SPATIAL COMPOSITION AND BEHAVIOR CHARACTERISTICS OF PILGRIMAGE ROUTES IN LHASA CITY, TIBET

The ideologies of Tibetan Buddhism bestow the Tibetan people (defined here as an ethnic group) with a unique religious behavior in which pilgrimages are made in a clockwise direction around sacred places following the specific routes. These pilgrimage routes, known as kora paths by Tibetans, have thus become a unique type of urban space in Tibetan cities. This study presents the environmental issues of Kora Paths in Lhasa City reflected in the behaviors of pedestrians based on a field survey. First, the study identifies both the ways in which the network structure has transformed in the last few decades, and the current status of kora paths in the city of Lhasa. Specifically, the physical composition is clarified, and the street spaces are classified into four types based on the measurements. Next, the behavior were observed and analyzed to clarify the characteristics of behaviors occurring in three target streets. Finally, the study makes arrangement of the issues from the view of behaviors, and approaches to the possible solutions. As a result, based on the current state of the target kora streets, this study provides adaptable suggestions for improving the physical environments of the kora paths in Lhasa.

Keywords: Pilgrimage, Pedestrian, Street, Tibetan Buddhism, Lhasa City

1. INTRODUCTION

1.1 Background

The theories and ideologies of Tibetan Buddhism introduced in the 7th century bestowed old Tibetan cities with unique urban forms that formed around religious cores. Moreover, with the development of Tibetan Buddhism, a religious activity developed in which pilgrimages to sacred places were made following a particular route in a clockwise direction around sacred places. This eventually became a daily religious activity of the Tibetan people. Such pilgrimage routes are called kora paths in Tibetan. The subsequently expansion of Tibetan cities resulted in the kora paths becoming incorporated into urban environments as important religious streets, which we refer to as “kora streets” in this study.

Lhasa city, the central city of Tibet, has a large number of religious buildings and facilities within its urban areas. In the last few decades, Lhasa has undergone rapid development, and it has experienced much physical expansion as well as change in terms of the social systems of its residents. Subsequently, the religious buildings and the surrounding Kora paths of the city have changed in several respects. First, the motorization until recently in the kora streets which were mainly occupied by pedestrians has caused the motor vehicles take precedence in the management and design of streets. Second, it has been requested to expand the capacity of the Kora streets to accommodate the ever-increasing numbers of pedestrians and automobiles; in addition, new types of pedestrian such as tourist, shopper, and so on, have led the reuse of buildings and facilities along the streets. As a result, the Kora street in Lhasa city have probable encountered the threats from both of cultural and environmental aspects.

In this context, studies on the physical composition and behaviors occurring in the kora street areas of Lhasa city are important to identify existing problems and to propose strategies for future development, as well to provide reference points for other Tibetan cities which are experiencing the early stages of urbanization.

1.2 Previous Research

There have been a limited amount of studies on the kora street spaces in Tibetan cities. A research project between Tibet University and the Norwegian University of Science has explored some of the important elements of kora streets as important factors of the urban landscape. The Chinese researchers analyzed the formation of Barkhor Street (one of the kora streets in Lhasa) from the perspective of Tibetan history and culture. The result of their study showed a close
relationship between Tibetan Buddhism and the formation and development of Barkhor Street; in addition, the study indicated how activity along the street led to economical development. One project which looked at the buildings border towns in China, also investigated the contents of street space in Tibet. The project analyzed the characteristics of Tibetan streets, including decorations, colors, windows, and doors, based on surveys conducted in one of the traditional streets of Gyantse city. Finally, there have been some additional studies by international researchers on Tibetan streets, including a Japanese study that investigated the composition of religious facilities such as kora paths and monasteries in Lhasa city. Nonetheless, these previous studies are not without inadequacies. Namely, no study focused specifically on the daily religious activity occurring in and along the kora streets, and the discussions about the physical composition of kora streets in modern Tibetan cities are insufficient, although some other studies on the streets used for pilgrimages in India can be used as a reference point. The current study, therefore, aims to analyze both of the spatial composition and behaviors of kora streets in modern city of Lhasa.

1.3 Research Objectives
This study aims to clarify the spatial composition and behaviors in the kora streets of Lhasa city following modernization. As such, the study objectives are as follows:
1. To illustrate the possible formation processes of the kora streets from the available literature, as well as the transformation process over the last century by investigating maps;
2. To identify the physical characteristics of the kora streets in the modern city of Lhasa based on field measurements;
3. To clarify the behavior patterns along the kora streets based on an investigation of the behaviors that occur there; and
4. To point out existing problems reflected by the investigated behaviors, and propose suggestions for environmental improvement from the perspective of not only pilgrims, but also other pedestrians.

2. METHODOLOGY

2.1 Overview of the Study
This study aims to identify the issues of the spatial composition in and around the kora streets reflected in the behaviors of pedestrians, based on the analysis of both the physical and behavioral aspects of the urban space. First, these two aspects are introduced in the following two chapters. Next, issues related to the physical aspects of the kora streets of Lhasa city as reflected by the observed human behaviors there are identified and described in chapters three and five. Finally, suggestions are proposed based on the results of the study.

Regarding data analysis, data collected in the field during August and September of 2010 and January of 2011 formed the basis of the analysis. Specifically, the following two types of analysis were conducted:

First, the physical characteristics of the kora streets were identified based on the following three aspects: formation, transformation, and the current situation. By investigating the previous literature on Tibetan Buddhism, the history of Tibet, historical maps, and previous research, we attempted to better understand the formation and transformation of kora streets in Lhasa city. Moreover, based on the results of our measurements and sketches made in the field, we analyzed the characteristics of kora streets from the aspects of street size, facilities, and buildings along the streets. Accordingly, the sections of the kora streets were divided into several groups.

Second, we investigated the behavioral characteristics by behavioral observation along three target street sections selected based on their physical features both in the summer and winter (August 2010, January 2011). We recorded the behaviors of people in these street sections hourly from 7:30 AM to 8:00 PM using video cameras. Specifically, we recorded the number of people passing by the point of observing per minute, and we also recorded the locations of people engaged in different behaviors in the street sections.

On the other hand, we utilize interview as a complementary investigation with the purpose of helping the author understand the behaviors of people in Kora Streets, and their requirement. The interview is conducted in August of 2010. 81 respondents (including 67 pilgrims and 14 tourists) were interviewed.

2.2 Outline of Case Study
Lhasa city, located in the hinterland of the Tibetan plateau, has experienced long term development periods following its establishment. In the period under the rule of Bon (630–842 AD), the Potala Palace and two temples were constructed as the political and religious centers, with the original city structure developing around this religious center. Then, following a few hundred years of divide rule, Tibetan Buddhism established its religiously

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Fig. 1 Religious Buildings and Kora Streets in Lhasa City
based governance in Lhasa, which resulted in the second development peak of Lhasa city (1642–1959 AD). In this period, many religious buildings were constructed and repaired in accordance with the rapid development of Lhasa city, and this growth was accompanied by the gradual development of the city’s infrastructure. Finally, Lhasa city entered the third period of modernization and urbanization following changes in the political system in 1959. Nowadays, Lhasa city has three kora streets surrounding Jokhang Temple, Potala Palace, and the entire old city area; also, most religious buildings are located along the biggest kora street (See Fig. 1). This study will discuss both the physical features and human behaviors that can be found along these three kora streets.

3. PHYSICAL CHARACTERISTICS OF KORA STREETS

3.1 Ideology related to the Kora Streets

Tibetan Tantric Buddhism, introduced in the 8th century from India, inherited the ideologies and pilgrimage practices of Indian Tantric Buddhism. The typical pilgrimage style in both Tibetan and Indian Buddhism is based on the ideologies and theories of Buddhism. The current study, therefore, inferred the ideologies of kora street formation in Tibet based on the theories of Buddhism and Tibetan history.

First, according to the Mandala model, which reflects the cosmology of Tantric Buddhism, the world formed around a single center. Accordingly, the kora streets also formed surrounding a single center, which became a sacred place in Buddhism. Moreover, kora streets actually formed the boundaries around sacred spaces. In addition, the establishment of a religious-based governance system resulted in the development of kora streets to also surround political-religious buildings.

3.2 Formation of Kora Streets

This study infers the formation of kora streets through an analysis of the relevant literatures on the theories of Tibetan Buddhism and the history of Lhasa city. As for the three target kora streets in Lhasa city, each is located around one of the following important landmarks: Jokhang Temple, Potala Palace, and the old area of the city. Accordingly, we could assume that the formation of these three streets was related to the establishment of their respective religious status (See Table 1).

1) From the available literature, the Barkhor street area was formed after the construction of Jokhang Temple in the 7th century. 11)
2) After the religiously based governing system was established, Potala Palace became an important religious-political building. Accordingly, the Zikhor street area is speculated to have been formed after the repair of Potala Palace.

### Table 1 Formation Process of Kora Streets in Lhasa City

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>633</td>
<td>Introduction of Tantric Buddhism</td>
</tr>
<tr>
<td>846</td>
<td>Bod Dynasty Split up Period</td>
</tr>
<tr>
<td>1642</td>
<td>Religiously Based Governance</td>
</tr>
<tr>
<td>1959</td>
<td>People’s Republic of China</td>
</tr>
</tbody>
</table>

#### Historical events

<table>
<thead>
<tr>
<th>Lhasa</th>
<th>Political and Religious center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linkhor</td>
<td>Conversion around 9th century</td>
</tr>
<tr>
<td>Potala</td>
<td>Political Building</td>
</tr>
<tr>
<td>Zikhor</td>
<td>Formed after 17th century</td>
</tr>
<tr>
<td>Jokhang</td>
<td>Built in 647</td>
</tr>
</tbody>
</table>

![Fig. 1: Religious Buildings and Kora Streets in Lhasa City](image1)

![Fig. 2: Diagrams of Formation of Kora Streets in Lhasa City](image2)

![Fig. 3: Transformation of Kora Streets in the Last Century](image3)
3) As Lhasa city continued to develop around Jokhang Temple and Ramoche Temple, it is assumed that the Linkhor street area formed around the areas related to these two temples 4).

In addition, Fig. 2 shows the possible form of kora streets in Lhasa City after the religious-based governance system was established.

3.3 Transformation of Kora Streets

Fig. 3 reflects the transformation of the kora streets and their surrounding areas concurrent with urban development over the last 100 years. We can clarify the features of this development based on three aspects, as shown in the figure:

1) With regard to the structure of the kora streets, Barkhor street did not seem to change much, while the south section of Zikhor street changed during the period of 1904 to 1970. However, the Linkhor street experienced an obvious change during the process of city development.

2) As for the locations of the kora streets in the city, Linkhor street, which was originally a peripheral road in 1904, became a major street in the city center following further expansion of the city.

3) Regarding the areas surrounding the kora streets, Barkhor street has always been surrounded by traditional settlements, and this is still true today. As for Zikhor street, there were no areas of new construction surrounding the street in 1904; however, from 1970 a plaza and park were constructed in the south and north areas, and some buildings were built in the east and west areas. As for Linkhor street, the southeast area has long been surrounded by traditional settlements, with the other parts barren of building and facilities. With city expansion, however, the areas surrounding Linkhor have become filled with different types of buildings.

3.4 Characteristics of Physical Composition

The current situations of the three streets are shown in Fig. 4, including the streets and their surrounding areas. First, Linkhor street is one of the main streets of the city with lots of commercial facilities. It surrounds the old city area and includes a large number of religious buildings and the other two Kora streets. Second, a park and a plaza are respectively constructed in north and south of Zikhor street. However, the religious buildings and facilities inside the north park cause that the northern part of Zikhor extends to inside of the park, (Fig. 4 b). Finally, Barkhor street area comprises the religious center of the city and traditional residential area, is still the most important place for pilgrimage. Accordingly, our investigation divides the three kora streets into 20 street sections (shown in Fig. 4). The physical characteristics of the three kora streets are reflected in the measurement data shown in Fig. 5, which is based on the following aspects:

1) First, the buildings along Barkhor street were found to be comprised of 56% traditional buildings and 44% modern buildings with two or three stories. Buildings along the western and eastern sides of the Zikhor street are all modern buildings. As for Linkhor street, apart from a few buildings in sections 10 and 20, the street is completely surrounded by modern buildings.

2) The properties of the shops along the target streets are different when compared to the other shops in the same area. Two types of shops, including shop houses in the buildings along the street and temporary shops, in the Barkhor street area consist mainly of tourism shops and Tibetan traditional clothing shops. The shops in the Zikhor area are now mostly those selling food, home appliances, or other retail products to meet people’s daily needs. As for the Linkhor street area in the central city area, there are a variety of shop types not unlike those found along the streets in other Chinese cities.

3) According to our investigation results of the buildings along the target streets, the availability of space for parking, the motorways, and the shop stalls, the spatial composition features of the three kora streets (20 sections in total) were divided into four categories (Fig. 5). The features of each category are as follows:

Type A: This type, named “pedestrian-stall type” includes the entire Barkhor street area and has the following common features: all sections of the street have pedestrian space but no space for motor vehicles. Buildings with two or three floors along both sides of the street form a narrow street space. Moreover, temporary stalls are set up in front of the buildings.

Type B: Only four sections of the Zikhor street area (5, 6, 7, and 8 in fig. 4) are of this type, called “pedestrian type.” The street sections are narrow and do not include any space for temporary stalls or motor vehicles. Moreover, there are some facilities for rest.

Type C: Some sections of the Linkhor street (11, 13, and 19 in fig. 4) belong to this type, named “parking type.” Sections of this street contain space for both pedestrians and motor vehicles. In addition, motor vehicles can park along the sidewalk space.

Type D: All other street sections are included in this type, named “non-parking type”. The spaces of this type are similar to those of Type C, but without parking spaces along the sidewalk.

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Fig. 4 Kora Streets of Lhasa City in 2007
4. BEHAVIORS IN KORA STREETS

We firstly analyze the basic information of pedestrians in the three streets; then conducted a behavior analysis based on the above physical analysis. Because the three kora streets are comprised of the four spatial types described above, four sections containing all four spatial types (i.e., 4=Type A; 5=Type B; and 13, 12=Type C & Type D) were observed to analyze the characteristics of kora street behaviors from the spatial temporal and phenomenal aspects.

Based on the local time of Tibet, we utilize the average data from 7:30 A.M. to 13 P.M. as the data of morning, 14 P.M. to 18 P.M. as afternoon, and 19 P.M. to 20 P.M. as nightfall. According to these results, we drew mesh figures by combining the observational records over time and dividing the street plan into grids of 2×2 m2. First, spatially the grids were filled with different colors based on the total number of the people in the three time periods of one day. Then, we temporally analyze the distribution of people present at different times of one day by recording the locations of people in the winter and summer periods. In the analysis of this part, we counted the numbers of pedestrian in every two meters along the street section during the three time periods, and calculated the pedestrian percentage inside the spaces of every two meters in all pedestrians along the street section. (See fig. 7) As the phenomenal behavior reflects the relation between individual and surrounding environment, we then used the Similarity Measure of Kulczynski (See Equation 1) to analyze the relation between behaviors and spaces. As the different facilities inside the space of every grid in the mesh figures may jointly affect the behaviors, we divide the spaces into different groups according to the composition of inside facilities before calculating the similarity coefficient between the behaviors and different types of space.

4.1 Pedestrian Information and Behavior Types

We made hourly observations in the target streets over the course of one day in the winter and summer. Fig. 6 shows two aspects of pedestrian data: the numbers of pedestrians engaging in different behaviors, and the ages of the pilgrims. Subsequently, we clarify the following features in the three kora streets.

Through the results of interview, we first clarify the pilgrimage characteristics as: a) it is rationally a unique religious activity of all the Tibetan Buddhists without differentiation between people with different ages and gender; b) the pilgrimages to sacred places were made following a particular route in a clockwise direction around religious buildings, or some special things with religious significance, in this process, there isn’t stipulated start point or end point; c) as it has become one part of people’s daily life, people can freely arrange their pilgrimage schedule and choose routes, normally, in religious festival days, more people conduct pilgrimages comparing in normal days; d) in process of pilgrimage, people always carry prayer beads or a prayer wheel, and walk with chanting scripture; e) pilgrims alone or with families always carry on other activities in process of pilgrimage such as shopping, communication with friends, taking rest, and etc.

In Lhasa city, the different historical and current situations of the Kora streets result in different status for pilgrims. First, as the religious building surrounded by the smallest Barkhor street is the most important religious building of Tibet and the city, pilgrims in this street are more than in the other two streets. Second, as the religious status of Potala Palace is lower than Jokhang temple, pilgrims in Zikhor street are less than in Barkhor street. Finally, the longest Linkhor street takes more important role than Zikhor street for the pilgrims from other regions of Tibet, because the area surrounded by street is seen as the religious center of Tibet.

Second, regarding the number of pedestrians, the numbers were greater in the winter than in summer. As for pedestrian peaks during a day, we observed
two pilgrimage peaks in the Barkhor street, one in morning and one at nightfall; we observed only one pilgrimage peak in the Zikhor street at morning; as for the Linkhor street area, however, only one pilgrimage peak arises in the morning, but there is also one commercial peak in the afternoon.

Third, regarding the behavior type, the Barkhor street area is mostly used by pilgrims, tourists, and tourism-shoppers in the summer; however, pilgrims and pilgrim-shoppers are the most common pedestrians in winter. On the other hand, the Zikhor street area is used mainly by pilgrims and pilgrim-shoppers in both winter and summer. Finally, in the Linkhor street area, pilgrims, shoppers, and pilgrimage-shoppers use the street.

Finally, in case of the ages of the pilgrims, the elderly comprise more than 30%, although the average age in the winter is lower than that in the summer. In addition, the proportion of elderly pilgrims in winter are 41% in Linkhor, 32% in Zikhor, and 37% in Barkhor; in case of summer, 54%, 41% and 40% are respectively in the same order, as shown in the pie graphs in Fig. 6.

Furthermore, based on the results of behaviors from the spatial temporal and phenomenal aspects shown in Fig. 7 and Table 4, we clarify the characteristics of the behaviors along the three Kora street areas are described separately as follows.

![Fig. 6 Information of Pedestrians](image)

**Table 2 Comparison of Pedestrian Informations between the Kora Streets**

<table>
<thead>
<tr>
<th>Kora Streets</th>
<th>Barkhor</th>
<th>Zikhor</th>
<th>Linkhor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrians are more than 50% in the other two streets</td>
<td>Two peaks: 10 A.M., 1 P.M.</td>
<td>One pedestrian: 10 A.M.</td>
<td>One pedestrian: 10 A.M.</td>
</tr>
<tr>
<td>Pedestrians are winter more than in summer</td>
<td>Two pedestrian peaks: 10 A.M. and 1 P.M.</td>
<td>Pilgrimage peak: 11 A.M.</td>
<td>Pilgrimage peak: 10 A.M.</td>
</tr>
<tr>
<td>Pedestrians are summer more than in winter</td>
<td>Two pedestrian peaks: 10 A.M. and 1 P.M.</td>
<td>Pilgrimage peak: 10 A.M.</td>
<td>Pilgrimage peak: 10 A.M.</td>
</tr>
<tr>
<td>Pedestrians are winter more than in winter</td>
<td>Pedestrians are summer more than in winter</td>
<td>Pedestrians are winter more than in winter</td>
<td>Pedestrians are winter more than in winter</td>
</tr>
</tbody>
</table>

![Fig. 7 Analysis on Distribution of Pedestrians in Kora Streets](image)

**Equation 1 Similarity Measure of Kulczynski**

\[ K2(x,y) = \frac{a/(a+b) + a/(a+c)}{2} \]
Table 3 Types of space in all the grids of the mesh figures

<table>
<thead>
<tr>
<th>Pedestrian-Stall Type (Section NO.3)</th>
<th>Pedestrian Type (Section NO.5 )</th>
<th>Non-Parking Ty &amp; Parking Type (Section NO.12 and NO. 13 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Facility</td>
<td>Amount</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>--------</td>
</tr>
<tr>
<td>T1</td>
<td>Streetlight, Shopfront, Stall</td>
<td>1 T2</td>
</tr>
<tr>
<td>T1</td>
<td>Stall, Footstep</td>
<td>2 T4</td>
</tr>
<tr>
<td>T1</td>
<td>Tree shade, Stall</td>
<td>3 T6</td>
</tr>
<tr>
<td>T1</td>
<td>Tree shade, Stall, Footstep</td>
<td>9 T8</td>
</tr>
</tbody>
</table>

Table 4 Similarity coefficients between behaviors and spaces

<table>
<thead>
<tr>
<th>Pedestrian-Stall Type (Section NO.3 in Barkhor )</th>
<th>Pedestrian Type (Section NO.5 in Zikhor )</th>
<th>Non-Parking Ty &amp; Parking Type (Section NO.12 and NO. 13 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Behavior (summer)</td>
<td>Behavior (winter)</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>T1</td>
<td>0 0 0 0.21 0.200 0 0 0.100</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T2</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T3</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T4</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T5</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T6</td>
<td>0 0 0 0 0 0 0 0</td>
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</tr>
<tr>
<td>T7</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>T8</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

4.2 Behavior Characteristics of Pedestrian-Stall Type (Barkhor street)

If the space in every grid of the mesh figure was named according to what was done inside their respective facilities, we first divided all the spaces of the observed street sections into 13 types by name (see Table 3) based on the comprised facilities which include: shop houses in the first floor of buildings, shop fronts, stalls in front of buildings, footsteps in front of buildings, a streetlight in the northeastern part of the area, a big tree in the northwest part of the area, and one Tajua column in the southeastern part of the area. Using these type, the behavior characteristics can be described as follows:

1) Spatially, the mesh figure shows that people were mostly concentrated in the south area of the street in the summer, but then comparatively more concentrated in the north area in the winter. Moreover, the area right around the Tajua column (see Fig. 7) was found to be the most crowded place both in the winter and summer.

2) The distributions of people are temporally shown by the percentages of people in profile. In the morning and nightfall in the summer, pedestrians used the entire width of the street area except for the space between the stalls and buildings; however, more than 70% of the people in the afternoon were found to use the southern space of street area. The locations of people in the winter, on the other hand, were similar throughout the whole day, with pedestrians utilizing the northern and middle spaces.

3) Table 4 reflects the relationship between the observed behaviors and the street area spaces by showing their Similarity coefficient: a) Religious behavior was found to have a close relationship with Tajua columns (0.513) independent of the use of other facilities. b) Similar to commercial behavior, tourists also only utilized the spaces related to commercial facilities. c) The calculation results also showed that the behaviors of rest and communication take place in many spaces, including the tree area, footstep area, and stalls, without the need for special spaces for rest. d) With regard to the different behavior-facility relationships between the winter and summer, the behaviors of pilgrimage, as well as rest and communication utilizing the facilities, were similar for both the winter and summer seasons; however, shoppers in the winter were found to use more commercial facilities than in the summer.

4.3 Behavior Characteristics of Pedestrian Type (Zikhor street)

The observed section of the Zikhor street area is located to the east of Potala Palace and has the following facilities: bench, entrance to Potala Palace, tree, tree shade, footsteps, streetlight, rail, and shop front. Accordingly, the space for each part of the grid is named according to the facility found inside its borders. However, because the trees within the section lose their leaves in the winter, the spaces near and under these trees did not have any shade from the sun, and thus the types of spaces in the winter were different than those in the summer. Specifically, our analysis results showed the following behavior characteristics:

1) First, the density of the people in this street was less than that in the Barkhor street area. Moreover, people spatially, were found to be more concentrated in the middle of the street in the summer compared to the winter.

2) The spatial distribution of people temporarily showed that people are mostly located in the spaces near trees and shade provided by them throughout the day in summer. On the other hand, a similar situation was also observed to occur in the winter during the morning and at nightfall. Nonetheless, a completely different situation in the afternoon during the winter indicates that most people use such spaces for rest in the winter.

3) Based on the results shown in Table 4, the relationship between behaviors and spaces were clarified as follows: a) religious behavior mostly takes place in spaces with tree shade in the summer, while pilgrims use more spaces in the winter. b) the similarity coefficients between tourism behavior and space $I_T$ and $T_T$ (respectively 0.379 and 0.630) reflect that tourists use the spaces near the entrance to Potala Palace, and other spaces with benches for rest in the summer. c) Commercial behaviors mostly take place in front of storefronts, but on the other hand, the similarity coefficient (0.102) between commercial behavior and
spaces with bench for rest reflects that people use benches in the rest areas to sell goods. d) In addition to the spaces with benches, people were also observed to use the spaces shaded by trees and near the footstep for rest and communication in the summer, while this kind of behavior was found to only take place in the rest areas in the winter.

4.4 Behavior Characteristics of the Parking and Non-Parking Type (Linkhor street)

The street shown as #13 and #12 in figure 4, spanning the Wenzhou shopping mall to the Ramoche intersection (shown in Fig. 7) and covering two types of spatial composition (parking type and non-parking type), was chosen as a target of observation in our field survey. This section was selected to support a comparative analysis of the behaviors occurring in the two space types. The southern side of this section, located north of a religious center, was observed to be used more by pilgrims than the northern side. The western part is composed of commercial buildings with verandas on the first floor, shop fronts, footsteps, pedestrian spaces, parking spaces, green belts, and bicycle paths. Moreover, the other parts of this section include the physical elements of shop fronts, seating areas, electric wire poles, stalls, pedestrian spaces, bicycle paths and a green belt. In the two sections, all the spaces are divided into 11 types. Hence, the behavioral features of the two space types can be concluded as follows:

1) The most crowded spaces are close to the buildings along the street in the summer, while in the winter people use comparatively more space far away from the buildings, including bicycle paths. In addition, people were found to utilize the first floor verandas of buildings along the street both in the winter and summer.

2) The distributions of pedestrians temporarily shown in Fig. 7 were similar throughout the day. Moreover, the results also showed that people utilized different spaces in the winter and summer, suggesting the influence of sunshine on human behavior. Finally, in both the summer and winter, the proportion of people in front of shops increased in the afternoon hours because of increased commercial behaviors.

3) The relationship between the behavior and the spaces is reflected by the results shown in Table 4: a) pilgrims mostly utilized the spaces near the buildings in the summer, such as verandas and shop fronts; in contrast, in the winter they utilized the spaces far away from buildings, even including bicycle paths. b) The commercial behavior-space relationships were similar in the winter and summer, reflecting the fact that commercial behaviors take place in pedestrian spaces in addition to the spaces for shop fronts, because the stalls utilize part of the pedestrian space. d) Finally, it was found that people mostly use the seats in front of shops without special spaces for rest along the street.

4) Finally, through a comparison of the behavior-space relationships in parking spaces and non-parking spaces, it was found that narrow pedestrian spaces in the “parking type” space were utilized mostly by those engaged in religious behavior; moreover, verandas were highly utilized in the summer. However, in the “non-parking type,” the large number of stalls utilized in the space led to many people being engaged in commercial behavior inside the space.

5. ISSUES AND STRATEGIES RELATED TO ENVIRONMENT OF KORA STREETS

Based on the results of our analysis above, we were able to clarify the different historical elements, physical features and behaviors, in the three target kora streets with the aim of identifying some of the issues facing the four spatial types of street sections. To this end, this study first highlighted several elements; accordingly, the probable causes of each of the problems are identified. Then, for each type, common strategies and other special strategies that we believe should be emphasized in design were pointed out (see Fig. 8). Accordingly, their possible common applications to the kora streets are as follows:

1) Functional combination: in order to develop the Kora streets into more available places in the modern city, we propose the approaches of “religiously based modern streets” through functional combination in the management and design of the streets.

2) Flexibility of facilities: a) in the Barkhor street area, the goods sold by stalls and shops only need to meet the needs of both tourists and pilgrims in the summer, but only pilgrims in the winter. b) Also in Barkhor, stalls should be set up in different spaces according to the different pedestrian flows in winter and summer. c) For the Zikhor and Linkhor street, some spaces for special utilization, should be shared with other behaviors depending on the time of day or year.

3) Needs of the elderly: a) all three target streets should consider the needs of elderly pilgrims, for the elderly comprise a big proportion of all the pilgrims in the three target streets. b) In particular, in Linkhor street, facilities and rest spaces for the elderly should be set up along the streets for long distance walking.

4) Utilization of solar radiation: a) In all three kora streets, future design should consider the prevention and utilization of solar radiation in the summer afternoons and during the entire day in the winter. b) Based on the observed pilgrimage peaks in the three streets, the spaces used for pilgrimages is not the same as the key spaces identified for sunshine prevention in summer afternoon hours. Moreover, this study identifies special spaces on each street area to be emphasized in the prevention of excessive solar radiation in the summer afternoon hours: the spaces near shop fronts, stalls, and the rest spaces in the Barkhor street area; the spaces for rest in the Zikhor street area; and the rest spaces, and spaces near shop fronts in the Linkhor street area.

Furthermore, the physical composition, historical elements, coupled with the identified behavior characteristics of the four types of kora streets, specify the suggestions for special strategies for each street including 4 types of space as follows:

1) Barkhor street (Pedestrian-Stall Type): we suggest “religious-tourism street” approach with the purpose of the preservation of traditional culture and development of tourism through the strategies as: a) utilization of religious facilities and stalls in the organization of pedestrian flow; b) locating facilities needed by pilgrims in the areas near religious facilities; c) locating facilities for rest in the space between buildings.

2) Zikhor street (Pedestrian Type): the “religious-recreation street” approach is given to Zikhor street area to create unique urban space which can give the urban residents a new opportunity to use the spaces for their urban life, not only for pilgrimage, by using the strategies of: a) create special spaces for temporary shops to meet the needs for daily shopping of pilgrims; b) areas for shade in rest areas should be identified and created more than in the pedestrian space; c) locate
facilities for pilgrims not only along the kora streets but also along the extended routes in parks.

3) Linkhor street (Non-Parking Type and Parking Type): Linkhor street is suggested to be a “religious-commercial street” that mainly serve the public at large, not only the pilgrims but also shoppers, through the strategies of: a) the first floor should be designed as an extended pedestrian space, while considering the utilization of sunshine based on direction and time of day; b) Locate facilities for rest within certain distances. c) Locate temporary commercial facilities in especially identified spaces rather than pedestrian spaces; c) with one additional suggestion for the parking type street, design the parking areas where enough space can be left for pedestrians to comfortably move through.

### 6. CONCLUSION

Unique and important daily religious behaviors have bestowed Tibetan cities with a unique religious space called kora streets. This study investigated the three kora streets of Lhasa City and analyzed their physical composition and behaviors as they exist in modern Lhasa City with the purpose of clarifying the problematic issues reflected by those behaviors, and suggesting design factors for future environmental improvement. First, we illustrated the formation and transformation processes, as well as the original forms of the three target kora streets in Lhasa city; then we clarified the spatial composition of these streets and divided them into four types (pedestrian-stall type, pedestrian type, parking type, and non-parking type) based on field observations. Subsequently, we identified the behavior characteristics of each spatial type of kora street from the aspects of pedestrian features, distribution of pedestrians, and behavior-facility relationships by observing the behaviors in three selected sections of the three streets which included all four aforementioned spatial composition types. Next, we proposed design concepts for the three streets based on their different historical elements, and highlighted likely he faced issues. Then we stated both general

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**Fig. 8** Procedure for Searching Out the Issues and Strategies for Every Type of Kora Street

<table>
<thead>
<tr>
<th>Characteristics for the four Types of Street Space</th>
<th>Issues in the four Types of Street Space</th>
<th>Design Strategies for Each Type</th>
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</thead>
<tbody>
<tr>
<td>Physical elements:</td>
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<td>Common Strategies</td>
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<tr>
<td></td>
<td></td>
<td>Common Strategies</td>
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</tbody>
</table>

Note: ▲ means a feature is present in one type of street space ▲ means one type of street space is facing the problem reflected in the behavior features which are present in this type of space.

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and unique strategies that should be emphasized in future development for all four spatial types of kora streets. Finally, we proposed special applications of these design strategies to all four spatial types of street based on their respective physical features.

The three observed streets of Lhasa city reflect the general situations of the kora streets in other Tibetan cities: a) kora streets surrounding a religious core, incorporating tourism and religious behaviors in the summer, as well as religious behavior in the winter. b) Kora streets without tourism facilities that are mostly utilized by pilgrims and a small number of tourists. e) Kora streets which surround entire old city areas are seldom present in other Tibetan cities.

Besides the common strategies indicated in the above analysis, this study also suggests the following ways of improving the environments kora streets in other Tibetan cities by: a) designing the space around the religious facilities and buildings in order to meet the needs of pilgrims, and reflect the religious culture of the city. b) Locating special spaces for rest while taking into consideration the direction and amount of sun exposure. c) Leaving sufficient space for temporary commercial facilities to meet the needs of different pedestrian groups at different times of the day and also seasons of the year.

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Note
*2) Tantric teachings were introduced into Tibet by Padmasambhava in the 8th century; they became an important part of Tibetan Buddhism after long-term association with the local religion and culture of Tibet.
*3) Maps drawn by the authors based on satellite photos of Lhasa City contained in the book Lhasa City Atlas (LHCA).
*4) Here, "pilgrim-shopper" refers to a person engaged in commercial behavior who also has characteristics of a pilgrim.
*5) Similarity Measure of Kulczynski widely used in the analysis on the relation between behavior and space is one method which computes the degree of similarity between a pair of objects. In equation 1, the two objects “x” and “y” separately represent the spaces and behaviors. As well the attributes are the grids in the mesh figures. The code “1” means a type of space is present in one grid and “0” means it is absent. Subsequently, in equation 1, “a” equals the number of cases of 1-1 matches; “b” is the number of cases of 0-1 matches; “c” is the number of cases of 1-0 matches, and “d” is the number of the cases of 0-0 matches. Then, we computing the similarity coefficient by using equation 1. The calculation results range from 0 to 1. The bigger numerical value of result means more similarity (closer relationship) between the two objects.
*6) Tajau Columns, common facilities in Tibetan Buddhism, are raised almost exclusively in front of religious centers. There are five Tajau Columns in the Barkhor street area.

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和文要約
チベット仏教徒による都市内の巡礼路巡る日常的な行為は、チベット都市で一般に見受けられ、大勢の巡礼者が利用する巡礼路はチベットの都市の骨格的な都市空間であるが、自動車の増加や観光化などの影響で巡礼路の環境は近年変化している。本研究は、ラサ市中心部を対象に、巡礼路の系統を整理した上で、現地調査に基づき、代表的巡礼路の形態的特徴を明らかにするために、幅員や構成要素等から空間構成を4タイプに型式 した。更に、巡礼者の夏季と冬季それぞれの路上の行為を記録、分析し、夏季と冬季それぞれにおける時間帯別の路上の人口密度変化、沿道建物用道や道路内の要素（樹木やファーニュ等）と路上行為と関係、路上の人分布状態の特徴と季節間の相違を明らかにした。以上の調査結果に基づき、歴史環境保全利用者等の観点から見たタイプ別巡礼路環境の課題とその解決策としての巡礼路環境の改善方針を整理した。

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