Factorial Ecology: Methodological Refinements Using 1960 Omaha Data

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FACTORIAL ECOLOGY: METHODOLOGICAL REFINEMENTS USING 1960 OMAHA DATA

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This thesis is dedicated to Juanita--
my devoted wife, and to our parents.
Their continued support made it all
possible.

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CHAPTER I

THE DEVELOPMENT OF AN ECOLOGICAL PERSPECTIVE

A General Orientation

American sociologists have had an abiding interest in the causes and consequences of urban phenomena. After all, the emergent American metropolis has a certain lure to it, which is no doubt engendered by its marked cultural and social heterogeneity, and fluid spatial and social mobility. Then too, urban problems are highly visible problems; declining and dilapidated areas, poverty "pockets", crime, etc. all command attention from diverse agencies and segments of the public.

Hauser (1964:13-33) concluded:

> . . . clearly the remediation of urban problems requires, first, an understanding of their origin, magnitude, and characteristics . . . (and) the study of sub-areas of urbanized areas or of an SMSA is often of direct interest in a given area, e.g. the study of communities[1] of a

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[1]Underlining by the present author.

specified size ranges with a given SMSA.[2]

Social scientists recognize today that spatial aspects of urbanized areas are important in any study concerned with generalizing to the populations of those areas. Hallenbeck (1951:168) proposed that:

> . . . it is necessary to make some more or less permanent arrangements for relating new data and information to the system of primary areal analytical units.

The traditional mode of investigation of urban systems has been to analyze specific aspects of their ecological organization. This is illustrated by Burgess and Bogue (1964:15), who agreed that:

> . . . the starting point for urban analysis traditionally has been with demographic and ecological study . . . (because) once the demographic and ecological facts are known, and the forces which account for existing patterns and present trends are spelled out, they provide a context with which the social and cultural life, the intergroup alliances, bonds and tensions, and the patterns of attitudes and values can be assessed and understood.

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[2]SMSA is a useful abbreviation for "Standard Metropolitan Statistical Area", a statistical concept adapted by the Bureau of the Census in 1960 for the purpose of ordering the large masses of census data into units larger than a metropolis. Prior to 1960 a designation--SMA, Standard Metropolitan Area, had been used, and was considered by some (Gottman, 1961) to be more functional for accurate descriptions of metropolitan areas.

In addition, the significance of ecological organization as a sphere of sociological research was emphasized by Hallenbeck (1951:145):

> Ecological studies view the patterns of spatial distribution of populations, economic activities and social institutions in the urban area as an important facet of ecological organization in and of itself; and moreover, patterns of spatial distribution in an urban area are seen as indicators of social and economic organization and relationships obtaining in the area.

From the brief foregoing comments it is obvious that an ecological perspective will hold within its conceptual framework valuable insights for urban analysis. But it will be shown in the next chapter that it is the methodological elements of the ecological perspective which have dominated the concern of social scientists from the beginning to the present.[3] Thus while the guiding perspective here will continue to be ecological, the specific task set forth for examination, following the dominance of methodology in ecological thought, must also be methodological.

Nor can one study examine all ramifications of ecological methodology within its confines. The task will be

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[3]Hawley (1950:4) asserts that ecology is distinguished not so much for its focus of attention as its method of approach.

limited to (1) an investigation of the relevance ecological methodology has in determining basic operant dimensions of urban residential patterns and (2) the power these dimensions display in providing an objective means of classifying intra-urban residential patterns into homogeneous sub-areas. Thus, the ultimate goal here is the synthesization of the myriad of data-attributes available by intraurban subunits into understandable patterns, and providing a useful classification of these subunits into manageable aggregates on the basis of the urban patterns.

Before this can be adequately accomplished, an examination of the development of human ecology, and ecological methodology is in order.

Historical Precedents of Ecological Investigation

Pre-classical Roots of Human Ecology

The common roots of ecological organization as a sociological concern extend profoundly into the past. As Schnore (1961) remarked, human ecologists can be regarded as "macrosociologists" because both their dependent and independent variables are aggregate characteristics.

Ecological organization encompasses social phenomena recognized as primary and central considerations by two early sociologists: Karl Marx and Emile Durkheim.

Gibbs (1970:III;16-18) analyzed Marx's contribution by observing that in the Marxian framework:

> . . . the <u>means of production</u> determines "economic relations" which in turn determine all other social and cultural characteristics of the society . . . economic relations encompass the allocation of goods and services . . . each individual stands in some relation to surplus production . . . the means of production refer to all factors that enter into the process by which goods and services are produced and distributed, including sustenance activities . . . Marx never tired of referring to the social character of production. His related observations suggest that, in addition to technology and physiographic features, the means of production includes the division of labor, and the role of socially organized groups in the productive process, both of which are components of ecological organization.

An ecological perspective is clear-cut in Durkheim's (1964) <u>The Division of Labor in Society</u>, which may be regarded as a classical work in human ecology.[4] Durkheim (1964) related high and low "material and moral density" to a high and low <u>degree of the division of labor</u> as a major

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[4]Theodorsen (1961) ignored both Durkheim and Marx in his survey of human ecology.

characteristic of sustenance activities.[5] Durkheim (1964) predicted a shift from "segmented societies" exhibiting a condition of <u>likeness</u> and <u>consensus</u> to an urban condition of <u>functional interdependence</u>.

Psuedo-Ecological Studies of the 19th Century

Several other less important researchers could be labeled "psuedo-ecologists" because of their general concern for the spatial distribution of social attributes.[6] In general these researchers lacked any coherent conceptual framework. They pursued a unidimensional explanation of what data were available at that time. But regretably, it was this tradition of unidimensional "causation" which persisted and was partially adapted by classical ecologists.[7]

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[5] It will be demonstrated later on that modern human ecologists consider the degree of the division of labor and sustenance activities as fundamental elements of ecological organization.

[6] In contemporary times, the mere investigation of attribute differentials over areal units has become a dominant concern in the discipline of geography more so than any of the other social sciences. What distinguishes Marx and Durkheim in this context are the compelling thoughts of their theoretical arguments.

[7] Cartwright (1969), as well as Levin and Lindesmith (1937) outlined these early studies in detail.

Included are M. de Guerry de Champneuf, a French ministry official, who studied the causes of crime in an areal context; Joseph Fletcher, publishing in 1850 a Summary of Moral Statistics of England and Wales used the term "natural area" for the first time; and Charles Booth, a student of social disorganization, who conducted statistical research of London districts and anticipated Burgess's Concentric Zone Theory--perhaps even influenced Burgess's later formulation of it.

The Classical School of Urban Ecology

The "Chicago" school defined and dominated further developments in human ecology. Theodorsen (1961) claimed their development was generated from three logical sources: animal and plant ecology, geography, and the early studies of the spatial distribution of social phenomena touched upon above.

The naturalistic emphasis of the school is well documented and quite evident in the many writings of classical human ecology.[8]

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[8] See Park (1936); McKenzie (1926); Park, Burgess and McKenzie (1925); Zorbaugh (1926); Reckless (1926); Wirth (1945).

Theodorsen (1961) ignored the reciprocal nature of this influence, which resulted in plant and animal ecologists borrowing terms and concepts from sociology. And Hawley (1956:6) reaffirms the distinct nature of human ecology.[9] Theodorsen (1961:3) asserted that the work of Park and Burgess in 1921". . . represented an attempt to systematically apply the basic theoretical scheme of plant and animal ecology to the study of human communities," and continued by asserting that the influence of the plant and animal ecologist Haeckel and the ideology of Darwinian "environmental adaptation" was pronounced. While it is recognized that this naturalistic impact was not an isolated occurrence, but followed a more general scientific trend of the time,[10] it is not wholly accurate.

A Normative Example of Classical Thought

It soon became obvious that a naturalistic approach by itself was only partially fruitful. Park's (1936) writings

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[9]We may note a concentrated interaction between the natural and social sciences. Note for instance Darwin (1919: 68). See Hinkle and Hinkle (1954) for a more detailed analysis of this trend in sociology.

[10]They are given credit for coining the term "human ecology."

represent more than any, the normative example of the naturalistic influence, but nevertheless he recognized its shortcomings. His writings and those that follow him were definitive for the period: various populations and interest groups compete in an urban setting, with one or another group achieving dominance within natural or functional areas of the urban community, with subsequent invasions and dominance successions. Park specified two types of competition: biotic or relatively unrestricted competition, and social competition, which is restricted by "societal institutions."

Park (1936:13) highlighted these distinctions as follows:

> The fact seems to be, then, that human society, as distinguished from plant and animal society, is organized on two levels, the biotic and the cultural. There is a symbiotic society based on competition and a cultural society based on communication and consensus.

Idealized Models of the City[11]

Another profound influence on the classical period

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[11] Figure 1 on page 10 depicts these models in an idealized fashion. For a succinct exposition on idealizations, see Lopreato and Alsten (1969).

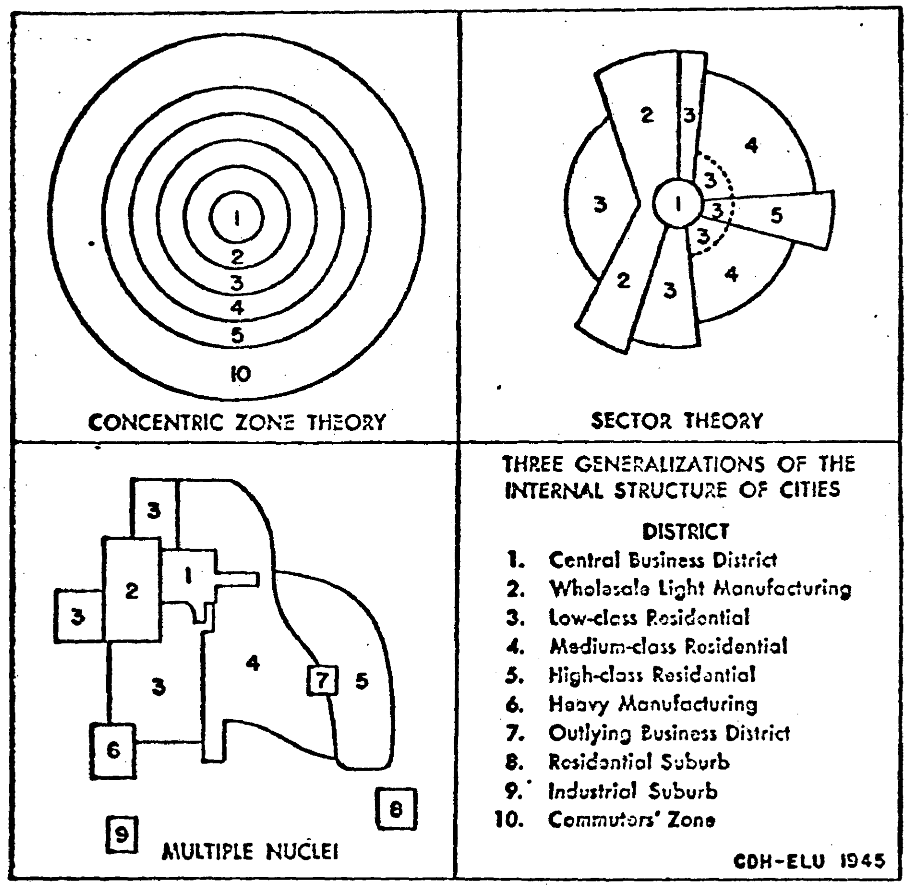

FIGURE I. IDEALIZED MODELS OF CITY*

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*Taken from Ullman and Harris (1945).

of human ecology was that of classical economics.[12] This influence can be seen in the formulation of the generalized ecological models of the city, which represented the most visible and perhaps the most significant accomplishment of that period.[13]

The first such model, postulated by Burgess (1925) was a direct, logical extension of the ecological perspectives of that time. The ecological process gained energy from increasing city growth. And as the economic strength of the older populations improved, these older populations migrated toward the periphery of the city, to be replaced at the core by new arrivals. This process resulted in concentric zones of successively increasing socioeconomic status.[14]

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[12]A specific example of the influence of economic thought on human ecology may be found in the use of natural areas by Gras's Introduction to Economic History, which was readily adapted by Zorbaugh (1929).

[13]Murdie (1969) points out that concentric models of land use are not new: "Early concepts were formulated by Plato, Aristotle, Marco Polo, von Thunen and Hurd."

[14]Summaries similar to this are becoming quite frequent, due no doubt in part from the current revival of some aspects of the Burgess and Hoyt theories. See for instance Berry and Rees (1969) and Rees (1968). It should be understood that

A concern for mobility and individual behavior typified this conceptual framework.[15] For instance, Burgess (1925:53) concluded

> Where mobility is the greatest, and where in consequence primary controls break down completely, as in the zone of deterioration in the modern city, there develop areas of demoralization, of promiscuity, and of vice.

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these models were intended to apply to twentieth century industrial cities, and no attempt was made to generalize to pre-industrial or non-western cities. These models have been contrasted with the pre-industrial city by several researchers (Sjoberg, 1960; Fava, 1966; Berry and Ries, 1969). Perhaps the definitive statement of contrast between pre-industrial and industrial cities was made by Sjoberg (1960:95-103) as follows:

> The feudal city's land use configuration is in many ways <u>the reverse</u> of that in the highly industrialized communities. The latter's advanced technology fosters, and is in turn furthered by, a high degree of social and spatial mobility that is inimical to any rigid social structure assigning persons, socially and ecologically, to special niches. . . . (There are) three patterns of land use wherein the pre-industrial city contrasts sharply with the industrial type: 1) the pre-eminence of the "central" area over the periphery, especially as portrayed in the distribution of social classes, 2) certain finer spatial differences according to ethnic, occupations, and family ties, and 3) the low incidence of functional differentiation in other land use patterns.

[15]Burgess stands as an early example of thought in what Warren (1971) has labeled "paradigm II." Perhaps had urban ecologists developed retorts to the apparent refutations of their critics, urban intervention programs would be more effective.

Other views were also presented. For instance, Louis Wirth in his oft quoted essay "Urbanism as a Way of Life" suggested that social disorganization could best be accounted for through the size, density, and heterogeneity of an urban area.

A second early model--that of generalized residential land-use patterns--was advanced by Hoyt (1933, 1939). This model proposed, after an examination of rent-value patterns in many major American cities, that the internal distribution of the city is sectoral in nature, not concentric as proposed earlier by Burgess. Hoyt (1939:118-119) asserted that residential subareas became distributed solely on the basis of who could afford to pay the most for the most amenities. These high-income segments of the city pre-empted land along "the best existing transportation lines," "high ground--free from the risk of floods," and "land along lake, bay, river, and ocean fronts where such water fronts are not used for industry."

The last "model"--proposed by Ullman and Harris (1945), was more of a negation of city patterns and models rather than a new model *per se*. It can best be considered as more accurately portraying part of the stream of general criticism of human ecology rather than part of human ecology.

Criticism of the Classical School

Classical ecology, as exemplified by Park, Burgess, Wirth, and others, came under a severe and broad-ranging attack in the late 30's and early 40's as far as their key concepts, basic assumptions, "theoretical constructs" and methods were concerned. This attack appears to have begun with Davie (1938) who observed that Burgess's "concentric zone theory" did not fit empirical data; was continued by Alihan's (1938) criticism of Park's biotic/cultural distinctions; Gettys' (1940) label of Classical Ecology as "biological determinism"; Hatt's (1946) counter-evidence that the concept of "natural area" did not fit empirical data; Hollingshead's (1947) assertion that the factor of culture was not properly taken into account; and culminated with Robinson (1950), whose bitter essay concerning the "ecological fallacy"[16] seemed to refute the most powerful propositions of classical ecology.

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[16] Treating aggregate and individual correlations on the same level. It is more correctly called the aggregation fallacy which has an equivalent individualistic fallacy (See Berry (1971). The interaction of levels (see Slatin, 1969) appeared to have been overlooked by Robinson.

In addition, Walter Firey (1945, 1947) questioned in detail a basic issue of classical human ecology: that the ecological processes (as specified by Park) e.g. competition, dominance, invasion, succession, etc., were not influenced by values and sentiments. This criticism culminated in Firey's famous "Beacon Hill" study, which depicted a residential neighborhood successfully resisting encroaching commerical activities--clearly against all classical ecological principles. Firéy (1947) asserted that specific spaces may inculcate "cultural values" and thus increase the "frictional" impediment to "ideal" ecological utility.[17] It is this basic question of the role of culture, indicated by values and sentiments, in ecological structures and processes that has caused a noted change in the direction ecological thought and investigations have taken.

Mid-Century Trends in Ecological Thought

The Controversy Over Culture

The main theoretical readjustment human ecologists made following the years of criticism was deciding to include

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[17]This conceptualization is not at odds with the idea of economic forces dealt with in human ecology as much as it attempts to "soften" the deterministic analytical mode of classical ecological thought.

or not, some aspect of culture in their own conceptual framework. (Theodorsen, 1961; Robson, 1969)

Theodorsen (1961:129) made a distinction in examining their work which was not entirely justified:

> Ecologists, however, are not agreed on the extent to which culture should be the primary explanatory concept in ecological theory. Those who place primary emphasis on culture have been referred to as "socio-cultural" ecologists. Another current ecological approach may be referred to as "neo-orthodox". Closer to traditional ecology, it rejects culture or values as a <u>primary explanatory concept</u>[18] in ecological theory . . .

This distinction is artificial. The real problem does not reside with deciding whether or not culture (or related ideas) have primary emphasis as explanatory <u>concepts</u>, but in choosing the appropriate subject matter for human ecology. Part of the problem exists because "culture" is not really a <u>concept</u> at all, simply because it has no direct empirical referents. It is constructual in nature and may be defined and used to suit the fancy of the theorist.[19]

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[18] Emphasis is given by the present author.

[19] A construct is defined as an abstract idea which cannot be empirically tested to determine its efficacy. A concept is defined as an abstract idea which can be empirically tested. The division of labor is a construct, while occupational differentiation is a concept.

In a way, making "culture" a part of ecological investigations, if it includes "values, sentiments, and attitudes" as it surely would, leads an ecological investigator into a conceptual and empirical trap. He must decide between individual and aggregate levels of analysis. If he chooses the individual level, he denies by forfeit the rich theory of ecological processes themselves, becomes immersed in a plethora of detail more suitable for social-psychological studies, and trades the empty lot of probabilism for a rich and fruitful determinism.

If he chooses the aggregate level, on the other hand, then the investigator must proceed to make sense out of such terms as "social conscience," "class-consciousness," and the like.[20] He will fall into a habit of seeing the homogeneity rather than the diversity of social phenomena. Only by rejecting "culture" as an improper investigative and unfruitful theoretical concern may ecological studies properly proceed to an analysis of overt acts at either the level of individual

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[20]And if, through astute semantic ledgerdomain, he succeeds here, he is then faced with empirical problems of operationalization, validity, and measurement reliability.

or aggregate, but necessarily including as well the interaction between levels.

The lack of empirical grounding for the construct "culture" was recognized by Duncan (1959:682) who commented:

> The functional and analytical approach of human ecology involves a concern not with culture as an undifferentiated totality but with aspects of culture as they play into the process of adaptation.

Ecological organization may not be concerned with areas outside of a specified realm and be viable. Its subject matter must be "bounded". By taking this stance, and by properly excluding considerations of culture, per se, ecologists are not negating its importance or possible effect on ecological organization, but are saying "We must draw the line somewhere with regard to what we are going to study, and this is it."[21]

A definite pattern may be noted in the relationship between a deterministic ecological theory and the rejection or acceptance of culture as a primary explanatory variable. As shown in Figure 2, it is obvious there is a general congruence

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[21] Speaking in terms of the general linear hypothesis, we may note that using culture in an explanation would possibly be a fruitful posture to take with regard to the residual effects.

THEORETICAL POSITION OF DETERMINISM

THEORETICAL POSITION OF "CULTURE"	MORE DETERMINISTIC	LESS DETERMINISTIC
CULTURE IS REJECTED AS PRIMARY EXPLANATION	MARX; DURKHEIM PARK (1936) BURGESS (1925) HOYT (1933) QUINN (1938) HAWLEY (1950) DUNCAN & SCHNORE (1959) GIBBS (1970)	
CULTURE IS CONSIDERED A PRIMARY EXPLANATION		ALIHAN HOLLINGSHEAD (1947) FIREY (1945)

FIGURE 2. THE RELATIONSHIP BETWEEN DETERMINISM AND CULTURE IN HUMAN ECOLOGICAL THEORY.

between more deterministic theory and rejection of culture (and vice versa). In a sense, if one were to consider culture as a primary explanation of ecological data, and wish to deal in terms of a more deterministic theory, a paradox, not easily rationalized away, is set in motion.

Gibbs (1959:29) reaffirmed this position and called for a proper separation of human ecology from social-psychological considerations:[22]

> Although each year demonstrates anew that this phenomenon remains too vital to be banished entirely from sociology, human ecologists have come to practice Uncle Tom postures in the presence of colleagues endowed with the current psychological orientation, and to spend their research hours assaying their data hopefully for values, sentiments, motivations, and other elusive psychological elements.

In any case, given a precise conceptual delimitation of ecological organization, to this point notably absent in the literature, the argument over culture as explanation is purely academic.

Ecological Theorists of the "Reactive" Period

The only new theoretical statements to come out of the "reactive" period immediately preceding the period of

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[22]It may be that by including "social-psychological" factors within ecology, the "ecological fallacy" is encouraged.

criticism of classical ecology came from James A. Quinn, Amos H. Hawley, Otis Dudley Duncan and Leo F. Schnore.

Quinn continued the distinction between two levels, the social and sub-social. The subsocial level involved the utilization of limited resources or limited space and is viewed as the "proper" focus of human ecology. The implicit assumption of rational economic behavior is evident in his writings. For as Quinn (1939) remarked: "in the process of subsocial interaction, units become spatially distributed, in accordance with the principle of minimum cost."

Hawley (1944, 1950) promptly rejected this distinction of Quinn's between social and subsocial levels. He gave increased attention to the role of "values and sentiments" in relation to ecological organization before rejecting this argument and simultaneously reaffirming and extending the classical preoccupations with plant and animal ecology.[23]

Hawley (1950:179) unequivocally remarked that:

> Human ecology studies the structure of organized activity without respect to the motivations or attitudes of the acting agents. Its aim is to develop a description

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[23]Hawley affirmed the dominant American sociological ideological stance of "equilibrium" or "maintenance of the status quo. See for instance Hawley (1950:15).

> of the morphology or form of collective life under varying external conditions. With its problem stated in that manner the irrelevance of the psychological properties of individuals is self-evident.
>
> And again: (1950:180) attitudes, sentiments, motivations, and the like are omitted from consideration not because they are unimportant, but because the assumptions and point of view of human ecology are not adapted to their treatment.

In Hawley's (1950) main discussion of ecological organization, subtitled "A Theory of Community Structure", he outlines its three primary aspects: (1) differentiation, (2) community structure, and (3) spatial structure. Hawley's orientation emphasizes functional organization rather than mere spatial patterning.[24]

Hawley delimited the field of human ecology as (1) the study of the form and functioning of the community, and (2) community structure. This ambiguous delimitation[25] of the field and narrow choice of proper ecological units was seriously questioned by Gibbs (1970:I;31):

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[24] Certain parallels between aspects of Hawley's dichotomous typology of communities into "dependent" and "independent" and Durkheim's categoreis of social solidarity--mechanical and organic--may be drawn, but this area of Hawley's work is not particularly strong.

[25] As ambiguous as any delimitation depending on the concept of "community".

> Human ecology should be concerned with units other than communities, especially so since some features of a community (e.g., the economic base of Detroit) may not be explicable without reference to the larger society. Additionally, the term "community structure" is too inclusive as a designation of human ecology's subject matter, since it includes social stratification (class and caste), political organization, religious associations, and kinship systems--subjects that are clearly central to other fields.

Twelve years earlier Gibbs (1959:29) made a similar comment:

> Furthermore, the community,[26] for the purposes of human ecology, is only one unit of observation; more macroscopic units such as regions, and nations must be included. There is nothing in the community that is intrinsically more "real" or "important" than is the case for countries. In fact, by placing its emphasis on societal organization human ecology is potentially capable of stemming the current trend which threatens to reduce sociology to social psychology.

Duncan and Schnore (1959:136) continue along the same lines as Hawley in their delimitation of human ecology:

> In the most general terms the framework of human ecology embraces four main referential concepts: population, environment, technology, and organization, which define what may be called the "ecological complex".

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[26]It is interesting to note, however, the considerable agreement between Hawley and Gibbs with reference to their definition of community--that of the structure of relationships through which a localized population provides its daily requirements.

But while the terminology and principles of plant and animal ecology are notably absent from the Duncan and Schnore framework, their scheme is still too broad to be considered as fully unique from sociology. In addition, the "ecological complex" as proposed above is 'synchronic'. This disregard of the temporal dimension leaves much to be desired.[27]

A Contemporary Ecological Perspective

The latest and one of the most powerful ecological theorists within sociology is Gibbs (1959, 1970) who has succeeded in providing his students with a coherent conceptual framework linked to classical sociological theorists, but also empirically grounded in modern research.

In outlining his framework, Gibbs (1970:III:1,2) accepted three basic assumptions upon which the foundations of human ecology can be laid: "(1) men always seek food . . . (2) seeking food inevitably entails an expenditure of energy

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[27]Synchronic here is used in the sense that the basic constructs of Duncan and Schnore's "ecological complex" do not take into account the ideas of process or social change. As such, any investigations structured by this flaw of "timelessness" would have to work hard to escape that static quality which inflicts much of sociology today.

. . . (3) _Homo sapiens_ will reproduce."

According to Gibbs, (1970:III:1,2) the first two assumptions point to "one central component of human ecology's subject matter--_sustenance activities_, defined as an expenditure of energy in the pursuit of food or in the production of a good or a service."

The third assumption--the biology of human reproduction

> assures that members of populations will interact, which is a necessary condition for social organization . . . to be sure social organization entails more than interaction _per se_; it requires a regularity and stability in interaction, such as found in the activities of a baseball team. However, in any case, the biological character of _Homo sapiens_ produce the necessary condition for social organization--some form of interaction.

Thus, the second core concern of human ecology is _social organization_--a concern which obviously is central to sociology.

Gibbs (1970) proposed a third and last aspect of human ecology: the spatial-temporal dimension. This dimension is implicit since _sustenance activities_ and _social organization_ must take place within spatial and temporal referents.

While Gibbs (1970) emphasized this last point, the transmittedness of these basic constructs from early ecological work is evident.

These basic components delimiting the concerns of human ecology cannot be taken as isolated or independent but must be considered in their interrelation to each other. Gibbs (1970) defined the total interrelatedness of sustenance activities, social organization, and spatial temporal aspects as <u>ecological organization</u>.

This set of interrelations can be graphically depicted as follows:

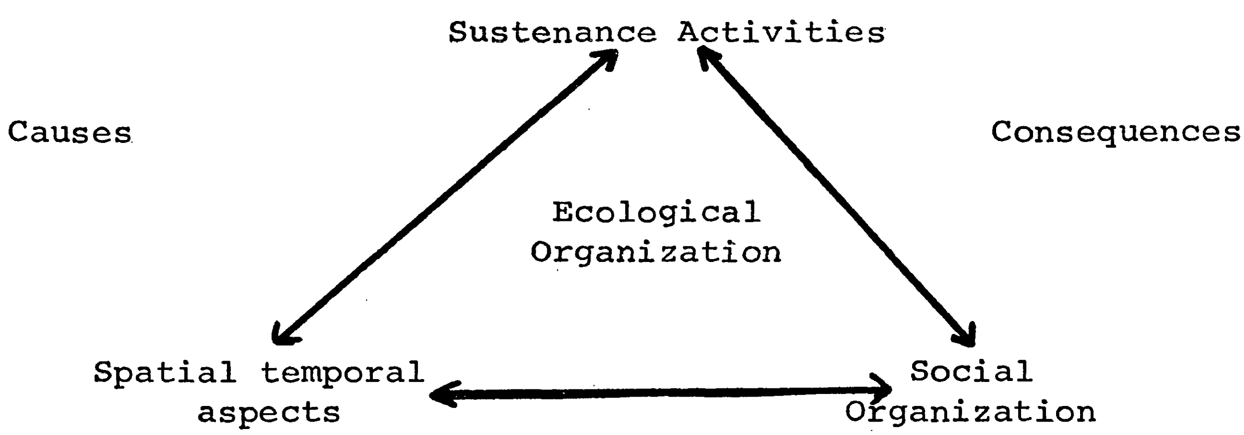

FIGURE 3. GIBBS' SCHEME OF ECOLOGICAL ORGANIZATION

With regard to the causes and consequences of ecological organization,[28] Gibbs (1970:III:6) remarked that:

> . . . the ultimate goal of human ecology is to identify the causes and consequences of ecological organization, and pursuit of that goal entails three considerations. First, no position need be taken on the ancient debate over the demonstrability of cause and effect; for heuristic purpose one can speak of causes and consequences without entertaining the notion that they are demonstrable. Second, the search for the causes and consequences of ecological organization never ends, that is, the goal is never realized; even if the "causes" are ever identified, the search for consequences would go on indefinitely. And, third, the search for causes and consequences is not and cannot be limited to any field or class of phenomena.

In further elaboration of the conceptual framework, Gibbs (1959:30) observed:

> That man survives through collective organization is fundamental to both sociology and human ecology. It is obvious, however, that not all populations organize themselves for the exploitation of natural resources in exactly the same manner. To the contrary, a wide variety of organizational forms are to be observed. It is this variability in the characteristics of sustenance organization among populations that human ecology finds its fundamental problem.

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[28] It should be noted that Figure 3, which is presented as a diagram delimiting the proper study of human ecology, does not imply or preclude, by the use of double-edged arrows, non-recursive structural equations as statements of the interrelationships between phenomena studied. While interaction and feedback are implied in any ecological model, even one delimiting its boundaries, monotonic interaction presents no problem and feedback, if it is asserted to be delayed, can be handled recursively. See Blalock (1971).

and again (1959:30):

> A brief consideration of what is entailed in sustenance organization can best begin with the conception of a population as an aggregate of individuals engaged in activities that provide them with a livelihood. These activities, here designated as sustenance activities, are abstracted from the total of human behavior and specifically exclude all activities not directly related to livelihood.

The universe of discourse of human ecology, i.e. the identification of the set of core concerns of human ecology as discussed above should be differentiated from the universe of inquiry, i.e. the enumeration of variables or variable-sets which bear some relation to that set of core concerns. Gibbs (1970:III:7) enumerates three categories of phenomena which bear directly upon his constructual framework of ecological organization: "(1) the physiographic attributes of the territory occupied by a population, (2) the size and biological qualities of the population, and (3) technology."

Thus, Gibb's proposed framework is transmitted from earlier ideas. For instance, all studies that utilized the ecological framework were concerned with the physical setting[29]

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[29] Physical setting, i.e. city, neighborhood and home, should be distinguished from the environment, which includes correlates of social interaction and organization.

of the observational units, as well as the demographic composition of populations residing within these settings. The importance of technology, the institutionalized "way of doing things" of human groups, has also had a long history of acceptance.

Old wine has again been rebottled. Ecologists are more precise in their theoretical statements and are more aware of analytical difficulties, but only as a ritualized prelude to their methodological interests. This lack of new theory within contemporary human ecology, and the consequent dominance of methodological issues, it shall be pointed out, has resulted in a separation between methodological considerations and theoretical perspectives.

CHAPTER II

SOCIAL AREA ANALYSIS TO FACTORIAL ECOLOGY: A NEW METHODOLOGICAL RHETORIC IN HUMAN ECOLOGY

The Development of Social Area Analysis in the Strict Sense

Social Areas Versus Natural Areas

Social Area Analysis, as a method of analysis originally formulated by Shevky and Williams (1949) and forcefully modified by Shevky and Bell (1955) reaches back in the human ecological literature for its beginnings. As the reader will recall, Zorbaugh (1926) introduced the concept of the "natural area"--i.e. a geographical area characterized by a certain individuality of physical setting and homogeneous population characteristics.[1] And this concept of a "natural

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[1]We may also see a correspondence between this term and the term "niche" so popular in modern animal ecology. Rees (1972) draws parallels between the term and similar ones used in geography as well.

area" came under criticism as part of the general stream of attack on human ecology, most notably by Hatt (1945). There is some question as to why this one study, conducted in the city of Seattle by Hatt, would have such a drastic effect on what appeared to be such a viable concept--the natural area. One can only surmise that it was a predictable result because the concept had yet to be precisely formulated in subsequent studies. In and of itself, the Hatt study may be cause to reformulate the concept of natural area, but certainly no selfrespecting methodologist would reject it out of hand, especially in light of its apparent fruitfulness for sociological investigation. In essence, though the authors strenuously deny any connection, we may view Shevky and Bell's 1955 monograph as a reformulation, in more precise form, and in a detailed enough prescription that will enable replication, of the classical ecology concept of natural area.

An Overview

A schematic indicating the general development of social area analysis is presented in Figure 4, below. The increased concern for methodological problems, and the general replicability of the Shevky-Bell social area analysis should

Social Area Analysis; Strictly Defined After
SHEVKY AND WILLIAMS; SHEVKY AND BELL

Criticism
HAWLEY AND DUNCAN;
DUNCAN

Cluster Analysis[2]
of socioeconomic
data for census
tracts.
TRYON

Continuing application of social area analysis, _sensu stricto_; e.g. HERBERT; McELRATH

Tests of social area constructs using factor analysis; BELL; VAN ARSDOL; CAMILLERI, AND SCHMID

Analysis of Variance of _sensu stricto_ indices; ANDERSON AND EGELAND

Factor Analysis of socioeconomic data for census tracts deriving basic dimensions which are compared with available theory:
SCHMID AND TAGASHIRA
SWEETSER
GOHEEN
MURDIE
PEDERSEN

Analysis of Variance of factorial dimensions
MURDIE; REES

FIGURE 4. THE DEVELOPMENT OF SOCIAL AREA ANALYSIS, _sensu stricto_.[3]

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[2] Cluster Analysis is Tryon's proposed alternative to factor analysis.

[3] SOURCE: Berry (1972:__).

be noted. Social areal analysis was thus able to undergo and successfully withstand its own critics, though it soon became supplanted by more sophisticated procedures.

Shevky and Bell's (1955) social area analysis was formulated basically as a method of classifying intraurban census tracts into groups of homogeneous "social areas", through the utilization of three deductively derived indices: social rank, urbanization, and segregation.[4] Once the standard scores for each index were known, comparative studies between census tracts, or in the case for larger metropolitan centers, groups of census tracts, could be made. In addition, this procedure had distinct advantages from the standpoing of survey sampling by areas, and the like.

Shevky-Bell Construct Formation

The steps Shevky and Bell (1955) used in their construct formation and index construction are presented in

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[4]Social areas, as conceived by Shevky and Bell (1955) served a two-fold purpose: it enabled social scientists to deal in terms of "natural areas" in a more sophisticated fashion; and sidestepped the semantic and philosophical issues involved in using the concept of community. A new less emotion-laden term, it became part of a rapidly forming urban rhetoric accepted on an interdisciplinary level.

Table 1. (Detailed computational procedures are provided in appendices A, B, and C.) Table 1 shows the underpinning "theory" of social area analysis, postulated changes in the structures of industrial societies, and finally, the derived measures.[5]

Theoretical Criticisms

The theoretical rationale for social area analysis is weak. As Duncan (1955), and Hawley and Duncan (1957) were quick to observe, the theory is highly generalized, very vague, and does not answer the fundamental question of why intraurban residential areas should be different.

It is demonstrated, for instance, that Shevky and Bell indulge in a fantastic jump from considerations of industrial society, to the arrangement of intraurban residential space, which ignores any possibility of significant regional variation from their proposed pattern.

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[5]The indices may also be referred to respectively as: economic status; family status, and ethnic status. The author prefers this usage over the former, because it is closer to indications of reality, but most diagrams and tables use the former terminology.

TABLE 1

SHEVKY AND BELL'S STEPS IN CONSTRUCT FORMATION AND INDEX CONSTRUCTION

Postulates Concerning Industrial Society (Aspects of Increasing Scale) (1)	Statistics of Trends (2)	Changes in the Structure of a Given Social System (3)	Construct: (4)	Sample Statistics (Related to the Constructs) (5)	Derived Measures (From Column 5) (6)	
Change in the range and intensity of relations	Changing distribution of skills: Lessening importance of manual productive operations--growing importance of clerical, supervisory, management operations	Changes in the arrangement of occupations based on function	Social Rank (economic status)	Years of schooling Employment status Class of worker Major occupation grp. Value of home Rent by dwelling unit Plumbing and repair Persons per room Heating & refrig.	Occupation Schooling Rent	Index I
Differentiation of function Complexity of organization	Changing structure of productive activity Lessening importance of primary production-growing importance of relations centered in cities-lessening importance of the household as economic unit	Changes in the ways of living --movement of women into urban occupations--spread of alternative family patterns	Urbanization (family status)	Age and sex Owner or tenant House structure Persons in household	Fertility Women at work Single-family dwelling units	Index II

TABLE 1 (CONTINUED)

Postulates Concerning Industrial Society (Aspects of Increasing Scale) (1)	Statistics of Trends (2)	Changes in the Structure of a Given Social System (3)	Construct: (4)	Sample Statistics (Related to the Constructs) (5)	Derived Measures (From Column 5) (6)	
Complexity of organization	Changing composition of population: Increasing movement--alterations in age and sex distribution--increasing diversity	Redistribution in space-changes in the proportion of supporting and dependent population --isolation and segregation of groups	Segregation (ethnic status)	Race and nativity Country of birth Citizenship	Racial & national groups in relative isolation	Index III

SOURCE: In Eshref Shevky and Wendell Bell, <u>Social Area Analysis</u> (Stanford University Press, 1955).

In another example, it is noted that Shevky and Bell (1955:5) gave as a "change in the structure of social systems" the creation and spread of alternative family patterns. These family patterns supposedly were responses to the increasing dominance of tertiary activities in the total society which changed the occupational composition of economically-active females. But the selection of indicator variables for utilization in the construction of indices shows a complete disregard for alternative patterns in favor of simple indicators of stages in a unidimensional life cycle (urbanization). Thus their move from the theoretical to the empirical level resulted in a shift in meaning as well as a shift in the level of analysis. There are other examples of such weak theoretical logic, but following an incisive review by Abu-Lughod (1969) the "theory" of Shevky and Bell has been virtually ignored. Abu-Lughod (1969:199) remarked:

> This theory, inadequately explicated as it was and appended uneasily to serve chiefly as an elaborate "rationalization" for Shevky's perspicacious and, as it later developed, "happy hunches" with respect to American urbanism, hinted at the possibility of relating the type and complexity of urban differentiation to the "scale" of the society in which a city was found.

Methodological Considerations

The original propositions and subsequent developments from social area analysis were predominantly methodological.[6] The reformulation of "natural areas" into social areas was a safe, secure step, especially since it was accompanied by a rudimentary but careful methodology.

Three indices of social rank, urbanization, and segregation were standardized to a range of 0 to 100, and each census tract was given a composite score based on the number of given attributes within its boundaries. Census tracts were compared to all others within a social space, which consisted of a typological matrix with sixteen cells.[7]

The general form of the Shevky and Williams and the modified Shevky and Bell social spaces is shown in Figure 5.

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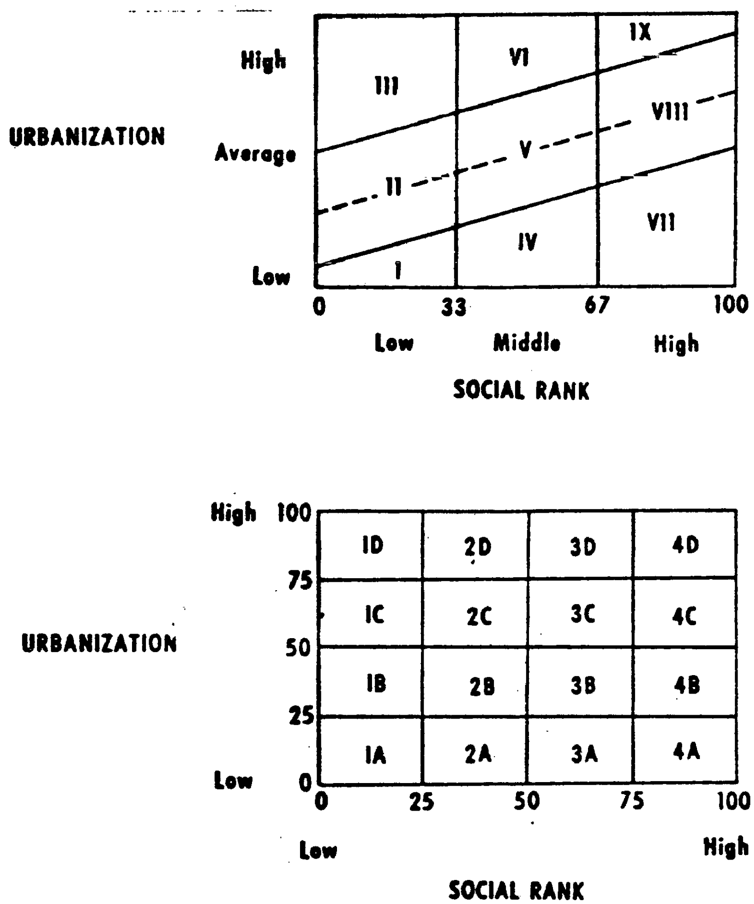
[6] It is suggested that the methodological dominance of social area analysis was a response (conscious or unconscious) to the severe theoretical criticism human ecology underwent.

[7] Shevky and Williams (1949) made nine logical divisions of the social space as follows: the social rank index was divided into three parts of equal range, with the urbanization index divided into three parts also, but spaced one positive and negative standard errors about the linear regression line of urbanization on social rank.



SOURCE: Shevky and Bell (1955)

FIGURE 5. SOCIAL SPACE CONSTRUCTS OF SHEVKY AND WILLIAMS (TOP) AND SHEVKY AND BELL.

The revised method of classification, which eliminated a regression determination between the first two indices, now became simpler for nonmathematically oriented sociologists to apply without the aid of computers. However, this simplification was untimely, for there was developing a growing trend toward more complex mathematical models, and increased use of computers, which has persisted to the present.

Methodological Criticisms

Several inconsistencies are obvious. For instance, the first index ignores a direct economic variable for which detailed information was available--income. Similarly, in the second index, "single-family-dwelling-units" was adopted as a measure of family status, even though there has been a persistent trend during the century to multi-family units, thus selection in this case could not be considered optimum and Abu-Lughod, (1969) in her study of Cairo, demonstrated that it was culture-bound as well.

With regard to the third index, it is implausible that two or more separate investigators would be able to identify the same ethnic groups in <u>relative isolation</u>, at least by any objective means. In addition, the segregation index must be examined within each social area, after the census tracts have been assigned on the basis of the first two dimensions. Thus the segregation index is not used in the classification of tracts *per se*, a decided disadvantage.[8]

So serious questions concerning the validity (always a moot question) of the Shevky-Bell formulation, the reliability of measures[9] used, and the theoretical derivations can be raised.

In addition, the methodology should be subjected to rigorous empirical verification. It will be shown further on that this has been the case--with social area analysis achieving a modicum of success--but at a time of rapid statistical and computational development which has relegated it to a position of historical insignificance.

It should be useful at this point to give an example of a social area analysis--for the identical study area which will be used in subsequent analyses.

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[8]If it is not used, one might ask "what is its purpose for the classification scheme?", a question for which Shevky and Bell provide only an implied answer.

[9]As Rees (1972) observes, the index scores were standardized to San Francisco rather than to some rational measure based on the national structure of cities.

The Social Areas of Omaha

In order to provide a timely example of social area analysis for a metropolitan city, the social areas for Omaha for 1950 and 1960 were determined, through a strict employment of the Shevky-Bell index construction and standardization procedures. Since the social areas of 1950 were determined first, the 1960 social areas use index scores standardized to the 1950 range, again strictly following the procedures of Shevky-Bell (1955). Social areas for Omaha for 1950 are presented in Figure 6, and for 1960 in Figure 7. One departure from the Shevky-Bell procedure was made. Those tracts, which according to the Shevky-Bell criteria, were to be considered as segregated tracts, were underlined in the two figures, in order to provide the reader with an easy grasp of all the distributions of three dimensions.

In looking at the distribution of census tracts in the social space, as presented originally by Shevky and Bell, it is interesting to note that: 1) there are few census tracts scoring high in the social rank index; 2) there are few elevated scores for urbanization (family status) with low social rank scores, or elevated social rank scores with low urbanization scores; and 3) the great majority of the Omaha census

INDEX OF URBANIZATION

INDEX OF SOCIAL RANK	0–25	25–50	50–75	75–100
		41,	18, 40,42	
	14,16 51,	17, 22,	43, 38,39	50,
	23,24 53, 21,28,31,32 6,11,12,20	25,26 54,55,57,58 33,44,60 7,8,9,10,13	19,49 3,15	45,46,47 48
	4,15,27,29,30	52,55,59 61,62	2 34,35,36,37	

SOURCE: Original analyses following the detailed computational procedures set forth in Appendices A, B, and C.

NOTE: Census tracts which are designated as segregated according to Shevky-Bell procedures are underlined. This does not mean simply segregation of blacks.

FIGURE 6. 1950 SOCIAL AREAS FOR OMAHA ACCORDING TO SHEVKY-BELL STANDARD SCORES.

tracts are located in the lowest quadrant of social rank and urbanization scores, and this is true of all but one of the segregated census tracts.

Now turning to Figure 7, which shows the social areas of Omaha for 1960 but standardized to the range for 1950, it is noted that an additional negative set of social area cells had to be added in order to adequarely depict the scores for 1960 tracts. This would indicate the drastic aging process the Omaha central city populations must have undergone from 1950 to 1960, with regard to their age compositions. Since these tracts represent the central city only, it might be auspicious to look to the suburbs for these lost youthful age groups, but evidence indicates that long range out-migration also had its effect.

Further, in the high social rank half of the social space (social rank scores of 50-100), the total number of tracts increased from 1950 to 1960 while the absolute number of tracts in these social areas decreased--thus indicating that the social rank of central city census tracts is decreasing with the age of the city. It is reasonable to assume that suburbanization is selective toward upper-income occupational

Index of Urbanization

Index of Social Rank	0–25	25–50	50–75	75–100
75–100	37 58 46 67 47 68 55	45	43 48 50	
50–75	2 58 73 34B 59A 64 35 60 65 36 61B 70 54 62A 56 62B	34A 38 44	39 49 51	19 41 42
25–50	3 11 4 28 6 30 7 59B 8 73 10 75	9 22 23 24 25 26 33	16	18 40
0–25	13A 31 14 71 15 72 20 27 29	13B 21 32	17	
−25–0	5	12 52 53	61A 74	66 69

SOURCE: Original Analyses following the detailed computational procedures set forth in Appendices A, B, and C.

NOTE: Census tracts which are designated as segregated according to Shevky-Bell procedures are underlined. This does not mean simply segregation of blacks.

FIGURE 7. SOCIAL AREAS FOR OMAHA, 1960 ACCORDING TO SHEVKY-BELL STANDARD SCORES.

groups and that this accounts for the trend. This generalization is easily born out in the literature.[10] It is clearly obvious that the status of segregated tracts has decreased over the decade in question. None of these segregated tracts are represented outside of the lowest quadrant of social areas and five times the number of central city tracts are now represented in the lowest social rank cell.

The Verification of Social Area Analysis

Following the advent and public attention given social area analysis, the empirical verification of the procedures and the proposed Shevky-Bell dimensions of social rank, urbanization, and segregation became a primary concern for sociologists oriented toward urban analysis.

Anderson and Egeland (1961) published an analysis of spatial variance of the three indices for several cities. They found evidence that the second dimension did exist, and that it behaved in the fashion earlier proposed by Burgess (1925), i.e. the urbanization scores of tracts decreased as

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[10] It should be remembered that the author is presenting this material merely as an example of the type of analysis available through social area analysis in the strict form.

distance from the center of the city increased.[11] In addition, social rank scores were distributed as proposed by Hoyt (1936)--in a sectoral fashion. It was concluded further by Anderson and Egeland (1961), as a result of their analyses of variance, that these two dimensions were additive.[12]

The most exhaustive verification of social area analysis dimensions was accomplished by Van Arsdol, Cammilleri, and Schmid (1958)[13] who employed an early factor analysis routine[14] to verify the six basic indices which made up the Shevky-Bell measures. Their hypothesis was quite simple. If,

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[11]Urbanization scores were constructed such that areas with high concentrations of family units, fertility, etc. were ranked low, while areas with low fertility and family units were ranked high. Thus if fertility, etc. increases from the center of the city, the urbanization scores will decrease.

[12]Analysis of variance provides for a test for interaction between nominal categories, which was not significant in all of the cities tested by Anderson and Egeland (1961). They concluded from this, then, that the dimensions were mathematically additive.

[13]It is obvious that Van Arsdol's dissertation (1957) led to the later published article with his mentors.

[14]Thurstone's multiple-group method was employed. Rotation was predetermined at three factors, although their own criteria indicated this may not have been optimal.

they reasoned, the Shevky-Bell measures do delineate basic urban dimensions, then the measures will be differentiated numerically as orthogonal factors. The hypothesized factor structure is shown in Table 2 below.[15]

TABLE 2

HYPOTHESIZED FACTOR STRUCTURE FOR SHEVKY-BELL MEASURES

Measure	Factors*		
	Social Rank	Urbanization	Segregation
Occupation	+	0	0
Education	+	0	0
Fertility	0	+	0
Women in Labor Force	0	+	0
Single Family Dwelling Unit	0	+	0
Negro	0	0	+

SOURCE: Van Arsdol, Cammilleri and Schmid (1958).

* + denotes positive correlation
0 denotes low correlation

Van Arsdol et al. (1958) found that the factor structure in six of ten cities studied conformed to the above

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[15] Factor analysis procedures were first used in 1942 by Margaret Hagood and Daniel Price, using urban data, and hand computations and rotations. (Published by Price, 1942)

hypothesized structure, while the four remaining cities displayed divergent structures, thus giving a partial verification to the Shevky-Bell indices.

This study was significant from another point. It demonstrated the more general nature of factor analysis as a procedure for determining the underlying dimensions of urban areas, and with the increasing availability of computer procedures, it soon supplanted the Shevky-Bell procedures.

Criticism of Verification Procedures

The use of factor analysis to verify the Shevky-Bell dimensions ushered in a new era of methodological emphasis in urban analysis. However, the basic use of factor analysis employed--to verify the existence of the constructed Shevky-Bell indices--was in error from one standpoint. Factor analysis makes use of whatever data is input, and several variables which went into the construction of the Shevky-Bell indices have a serious indirect effect on the derived factor structure. In order to detect whether or not the underlying assumptions of such a verification were correct, the indirect effects of several subsidiary variables should have been determined. For instance, use of the constructed indices implies that the census tracts used as the basic taxonomic units are indeed homogeneous with regard to various density measures, size, etc. Then, too, collinearities may be built into the constructed measure which will influence the intercorrelations upon which factor analysis rests.

It would have been wise to include as raw variables all of the data used directly or indirectly in the factor analysis. Thus, differences in density, size of tracts, etc. if there were any, would be detected.

The first two modes of social area analysis have already been described. They are concerned primarily with the formulation, utilization, and verification of the Shevky-Bell constructed indices. The last two modes have to do with "factorial ecology" which rests on the technique of factor analysis.

Differentiating Characteristics of Factor Analysis

What distinguishes factor analysis from other multivariate statistical techniques? Rummel (1970:3-4) outlines several distinguishing characteristics:

1. Factor analysis can analyze such a large number of phenomena with the assistance of an electronic computer that 100-variable analyses become routine.

2. It disentangles complex interrelationships among the phenomena into functional unities or separate or independent patterns of behavior and identifies the independent influences or causes at work.

3. It handles social phenomena in the situation. There is no need to abstract phenomena to a laboratory setting or to select only certain variables and assume that others are constant. The interrelationships between behavior and environment can be analyzed as they exist in real life.

4. Factor analysis is a flexible instrument applicable to a wide range of research designs (hypothesis-testing, concept-mapping, case studies) and to a variety of data (time series, voting results, sample survey responses).

5. It has been widely studied by mathematicians, statisticians, and methodologists and has its roots in social science (psychology), mathematics (principal axes, diagonalizing a matrix, eigenvalues, eigenvectors), and natural science. Although an actual tabulation of the literature has not been made, it appears that far more methodology books have been written on the subject of factor analysis than on any other social science method or technique.

6. It has had wide application. Factor analysis is not a new method. Hundreds, perhaps thousands, of cases of its application are scattered through the social science literature. These applications have been and can be studied to gain insight and confidence in its use.

7. Its mathematical structure is related to such commonly used techniques as multiple regression, product moment correlation, canonical analysis, partial correlation, and analysis of variance. It is thus theoretically capable of integrating many diverse findings.

8. It yields a set of equations that can be used to describe and predict behavior. Moreover, these equations are not structurally *ad hoc* but are developed as theorems in another field of mathematics--linear algebra. The factor analysis model can thus be used as a mathematical theory of behavior, drawing on a familiar field of mathematics to make deductions and behavioral predictions.

9. Factor analysis has a geometrical representation that allows for the visual portrayal of behavioral relationships. It allows for building physical models of social reality that can be studied in abstraction from the equations underlying them, much as the chemist builds physical (often colorful) representations of molecular systems. These physical models or geometric representations make it feasible to discuss and perceive relations and theory in a way not possible with equations alone.

The Rise of Factorial Ecology

Social Area Analysis (in the broad sense)

While a few studies in the strict social area analysis sense continued to be published (Bell, 1958; Greer and Kube, 1959; and Cox, 1968) and a few studies employing factor analysis of strictly social area analysis measures (McElrath, 1962; Herbert, 1967; and Robson, 1969) the main thrust of social area analysis after the Van Arsdol et al. (1958) article was translated almost entirely to a factor analytical framework in which an increased number of empirical indicators, including the Shevky-Bell set, were utilized. Figure 8 presents an overview of these main trends within social area analysis as it is broadly defined.

Social Area Analysis (in the broad sense)

type	SOCIAL AREA ANALYSIS, SENSU STRICTO	FACTOR ANALYSIS OF SOCIAL AREA SENSU STRICTO VARIABLES	FACTORIAL ECOLOGY I	FACTORIAL ECOLOGY II
theory employed	urbanization; assimilation; changes in scale	none	none	changes in scale; classical ecology, economic deter.
method employed	Construction of Shevky-Bell Indices	Factor analysis of Shevky-Bell variables	Factor analysis of wider set of socio-economic variables, including the Shevky-Bell set.	More sophisticated factor analytic models, subarea delimitation
examples	Shevky and Bell (1955) Bell (1958)	McElrath (1962) Herbert (1967) Robson (1969)	Rees (1968) Berry (1969) Murdie (1968)	Sweetser (1965) Abu-Lughod (1969)

SOURCE: Taken partially from Rees (1968) and Berry and Horton (1970:315) which is based on Rees, but with substantial modifications.

FIGURE 8. TAXONOMY OF MAJOR TRENDS WITHIN THE SOCIAL AREA ANALYSIS FRAMEWORK.

Factorial Ecology: Type I[16]

Basic Procedures of Factorial Ecology, I

The most concise description of the basic procedures involved in carrying through a "factorial ecology" are outlined by Rees (1970:221) as follows:[17]

> The steps involved in carrying through a factorial ecology follows below.
>
> (1) Assembly of a data matrix A of order n x a, where n refers to observations (e.g., countries, counties, or census tracts) and the a refers to attributes (e.g., measures of the social and economic structure of the area populations or economy.)
>
> (2) Conversion of matrix A to a matrix Z, again order n x a, in which the original variables or attributes have been expressed in the standardized form of zero mean and unit variance, perhaps following transformation to satisfy linearity assumptions.
>
> (3) Calculation of matrix R, from the matrix Z, of zero-order correlation coefficients (usually Pearson's product moment coefficient of correlation) between pairs of variables, the matrix being of order a x a.

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[16] For a brief description of specific studies of type I, see Appendix E.

[17] This is a traditional exposition of factorial ecology after the procedures "perfected" by Berry's (1966) papers. The geographical dominance of these basic definitional stages of factorial ecology represents a fundamental element in Factorial Ecology I.

Either

(4a) A principal components analysis of R is then performed that produces a matrix F of order a x s, where the s are principal components or the dimensions of variance underlying the original variables. Any cell of the F matrix f_{ij} is a correlation coefficient, normally called a loading, of variable i on factor or dimension j. The value of f_{ij} varies between -1.0 and +1.0. King's (1969) statistical text [205] gives a detailed account of how the matrix F is derived from the matrix R by matrix manipulations.

(5a) The components may or may not be rotated to different positions in the factor space, maintaining their 90 degree positions ("orthogonal" rotation) or moving away from them ("oblique" rotation).

(6a) In addition, an n x s matrix S is calculated. The column vectors of S are scaled to zero mean and unit variance. Each s_{ij} is a component score, the score given to observation i on factor j.

Or

(4b) A factor analysis of a $(R - U^2)$ matrix is performed, where U^2 is a diagonal matrix containing the unique portion of the variance of each of the a variables. Generally, the u_i^2 is estimated as $(1.0 - h_i^2)$, where h_i^2, the communality of variable i, is approximated by computing the coefficient of determination resulting from the regression of i on the remaining a less i variables in the set. In this type of analysis only the common variance is factored, not all of the variance, as is the case in the principal components solution. The other steps proceed as noted in (4a), (5a), and (6a).

Or

(4c) There are several other variants of factor analysis which are discussed in the literature: Harman (1966), Horst (1965) and Lawley and Maxwell (1963).

A General Critique

The level of analysis typified by the implementation of census tracts as the basic unit of observation and the SMSA[18] or city as the universe of discourse is the most extensive level at which factor analysis has been employed. A preponderant percentage of all studies may be accurately classified under the third category of Figure 8--Factorial Ecology I. The basic characteristics of studies in this category are quite similar. They are typically conducted by geographers whose primary motives are both exploratory and inductive. The overriding orientation is methodological. No hypotheses or theory are tested. Lip service is ritualistically paid to some sort of "theory"--be it classical urban models, or a more contemporary land use model.

The atheoretical nature of the first type of factorial ecology is well documented (Janson, 1969; Rees, 1970; Alford,

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[18]SMSA is an accepted abbreviation for the constructed censal observational unit--the Standard Metroooolitan Statistical Area. It is important to note that while there is empirical evidence to support the homogeneity of SMSA's (Dean, 1970) no such evidence is available for census tracts. And there is serious doubt whether such evidence could be found.

1972).[19] Here, the concern is exclusively with deriving "underlying dimensions" in a wide range of variables empirically. Each study has selected widely variant sets of variables as input in the factor analysis and therefore are not really comparable. No predictions are made concerning either the expected dimensions which will result or the configuration of variables on dimensions. Most important of all, the technique of factor analysis *per se* is seen as the unifying force between studies of different cities, rather than any generalizations concerning regularities in the causal forces of which variables selected may be indicators.

The definitive statement with regard to this first type of factorial ecology appeared in a special supplement of *Economic Geography*, June, 1970. In this issue, Rees (1970) defines formally as *factorial ecology* any study which used factor analysis to order data collected as areal attributes.

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[19] Whether or not this atheoretical nature of factorial ecology, which was heightened by the geographer's dominance of the field is a result of their conscious disregard for theoretical considerations, or pinpoints a serious weakness in geographical thought--an unconscious blind spot, so to speak, remains to be seen.

Thus factorial ecology has been taken a step further--not only is it defined strictly as method, but any connection with the vast theoretical body of human ecology is not utilized.

Rees, (1970:230) generalized the dimensions which have emerged from ". . .most American factorial urban ecologies: (1) a socioeconomic status dimension; (2) an age structure of family type dimension; (3) a number of ethnic factors, the most important of which is that of racial status. . . ." And concluded (Rees, 1970:231): "The end product is a descriptive picture of residential area types."

Critique of the Theory of Method

There were several consequences which resulted from this formal definition and identification of factorial ecology as mere method. The two most serious can be separated into (1) those dealing with the basic assumptions underlying the nature of factor analytic studies; and (2) the philosophical assumptions of using factor analysis in empirical investigations. The former is explicitly asserted by Rees (1970:221) as follows:

> There have been many views as to the nature of the dimensions that emerge from such an analysis. Some would see them as explanatory factors that account for the variation in the original data matrix and assign to the factors causal meaning. However, this is more and more a minority view in ecological applications. More modest is the claim that components or factors represent concise descriptions of patterns of associations of attributes across observations. . . If this view is adopted, then factor analysis is seen to be an exploratory technique on the descriptive level akin to multidimensional scaling of data matrices containing ordinal data.

Here is an example of a self-fulfilling prophecy. Rees, and others of the same orientation define "ecology" to suit their personal methodological bent and lack of theoretical bases. They continue in this vein by asserting that the method of factor analysis is limited to concise description, primarily because that is the only form they have succeeded in utilizing it.

The remarks of Berry (1970:___) concerning the philosophical implications of factorial ecology are even more insidious. They reflect a growing disallusionment with factorial ecology in its present form:

> The approaches, arguments, and conclusions of the contributions to this volume, and indeed of all factorial ecologies, comparative or otherwise, cannot be evaluated from the scientistic perspective of positivism, for their essence is the idea that meaning in any situation has to be learned rather than posited by aprioristic

> theory. To understand the how and why of factorial ecology, the perspective of a phenomenological philosophy is required.

Thus, because factor analysis has not been implemented from a strong theoretical position, its use for such purposes is negated. That this is an isolated position, taken primarily by geographers stepped in their methodology is indicated by Rummel (1970) who maintains that factor analysis may be used not only as concise descriptions (empirical concepts) but within the framework of formal (analytic) concepts and theoretical constructs. He comments on the use of factor analysis within the deductive scheme (1970:22):

> Deduction involves two ways of using factor analysis. One approach is to employ the factor analysis model as part of a theory. . . A second deductive approach involves hypothesizing that certain patterns exist, The data then are factored to see if these patterns emerge. Factor analysis has not often been employed to test hypotheses, but the restraint is due to research tradition and not to methodological difficulties.

The strong but virtually unrecognized position of factor analysis within a prioristic schemes is further emphasized by its close relationship to and implementation in causal models such as formulated by Blalock (1971), Turner and Stevens (1959), Wright (1960), Duncan (1966), Duncan, Haller and Portes (1968 and 1970), Sullivan (1971), Werts, Linn and Joreskog (1971) and Wilson (1971). Here factor analysis is viewed as an underidentified model lacking regression estimates to name but one approach taken.

Another important distinguishing characteristic of the work of type I research are their common and rigid adherence to two factor models, which approach somewhat of an ideological stance.[20] These two factor models were noted earlier in the "normative" methodological summary by Rees (1970). They are the principal components, and the principal-axes varieties.[21] The first type of factor analysis model, by its placement of unities in the diagonal of the correlation matrix (as a communality estimate) makes the assumption that each variable in the analysis is composed of just one part--a part which varies in common with the other variables

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[20]This of course is a logical outcome of a condition where the method itself is the unifying principle between similar studies, rather than a substantive framework.

[21]Rees differentiates these techniques by calling the former principal components analysis and the latter factor analysis, but this distinction is arbitrary.

in the matrix. This is crucial, as Hunter (1972) has pointed out, for two reasons. First of all, this assumption concerning the nature of variables, especially in sociological research, is hardly defensible on substantive grounds. Secondly, it ignores completely the existence of the residual term found in the general linear hypothesis (upon which all regression analyses are based)--thus it equates least squares estimations of distributions with the actual distributions.

The second and most prominent factor model--the principal-axes model, is not without problems itself, although here they are of a different sort. Communality[22] estimates replace unity in the diagonal, thus it is recognized that each variable consists of two parts--a part which varies in common with the other variables in the matrix, and a part which is unique to that variable. Thus, Hunter (1972) noted that the initial solution of principal axes methods yield factors which lie outside of the variable space (in contrast to principal components analysis where factors are located within the

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[22]Communality is defined as the proportion of a variable's total variance that is accounted for by the factors, and is the sum of the squared loadings for a variable (Rummel, 1970:142).

space defined by the variables). Consequently, these factors must be interpreted as hypothetical constructs (in contrast to principal components analysis factors, which may be interpreted exactly in terms of the variables). In addition, because of these characteristics, factor scores[23] can only be estimated, and are not uniquely computable for principal-axes analyses.

Factorial Ecology: Type II

Type II factorial ecologies are distinguished from Type I studies primarily on four counts: (1) more attention is given to substantive and theoretical needs, which may precede as well as follow a factor analysis;[24] (2) in general, factor analysis is conceived of simply as one methodological

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[23]Factor scores represent the unique position of a particular observational unit along the range of a factor. The range is easily described as a probability curve with mean zero and standard deviation of one.

[24]Theory thus is viewed by the author as interactive with methodology at two points: prior to empirical testing (i.e. in this case factor analyzing) or research guided by theory; and after empirical testing, or theory generated by methodology. The theory-generation phase is highly neglected mode in the social sciences.

tool, rather than as a unifying element between studies;[25] (3) factor analytical models are an integral part of more sophisticated methods;[26] and (4) the second step of social area analysis--the delimiting of observational units into homogeneous social areas using the derived dimensions as the differentiating criteria, is accomplished.

The most representative examples of type II factorial ecology are Sweetser (1965) and Abu-Lughod (1969). Since these two studies differ in emphasis, they merit some examination.

Sweetser compared two metropolitan areas from divergent cultural centers--Metropolitan Boston and Helsinki. A deliberate attempt was made to prepare variable-sets for between-city comparisons, as well as separate sets of variables for within-city comparisons. In both within and between cases, three common dimensions were isolated. In their order of importance these were: "Socioeconomic status"; "Young Familism";

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[25]The primary concern is generalization rather than methodological refinement.

[26]By sophistication is meant of the total methods employed in a given study, not simply refinement of the factor analytical model itself.

and "Urbanism". Coefficients of congruence[27] computed for factor structures between cities, and differing sets of variables for the same city showed cross-national similarities. And while the coefficients were (as expected) higher for within-city comparisons, they still were relatively high between-cities.[28] In addition to these three common factors, Sweetser (1965) found two additional dimensions in Helsinki--"Career Women" and "Postgeniture," and four in Boston--two migration factors, and two ethnic factors. Factor scores were used to study the zone and sectoral distributions in each city as well.

The most important single study of the factorial ecology tradition is Abu-Lughod (1969).[29] This article runs

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[27]Rummel (1970:461-462) gives a detailed definition and description of this correlation related coefficient, which in light of more contemporary refinements, is falling out of favor. Essentially, it measures not only pattern but also magnitude similarity.

[28]Implying then, similar processes at work between divergent urban milieu. The coefficients, interpreted the same as correlations were: Between cities--.744, .792 and .480.

[29]The published article is merely an abbreviated summary of many of the basic theoretical considerations made by the author in earlier working papers.

the gamut from testing the early social area analysis dimensions to running factor analyses of larger variable-sets. An added advantage is seen in the comparison of two time-periods.

The most important contribution Abu-Lughod (1969) made however, was the formulation of <u>necessary conditions</u> for separation of basic dimensions. These necessary conditions are set forth in Table 3. It is obvious from this formulation that the older concepts of <u>scale</u>, evidenced in Shevky and Bell's monograph, play a role in this scheme as well.

Both the Sweetser (1965) and the Abu-Lughod (1969) studies employed a conventional factor analytic model--i.e. principal-axes factor analysis with orthogonal rotation using the varimax criterion. Thus, the distinguishing characteristic of Factorial Ecology Type II, is not further refinements of the factor analysis procedures <u>per se</u>, but rather the use factor analysis is put to, and the theoretical concerns of the investigators, both <u>a priori</u> and <u>ex post facto</u>.

Present day computer facilities provide considerably more flexibility in available factor analytical programs (than what was available in earlier studies). Because of

TABLE 3

SUMMARY OF JANET ABU-LUGHOD'S "NECESSARY CONDITIONS"

Factor Conditions	Types of Variables Used	Necessary Conditions
Socio-economic Status Factor	Education, Occupation, Income	1. "That the effective ranking system in a city be related to the operational definition of social status"; 2. "That the ranking system in a city be manifested in residential segregation of persons of different rank at a scale capable of being identified by the areal units of observation used in the analysis."
Family Status Factor	Family Size, Portions of the Age Pyramid, Fertility.	1. "That family types vary, either due to 'natural' causes such as those associated with sequential stages in the family cycle, or to 'social' causes such as those associated with other divisions in society, whether ethnic, socio-economic or other"; 2. "That subareas within the city are differentiated in their attractiveness to families of different types" at a scale capable of being identified by the areal units of observation used in the analysis.
Disassociation between Socio-economic Status and Family Status Dimensions		either 1. That there exists little or no association between social class and family type;

TABLE 3 (Continued)

Factor Conditions	Types of Variables Used	Necessary Conditions
		or 2. if there is some association between social class and family type,
		that (a) there is a clear distinction between stages in the family cycle, each stage being associated with a change of residence;
		that (b) "subareas within the city offer, at all economic levels, highly specialized housing accommodations especially suitable to families at particular points in their natural cycle of growth and decline" at a scale capable of being identified by the areal units of observation used in the analysis;
		and (c) "Cultural values permitting and favoring mobility to maximize housing efficiency, unencumbered by the 'unnatural' frictions of sentiment, local attachments or restrictive regulations."

SOURCE: Berry and Horton (1970:318). See also: "A Critical Test for the Theory of Social Analysis: The Factorial Ecology of Cairo, Egypt. (Paper, Department of Sociology, Northwestern University, 1968).

this, further refinements of the methodology of factorial ecology are probable. Whether this is done in disregard for theoretical underpinnings of the factor models and follows a phenomenological framework--i.e. Type I; or with sensitivity to theoretical issues, and as an integral element in theory-testing--i.e. Type II, is open for conjecture.

In any case, it is hoped that the preceding analysis has provided the reader with: (1) sufficient background in an ecological perspective; (2) sensitivity to the process of divergent methodological developments; and (3) a feeling for the complexity of contemporary methodological issues revolving around factor analysis--such that the following attempts to use a refined factorial ecology in an objective delimitation of homogeneous subareas within a metropolitan area may fall on sympathetic ears.

Delimiting Social Areas Through Factor Structure

Following the rapid and popular shift from social area analysis as originally proposed by Shevky and Bell (1955), factorial ecologists became enamored with descriptions of factor structure of urban systems to the degree that identifying "social areas" within these urban systems was neglected.[30] In some cases, (Rees, 1968; Berry, 1969) factor scores on the first two dimensions--usually socio-economic status and family status (or a variant of them) were plotted and homogeneous areas were roughly mapped out. But this only gave a two-dimensional "map" of what generally is a multi-dimensional structure. When Rees (1968) employed an "objective" classification procedure to Chicago sub-communities, he admittedly did it only as an example of the potential this direction had. But it was obvious that the available computer program did not provide a means for choosing an optimum grouping solution. Looking back at Sweetser (1965) for instance, his use of factor scores entailed computing averages of census tract groups and testing for zone and sectoral differences with analysis of variance--a procedure similar to that reported by Anderson and Egeland (1961).

The delimiting of homogeneous social areas composed of census tracts with similar scores, be they standardized

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[30] This concern with delimiting social areas was the prime Shevky-Bell objective, and as it is shown, this is a direct link to early "natural area" investigators.

Shevky-Bell indices, or factor scores, may be considered a fundamental part of factorial ecology--even though additional procedures are needed beyond factor analysis *per se*.

But the degree to which factor analysis procedures *per se* are reified by Type I factorial ecologists is quite evident by the total disregard of this phase of social area analysis (in the broad sense). For instance, the special issue "Comparative Factorial Ecology" in *Economic Geography* (1970) does not include a single article in which social areas are actually delimited. This is also true of Berry's (1972) *City Classification Handbook* where intra-city classification is alluded to in general terms by Rees (1972), but the full force of his article shifts hastily back to factor structure.

In subsequent chapters, this author will endeavor to build a defensible classification technique into a more refined factorial ecology.

CHAPTER III

METHODS AND PROCEDURES

General Procedures

Choice of Study Area

The study area chosen consisted of 79 census tracts all or partly located within the official boundaries of Omaha, Nebraska. The reasons for excluding areas outside of Omaha that were tracted are as follows:

(1) Those areas located in Nebraska but within the Omaha-Council Bluffs SMSA covered such a gross amount of acreage over and above city tracts it was feared the range of variation in size, which consequently affected various density relationships within tracts, would seriously distort the analyses performed.

(2) Tracted areas located in Iowa, that were part of the Omaha-Council Bluffs SMSA were also excluded.

It must be remembered that the SMSA is a statistical construct formulated by the Bureau of the Census to aid in providing observational units with a high degree of functional homogeneity and integration. In this case, the SMSA straddles not only a major river, but a major political boundary as well. So it was felt that the functional integration between the excluded areas and the study area would be depressed.

Temporal Focus of Study

The city of Omaha was first tracted by the Census Bureau in 1950 at which time there were 62 tracts, all located in the "central city" area. In 1960, with the advent of SMSA's, the three county region which comprises the Omaha-Council-Bluffs SMSA were tracted. At the time this study was in progress, sufficient data from the 1970 census was not available, thus the study was restricted to analyses for the 1950 and 1960 censal years. The range of variables available for 1950 were extremely limited. In addition, inclusion of 1950 would have seriously depressed the sample size. This investigation then, is cross-sectional since for all practical purposes it is limited to data for 1960.

Units of Observation

The units of observation are all census tracts located all or in part within the city limits of Omaha, Nebraska at the time of data collection by the Census Bureau. The lack of sufficient data by any other areal unit for Omaha during these censal years has prompted this decision. For instance, several housing characteristics were reported by blocks for 1960, but variables considered of prime importance for a sociological study were not available.[1] Because the units of observation--i.e. census tracts, were predetermined, the question of the validity of these areal units--usually couched in terms of within-tract homogeneity (Myers, 1954) or the maximization of between-area variation (Beshers, 1959)--is not a crucial question. At least this is the case if one assumes that some data are better than none. An assumption that census tracts, as used in this study, are valid areal units legitimately employed in ecological research is just as reasonable as the opposite conclusion. Reliance on face validity is therefore justified.

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[1]The expenditure of resources in coding and putting 1960 block data in a computer manipulatable form would have been tremendous.

In addition, there shall be no attempt to infer to individual behavior, or to the general social structure of other cities. Thus, as Beshers (1960) concluded, when investigatory hypotheses are stated in terms of the areal units themselves, the dilemma of inference, as proposed by Robinson (1950) is avoided.

Selection of Empirical Indicators

General Remarks

The selection of appropriate variables for inclusion in a "factorial ecology", and the decision concerning the proper form these variables should take are the two most important and most neglected phases of this particular type of investigative process. It is the variable-input which determines the factor dimensions emerging from a factor analysis. As Wright (1954) demonstrated, the outcome of factor analysis results which failed to be guided by explicit assumptions derived from a definite conceptual framework, tend to be meaningless.

Each variable selected for inclusion must be logically linked to the conceptual framework of the investigator. Of course, to demonstrate *a priori* specific links of large numbers of indicators (in this case, N=68) is not possible. This is especially true in cases where the investigator has in mind a definite constructual framework and is in possession of a large number of potentially useful empirical indicators of one sort or another, but lacks anything but a hazy notion of the proper conceptual links between the two. Such is the case here. Factor dimensions resulting from a factor analysis in this particular case serves two purposes. First, it provides objectively derived conceptual links between the empirical indicators and the constructed theoretical framework. Secondly, it tests the empirical validity of hypothesized variable groupings or untested concepts. If hypothesized but untested concepts can be shown to have theoretical relevance[2] then single variable-inputs may be treated as empirical indicators of these concepts, and the

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[2]Theoretical relevance here refers simply to the reasonableness of connection between empirical indicators, and the broad ecological framework, which is delimited by the interrelationships between three constructs: sustenance activities, social organization, and spatio-temporal aspects.

body of statistical techniques for testing <u>indicator validity</u> may be implemented.[3]

For convenience's sake, variable-sets are defined as <u>concepts</u>, and an individual variable is defined as an <u>indicator</u>. In this scheme the interrelationships between concepts is defined as an <u>ecological framework</u>.[4] The ecological framework is delimited in turn by restricting it to the examination of interrelationships[5] between three constructs defining ecological organization: sustenance activities, social organization, and spatial-temporal aspects.

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[3]The most common method approaches the problem from the standpoint of the internal consistency of a system of indicators, but Costner (1969) and Van Valey (1971) demonstrate on simple models the methods of evaluating multiple indicators of unmeasured variables. Here variable can be equated with the present usage of the term <u>concept</u>.

[4]This particular scheme, which outlines the relationship between constructs, concepts, and indicators, is not unique in ecological investigations. A similar "frame of reference" was presented by Bailey and Mulcahy (1972), but they began from the idea of an "ecological complex" proposed by Duncan and Schnore (1959).

[5]The interrelationships discussed here are assumed to be symmetrical by nature. In order for assymmetrical relationships to be postulated, Costner and Leik (1964) show that the assumptions of time-precedence and uncorrelated residuals between variables must be made.

Interrelationships between concepts derived from these constructs, which are part of the ecological framework, may be assumed, since the constructs from which they are derived are assumed to be interrelated.[6] However, the specific type of interrelationship, as well as their magnitude may be designated as un-identified--i.e. a model defining interrelationships between concepts and defining empirical indicators has not been proposed or empirically tested.[7]

The specific indicators selected for inclusion in this study will be listed and described in subsequent chapters. They were selected to represent the following conceptual areas:

1. Population composition;
2. The physical setting;[8]

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[6]There is of course no way to test a proposition, which is a statement of relationship between two or more constructs, or to test a theorem, which is a statement of relationship between two or more concepts.

[7]Duncan (1966) gives a sensible explication of the relationship between factor analysis and causal models.

[8]The physical setting refers to the physical aspects of areal units viewed independently of considerations of populations residing within them, or the operation of organization upon them.

3. The environment;[9]
4. Residential structure;
5. Labor force structure and mobility;
6. Socioeconomic differentials;
7. Quality of the environment;

Each of these will be discussed in turn briefly below.

Population Composition

A fundamental ecological concern revolves around the differential composition of populations residing within defined areal units (in this case census tracts). Previous factorial ecologies (Type I) have included a broad range of demographic indicators, but have implicitly assumed the operation of what animal ecologists would call the one-species model. Further, these studies usually included just one or two indicators for each of the ethnic groups that made up a significant portion of the population inhabiting the study areas under investigation. Subsequently, when these indicators are factor analyzed, even if their pattern of areal variance is divergent from other demographic indicators,

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[9] The environment refers to the interrelationships resulting from the operation of organization and populations upon the physical setting of areal units.

the force of that areal variance is insufficient to produce separate factor dimensions. This condition is similar to the observation made by Abu-Lughod (1969) concerning the need for sufficient "scale" appearing in the areal attributes under question.

The historical context and contemporary events regarding race relations and differentials, from evidence of dual housing markets (Brown, 1972) to educational and occupational discrimination (Taeuber and Taeuber, 1965) etc. provide face validity for the adoption here of a <u>two-species model</u> for investigation of the population compositions of specific areas in Omaha.[10] Nothing more is implied here by the adoption of a two-species model other than the observation that investigations of populations within specific environments[11] are better served by making the assumption of the operation of <u>caste</u> structures within contemporary

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[10]In some urban systems this model in all likelihood could be effectively expanded to a three-species model. But an examination of the percentages of other ethnic groups indicated that any increment on the residual variation by ignoring these ethnic groups for Omaha would be negligible.

[11]Environment here entails simply populations interacting with particular types of physical settings.

American urban systems.

To couch this argument in more statistical terms, the expectation is that intra-species (intraclass) variation in Omaha is significantly different, such that pooled intraclass correlations along n attributes would not adequately explain variation in the data.

For these reasons, a parallel set of demographic indicators for white and nonwhite population components were selected, as well as more general demographic attributes.

The Physical Setting

The special characteristics of areal units *per se* without alluding to populations, etc. is another important consideration. Since this investigation has been restricted to analysis of interval attributes, such important attributes as "nearness to large bodies of water," "slope of the land," "drainage," "type of or lack of vegetation," "transportation accessibility," are necessarily excluded.[12] But

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[12] In any case, these variables would be difficult to work with, since they would obviously be of nominal order, and thus would not fit into a multivariate scheme.

such considerations as the "differential age of areal units" (as developed residential components) and their position as a unit within the total urban system, are available and will be implemented.[13]

The Environment

The interrelationships of characteristics of populations (population size), and the characteristics of the physical setting (total area) produce definite indicators of the structure of the environment. Density relationships have been found in other studies (Rees, 1968; Winsborough, 1965; Newling, 1966) to be of particular importance. Looking back at Shevky and Bell (1955), for instance, the probability of social interaction was linked to population density.

Residential Structure

Without asserting cause and consequence, the relationship between differential allocations of organizational

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[13]In order for variables indicative of process to be relevant, it is not necessary that a study be longitudinal. Cross-sectional studies many make use of indicators of process so long as conclusions about process are not made. Conclusions made in this vein are another example of ecological fallacies, see Alker (1969).

resources and the areal environments is evident from an examination of characteristics of the residential structures of areal units--with special attention paid to the housing structures existent within different areas. This consideration is of course related to a complex group of processes operating within urban systems. For instance, through the mediation of the housing market, not only are economic decisions linked to changes in the areal distribution of population groups, but other less obvious forces operate (Brown, 1972).

Thus, indicators relating to the type, condition and ownership of housing by areal units is appropriate.

Labor Force Structure and Mobility

Participation in the labor force by sex, age and ethnic groups will vary according to the composition of various population components within areal units. In order to classify areas by homogeneous attributes, labor force participation must be taken into consideration. These indicators must be distinguished from occupational categories, which will be dealt with later.

Socioeconomic Differentials

Variation in the composition of populations within areal units with regard to indicators of occupation, education, and income will be noticeable. Areas typified by poor and old housing will be relegated to lower income groups--who in turn are drawn from the less educated and most "transient" occupations. In addition, since interest rates on new mortgages are increasing, as well as construction costs, these factors will tend to depress low income groups in their areal distribution.

Quality of the Environment

Rees (1971) demonstrated the effect of environmental features (density) on the incidence of communicable diseases. The necessary conditions for a broad range of pathological conditions--social, physical, and psychological, are related to the environmental condition of areal units. Thus, the quality of areal environments, as indicated by housing conditions, density ratios, etc. is another important ecological consideration which will be dealt with here.

General Methods

Tests of Study Area Adequacy

In order that the adequacy of selection of the study area--79 census tracts located all or in part within the official boundaries of Omaha, Nebraska in 1960--be determined, factor analyses of 13 variables by tracts within the study area were compared visually with factor analyses of 13 variables by tracts in the entire Omaha-Council Bluffs SMSA. If discrepancies in variable factor-loadings between these two factor analyses appeared, this would indicate that there are noticeable differences in the empirical indicators between the Omaha central city and the total SMSA. On the other hand, similarities between factor structures would indicate that choice of study area makes little difference. Thus, other considerations such as expediency of data collection may be given priority.

Tests for Linearity in Indicators

Through the implementation of the OMNITAB II[14] statistical program Correlations, Pearson product-moment cor-

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[14]OMNITAB II is a general purpose software package developed by the Bureau of Weights and Measures, U.S. Government.

relations, Spearman rank-order correlation (adjusted for ties) coefficients, two-tailed significance levels (assuming normality)[15] and confidence limits (using Fisher's transformation) were obtained for each pair of 68 indicators across 79 areal units. The assumptions of the Pearson product-moment correlation coefficient--a bivariate normal distribution, linearity of association between pairs of indicators, and homoscedasticty (or equal variances) in the data--are not required by the Spearman rank-order coefficient. Thus, the Spearman rank-order correlation coefficient will measure the magnitude of nonlinear association between indicators.

If the magnitude of the correlation between two indicators, using both the Pearson and the Spearman correlations, is within the 99 per cent confidence limits about the coefficient, the association between those indicators may be said to be linear. Thus Pearson product-moment correlations between indicators may be used in the factor analysis without special transformations being made.

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[15] Direction of association was not postulated *a priori*, therefore a two-tailed test must be used. See Blalock (1960:122-123).

Transformation of Indicators

Particular attention was given to specific forms for expressing indicators. If nonlinearity was demonstrated in any of the associations between indicators, the appropriate logarithmic or quadratic transformations were computed, and the computed version used so that the linearity assumptions of the numerical analyses was satisfied.

Most of the indicators were expressed in terms of percentages, ratios, means or medians. This is particularly crucial in factor analysis. Oftentimes all the derived factors represent, if this is not done, is the specific form indicators were inputed as. For instance, one factor may reflect raw totals, another may represent percentages, etc. This is all well and good, if the investigator desires factors which represent variations in scale or size (raw totals) or variations by an "average person" (per capita). But since there was no reason for such factors in this investigation, they were excluded in this form.

The Factor Analytic Model

Preliminary Preparation

The term Latent Factor Dimensions[16] will be used to denote those "underlying operant dimensions" which have been interpreted (after the general technique of factor analysis which is used to derive them). Latent Factor Dimensions (LFD's) represent interdependent composite scales summarizing selected empirical indicators judged to have significant relevance for an ecological conceptual framework.

Transformed indicators, which approximated the linearity assumptions of the model, were inputed into two general factor analysis computer programs. The first was available from Henry Kaiser (1970) and was entitled by him as the: "second generation little jiffy." The second is Veldman's (1967) Image-Varimax routine.

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[16]This terminology was adopted after recent usage by Brian Berry in an unpublished manuscript (1971) entitled: "Latent Structure of the American Urban System." It refers simply to interpreted factors derived from a common R-type factor analysis and rotated to simple structure. It has been a convenient method of distinguishing between factors which are given interpretation and therefore meaning, from factors which stand uninterpreted or uninterpretable.

First Pearson product-moment correlation coefficients were obtained for each pair of 68 indicators, all of which were treated as continuous. Since each indicator was assumed to consist of two parts--a part it shared in common with other indicators, and a unique portion, the initial 68 by 79 correlation matrix was transformed into an image-covariance matrix, following Guttman's (1953) technique. Image theory, after Guttman (1953), Harris (1962) and Kaiser (1963) defines a matrix hereafter called "G" solely in terms of the "R" (Pearson product-moment correlations) matrix.[17] In essence, according to Veldman (1967: 218):

> It is an elegant . . . solution to the "communality" problem which represents relationships between only the common portions of the original variation, where "common" means "shared by two or more variables."

Principal-axes Factoring and Varimax Rotation

The G matrix[18] (image-covariances) was factored using

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[17]The only assumption, according to Rummel (1970:117) one need make with regard to image analysis is that the residuals of the dependent variable and the m-1 independent variables are uncorrelated.

[18]Both Rummel (1970) and Harman (1967) indicate that the number of cases used in image factor analysis must be

Veldman's programmed version of Hotelling's (1936) principal-axes routine. All possible factors were obtained, rather than calling from an available option only factors with an eigenvalue equal-to-or-greater than 1.0.[19] Since the principal-axes (as the name implies) factor analysis maximizes the first factor extracted, and, according to Kaiser (1959:413) "is an appropriate solution only where theoretical considerations suggest a single primary factor,"[20] the principal-axes variables loadings[21] were rotated to simple structure using Kaiser's (1959) normalized-varimax procedure.

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only one more than the number of variables included. Thus the image factor analysis may handle a greater absolute number of variables--a decided improvement over other techniques.

[19]Kaiser (1960) recommends that researchers use only factors with an eigen-value of 1.0 or higher, as does Veldman (1967). Allowing the program to extract all possible factors takes a considerable amount of extra computer time but does not effect the factors ultimately chosen by the researcher as significant. But it may effect the decision process, the identification of residual factors, and can be helpful in preparing additional analyses with modified variable-sets later on.

[20]It is hard to conceive of any ecological investigation where this would be an appropriate solution.

[21]Principal-axes variable loadings may be interpreted similarly to Beta or path coefficients in regression or path models.

Oblique Rotation to Simple Structure

The normalized varimax rotation to simple structure produces factors that are orthogonal to one another.[22] This condition is imposed on the data by the statistical procedures. A natural or empirical orthogonality of factors cannot be assumed. In order to determine whether or not the derived factors were indeed empirically (or naturally) independent, and to what extent, the principal-axes variable loadings were again rotated, using the oblique rotation Harris-Kaiser after Harris and Kaiser (1964). An oblique rotation, while it produced a simple structure, does not impose orthogonality on any of the derived factors. Thus, when factors were correlated with each other, the extent of empirical (natural) orthogonality is established.

Moreover, since the oblique rotation produced a correlation matrix across all factors, second-order factor structures can be computed from this matrix. In the present study, second-order factors were computed in much the same fashion as first order factors with one exception. The

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[22]Orthogonality is defined as zero correlation across factors for either factor loadings, or factor scores along two or more factors.

Harris-Kaiser procedure has been judged the most efficient oblique factor transformation by Hakstian (1971).

It follows that the factor structure interpretation must implement the oblique solution if a natural orthogonality is not discovered and even if second order factoring does not prove fruitful. This logic will be followed here.

Objective Grouping Into Social Areas

Following the tradition began in ecological research during the classical period, and formalized by Shevky and Bell (1955), the grouping of areal units into homogeneous social areas may be considered an integral part of factorial ecological research. It is immaterial whether or not the basic factor analysis procedures must be supplemented by other techniques, except in cases of Type I research where the factor analysis is reified, and objections are made on ideological grounds.

The most appropriate extensions which supplement factor analysis procedures readily are hierarchical cluster analysis and multiple discriminant analysis. Both of these procedures, for clarification's sake, may be considered as extensions of analysis of variance procedures.

Hierarchical Cluster Analysis

A given set of 79 areal units, each measured on 10 different criterion attributes (LFD's) were grouped together such that the within sum of squares was minimized, and the between sum of squares was maximized. This step was repeated from an initial stage where each of 79 areal units were considered one group, and continued until all of 79 areal units were in one group.[23] At a given stage between the initial step and the final step, the clustering procedure has defined an optimum stage. The optimum stage was defined as that stage where the cumulative increment in the error sum of squares (within sum of squares) increased by the greatest amount, thus creating a significant change in the slope of the error curve plotted against grouping stages.

An optimum solution to the basic question: "to what extent do there exist natural clusters?" was achieved since it was assumed there was a modicum of natural clustering present in the data (Veldman, 1967; Ward, 1963).

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[23]This method is termed agglomerative, and according to Johnston (1970) is preferred to other alternative methods. Johnston (1970), Rao (1952), and Lankford (1969) provide a sound breadth of analysis of these procedures, and the role of objectivity and subjectivity in relation to them.

The Latent Factor Dimensions previously derived were treated as criterion attributes of areal units upon which the clustering procedures was based. The LFD's were weighted before being inputed into the program to reflect their respective proportions of the total variance explained. This was done because the hierarchical cluster analysis procedure treats each criterion attribute equally. The weighting procedure was quite simple. Each LFD score was entered as a criterion attribute one time for each one per cent of the variance explained by that LFD.[24]

Multiple Discriminant Analysis

Johnston (1970) has shown that three sets of subjective decisions must be made in the application of clustering procedures. These decisions include:

(1) the researcher must decide whether to subdivide a population, or to group individuals;

(2) a method denoting some degree of similarity between all pairs of individuals must be chosen;

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[24]An LFD score is simply the factor score of any K areal unit along an interpreted factor--having a mean of zero, and a standard deviation of unity.

(3) the researcher must choose from several definitions of <u>group</u>, several criteria for group inclusion of individuals, and several means for handling highly dispersed deviates.

Assuming that the researcher has decided to use the agglomerative technique, and the between-and-within-sum of squares for denoting similarity, the hierarchical cluster analysis unfortunately does not provide sufficient statistical information for making intelligible judgements in the third decision area. However, this is provided by the implementation of multiple discriminant analysis.

The multiple discriminant model extracted those "roots" (discriminant functions) from criterion attributes which significantly discriminated the optimum clusters (social areas).[25] Cooley and Lohnes (1971:244) observed that "the model derives the components which best separate the cells or groups of a taxonomy in the measurement space."

Several methodological hypotheses concerning the groups and criterion attributes were tested. They provided

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[25]It should be noted that multiple discriminate analysis cannot taxonomize, but is restricted to analyses of posterior probabilities, and depends on existing taxonomies.

the information necessary for making the correct subjective decisions, and for mapping the derived relationships. The overall discriminating power of the test battery (criterion attributes taken together) was tested using Wilks' Lambda. The significance of Lambda was tested with an F-ratio, and interpreted as the significance of the overall group differentiation. Bartlett's (1950) chi-square approximation was used to test the significance of each successive root (discriminants function) to discriminate the clusters after the clustering information associated with preceding discriminant functions has been removed. Univariate analyses of variance were performed on each original indicator (LFD's) to test whether or not individual criterion attributes, by themselves, significantly discriminated the clusters.[26]

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[26] Since the input of criterion attributes are LFD (factor) scores, which are by definition orthogonal, the discriminant functions and criterion attributes should remain identical throughout the series of analyses. But a definite distinction should be made between a Latent Factor Dimension, which explains variation in the data set, and the Discriminant Function of a criterion attribute, which measures the power of that criterion attribute to discriminate. The two may be related but not identical.

CHAPTER IV

PRELIMINARY METHODOLOGICAL FINDINGS

The Adequacy of the Study Area

It was noted earlier that the study area in the present investigation was restricted to 79 census tracts located all or in part within the 1960 Omaha city boundaries. Whether this study area was adequate, in light of the popularity of utilizing the total SMSA (supposedly for its superiority with respect to "functional integration")[1] was considered a matter for research verification. In order to verify (at least partially) the adequacy of the study area in the present paper four separate factor analyses of thirteen widely used indicators which were performed are presented in Table 4.

Two of these factor analyses were computed for the Omaha central city, and two were computed on the total Omaha Nebraska-Council Bluffs, Iowa SMSA. Analyses using

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[1]The Bureau of the Census uses only one criteria -- journey to work -- to determine the "functional integration" of potential SMSA's.

TABLE 4

COMPARISON OF FOUR PRINCIPAL COMPONENTS FACTOR MATRICES

ROTATED TO VARIMAX SOLUTION, OMAHA, 1960

VARIABLE NUMBER	DESCRIPTION OF VARIABLE	FACTOR LOADINGS[1]											
		FACTOR I				FACTOR II				FACTOR III			
		CENTRAL CITY		SMSA		CENTRAL CITY		SMSA		CENTRAL CITY		SMSA	
		U[2]	T	U	T	U	T	U	T	U	T	U	T
1	%White Collar	.919	.929	.909	.854								
3	MDN Sch Yrs	.894	.889	.873	.862								
9	MDN Income	.879	.843	.869	.823								
2	%Prof Tech	+.832	.837	.828	.826								
12	Det Dilapid	-.790	-.753	-.702	-.750								
8	%Negro	-.714	-.609	-.697	-.536								
10	Pop Per Hsld					.963	.962	.952	.935				
6	%Singl Family		.410			.838	.811	.827	.793				
13	%Owner Occpd.	.424	.606		.539	.812	.702	.801	.668				
7	Fertility	-.460	-.439			.782	.791	.763	.803				
11	Median Age					-.786	-.762	-.752	-.781				
5	%Women Inlbf									.892	.916	.885	.888
4	Median Rent		.498		.426					-.826	-.689	-.813	-.690

SOURCE: Sent to author by Phil Rees and Brian Berry, Center for Urban Studies, University of Chicago, Chicago, Ill.

[1]Only factor loadings > ± .40 are included in order to simplify the presentation and accentuate patterns.

[2]"U" stands for untransformed fact or loadings and "T" stands for factor loadings transformed to log base 10.

transformed indicators[2] as well as raw percentages, medians, and ratios were used. A careful examination of Table 4 indicated that there were no significant differences between transformed and untransformed indicators. While this does not provide conclusive evidence that there were no significant differences with regard to other indicators implemented in the present study, it does lend a certain aura of doubt to the popular notions regarding the urgency with which the total SMSA must be utilized in areal studies, at least for Omaha.[3] In addition, Omaha has not been adverse to annexation, albeit selectively, which of itself lends greater credence to the use of tracts within its city boundaries.

Underlying Problems of Utilizing Parametric Statistics in Present Study

There are several underlying complex problems detected during the analytic stage of this investigation. These revolved around the violation of assumptions of parametric statistical procedures, which loosely speaking, involve

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[2] The transformation was to the logarithm of base 10.

[3] More and more, separate cities are being treated as independent universes. Research which tends to make generalizations to other cities usually doesn't work too well.

factor analysis to the degree that the factored input is a product-moment correlation matrix and the diagonal matrix elements are chosen on the basis of statistical theory. These problems included the following:

1) the observed need to standardize most of the indicators utilized in order to remove the disparate effects residing in the nature of the observational units;

2) the observed need to normalize most of the indicators utilized in order to remove the possibility of correlational distortions;

3) questions concerning the power of and need for the proposed test for nonlinearity;

4) the possibility of producing collinearities in the data by either standardization or normalization procedures.

Each of these problems will be discussed here very briefly in order to provide the reader with a contextual framework upon which to judge the substantive findings revolving around the notions of "factorial ecology" and the delineation of sub-areas for Omaha in 1960. It will become quite obvious in the process that these problems are highly interrelated.

The Problem of Standardization.

While the original decision to use census tracts as the basic unit of observation in the present study was made from a pragmatic consideration of data availability, it must be reported that from a statistical standpoint, the census tract in Omaha is less than appropriate as a basic unit of observation for social science research, if one of the primary goals of an investigation include making between-tract comparisons.[4] The variation between tracts with respect to population size, population age structure, land area, etc. -- i.e. crucial indicators upon which the variation of most other salient indicators is dependent, is very extreme. To illustrate this point, a few descriptive statistics for some of these above-named indicators are presented in Table 5. It follows that if these indicators are highly kurtotic and/or skewed (and it is obvious that they are) then concepts dependent on them will be similarly distorted. Thus, before further analyses were performed, and interpretations made, the data were standardized. But

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[4]The Taeubers are now engaged in analyzing block statistics for major American cities. After reaching similar conclusions, Jeff Passel, a Ph.D. candidate at Johns Hopkins University, who has done research on the discrimination of blacks, documented this extremely well in an unpublished paper on Texas urbanized areas.

TABLE 5

DESCRIPTIVE STATISTICS FOR SELECTED VARIABLES,

OMAHA CENSUS TRACTS, 1960

DESCRIPTION OF VARIABLES	MEAN	STD.DEV.	SKEWNESS	KURTOSIS
AREA OF TRACT (ACRES)	303.3418	1164.7561	21.6725*	69.5614*
TRACT POPULATION (1960)	4698.3924	3008.5033	.3384**	- 2.5185***
TRACT POPULATION (1968)	5099.1139	3306.1967	11.4367*	29.1004*
POPULATION/RESIDENTIAL ACRE	35.7734	95.7456	26.1684*	100.044*

*The probability that these distributions are drawn from or represent a normal universe is less than P = .0000.

**The probability that these distributions are drawn from or represent a normal universe is P = .7348.

***The probability that these distributions are drawn from or represent a normal universe is P = .0114.

this was no easy task. The appropriate standardization procedures, as reported by Rees (1968) or Keyfitz and Flueger (1972) produced collinearities in the data which obviated their use in factor analysis. It must be reported that the conversion to percentages and ratios, based solely on the individual tract populations was the only compromise available. This did not remove the effects of all of the deviant indicators, but it did minimize them. The disadvantages of comparing two tracts with widely disparate populations along any attribute were of course obvious. The relative scale of each was not taken into account, and the analyses became blind to interactive elements related to scale effects.[5]

The Problem of Normalization

The sum of all tracts in any given area represent a clustered sample and not a random sample. The application of parametric statistical procedures to such a sample is of doubtful validity.[6] For instance, significance tests (which rest on the concept of a normal sample), may not be made

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[5]Alker (1969) portrays interaction between aggregate and individual levels, or between aggregate levels as a major problem in ecological research.

[6]Songuist and Morgan (1968) in their explanation of Automatic Interaction Detection and Multiple Classification Analysis make this same point more forcefully.

and the interpretation of data may not be generalized beyond the particular units under investigation, or any other time period. Carrying this one step further, if one considered the sum of tracts the total universe, as the present author has done, the additional assumption that the universe is normal is unfounded.[7] This proposition was tested empirically for all of the indicators used in the analyses performed. It followed that a given univariate distribution was normally distributed if the kurtosis and skewness of that distribution approached zero. Of the 68 indicators under consideration, only 11 did not display abnormalities of skewness and kurtosis in their distributions. These indicators may be identified in Appendix F. which describe all of the transformations computed for the indicators utilized in this study.

In addition, as Schuessler (1972) has pointed out, ratio data will follow a binomial distribution rather than a normal distribution, although when a sample consists of large number of cases, the difference is usually negligible.

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[7]In order not to confuse the issue any more than it already is, it is univariate normality that is being referred to at this point.

Rather than attempt any a priori reasoning with regard to what kind of transformation was required for a given distribution, the best approximation to a normal distributional transformation was empirically determined in this instance by computing a variety of possible alternatives. These included:

1. X' = X + n; where n equals any given constant whole number.

2. X' = Square root of X

3. X' = A quadratic function of X (square, cube, etc.)

4. X' = X/n; where n equals any given constant whole number.

5. X' = logarithm to base 10 of X

6. X' = arcsin of X

7. X' = n times X, where n equals any given constant whole number.

8. X' = arsin times the square root of X plus n, where n equals any given constant whole number.

9. X' = any combination of the above transformations.

It must be emphasized that these were merely first approximations. In almost every case the end result still showed a degree of kurtosis and skewness for the indicators involved. In addition, a few of the indicators displayed a bimodal distribution, and by no feat or stretch of mathematical transformations can this be helped. In order that the reader may be apprised of the degree of success or failure of this step in the analysis the final form of the indicators and their "before and after" kurtosis and skewness are presented in Appendix G. of this study.[8]

One may ask the question -- just how necessary is it to make these rather elaborate transformations? In reply two difficulties which will arise by ignoring these underlying assumptions may be alluded to. First, as Rummel (1971) has pointed out, the resultant factor matrix may be seriously distorted when the inputed product-moment correlation coefficients are based on data which violates parametric assumptions. When highly skewed univariate distributions are correlated for instance, not only may a highly attenuated correlational range result (from the theoretical range of ± 1.00) but there may be changes in the direction the correlation takes from what is really the case. One can imagine, for instance, correlating a highly positively skewed and a highly negatively skewed

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[8]It is wise to empirically determine the correct transformations even when one is dealing with the same indicator in the same area but at a different time period.

distribution. This would result in a negative correlation regardless of the true association. With regard to the more commonly discussed effects of <u>monotonic interaction</u> (curvilinearity) the danger of <u>misinterpretation</u> is even more acute (See Blalock, 1971).

Secondly, Sonquist (1970) has mentioned in his monograph the possibility that the tails of univariate distributions may not behave in association with another variable in the same manner as the area approaching the mean. Here the problem may entail <u>nonmonotonic interaction</u>. One need only attest to the applicability of the logistic curve to recognize the significance of this problem.[9]

The problem of bivariate and univariate normality are intertwined. Since bivariate normality is the sufficient condition for the proper application of factor analysis, transformations of indicators to a univariate normality may be considered a necessary but not sufficient condition for bivariate normality. Thus, transformations aimed at normalizing univariate distributions may be used as an

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[9]In a way, the logistic curve is a poor example of nonmonotonic interaction, even though, strictly speaking, more than one direction of interaction is involved. It could just as easily be considered as a special curvilinear case, and was used here only as the simplest example of nonmonotonic interaction.

important preliminary approximation of bivariate normality. In many cases, additional transformations will be unnecessary.

At the present time there is no clear direction researchers may take in this matter. It must be admitted that no appealing solution has presented itself, and that most social research entails statistical and methodological violations. Only the standard of success in the face of such discouragement, such as is evidenced by the "golden helix" research of genetics may ameliorate this situation.

The Problem of the Nonlinearity Test

Comparisons of product-moment correlations of both raw and transformed indicators with Spearman rank-order correlations showed highly disparate coefficients in many cases. And while the transformed indicators usually agreed more closely between Pearson and Spearman rank order coefficients the validity of the comparison in this case is subject to question. Is it any more reasonable to assume that rank order correlations are more accurate, given the possibility of unequal intervals between ranks? If the researcher must choose between the three probabilities -- interaction producing nonlinear association, magnitude disparities due to unequal rank intervals, or both, the latter decision is most likely to be made. Which leaves one remaining course of action, that of plotting each and every unique association -- an almost impossible and certainly expensive process when dealing with large correlation matrices.

Thus, once again, the reader must be cautioned with regard to the powerful sources of error which accompany a study of this sort. There are no quick and easy solutions, and as the experienced researcher will acknowledge, it is virtually impossible not to violate several basic assumptions during the pursuit of a research goal.

Collinearities in Data

As was noted earlier, a complete and appropriate standardization of a large number of indicators produced a highly undesirable side effect -- data collinearity. Without going deeply into the matrix algebra of factor analysis[10] it may be stated that collinearity will produce a singular matrix -- i.e. a matrix which cannot be inverted.

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[10] See Rummel (1970:84-87) for a detailed discussion of these attendant problems.

It follows, then, that should a particular data matrix (in this case a 68 x 68 correlation matrix) be successfully factored, there exists no significant collinearities in the data. Such is the case here for the final compromise data form and for the first order factor analysis.

Unfortunately, there were collinearities between two or more of the obliquely transformed factors which were strong enough to produce a second-order singular matrix Thus, in this case, a second-order factor analysis was impossible.

CHAPTER V

THE FACTORIAL ECOLOGY OF OMAHA, 1960

The Oblique Procedure

A Crucial Question: Factor Independence or Interdependence

A crucial question which must be determined during the performance and interpretation of a factor analysis on areal data is: what degree of independence, or put another way -- what degree of interdependence exists between derived factors? From either a theoretical or methodological standpoint, it makes no sense to proceed with an inappropriate factor-analytic-rotation-to-simple-structure into the interpretive research stages.

During the early development of factorial ecology (Type I) when the only available method of rotation to simple structure often was orthogonal (usually the varimax procedure) there was some justification for its use, even when evidence indicated that the solution obtained was highly artifactual. But a careful examination of the literature of factorial ecology (Type I) brings no mention of any awareness on the part of factorial ecologists of this problem, until quite recently. Haynes (1971) and Berry (1971), who at this point represent Type II factorial ecologists, were the only ones who recognized that the orthogonal solution was unwarranted in many circumstances. Still the present author is aware of no such study that has implemented a nonorthogonal solution in their analysis, despite a rich and readily available documentation and scientific discourse on the subject in such journals as Psychometricka which spans three decades.[1]

It follows that the use of the varimax (or any orthogonal solution) is methodologically and theoretically unsound, unless the natural independence of the data matrix is tested and verified. This necessitates using an oblique solution that does not impose orthogonality on the data matrix. Should an oblique rotational solution fail to verify the existence of factor independence, the researcher's only recourse would be to proceed with his interpretation on the basis of the oblique solution, regardless of its increased level of difficulty.

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[1]Indeed, the question of misuse of methods of rotation in psychological studies may be made similarly.

Since an oblique solution, regardless of whatever specific procedure is employed, produces a factor-intercorrelation matrix, the degree of independence of factors may be quantitatively determined.[2] Table 6 presents the factor intercorrelation matrix derived from the Kaiser-Harris quartimax-based rotational procedure for the factored data enumerated in Appendix F. It will be noted that in 21 out of 40 nonredundant correlations, the coefficient is greater than .30. Based on this evidence, it may be legitimately concluded that the data matrix is interdependent. An orthogonal solution (such as the varimax) would not be a sufficient method for accurate interpretation of the relationships involved. For this reason, the following analyses will be based on the Kaiser-Harris oblique solution.

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[2]Some have argued (Harris, 1962; Kaiser, 1970) that there is no need at all for using an orthogonal rotation, since the oblique rotation will provide an exact solution with empirically determined degrees of orthogonality. Thus, if an oblique rotation is not utilized, the researcher has not proceeded in a methodologically sound manner. And if his data do exhibit empirical orthogonality, the varimax rotation is simply redundant. The whole popularity of orthogonal rotations rests on the popularity of the regression model which assumed independence among predictor variables. But with the advent of path analysis and highly developed methods for handling interdependencies among predictor variables, it is assumed that oblique rotations will now assume ascendancy.

TABLE 6

KAISER-HARRIS FACTOR INTERCORRELATION[a]

MATRIX FOR LATENT FACTOR DIMENSIONS[b]

	I	II	III	IV	V	VI	VII	VIII	IX	X
I	1.00[c]	.78	.03	.31	-.05	.21	-.19	.78	-.39	.84
II		1.00	-.36	.27	.19	.46	.28	.63	-.19	.71
III			1.00	.33	-.57	-.19	-.64	.04	-.11	-.06
IV				1.00	-.07	-.07	-.13	.61	-.35	.26
V					1.00	-.07	.51	.14	-.40	.13
VI						1.00	.52	.09	.42	.07
VII							1.00	.03	.26	.04
VIII								1.00	-.55	.70
IX									1.00	-.36
X										1.00

SOURCE: Original Computations

a. Although the total factor intercorrelation matrix includes 16 factors, only those factors which were interpreted are presented here.

b. Roman numerals correspond to interpreted factors presented in Table 7.

c. Pearson product moment correlation coefficients are rounded here to two decimels, but were originally computed to four places.

Importance of Pattern and Structure Factor Loadings for Interpretation When Oblique Rotation Is Adopted

Since the oblique rotation will be used in all of the analyses that follow here, it is perhaps wise to present an illustration of the importance of interpreting both the factor pattern and the factor structure indicator loadings. This is best done using the schematics and concepts associated with path analysis, a method intimately related to factor analysis.[3]

Consider the case shown in Figure 9, where one factor -- W_z is assigned causal priority or determinancy to three empirical indicators, depicted as Z_1, Z_2, and Z_3 respectively. Since no curved arrows are shown between the empirical indicators, the effect of W_z has been to theoretically remove any association between them. Thus we have the classical depiction of spurious correlation. To clarify matters, when the bivariate case is being considered, the product-moment-correlation coefficient is equivalent to the factor-structure-indicator-loading which is in turn equivalent to the path coefficient between each

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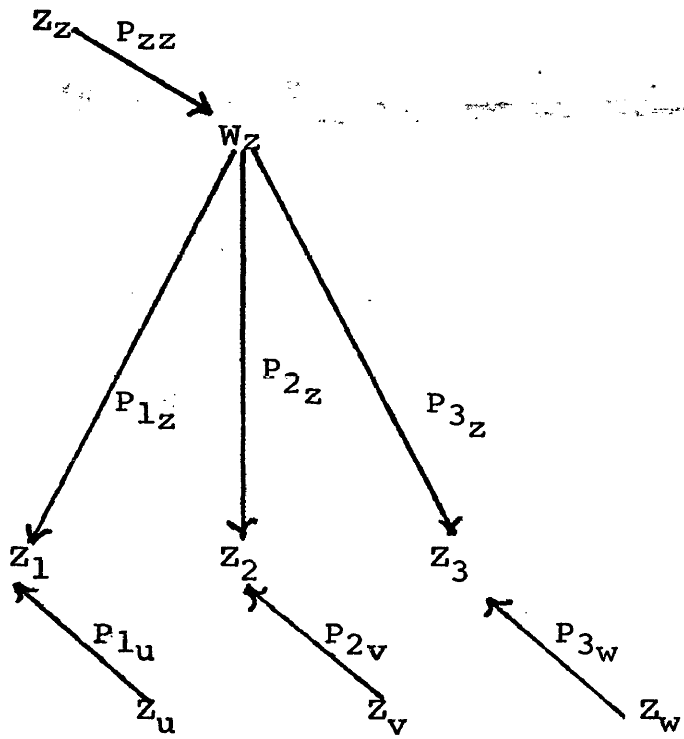
[3]A factor represents the ultimate case of underidentification in the path analysis framework.



Where:

W_z = .a derived <u>factor</u>

Z_1, Z_2, Z_3 = standardized empirical indicators

Z_u, Z_v, Z_w, Z_z - residual terms

P_{zz}, P_{1_u}, P_{2_v}, P_{3_w} = residual path coefficients

P_{1_z}, P_{2_z}, P_{3_z} = factor structure loadings[a] or path coefficients

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FIGURE 9. Illustration Using Path Analysis Notation of Relationship Between Indicators and Oblique Factors

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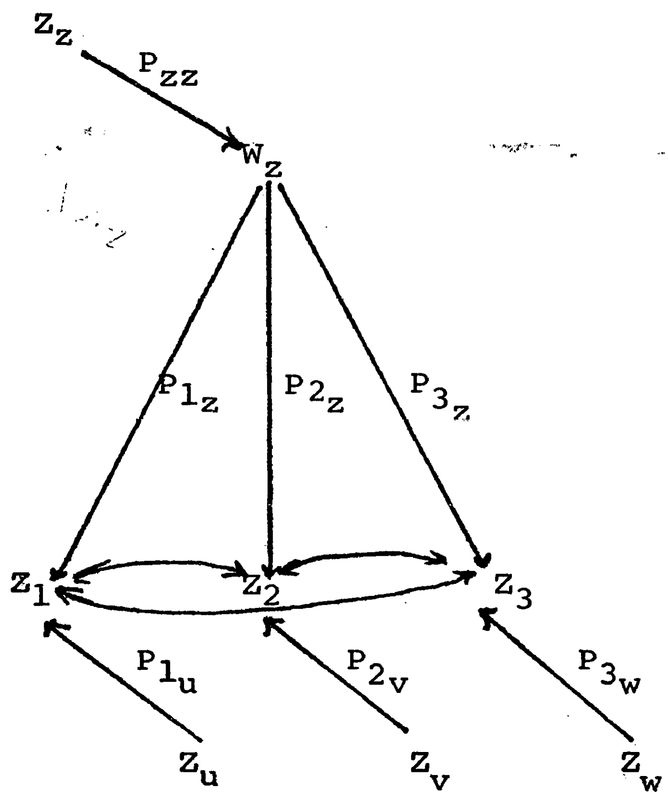
a. The factor structure loading in each case considers only the bivariate relationship of indicator as dependent and factor as independent.

indicator and the derived factor. The path coefficient is interpreted as the total direct effect of the factor on each indicator. Its theoretical range may vary from 1.00 to a minus 1.00. As the reader may recall from looking at the simple regression equation relationships the bivariate Beta (path coefficient) is equivalent to the regression coefficient (assuming standardized indicators) and the Pearson r.

On the other hand, the pattern-loadings (as Rummel makes quite clear) may be interpreted as a measure of the unique contribution each factor makes to the variance of the indicators. Thus, in order to consider, (through a common brand of backward reasoning) the pattern-loadings as a measure of unique indicator variance, it is necessary to take into consideration the relationships between indicators as well. This situation is depicted in Figure 10. In this case, it is the factor-pattern-loadings, that are path coefficients not the structure loadings, but now the total model is quite different, since arrows designating association between indicators are included. In this case, the Beta (standardized regression coefficient) is still equivalent to the path coefficient, but not to the correlation coefficient, since the indirect effects between indicators absent in the first case, must now be computed.



Where:

W_z = a derived factor

Z_1, Z_2, Z_3 = standardized empirical indicators

Z_u, Z_v, Z_w, Z_z = residual terms

P_{2_z}, P_{1_u}, P_{2_u}, P_{3_w} = residual path coefficients

P_{1_z}, P_{2_z}, P_{3_z} = factor pattern loadings or path coefficients

FIGURE 10. Illustration Using Path Analysis Notation of Indicator Interrelationships and Indicator/Factor Relationships for Oblique Factors.

In general, the factor-pattern-loadings are more indicative of the true clustering of indicators in Euclidean space, since when an axis is projected through a cluster of variables, the pattern projections on the other factors will be near zero (Rummel, 1970:399). The structure-loadings, Rummel (1970:401) maintains:

> . . . measures a variables direct relationship with each factor and the interaction between two factors expressed in their factor correlation. In factor interpretation, it is desirable to discriminate between the independent factor contributions to variation in the variables. The structure matrix is not very useful for this purpose. Its main value is in measuring the variance (structure-loading squared) of each variable jointly accounted for by a particular factor and the interaction effects of that factor with the others.

An Outline of Recent Methodological Improvements in the Factor Model and Their Relation To Present Study

The Harris-Kaiser factor analysis procedures are the culmination of three decades of practical computer adaptation and refinements to early mathematical theories. It provides several evaluative tools previously unavailable. These include the following: 1) a root-mean-square-correlation for each input indicator and overall; 2) a measure of sampling adequacy for each input indicator and overall; and 3) an index of factorial simplicity for each input indicator, and overall. These tools provide the researcher with the means of making a more complete evaluation of important aspects of factor analysis results.

Root-mean-square-correlation. Kaiser (1970) has provided a measure of the amount of "distance" between any input indicator and the P-1 remaining indicators, and an overall measure of indicator distance. The formulas are provided in Harmon (1967) and Rummel (1970). Until Kaiser's innovative application within the same factor matrix, the root-mean-square correlation previously was used to measure the distance between similar factors of different analyses in Euclidean space. Here, it provides an additional means of determining the relative interdependence of both the indicators and the total factor matrix. Perfect agreement between indicator loadings would be signified by a root-mean-square coefficient of zero. As the root-mean-square-correlation coefficient increases it is indicative of increased distance or separation within Euclidean space. Thus the overall measure indicates the general degree of separation between factors, and the measure for individual indicators the "relatedness" of the indicator to the total matrix.

Measure of Sampling Adequacy. The next innovative measure, devised by Kaiser (1969) is the Measure of Sampling Adequacy. It is again computed either as a measure of individual indicator sampling adequacy, or as an overall measure. This measure, the formula which is given in Kaiser (1969), varies from a perfect score of +1.00 to a decreasing degree of sampling adequacy, which theoretically extends to a minus infinity. In practical terms a "MSA" score is considered "poor" under +0.40. Thus the factorial ecologist is provided with a methodologically sound measure of the applicability of factor analysis to any given areal input data matrix, since it follows that when the data matrix represents a population and not a sample; what is being measured is not sampling adequacy, but its reciprocal -- factor analytic applicability.

Index of Factorial Simplicity. An example of perfect factorial simplicity is provided in Table 2 on page 49. Here, each indicator has one of three factor loadings -- $\pm$ 1.0 or 0.0. In this situation, the theoretical solution in its most simple state is orthogonal. But given an oblique rotation, where orthogonality is not imposed, it is obvious that indicator loadings will be non-zero and not unity. Thus their loadings across m factors will decrease in factorial simplicity from the theoretical "ideal". It is in such situations where a measure of factorial simplicity becomes salient.

Overall Measures for Present Study.[4] The overall measures across the three measures discussed for transformed and non-transformed data matrices utilized in the present study are presented in Table 7. It is obvious that the importance of transforming the 68 input indicators was justified by the increase in the overall MSA score. It may be noted in addition that the pessimism expressed by the author with regard to the applicability of factor analysis procedures to areal data, at least under the stringent requirements of the psychometricians, is justified. But

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[4]A logical query which could be made with regard to the "springing" of several never previously mentioned measures at this late date, which could appropriately be placed not in a "report of findings," but in the chapter on methodology. *Ex post facto* revisions of a segment of research which appropriately takes place *a priori* merely obfuscates the true dynamics of that research as it progresses and regresses through various stages. It must be pointed out that this thesis is primarily exploratory as well as methodological. To skip an important step -- the need to revise one's methodology in the middle of the stream, so to speak, shorts the reader of part of the true richness of sociological research -- its faltering path from refinement-to-refinement built on the frustrating "mistakes" or "misjudgements" of the participants as they progress from minute discovery to minute discovery.

TABLE 7

OVERALL MEASURES OF FACTORIAL EFFICIENCY

COMPUTED FOR PRESENT ANALYSIS

MEASURE	TRANSFORMED[a] DATA MATRIX	UNTRANSFORMED[b] DATA MATRIX
Root-Mean-Square Correlation[c]	.31	.23
Measure of Sampling Adequacy[d]	-.03	-2.00
Index of Factorial Simplicity[e]	.74	.73

SOURCE: Original Data Analyses

a. Data was transformed as indicated in Appendix G.

b. Data which were standardized but not subjected to any normalization procedures.

c. The root-mean-square correlation with a range of 0 to 1.00 measures the interrelationship of indicators loading on all factors.

d. The measure of sampling adequacy, with a range of +1.00 to - infinity, indicates the degree to which the data are appropriate for use in factor analytic procedures. It increases with 1) sample size; 2) number of variables; 3) as number of factor decreases; 4) magnitude of $\underline{\Upsilon}$.

e. The index of factorial simplicity, with a range of 0 to 1.00, indicates the degree with which indicators load on one primary factor.

in view of the areal nature of the data, it is reasonable to strongly suggest that aggregate data drawn as a population[5] may not correspond to the same requirements as psychological data, simply because it is the overall areal patterns which are of primary importance, and not the power of inferences that may be made. With regard to the simplicity of the factorial patterns, the scores remain relatively invariant across two highly disparate sets of data, and approach the level of adequacy considered by Kaiser (1970) to be sufficient to draw conclusions about the factorial patterns of central importance to this study.

In order to provide the reader with sufficient information with regard to the total battery of indicator scores, all of these statistics are reported for each indicator as they appear within the factor matrix. Thus, in future studies, many indicators which have shown a low degree of fruitfulness here may be discarded, or transformed to a more acceptable form.

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[5]A population is assumed even though many of the indicators represent sampled census items. But it is probably safe to assume that had all census tracts in the SMSA been used the MSA would have somewhat improved.

An Overview of Omaha Factorial Patterns

Number of Factors and LFD'S

The Kaiser-Harris image analysis with ortho-oblique rotation (quartimax-based) to simple structure factored out 16 interrelated factors explaining virtually 100 per cent of the total matrix variance.[6] Of these original 16 factors, 10 were subsequently interpreted and will henceforth be defined as the "latent factor dimensions" for this study. These 10 LFD's explained 89.89 percent of the total variance, while the remaining 6 factors explained the remainder. Due to the low proportion of the variance which was explained by the last six factors, these were arbitrarily considered "error terms" and were left uninterpreted. This strategy is perfectly permissible, since factor analysis is related to the regression analysis family, where the general linear equation takes the form:

$$Y = BZ_1 + e \qquad (1)$$

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[6]The Kaiser-Harris routine uses as a criteria for the number of factors <u>retained</u> for interpretation those where there is evidence that they did not occur "by chance". In technical terms, factors retained must have an eigenvalue greater than the mean-eigenvalue.

and where: B is the Beta constant for standardized (mean of zero and standard deviation of one) variable Z_1 and e is an error term. Since factor analysis "arranges" the indicators into clusters, it is the <u>factor</u> which represents the predictor value in a regression equation. The indicator loadings are the predicted or dependent variable Betas between the indicator and the factor. It is logical from this that factors which derived from an "arrangement" of the variables due to purely error variance will arise.[7]

The relative contributions of each factor and LFD are presented in Table 8 along with a brief description of each. This description is meant primarily as a "shorthand" label for each LFD, since the patterns which were observed were quite complex and defy any attempts at "labeling". A general pattern may be detected between LFD's. Positive correlations between LFD's (see Table 6)

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[7]In the final analysis, there is no acceptable method for determining which factors are LFD's and which represent an error variance, except the probability of interpretation of the factors concerned. Given this circumstance, it is reasonable to assume that an arbitrary decision is <u>valid</u> only if the condition of perfect or near-perfect knowledge on the part of the researcher is present -- an unlikely situation which obviates the need for factor analysis to begin with. In order to circumvent an obviously unsatisfactory procedure, the decision is relegated primarily to factors on the "tail-end", which account for minute proportions of the variance and thus are relatively unimportant.

TABLE 8

RELATIVE CONTRIBUTION OF ALL DERIVED KAISER-HARRIS FACTORS IN EXPLAINING THE TOTAL VARIANCE OF THE 79 x 68 INDICATOR MATRIX

NO.	LATENT FACTOR DIMENSIONS DESCRIPTION	% VARIANCE EXPLAINED
I.	Family Formation Life Cycle Stage	32.84
II.	Social Disorganization	11.34
III.	Housing Conditions	10.87
IV.	Educational Status	5.49
V.	White Age Structure	5.41
VI.	Nonwhite Populations	5.13
VII.	Older Family Stage in Life Cycle	5.03
VIII.	College Populations	4.86
IX.	Low Socioeconomic Status	4.73
X.	Foreign Populations	4.19
	Total Explained Variance	89.89
	RESIDUAL FACTORS	
XI.	Uninterpreted	2.49
XII.	Uninterpreted	1.86
XIII.	Uninterpreted	1.81
XIV.	Uninterpreted	1.42
XV.	Uninterpreted	1.38
XVI.	Uninterpreted	1.14
	Grand Total Explained Variance	99.99

did not involve either LFD: III or LFD: IX. The only exception to this general observation involved a zero-order correlation between LFD: VI and LFD: IX. Referring strictly to the "labels" given in Table 8, this is saying simply that there is a moderate interrelationship between a low status "working-class" dimension and nonwhite populations. This is quite reasonable and in agreement with the general literature concerning the position of Blacks in urban communities. A similar pattern is noted with regard to the negative factor intercorrelations, except that in this case, all negative correlations involved one of the two above mentioned LFD's (III and IX).

Concentric Zones as Factor Correlates. Variable number 47-DISTANCE refers to the approximate distance in quarter miles between the W. O. W. tower in the central business district of Omaha, and the approximate center point of census tract populations. It was included as an input indicator in the presently discussed analyses.[8] Following

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[8]DISTANCE was estimated by the present author with the help of areal maps taken photographically in 1968. The map scale was sufficient to visually determine the land use patterns. It is in error to the degree that any measurement from a scale map will be off. In cases where axial transportation routes did not provide direct "as the crow flies" routes to the census tract centers, the distance measurement was taken on the most direct transportation route available, so in many cases it is not the most direct measurement possible.

the importance of the Burgess concentric zone theory to human ecology and areal delineation it follows that knowledge of the concentric nature of LFD's may lead to important behaviorial or ecological insights with regard to residential populations.

In the present case DISTANCE loaded saliently[9] on three LFD's: I, IV, and VII. The factor pattern loading is strongest on LFD: I, while the factor structure loading is strongest on LFD: VII. These findings are in agreement with the findings of Anderson and Egeland (1961) in that the first LFD represents the "family formation" stage in the life cycle of residential populations, and the salient indicators refer to such things as the Gross Incidence of Dependency (DEPENDCY), the gross incidence of fecund females to the total population (FECUND), etc. A negative or positive DISTANCE structure-loading, such as presented in LFD: VII or II represents a measure of <u>centrality</u> or dispersion for those LFD's to the degree that the W.O.W. tower is located in the center of the C.B.D. Indicators

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[9]Kaiser (1970) has included in his "second generation little jiffy," a measure of "salience" of indicator pattern loadings, which considers the joint effects of the MSA, IFS, SMC, and the structure loadings, but this segment of his routine is at present undocumented in any published form.

which load in the opposite direction, will generally be more or less centrally placed. To determine the exact relationship between DISTANCE and any other indicator, the zero-order Pearson product-moment correlation coefficient must be computed since in the case of LFD's, the relationships of direct effects between indicators is undetermined.

The Latent Factor Dimensions of Omaha, 1960

LFD: I. Family Formation Stage in Life Cycle

The most important LFD for Omaha in 1960 represents a dimension normally associated in the literature as "stage in the Life Cycle," and is presented in Table 9. The most salient pattern-loadings of this LFD include indicators associated with fertility, and family formation. Indicators which denote some form of instability or deprivation -- i.e. "percent of homes sharing or lacking a private bathroom facility, or the incidence of mental illness, etc. load in the opposite direction both on the pattern and the structure matrices, thus indicating that in low family formation areas these conditions prevail.

TABLE 9

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION I: FAMILY FORMATION LIFE CYCLE STAGE

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
6	LABORMAL	.45	.28	.97	1.35*	.2669
33	MEDRENT	-.90	.36	.95	-1.08	-.3699
58	ILLITER	-.18	.29	.90	-1.07	-.1805
27	PCSHARE	.48	.34	.97	-1.06*	-.4191
68	TUBER	-.91	.33	.93	-1.00	-.1134
36	MENTAL	-.52	.37	.98	-.92*	-.2537
49	DEPENDCY	.21	.69	1.00	.90*	.9862
1	FECUND	.28	.78	1.00	.87*	.9868
26	DILAPD	.49	.29	.93	-.87	-.2325
57	LABORFEM	-1.16	.37	.94	-.86	-.0916
43	ARREST	.49	.34	.93	-.82	-.2805
46	POPCHNG	.65	.31	.93	.81	.7946
47	DISTANCE	.38	.29	.98	.75*	.1961
20	PROFMALE	-10.46	.31	.91	.74	-.0256
10	NWMMAGE	.10	.64	.97	-.73	.0217
9	NWUNDER 5	.36	.73	.99	.65*	.3606
24	CITYWORK	-1.30	.32	.92	.65	-.2143
61	ETHNIC I.	-.25	.46	.96	.63	.4234
7	WUNDER 5	.51	.29	.97	.61*	.9327
34	CRAFTMAL	-1.17	.45	.96	.61	-.0223
13	WFNPM	.33	.33	1.00	.60*	.8549
29	PCMDU	-.92	.44	.96	.58	.4229
42	WOOH	.09	.31	.96	.58	-.0590
45	GROSSDEN	.01	.29	.98	-.52	.6314
39	DRPOUT	-.26	.37	.88	-.50	-.0655
2	DYSENT	.38	.30	.83	-.48	.0175
44	ILLEGIT.	-3.43	.29	.88	-.47	-.0658
30	OVERCRWD	.14	.22	.99	.42	-.0605
51	HISCHOOL	.74	.35	.98	.42	.8981

Several occupational indicators load on this LFD as well, though only one is "salient" thus leading one to conclude that Abu-Lughod's necessary conditions (see p. 68 and 69) for the factorial separation of socioeconomic status and family status dimensions has not been met for Omaha in 1960. At first glance, one would not consider that percent of the male labor force engaged in labor and "percent of the male labor force in professional occupations" would load positively on the same dimension. Evidence reported in most previous literature is either in the opposite direction or these indicators were not used.

The explanations that may in part account for this "deviation" are available. First of all, it is probable that the areal unit involved -- the census tract, is not of the necessary scale for differentiating what would in fact be a clear pattern of residential segregation by occupation (if one used blocks, for instance). One need only bring to mind the Chicago gold coast, where wealth and affluence are side by side with abject poverty and are separated by only one or two short blocks. Secondly, the theoretical orientation with regard to what is considered the "proper" relationships of occupations is changing. One theory rapidly gaining acceptance postulates two distinct labor markets--primary and secondary. A primary labor market is typified by stability, steady career-like occupational progression, periodic raises, etc. The secondary labor market, on the other hand, is composed of "menial" dirty jobs, with minimal skills, virtually no career progression, low pay, frequent unemployed periods, etc. Thus, it may be that the indicator loadings here point to occupational patterns of the <u>primary</u> sort, rather than any complex but traditional vertical portrayal.[9] If this is the case, then the wrong questions have been asked by the Bureau of the Census. It is certainly necessary to question traditional methods of collecting and presenting census data with regard to occupational questions because they rest on a set of assumptions concerning the operation of the labor market which may no longer be valid. The evidence in favor of a "dual labor market" is accumulating.

<u>LFD II: Social Disorganization</u>

The second LFD is labeled "social disorganization" and is presented in Table 10. Here there is the definite

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[9] It must be remembered that the present census designations hail from the pre-World War Two era, so there is room to suspect their obsolescence. The concept of a dual labor market is relatively new. The present author's only current source of information is contained in a relatively new publication by Gordon (1972).

pattern of illness, deviance, and mortality indicators loading -- indicative of the breakdown of the social structure in some areas. An increased "gross density" and "residential density" are associated with this LFD.

TABLE 10

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION II: SOCIAL DISORGANIZATION

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
41	DELINQU.	.19	.44	.95	1.38*	.2801
36	MENTAL	-.52	.37	.98	1.26*	.2721
39	DRPOUT	-.26	.37	.88	1.03*	.0586
45	GROSSDEN	.01	.29	.98	.95*	.5913
68	TUBER	-.91	.33	.93	.90*	.3210
44	ILLEGIT.	-3.43	.29	.88	.90	.0003
33	MEDRENT	-.90	.36	.95	.88*	.0778
27	PCSHARE	.48	.34	.97	.82*	.0942
26	DILAPD	.49	.29	.93	.78	.1939
43	ARREST	.49	.34	.93	.73	.1460
6	LABORMAL	.45	.28	.97	-.70*	-.1575
12	WMNPM	.29	.85	1.00	.67*	.9758
55	CRAFTFEM	-10.61	.36	.84	.60	.0935
42	WOOH	.09	.31	.96	-.56	.1169
16	MOVECC	-.05	.29	.97	.55*	.0686
10	NWMMAGE	.10	.64	.97	.53*	.2916
14	NWMNPM	.69	.64	.98	.50*	.5561
57	LABORFEM	-1.16	.37	.94	.46	.1301
67	RESDEN	-1.90	.26	.96	-.43	.0439
9	NWUNDER 5	.36	.73	.99	-.42*	.4785
4	INFMORT.	-4.16	.37	.99	.42	-.0469
3	SAMEHOUS	-3.22	.72	.96	.40	.0674

This would signify that space allocations per person may reach a point where they are contributory to social disruption, and physical and psychological illness (See Rees, 1971). Here again, there is some evidence of the operation of a dual labor market. Female participation in low status occupational categories loads highly on this LFD, while the relationship between "male laborers", which loaded highly on LFDI. now loads in the opposite direction.

The initial interpretation is further reinforced by a joint loading of "white and nonwhite males not presently married" on this LFD. These indicators point toward a similar pre-marital or post-marital state for both races -- composed primarily of rental households, a high degree of instability (moving) and low status female labor participation. It should be observed that indicators pointing to these qualities are all present in their "salient" form in this LFD.

Since Table 6 indicates that LFD I and II are highly correlated, the LFD scores between the two LFD's were plotted against each other and are presented in Figure 11. In this figure, the letters signify group membership of census tracts (as presented in Appendix J), which will be dealt with later in the chapter. What is important to notice is simply that with few exceptions, the two factors are linearly related in a positive direction.

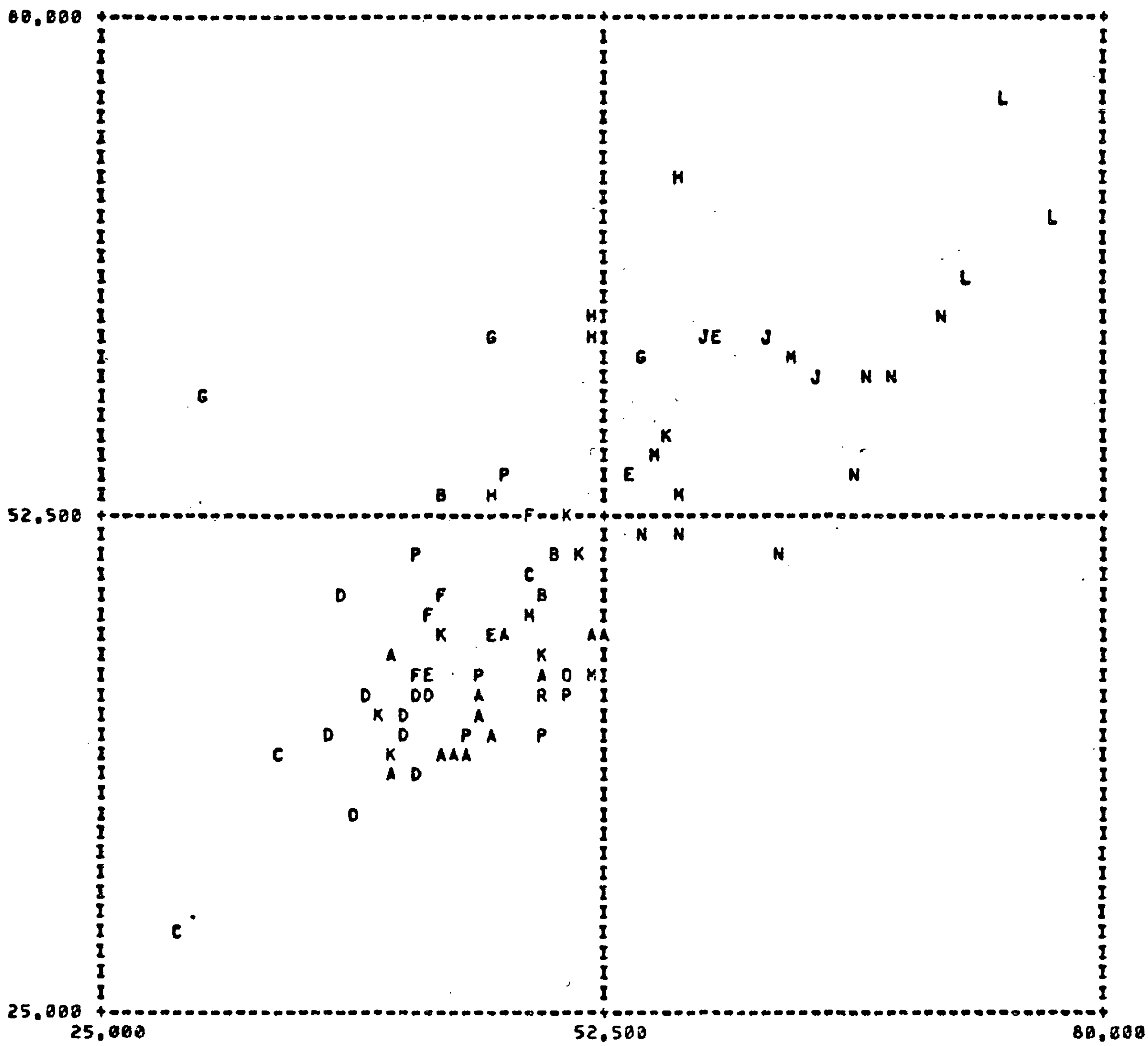

Figure 11. Plot of LFD Scores, Factor I. against Factor II.

This is one sign that the central city is not an appropriate universe after all. It is quite probable, that had the remainder of the SMSA tracts been included, the degree of factor correlation would have been lower and of sufficient scale so that separation of a socio-economic status and stage in life cycle factors would be accomplished. It is also evident that this high degree of factor association accounts for the colinearity of the factor correlation matrix, which negated the possibility of computing a second-order-factor-matrix.

LFD III: Housing Conditions

This dimension is related to the amount of space available in dwelling units and is presented in Table 11.

TABLE 11

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION III: HOUSING CONDITIONS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
31	MEDROOMS	-.58	.98	1.00	1.04*	.9899
32	SINGLDWL	-.63	.37	.98	.61*	.0659
34	CRAFTMAL	-1.17	.45	.96	-.50	-.0576
48	POPHOUS	-.38	.37	1.00	.48*	.8580
24	CITYWORK	-1.30	.32	.92	.44	.0896
44	ILLEGIT.	-3.43	.29	.88	.40	.1891
30	OVERCRWD	.14	.22	.99	-.37*	-.1576

It suggests that the housing market is such that serious overcrowding is minimized at least for the primary labor sectors. There is a close correspondence between the indicator signifying space, and the indicator denoting size of the households on the average. Included in this factor is a positively loaded "single family dwelling" indicator which is related both to "size of family", and "amount of available space." This is an important observation which in effect verifies one of the main conclusions of Peter Rossi (1955) -- that families move for a variety of reasons and one reason is an expanding or contracting family space requirement.

<u>LFD IV: Educational Patterns</u>

The most salient and highest loaded empirical indicator of this dimension (Table 12) is MEDEDUC. The only other salient loadings are in the opposite direction, and here a definite pattern of social deviance is delineated. For instance, while the incidence of alcoholism increased with the median educational level, delinquency decreased. The ethnic indicator also points to a pattern of low achievement, since it too loads in the opposite direction.

TABLE 12

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION IV: EDUCATIONAL STATUS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADINGS	FACTOR STRUCTURE LOADING
40	MEDEDUC	-.88	.93	.99	.95*	.9402
47	DISTANCE	.38	.29	.98	-.53*	-.2976
37	ALCOHL	-5.52	.38	.87	.52	.1342
19	FLABFRC	-6.92	.22	.88	.51	.3004
57	LABORFEM	-1.16	.42	.94	-.46	-.3713
23	AUTOS	-.76	.39	.92	-.42	-.3046
41	DELINQU	.19	.44	.95	-.42	-.2767
61	ETHNIC 1	-.25	.46	.96	-.41*	-.1686

LFD V: White Age Structure

The only salient pattern or structure loadings here are the white median male and female age (Table 13). In general, as these median ages of populations increase, there is a general tendency for the populations to lose with respect to mean income, due in part to the effects of retired populations.

TABLE 13

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION V: WHITE AGE STRUCTURE

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
8	WMMEDAGE	-1.29	.66	.97	1.19*	.8521
5	FWMEDAGE	-.66	.96	.99	1.16*	.9691
25	NWOOH	-.50	.30	.87	-.56	-.0607
65	INCOME	-2.76	.41	.82	-.52	-.1310
55	CRAFTFEM	-10.61	.36	.84	.51	.1398
58	ILLIT	-.18	.29	.90	-.45	-.1840
68	TUBER	-.91	.33	.93	-.42	-.2976

LFD VI: Nonwhite Populations

This dimension presented in Table 14, definitely defines the greatest proportion of the variation within nonwhite populations. It is the only LFD positively correlated with LFD IX: Low Status Neighborhoods. A low occupational position is definitely defined, as an

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSIONS VI: NONWHITE POPULATIONS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
9	NWUNDER 5	.36	.73	.99	.96*	.9392
55	CRAFTFEM	-10.61	.36	.84	-.84*	-.1230
15	NWFNPM	.44	.86	.99	.87*	.9593
34	CRAFTMAL	-1.17	.45	.96	-.85*	-.4320
14	NWMNPM	.69	.64	.98	.74	.9396
42	WOOH	.09	.31	.96	.61*	.6925
57	LABORFEM	-1.16	.37	.94	.53*	.3293
64	ETHNIC 4	.36	.33	.97	-.52*	-.1037
6	LABORMAL	.45	.28	.97	-.51*	-.5687
11	NWFMAGE	.11	.62	.97	.48*	.7970
3	SAMEHOUS	-3.22	.72	.96	-.46*	-.1815
19	FLABFRC	-6.92	.22	.88	.44	.0535
25	NWOOH	-.50	.30	.87	-.40	.3770

important correlate since only the lower male occupations load above the plus or minus .40 cutoff, and the pattern between the indicator FLABFRC and LABORFEM is reversed from that in other LFD's. This LFD represents a relatively independent factor and appears to be related only to other LFD's denoting some kind of inferior social position or organization within the community.

LFD VII: Older Family Stage in Life Cycle

This dimension shows a definite "centralizing" tendency (see Table 15). It defines areal patterns in terms of their percent of single dwellings, white owner occupied housing, stable residency patterns, and patterns of daily life which have increased the number of households without an auto. Although there is a high degree of centralization of this LFD, it defines primarily white areas.

TABLE 15

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION VII: OLDER FAMILY STAGE IN LIFE CYCLE

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
53	NOAUTO	.44	.93	.99	.92*	.9576
32	SINGLDWL	-.63	.37	.98	.86*	.4326
64	ETHNIC 4	.36	.33	.97	.71*	.0969
42	WOOH	.09	.31	.96	.55*	.5147
47	DISTANCE	.38	.29	.98	-.53*	-.7707
16	MOVECC	-.05	.29	.97	-.45*	.6816
25	NWOOH	-.50	.30	.87	-.44	-.1198
68	TUBER	-.91	.33	.93	-.44	-.3688
3	SAMEHOUS	-3.22	.72	.96	.40	.0701

LFD VIII: College Populations

The eighth LFD (Table 16) defines patterns of college attendance, which is accompanied by decreased rates of single dwellings, decreased rates of various types of illness, and increase in the residential density.

TABLE 16

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION VIII: COLLEGE POPULATIONS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
505	COLLEGE	-.01	.98	.99	1.03*	.9812
37	ALCOHL	-5.52	.38	.87	-.77*	-.1197
24	CITYWORK	-1.30	.32	.92	-.77*	-.4295
4	INFMORT	-4.16	.37	.87	-.73*	-.2570
67	RESDEN	-1.90	.26	.96	.71*	.4496
19	FLABFRC	-6.92	.22	.88	-.63	.0172
2	DYSENT	.38	.30	.83	.48	.1616
32	SINGLDWL	-.63	.98	.98	-.45*	-.3113
20	PROFMAL	-10.46	.31	.91	-.44	-.1409
35	GONORR	-5.87	.37	.82	-.44	-.1644
18	MLABFRC	-.87	.85	.98	.41*	-.2096

LFD IX: Low Socioeconomic Status

This dimension shown in Table 17, defines a low socioeconomic position within the social structure of the community more than anything else. The pattern loadings for occupationally related indicators is evidence that there is indeed a secondary labor market. These participants are typified by low educational levels and high levels of welfare dependency -- data which support the dual labor market hypothesis with reference to the expected behavior of secondary occupational populations.

TABLE 17

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION IX: LOW SOCIOECONOMIC STATUS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
60	ELEMED	.58	.86	.98	.98*	.8975
38	ADCLOAD	.33	.44	.96	.90*	.6513
34	CRAFTMAL	-1.17	.45	.96	.83*	.2811
59	BARLIT	.63	.59	.98	.77*	.8516
54	MEDOOH	.68	.69	.97	-.73*	-.8028
56	OPERFEM	.59	.42	.97	.63*	.7899
16	MOVECC	-.05	.29	.97	-.62*	-.2550
66	SYPHILIS	-3.06	.32	.85	-.61	-.1487
2	DYSENT	.38	.30	.83	.48	-.3429
32	SINGLDWL	-.90	.37	.98	-.45*	.4111
35	GONORR	-5.87	.37	.82	.44	.0474
67	RESDEN	-1.90	.26	.96	.43*	-.0012
6	LABORMAL	.45	.28	.97	-.37*	-.7207
20	PROFMAL	-10.46	.31	.91	-.37*	-.0191

LFD X: Foreign Populations

Since all four indicators of foreign populations load saliently on this dimension, (Table 18), it is hard to label it any other way. Several correlative patterns are evident as well. First of all, illiteracy loads highly, which may support a conclusion that assimilation of foreign populations was not yet complete in 1960 in Omaha. In addition, there is a recurrent pattern which is present whenever an ETHNIC indicator loads highly on an LFD -- indicators of illness or deviance usually load negatively to the ETHNIC indicators.

TABLE 18

FACTOR-PATTERN LOADINGS, FACTOR-STRUCTURE LOADINGS AND RELATED MEASURES FOR LATENT FACTOR DIMENSION X: FOREIGN POPULATIONS

CODE NO.	MNEMONIC NAME	MEASURE OF SAMPLING ADEQUACY	INDEX OF FACTORIAL SIMPLICITY	SQUARED MULTIPLE CORRELATION	FACTOR PATTERN LOADING	FACTOR STRUCTURE LOADING
62	ETHNIC 2	.42	.88	.99	1.10*	.9550
61	ETHNIC 1	.25	.46	.96	.67*	.6197
63	ETHNIC 3	.56	.47	.98	.60*	.8972
41	DELINQU	.19	.44	.95	-.61*	-.2669
58	ILLITER	-.18	.29	.90	.58*	.0247
10	NWMMAGE	.10	.64	.97	.49*	.0179
23	AUTOS	-.76	.39	.92	-.47	-.4151
64	ETHNIC 4	.36	.33	.97	.48*	.8972
42	WOOH	.09	.31	.96	-.43*	-.2219
66	SYPHILIS	-3.06	.32	.85	-.42	.0358
36	MENTAL	-.52	.37	.98	-.41*	-.3007
6	LABORMAL	.45	.28	.97	-.41*	.0482
20	PROFMAL	-10.46	.31	.91	-.41	.0804
24	CITYWORK	-1.30	.32	.92	-.40	-.2980
56	OPERFEM	.59	.42	.97	.40*	-.0367

Summary of LFD Description

In this brief description of the Latent Factor Dimensions derived from a Kaiser-Harris image analysis with an oblique rotation, it was noted that all of the LFD's are highly interrelated -- enough to produce sufficient colinearity in the factor interrelation matrix such that a second-order analysis could not be completed. Further, it was noted that a strong socioeconomic status factor, separate from a stage in life cycle factor, did not appear.

In general terms, several factors dealt with specific aspects of population composition and its correlates -- race, age, etc. The indicators of environment define primarily a "housing conditions" factor. The indicators of environmental quality (N=14) loaded on every factor except LFD VI: Nonwhite Populations, and LFD III: Housing Conditions, so no clear cut pattern could be determined, except to note that there was a weak association of some of these indicators with socioeconomic status and life cycle indicators.

Labor force structure and mobility appeared to be highly related with stage in life cycle and socio-economic variables (education and income), but the evidence of observed patterns supports a dual labor market rather than a vertically dimensioned occupational hierarchy with respect to areal patterns.

Indicators with Low Squared Multiple Correlations (SMC)

Practically speaking, the larger a correlation matrix, the greater the SMC for each indicator entered into that matrix. In the present study, the majority of the indicators has an SMC greater than 0.95. However, in surveying the amount of variation explained by the total correlation matrix for each indicator, two sets of indicators with low SMC's emerged. These indicators obviously have less in common with other indicators in the matrix.

The first group were indicators of "deviance" or social disorganization--i.e. ILLITER, DRPOUT, ILLEGIT, INFMORT, AND ALCOHOL on one LFD, and DYSENT, SYPHILIS, and GONORR on another. The second group were FLABFRC, CRAFTFEM, NWOOH, and INCOME.

No light is shed on this observation by examining the various descriptive statistics associated with each indicator (partially present in the appendix). Nor does the type of transformation these indicators were subjected to during the course of the investigation help. But taking into consideration the aggregate level upon which these indicators were constructed, the difference in explained variation for those indicators enumerated above and the rest of the indicators in the correlation matrix must not be lightly discounted. In all probability, if similar indicators were derived from block or individual levels, it may be assumed that the differences between these low SMC indicators, and the others in the matrix would become even greater, since at these levels physiological conditions become more important.[10]

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[10]This conclusion is based on the general observations of Robinson (1950) and Alker (1969) that correlation becomes elevated as an effect of increased aggregation. In the case of morbidity rates, this has been demonstrated not to hold.

One may speculate on the existence of "hidden" dimensions not included in the present study that might possibly explain a greater proportion of the variation in these indicators. Indeed, there must be some or other process or interaction which has masked the true nature of interrelationships of indicators. But for the time being, this finding must remain an anomaly.

The Homogeneous Clustering of Census Tracts by LFD's

The 79 Omaha census tracts which comprised the study area were clustered into homogeneous clusters through the use of the statistical program HGROUP (Veldman, 1967).[11] LFD scores for the ten LFD's derived from the factor analytic procedures were used as the criterion attributes for this procedure. Criterion attributes were weighted to reflect their

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See a replication of Rees (1971a) by Dean (1972a). In the replication, the same indicators remained unchanged, decreased, and increased, over changes in the aggregate measurement level. A hypothesis concerning the effects of aggregation found support on only 30% of the indicators.

[11] These clusters, then, correspond to "social areas" discussed previously in Chapter II.

relative importance in explaining variation in the original correlation matrix.[12] This last procedure was followed because in a previous study of 96 Texas counties (Dean, 1972b) it was found that a weighting procedure increased the probability of achieving contiguous homogeneous areas.[13]

The <u>error sum of squares</u> associated with each stage of the iterative hierarchical cluster analysis were computed. The largest single increment in the <u>error sum of squares</u> was between the 17th and the 18th stages in the clustering process, and it increased exponentially from that point. For this reason, the 17th clustering stage was chosen by the author as the optimum cluster stage. This stage represents a "natural" break in the error curve. One other "natural" break in the error sum of squares, at the 8th stage of the clustering process, was rejected simply because the increase in the error factor would produce "homogeneous" clusters which

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[12]It should be recalled that the HGROUP (VEldman, 1967) procedure treats each criterion attribute equally, regardless of what proportion of variation is explained.

[13]In order to determine the effect of weighting the criterion attributes (LFD's) used as input in the grouping analysis, the same LFD criterion attribures were used an additional time without being weighted. A cursory perusal of this run indicated in fact that tracts in Omaha were grouped less contiguously.

would not be as meaningful. The error curve was plotted from the 30th iterative stage and appears in Figure 12. Based on the 17th grouping stage as optimum, the derived clusters of homogeneous census tracts within Omaha for 1960 are presented in Table 19. An examination of the curve constructed by plotting the number of cluster members by each derived cluster (shown in Figure 13) indicated further the adequacy of this cluster stage. For instance, if the cluster analysis produced clusters of tracts, such that each cluster contained about the same amount of tracts, this would indicate there existed an intrinsic bias within the statistical program. This bias would manifest itself in cases where the objects (in this case tracts) did not display a "natural" tendency to cluster when all other factors are held constant, and the derived clusters are rank ordered by cluster size. The resultant curve should correspond approximately to one tail of a binomial curve, as it does in this case.

The clusters of homogeneous census tracts in the study area were also mapped (see Figure 14) in order to detect whatever interacting areal patterns were present in Omaha in 1960.

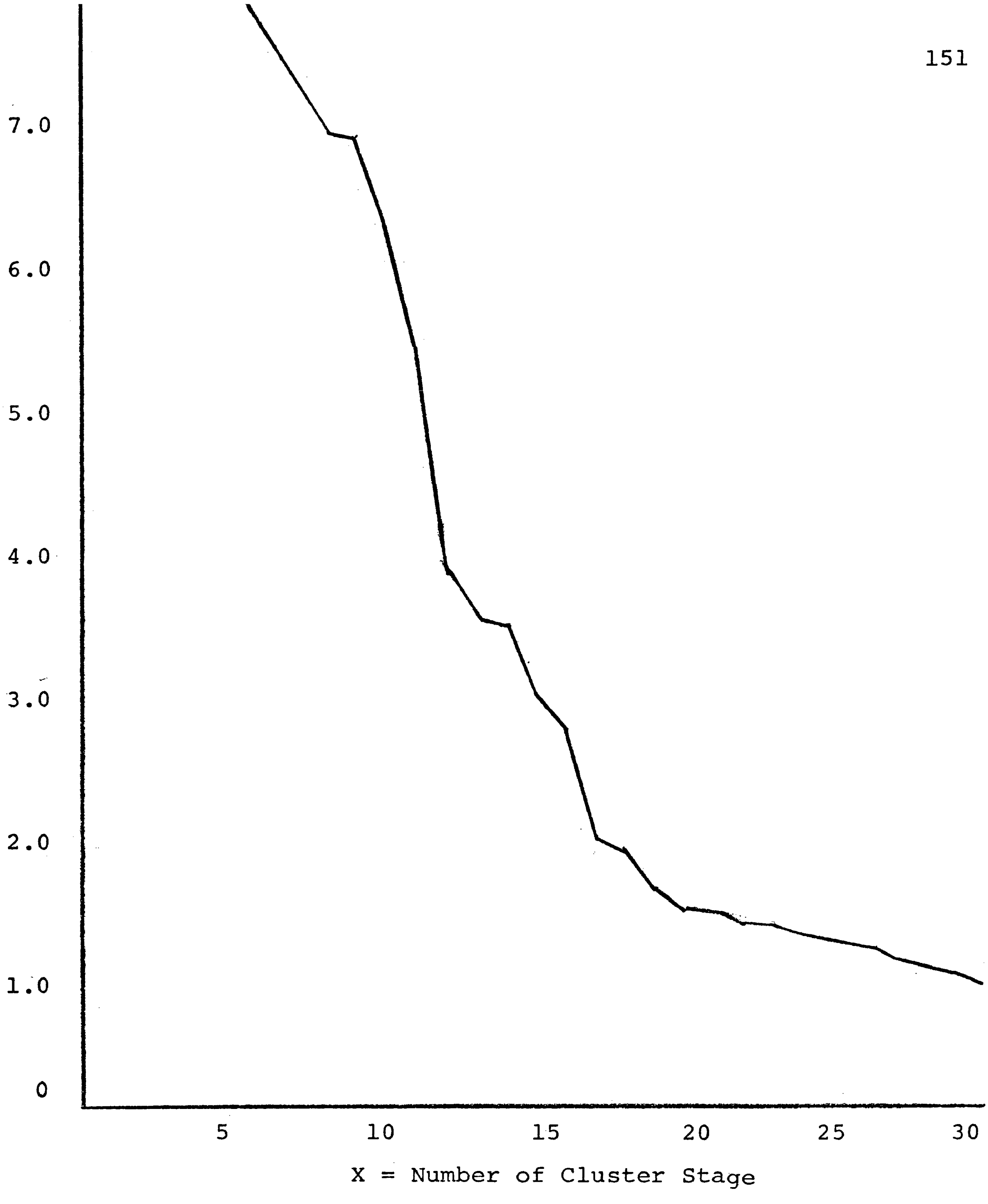


FIGURE 12

PLOT OF ERROR SUM OF SQUARES FOR STANDARDIZED
KAISER-HARRIS LATENT FACTOR DIMENSION SCORES
AT SUCCESSIVE CLUSTER STAGES

TABLE 19

HOMOGENEOUS CLUSTERS OF CENSUS TRACTS
IN STUDY AREA FOR 1960

Census Tract Group Code	Plotting Code Character	Size of Cluster Group	Code Numbers of Tract Members in Each Cluster[a]
1	A	12	01,02,37,38,43,45,46,49,55,57, 59,60
3	B	3	03,06,12
4	C	3	04,65,76
5	D	9	05,07,13,25,26,27,28,33,53
8	E	5	08,21,24,29,32
9	F	4	09,10,11,15
14	G	3	14,17,18
16	H	4	16,19,41,42
20	J	3	20,30,31
22	K	7	22,23,39,40,50,51,52
34	L	3	34,44,58
35	M	6	35,36,54,61,62,74
47	N	7	47,56,67,68,70,72,73
48	O	2	48,71

TABLE 19 (Continued)

Census Tract Group Code	Plotting Code Character	Size of Cluster Group	Code Numbers of Tract Members in Each Cluster[a]
63	P	6	63,64,69,75,77,79
66	R	1	66
78	S	1	78

[a]See Appendix I for conversion table to official census tract numbers.

SOURCE: Original analyses.

FIGURE 13

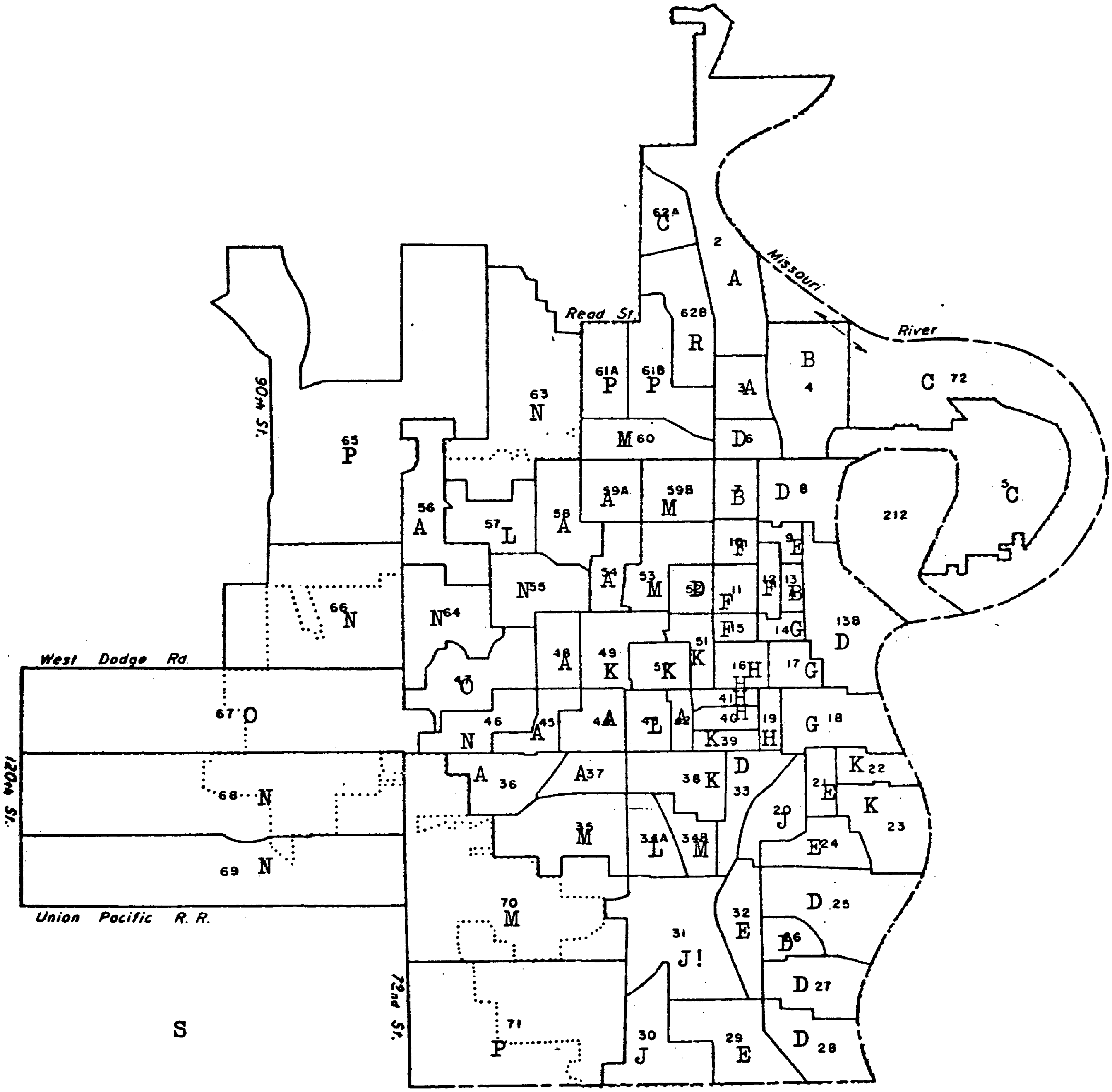
CURVE OF NUMBER OF CLUSTER MEMBERS BY CLUSTERS

AT 17 GROUP STAGE (RANKED BY SIZE)

General Areal Patterns of Tract Clusters

A visual inspection of Figure 14 reveals a considerable amount of cluster contiguity. It is especially pronounced with respect to clusters A, F, and H. Following classical ecological patterns several quasi-sectoral patterns were quite evident in the type of contiguity displayed by clusters D,E,J,M,N, and P. This pattern is not regular, as one might expect in such cases where tract boundaries are irregular. It would appear that labeling any areal patterns as "sectoral" would be an oversimplification of the complex patterns that exist. Not only are clusters more or less contiguous, but groups of clusters also appear related. This is verified by noticing the repititive relationship between clusters O and N. Tracts 46 and 67 cut sectorally west, while the N cluster bound them North and South to a great degree.

Clusters which do not exhibit marked contiguity, such as the L cluster (composed of tracts 34A, 43 and 57) seem to be a part of a larger areal pattern. They play a role that is transitional--a buffer area, so to speak. This cluster (L), while non-contiguous, are all near or contiguous to the A and M clusters of tracts.



SOURCE: Map taken from Zipay (1967)

FIGURE 14

THE OMAHA AREA BY 1960 CENSUS TRACTS SHOWING HOMOGENEOUS CLUSTER DESIGNATION LETTERS FOR EACH TRACT IN STUDY AREA

In an attempt to provide meaning for the areal patterns exhibited between various clusters, Table 20 provides the high and low mean LFD scores for the 17 clusters derived from the analysis. It may be noted that the ranges exhibited by the various mean LFD scores for the clusters are quite regular, and extreme scores are absent. Table 21, on the other hand, shows the rank order of clusters for the first four LFD's. It is from an examination of these data that a few patterns begin to emerge. There is some indication that a quasi-sectoral pattern existed in Omaha in 1960. Clusters that were contiguous (J-E-D in south Omaha; and N-O in west Omaha) showed opposing rank orderings--indicative of rather drastic variations between contiguous clusters--again a phenomena not unlike that reported by the classical ecologists.

In addition to this, in many cases there is a consistent change in the rank ordering of clusters as the distance from the center of the city increases. For instance, D-F-K-N clusters, which move in a broad area to the northwest, have scores on LFD:I of 16-14-10-3. Thus, as Anderson and Egeland (1961) found for other American cities--sectoral and concentric patterns which were additive--is verified similarly for Omaha.

TABLE 20

HIGH AND LOW MEAN LFD SCORES[a] FOR 17 HOMOGENEOUS CLUSTERS IN OMAHA, 1960

LFD	High	Low
I	76.56	37.48
II	84.20	39.65
III	67.21	25.68
IV	68.57	36.97
V	68.28	35.68
VI	72.33	40.73
VII	74.44	38.18
VIII	70.53	25.92
IX	64.47	30.34
X	70.28	36.95

[a]These LFD scores have a mean of 50.0 and standard deviation of 10.0.

SOURCE: Original data analyses.

TABLE 21

THE FIRST FOUR MEAN LFD SCORES

BY RANK ORDER

Cluster Code Designation	FAMILY FORMATION STAGE I	SOCIAL DISORGA NIZATION II	LFD's HOUSING COND. III	EDUC. STATUS IV
A	12	14	7	7
B	9	9	2	1
C	17	16	12	17
D	16	15	8	14
E	7	7	13	13
F	14	10	9	16
G	15	5	16	15
H	6	3	17	3
J	4	4	10	12
K	10	11	14	10
L	12	2	15	2
M	5	8	11	9
N	3	6	3	4
O	13	17	1	5
P	11	12	6	11
R	8	13	4	8
S	1	1	5	5

SOURCE: Original data analyses.

Discriminant Analysis of Clusters

Multiple discriminant analysis does not provide a sensitive measure of optimum clustering. But it does provide greater flexibility in presenting concise depictions of already delineated cluster attributes (Dean 1972b). The significance and discriminating power of each criterion attribute (LFD) was tested against the existing clusters as part of this analysis as well.

The mean discriminant function scores (centroids) for each cluster of tracts are given in Table 22. Only those discriminant functions which explain more than 5 per cent of the variance between groups are included. The Bartlett approximation of chi-square tests of significance are also provided for each discriminant function. The plotting code characters for each census tract cluster are given so that the reader may compare the mean discriminant function scores of these clusters with their areal representations in Figure 14. In addition, the first two discriminant function scores for each census tract were computer-plotted and appear in Figure 15 below.

It would appear, that with some exceptions, the majority of the clusters may be successfully differentiated

TABLE 22

MEAN DISCRIMINANT FUNCTION SCORES (CENTROIDS) FOR 17 OMAHA CENSUS TRACT CLUSTERS ALONG FIVE DISCRIMINANT FUNCTIONS

Plotting Character Code[a]	Census Tract Group Code[b]	Size of Group	Mean Discriminant Function Scores[c]				
			I	II	III	IV	V
A	1	12	34.91	48.98	26.47	-42.29	28.66
B	3	3	32.07	51.74	41.26	-47.16	24.75
C	4	3	10.29	42.35	39.33	-38.12	21.22
D	5	9	25.48	55.63	36.24	-41.18	32.65
E	8	5	35.72	64.12	41.47	-41.18	32.65
F	9	4	20.88	61.83	37.59	-36.93	32.12
G	14	3	24.55	78.43	32.23	-30.64	31.23
H	16	4	42.61	74.00	25.73	-40.11	21.07
J	20	3	47.64	61.26	49.63	-44.45	28.73
K	22	7	38.38	59.91	28.99	-42.57	25.46
L	34	3	56.97	58.15	35.95	-39.44	26.80
M	35	6	41.35	50.95	36.06	-43.15	26.48
N	47	7	48.16	42.54	34.32	-34.74	32.19
O	48	2	37.50	36.53	28.01	-35.43	40.42
P	63	6	29.20	40.25	36.37	-39.49	22.31
R	66	1	34.00	44.16	29.14	-41.29	26.86
S	68	1	58.81	47.88	51.73	-30.15	19.54
Percent Variance Explained			38.90	30.71	10.42	6.13	5.68
Chi-Squared[d]			164.10	150.04	91.01	66.78	63.66
			(df=25)	(df=23)	(df=21)	(df=19)	(df=17)

[a]Corresponds to characters plotted on first two discriminant functions in Figure 15.

[b]Corresponds to code of first census tract assigned to group as shown in Appendix I.

TABLE 22 (Continued)

[c]All mean discriminant function scores that explained 5.0 per cent or more of the variance are presented here. Decimals were rounded to two places.

[d]All chi-square values are significant, $p < .001$.

SOURCE: Original analyses.

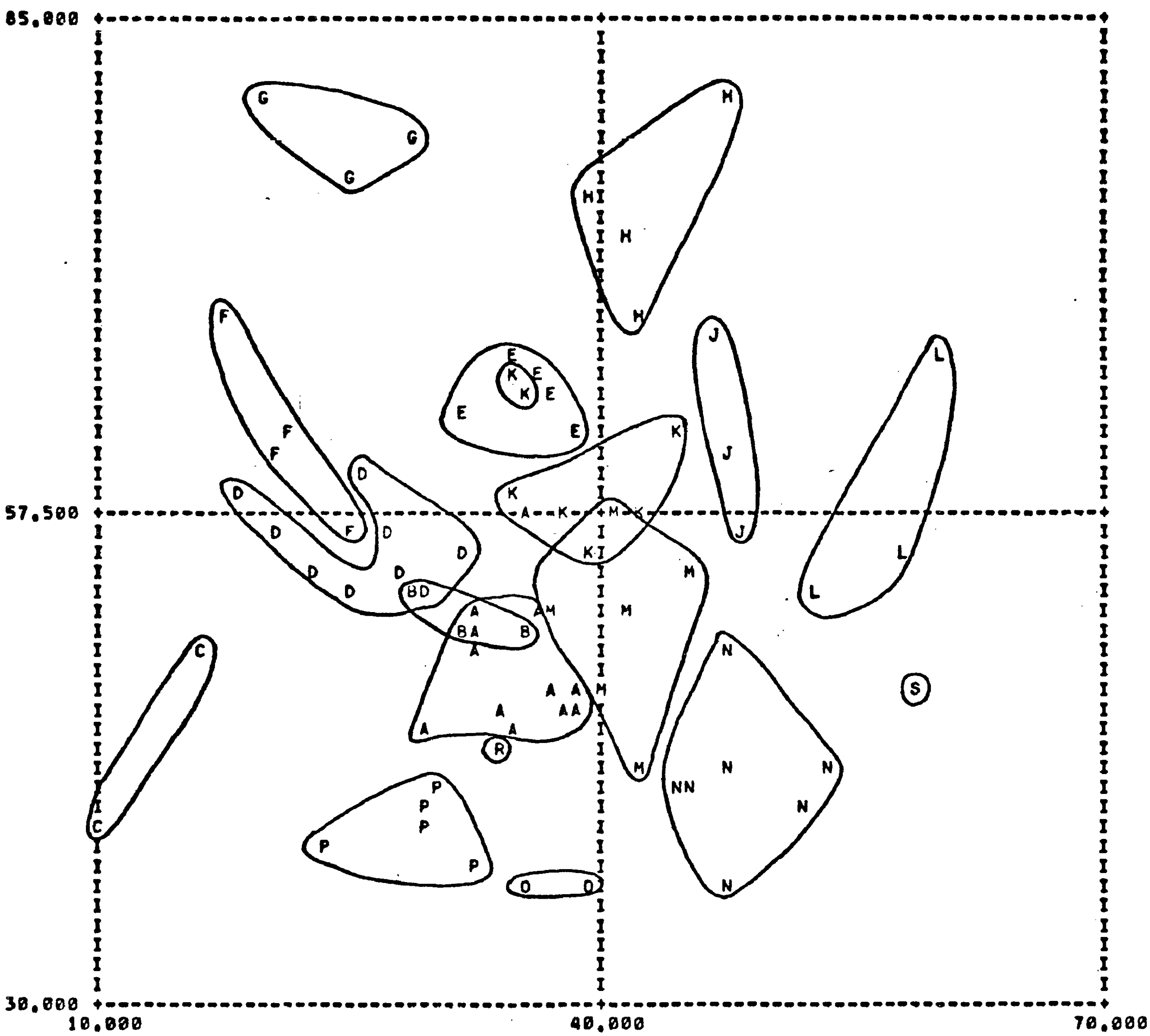


FIGURE 15

PLOT OF DISCRIMINANT FUNCTION SCORES I AND II
FOR 79 OMAHA CENSUS TRACTS, 1960

with just the first two discriminant functions. While it is indicated that 69.61 per cent of the variance in the 17 clusters may be differentiated by these two functions, the necessity of at least a third dimension is clearly indicated by the presence of overlapping clusters in Figure 15.

In addition to this, we may compare two types of adjacency--areal contiguity, and Euclidean distances of clusters, and from this gain further insights. For instance, the first speculation concerning the role of the non-contiguous L cluster is wrong, since the Euclidean distance between this group and the A and M clusters is considerable, while the relationship between the A and M clusters is born out by their nearness in Euclidean space.

And finally, Table 23 presents the correlations between the criterion attributes which were entered into the discriminant analysis (LFD scores) and the resulting discriminant function scores used to plot clusters. This table should enable the reader to refer back to the substantive meaning of LFD's.

TABLE 23

CORRELATIONS[a] BETWEEN CRITERION ATTRIBUTES (LFD's) AND DISCRIMINANT FUNCTION SCORES

LFD Criterion Attribute	F-Ratio[b] of LFD Discriminating Power	Discriminant Function Axes I	II	III	IV	V
I	14.58	.8346				
II	13.32	.6234	.4098	.3555	.3767	
III	8.55		-.7071			.3254
IV	3.09	.46.12				
V	5.44		.4606	-.5410		
VI	7.12		.4946	.4152		
VII	27.92		.9587			
VIII	24.54	.9235				
IX	15.40	-.6088	.3410	.5625	-.3912	
X	22.88	.8748		.3164		

[a]Correlations less than plus or minus .030 are not included in order to simplify the presentation. They are available on request from the author. Correlations of criterion attributes (LFD's) on discriminant functions may be interpreted the same as the loadings of variables on factors in factor analysis.

[b]All F-ratios are significant, $p < .0001$.

CHAPTER VI

A FEW FINAL REMARKS

This investigation reviewed the development of ecological thought in the social sciences over the past two centuries. During the course of this review, it was observed that human ecology came under a severe critical attack (during the 30's and 40's). This attack, which took the form of both methodological and theoretical criticism, did not succeed in fully destroying the ecological perspective. But it did succeed in forcing a shift in emphasis away from theoretical considerations toward mainly methodological pursuits.[1] Following this shift, as one might expect, important methodological strides were made which may be traced to earlier ecological work.

One of the most severe attacks focused around the ecological concept of "niche" or natural area. Work in this area had in fact violated what would be known a few years

[1] Gibbs (1970) claimed that no truly original theoretical advances have been made in human ecology to date. This shift follows a general trend but is much sharper.

hence as the "ecological fallacy", so part of the severity of the attack sprang from its justification not only from theoretical considerations, but from methodological ones as well. But, following the period of general criticism to human ecology, a direct conceptual line from the concept of natural area to the Social Area Analysts of the 50's is evident.[2] With the advent of efficient computer hardware, and the diffusion of software designed to easily handle complex numerical analyses such as factor analysis, what is now known as factorial ecology developed and took the forefront.

But the very absence of further theoretical development within the ecological perspective acted to produce an atheoretical factorial ecology, at least in the dominant mode labeled in this investigation as Type I. Lack of 1) alternative factor analysis programs (to suit different research needs); or 2) deep understanding of factor analysis on the part of early researchers[3] relegated the procedure to exploratory studies rather than hypothesis testing.

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[2] Regardless of Shevky and Bell's disclaimers of this.

[3] An exception to this general rule was the early work of Daniel Price (1942) who worked through the factor analysis procedures available at the time, by hand. But even so, no real flexibility was possible with regard to choice of techniques at that time.

These factors acted to institutionalize the use of the dominant factor model--"principal components with varimax rotation," in Type I research.[4] The persistence over time of this mode, in the face of criticism concerning its conceptual adequacy, and during a period when alternative models were becoming readily available, was bolstered by the crystallization of a phenomenological ideology striking at the very heart of the logico-deductive scientific method (See Berry, 1971).

Thus the unifying force between factorial ecologists was not an ecological perspective, but an ideologically-biased methodology. No union of theory and method were possible under such conditions.[5]

More recently, the ideological elements within factorial ecology have manifested themselves in the form of

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[4]A similar institutionalization process occurred in Psychology. A group of procedures including image analysis with varimax rotation, as a normative mode, even was given a name--Little Jiffy, by the leading factor analysts here.

[5]Indicative of the ideological crystallization present in factorial ecological studies were the remarks of Berry (1971) who found it necessary to call for more varied use of alternative procedures in 1971, some three decades after the first application of factor analysis to urban data (Price, 1942).

resistance to complementary techniques which may profitably be employed with factor analysis. The earlier resistance to newer factorial models is melting in the face of punitive peer group reactions and obviously superior computer software. This recent manifestation has succeeded in sidestepping an important issue--whether or not urban areas may be divided into identifiable sub-areas, or whether the total urban space is integrated to such an extent that this is impossible (or at least irrelevant).

Within this framework the present investigation attempted to do several things simultaneously:

1) Link the methods of factorial ecology more closely with ecological theory;

2) Link the input data matrix more closely with ecological concepts;

3) Refine the factorial model, *per se*, and the preliminary steps a researcher must consider before its use--i.e. preparation of data to satisfy underlying statistical assumptions and deciding upon the form the data should take.

4) Adopt objective classification procedures to delineate (if possible) urban subareas as an integral part of a "factorial ecology";

5) Perform a factorial ecology on a test area--Omaha, Nebraska.

Success or Failure?

A refined factor model was devised, not by the present researcher, but by Kaiser (1970) and adopted for use here. Kaiser's factor model included a measure of the sampling adequacy of all data used as input into the factor analysis. From the standpoint of his measure (MSA), the study was an abyssmal failure. In only a few cases were specific datum considered to be even of fair quality.[6] Since highly transformed census data were used, this offers two possible conclusions. First, the factorial ecology of Omaha, as presented here is of doubtful validity. Second, unless further data for other cities can be found which will produce adequate MSA scores, the validity of factorial ecology applied to urban

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[6] See Table 7, page 124.

areas is thrown into question.[7] For if the data input into the factor program is irregular, then any conclusions concerning "patterns" or "dimensions", are worthless. Clustering procedures, based as they were on factor scores, must also be similarly called into question on identical grounds.

Why were data used in this study "inadequate"? An examination of Federal collection procedures notes that indicators were sample items in most cases. They were not random samples, but rather were systematic samples. This fact may effect the final use of such data. Secondly, the data were never adequately corrected for extreme variation in the size and density of populations by census tracts. Third, the size of the universe (N=79) is low insofar as sampling requisites are concerned. All of these factors contributed to the problem of extremely poor sampling adequacy.

On the practical side, the derived factorial dimensions did make consistent logical sense and the clusters which resulted from the objective classification of the LFD scores seemed approximately "right". In many instances the sub-areas

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[7]The factor analysis procedure used in this investigation represents the first known applciation to areal data.

delineated here duplicated earlier work on an informal basis by community sociologist Wayne Wheeler, of the University of Nebraska. The author's own personal impressions from residence in Omaha over a three year period also verified both the dimensions and the derived sub areas. And it is these observations that in part offset the strictly quantitative determination of validity.

But regardless of any conclusions one might make on the issue of validity the fact remains that the findings on several points are not clear cut enough to make any lasting conclusions. This investigation then, fulfills an earlier promise with regard to its exploratory nature.

Suggestions for Future Work

Most theses find it expedient at some point to make suggestions on how others interested in similar work may proceed without falling into the myriad of pitfalls encountered by them. In the present case, advice is doubly warranted, since the overall conclusions of the present author are negative in nature.

First of all, this investigation did provide certain refinements in methodological techniques associated with factorial ecology, but the most damning sin of factorial ecologists was committed in the early data collection stage of the investigation. Here the lack of direction in data collection is referred to. Not only were the data collected purely on the basis of what other studies had previously collected for other investigations, but without any clearcut theoretical guidance. Theory and data were not adequately linked.

Secondly, the size and nature of the sample or universe under study was not given any preliminary methodological attention. Rather, theoretical considerations vacuously revolving around vague terms such as "integration of metropolitan areas" determined the size of the sample, and the form and nature of indicators.

Third, extreme variation in 1) the areal size of the census tract units, and 2) the population size of the units were not sufficiently standardized. This remains a thorny problem. For it was observed earlier, when one standardizes, colinearities are introduced within the data matrix.

Finally, if one suggestion were most important, it would simply be to restrict the number of indicators investigated to just a few. Pay full and careful attention to them. This not only insures careful conceptual development, but allows the adoption of more powerful statistical techniques such as regression.

A P P E N D I C E S

APPENDIX A[1]

SOCIAL AREA ANALYSIS

Computational Procedures

In some instances, modifications are required by these techniques depending on the reporting procedures used in a particular census. These modifications are not difficult and usually are obvious. See Shevky and Bell (1955:54-57) for examples of such modifications.

I. For each census tract compile the basic data and compute the ratios for the indexes of social rank, urbanization, and segretation. Compute the standard scores and combine these into index scores as indicated below:

A. Social Rank Components

1. Occupational ratio (total number of craftsmen...operators...and laborers...per 1,000 employed persons...):

a. Add:

(1) "Craftsmen, foremen, and kindred workers"
(2) "Operatives and kindred workers"
(3) "Laborers" ("Laborers, except mine" in 1950 census)

b. Subtract the total number of persons with "Occupation not reported" from the total number of persons "Employed."...

c. Divide the total number of craftsmen... operatives... and laborers by the above difference.

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[1]Taken from Shevky and Bell (1955)

2. Occupation standard score: Substitute in standard score formula:

   Occupation score = 100 - (x (r-o))
   where x = 0.161812
   o = 41
   r = occupation ratio for each census tract.

3. Education ratio (number of persons who have completed no more than grade school per 1,000 persons 25 years old and over):

   a. Add number of persons 25 years old and over who have had only eight years of schooling or less.
   b. Subtract the total number of persons with "School years not reported" from the total number of "Persons 25 years old and over."
   c. Divide the total number of persons completing only elementary school or less by the above difference.
   d. Multiply the quotient by 1,000.

4. Education standard score: Substitute in standard score formula:

   Education score = 100 - (x (r-o))
   where x = 0.210526
   o = 81
   r = education ration for each census tract.

5. Social rank index: Compute the simple average of the occupation and education standard scores. The average is the index of social rank.

B. Urbanization Components

1. Fertility ratio (number of children under 5 years per 1,000 females age 15 through 44.):

a. Record the total number of persons "Under 5 years.":
b. Add the number of females in the age rante 15 through 44.
c. Divide the total number of children under 5 by the total number of females age 15 through 44.
d. Multiply the quotient by 1,000.

2. <u>Fertility standard score</u>: Substitute in standard score formula:

Fertility score = 100 - (x(r-o))
where x = 0.232019
o = 160
r = fertility ratio for each census tract.

3. <u>Women in the labor force ratio</u> (number of females of the labor force per 1,000 females 14 years old or over):

a. Record number of females "14 years and over" who are in the "labor force".
b. Divide the above by the total number of females $14 years old and over".
c. Multiply the quotient by 1,000.

4. <u>Women in the labor force standard score</u>: Substitute in standard score formula:

Women in the labor force score - x (r-o)
where x = 0.206186
o = 188
r = women in the labor force ratio for each census tract.

5. <u>Single family dwelling units ratio</u> (the number of single family dwelling units per 1,000 dwelling units of all types):

a. Record the number of "1 dwelling unit, detached (includes trailers)" in 1950 census.

b. Divide by total of "All dwelling unit."
c. Multiply the quotient by 1,000.

6. Single family detached dwelling units standard score: Substitute in standard score formula:

SFDU score = 100 - (x(r-o))
where x = 0.107527
o = 64
r = single family detached dwelling units ratio.

7. Urbanization index: Compute a simple average of the fertility, women in the labor force, and single family dwelling units standard scores. The average is the index of urbanization.

C. The Index of Segregation

1. Add the number of persons designated: "Negro", "Other Races", and "foreign-born whites" from "Poland", "Czechoslovakia", "Hungary", "Yugoslavia", "U.S.S.R.", "Lithuania", "Finland", "Rumania", "Greece", "Italy", "Other America", "Other Europe", "Asia", "French Canada", "Mexico".

2. Divide the above sum by the total population in each census tract.

3. Multiply the above quotient by 100 to obtain the index of segregation for each census tract.

II. Construction of the Social Areas

A. Divisions in the Index of Social Rank (economic status). Divide the census tracts into four groups on the basis of their scores on the index of social rank. Group tracts together having social rank scores of 0 to 24, 25-49, 50-74, and 75 to 100 respectively. Designate these groups of tracts as social areas on the order 1, 2, 3, and 4 respectively.

B. Divisions in the Index of Urbanization (family status). Divide the census tracts into four groups on the basis of their scores on the index of urbanization. Group together tracts having urbanization scores of 0 to 24, 25-49, 50-74, and 75 to 100 respectively. Designate these groups of tracts as social areas of the order A, B, C, and D, respectively. Combining these divisions in the index of social rank, there are sixteen possible social areas. These are designated 1A, 1B, 1C, 2A, ...4D.

NOTE: Census tracts might have a score below 0 or above 100. These tracts are placed in the nearest social area after regarding the index score of the factor which does not exceed the limits of 0 and 100.

C. Division in the Index of Segregation (ethnic status). Divide the census tracts into two groups on the basis of their scores on the index of segregation. Select as the cutting point the percent of the total population of the urban area represented by the combined racial and nationality groups considered subordinate. Those tracts having more than the average proportion of the combined subordinate groups designate "segregated tracts"; those tracts having less than the average proportion of the combined subordinate groups designate "non-segregated". Thus, there are thirty-two possible groupsings of census tracts into social areas: 1A, 1B, 1C, 1D, 2A, ...4D and 1AS.

APPENDIX B[1]

SOCIAL AREA ANALYSIS

Standardization of Scores to the Ranges of the Index Components in Omaha, 1950:

All of the measures composing the indexes of social rank and urbanization have been standardized to their respective ranges in Omaha for 1950. Thus a sinle scale is established for the direct comparison of census tract scores on the respective indexes for different cities at the same time, or the same city at different times. Intracity comparison is not handicapped and intercity comparisons are made possible. Of course, the index of segregation scores are comparable since they are simple percentages.

In the 1950 Omaha analysis the scores composing the indexes of social rank and urbanization were standardized to a range of 0 to 100 in the following way:

a) The basic formula for standardization is: $s = x(r-o)$

where: s = the standardized score
o = the lower limit of the census tract ratios for each component.
x = 100/ the range of the ratio
r = the ratio being computed

b) For those variables (occupation, education, fertility, and single family dwelling units) which had an inverse relation to the basic indexes for which they were computed (social rank and urbanization), the formula was adjusted to read as follows: $s = 100 - (x(r-o))$.

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[1] This standardization procedure was taken from Shevky and Bell (1955:67).

c) The range, the lower limit of the range, and the conversion factor (x) for each of the ratios for the census tracts of the Omaha area for 1950 are as follows:

Ratio	Range	Lower Limit(o)	Conversion Factor (x)
Occupation - - - - - - -	618	41	0.161812
Education- - - - - - - -	475	81	0.210526
Fertility- - - - - - - -	431	160	0.232019
Women in Labor Force -	485	188	0.206186
Single Family Dwelling Units - - - - - - - - -	930	64	0.107527

TRACT NO.	SOCIAL RANK STANDARD SCORE	URBANIZATION STANDARD SCORE	TRACT SEGREGATED?	SOCIAL AREA
29	4.53	24.47	Yes	1A
30	22.23	19.70	No	1A
31	8.83	30.85	Yes	1B
32	19.74	41.88	Yes	1B
33	27.94	34.11	No	2B
34	53.11	23.07	No	3A
35	50.49	9.22	No	3A
36	71.09	15.00	No	3A
37	74.32	22.42	No	3A
38	60.39	52.07	No	3C
39	54.79	70.86	No	3C
40	68.25	85.88	No	3D
41	47.99	92.32	No	2D
42	70.27	75.77	No	3D
43	80.52	70.95	No	4C
44	64.14	43.45	No	3B
45	82.33	28.87	No	4B
46	90.98	26.57	No	4B
47	100.00	32.16	No	4B
48	89.35	45.03	No	4B
49	63.28	45.74	No	3B
50	77.47	60.95	No	4C
51	67.80	58.64	No	3C
52	40.96	21.82	Yes	2B
53	33.56	27.16	Yes	2B
54	52.81	26.19	No	3B
55	76.96	26.30	No	4B
56	42.09	13.62	No	2A
57	59.25	25.11	No	3B
58	73.27	29.82	No	3B
59	50.97	17.72	No	3A
60	47.88	31.06	No	2B
61	23.75	9.83	No	1A
62	72.54	12.04	No	3A

APPENDIX C

STANDARDIZED SCORES OF SOCIAL RANK AND URBANIZATION SOCIAL AREA ANALYSIS DIMENSIONS FOR OMAHA CENSUS TRACTS, 1950

CENSUS TRACT NO.	SOCIAL RANK STANDARD SCORE	URBANIZATION STANDARD SCORE	TRACT SEGREGATED?	SOCIAL AREA
2	65.1	19.40	No	3A
3	60.75	26.82	No	3B
4	3.93	10.10	No	1A
6	23.38	33.51	No	1B
7	34.77	33.11	No	2B
8	37.37	39.44	No	2B
9	31.77	42.72	No	2B
10	34.67	37.58	Yes	2B
11	20.32	43.83	Yes	1B
12	19.78	37.52	Yes	1B
13	40.05	38.59	Yes	2B
14	10.46	28.20	No	1B
15	17.83	58.38	No	1C
16	53.85	66.66	No	3C
17	11.09	71.89	No	1C
18	34.74	88.50	No	2D
19	54.78	80.52	No	3D
20	22.15	32.53	No	1B
21	15.99	35.26	Yes	1B
22	42.95	57.15	Yes	2C
23	19.84	44.30	Yes	1B
24	17.78	41.34	No	1B
25	35.33	35.76	No	2B
26	36.28	33.47	No	2B
27	13.01	24.82	Yes	1A
28	12.92	26.53	No	1B

CENSUS TRACT NO.	SOCIAL RANK STANDARD SCORE	URBANIZATION STANDARD SCORE	TRACT SEGREGATED?	SOCIAL AREA
29	4.53	24.47	Yes	1A
30	22.23	19.70	No	1A
31	8.83	30.85	Yes	1B
32	19.74	41.88	Yes	1B
33	27.94	34.11	No	2B
34	53.11	23.07	No	3A
35	50.49	9.22	No	3A
36	71.09	15.00	No	3A
37	74.32	22.42	No	3A
38	60.39	52.07	No	3C
39	54.79	70.86	No	3C
40	68.25	85.88	No	3D
41	47.99	92.32	No	2D
42	70.27	75.77	No	3D
43	80.52	70.95	No	4C
44	64.14	43.45	No	3B
45	82.33	28.87	No	4B
46	90.98	26.57	No	4B
47	100.00	32.16	No	4B
48	89.35	45.03	No	4B
49	63.28	45.74	No	3B
50	77.47	60.95	No	4C
51	67.80	58.64	No	3C
52	40.96	21.82	Yes	2B
53	33.56	27.16	Yes	2B
54	52.81	26.19	No	3B
55	76.96	26.30	No	4B
56	42.09	13.62	No	2A
57	59.25	25.11	No	3B
58	73.27	29.82	No	3B
59	50.97	17.72	No	3A
60	47.88	31.06	No	2B
61	23.75	9.83	No	1A
62	72.54	12.04	No	3A

APPENDIX D

STANDARDIZED SCORES OF SOCIAL RANK, URBANIZATION, AND SEGREGATION, SOCIAL AREA ANALYSIS DIMENSIONS FOR OMAHA CENSUS TRACTS, 1960

Census Tract Number	Social Rank Standard Score	Urbanization Standard Score	Segregation Standard Score
2	21.72	69.70	4.84
3	15.77	47.77	5.11
4	2.18	28.48	4.80
5	-10.03	-20.01	4.10
6	22.72	44.70	5.19
7	17.37	26.37	-66.59
8	17.63	32.19	-55.39
9	25.85	26.34	-66.82
10	7.77	44.69	-92.82
11	4.26	25.14	-94.06
12	-5.17	32.00	-67.90
A13	17.64	20.35	-54.39
B13	27.15	21.78	7.43
14	18.42	20.12	-57.87
15	8.03	13.20	-79.12
16	51.40	47.76	5.98
17	74.78	12.29	13.41
18	79.60	29.29	13.85
19	80.83	57.63	7.15
20	18.06	20.40	-18.66
21	35.67	14.54	-35.33
22	49.62	40.95	-26.66
23	34.19	35.01	-22.74
24	25.74	34.13	19.02

APPENDIX D--Continued

Census Tract Number	Social Rank Standard Score	Urbanization Standard Score	Segregation Standard Score
25	25.16	35.88	16.17
26	33.65	38.13	10.85
27	20.26	10.66	-29.25
28	17.45	27.43	-24.82
29	5.25	7.51	-27.89
30	12.71	28.41	15.63
31	9.33	16.45	-29.02
32	34.35	21.25	-19.89
33	26.07	27.01	-15.34
A34	33.54	65.39	8.70
B34	14.71	54.96	12.54
35	14.09	61.37	12.18
36	17.00	71.29	8.13
37	21.77	75.77	10.37
38	33.95	59.16	6.92
39	53.18	50.88	8.47
40	79.02	40.87	4.86
41	92.05	56.54	6.23
42	81.73	72.16	6.62
43	72.47	79.61	6.34
44	42.42	66.32	6.20
45	26.47	83.11	7.22
46	8.55	93.58	8.29
47	17.46	97.73	14.65
48	62.66	80.92	8.95
49	50.37	71.34	5.74
50	63.97	76.22	5.15
51	56.68	59.91	6.28
52	-7.83	30.42	-41.87
53	-0.52	40.13	-19.80
54	19.05	54.34	4.94
55	17.52	81.87	13.63
56	14.73	54.24	4.66
57	17.15	65.64	5.65
58	18.78	79.21	4.31

APPENDIX D--Continued

Census Tract Number	Social Rank Standard Score	Urbanization Standard Score	Segregation Standard Score
A59	3.55	61.62	3.46
B59	8.63	44.60	-16.90
60	19.46	52.95	3.41
A61	-7.53	55.95	3.85
B61	5.39	59.40	3.25
A62	11.44	57.14	2.27
B62	7.81	72.82	3.90
63	3.22	72.31	4.38
64	5.40	72.22	8.26
65	4.87	69.70	4.45
66	-6.18	77.50	4.75
67	11.71	91.89	5.94
68	7.97	94.03	4.95
69	-13.66	88.48	3.67
70	2.39	57.39	7.59
71	4.21	18.77	9.54
72	1.22	0.32	3.15
73	2.51	41.24	2.96
74	-1.70	56.65	5.81
75	4.34	42.11	1.22

APPENDIX E[1]

COMPARISON OF RELEVANT EMPIRICAL STUDIES CONCERNING URBAN ECOLOGICAL STRUCTURE AND CHANGE

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Source & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Social Area Analysis	E. Shevky & M. Williams *The Social Areas of Los Angeles*	1949	Los Angeles	Occupation, Education, Fertility, Women in Labor Force, Single Family Dwelling Units, "Negro," "Other Races" & Foreign Born White"	U.S. Census of Population 1940	Social Area Analysis	Economic Status, Family Status, Ethnic Status	
	E. Shevky & W. Bell *Social Area Analysis*	1955	San Francisco Bay Region		U.S. Census of Population 1940 & 1950			
	D.T. Herbert *Social Area Analysis: A British Study*	1967	Newcastle-under-Lyme	Occupation, Education, Fertility, Women in Labor Force	British Census of Population 1961		Economic Status, Family Status	Generally corresponds with known structure of the town
Empirical Verification	R.C. Tryon *Identification of Social Areas by Cluster Analysis*	1955	San Francisco Bay Region	Thirty-three Census Variables		Cluster Analysis		
	W. Bell, *Economic, Family and Ethnic Status: An Empirical Test*	Feb. 1955	Los Angeles, San Francisco	Six Social Area Variables	U.S. Census of Population 1940	Factor Analysis	Economic Status, Family Status, Ethnic Status	

[1] Taken in part from Murdie (1969) and extended to cover more recent studies.

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Source & Year of Date	Analytical Technique	Structural Patterns	Spatial Patterns
Empirical Verification	M. Van Arsdol, Jr., S.F. Camilleri, C.F. Schmid, The Generality of Urban Social Area Indexes	June 1958	Ten large cities in various parts of the U.S.	Six Social Area Variables	U.S. Census of Population 1950	Factor Analysis	Economic Status Family Status Ethnic Status	Generally corresponds with known structure of the town
	T.R. Anderson & L.L. Bean The Shevky-Bell Social Areas: Confirmation of Results and a Reinterpretation	December 1961	Toledo, Ohio	Thirteen Census Variables	U.S. Census of Population 1950	Factor Analysis	Economic Status Family Status Ethnic Status Urbanization	
	T.R. Anderson & J. Egeland Spatial Aspects of Social Area Analysis	June 1961	Akron & Dayton, Ohio Indianapolis Syracuse	Six Social Area Variables	U.S. Census of Population 1950	Social Area Analysis, Analysis of Variance	Economic Status Family Status	Sectorial (Economic Status) Concentric (Family Status)
Spatial Patterns	D.C. McElrath The Social Areas of Rome: A Comparative Analysis	August 1962	Rome, Italy	Nonmanual workers Literacy Ratio Fertility Women in Labor Force	Census of Rome, Italy 1951	Social Area Analysis, Analysis of Variance	Economic Status Family Status	Economic Status & family status are both sectorial & concentric, Economic Status is highest in the central district

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Sources & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Spatial Patterns	D.C.McElrath & J.W.Barkey <u>Social and Physical Space: Models of Metropolitan Differentiation</u>	October 1964	Chicago	Six Social Area Variables	U.S.Census of Population	Social Area Analysis, Analysis of Variance	Economic Status Family Status Ethnic Status	Sectorial (ethnic status) Concentric (economic status) family status)
Multivariate Analysis	F.L. Sweetser <u>The Social Ecology of Metropolitan Boston:1950</u> (1961) F.L.Sweetser <u>The Social Ecology of Metropolitan Boston: 1960</u> (1962) F.L.Sweetser <u>Patterns of Change in the Social Ecology of Metropolitan Boston:1950-1960</u>	1961 1962	Metropolitan Boston	Seventeen Census Variables	U.S.Census of Population 1950 & 1960	Linkage Analysis	Economic Status Family Status	Sectorial (Variables related to economic status) Concentric (other variables)
	E. Gittus <u>The Structure of Urban Areas</u>	1964	Merseyside and South-east Lancashire,U.K.	Twenty-seven Census Variables	U. K. Census 1951	Component Analysis	Age Structure Over-crowding	

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Source & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Multivariate Analysis (continued)	E. Gittus *An Experiment in the Definition of Urban Sub-Areas*	1964-65	Merseyside and Hampshire	Sixty Census Variables	U.K.Census 1961	Component Analysis	Overcrowding Lack of Household Amenities	Analysis of county borough of Bootle within Merseyside confirms pre-conceived notions
	C.F.Schmid and K. Tagashira *Ecological and Demographic Indices: A Methodological Analysis*	1964	Seattle	Forty-two Variables	U.S.Census 1960	Factor Analysis	Economic Status Family Status Ethnic Status Maleness Population Stability	
	F.L.Sweetser *Factor Structure as Ecological Structure in Helsinki and Boston*	1965	Helsinki and Boston	Twenty Census Variables	Finnish and U.S. Census 1960	Factor Analysis	Economic Status Progeniture Urbanism	
	F.L.Sweetser *Factorial Ecology: Helsinki, 1960*	1965	Helsinki	Forty-two Census Variables	Finnish Census 1960	Factor Analysis	Economic Status Feminine Careerism Residentialism Established Familism Postgeniture	

Type of Study	Author(s) and Title	Date Of Publication	City	Variables	Source & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Multivariate Analysis	F.L.Jones A Social Profile of Canberra, 1961	1965	Canberra, Australia	Twenty-four Census Variables	Australian Census 1961	Component Analysis	Ethnicity Demographic structure Age of Area	
	B.J.L.Berry & R.J. Tennant Metropolitan Planning Guidelines: Commercial Structure	1965	Northeastern Illinois	Fifty Social & Economic Variables	Suburban Factbook, 1960	Factor Analysis	Economic Status Family Status Ethnic Status New Suburbs Distance-Density Housing Vacancies	Economic Status (somewhat sectorial) Family Status (somewhat concentric)
	P.O.Pederson, An Empirical Model of Urban Population Structure in Copenhagen	1965	Copenhagen	Fourteen Census Variables	Danish Census 1950 and 1960	Factor Analysis	Family Status Economic Status Growth & Change	Sectorial (Economic status) Concentric (Family status)

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Source & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Multivariate Analysis	G.W.Carey <u>The Regional Interpretation of Manhattan Population and Housing Patterns Through Factor Analysis</u>	October 1966	Manhattan, New York City	Thirty-three demographic & housing variables	U.S.Census of Population 1961	Factor Analysis	General Manhattan Population Residence Puerto Rican sub-population Middle income Negro Low Density Transient Residence West side Rooming House	Factor scores are mapped but the resulting patterns are not compared with the classic descriptive models
	Robson, <u>Urban Analysis: A Study of City Structure</u>	1969	Sunderland	Thirty Census Variables	Enumeration District Data (Great Britain 1961	Component Analysis	Non-linearity of variable distribution	Identification of homogeneous sub-areas and application to attitudes to education
	Abu-Lughod, <u>Testing the Theory of Social Area Analysis: The Ecology of Cairo, Egypt</u>	1969	Cairo, Egypt	13 Census Variables	Census Data (Egypt) 1947 & 1960	Factor Analysis	Socio-economic & Family Status	Pattern reversed from Western cities

Type of Study	Author(s) and Title	Date of Publication	City	Variables	Source & Year of Data	Analytical Technique	Structural Patterns	Spatial Patterns
Multivariate Analysis	Murdie <u>Factorial Ecology of Metropolitan Toronto 1951-1961</u>	1969	Toronto, Canada	109 Census Variables	Census Data (Canada) 1951 & 1961	Factor Analysis; Analysis of Variance	Economic Status Family Status Recent Growth	Concentric and Sectorial
	Berry and Rees <u>The Factorial Ecology of Calcutta</u>	1969	Calcutta, India	Thirty-seven Census Variables	Census Data (India) 1961	Factor Analysis	Land Use and Familism	Reversed Concentric

APPENDIX F

DESCRIPTION OF INDICATORS USED IN THIS STUDY ALONG WITH THE FINAL MATHEMATICAL TRANSFORMATIONS COMPUTED

NO.	MNEMONIC CODE	DESCRIPTION OF INDICATORS	TRANSFORMATIONS COMPUTED
1	FECUND	% of Females age 15-44 to total population	LOG to Base 10
2	DYSENT	Gross Dysentery incidence	2 (Square Root)
3	SAMEHOUS	% of total housing units in same house, 1955	ARCSIN (Sq. Rt.)
4	INFMORT	Gross incidence of infant mortality	LOG 10
5	FWMEDAGE	White female median age	NONE
6	LABORMAL	% of male labor force employed as laborers	ARCSIN (Sq. Rt.)
7	WUNDER 5	% White children under 5 yrs. of age	LOG 10
8	WMMEDAGE	White male median age	LOG 10
9	NWUNDR 5	% Nonwhite children under 5 yrs. of age	LOG 10
10	NWMMAGE	Nonwhite male median age	LOG 10
11	NWFMAGE	Nonwhite female median age	LOG 10
12	WMNPM	White males not presently married	LOG 10
13	WFNPM	White females not presently married	LOG 10
14	NWMNPM	Nonwhite males not presently married	LOG 10
15	NWFNPM	Nonwhite females not presently married	LOG 10
16	MOVECC	% of Total households moving to other part of city	LOG 10
17	CENCMOVE	% of Total households moving within central city	ARCSIN (Sq. Rt.)
18	MLABFRC	% of Males in civilian labor force	NONE
19	FLABFRC	% of Females in civilian labor force	Sq. Rt.
20	PROFMAL	% of Male labor force in professional occupations	ARCSIN (Sq. Rt.)
21	PROFFEM	% of Female labor force in professional occupations	LOG 10
22	UNPAID	% of Unpaid workers to total workforce	LOG 10
23	AUTOS	% of Autos to Households	NONE
24	CITYWORK	% of Labor force working in city limits	NONE
25	NWOOH	% of Total housing with nonwhite owners	ARCSIN (Sq. Rt.)
26	DILAPD	% of Total housing with dilapidated condition	LOG 10
27	PCSHARE	% of Total housing sharing or lacking bath	LOG 10
28	DUPLEX	% of Total housing that are duplexes	NONE
29	PCMDU	% of Total housing in 3 or 4 units	LOG 10
30	OVERCRWD	% of Total housing with 1.01+ persons per room	NONE

APPENDIX F (Continued)

NO.	MNEMONIC CODE	DESCRIPTION OF INDICATORS	TRANSFORMATIONS COMPUTED
31	MEDROOMS	Median number of rooms per housing unit	NONE
32	SINGLDWL	% of Total housing that are single family dwelling units	ARCSIN (Sq. Rt.)
33	MEDRENT	Median rent of all rental housing units	ARCSIN (Sq. Rt.)
34	CRAFTMAS	% of Male labor force in craftsman occupations	NONE
35	GONORR	Gross incidence of reported Gonorrhea	LOG 10
36	MENTAL	Gross incidence of reported mental illness	LOG 10
37	ALCOHL	Gross incidence of reported alcoholism	LOG 10
38	ALCLOD	Gross incidence of adc. case loads	LOG 10
39	DRPOUT	Gross incidence of school dropouts	LOG 10
40	MEDEDUC	Median number years of school	LOG 10
41	DELINQU	Gross incidence of reported delinquency	LOG 10
42	WOOH	% of Total housing owned by whites	ARCSIN (Sq. Rt.)
43	ARREST	Gross incidence of all arrests	LOG 10
44	ILLEGI	Gross incidence of illegitimate births	LOG 10
45	GROSSDEN	Gross density of tract	LOG 10
46	POPCHNG	Gross population change 1960-1968	LOG 10
47	DISTANCE	Approximate distance from W.O.W. tower	LOG 10
48	POPHOUSE	Population per household	LOG 10
49	DEPEND	% of Population 5-34 yrs old as fulltime students	LOG 10
50	COLLEGE	% of Population enrolled in college	LOG 10
51	HISCHOOL	% of population with high school education	LOG 10
52	COLGRAD	% of Population with 4 or more yrs of college	LOG 10
53	NOAUTO	% of Housing units with no auto available	NONE
54	MEDOOH	Median value of owner occupied housing units	NONE
55	CRAFTFEM	% of Female labor force in craft occupations	LOG 10
56	OPERFEM	% of Female labor force in operative occupations	NONE
57	LABORFEM	% of Female labor force in laborer occupations	LOG 10
58	ILLIT	% of Adult population with no school yrs completed	LOG 10
59	BARLIT	% of Adult population with 1-4 yrs school completed	LOG 10
60	ELEMED	% of Adult population with 5-7 yrs school completed	LOG 10
61	ETHNIC 1	% of Population Puerto Rican plus Mexican foreign stock	LOG 10
62	ETHNIC 2	% of Population Polis plus Hungarian foreign stock	LOG 10

APPENDIX F (Continued)

NO.	MNEMONIC CODE	DESCRIPTION OF INDICATORS	TRANSFORMATIONS COMPUTED
63	ETHNIC 3	% of Population Czech plus U.S.S.R. foreign stock	LOG 10
64	ETHNIC 4	% of Population Italian foreign stock	LOG 10
65	INCOME	Median income per household	ARCSIN (Sq. Rt.)
66	SYPHILIS	Gross incidence of syphilis	ARCSIN (Sq. Rt.)
67	RESDEN	Gross residential density	LOG 10
68	TUBER	Gross incidence of Tuberculosis	LOG 10

APPENDIX G

SELECTED STATISTICS FOR INDICATORS UTILIZED IN THIS STUDY FOR OMAHA, 1960

NO.	MNEMONIC NAME	COEFFICIENT OF RELATIVE VARIATION	UNTRANSFORMED SKEWNESS	UNTRANSFORMED KURTOSIS	TRANSFORMED SKEWNESS	TRANSFORMED KURTOSIS
1	FECUND	2.825	3.445	12.073	.772	.471
2	DYSENT	2.558	-1.112	-.688	-1.235	-.273
3	SAMEHOUS	-.047	-.463	-.383	-1.306	-.011
4	INFMORT	4.268	2.910	7.026	.911	.761
5	FWMEDAGE	4.457	-.144	2.361	-.144	2.361
6	LABORMAL	.391	.714	.006	-.317	-1.361
7	WUNDER 5	1.915	3.883	16.374	.564	.362
8	WMMEDAGE	15.177	.857	2.229	-.264	1.607
9	NWUNDER 5	.746	4.487	24.361	.876	-.462
10	NWMMAGE	2.254	1.720	1.706	1.381	.036
11	NWFMAGE	1.095	-.144	2.361	1.618	.699
12	WMNPM	2.127	5.130	29.651	.884	.621
13	WFNPM	2.075	6.185	43.848	.759	.683
14	NWMNPM	.607	3.834	16.503	.825	-.405
15	NWFNPM	1.175	4.483	20.329	.793	-.459
16	MOVECC	1.501	2.396	6.039	.567	.767
17	CENCMOVE	.341	.366	.743	-.656	-1.048
18	MLABFRC	1.495	.894	.487	.894	.487
19	FLABFRC	1.136	3.310	9.518	1.178	.865
20	PROFMAL	.073	8.192	67.319	-.090	-1.395
21	PROFFEM	4.865	6.740	45.783	.805	2.705
22	UNPAID	2.871	.888	.709		
23	AUTOS	1.330	.416	-.917	.416	-.917
24	CITYWORK	1.294	.921	-.216	.921	-.216
25	NWOOH	1.119	-2.536	5.339	-2.354	6.960
26	DILAPD	.547	4.146	18.506	-.026	-.586
27	PCSHARE	.701	8.497	71.432	-.317	.118
28	DUPLEX	1.218	.667	-.766	.667	-.716
29	PCMDU	.635	5.619	32.078	-.105	-.001
30	OVERCRWD	1.884	.745	.887	.745	.887
31	MEDROOMS	4.746	-.429	4.072	-.429	4.072
32	SINGLDWL	.133	-1.091	.150	.254	-1.084
33	MEDRENT	.500	-.589	-.759	-.829	-.908

APPENDIX G (Continued)

NO.	MNEMONIC NAME	COEFFICIENT OF RELATIVE VARIATION	UNTRANSFORMED		TRANSFORMED	
			SKEWNESS	KURTOSIS	SKEWNESS	KURTOSIS
34	CRAFTMAL	2.726	-.395	-.425	-.395	1.084
35	GONORR	3.200	.442	-1.525	-.206	-1.555
36	MENTAL	6.286	7.133	54.815	.887	2.330
37	ALCOHL	3.031	.834	-.916	.257	-1.485
38	ADCLOD	2.498	2.255	4.255	-.124	-.141
39	DRPOUT	3.022	2.821	6.117	.958	1.021
40	MEDEDUC	.547	8.122	67.291	5.078	36.355
41	DELINQU	3.271	3.549	11.671	.525	.835
42	WOOH	.781	-2.536	5.339	1.989	2.833
43	ARREST	4.670	1.383	.887	-.049	-.965
44	ILLEGI	2.984	.797	-1.254	.113	-1.360
45	GROSSDEN	2.412	8.066	65.933	.781	1.670
46	POPCHNG	1.065	1.792	6.976	-.066	-1.857
47	DISTANCE	1.133	.644	-.330	-.838	.817
48	POPHOUSE	5.383	10.406	10.406	-.965	4.410
49	DEPEND	2.916	3.896	16.923	.822	.628
50	COLLEGE	.303	5.105	29.981	-.252	.570
51	HISCHOOL	2.227	3.276	10.782	.374	.149
52	COLGRAD	.783	3.699	14.592	-.119	1.257
53	NOAUTO	1.197	.849	.260	.849	.260
54	MEDOOH	2.234	.631	1.315	.631	1.315
55	CRAFTFEM	.075	1.017	1.258	-.626	-.593
56	OPERFEM	1.440	1.040	.616	1.040	.616
57	LABORFEM	.487	2.972	10.304	.190	-.904
58	ILLIT	.326	2.727	8.324	-.517	-.309
59	BARLIT	.737	1.124	.314	-.335	-.232
60	ELEMED	2.983	.710	-.100	-.884	1.010
61	ETHNIC 1	.933	2.762	7.551	.453	-.811
62	ETHNIC 2	.171	5.122	29.700	.368	.298
63	ETHNIC 3	.647	3.295	12.001	-.029	-.392
64	ETHNIC 4	.200	4.491	25.010	-.347	.684
65	INCOME	.228	6.556	45.909	.425	-1.265
66	SYPHILIS	.157	-.418	-1.792	-.757	.354
67	RESDEN	2.563	7.215	55.180	-.154	2.799
68	TUBER	2.567	1.269	-.354	.816	-.811

APPENDIX H

LATENT FACTOR DIMENSION SCORES FOR 79 OMAHA CENSUS TRACTS, 1960

00012 GROUP ONE										
01	48.85	44.22	55.25	51.91	59.00	40.01	44.53	50.32	42.32	44.60
02	47.14	45.66	53.83	49.76	53.85	41.58	47.81	47.55	49.99	45.89
37	46.22	40.07	51.92	53.50	60.44	38.49	44.51	51.58	41.21	48.13
38	43.28	39.08	57.02	52.69	56.50	40.03	45.51	51.41	42.18	48.54
43	41.01	45.12	38.10	54.97	54.24	41.83	52.67	52.90	43.95	42.85
45	40.84	38.64	50.98	52.25	54.17	42.71	50.06	49.93	44.22	40.99
46	45.73	41.07	57.34	54.10	63.27	41.10	47.92	51.04	36.49	48.33
49	44.84	39.39	50.87	54.09	61.13	41.08	51.77	51.23	38.86	46.83
55	45.63	42.86	53.07	50.60	47.81	41.68	46.70	47.56	48.09	45.44
57	52.02	46.30	50.46	52.69	52.47	42.05	44.37	48.65	47.48	47.66
59	52.71	46.25	55.26	54.71	53.21	41.95	45.54	53.05	39.89	50.06
60	44.41	39.65	50.91	51.69	51.59	40.67	43.44	46.34	49.75	40.45
00003 GROUP THREE										
03	48.92	47.64	46.40	44.66	42.19	50.64	42.66	49.54	58.61	48.52
06	49.66	49.75	55.88	42.76	49.57	70.04	50.68	47.11	63.93	44.50
12	43.27	53.41	86.50	118.29	15.29	61.49	43.47	61.06	68.86	43.58
00003 GROUP FOUR										
04	48.45	49.70	45.94	33.65	33.25	53.88	44.40	33.25	72.81	36.35
65	29.45	29.88	55.06	44.28	44.00	38.87	41.01	27.80	52.11	24.88
76	34.54	39.53	46.54	32.99	35.12	44.87	32.82	16.71	68.48	29.44
00009 GROUP FIVE										
05	41.76	40.07	52.96	49.77	54.01	37.86	50.64	43.06	55.01	38.45
07	43.13	43.44	52.30	42.65	49.32	66.05	53.42	39.87	58.72	41.34
13	37.92	47.67	47.53	42.86	57.17	49.98	56.89	31.94	55.12	42.48
25	42.68	43.02	53.90	45.96	53.49	39.81	50.52	42.63	53.47	51.05
26	39.64	42.86	53.39	46.16	50.08	44.69	50.23	40.10	53.43	47.08
27	37.06	40.27	48.79	37.85	53.59	40.46	54.93	36.34	59.73	47.12
28	41.25	41.43	50.57	41.42	48.94	47.89	47.34	39.37	57.13	49.56
33	42.45	42.11	51.76	43.98	41.87	40.93	51.56	37.17	58.90	51.33
53	42.25	38.24	51.90	41.77	40.01	60.92	55.88	39.64	61.76	37.71
00005 GROUP EIGHT										
08	58.45	61.93	43.46	46.60	58.75	76.43	59.19	55.80	60.12	53.45
21	42.57	43.86	49.72	39.02	49.43	50.66	59.78	46.96	59.92	53.38
24	54.04	54.94	51.06	48.02	56.54	44.16	57.21	49.39	53.13	59.68
29	45.99	46.37	48.07	36.99	40.47	65.29	57.62	45.13	64.32	51.61
32	54.40	61.76	45.98	47.55	53.74	58.83	58.67	44.74	54.64	64.43
00004 GROUP NINE										
09	48.31	52.71	53.04	46.98	48.54	75.65	56.50	49.70	57.68	35.89
10	42.96	46.48	53.84	38.11	41.20	73.89	60.55	45.22	66.08	32.91
11	42.30	44.19	45.33	41.15	37.32	70.89	69.52	39.66	62.72	36.84
15	43.67	47.97	52.79	40.74	48.45	68.89	60.43	39.56	66.09	42.15

00003 GROUP FOURTEEN

14	54.44	60.85	42.86	42.50	53.77	72.20	78.20	49.67	56.91	49.72
17	46.22	62.01	18.65	43.17	69.17	61.36	77.19	34.17	54.04	50.31
18	30.65	59.46	15.33	43.75	81.89	54.50	67.93	37.03	46.64	45.37

00004 GROUP SIXTEEN

16	46.46	54.02	35.60	51.55	52.11	52.99	59.94	60.60	51.10	49.52
19	56.78	70.81	21.26	59.87	77.06	57.52	71.43	64.54	43.88	60.39
41	51.83	62.24	28.93	55.42	67.42	51.87	65.17	58.68	47.18	53.70
42	51.98	63.16	26.69	56.76	69.16	55.09	69.51	61.15	45.25	48.09

00003 GROUP TWENTY

20	57.96	62.06	50.35	45.18	49.24	52.12	57.48	55.29	59.30	69.00
30	64.21	60.56	51.27	47.93	45.36	49.77	46.67	55.84	55.92	69.41
31	61.36	62.39	51.43	44.84	44.39	48.88	48.66	52.70	61.65	72.43

00007 GROUP TWENTY TWO

22	40.17	41.13	51.21	43.85	42.12	47.75	59.60	53.34	55.83	44.67
23	40.52	39.10	53.60	45.03	49.18	42.29	53.41	50.84	56.50	45.37
39	50.51	52.82	48.35	53.42	51.51	47.65	53.43	51.87	46.05	52.25
40	43.34	45.90	37.68	51.15	53.23	42.85	59.81	51.53	49.42	45.88
50	48.80	44.64	49.26	54.45	49.75	42.15	52.13	55.40	44.21	49.01
51	51.09	50.13	47.49	56.68	51.25	44.11	53.21	60.51	42.44	49.25
52	55.91	57.00	44.73	56.34	51.58	47.64	57.22	61.00	44.23	55.51

00003 GROUP THIRTY FOUR

34	77.46	68.69	51.07	59.09	45.71	54.36	49.08	67.92	42.45	75.64
44	74.42	75.94	37.88	65.55	64.71	60.10	59.73	77.42	36.36	69.27
58	72.77	65.16	52.27	57.81	50.68	49.90	48.25	66.27	45.23	66.06

00006 GROUP THIRTY FIVE

35	48.60	47.14	54.89	51.49	48.45	44.36	46.94	49.15	50.87	53.59
36	51.97	43.73	52.00	51.41	47.82	43.15	42.94	50.94	45.72	55.31
54	62.96	61.13	48.58	51.19	40.91	66.61	46.92	59.91	54.17	59.98
61	55.40	55.66	47.83	51.97	48.38	63.44	50.85	55.15	54.14	56.46
62	56.44	53.15	50.92	53.90	54.25	43.01	47.45	58.07	49.83	51.59
74	50.60	43.62	51.31	50.18	37.86	41.39	36.13	54.11	48.40	52.16

00007 GROUP FORTY SEVEN

47	54.71	51.94	64.50	55.49	55.31	48.07	42.94	57.38	31.36	54.31
56	56.36	51.04	56.05	55.95	62.42	44.21	46.72	58.70	37.13	59.95
67	68.36	59.97	52.78	55.52	45.95	48.27	39.08	58.85	41.54	62.05
68	62.38	50.53	53.11	52.95	40.62	53.27	38.19	57.02	43.17	58.64
70	71.21	63.81	55.35	55.07	42.24	49.62	39.38	63.98	34.69	65.56
72	66.83	60.33	62.48	58.44	49.28	51.36	42.39	63.83	23.81	62.11
73	66.07	54.18	57.58	53.68	36.22	46.77	37.10	56.92	28.70	61.38

00002 GROUP FORTY EIGHT

48	39.07	35.88	73.81	53.08	62.18	44.59	40.32	47.54	30.19	46.08
71	50.15	43.42	60.62	53.28	53.04	43.59	37.70	52.68	30.48	47.59

00006 GROUP SIXTY THREE

63	48.88	39.91	52.36	48.52	35.82	43.93	38.37	41.83	50.40	48.30
64	50.29	42.59	52.38	49.82	40.85	43.71	38.36	43.23	50.32	44.74

69	45.05	40.67	56.92	49.69	43.06	39.39	36.28	46.74	42.26	41.20
75	45.53	43.24	48.45	40.31	38.02	45.95	33.61	39.08	62.15	48.25
77	46.74	55.20	55.53	45.36	43.62	45.10	34.39	43.71	50.44	41.12
79	42.32	50.06	49.98	45.09	45.55	40.76	34.24	42.11	52.27	31.38

00001 GROUP SIXTY SIX

66	48.84	43.01	55.74	51.69	48.68	40.73	42.68	49.59	44.94	44.62

00001 GROUP SEVENTY EIGHT

78	76.56	84.20	53.02	54.17	40.16	57.34	38.18	70.36	41.23	69.28

PLEASE NOTE------THE CORRELATION MATRIX SHOWN IN TABLE 6 REPRESENTS THE CORRELATION BETWEEN LATENT FACTOR DIMENSION SCORES. CENSUS TRACTS ARE ARRANGED IN THE GROUPS TO WHICH THEY APPEAR TO BE MOST HOMOGENEOUS IN THE OPTIMUM CLUSTERING STAGE OF THE OBJECTIVE GROUPING PROCESS.
LATENT FACTOR DIMENSION SCORES ARE DEFINED AS SCORES WITH A MEAN OF 50 AND A STANDARD DEVIATION OF 10, WITH AN ABSOLUTE RANGE OF 0 TO 100.

APPENDIX I

1960 CONVERSION TABLE OF STUDY CODE NUMBERS TO OFFICIAL CENSUS TRACT NUMBERS

Code No. Assigned for Present Study	Official Census Tract Designation for 1960	Code No. Assigned for Present Study	Official Census Tract Designation for 1960
01	02	27	27
02	03	28	28
03	04	29	29
04	05	30	30
05	06	31	31
06	07	32	32
07	08	33	33
08	09	34	34A
09	10	35	34B
10	11	36	35
11	12	37	36
12	13A	38	37
13	13B	39	38
14	14	40	39
15	15	41	40
16	16	42	41
17	17	43	42
18	18	44	43
19	19	45	44
20	20	46	45
21	21	47	46
22	22	48	47
23	23	49	48
24	24	50	49
25	25	51	50
26	26	52	51

APPENDIX I (Continued)

Code No. Assigned for Present Study	Official Census Tract Designation for 1960	Code No. Assigned for Present Study	Official Census Tract Designation for 1960
53	52	67	63
54	53	68	64
55	54	69	65
56	55	70	66
57	56	71	67
58	57	72	68
59	58	73	69
60	59A	74	70
61	59B	75	71
62	60	76	72
63	61A	77	73
64	61B	78	74
65	62A	79	75
66	62B		

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