A Study of the Transformation of Street-blocks in Tokyo: A Case Study in Shinjuku

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Abstract
This study presents an analysis of forms of street-blocks in a selected case-study area in Shinjuku. It focuses on the changes of the geometrical properties of selected block formation during the development between 1886 and 1997. At first it illustrates the origins and arrangement of the area’s early urban pattern. Secondly, it shows how the selected block forms developed, and how the block pattern reached its present stage. The study deduces how the initial properties of the blocks influenced the manner of their transformation and present properties, and also how they adapted to emerging changes.

Keywords: street-block; shape analysis

1. Introduction
The diversity in forms of street-blocks in Tokyo is a result of the complex process of urban growth. Since their initial arrangement, street-blocks have been subject to changes of density and transformations in land use due to changing economic and social requirements. In the case of central districts of the city, existing blocks established during earlier morphological periods have been subject to adaptation rather than replacement (Conzen 1968). In that sense, the initial arrangement has a fundamental effect on the future properties of the block: it is a major determinant of the space during the period of initiation, and a major determinant of the processes of adaptation during the period of transformation (James, Vance 1990).

In central Tokyo, the process of city growth has given rise to the formation of blocks characterized by great geometrical and spatial complexity. The irregular arrangements of neighborhoods and diversity in block forms have produced a strikingly unique urban fabric. By examining the particular formation of selected blocks from central districts in Tokyo, this paper attempts to illustrate how the initial block geometry developed and reached its present state.

Using cartographic records of the selected case study area, the study first identifies the initial block forms and illustrates the logic of their preliminary arrangement. Secondly it analyzes the evolution process and uncovers the morphological phases which are essential for development; it illustrates the characteristics of each development phase; it investigates how blocks adapted to emerging changes and how the initial forms of the blocks determined the manner of their transformation.

2. Methodology
A case study area was selected for the analysis on the basis of its rich historical context and complex morphological structure. The study illustrates the evolution of its urban pattern from 1886 until 1997.

In order to identify land use patterns in the late Edo Period the study used the map lehigaya Usigome-Eizu 1857 (Shinjuku-ku Kyouikuiinkai 1978). Due to the great impact of plot pattern on the form of block, this study analyzes maps which present the block boundary together with individual property lines, i.e. cadastral maps. For detailed analysis and measurements the following maps were utilized:

a) Tokyo Jissoku-zu 1886 (Shinjuku-ku Kyouikuiinkai 1978)
b) Tokyo Jissoku-zu 1895 (Shinjuku-ku Kyouikuiinkai 1978)
c) Usigome-ku Zenzu 1907, 1922 (Shinjuku-ku Kyouikuiinkai 1978)
d) Kasaihoken Tokushu Chizu 1948 (Toshi Seizusha 1948)
e) HaiMappu Shinjuku-ku 1997 (Seikosha 1997)

In order to analyze the block evolution process, this study examined and compared the following parameters in each morphological phase:
- Number of blocks
- Block size
- Block perimeter length (including length of cul-de-sac alleys)

However it must be mentioned that the measurements of block shape carry a degree of inaccuracy, due to inaccuracies in the historical maps and the number of modifications in block boundaries.
during development. In this respect, the measurements of block shapes are approximations.

3. Analysis

Context: The case study area is located in Shinjuku, one of the 23 wards of Tokyo. The surveyed area covers approximately 45 hectares and includes the following districts: Yaraicho, Yokoteramachi, Minami-Enokicho, Ichigaya-Yamabushicho, parts of Iwatocho, Tansumachi, Ichigaya-Yanagicho, Kita-Yamabushicho, Kagurazaka, Bentecho, and Enokicho.

At the present time the case study area is characterized by mixed land use (the majority is Residential and Apartment) and population densities range from 100 to 300 people per hectare (Shinjuku-ku Tochiriyou 2003).

![Fig.1. Shinjuku. Location of Case Study Area](image)

Early development - until 1895

In the Edo Period (from 1600 to 1867), the case study area was located in the western part of Edo (the name of Tokyo during the Edo Period), a region called Yamanote. The patterns of early urban development of Yamanote were structured by three factors: topography, the basic road network and the Feudal Lord (Daimyo) estates. The hilly terrain determined the road system and property distribution, which resulted in the irregular configuration of street and block patterns. The main roads followed principal ridges; the secondary set of roads followed the valley floors, and smaller ridge roads connected those two systems (Jinnai 1995). In the Edo Period the Yamanote region was mostly occupied by Feudal Lord estates, samurai, temple and shrine properties. Large Feudal Lord estates were located along the main roads, making the best use of site topography by occupying the exposed slopes.

The much smaller samurai properties were distributed between daimyo estates and were constrained by hilly topography (Sorensen 2002). Such arrangement of the city was reflected in the early urban pattern of the surveyed area (Fig.2a.). The largest block was occupied by a Feudal Lord estate and servants. Surrounding smaller blocks were occupied by samurai properties, temples and shrines. Those blocks were mostly oblong and densely subdivided. The general organization of blocks followed the manner which could be found in most blocks of western Tokyo, at that time: blocks were divided into two rows of plots which backed on to each other. The shorter side of blocks generally measured about 40 to 60 ken (73-109 m), which was the result of the modular plot depth (20 – 30 ken = 36 – 54m). The length of the block was constrained by the transportation network and it appears that it was not determined by a particular module.

Survey shows that the largest block (within the surveyed area) occupied by the Feudal Lord measured around 24 ha and was irregularly shaped. The surrounding eleven blocks were much smaller, measured around 1.7 ha and had relatively compact form: eight of these blocks were quadrilaterals of an oblong shape, slightly disturbed by site topography. Two blocks located in southern part of a site had an L-shape, consisting of two concave edges (Fig.2a.).

![Table 1. Block Properties in 1895](image)

| Parameter                   | Blocks A | Blocks B | All Blocks |
|-----------------------------|----------|----------|------------|
| Number of Blocks            | 11       | 39       | 50         |
| Average Area of Blocks (ha) | 1.7      | 0.5      | 0.8        |
| Average Perimeter Length of Blocks (m) | 586      | 286      | 352        |

The second phase of urban development was related to the Meiji Restoration and the development of the Feudal Lord property. About 1890 the large property was fragmented into a number of blocks (Fig.2.b). The central part of the former Feudal Lord property was partitioned into two large blocks: the one in northern and the one in the southern part. The eastern and western parts of the former Feudal Lord property were subdivided into a number of quadrilateral blocks. These blocks had the size of around 0.5 ha and were oblong in shape, in some cases disturbed by adjustment to the existing urban pattern.

Investigation of maps dated 1886 and 1895 suggests that the formation of new blocks overlapped and precisely adopted the earlier plot pattern. As a result,
Fig. 2. Case Study Area - Development of the Urban Pattern
(Adapted from: 1886, 1895: Tokyo Jissoku-zu; 1948: Kasaihoken Tokushu Chiza; 1997: HaiMappu Shinjuku-ku)
the majority of these newly introduced blocks consisted of one or two properties.

Moreover, a number of large blocks appeared at the western boundary of the former Feudal Lord property. Those blocks were created in the place where the urban structure created around 1890 met blocks formed in the Edo Period. The forms of these blocks were very irregular and characterized by a number of concave edges.

Section 1895 – 1948

Comparison of maps published between 1895 and 1948 suggests that during that period the surveyed block pattern was subject to several modifications. The majority of large blocks were fragmented. In the case of large irregular blocks, they were partitioned into more compact ones (Fig.3a. and 3b.). A fragmentation process resulted in decreasing of the average block area size of all blocks from 0.8 ha to 0.6 ha together with a decrease in the average perimeter length of blocks (from 352m to 305m, a change ratio of 0.8). The highest area change ratio was related to blocks formed in the Edo Period, which decreased their average size from 1.7 ha to 1.0 ha (Tables 1 and 2).

Modifications of small and oblong blocks formed around 1890 were related to plot pattern rather than to block form. As mentioned previously, in the initial phase the majority of blocks consisted of one or two plots per one block. Around 1925, the majority of these blocks were subdivided into two or three properties. Due to the small size of those blocks, the majority of plots had two or three frontage sides and a low depth (Fig.3d.).

Table 2. Block Properties in 1948

| Parameter: | Blocks A | Blocks B | All Blocks |
|------------|----------|----------|------------|
| Number of Blocks | 17 | 50 | 67 |
| Average Area of Blocks (ha) | 1.0 | 0.4 | 0.6 |
| Average Perimeter Length of Blocks (m) | 436 | 261 | 305 |

Section 1948 – 1997

Development of a case study area in the postwar period is derived from the map HaiMappu Shinjuku-ku 1997, and shows radical change when compared with 1948. It suggests that modifications of block form were mainly prompted by the modification of plot patterns (Figs.2c. and 2d.). The character of plot re-subdivision during the postwar period is a clue to understanding the present block properties. Unfortunately, the lack of cartographic records illustrating the property...
configuration inside the blocks between 1948 and 1997 makes such a process difficult to monitor step by step.

However, investigation of maps dated 1948 and 1997 suggests several forms of the morphological transformations of plots: in the case of originally very large "samurai" plots (initially subdivided in the Edo Period) a process of fragmentation gave rise to long and, in some cases, complex dead-end alleys (Fig.3c.). It must be pointed out that these plots were not designed for dense urban purposes: they were elongated and faced only one side of the block. By contrast, shallow plots within small blocks originating in 1890 were wide enough to accommodate the transverse subdivision of initial plots (Fig.3d.).

The comparison of 1948 and 1997 data suggests that development of the block pattern did not affect the average size of blocks. However the introduction of dead-end alleys increased 1.4 times the average periphery length of all blocks (from 305 m in 1948 to 415 m in 1997; Tables 2 and 3). Blocks originating in the Edo Period were affected the most: the average perimeter length of blocks extended more than 1.5 times.

**Table 3. Block Properties in 1997**

| Parameter:       | Blocks A: Blocks originating in the Edo Period | Blocks B: Blocks subdivided around 1890 | All Blocks |
|------------------|------------------------------------------------|-----------------------------------------|------------|
| Number of Blocks | 19                                             | 53                                      | 72         |
| Average Area of Blocks (ha) | 1.0                                             | 0.4                                      | 0.6        |
| Average Perimeter Length of Blocks (m) | 676                                             | 321                                      | 415        |

### 4. Conclusions

This study shows that there are two phases of urban development which had a great impact on the present block configuration of the selected case study area: the first one coincides with the Edo Period and the second with the development of the Feudal Lord property around 1890. Despite a number of block modifications, the present block pattern resembles to a large degree that from 1890.

In both phases predominant type of initial block shape was the oblong one; however some blocks were slightly deformed in order to adjust to site topography or the existing transportation network.

Blocks created during the Edo Period were initially much bigger (average block size 1.7 ha) than those created around 1890 (average block size 0.5 ha)

The adjustment of an urban pattern formed in 1890, which was characterized by smaller block size than the existing one (Edo Period), resulted in a number of large, irregular blocks. The complex form of those blocks was accompanied by a composite plot pattern which consisted of two kinds of plots: those originating in the Edo Period as well as properties subdivided around 1890 (Figs.2a. and 2b.).

The comparison of data shows that development of the selected block formation had a great impact on the geometrical properties of consisting blocks. However the character of changes in the period between 1890 and 1948 differed significantly from that in the postwar period.

The fragmentation of blocks into smaller ones was a common method of adjusting initial blocks to more intensive land use. The fragmentation of blocks mainly affected large blocks: those established in the Edo Period as well as irregular blocks created around 1890. However, as Fig.4. suggests, changes of block number were mostly related to pre-war development of the area: between 1890 and 1948 the total number of blocks increased from 50 to 67 (134 %), while between 1948 and 1997 from 67 to 72 (107 %). During the pre-war period, the block partition process decreased the average area size of blocks from 0.8 ha (in 1895) to 0.6 ha (in 1948) and average perimeter length of blocks from 352 m to 305 m. The parameters of blocks created in the Edo Period were subject to the greatest changes: average area was reduced from 1.7 ha in 1895 to 1.0 ha in 1948, and average perimeter of blocks went from 586 m (in 1895) to 436 m (in 1948).

In the case of the postwar period, modifications in block forms were mainly determined by changes in plot pattern (fragmentation or amalgamation of initial plots), as a result of intensification of residential density and changes in land use. This study shows that creation of cul-de-sac alleys was common during the postwar development, especially in the case of re-subdivision of plots planned for detached housing.

The introduction of cul-de-sac alleys increased the average perimeter of a block significantly: from 305 m in 1948 to 415 m in 1997 (136 %). During the same period, the average area of blocks remained constant (Fig.4.).

The introduction of cul-de-sac alleys affected blocks established in both morphological phases, but in a different way. Fragmentation of deep plots of "Edo blocks" caused the introduction of long and complex cul-de-sac alleys; consequently, the average perimeter length of those blocks increased drastically from 436 m in 1948 to 676 m in 1997 (155%). By contrast, short and straight cul-de-sac alleys were introduced in blocks originating 1890, due to the small size of blocks and the low depth of their plots. In the case of these blocks, the average perimeter length of blocks increased from 261 m in 1948 to 321 m in 1997 (122 %).

In some cases, the whole plot or set of adjusting plots was transformed into a single block, being cut off from its parent shape. As a result of such a process, the "new" block was usually compact and regular, while the "parent" block reached a more complex form.
The fragmentation of blocks into smaller quadrilateral ones as well as the lowest degree of modifications of the small oblong blocks (those created around 1890) suggest that this form of block (i.e. oblong shape measuring 0.4 – 1.0 ha) was the most suitable form for the development of the selected area.

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