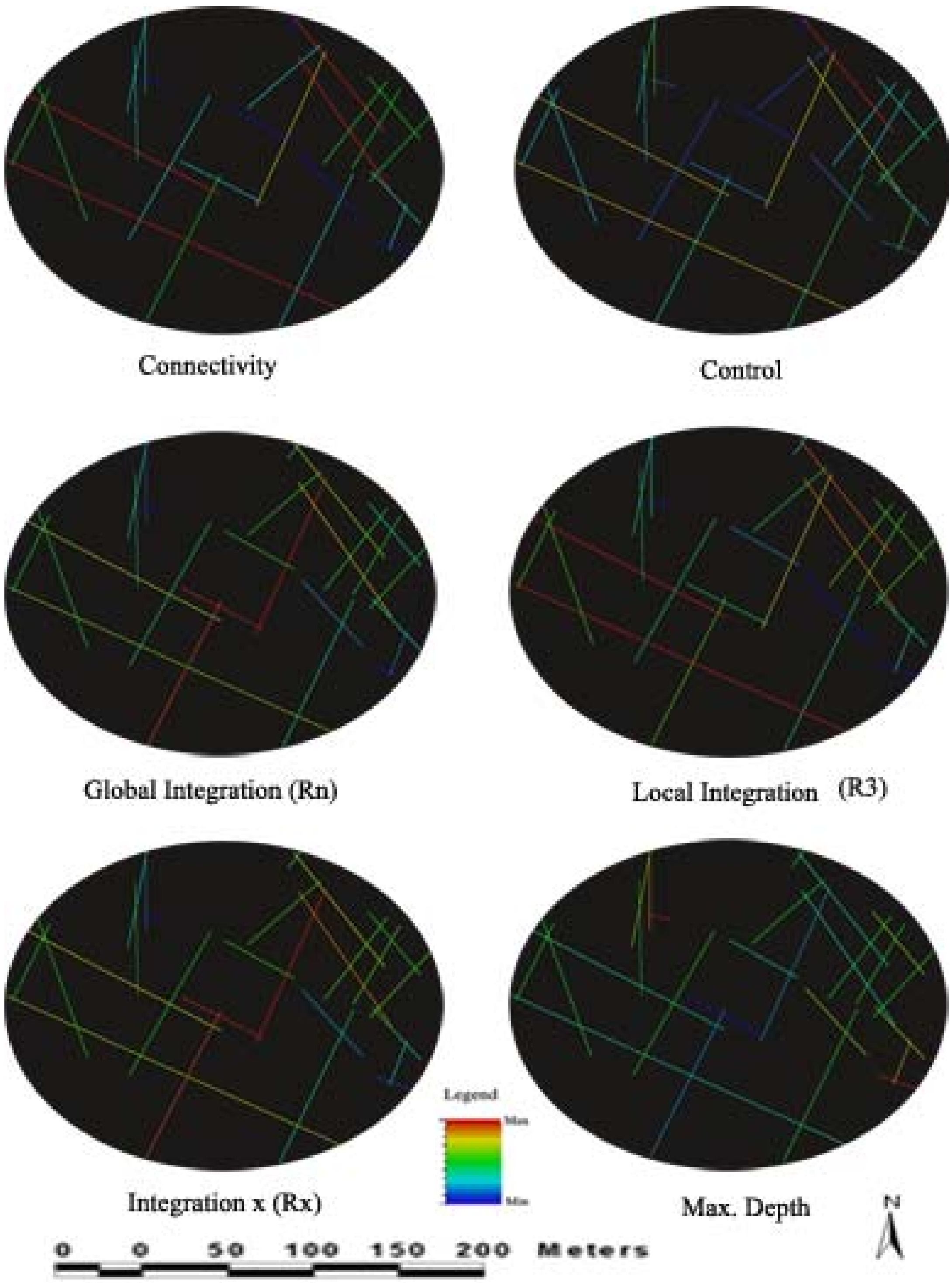
Fig(A.1) *Various syntactic graphs for Mazigh community show six measures.*



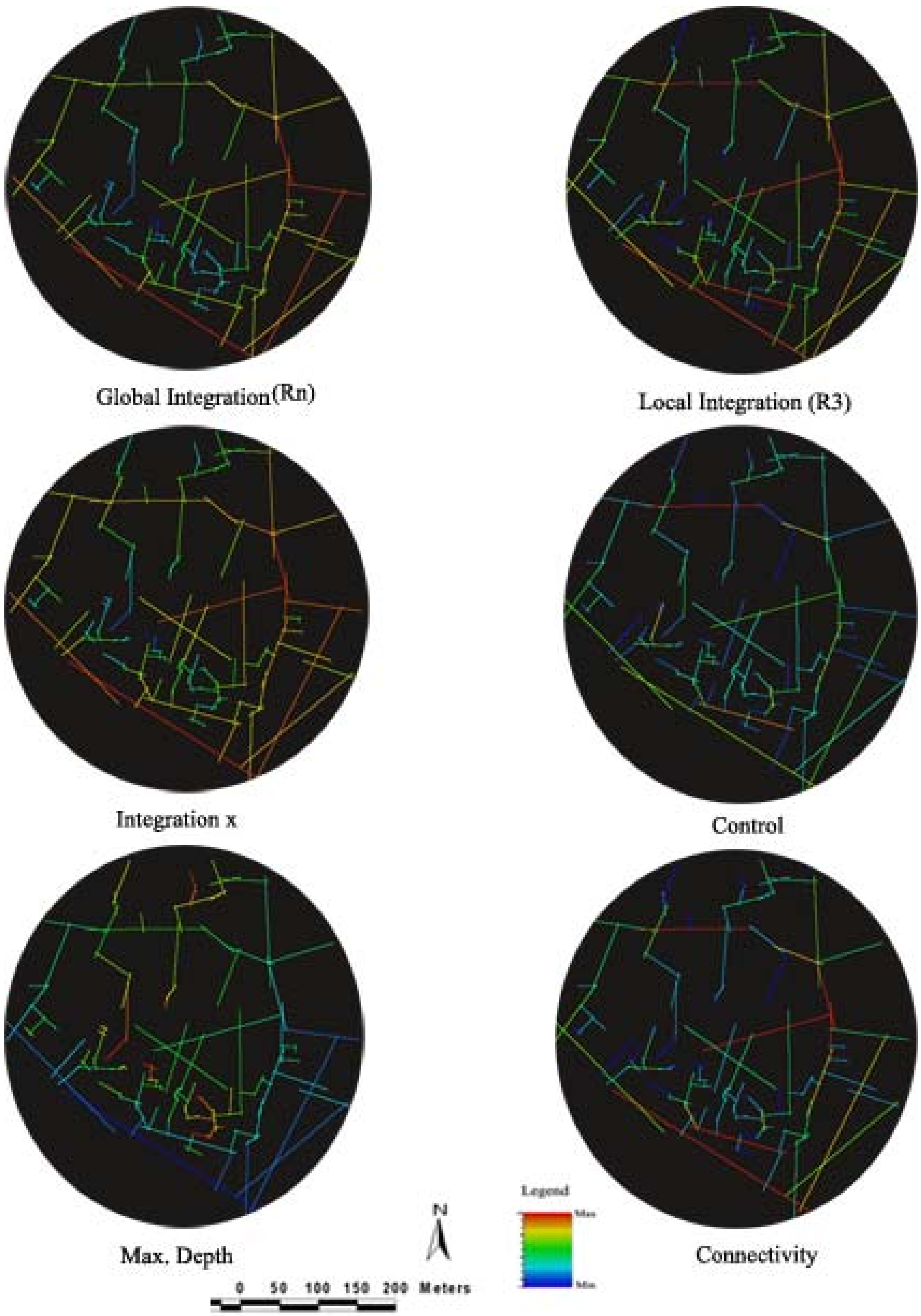
Fig(A.2) *Various syntactic graphs for Giorsan community show six measures.*



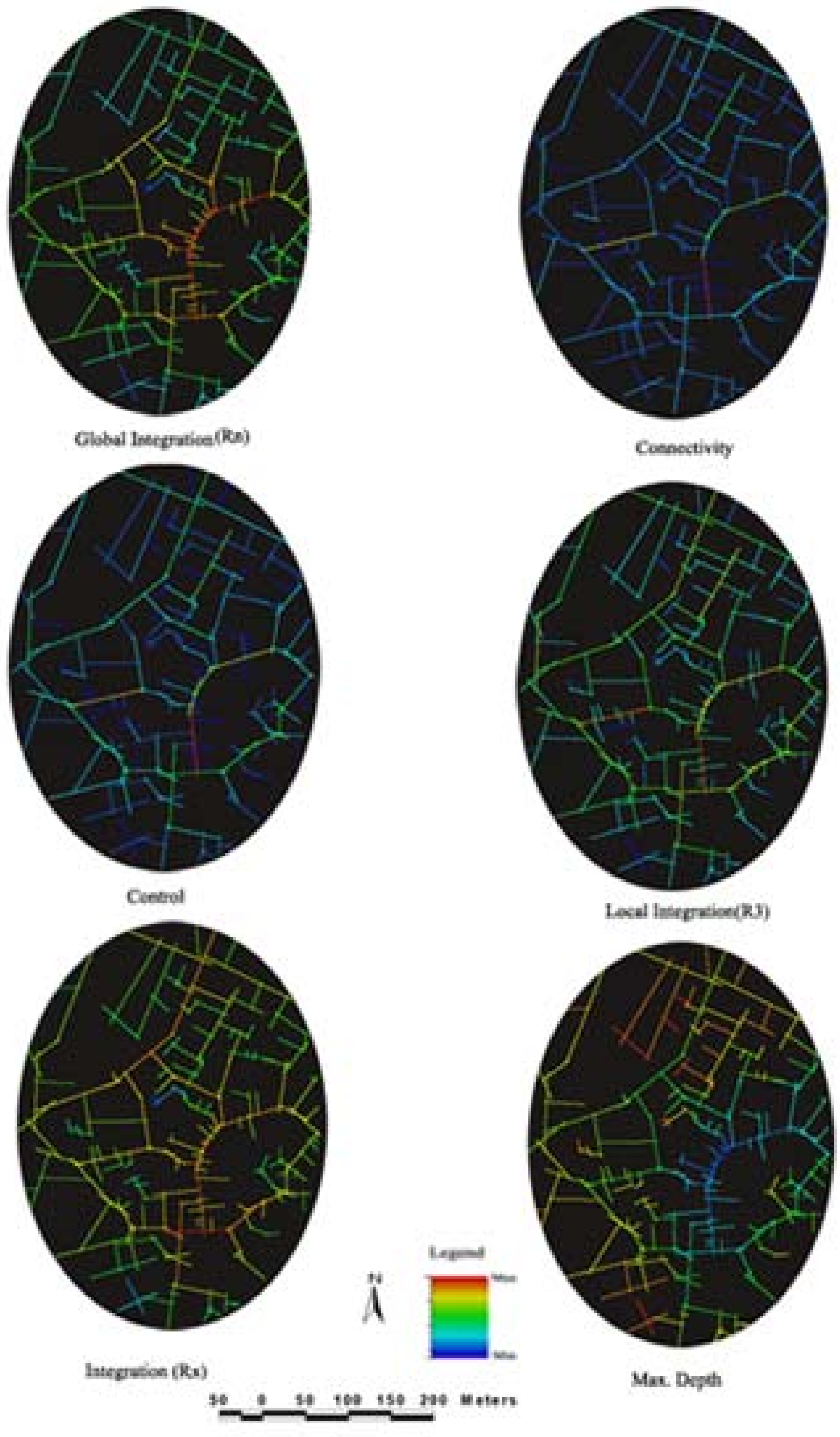
Fig(A.3) *Various syntactic graphs for Tharefra community show six measures*



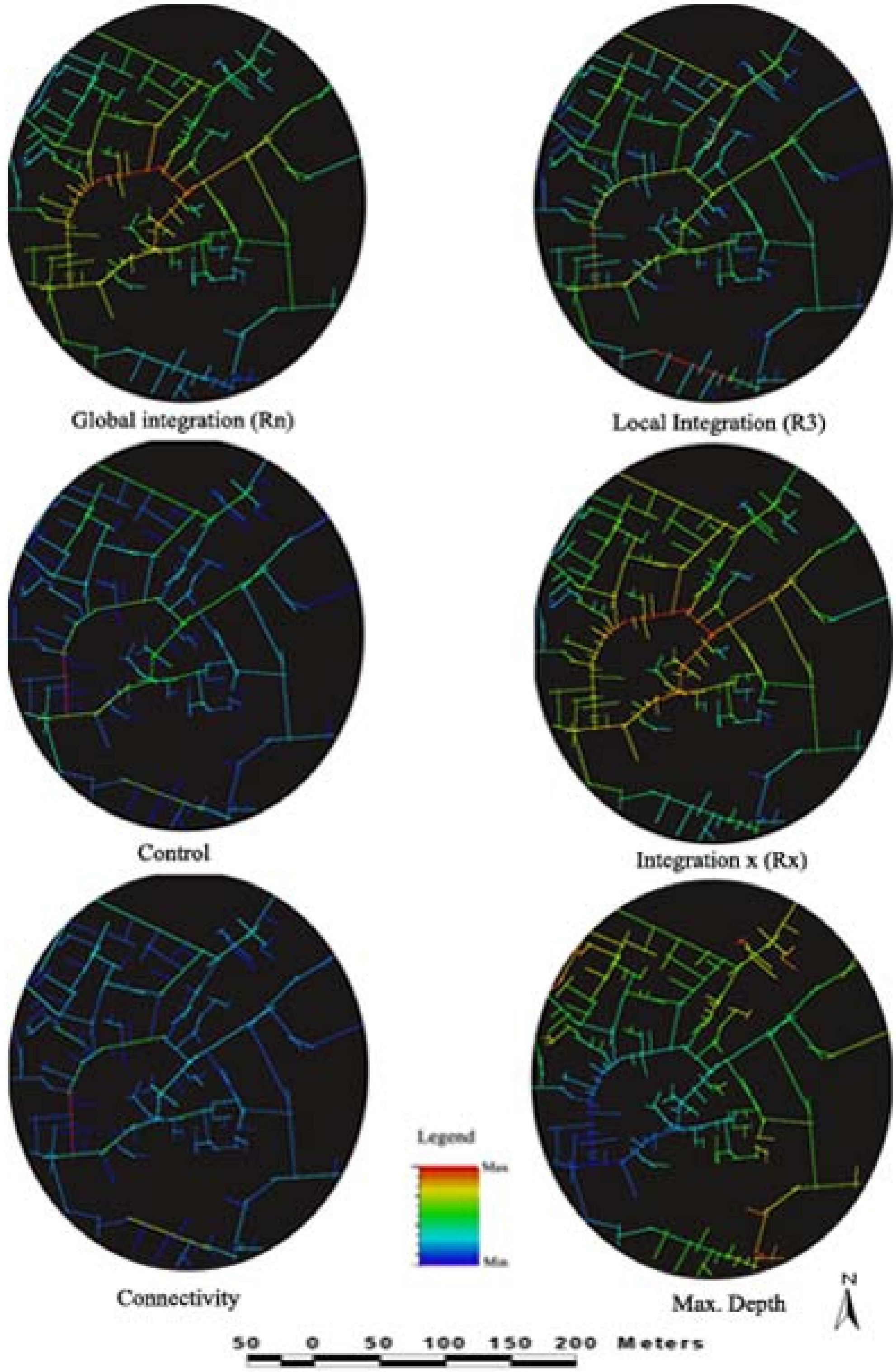
Fig(A.4) *Various syntactic graphs for Old Soak community show six measures*.



Fig(A.5) *Various syntactic graphs for Auld Blel community show six measures.*



Fig(A.6) *Various syntactic graphs for Djarrasan community show six measures.*



Fig(A.7) *Various syntactic graphs for Tsuku community show six measures.*

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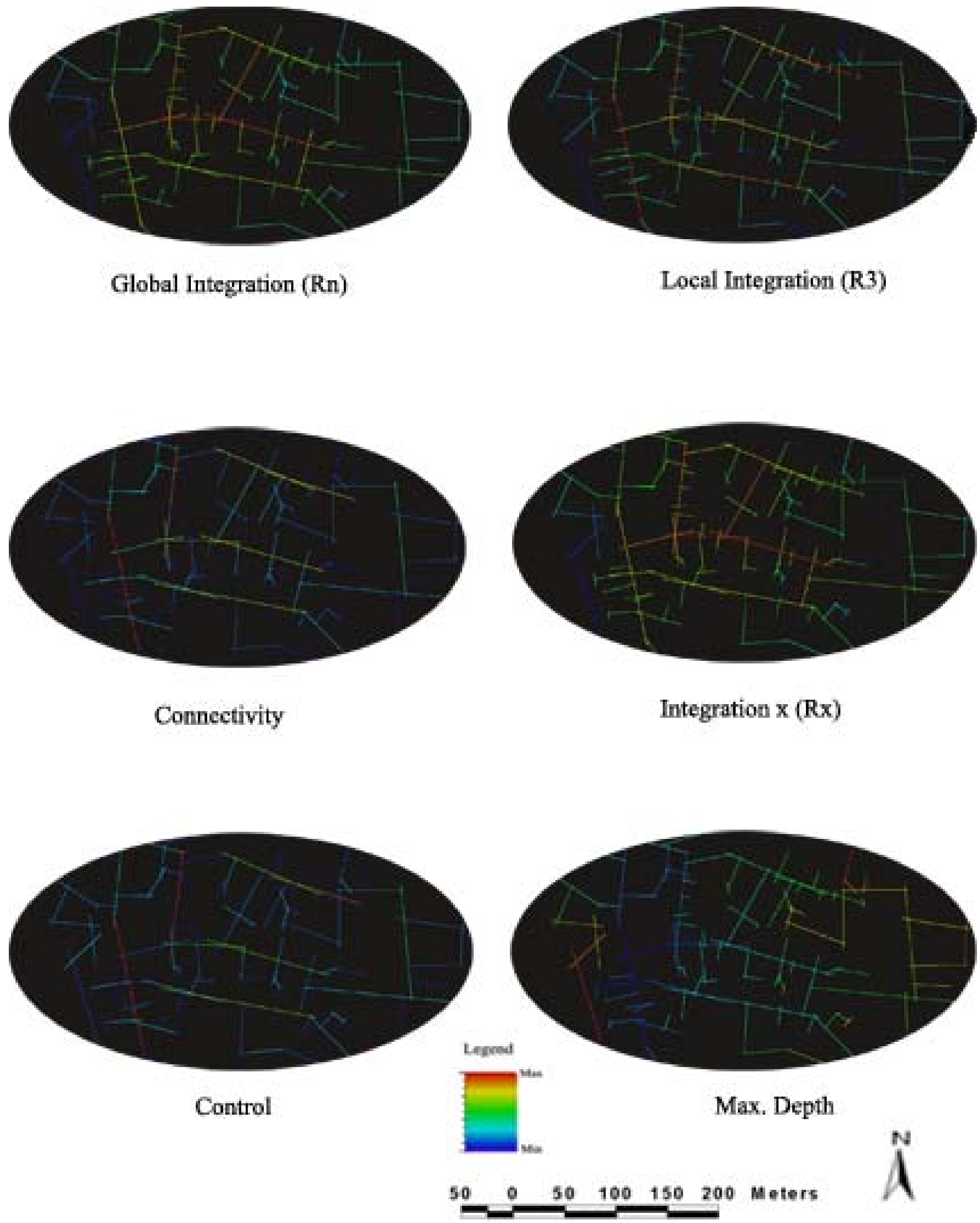


***Fig (A**.8) Various syntactic graphs for Tangzin community show six measures.*

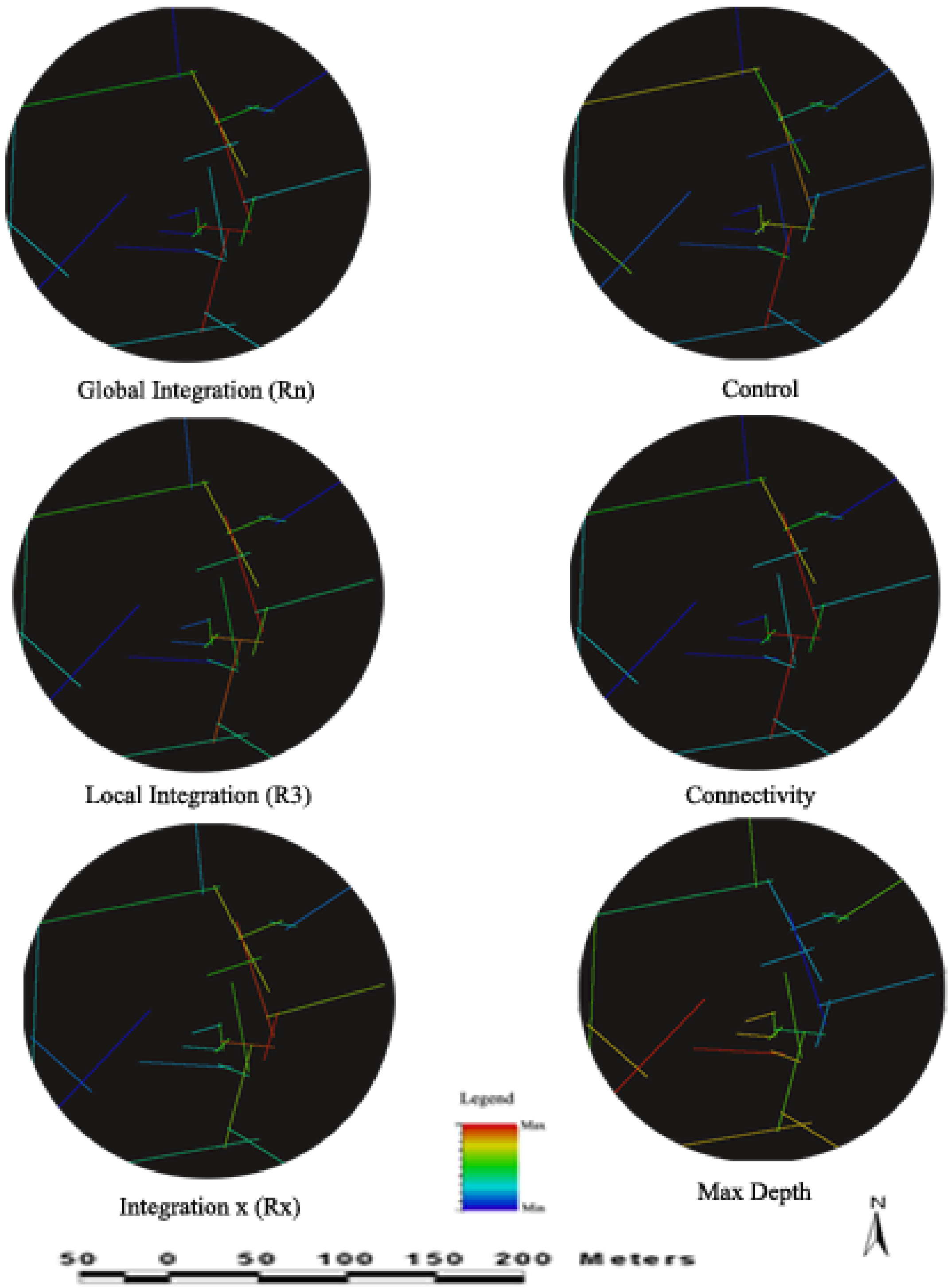


__Fig (A.9)__ Various syntactic graphs for Tuarg community show six measures.

APPENDIX B: VISUAL DESCRIPTIVE STATISTICS FOR THE SELECTED COMMUNITIES

Descriptive statistics for the nine communities shows summary of their visual and metric properties through the various measures and their visual and metric maps.

Table (B.1) Descriptive Statistics For Mazigh (Site No.1)

	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity Degree	2019	3.0	512.0	159.542	166.6850
Isovist Maximum Radial	2019	4.92	154.02	48.5209	30.06794
Isovist Moment of Inertia	2019	187.40	4866973.00	700494.753	995852.44419
M.M.ShortestPathAngler3	2019	0	0	.00	.000
M. M.Shortest Path Distance	2019	149.18	313.96	205.8212	31.25402
MetricMeanShortestPathDistan	2019	.00	1.76	1.6037	.17735
M. M. Straight Line Distance	2019	70.62	152.36	97.3430	20.42430
M.M.StraightLineDistancer3	2019	.00	1.76	1.6037	.17735
Visual Clustering Coefficient	2019	.33	1.00	.8098	.14506
Visual Control	2019	.15	2.26	1.0000	.28527
Visual Controllability	2019	.06	.84	.4391	.24105
Visual Entropy	2019	2.38	3.39	3.1352	.21878
Visual Entropyr3	2019	.66	1.58	1.3131	.16942
Visual Integration HH	2019	.93	2.34	1.5490	.24221
VisualIntegrationHHr3	2019	1.67	14.94	6.3889	3.28936
Visual Integration Tekl	2019	.39	.43	.4087	.00692
VisualIntegrationTeklr3	2019	.44	.57	.4947	.03259
Visual Mean Depth	2019	4.60	10.00	6.5610	.90784
VisualMeanDepthr3	2019	1.47	2.84	2.1468	.40172
Visual Relativised Entropy	2019	2.70	4.21	3.5343	.40614

Table (B.2)Descriptive Statistics For Giorsan (Site No.2)

	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity Degree	4992	1.00	1320.00	639.1446	409.53793
Isovist Maximum Radial	4992	2.20	174.06	84.2889	30.82559
IsovistMomentofInertia	4992	23.43	31251020.0	6773043.99	6185321.17231
MetricMeanShortestPathDistan	4992	144.79	312.49	193.7530	44.54640
MetricMeanStraightLineDistanc	4992	92.87	202.52	126.8482	24.55961
VisualClusteringCoefficient	4992	-1.00	1.00	.7950	.10099
V. Control	4992	-1.00	2.36	.9996	.24557
V. Controllability	4992	-1.00	.88	.5259	.21902
V. Entropy	4992	1.99	2.98	2.5904	.27764
V.Entropyr3	4992	.17	1.58	1.3396	.20841
V. Integration HH	4992	1.27	4.86	3.0555	.71529
V.IntegrationHHr3	4992	1.38	32.38	9.9048	4.06384
V. Integration Tekl	4992	.40	.46	.4392	.01101
V.IntegrationTeklr3	4992	.44	.64	.5110	.03059
V. Mean Depth	4992	3.00	8.63	4.3723	.87524
V.MeanDepthr3	4992	1.22	2.97	1.9458	.40270
V. Relativised Entropy	4992	2.14	4.03	2.7118	.32356
V.RelativisedEntropyr3	4992	1.83	3.98	2.1766	.42705

Table (B.3) Descriptive Statistics for Tangzin (Site No.3)

	N	Minimum	Maximum	Mean	Std.
Connectivity Degree	1590	1.00	163.00	53.0969	40.12908
Isovist Maximum Radial	1590	3.11	103.56	38.7574	22.21852
Isovist Moment of Inertia	1590	46.85	1244204.0	153840.42	192524.212
Metric M. Shortest Distance	1590	102.86	195.86	142.6831	22.92229
Metric M. Straight Line	1590	79.21	159.79	107.8142	20.71361
Metric Node Count	1590	1590.00	1590.00	1590.0000	.00000
Visual Clustering Coefficient	1590	-1.00	1.00	.7749	.15334
Visual Control	1590	-1.00	2.35	.9992	.34009
Visual Controllability	1590	-1.00	.95	.3210	.20622
Visual Entropy	1590	2.25	3.19	2.7755	.22478
VisualEntropyr3	1590	.69	1.58	1.3023	.14376
Visual Integration HH	1590	1.15	3.42	2.0800	.41632
Visual Integration HHr3	1590	.98	7.26	4.3043	1.01156
Visual Integration Tekl	1590	.40	.45	.4216	.00956
Visual IntegrationTeklr3	1590	.42	.55	.4744	.01651
Visual Mean Depth	1590	3.35	7.98	5.0278	.79248
VisualMeanDepthr3	1590	1.72	2.83	2.3910	.23029
Visual Node Count	1590	1590.00	1590.00	1590.0000	.00000
VisualNodeCountr3	1590	12.00	858.00	367.3648	168.08541
Visual Relativised Entropy	1590	2.20	3.49	2.6873	.21168
VisualRelativisedEntropyr3	1590	1.97	3.39	2.5563	.24342

Table (B.4) Descriptive Statistics for Tharefra (Site No.4)

	N	Minimum	Maximum	Mean	Std. Deviation
ConnectivityDegree	1016	2.00	150.00	43.9941	26.09131
IsovistMaximumRadial	1016	2.20	96.05	38.1721	20.80834
IsovistMomentofInertia	1016	46.85	892538.80	127841.38	163087.19907
MetricMeanShortestPathAngle	1016	1.68	5.74	2.7184	.58550
MetricMeanShortestPathDistan	1016	93.71	175.73	119.5688	16.46163
MetricMeanStraightLineDistanc	1016	58.74	113.65	79.7754	14.01417
MetricNodeCount	1016	1016.00	1016.00	1016.0000	.00000
VisualClusteringCoefficient	1016	.40	1.00	.7722	.13185
VisualControl	1016	.21	2.24	1.0000	.33367
VisualControllability	1016	.08	.81	.3027	.12046
VisualEntropy	1016	2.27	2.86	2.5777	.11043
VisualEntropyr3	1016	.66	1.58	1.3584	.13253
VisualIntegrationHH	1016	1.14	3.67	2.2688	.43707
VisualIntegrationHHr3	1016	1.49	6.82	4.1124	.75648
VisualIntegrationTekl	1016	.39	.45	.4261	.01026
VisualIntegrationTeklr3	1016	.44	.59	.4739	.01344
VisualMeanDepth	1016	3.02	7.48	4.3968	.68820
VisualMeanDepthr3	1016	1.54	2.84	2.3761	.17972
VisualNodeCount	1016	1016.00	1016.00	1016.0000	.00000
VisualNodeCountr3	1016	14.00	665.00	310.7579	128.02517
VisualRelativisedEntropy	1016	2.07	3.41	2.5583	.22189
VisualRelativisedEntropyr3	1016	1.83	3.43	2.4916	.23455

Table (B.5) Descriptive Statistics For Auld Blel (Site No.5)

	N	Min.	Max.	Mean	Std.
Connectivity Degree	3156	3.00	486.00	131.5539	153.07640
IsovistMaximumRadial	3156	3.11	120.18	41.7103	20.72119
IsovistMomentofInertia	3156	163.98	4419310.	528937.65	828742.601
Metric Mean Shortest Path Distance	3156	131.14	284.57	178.5307	28.55386
Metric M. ShortestPath Distancer3	3156	.00	1.76	1.6028	.15637
Metric M. Straight Line Distance	3156	86.35	181.78	116.8325	18.98233
Metric M.Straight Line Distancer3	3156	.00	1.76	1.6028	.15637
Visual Clustering Coefficient	3156	.34	1.00	.7768	.14476
Visual Control	3156	.11	2.18	1.0000	.30254
Visual Controllability	3156	.03	.82	.3777	.21963
Visual Entropy	3156	2.46	3.60	3.1165	.26434
Visual Entropyr3	3156	.57	1.58	1.3011	.14054
Visual Integration HH	3156	.93	2.53	1.7239	.27073
Visual IntegrationHHr3	3156	1.83	13.00	5.9769	3.20498
Visual Integration Tekl	3156	.39	.43	.4142	.00689
Visual IntegrationTeklr3	3156	.44	.56	.4890	.03253
VisualMean Depth	3156	4.58	10.73	6.3875	.93374
VisualMean Depthr3	3156	1.53	2.87	2.2314	.39776
VisualNodeCount	3156	3156.00	3156.00	3156.0000	.00000
VisualNodeCountr3	3156	29.00	1182.00	489.6717	230.97964
VisualRelativised Entropy	3156	2.47	3.87	3.0425	.22661
Visual Relativised Entropyr3	3156	1.83	3.54	2.4256	.38085

Table (B.6) Descriptive Statistics For Djarrasan (Site No.6)

	N	Min.	Max.	Mean	Std.
Connectivity Degree	3156	3.00	486.00	131.5539	153.07640
Isovist Maximum Radial	3156	3.11	120.18	41.7103	20.72119
Isovist Moment of Inertia	3156	163.98	4419310.	528937.56	828742.6011
MetricM. Shortest Path Distance	3156	-1.00	190.79	-.2509	11.23997
MetricM.Shortest Path Distancer3	3156	.00	1.76	1.6028	.15637
MetricM. Straight Line Distance	3156	-1.00	146.16	-.3992	9.00569
Metric M. Straight Line Distancer3	3156	.00	1.76	1.6028	.15637
Metric Node Countr3	3156	1	5	3.90	.876
VisualClusteringCoefficient	3156	.34	1.00	.7768	.14476
VisualControl	3156	.11	2.18	1.0000	.30254
VisualControllability	3156	.03	.82	.3777	.21963
VisualEntropy	3156	2.46	3.60	3.1165	.26434
VisualEntropyr3	3156	.57	1.58	1.3011	.14054
VisualIntegrationHH	3156	.93	2.53	1.7239	.27073
VisualIntegrationHHr3	3156	1.83	13.00	5.9769	3.20498
VisualIntegrationTekl	3156	.39	.43	.4142	.00689
VisualIntegrationTeklr3	3156	.44	.56	.4890	.03253
VisualMeanDepth	3156	4.58	10.73	6.3875	.93374
VisualMeanDepthr3	3156	1.53	2.87	2.2314	.39776
VisualNodeCount	3156	3156.00	3156.00	3156.0000	.00000
VisualNodeCountr3	3156	29.00	1182.00	489.6717	230.97964
Visual Relativised Entropy	3156	2.47	3.87	3.0425	.22661
Visual Relativised Entropyr3	3156	1.83	3.54	2.4256	.38085
Valid N (listwise)	3156				

Table (B.7) Descriptive Statistics for Tsuku (Site No.7)

	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity Degree	3170	1.0	423.0	91.938	114.0560
Isovist Maximum Radial	3170	2.00	166.48	39.1636	24.83372
Isovist Moment of Inertia	3170	16.00	2404736.00	265286.433	407999.53534
Metric Mean Shortest Path Distance	3170	146.86	375.37	222.0629	42.55134
Metric Mean Straight Line Distance	3170	95.21	192.56	128.9736	20.20106
Visual Clustering Coefficient	3170	-1.00	1.00	.7925	.15090
VisualControl	3170	-1.00	2.32	.9993	.30543
VisualControllability	3170	-1.00	.96	.3571	.21362
VisualEntropy	3170	3.06	3.84	3.4752	.21305
Visual Entropyr3	3170	.49	1.58	1.3102	.17954
Visual Integration HH	3170	.73	2.43	1.4684	.32022
Visual Integration HHr3	3170	1.22	12.50	4.9693	2.37736
Visual Integration Tekl	3170	.38	.43	.4072	.00902
Visual IntegrationTeklr3	3170	.43	.56	.4806	.02582
Visual Mean Depth	3170	4.73	13.33	7.4675	1.45410
Visual MeanDepthr3	3170	1.53	2.90	2.3168	.32153
Visual Relativised Entropy	3170	2.47	4.29	3.2157	.41991
Visual Relativised Entropyr3	3170	1.87	3.63	2.4906	.33393

Table (B.8) Descriptive Statistics For Old Soak(Site No.8)

	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity Degree	2847	7.00	802.00	393.9024	219.62668
Isovist Maximum Radial	2847	6.60	200.83	88.4294	39.99435
Metric Mean Shortest Path Angle	2847	1.01	5.69	2.0271	.53441
MetricMeanShortestPathDistance	2847	86.66	221.67	135.3986	27.29808
Metric Mean Straight Line Distance	2847	70.79	130.43	93.9500	14.08870
Visual Clustering Coefficient	2847	.39	1.00	.8063	.10894
Visual Control	2847	.13	2.05	1.0000	.28323
Visual Controllability	2847	.02	.87	.4661	.21410
Visual Entropy	2847	1.52	2.74	2.3631	.23594
Visual Entropyr3	2847	.37	1.58	1.3908	.16287
Visual Integration HH	2847	1.28	6.39	3.6606	.76692
Visual IntegrationHHr3	2847	2.73	18.28	8.4744	3.42485
Visual Integration Tekl	2847	.40	.48	.4488	.01119
Visual Integration Teklr3	2847	.45	.57	.5038	.02796
VisualMeanDepth	2847	2.39	7.93	3.5582	.67257
VisualMeanDepthr3	2847	1.41	2.92	2.0324	.33352
VisualNodeCountr3	2847	39.00	2623.00	1342.3007	459.00284
Visual Relativised Entropy	2847	2.07	3.63	2.4342	.22083
Visual Relativised Entropyr3	2847	1.82	3.76	2.2030	.32071

Table (B.9) Descriptive Statistics for Tuarg (Site No.9)

	N	Min.	Max.	Mean	Std.
Connectivity Degree	673	2.00	208.00	77.6999	46.29366
Isovist Maximum Radial	673	2.20	76.37	37.0242	12.84481
Isovist Moment of Inertia	673	46.85	727692.80	147776.341	132690.05
Metric Mean Shortest Path Distance	673	63.66	166.69	92.6862	20.99029
MetricMeanStraightLineDistance	673	49.58	102.17	67.5847	12.12233
MetricNodeCount	673	673.00	673.00	673.0000	.00000
VisualClusteringCoefficient	673	.39	1.00	.8189	.14916
VisualControl	673	.16	2.41	1.0000	.28444
VisualControllability	673	.05	.77	.4115	.17028
VisualEntropy	673	1.82	2.93	2.5380	.28717
VisualEntropyr3	673	.78	1.58	1.4384	.11763
VisualIntegrationHH	673	1.27	4.50	2.5883	.57897
VisualIntegrationHHr3	673	1.51	7.95	5.1267	1.33725
VisualIntegrationTekl	673	.40	.47	.4340	.01303
VisualIntegrationTeklr3	673	.43	.53	.4891	.02056
VisualMeanDepth	673	2.52	6.37	3.7751	.64566
VisualMeanDepthr3	673	1.74	2.79	2.1726	.26574
VisualNodeCount	673	673.00	673.00	673.0000	.00000
VisualNodeCountr3	673	26.00	558.00	318.9465	99.76083
VisualRelativisedEntropy	673	1.96	3.13	2.4145	.22110
VisualRelativisedEntropyr3	673	1.91	3.30	2.2747	.27718
Valid N (listwise)	673				

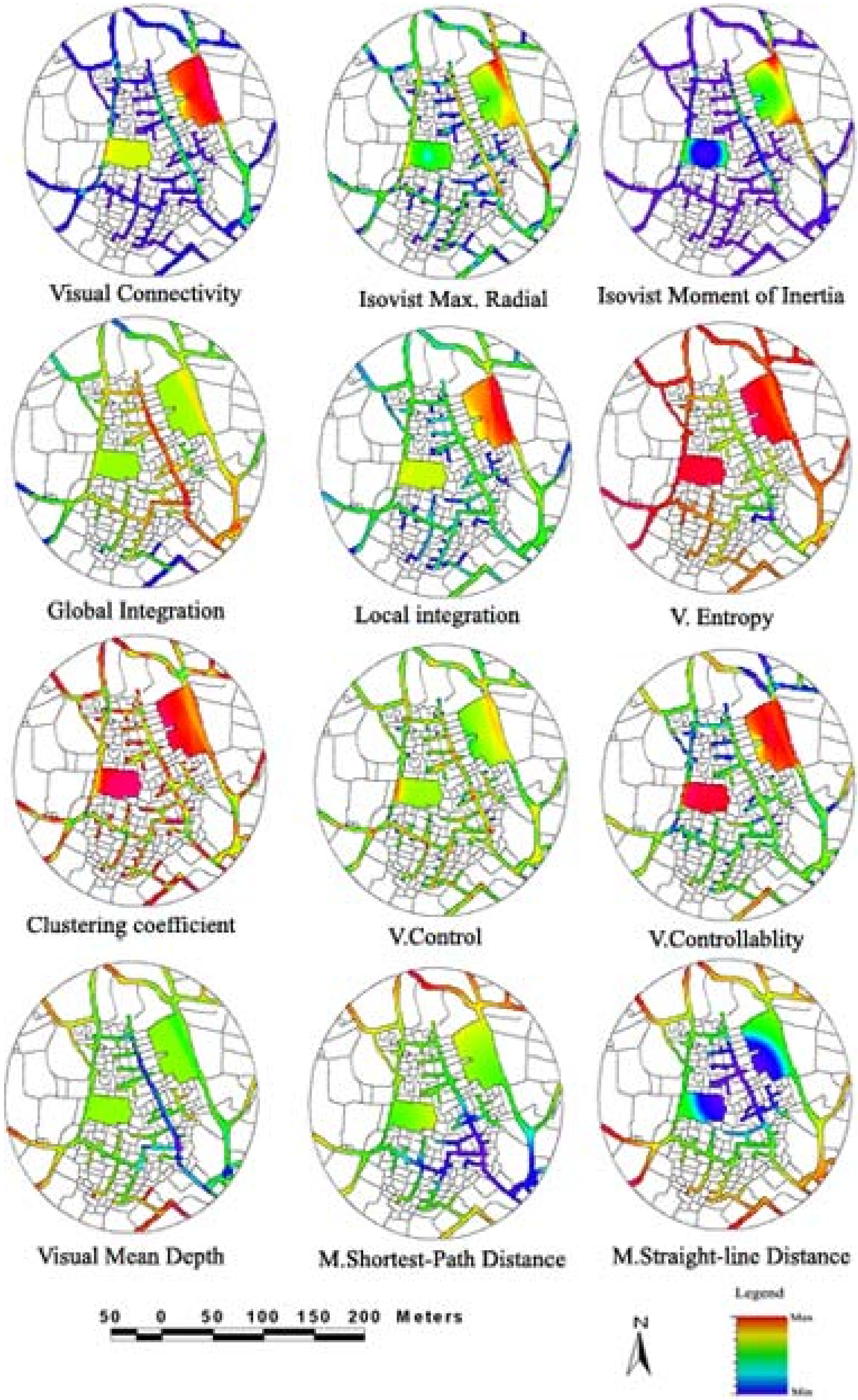


Fig (B.1) *Visibility graphs for Mazigh show visual and metric measures*

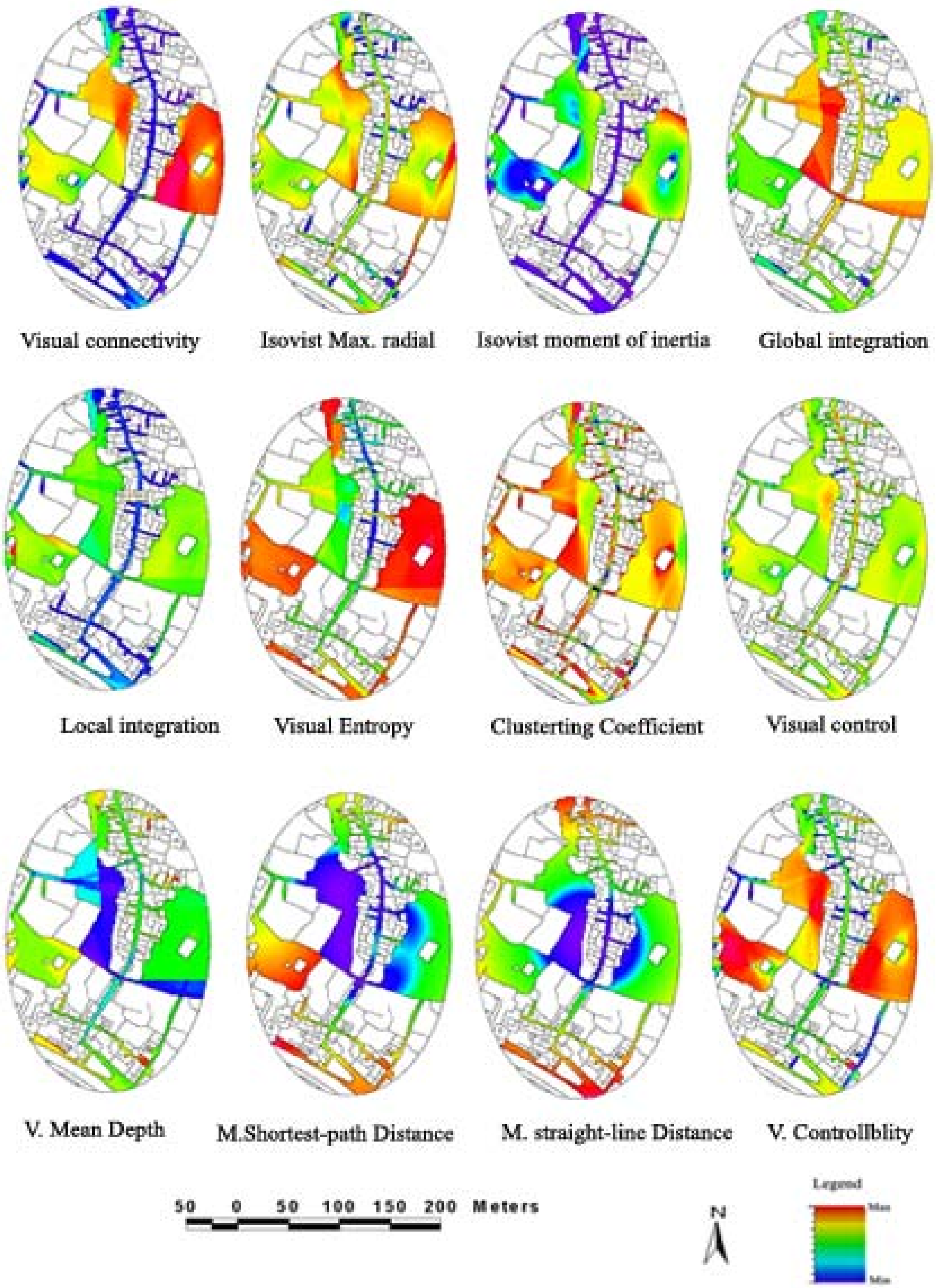


Fig (B.2) *Visibility graphs for Giorsan show visual and metric measures*

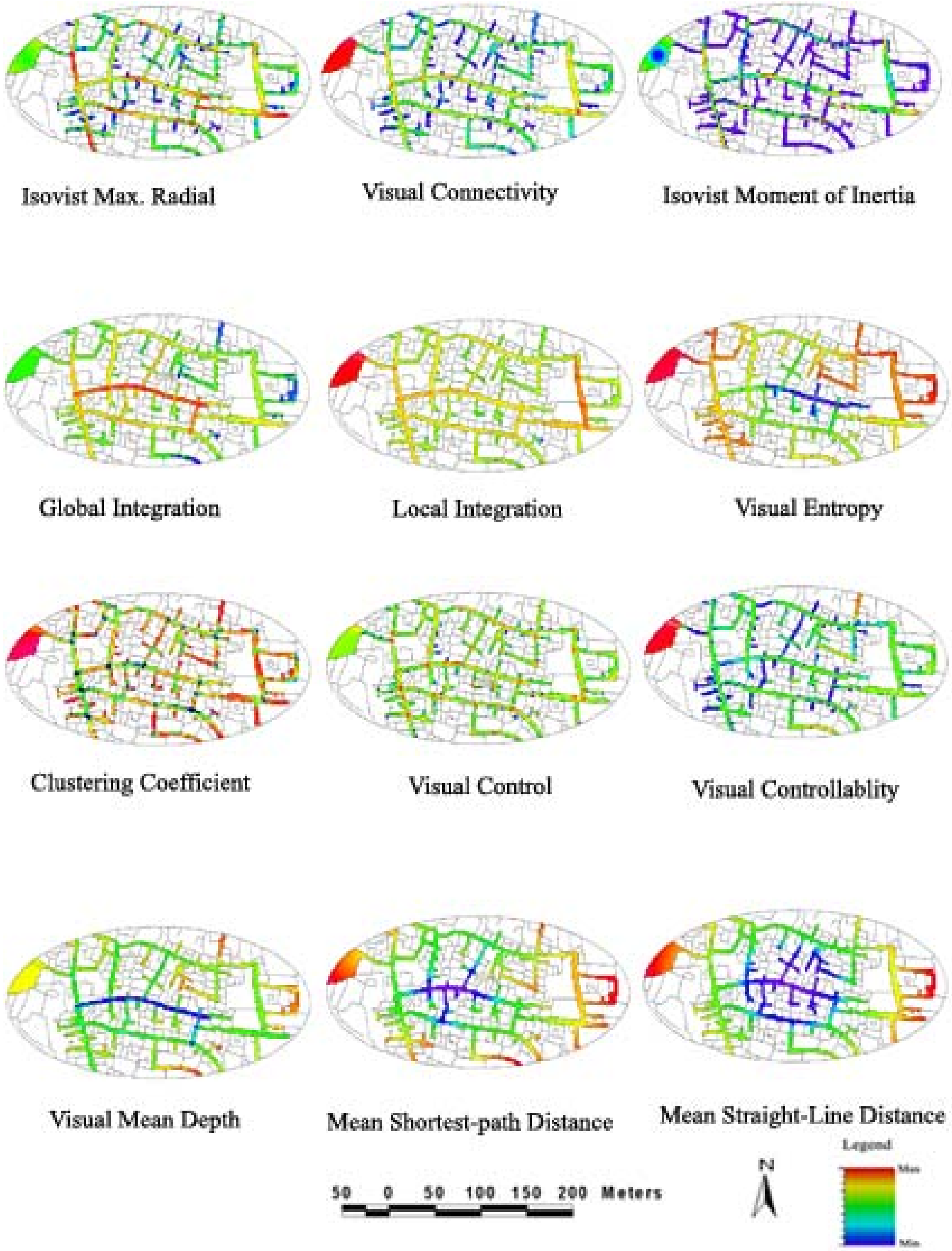


Fig (B.3) *Visibility graphs for Tangzin show visual and metric measures*

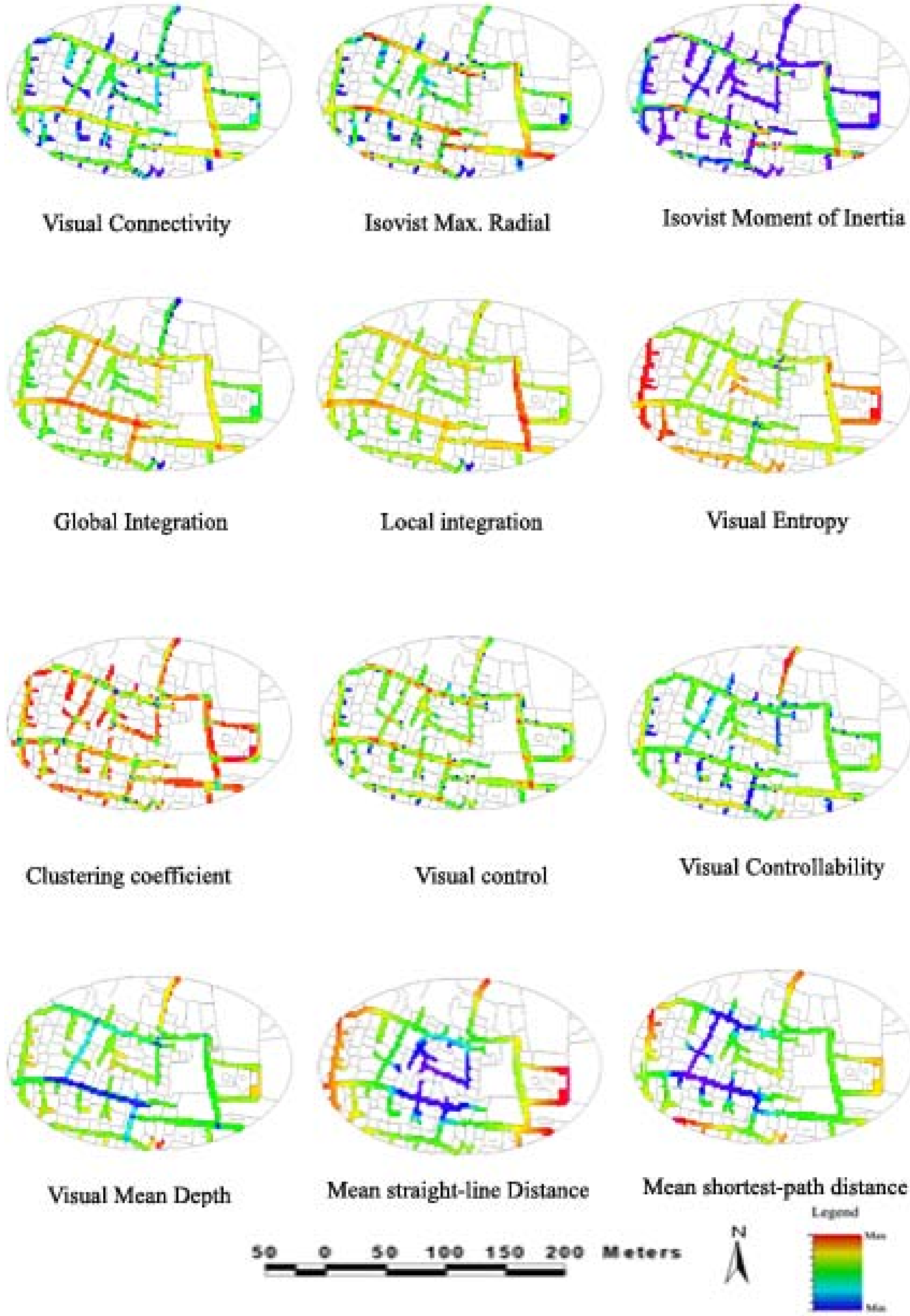


Fig (B.4) *Visibility graphs for Tharefra show visual and metric measures*

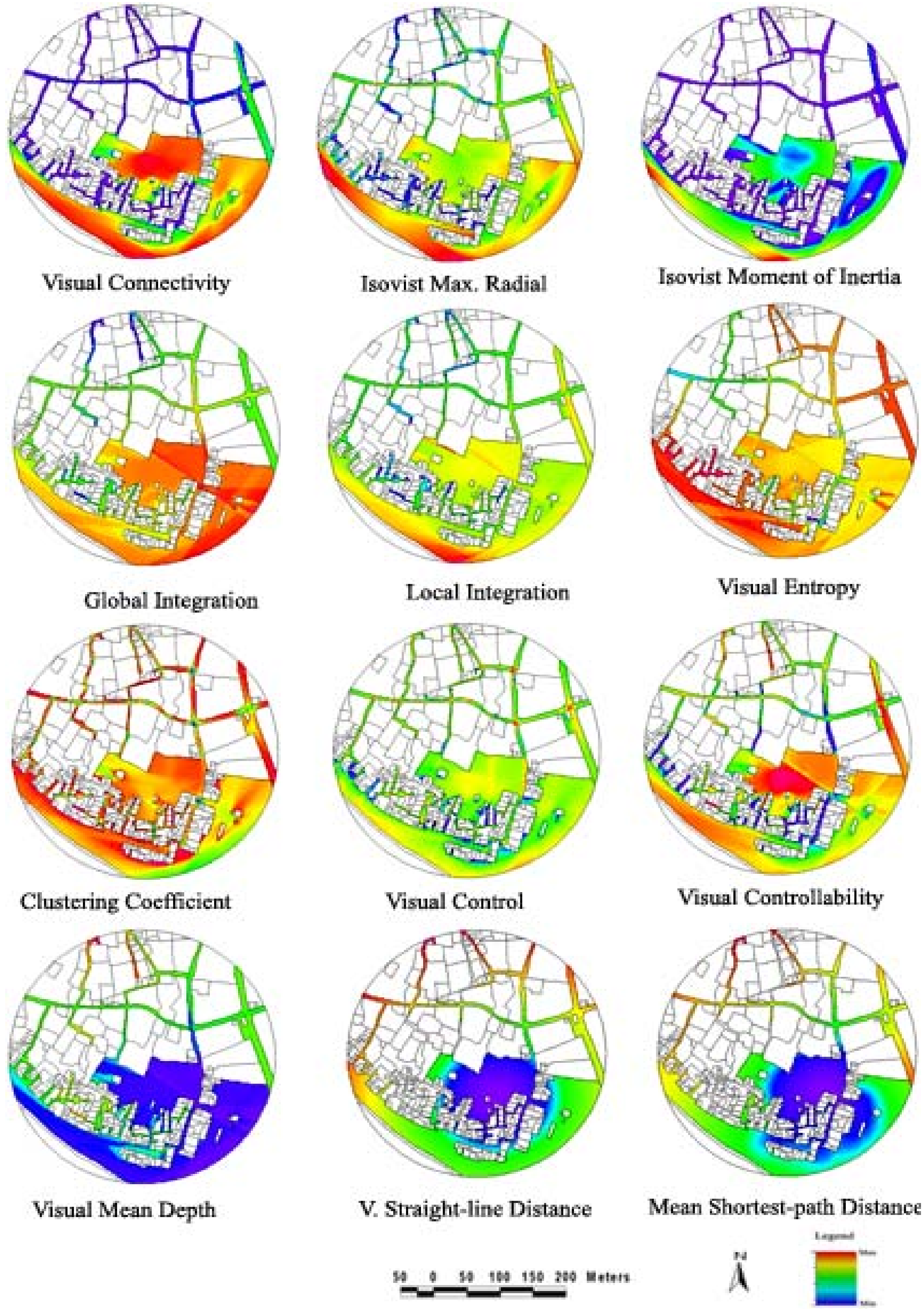


Fig (B.5) *Visibility graphs for Auld Blel show visual and metric measures*

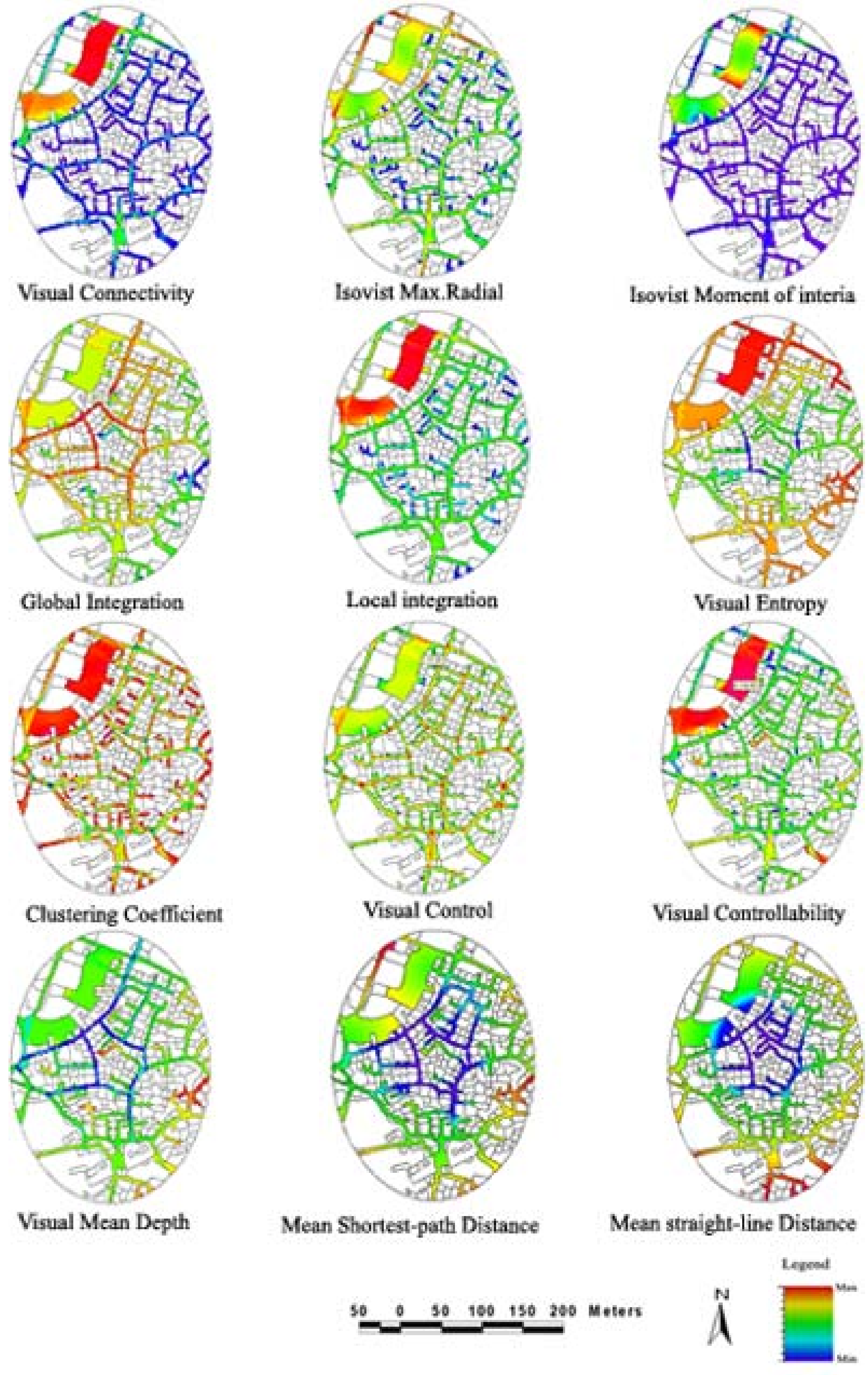


Fig (B.6) *Visibility graphs for Djarrasan show visual and metric measures*

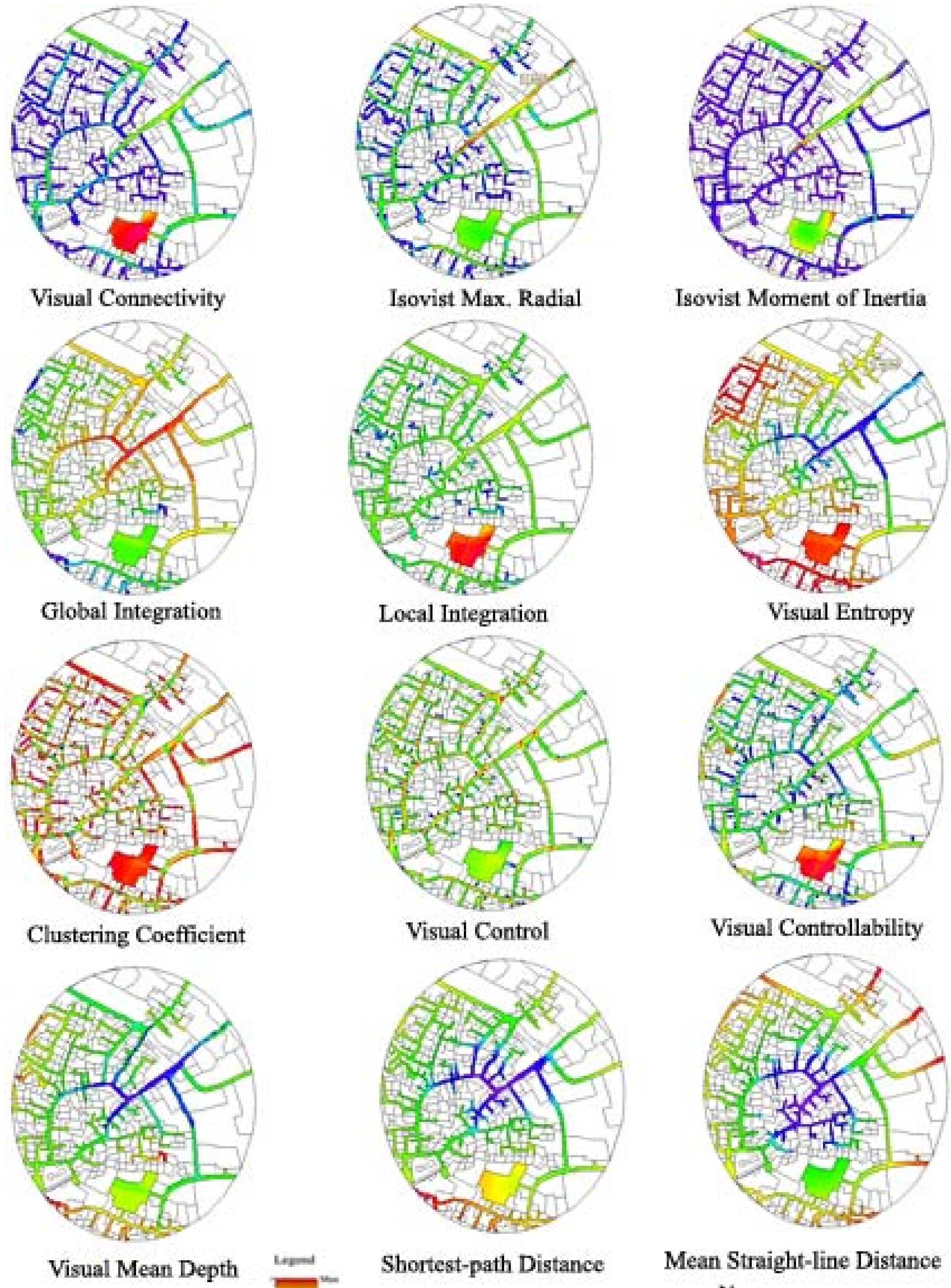


Fig (B.7) *Visibility graphs for Tsuku show visual and metric measures*

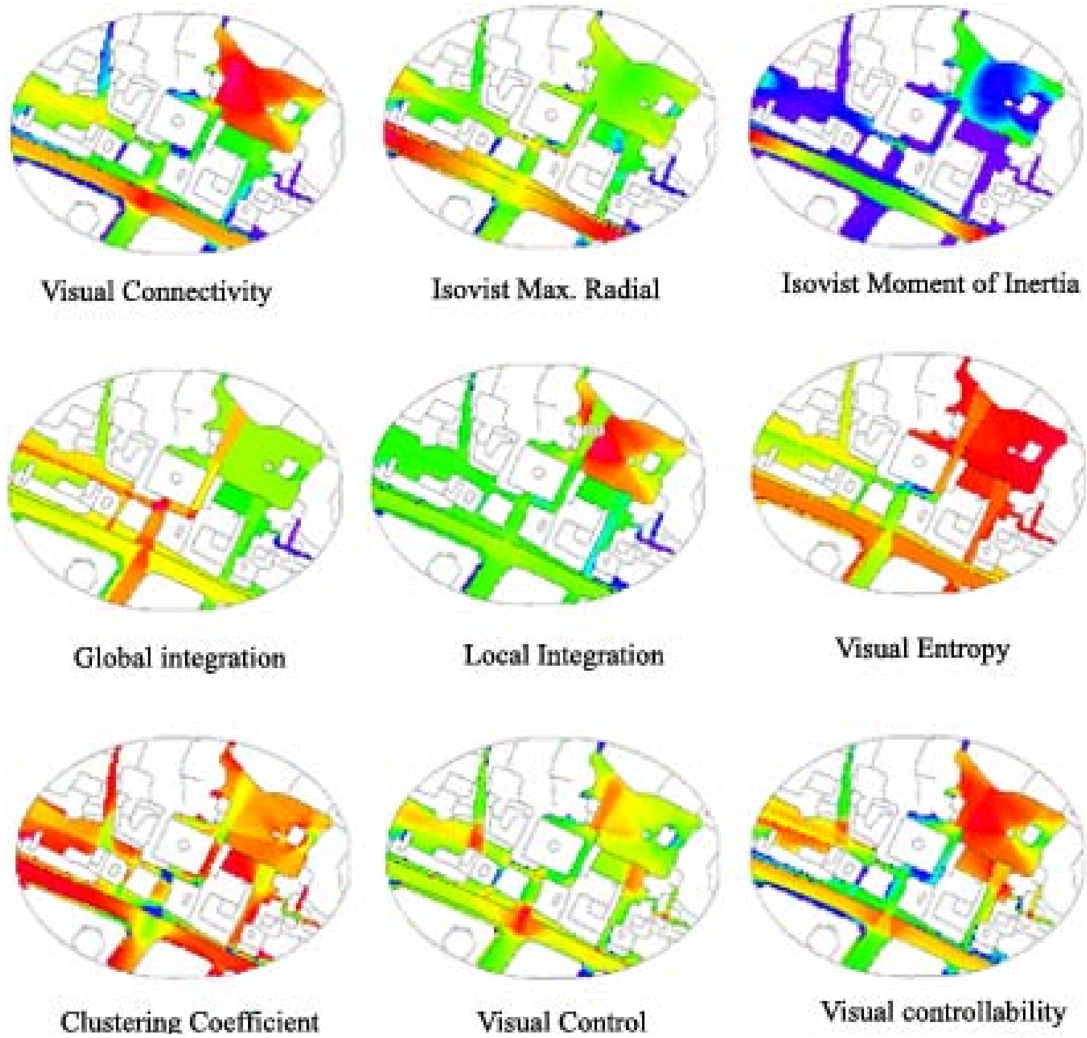


Fig (B.9) Visibility graphs for Tuarg show visual and metric measures

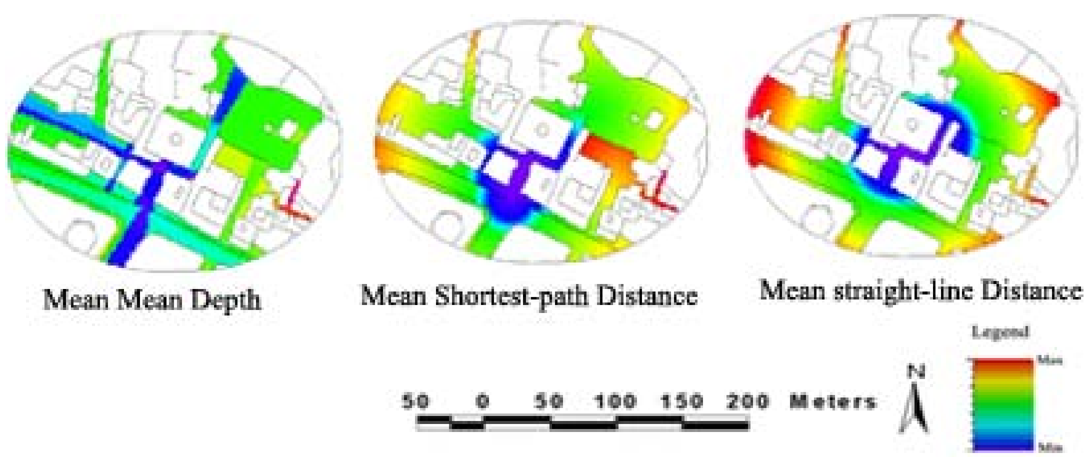


Fig (B.8) *Visibility graphs for Old Soak show visual and metric measures*

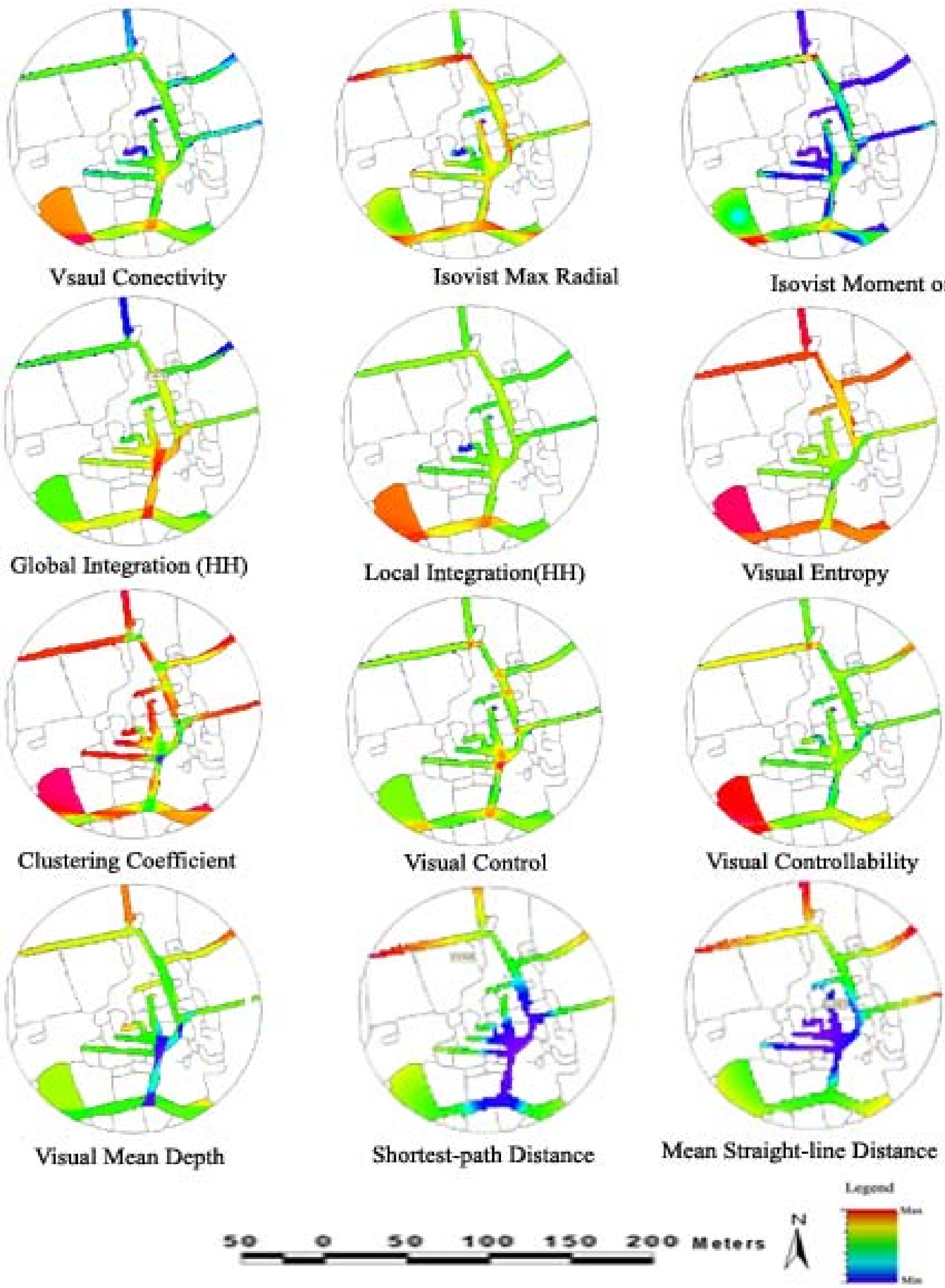


***Fig (B.9)** Visibility graphs for Tuarg show visual and metric measures*

APPENDIX C: VISUAL DESCRIPTIVE STATISTICS FOR THE LIBYAN CITIES

Descriptive statistics for the six Libyan cities shows summary of their syntactic values, axial maps, summary of visual and metric values, visual maps.

Benghazi Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
total stepDepth	4154	78982	30	79012	1.8E+08	44369.33	7220.52
total count	4154	4132	11	4143	17164570	4132.06	212.37
total r3 depth	4154	282	3	285	170370	41.01	35.18
total r3 count	4154	160	3	163	98602	23.74	18.90
connectivity	4154	56	1	57	18526	4.46	3.76
CONTROL	4154	16.87963	.03704	16.91667	4154.000	1.0000000	1.0007449
Intergration	4154	1.165137	.294904	1.460041	4122.244	.99235523	.15470824
Intergration 3*	4154	9.21990	.21093	9.43082	10502.06	2.5281794	1.0417389
Fractional ra	4154	.39763	.00111	.39874	10.46370	2.52E-03	1.474705E-02
Max depth*	4154	25	5	30	90533	21.79	2.17
IntergrationX*	4154	1.690061	.328380	2.018441	6075.593	1.462589	.23865733
Fractional X	4154	.235658	.014342	.250000	641.5511	.15444176	5.6955E-02
Fractional count	4154	0	1	1	4154	1.00	.00
Valid N (listwise)	4154						

Benghazi old town Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
total stepDepth	868	0	11284	5615698	6469.70	1282.83	1645641
total count	868	0	864	746496	860.02	58.55	3428.170
total r3 depth	868	0	217	34280	39.49	30.01	900.728
total r3 count	868	0	125	19898	22.92	16.40	268.942
connectivity	868	0	31	3788	4.36	3.48	12.100
CONTROL	868	0	8	864	1.00	.90	.806
Intergration	868	1	2	994	1.15	.22	5.031E-02
Intergration 3*	868	0	6	2172	2.50	.98	.962
Fractional ra	868	0	0	5	6.30E-03	1.29E-03	1.654E-06
Max depth*	868	0	21	12773	14.72	2.29	5.240
IntergrationX*	868	0	2	1258	1.45	.24	5.648E-02
Fractional X	868	0	0	131	.15	5.81E-02	3.374E-03
Fractional count	868	1	1	868	1.00	.00	.000
Valid N (listwise)	868						

Tripoli Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
total stepDepth	1836	4	44055	34001078	18519.11	4618.25
total count	1836	4	1828	3341616	1820.05	120.17
total r3 depth	1836	3	208	58034	31.61	27.48
total r3 count	1836	3	120	34364	18.72	14.92
connectivity	1836	1	30	7022	3.82	2.96
CONTROL	1836	.0	7.1	1836.0	1.000	.768
Intergration	1836	.33335	1.50978	1741.016	.9482656	.2012149
Intergration 3*	1836	.21093	5.87085	4092.202	2.2288683	.9575008
Fractional ra	1836	.00214	.36464	8.54655	4.65E-03	1.801750E-02
Max depth*	1836	2	40	48234	26.27	3.26
IntergrationX*	1836	.32838	2.02435	2471.199	1.3459692	.3033452
Fractional X	1836	0	0	0	.00	.00
Fractional count	1836	1	1	1836	1.00	.00
V20	367	.21093	5.87085	1007.473	2.7451592	.9945061
Valid N (listwise)	367					

Tripoli old town Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
total stepDepth	499	0	7413	1923565	3854.84	1072.59	1150453
total count	499	0	487	235221	471.38	85.88	7375.562
total r3 depth	499	0	105	9083	18.20	16.96	287.535
total r3 count	499	0	61	5715	11.45	9.36	87.702
connectivity	499	0	19	1381	2.77	2.26	5.098
CONTROL	499	.00000	8.08333	482.63889	.9672122	.9063580	.821
Intergration	499	.44650	1.54259	464.95833	.9317802	.1969834	3.880E-02
Intergration 3*	499	.21093	5.17833	843.56942	1.6905199	.9191539	.845
Fractional ra	499	.00000	.02782	6.81303	1.37E-02	3.795813E-03	1.441E-05
Max depth*	499	0	25	8640	17.31	3.96	15.646
IntergrationX*	499	.39287	1.80556	555.20932	1.1126439	.2671709	7.138E-02
Fractional X	499	0	0	0	.00	.00	.000
Fractional count	499	1	1	499	1.00	.00	.000
Valid N (listwise)	499						

Ghat Town Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
total stepDepth	370	1774	5432	1095848	2961.75	654.36	428189.3
total count	370	370	370	136900	370.00	.00	.000
total r3 depth	370	3	115	7606	20.56	18.79	353.120
total r3 count	370	3	71	4740	12.81	10.30	106.062
connectivity	370	1	25	1134	3.06	2.36	5.584
CONTROL	370	.071	5.982	370.000	1.00000	.80087	.641
Intergration	370	.43534	1.56876	332.15233	.8977090	.1999748	3.999E-02
Intergration 3*	370	.210927	5.710034	669.4687	1.809375	.91907178	.845
Fractional ra	370	.01016	.03295	6.43451	1.74E-02	3.822502E-03	1.461E-05
Max depth*	370	11	21	5775	15.61	2.08	4.315
IntergrationX*	370	.32854	1.78800	414.54073	1.1203804	.2855409	8.153E-02
Fractional X	370	0	0	0	.00	.00	.000
Fractional count	370	1	1	370	1.00	.00	.000
Valid N (listwise)	370						

Ghdames building links Descriptive Statistics

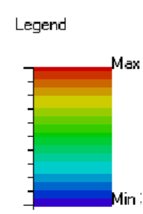
	N	Minimum	Maximum	Sum	Mean	Std. Deviation
total stepDepth	2139	5.00000	63726.00	7.3E+07	34022.87	7070.1770543
total count	2139	4.00000	2141.000	4573173	2137.996	79.9937935
total r3 depth	2139	3.00000	109.00000	42771.00	19.99579	15.7110985
total r3 count	2139	3.00000	66.00000	26038.00	12.17298	8.7778955
connectivity	2139	1.00000	25.00000	5027.000	2.3501636	2.6051980
CONTROL	2139	.04000	17.95311	2139.606	1.0002831	1.7221692
Intergration	2139	.29484	.92023	1265.746	.5917468	.1114023
Intergration 3*	2139	.21093	6.95018	3525.039	1.6479847	.9461577
Fractional ra	2139	.00316	.29631	11.82508	5.53E-03	1.059562E-02
Max depth*	2139	2.00000	47.00000	72204.00	33.75596	5.0457501
IntergrationX*	2139	.47212	1.70442	2455.088	1.1477737	.2067065
Fractional X	2139	.00000	.22147	.22147	1.04E-04	4.788606E-03
Fractional count	2139	1.00000	1.00000	2139.000	1.0000000	.0000000
V20	310	.21093	5.00014	424.30924	1.3687395	.7984589
Valid N (listwise)	310					

(a) Benghazi old Town, Global Integration Rn

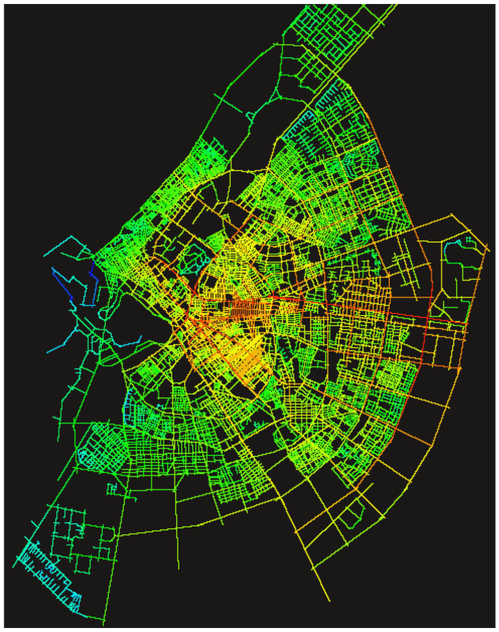
(b) Benghazi old Town, Local Integration R3

(c) Benghazi old Town, Integration Rx

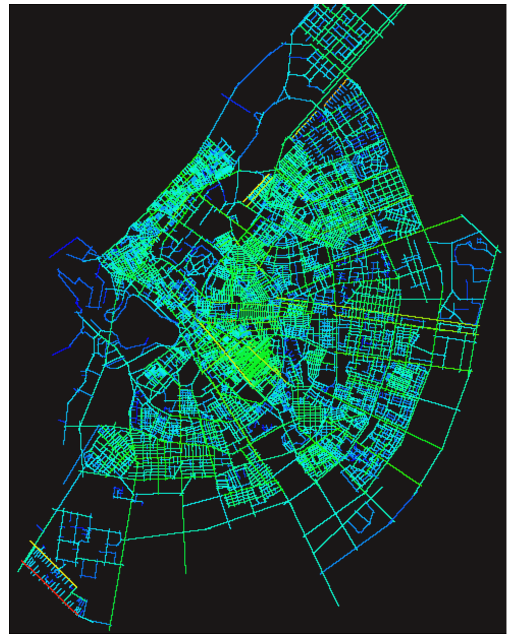
(d) Connectivity



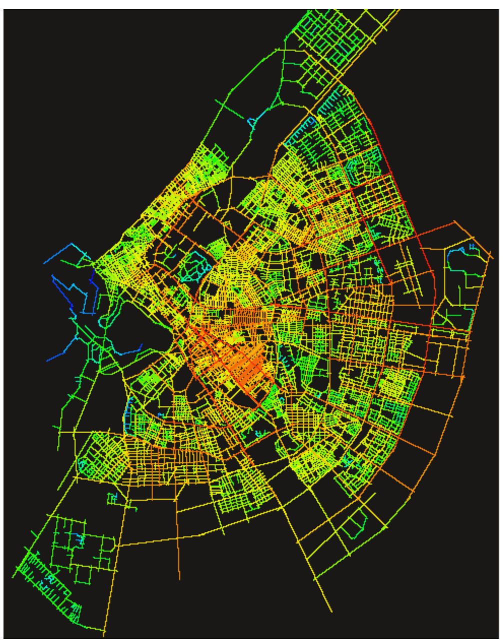
Fig(C.1) *Visibility graphs for Benghazi Old Town show syntactic measures*



(a) Benghazi, Global integration Rn

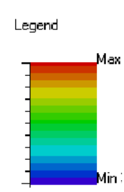


(b) Benghazi, Local Integration R3

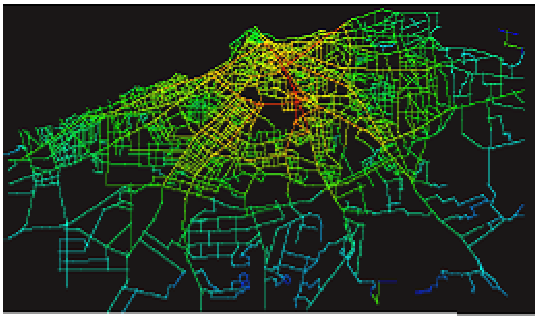


(C) Benghazi, Integration x

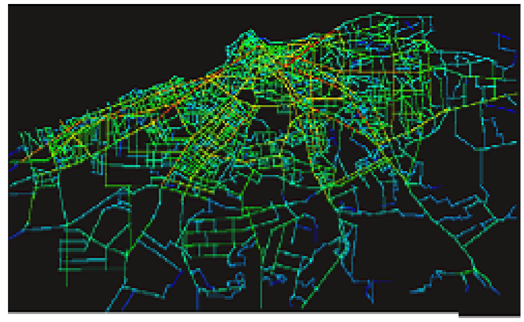
(d) Benghazi, Connectivity



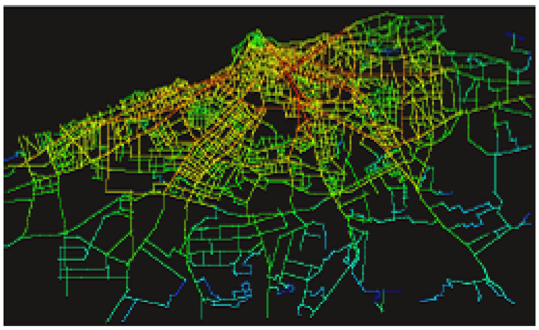
Fig(C.2) *Visibility graphs for Benghazi City show syntactic measures*



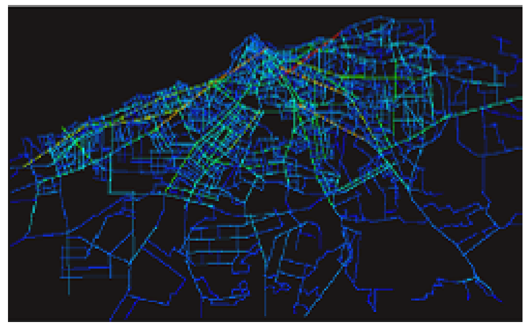
(a) Global integration (Rn)



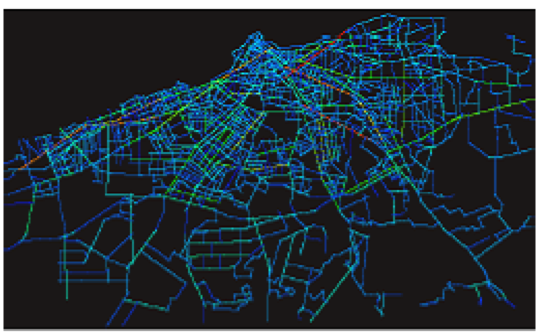
(b) Local integration (R3)



(c) Integration (Rx)

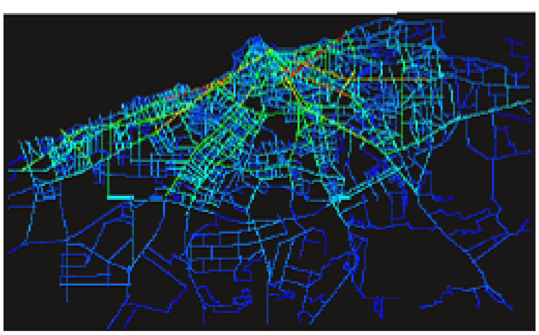


(d) Connectivity (Con.)



(e) Control (Ctrl)

(f) Total step depth



(g) Total step depth.

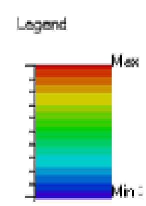
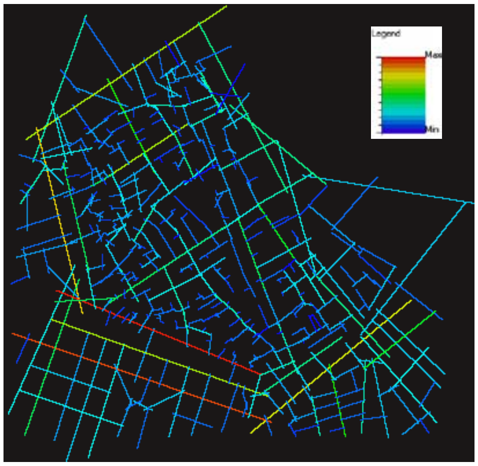
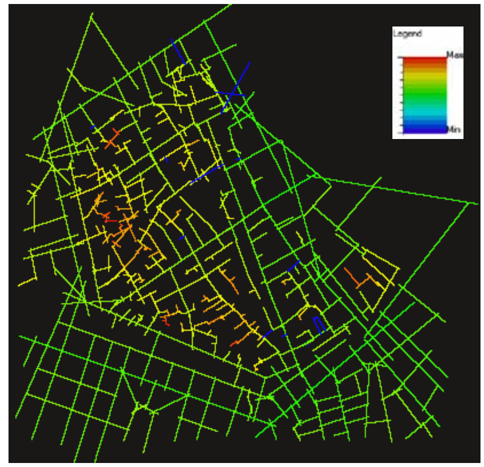


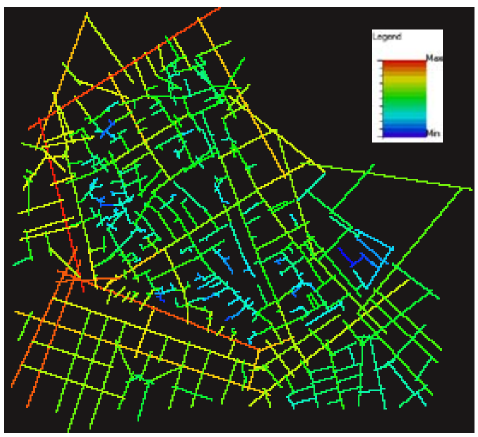
Fig (C.3) *shows syntactic graphs for Tripoli city includes seven syntactic measures*



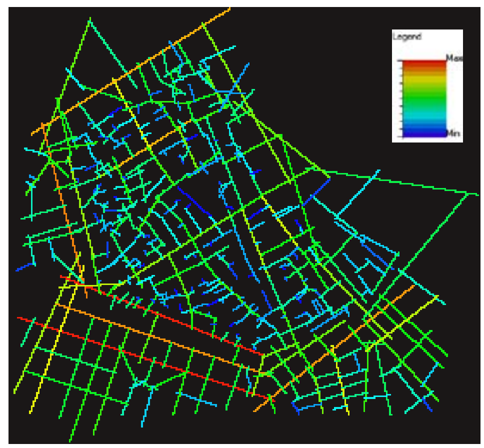
(f) Old Tripoli, Control



(f) Old Tripoli, Max Depth

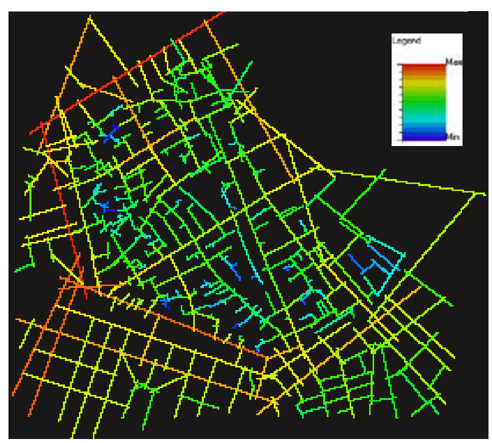


(f) Old Tripoli ,Integration x



(f) Old Tripoli, Local Integration

(f) Old Tripoli, Connectivity



(f) Old Tripoli Integration x (Rx)

Fig(C.4) *Visibility graphs for Tripoli old City show syntactic measures*

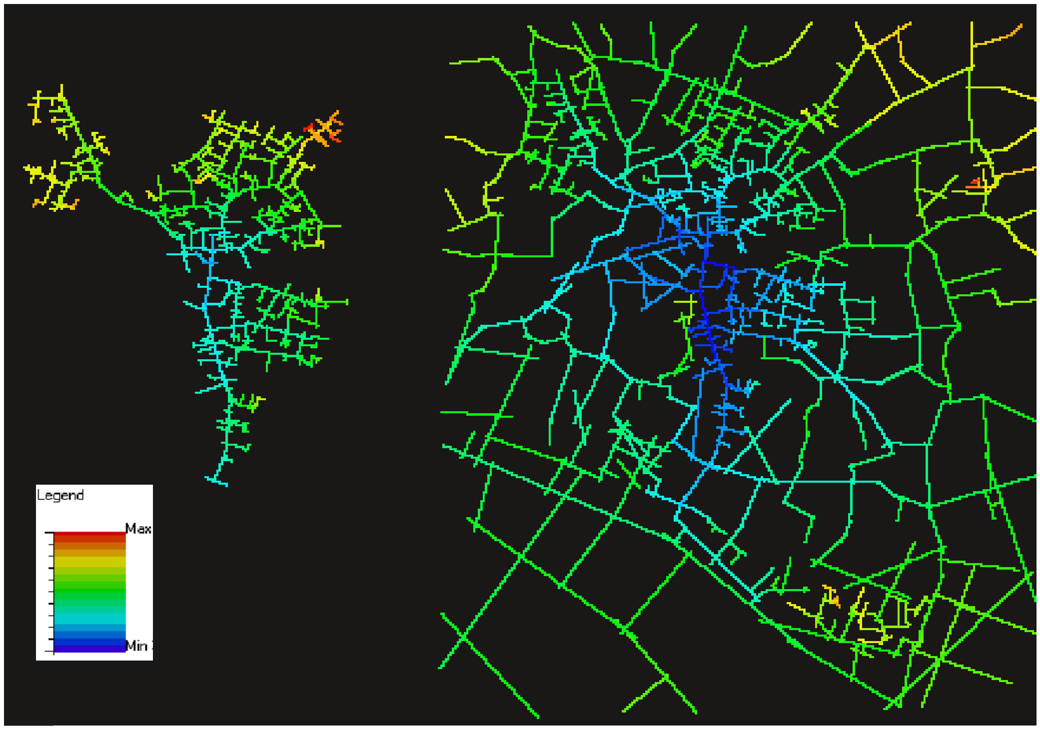
(a) Ghat, Global integration Rn

(a) Ghat, Local integration R3

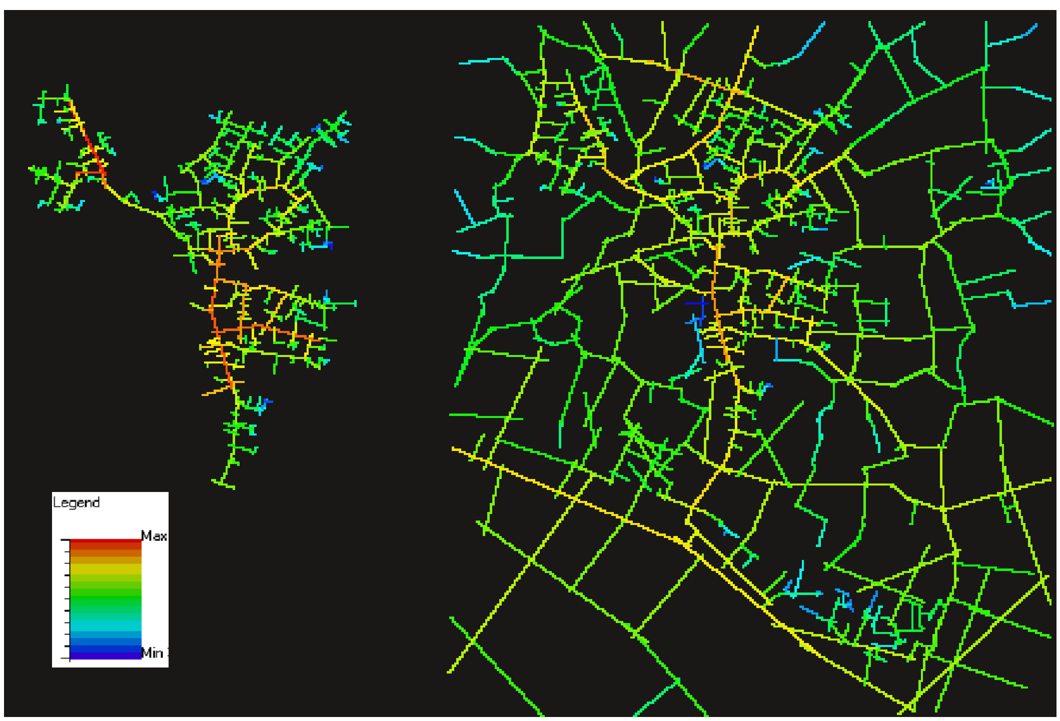
(c) Ghat, Integration x Rx

(d) Ghat, Connectivity Con.

Fig(C.5) *Visibility graphs for Ghat show four syntactic measures*



Fig(C.6) *Ghadames Ground Floor and Upper Floor in embedded model shows* Integration x (Rx)



Fig(C.7) *Ghadames Ground Floor and Upper Floor in embedded model shows Max. depth*

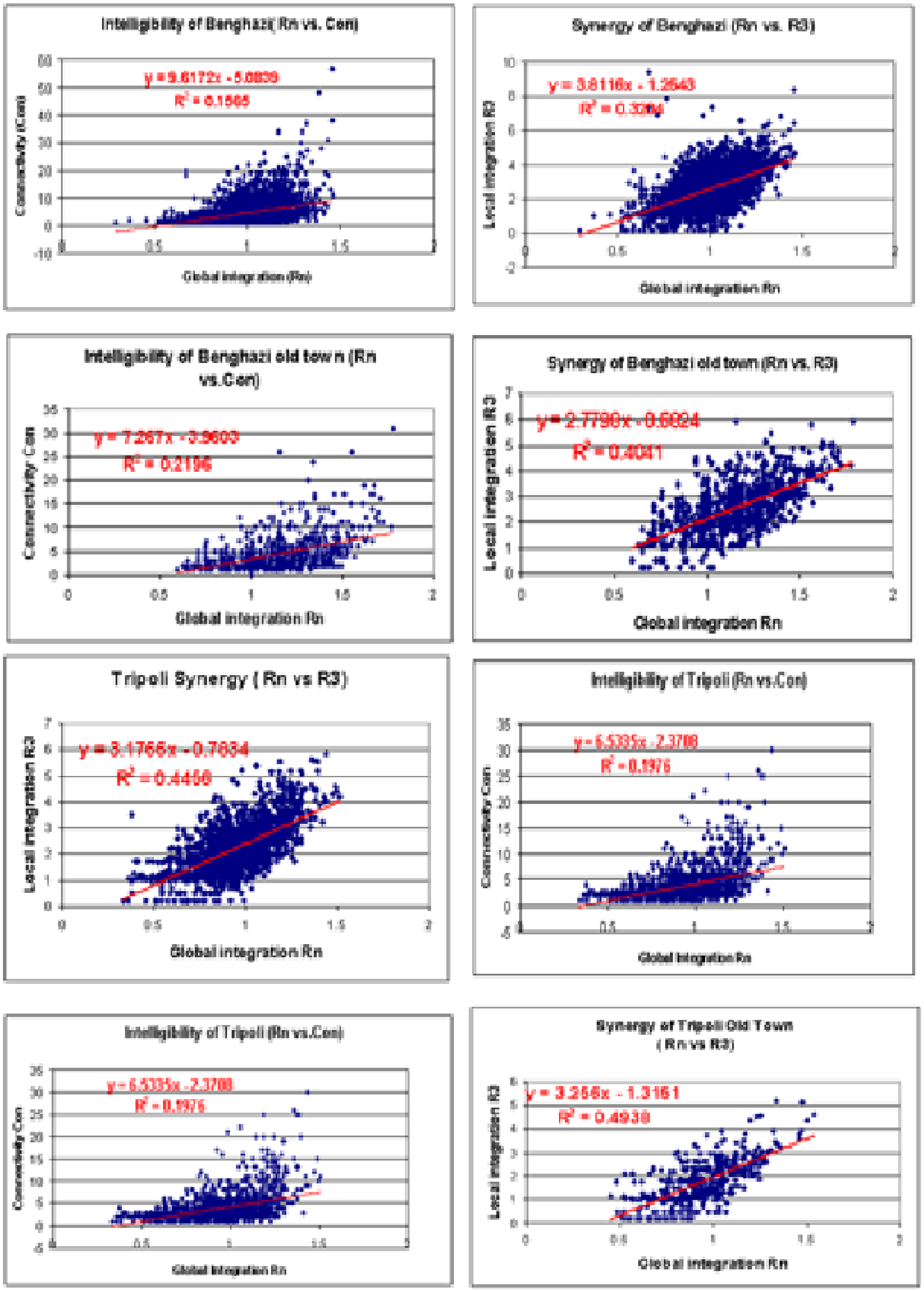


Fig (C.8) Diagrams show intelligibility and synergy for the six Libyan cities

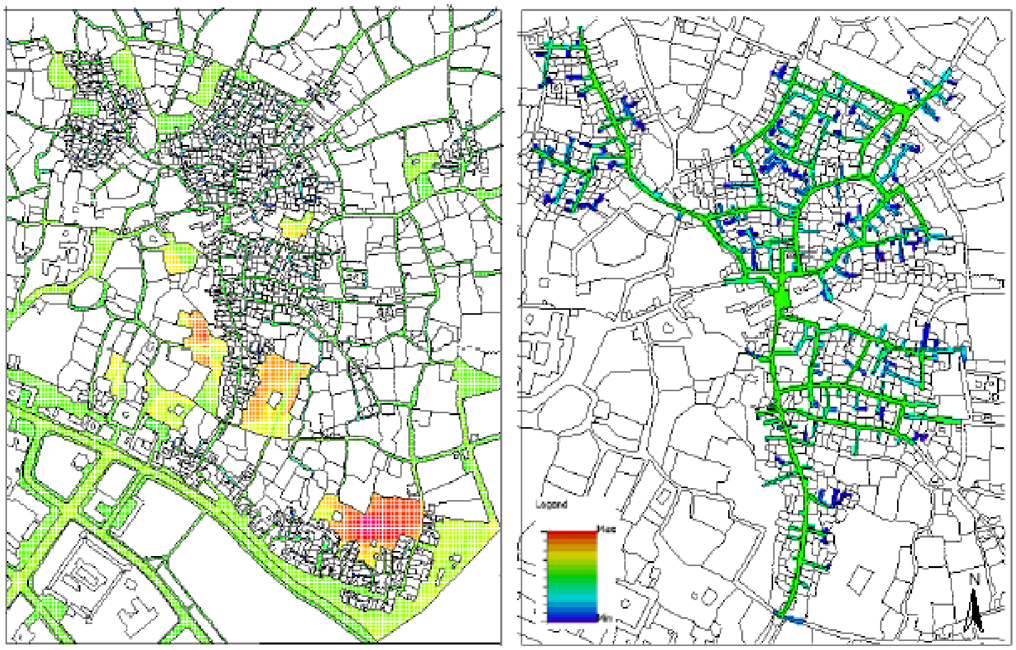
Table(C.2) *show visual and metric measures for the six Libyan cities*

Descriptive Statistics For Benghazi old Town using VGA

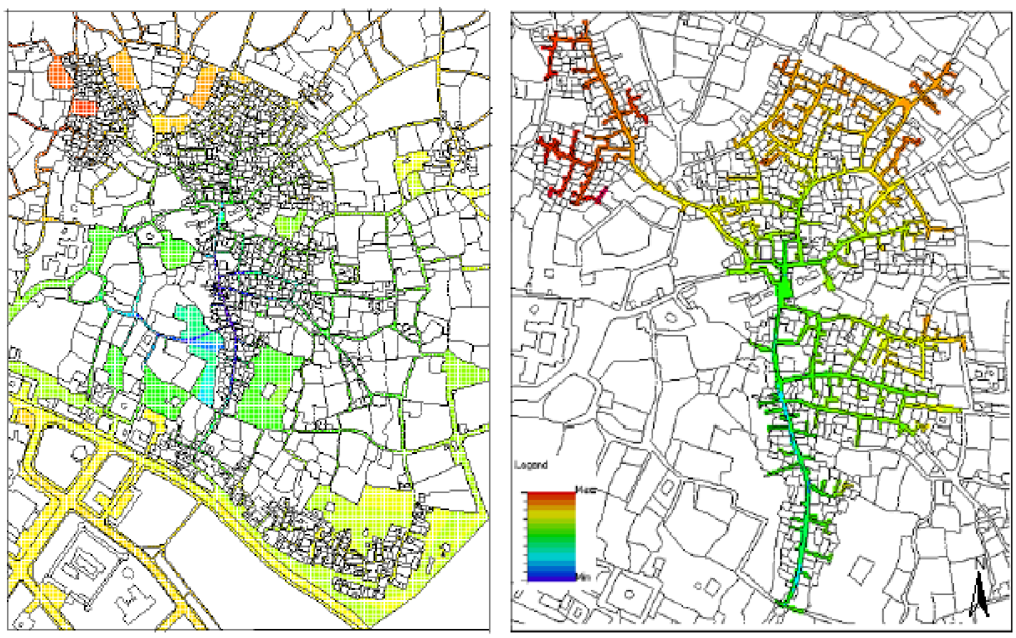
	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity (Degree)	37859	1	1624	285.13	290.042
Isovist Maximum Radial	37859	4.0000	979.8776	245.98898	192.9748143
Isovist Moment of Inertia	37859	256	39897580	18918608	419008653.56
Visual Clustering	37859	-1.0000	1.0000	.780813	.1516803
Visual Control	37859	-1.0000	2.7475	.999683	.3490603
Visual Controllability	37859	-1.0000	.8833	.182063	.1311864
Visual Entropy	37859	2.2390	2.9678	2.641131	.1414028
Visual Entropy r3	37859	.1491	1.5841	.990215	.2334550
Visual Integration (HH)	37859	1.3790	4.6598	3.029229	.5384527
Visual Integration (HH) r3	37859	1.2242	8.8104	5.750974	.9336191
Visual Integration (Tekl)	37859	.4132	.4568	.439867	.0067495
Visual Integration (Tekl) r3	37859	.4211	.5854	.471525	.0077530
Visual Mean Depth	37859	3.7092	10.1546	5.313020	.8454122
Visual Mean Depth r3	37859	1.4957	2.9760	2.663629	.1562103
Visual Node Count	37859	37858	37859	37859.00	.031
Visual Node Count r3	37859	14	19109	5810.49	3564.317
Visual Relativised Entropy	37859	2.3286	4.0464	2.814737	.2324048
Visual Relativised Entropy	37859	1.8253	4.0013	3.015810	.3095458
Valid N (listwise)	37859				

Descriptive Statistics for Tripoli Old Town (VGA)

	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity Degree	36209	1.00	4255.00	698.8793	843.21425
Isovist Maximum Radial	36209	3.00	721.00	202.7690	143.22958
Isovist Moment of Inertia	36209	81.00	31888770	13813359	266919557.18
Visual Clustering	36209	-1.00	1.00	.7602	.15012
Visual Control	36209	-1.00	2.58	.9999	.33032
VisualControllability	36209	-1.00	.96	.2474	.16195
VisualEntropy	36209	2.37	3.26	2.9553	.13939
VisualEntropyr3	36209	.13	1.58	1.1997	.25185
VisualIntegrationHH	36209	1.20	4.11	2.7870	.57160
VisualIntegrationHHr3	36209	1.35	10.83	6.5913	1.57916
VisualIntegrationTekl	36209	.41	.45	.4366	.00805
VisualIntegrationTeklr3	36209	.43	.73	.4780	.01133
VisualMeanDepth	36209	4.05	11.48	5.7425	1.20262
VisualMeanDepthr3	36209	1.50	2.98	2.4874	.22949
VisualNodeCount	36209	36208.00	36209.00	36208.998	.03562
VisualNodeCountr3	36209	7.00	16256.00	6466.8996	4109.97775
VisualRelativisedEntropy	36209	2.30	4.04	2.7888	.32841
VisualRelativisedEntropyr	36209	1.83	4.03	2.7085	.37243
Valid N (listwise)	36209				



Local Integration graph for the whole Ghadames (ground floor and upper floor embedded)

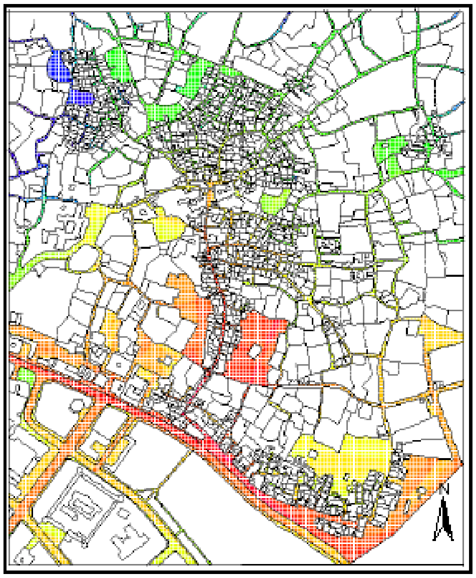


Relativised Entropy graph for the whole Ghadames (ground floor and upper floor embedded)

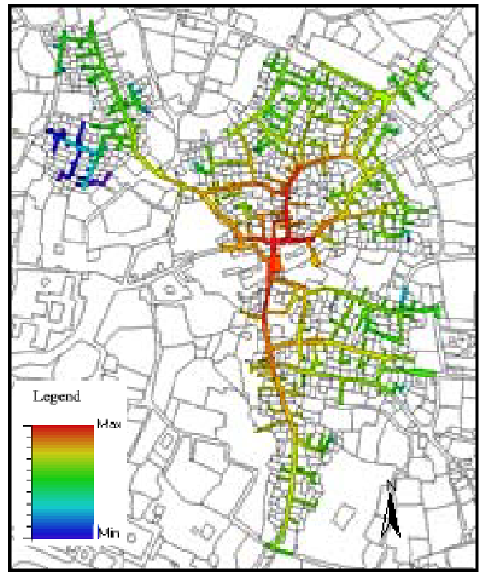
100 0 100 200 300 Meters

100 0 100 200 300 Meters

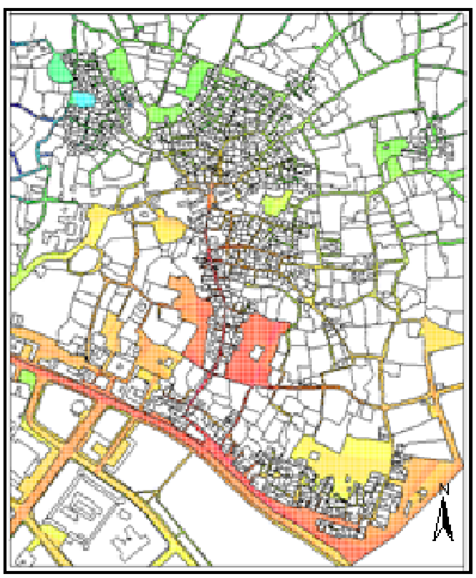
Fig(C.9) *Visibility graphs for Ghadames show two visual measures*



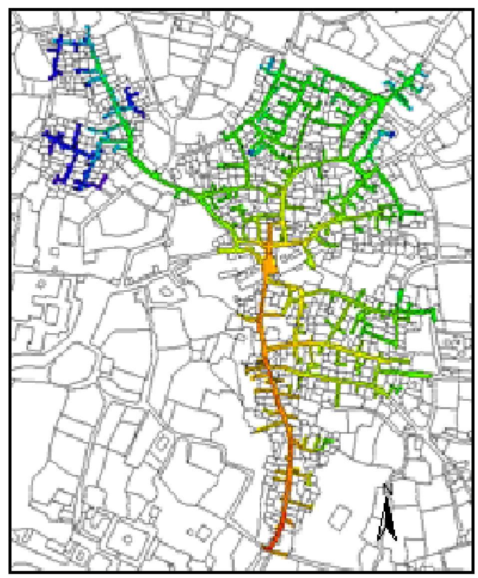
Ground floor "male" shows visual global integration in cut-out model of space.



Upper floor "female" shows visual global integration in cut-out of space.

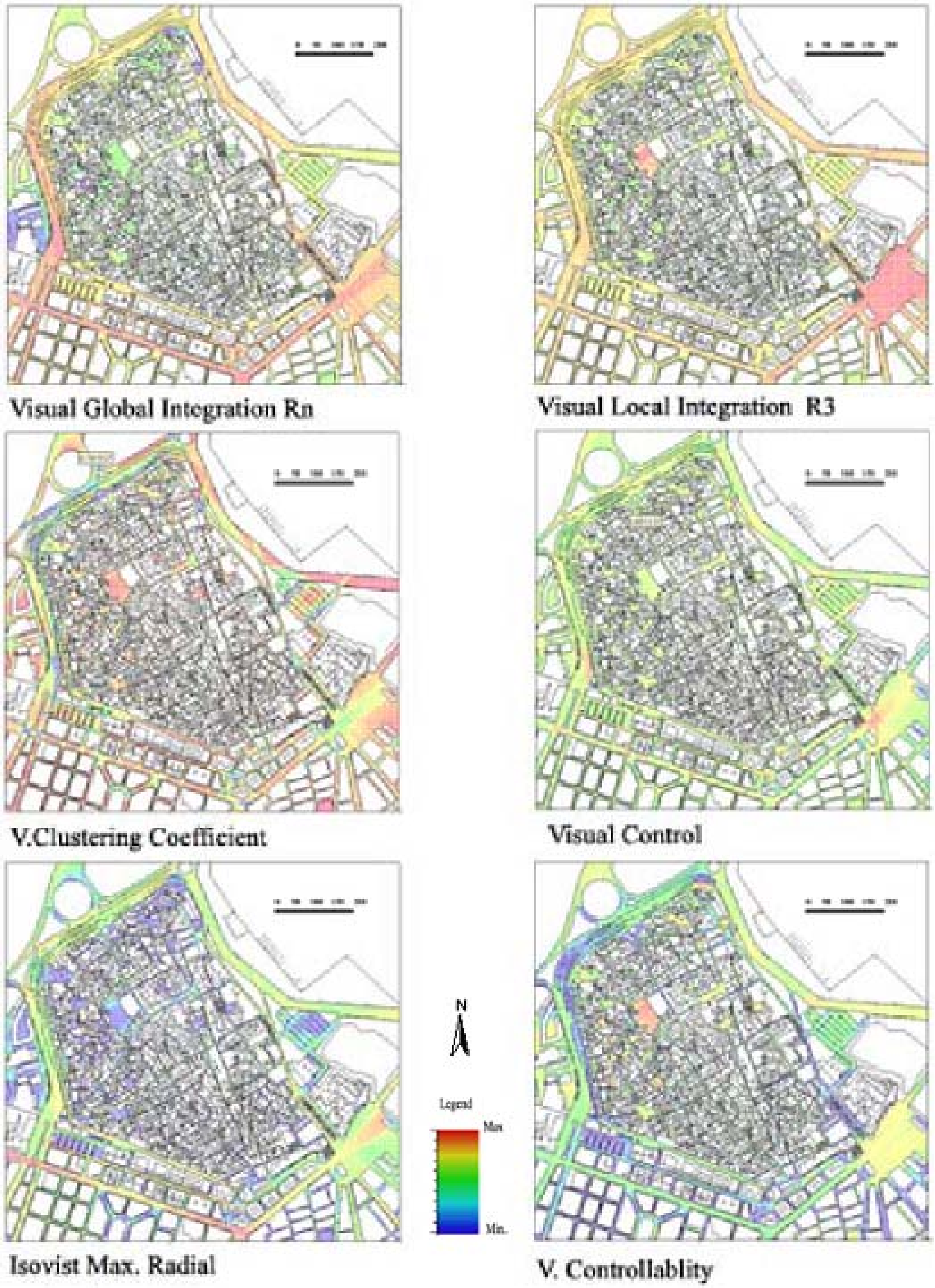


Ground floor "male domain" shows visual global in embedded model of space.



Upper floor "female domain" shows visualglobal integration in embedded model of space.

Fig(C.10) *Visibility graphs for Ghadames show two visual measures in two models of space*



Fig(C.11) *Visibility graphs for Tripoli Old Town show six measures*

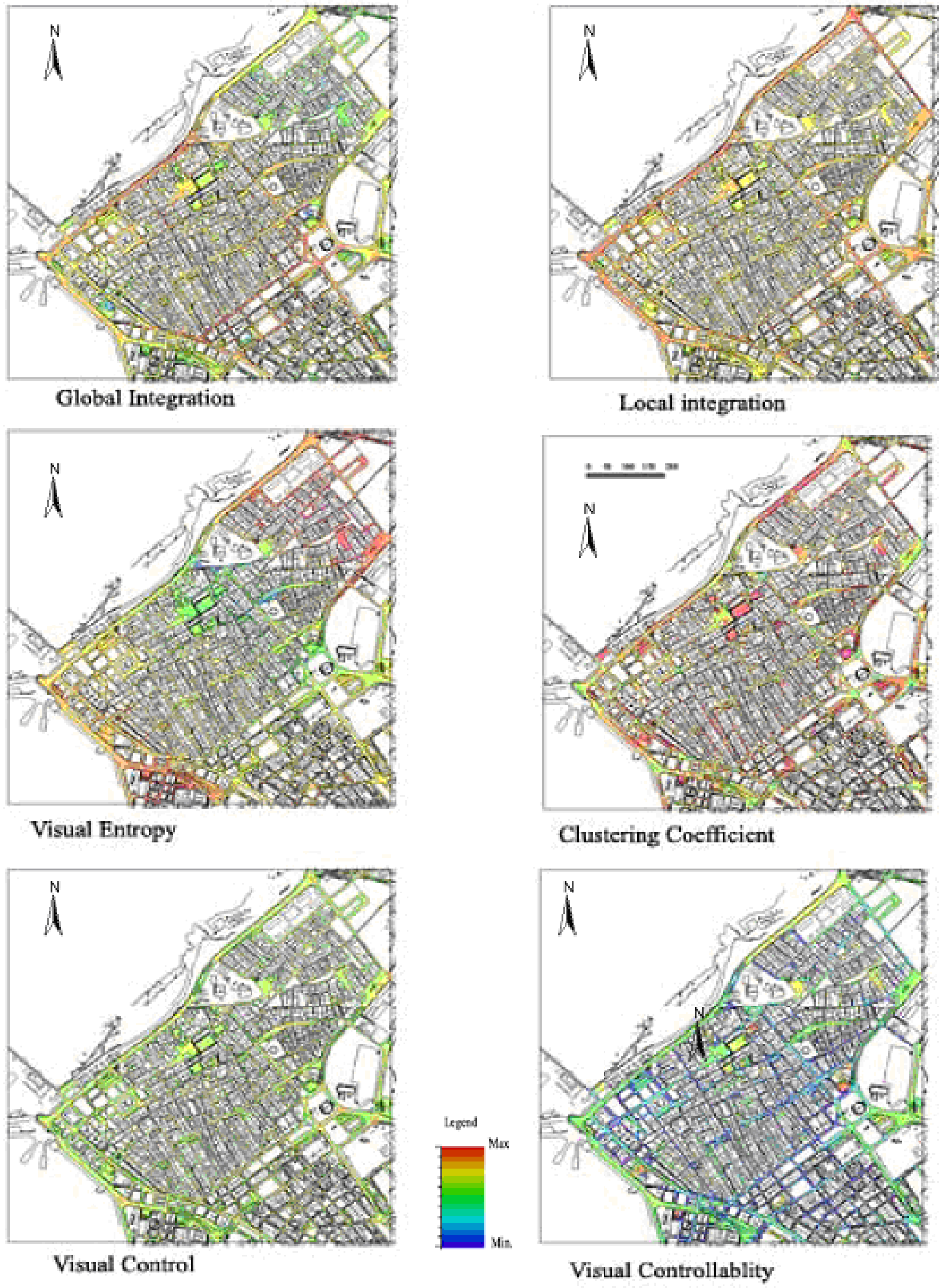


Fig (C.12) *Visibility graphs for Benghazi Old Town shows six measures.*

Fig (C.13) Shows view of the main gate to Ghadames city presented in three dimensions.

Fig(C.14) Shows view of roof foot for female movement within Ghadames city presented in three dimensions.

APPENDIX D : GLOSSARY

Space Syntax is a method for describing and canalizing the relationships between spaces of urban areas and buildings. Architects and urban planners normally refer to this relationship as "layout". In space syntax, the spaces are understood as voids (streets, squares, rooms, fields, etc.) between walls, fences and other impediments or obstructions that restrain (pedestrian) traffic and/or the visual field. The purpose of this glossary is to assist reader's not previous familiar with space syntax, by providing a simple (non-mathematics) explanations of some basic terms.
There are three basic conceptions in space syntax:

Convex space is a space where no line between any two points crosses the perimeter. A concave space has to be divided into the least possible number of convex spaces.

Axial space or an axial line is a straight line ("*sight line*"), possible to follow on foot.

Isovist space is the total area that can be viewed from a point.

The spatial structure of a layout can be represented using three types of syntactic maps:

Convex map depicts the least number of convex spaces that fully cover a layout and the connections between them. The interface map is a special kind of convex map showing the permeable relations between the outdoor convex spaces to adjacent building entrances.

Axial map depicts the least number of axial lines covering all convex spaces of a layout and their connections.

Isovist map depicts the areas that are visible from convex spaces or axial lines.

All three types of maps can be transformed into graphs for purpose of analysis:

Graph is a figure representing the relationships of permeability between all the convex spaces or axial spaces of a layout. The spaces are represented by circles or dots (called nodes) and the links with lines. It is possible to also use links in order to represent relationships of visibility between spaces.

Syntactic step is defined as the direct connection or permeable relation between a space and its immediate neighbours or between overlapping isovists. In an axial map a syntactic step may be understood as the change of direction from one line to another.

Depth between two spaces is defined as the least number of syntactic steps in a graph that are needed to reach one line to another.

Justified graph is a graph restructured so that a specific space is placed at the bottom, "*root space*". All spaces one syntactic step away from root space are put on the first level above, all spaces two spaces away on the second level, etc. Justified graphs offer a visual picture of the overall depth of a layout seen from one of its points. *A tree-like* justified graph has most of the nodes many steps (levels) away from the bottom node. In such a system the mean depth is high and described as deep. *A bush-like* justified graph has most of the nodes near the bottom and the system is described as *shallow*.

There are four syntactic measures that can be calculated. They are used in quantitive representations of building and urban layouts:

Connectivity measures the number of immediate neighbours that are directly connected to a space. This is a static local measure.

Integration is a static global measure. It describes the average depth of a space to all other spaces in the system. The spaces of a system can be ranked from the most integrated to the most integrated to the most segregated.

Control value is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbours taking into account the number of alternative connections that each of these neighbours has.

Global choice is a dynamic global measure of the “flow” through a space. A space has a strong choice value when many of the shortest paths, connecting all spaces to all spaces of a system, passes through it.

It is also possible to develop second order measures by correlating these four first order measures. ***Intelligibility***, for example, is the correlation between connectivity and integration and describes how far the depth of a space from the layout as a whole can be inferred from the number of its direct connections, i.e. what can be understood of the global relation of a space from what can be observed within that space. The spaces of a layout can be ranked according to each of the measures. Mapping the rank order back onto the syntactic map offers a picture of *syntactic structure*.

Core is the set of the most integrating (controlling, etc) spaces of a system. For example, the 10% most integrated spaces are normally referred as the integration core. The configuration of that core, whether it assumes a shape of a spine or a wheel, whether it penetrates into all parts or remains clustered in one area, is an important property of layouts.

The spatial measures can be related to social indicators, to test socio-spatial hypotheses or to develop predictive models the “social effects” of spatial layout. Such indicators can be the rate of crime, traffic flow, satisfaction, turnover, etc. The relation between the “socio-spatial” factors can be calculated using statistics such as linear correlation.

Encounter rate is a measure that indexes the density, i.e. the number of people observed in a space. We use a standardized technique to tally moving and static people on a route consisting of a stratified sample of spaces passed twenty times. The unit of axial analysis can be” number of persons/100metres”.

In traditional grid system patterns the encounter rate of moving people mostly has a high correlation to integration, i.e. integration is here a good predictor of pedestrian flow. On this fact an interesting debate has started, whether it is the spatial structure or if it is the attraction of shops and other functions that creates movement. We claim that shops locate to streets with high encounter rate or they are located where the plan designers can foresee a high rate. *Space precedes function!* An other question raised as whether a spatial pattern “creates” crime or if it just ”attracts” crime. Crime is in fact normally highly correlated to spatial measures.

The meaning of words used in space syntax changes slightly over time and even the scholars most closely associated with the development of space syntax have sometimes their own interpretation.

Space syntax originated by Hillier and Hanson has been a powerful tool to analyze urban forms, as a number of empirical works have already established. A typical approach in space syntax is to construct an axial map for public space based on the city map by drawing a set of axial lines, which represent the minimum number of visible lines that cover all the spaces in question.

Many of axial indices frequently used are derived from looking at the relations of a space with its adjacent spaces either in global or local context. Global indices are given by taking into account all the spaces that are in the area concerned. While local indices are given by limiting the scope to the finite number of “steps” (in axial analysis, this means the number of changes of direction). The actual calculation is done by treating the axial map as a graph representation in such a way that each axial line is presented by a vertex and the intersection point of two axial lines is an edge connecting two vertices.

For the axial lines, the following indices have been computed: connectivity, control, mean depth, integration, maximum depth, local mean depth, local spaces (K), and clustering coefficient (G1, G2).

(1) ***Connectivity*** is the number of immediate neighbours of the axial line. This is the equivalent of what is called the degree of vertex in graph theory.

(2) ***Control*** can be thought of as a measure of relative strength of the axial line in "pulling" the potential form its immediate neighbours. When an axial line 1x has n neighbours and connectivity of each neighbour, 1i (i=1,2,3,…,n)is represented by C(1i), the control value of the axial line 1x is given by:

$$\text{Control} = \sum_{i=1}^{n} \frac{1}{C(li)}$$

(3) ***Mean depth*** (designated as MD) is the mean distance of all the axial lines from an axial line. Integration is derived from mean depth, and it was invented in an attempt to compare values between systems with different numbers of axial lines. Suppose that an axial line has mean depth MD in a system with k lines. The mean depth can be transformed so that it takes a value between 0 and 1 as:

$$\text{RA}= \frac{2(MD-1)}{k-2}$$

This value (RA) is then relativised by dividing by the RA of the "diamond shaped" graph with the same number of vertices (axial lines) in which the vertices are ordered so that there are m (>1) vertices whose distance minus 1, and so on (figure). Integration is a reciprocal of this value, which is given by the formula:

$$\text{Integration} = \frac{D_k}{RA}$$

Where

$$D_K = \frac{2\left(K\left(\log_2\left(\frac{k+2}{3}\right)-1\right)+1\right)}{(k-1)(k+1)}$$

Discussions on this method of relativization can be found in Hillier and Hanson (1984), and Kruger (1989).

(4) ***Maximum depth*** (designated as Max D) is the maximum distance of the axial line found in the system.

(5) ***Local mean depth*** (designated as M Di) is the mean distance of axial lines within the number of radius (in this paper, i=3, 4,…., 10) from the root space, and local spaces (designated as Ki) is the number of axial lines included in such a local system within radius 2 includes the root space and the axial lines that are adjacent to the root space.

(6) ***Clustering coefficient*** (designated as Gi, with i=1, 2) is based on the definition by Watts and Strogatz (1998), and it measures the "cliquishness" (Watts, 1999) of the neighbourhood of the root space. It takes the ratio of the actual number of

(7) ***Connections*** (edges) to the number of connections of the complete graph with the same number of axial lines (vertices). G1 includes the local system of radius 2, i.e. the root space plus the entire axial lines one or two steps away from the root space (Turner, et al., 2001).

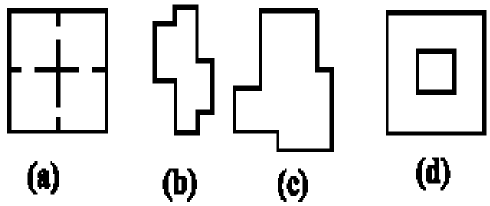


Fig (d1) *Four hypothetical plans*

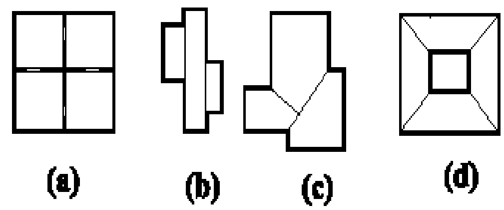


Fig (d2*) Modified minimum partitions of hypothetical plans*

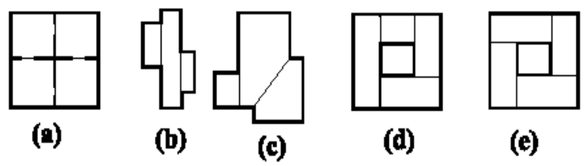


Fig (d3*) Minimum partitions of hypothetical plans*

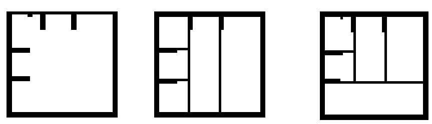


Fig (d4) *Alternative minimum of a hypothetical plan*

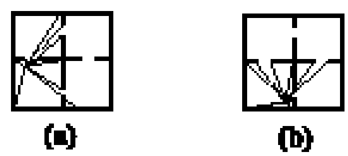


Fig (d6) *Changing relationships of a moving subject to the available to an s-space.*

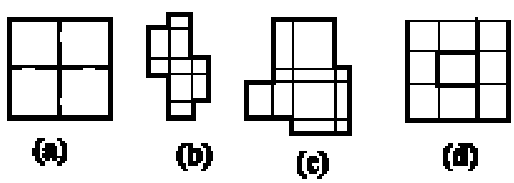


Fig (d5) *S-partitions of four hypothetical*

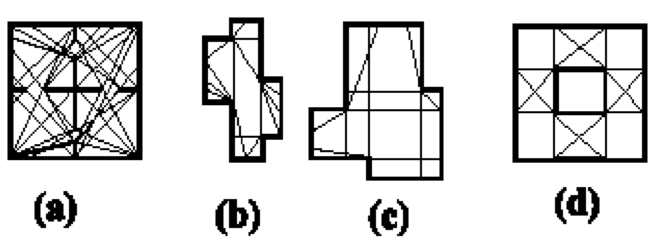


Fig (d6.) *e-partition of four hypothetical plans*

VITA

Mr. Farag A. El-Agouri was born in Benghazi, Libya on May 1964. He received his B.Sc. degree in Architecture and Urban Planning with honors from Garyounis University in Feb. 1989. He worked in Urban Design and City Planning as a planner from 1989 to 1994 in El-Emara Engineering Consultant Ltd. (public Firm). His work covers planning and designing many projects including 608 Housing Units Project in Sirit, Military Hospital Neighbourhood Project in Benghazi, Contribution in preparing master plans for 45 villages in Al Akatar Mountain and other individual small projects.

He joined graduate program in the same department in 1990 and received his M.Sc. degree in City Planning in April 1994. Since then he has been a lecturer in his department. He published four articles: "Spatial analysis of Retail activity in Benghazi, proceeding of Urban Planning Conference Feb.1994.;"Application of Urban Models in Landuse Planning", EL Handasi Journal. June, V3, 1996. "Strategies for Benghazi TSM" Problem of Urban Extensions, international Conference, Demascas, 1995." Optimization of Road Network in Benghazi", Indian Highways Journal, V1 7, 1996.

He received a scholarship from his University to study for Ph.D. at METU in Turkey. His main areas of interest are graph theory, Space Syntax and Isovist analysis.