Ann Reg Sci (2008) 42:141–151
DOI 10.1007/s00168-007-0126-6

ORIGINAL PAPER

Administrative spatial structure: a note on an alternative approach

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Received: 20 April 2007 / Accepted: 24 April 2007 / Published online: 13 June 2007

Abstract This note explores the manner in which the administrative system may be related to an economic or functional system in terms of spatial structure. Following the specification of criteria for the spatial structure of a viable administrative system, the salient features of a functional system are outlined. It is shown that when the administrative system is required to correspond to such a functional system in all respects, a crucial criterion cannot generally be satisfied. If, however, this particular criterion is imposed on the administrative system, a feasible structure is possible, which co-exists with the functional system. The two emphases (involving correspondence and co-existence, respectively) are brought together in a worked example, which also demonstrates how a common feature of administrative systems can be accommodated.

JEL Classifications R12 · R50 · R53

1 Introduction

The concern of this note is with the spatial structure of administration (at the local or regional level), in relation to the spatial structure of the underlying functional system. The link between the two spatial structures, which is not a straightforward one, has probably not received the attention that it deserves. Each spatial structure has its own distinctive logic, and it is only on rare occasions (observed and theoretical) that the two coincide. To approach this question, an administrative structure is compared and contrasted with a functional structure, represented by an urban system. Building on a more extensive study (Parr 2007), two important modifications are introduced. First, the urban system is based on a square or rank-and-file spacing of

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centers, leading to square functional (service) areas. This is in contrast to the more familiar triangular spacing of centers, which gives rise to hexagonal areas. Second, the perspective adopted is a downward one. For both the functional and the administrative structure, two hierarchical levels are considered. The primary level contains relatively few centers with correspondingly large service areas, while the secondary level comprises more centers and therefore smaller service areas. Within this two-level structure, the primary level is taken as the benchmark or reference level, so that the downward perspective is concerned with the spatial configuration of the secondary level. This differs from an upward perspective, where the secondary level is the benchmark level, and attention is focused on the primary level.

Consideration is given initially to a set of criteria that might reasonably be required of an efficient administrative system. Certain of these criteria are related to the nature of administrative organization, while others take account of the fact that an administrative system does not exist in isolation from the functional system. Attention next turns to the functional system, itself, which is viewed in terms of a hierarchical model of urban structure. There is then an examination of the extent to which the various criteria can be satisfied in three distinct settings. In the first, the administrative system corresponds exactly to the functional system. In the second, the administrative system co-exists with the functional system. In the third setting, aspects of the previous two are combined in a sequential fashion, in order to illustrate an important facet of administrative systems.

2 Spatial criteria for an administrative system

It is assumed that the administrative system of a given territory supplies a set of specified services to users (households and/or firms). This set comprises two sub-sets, one being supplied only at the primary administrative level, and the other at both the primary and secondary levels. The frequency of centers (and thus areas) of each sub-set of services will reflect such factors as user demand, economies of scale in the provision of the relevant services, and the transportation costs associated with these services that are incurred by the users or by the authority involved. We now introduce five spatial-structure criteria, which may be regarded as desirable attributes of an administrative system. Whether all five criteria can be satisfied simultaneously is a matter for investigation. The criteria are specified individually in purely diagrammatic form in Fig. 1, where each criterion is indicated as being satisfied and not satisfied.

1. Inclusion: this criterion, which links the two levels, requires a secondary administrative center and its secondary administrative area to be located wholly within a primary administrative area. If this criterion is not satisfied, the administrative system becomes unworkable, since a given secondary administrative area will fall within the jurisdiction of two or more primary administrative areas. It is for this reason the criterion of inclusion is invariably adhered to.
2. Centrality: the basis for this criterion is the rather obvious one of minimizing aggregate travel (and thus maximizing accessibility to an administrative center) for users of the service sub-set within the relevant administrative area. In the absence of information on the distribution of population and economic activity

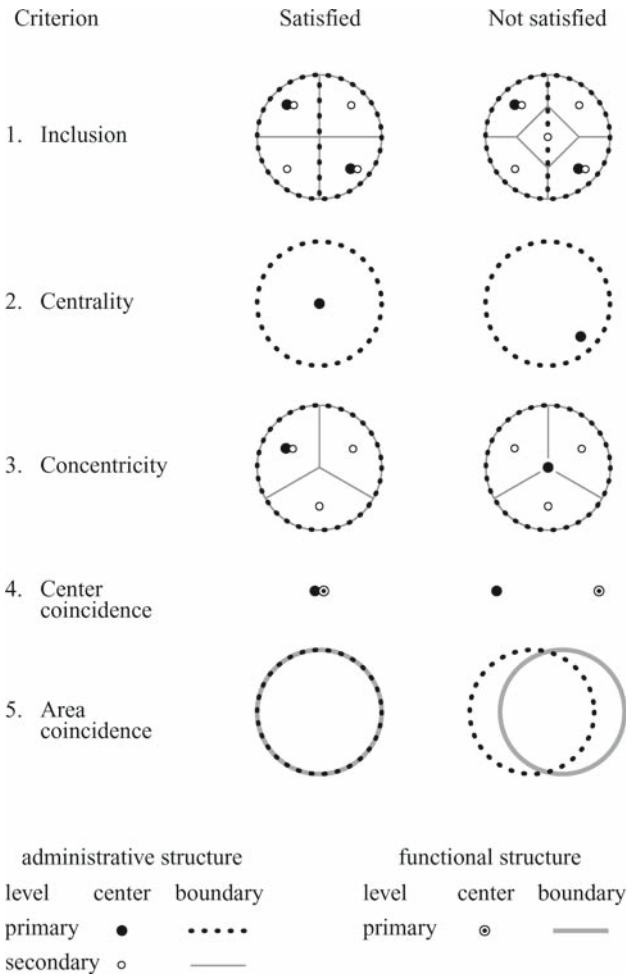

Fig. 1 Criteria for the spatial structure of administration

within a territory, centrality cannot be measured accurately, and is therefore approached in simple geometrical terms.

3. Concentricity: this criterion, which also links the two levels, requires every primary administrative center to be situated at the location of a secondary administrative center, this being a frequently observed phenomenon. With the criterion of concentricity there is the possible advantage of local communication between administrative levels, although such an advantage will only apply in a limited number of cases.
4. Center Coincidence: by this criterion the administrative center of a given level must coincide with a functional center of the same level. The basis for such a criterion is that the administrative center is able to draw on the infrastructure of the functional center with respect to transportation, public utilities, business services, etc. There may also be certain advantages in the form of user convenience.

5. Area Coincidence: the final criterion requires the administrative area of a given level to coincide exactly with a functional area of the same level. Such coincidence may have certain advantages where the administrative system contributes to (or in some sense interacts with) the functional system, and/or where there are possibilities for public-private co-ordination or co-operation.

It is important to emphasize that each criterion is independent of the others, so that no criterion is redundant. Furthermore, with the exception of the first criterion, any criterion can be dispensed with. Under actual conditions this is not at all unusual, either because it is deemed by the competent authority to be relatively unimportant or even undesirable, or because by satisfying it, one or more other criteria would not be satisfied. For a discussion of various considerations in the organization and planning of administrative spatial structures, the reader is referred to Barlow (1981), Hall (1975) and Massam (1975).

3 The spatial structure of a functional system

Of the numerous possibilities for representing the functional system, a particular class of models from central-place theory has been selected, involving a familiar, if stylized, characterization of the urban system (Hoover 1971; Lösch 1944,1954). The principal justification for this selection is that administrative systems typically display certain features of central-place theory, notably centrality and hierarchical structure. The central-place framework thus represents a convenient vehicle for examining the spatial structure of administration. Various cases of the functional system are illustrated in Fig. 2. In all cases the centers are centrally located within their respective functional (market) areas, and the hierarchy is successively inclusive, so that the location of a primary center is always at the location of a secondary center.

Unlike most representations of central-place structures such as that proposed by Christaller (1933,1966), the one considered here is based on a square spacing of centers and square areas. A comparison of the various functional-area shapes is provided by Beckmann (1968, p.84–85). In actual central-place structures the square shape of functional areas is generally held to result from land surveys and land-allocation schemes in newly settled territories being undertaken in terms of latitude and longitude. In the US these involved the so-called “township and range lines” (Mead and Brown 1962). The square shape is to be observed in parts of North America, Latin America, Australia and Japan. The brief comments of Lösch (1944,1954, p.417n) in this connection are pertinent. The square shape also has relevance at the intra-urban level, where the grid-pattern of streets tends to exert a strong influence on spatial organization.

Since a downward perspective is being adopted, the size of the primary functional area in Fig. 2 is held constant for all cases, and attention is focused on the secondary functional level. Each of the five cases of Fig. 2 can be characterized by its K value. This represents the number (or equivalent number) of secondary functional areas that are enclosed within a primary functional area. For example, in the $K = 2$ case the primary functional area contains $1 + 4\ (0.25)$ or 2 secondary areas, and in the $K = 5$

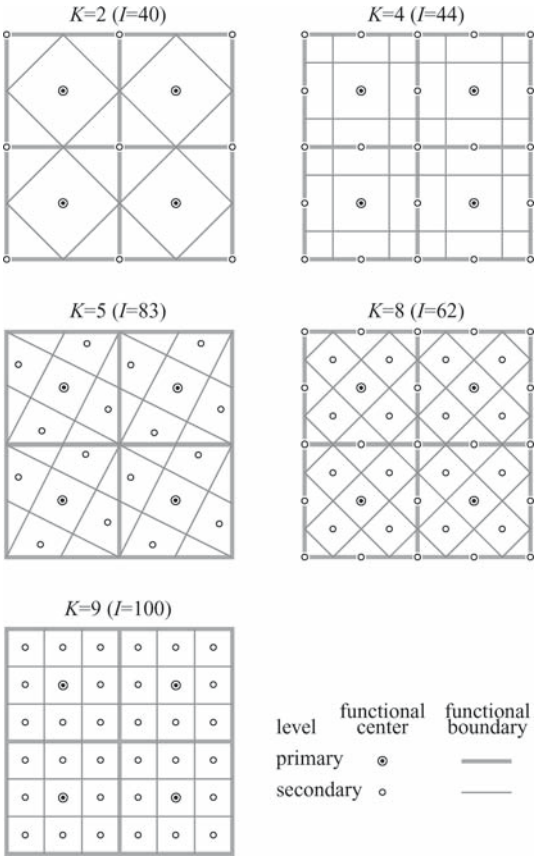

Fig. 2 Functional system (and also corresponding administrative system in Sect. 4)

case it contains 1 + 4 (0.75) + 4 (0.25) or 5 secondary functional areas. The values that can be assumed by K are 2, 4, 5, 8, 9, 10, 13, 16, 17, etc., or more generally $x^2 + y^2$, where x is a positive integer and y is a non-negative integer, such that $x = y$ for $x = 1$ and $x \geq y$ for $x > 1$ (Parr 2002). In actual functional systems based on square areas, the $K = 2$ and $K = 4$ cases are common (Hoover 1971; Lösch 1944,1954), whereas cases involving higher values for K seem to be rare. The value of K has various interpretations, which are discussed elsewhere (Parr 1981).

4 Correspondence to the functional system

Having outlined a two-level functional system, we next wish to see whether such a structure can form the basis for an administrative system. In terms of centers and areas, the administrative system is required to correspond in every respect to the functional system of Sect. 3. Figure 2 may therefore be seen as referring to the administrative system as well as the functional system, so that the value of K can be used to define

either structure. With this imposed correspondence, we explore the extent to which the various criteria for administration outlined in Sect. 2 are satisfied in the five cases of Fig. 2. Neglecting for the moment the first criterion (inclusion), the remaining four criteria are satisfied in all cases, reflecting the nature of this particular model of the functional system. Note that the criterion of centrality in the administrative system is equivalent to the centrality property of the functional system, and that the criterion of concentricity is equivalent to the successively-inclusive hierarchy. Up to this point, therefore, the model of the functional system considered here appears to provide the basis for an administrative system. With other hierarchical models of functional structure (including certain central-place frameworks) this would not be the case, since the administrative systems based on these would not necessarily satisfy certain criteria. For example, in the model proposed by Tinbergen (1961) the criterion of concentricity is not satisfied (Mulligan 1982).

Consideration is now given to the very important criterion of inclusion, by which each secondary administrative center and its secondary administrative area must be wholly situated within a primary administrative area. For obvious reasons this criterion is best considered in binary terms, i.e., satisfied or not satisfied. It is possible, however, to construct an index that measures the extent to which this criterion is met. The index I, which is indicated for each case of Fig. 2, is expressed as follows:

$$I = \left(\frac{a}{a+b}\right) 100 \tag{1}$$

where a is the area of the primary administrative area, and (for the secondary administrative areas which extend beyond the boundaries of a given primary administrative area) b represents the combined area of those parts which are not included within the primary administrative area. When $b = 0$, there is complete inclusion ($I = 100$). For square administrative areas, $I = 100$ whenever K is an integer greater than 1, having a positive square root that is an odd integer. It will be seen shortly that for other permitted values of K the condition of $I = 100$ can be imposed, although this usually results in the primary administrative area having a non-square shape.

In Fig. 2 only the $K = 9$ case satisfies the criterion of inclusion (though values for K greater than 4 are rarely observed in functional systems). In each of the other cases certain of the secondary administrative areas are located within two or more primary administrative areas, thus replicating the structure of the underlying functional system. Such a structure is frequently seen in functional systems, being entirely consistent with commercial organization, and not adversely affecting consumer convenience. When, therefore, an administrative system corresponds exactly to a functional system having this structure, the criterion of inclusion cannot be satisfied. For this reason, it would therefore seem that, in general, a functional system of the type considered here is unable to provide a suitable basis for an administrative system. This is not the case, however, as the next section attempts to demonstrate.

5 Co-existence with the functional system

The administrative system is again superimposed on the functional system of Fig. 2, but now with the proviso that the important criterion of inclusion is satisfied, so that $I = 100$. The outcome is shown in Fig. 3, which reveals the variety of shapes assumed by the primary administrative area. Since the physical extent of the primary (secondary) administrative area and the primary (secondary) functional area are equal, the value of K again refers to the administrative as well as the functional system. In all cases the criteria linking the two levels (i.e., inclusion and concentricity) are satisfied, the first by assumption. For the secondary administrative level, the criteria of centrality, center coincidence and area coincidence are satisfied in all cases. For the primary level, the criterion of centrality is only satisfied in the $K = 5$ and $K = 9$ cases, and while the criterion of center coincidence is satisfied in all cases, the criterion of area coincidence is only satisfied in the $K = 9$ case. In contrast to the situation in Sect. 4, the administrative system now co-exists with the functional system, from which it exhibits a degree of independence.

The criteria of centrality and area coincidence have been considered above in binary terms, but it is useful for comparative purposes to express each criterion as an index, showing the degree to which it is satisfied for the primary administrative level. These indexes are indicated for each case in Fig. 3. For the criterion of centrality, the index C is as follows:

$$C = \left(1 - \frac{d}{s}\right) 100 \tag{2}$$

where d is the distance from the geometric center of a primary administrative area to its actual center, and s is a scaling factor equal to the distance from the geometric center of the primary administrative area to its furthest point. When $d = 0$, there is maximum centrality ($C = 100$), and when $d = s$, centrality is at a minimum ($C = 0$). For the criterion of area coincidence, the index A is as follows:

$$A = \left(\frac{c}{f}\right) 100 \tag{3}$$

where c is the area over which the primary administrative area and the primary functional area coincide, and f is the area of the primary functional area. When $c = f$ there is complete area coincidence ($A = 100$), and when $c = 0$, area coincidence is non-existent ($A = 0$), this being a purely imaginary situation.

With the aid of these two indexes, we briefly examine the varying levels of efficiency of the administrative systems shown in Fig. 3, focusing on the primary administrative level. Clearly, the $K = 9$ case is ideal, in the sense that it satisfies all five criteria. The $K = 5$ and $K = 8$ cases can be considered reasonably efficient, however. The criterion of centrality is satisfied in the $K = 5$ case ($C = 100$), and is satisfied to an adequate level in the $K = 8$ case ($C = 76$). Furthermore, in both cases the criteria of concentricity and center coincidence are satisfied, and the extent of area coincidence is relatively high ($A \geq 78$). By contrast, the $K = 2$ or $K = 4$ cases, though

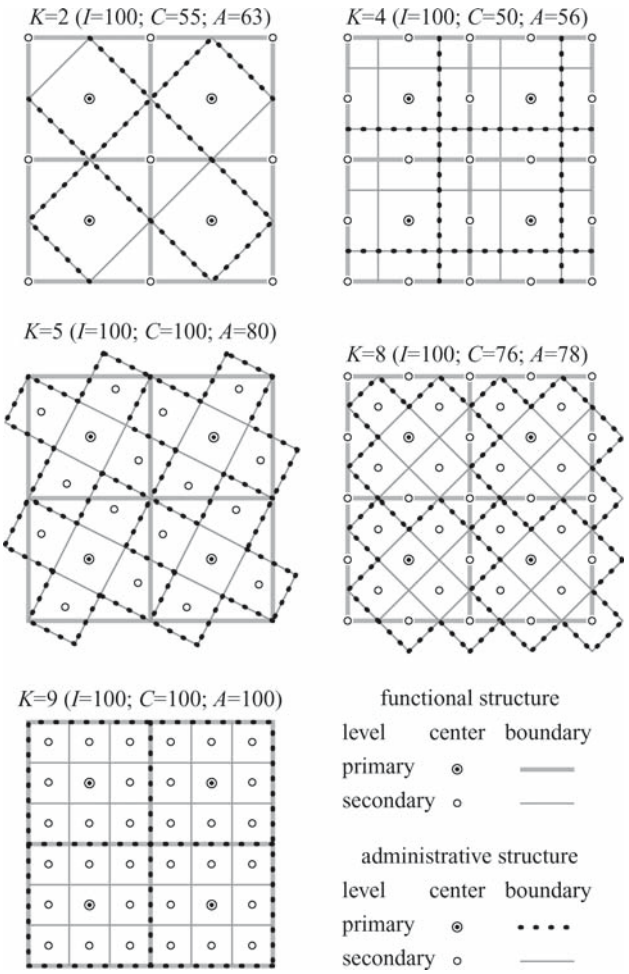

Fig. 3 Functional system and co-existing administrative system

organizationally workable, cannot be regarded as efficient. The criteria of concentricity and center coincidence are satisfied, but centrality is seriously lacking ($C \leq 55$), and area coincidence is relatively low ($A \leq 63$). It should be mentioned that in these two cases, as well as in the $K = 8$ case, the criterion of centrality can be satisfied, but only if the criteria of concentricity and center coincidence are abandoned.

6 An extension

Drawing on approaches of the two previous sections, the analysis is extended to consider a particular feature of certain administrative systems. This is present when the "administrative span of control" (i.e., the K value for administrative areas) assumes a relatively high level. According to the criterion of area coincidence discussed in

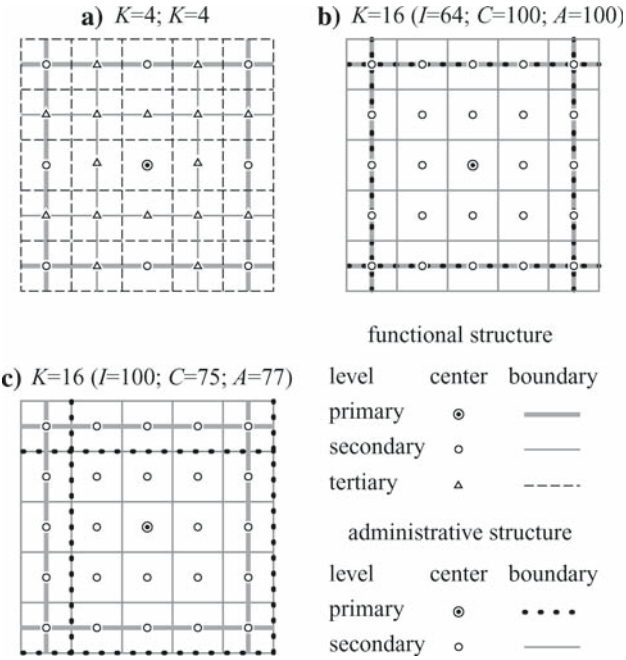

Fig. 4 **a** functional system; **b** functional system and corresponding administrative system; **c** functional system and co-existing administrative system

Sect. 2, each secondary administrative area must coincide with a secondary functional area. But this will be infeasible, if the required number of secondary administrative areas is substantially greater than the number of secondary functional areas, a situation that frequently occurs. As noted in Sect. 3, however, the K value for actual functional areas rarely exceeds 4. The solution to such an apparent problem lies in making use of the next lower level of the functional system (the tertiary level), assuming that such a level exists. In Fig. 4a the secondary functional level conforms to the $K = 4$ case, so that there are only four secondary functional areas within a primary functional area. We may consider a situation in which n, the required frequency of secondary administrative areas, is significantly greater than 4, such that $13 < n < 17$. Obviously, relying on the secondary functional level will yield an insufficient number of secondary administrative areas.

It is at this point that the tertiary functional level becomes relevant. We assume that the tertiary functional structure also conforms to the $K = 4$ case (there are the equivalent of four tertiary functional areas within each secondary functional area), as indicated in Fig. 4a. The secondary and tertiary functional levels are now combined to form the locational matrix for a single secondary administrative level, in which $K = 16$. This is shown in Fig. 4b, where the secondary administrative centers are made to coincide with both the secondary and tertiary functional centers of Fig. 4a. The outcome is broadly consistent with the approach of Sect. 4 (where the administrative system corresponds to the functional system), although there is one obvious

difference. A comparison of Fig. 4a and b reveals the contrast between the three-level structure of functional areas (where the frequencies, starting with the primary level, are 1, 4 and 16), and the two-level structure of administrative areas (where the frequencies are simply 1 and 16, the value of 16 lying within the required range).

At the secondary level of administration under this arrangement the criterion of centrality is satisfied, but the criteria of center coincidence and area coincidence are only partially satisfied (most of the secondary administrative centers coincide with tertiary functional centers, so that most of the secondary administrative areas coincide with tertiary functional areas). At the primary level, however, the criteria of centrality, center coincidence and area coincidence are all satisfied. Turning finally to the two linking criteria, concentricity is satisfied, whereas the important criterion of inclusion is far from being satisfied ($I = 64$). Thus although the underlying functional system is suitable in certain respects, it does not represent an appropriate basis for an administrative system.

It is possible to improve on this outcome by adopting the approach of Sect. 5, where the criterion of inclusion is imposed ($I = 100$). This is shown in Fig. 4c. Under such an alternative administrative structure the linking criteria of inclusion and concentricity are satisfied. At the secondary level the criterion of centrality is satisfied, but again the criteria of center coincidence and area coincidence are only partially satisfied. As in Fig. 4b, most secondary administrative centers are located at tertiary functional centers, and as a result most secondary administrative areas coincide with tertiary functional areas. This would imply either that the advantages associated with the criteria of center coincidence and area coincidence are forgone in order to gain the benefits of high frequencies for secondary administrative centers and areas, or that these advantages can be realized even with reliance on the tertiary functional level.

At the primary level of administration the criterion of center coincidence is satisfied. Such is not the case for centrality or area coincidence, however, although the consequences of this in terms of administrative efficiency are not serious: the level of centrality is still relatively high ($C = 75$), as is the extent of area coincidence ($A = 77$). All things considered, the administrative system, which now co-exists with the functional system, may be judged satisfactory. Interestingly, the diagrammatic form of Fig. 4c reflects the fact that the primary administrative area coincides only partially with the primary functional area, and also encroaches on certain adjacent primary functional areas, phenomena that can be observed in certain political/administrative regions of various nations, including Germany and Italy (Parr 2007).

7 Concluding comments

Certain parallels notwithstanding, the administrative system has a different rationale from that of the functional system. This was demonstrated, using a particular model from central-place theory to represent the functional system. It was shown that if the administrative system corresponds exactly to the functional system, the important criterion of inclusion cannot be satisfied, except under a narrow set of conditions. When, however, this criterion is imposed, a workable administrative system (of varying efficiency) emerges. Such an outcome reflects the common phenomenon of an

administrative system differing from the underlying functional system, but still being strongly influenced by it.

As part of an attempt at generalizing earlier work on administrative spatial structure, an alternative approach involving two modifications has been introduced. Not surprisingly, these modifications result in a distinct set of administrative structures. In the first modification a square (rather than triangular) spacing of centers is assumed. The square spacing of centers permits a slightly greater range of possible sizes for administrative areas, and in a limited set of cases also allows all five criteria of administrative spatial structure to be satisfied simultaneously, something that is never possible with triangular spacing. In the second modification a downward (as opposed to an upward) perspective is adopted. This is appropriate when the administrative system has developed (or is developing) in a downward direction. On other occasions a downward perspective may be important when the structure of the secondary level is directly related to (or influenced by) the primary level, as in the case of education and health-care facilities, for example.

It transpires that the modifications employed in this alternative approach give rise to sets of functional structures and thus sets of administrative structures that are not fundamentally dissimilar to their respective counterparts considered in the earlier approach. As a consequence the two approaches (involving different geometries and different perspectives) are to be regarded as complementary rather than competing, thus helping to establish a broader framework for examining the spatial structure of administration.

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