



Investigation and Research on Spatial Types of Maternal and Infant Space in Commercial Space - A Case Study of Beijing

Ouyang Wen*, Zhou Qiang

School of Architecture and Urban Planning, Beijing University of Civil Engineering and Architecture, Beijing, China

Email address:

ouyangwen@bucea.edu.cn (Ouyang Wen), 446171906@qq.com (Zhou Qiang)

*Corresponding author

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Abstract: With the release of the three-child policy and the social environment that encourages breastfeeding, the maternal and infant population has become a special group that can not be ignored in society. They need and have the right to own and use public space. At the same time, China's new generation of young mothers is more willing to take their babies into social life as soon as possible to promote their growth. As the commercial space in the city is clean and tidy, with the appropriate temperature, convenient shopping and dining, convenient parking, and complete children's facilities, it has become the first place for mothers to bring their children. However, a series of problems such as the lack of maternal and infant supporting facilities and unreasonable spatial allocation in the current city have led to obstacles to the activities of maternal and infant groups outside. Taking the maternal and infant space in the commercial space as the research object, this paper collates and investigates the distribution of commercial space in Beijing and the relevant information on maternal and infant space in the commercial space. Then, we select 15 typical commercial spaces in Beijing to conduct in-depth research on the location distribution, function setting, and spatial form of maternal and infant spaces. Combined with the current situation and the cognition of the basic behavior law of the maternal and infant population, we take each functional space in the maternal and infant space as a spatial unit, analyze the relationship between each spatial unit, and conduct an integrated study on the spatial types of maternal and infant space, and put forward the basic combination principles of maternal and infant space according to the characteristics of the commercial space, so as to provide feasible suggestions for the rational configuration of maternal and infant space in commercial space.

Keywords: Commercial Space, Maternal and Infant Population (MIP), Maternal and Infant Space (MIS), Spatial Unit, Spatial Type

1. Introduction

Since 2012, the promotion activities, suggestions, and proposals related to maternal and infant facilities have been carried out continuously, reflecting the increasing attention of the society to MIP. In May and July 2021, China successively deliberated and published the decision on Optimizing Fertility Policies and Promoting Long-term Balanced Population Development, emphasizing that supporting measures should be actively implemented while the State implements the three-child policy. This decision makes society pay more attention to the implementation of the rights of MIP.

MIS, as a space that provides convenient facilities for breastfeeding, feeding, changing diapers, and a series of parenting behaviors in public places, has developed for many years in Japan, the US, and other countries. They are mostly set up in airports, shopping malls, parks, and other crowded places in the city, and provide free services to families carrying infants and young children [1]. Setting up maternal and infant rooms in public places not only reflects the social respect and care for women and children but also reflects the humanization of the concept of public service, it is a sign of the degree of civilization of a city [2]. At present, the construction of MIS in China is still in the primary stage of

development. Exploring the spatial form and function setting of MIS is of certain positive significance to promote the rational construction of MIS.

According to the data, as of February 2019, Beijing has the largest number of mother and baby rooms in China. According to the distribution of mother and baby rooms in various places in Beijing, the number of them in commercial spaces accounts for more than half of the total [1]. Through research, personal experience and network data sorting, we found that although the number of mother and baby rooms in commercial spaces is relatively large compared with other places, there are still a large number of commercial spaces without mother and baby rooms. In the commercial space with mother and baby rooms, there are some problems such as insufficient cognition of MIS, unreasonable function settings, and inefficient use of space. Based on the above problems, this paper selects the MISs of 15 typical commercial spaces in Beijing for in-depth investigation, and optimizes the type of MIS in combination with the current situation, to provide feasible suggestions for the rationale of MIS in commercial space, and provide a targeted reference for the subsequent preparation and revision of relevant norms and standards of MIS in China, to promote faster development of the construction of MIS in public places.

2. Research Object

This paper takes the MIS in commercial space as a research

object (excluding the MIS in children's theme parks and Early Childhood Education Center). The selected commercial space refers to the commercial entity space integrating a variety of business forms, having perfect service facilities, focusing on commercial functions, and supporting multiple functions [3]. It can be shopping malls, commercial buildings, department stores, shopping centers, and so on, a place for leisure activities to meet consumers' purchase needs and daily life [4].

The basic functions of the MIS are mainly breastfeeding and changing diapers, and the additional functions include infant meal preparation, rest, toilet for MIP, etc. The users of MIS include breastfeeding mothers, infants aged 0 to 3, and other groups caring for the infant [5]. In this paper, we use the word MIS to express this kind of public service space that can provide breastfeeding, diaper changing, nursing, washing, rest, and other functions for breastfeeding mothers, fathers, grandparents, relatives, nannies, and other people taking care of infants.

In recent years, some national codes and local standards have also begun to involve the regulations on MIS. For example, the mother and baby room is defined for the first time in Codes for Accessibility Design [6], the use area and basic functions of the mother and baby room are specified in Uniform Standard for Design of Civil Buildings [7], and the definition, internal facilities and use area of family toilets are given in Standard for Design of Urban Public Toilets [8], and so on, these relevant regulations provide the basis and reference for study on the types of MIS in this paper.

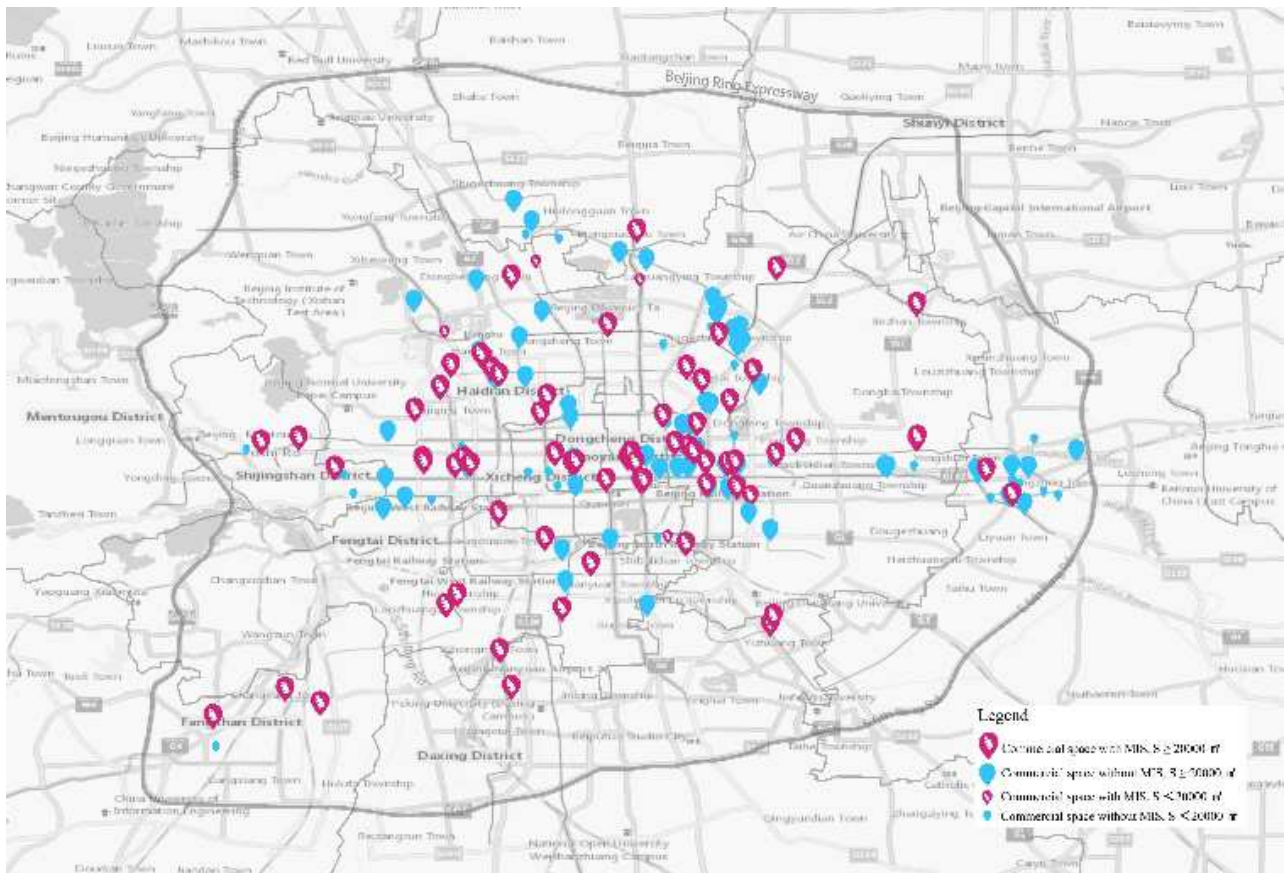
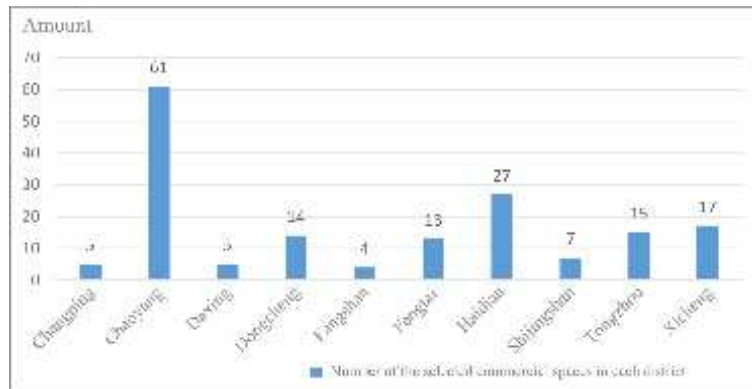
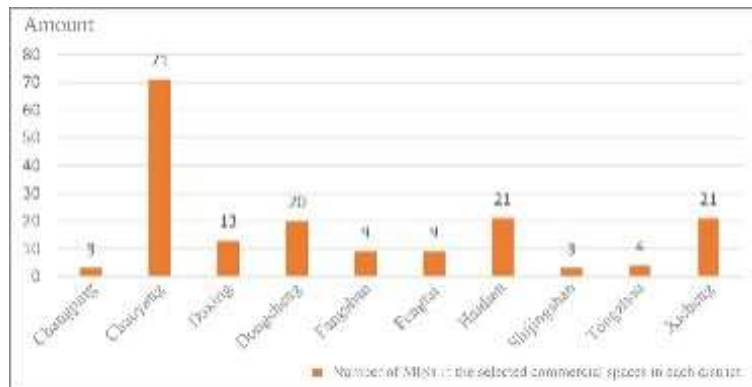


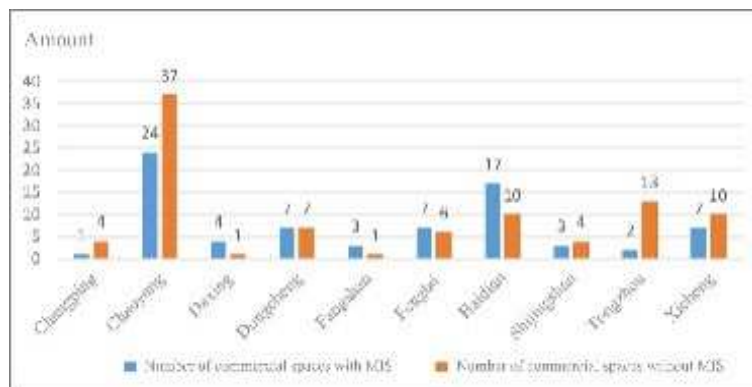
Figure 1. The selected commercial space and the setting of MISs in BRE.



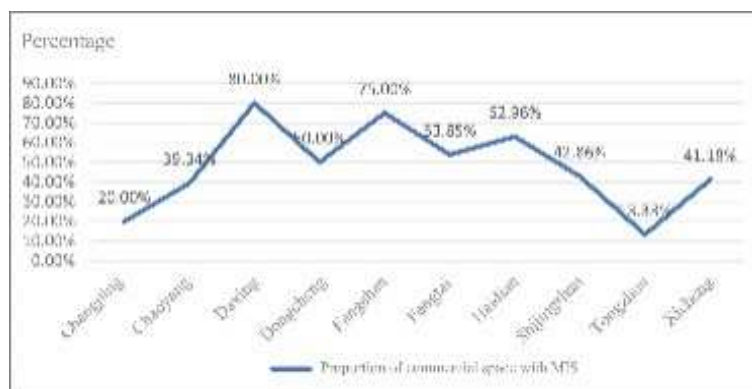
(a)



(b)



(c)



(d)

Figure 2. Statistics on the number of selected commercial spaces and the setting of MISs in each district of BRE.

3. Real State Investigation of MIS in Commercial Space in Beijing

We searched the commercial space within Beijing Ring Expressway (BRE) through the Baidu map and Gaode map, extracted and combed the obtained data, and finally selected 168 commercial spaces consistent with this study. Combined with the Gaode map, we searched the number of MISs and counted the number of MISs in the selected commercial spaces (Figure 1). According to the preliminary data analysis, there are more large-scale commercial spaces in the Fourth Ring Road of Beijing, and the commercial spaces with MISs with a commercial area of more than 20000 m² are generally more than those with MISs with a commercial area of less than 20000 m², which is also related to the relatively long residence time of MIP in large-scale commercial spaces. Among them, there are most commercial spaces in Chaoyang District, and the number of MISs is also the largest. However, judging from whether there are MISs in the selected commercial spaces in Chaoyang District, the number of commercial spaces with MISs is less than that without MISs (Figure 2). Most commercial spaces need to further increase the configuration of MIS.

Combined with the collection of preliminary data and collation of literature, this paper selects 15 representative commercial spaces with MIS in BRE for further in-depth investigation (Figure 3). We conduct field research and data sorting on the commercial area, location, and business format

of the selected commercial space, as well as the number, location, function, space form and uses the area of MIS in the selected commercial space, and focus on the classified research on the location distribution, function setting and spatial form of MIS.

3.1. The Location of MIS in Beijing's Commercial Space

According to the field survey, the location of MIS in commercial space is mainly divided into two types:

One is to form a complete supporting facilities area in combination with the setting of public toilets; It is divided into the MIS set in the public toilet area and the MIS set adjacent to the public toilet (Table 1).

The second type is set near the area of children's supplies, which is convenient for the nearby use of MIP; It mainly focuses on the type of comfortable mother and baby room, with complex functions, comfortable space, easy to find, and high utilization rate (Figure 4).

In addition, some commercial spaces have introduced mobile mother and baby rooms, which are not fixed and are relatively free. They can be moved in combination with the needs of commercial space, which is convenient to use. At the same time, they also play a certain role in promoting social care for MIP and publicity for mother and baby products; However, the survey found that the current situation of mobile mother and baby rooms is not optimistic, and some of them are in the state of maintenance and not open for use, which needs to be further popularized and optimized. (Figure 5)

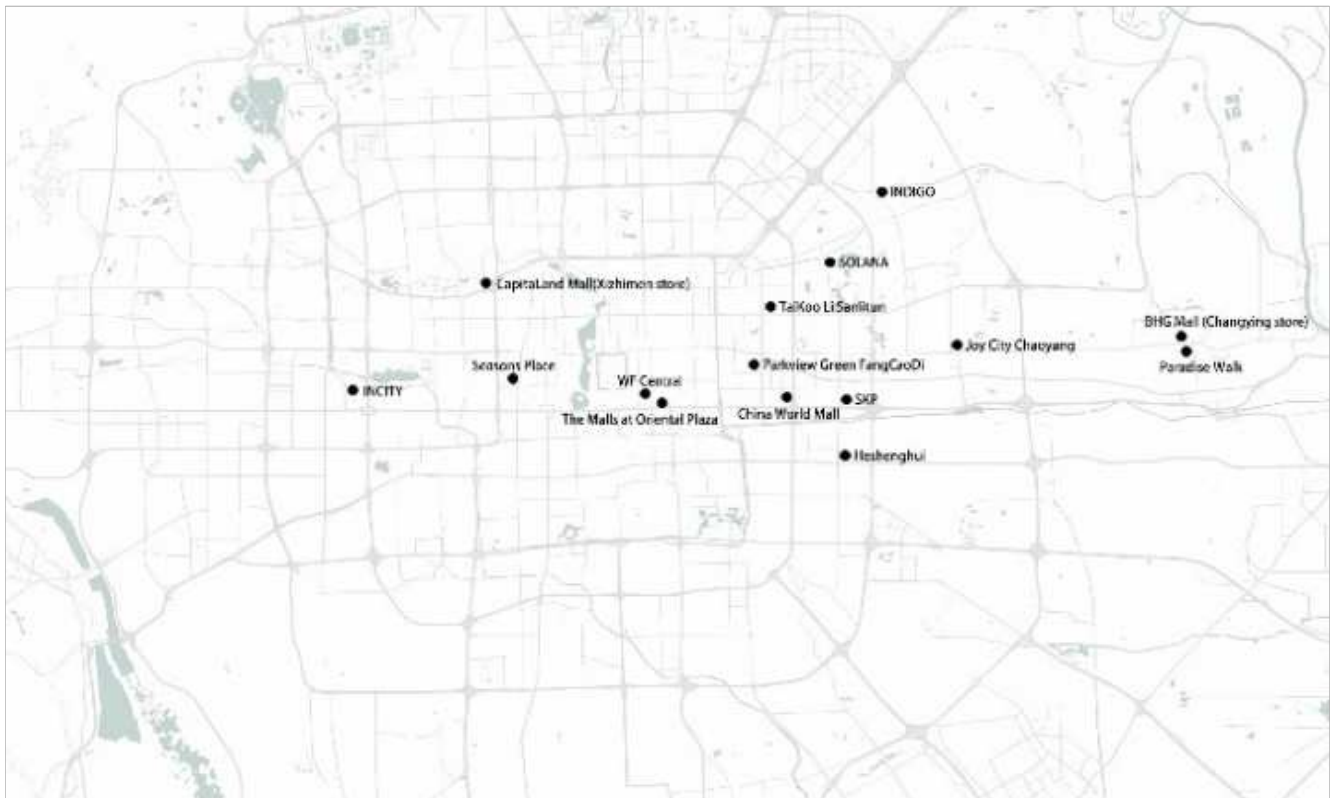


Figure 3. Location map of 15 selected commercial spaces.

Table 1. Positional relationship between MIS and Public Toilet.

Type	the MIS set in the public toilet			the MIS set adjacent to the public toilet		
	MIS is combined with the family toilet	MIS is set in the women's toilet	MIS is set between the men's and women's toilets	MIS is at the end of the public toilet	MIS is set in parallel with the public toilet	MIS is set opposite to the public toilet.
Problem	1. Save space resources 2. The internal facilities are not set uniformly, and the functions are incomplete. 3. Breastfeeding is set in the family toilet, which has potential health hazards.	1. Convenient for female baby carriers and lactating mothers. 2. Male baby carriers cannot use it	1. Convenient for all kinds of people with babies 2. MIS is vulnerable to the noise of people entering the toilet	1. It has good privacy and quiet environment 2. Susceptible to the smell of public toilets	1. It is easily affected by the flow of people entering the toilet and has poor privacy 2. Buffer zones or rest areas are set in some commercial spaces to reduce the impact	1. It is easily affected by the vision, smell and noise of public toilets 2. Some commercial spaces have taken corresponding measures to mitigate the impact
Relationship diagram of plane position						
Legend	MIS Men's toilet Women's toilet Family toilet without breastfeeding and diaper changing Public toilet Public corridor					



Figure 4. MIS of Beijing Heshenghui Shopping Center (From left to right: close to children's supplies area, rest area at entrance, independent breastfeeding room, diaper changing area and rest area).



Figure 5. Mobile Mother and Baby Room in Suspended State.

Through the sorting of survey data, it is found that the location setting of MIS has a certain relationship with space form and use area. The use area of MIS set in combination

with public toilet is relatively small, the space form is mainly single space, and the function setting is mainly diaper changing, toilet, and breastfeeding. The space design of this type of MIS is similar to that of a public toilet, and less consideration is given to the psychological needs of MIP. The MIS set near the area of children's supplies has a larger use area, the space form is mainly composite space, and the function setting is richer, the overall space design is used warm colors and pleasant elements, which not only meets the basic needs of MIP but also has relatively high comfort.

3.2. The Spatial Types of MIS in Beijing's Commercial Space

According to the analysis of the survey data, among the 92 samples of MIS selected for the survey, 84% of them have a usable area of less than or equal to 6 m², and the space form is a single space, the supported functions are mainly breastfeeding, diaper changing and parent-child toilet, they are compact spaces which are more popular in commercial space. The other 16% of them have a usable area of more than 6 m², and most of the space forms are composite spaces.

Maternal and Infant Spaces with a usable area of more than 20 m² have more comprehensive functions, clearer zoning, are relatively independent function spaces, which can meet the simultaneous use of multiple groups, and they are more comfortable. In the investigated samples, there is no MIS with an area of 10 m² - 20 m². The possible reason is that the MIS in this usable area is not conducive to the design of intensive and efficient use of space (Figure 6).

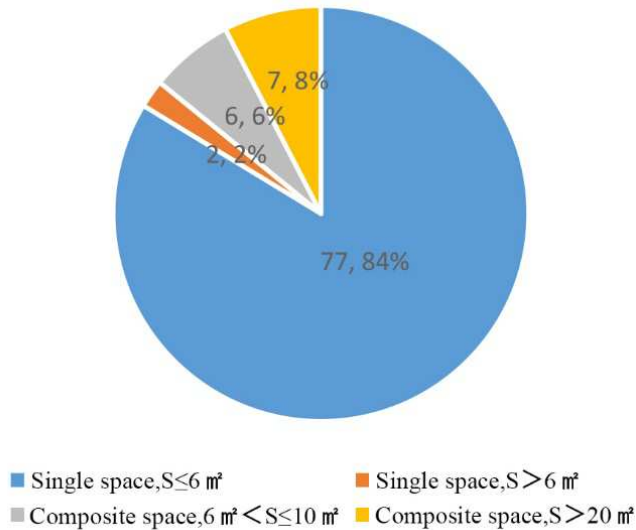


Figure 6. Number and proportion of MIS in different space forms and use areas.

3.2.1. Single Space Form of MIS

Single space refers to setting functions in complete small-scale space. Through the investigation, in this form, MIS is mainly equipped with two functions of breastfeeding and diaper changing and two functions of diaper changing and (parent-child) toilet, while the other spaces are MIS with a single function, such as diaper changing, parent-child toilet, breastfeeding. In the commercial space, there are mainly two types: the family toilet and the independent mother and baby room.

The internal functions of the family toilet are also slightly different in different commercial spaces, such as diaper changing and adult toilet/parent-child toilets/diaper changing and parent-child toilets. Different functions lead to different users, and the confusion of functions is easy cause inconvenience to some users. The functional setting of the family toilet shall meet the needs of families with children and barrier-free design according to the specification requirements.

The function setting of the independent mother and baby room is divided into four types: first, it only has the functions of diaper changing and hand washing, which provides an independent space for infants to change diapers. Through investigation, we found that this type of space is small and the space utilization rate is low. The second type is only equipped with breast-feeding function, which is often

combined with the family toilet on the same floor, they can not only meet the needs of MIP to go to the toilet, but also provide private breastfeeding space for mothers and infants. The third type is to meet the two basic functions of breastfeeding and diaper changing in a single space. It is a common type in commercial space at present, which reflects the intensive utilization of space; The fourth category is that there are three functions of breastfeeding, diaper changing, and toilet in the same space. Although it can meet the breast-feeding and toilet for breastfeeding mothers, breast-feeding, as the feeding behavior of infants, is mixed with the toilet function, it is easy to produce bacteria and unpleasant smell, which is not conducive to the physical and mental health of infants (Table 2).

3.2.2. Composite Space Form of MIS

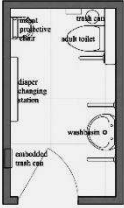
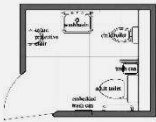
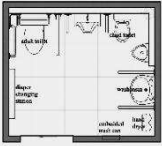
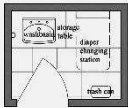

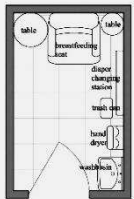
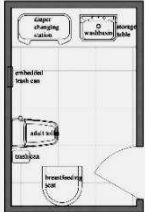
Composite space refers to the space form composed of multiple single spaces or containing multiple small spaces in a large space [9]. This kind of space has more complete functions, basically including two functions: breastfeeding and diaper changing. In the survey samples, there are the main types:

The first type is the composite space formed by multiple single spaces in series or parallel; In commercial space, two single spaces are mostly presented in series and two single spaces are connected in parallel through a public space. Through investigation, we found that such space forms have problems such as fuzzy function positioning, chaotic function combination, waste of space, improper use, and so on. By studying the psychology of MIP, it can be seen that when a group enters the series spaces, they will choose to lock the door to increase their sense of security and privacy, resulting in the phenomenon of occupying two spaces at the same time (Figure 7a). In the parallel spaces, because of paralleling two independent spaces with different functions, when one group of users who need to change diapers are used in the space with breast-feeding and diaper changing functions, the other group of users with breastfeeding needs cannot use the other space that can only change diapers (Figure 7b).

The second type is a composite space with multiple small spaces in a large space; In the commercial space, their use area is larger, and they form a small nursery place. The main functions include breastfeeding, diaper changing, meal preparation, rest, etc. the functional zoning is relatively clear, the comfort and utilization rate are high, and the public area can produce positive communication and interaction.

Through the investigation, we find that there are common problems in the spatial form and functional organization of MIS in commercial space: first, the internal functional positioning of MIS is fuzzy and the functional organization is chaotic. Second, the relationship between the spatial form and functional organization of MIS lacks consideration of the behavior habits of applicable people, resulting in a low space utilization rate and space waste.

Table 2. Function setting of MIS in single space form.

	Family Toilet			Mother and Baby Room			
Function	Diaper changing and toilet	Parent - child toilet	Diaper changing and parent - child toilet	Diaper changing	Breastfeeding	Breastfeeding and diaper changing	Breastfeeding, diaper changing, and toilet
Main internal facilities	diaper changing station, adult toilet, infant protective chair, washbasin, trash can.	adult toilet, infant protective chair, child toilet, washbasin, trash can.	diaper changing station, adult toilet, infant protective chair, child toilet, washbasin, trash can.	diaper changing station, washbasin, storage table, trash can.	breastfeeding seat, storage table, trash can, power socket.	breastfeeding seat, diaper changing station, washbasin, storage table, trash can, infant protective chair., power socket.	breastfeeding seat, diaper changing station, washbasin, storage table, trash can, adult toilet.
Typical plan of survey sample							

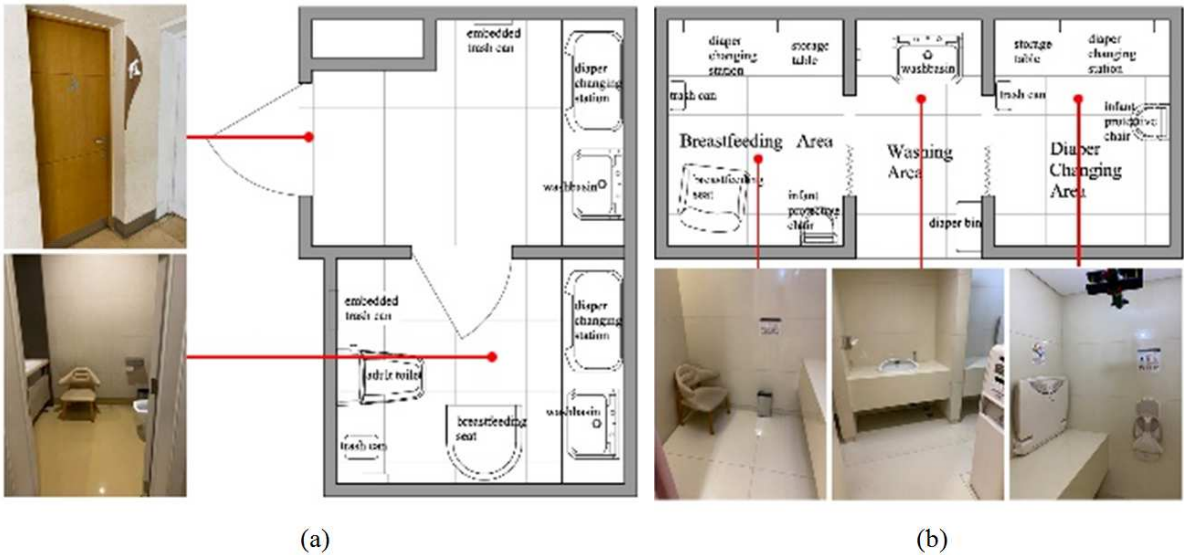


Figure 7. Plans and pictures of composite spaces in the survey samples (a. two single spaces in series b. two single spaces in parallel).

In the book Theory of Architectural Space Composition, Mr. Peng mentioned: as early as 2000 years ago, the great Roman architect Vitruvius listed "utility" as one of the three principles of architecture when discussing architecture, and the spatial form of architecture must first follow the functional requirements [10]. For the research of MIS, starting with the spatial form and functional organization, exploring the reasonable type of MIS in commercial space is the basis and premise to meet and ensure the basic functional needs of MIP.

4. Study on the Types of MIS in Commercial Space

For the spatial layout of any type of urban public service facility, conforming to the general behavior law of the target population is the basic premise of facility spatial planning [11]. MIP need its own public service spatial units, which are easy to identify [12].

Based on the cognition of the basic behavior law of the target

population in the investigation and literature, and to enhance the pertinence and readability of MIS, this paper takes each functional space in MIS as a spatial unit, studies the types of MIS in commercial space in combination with the relationship between the spatial units. Then, according to the spatial layout, business format distribution, and user characteristics of the commercial space, we summarize and put forward the basic combination principles of MIS, to provide some guidance and suggestions for the rational configuration and design of MIS in the transformation and new construction of commercial space.

4.1. Functional Spatial Unit of MIS

4.1.1. Basic Functional Spatial Unit

Breastfeeding Spatial Unit: its function is breastfeeding and sucking (with a breast pump) for lactating women. The internal basic facilities include a breastfeeding seat, storage table, power socket (for electric breast pump), clothes hook, trash can, emergency call button, and lockable door/curtain. The minimum size of a breastfeeding spatial unit is generally

1200mm x 1200mm [13]. This kind of spatial unit requires high privacy and quietness (Figure 8a).

Diaper Changing Spatial Unit: its function is to meet the needs of infants to change diapers. The internal basic facilities include a diaper changing station, washbasin, storage table, and trash can (Figure 8b).

4.1.2. Additional Functional Spatial Unit

Meal Preparation Spatial Unit: its function is to meet the needs of preparing milk formula, heating food, and eating for infants. The basic facilities include a food warmer, water dispenser, steam sterilizer, and baby dining chair. This kind of spatial unit is a semi-open space. It can set up meal preparation facilities in combination with the storage desk in the hand washing area. When conditions permit, it can form an independent spatial unit by itself to set up a comfortable meal preparation and dining area (Figure 8c).

Toilet Spatial Unit: it's a private space, the internal basic facilities include an adult toilet, infant protective chair, child toilet, etc. It can meet the needs of people with babies alone and

parent-child families with children. It can be combined with the design of a barrier-free toilet. It is barrier-free and does not clearly distinguish gender. The family toilet with complete facilities can be used by multiple family members, which fully shows the humanized goal and humanistic care of architectural design [14]. It can meet the needs of people such as fathers with female infants and mothers with male infants, It can also be used by two or three children of different ages in a family at the same time, which solves the problem of toilet difficulty for people with children. Considering that the toilet function is easy to have a negative impact on the breastfeeding and dining environment, it should not be set in the same space with the breastfeeding spatial unit and meal preparation spatial unit. When it is set in the composite space, it should avoid being adjacent to the breastfeeding spatial unit and meal preparation spatial unit (Figure 8d).

Rest Spatial Unit: it is a semi-open space. The basic facilities include rest seats, infant game facilities, etc. Its function is to provide a rest space for people waiting to use the MIS and their companions (Figure 8e).



Figure 8. Pictures of different functional spatial units.

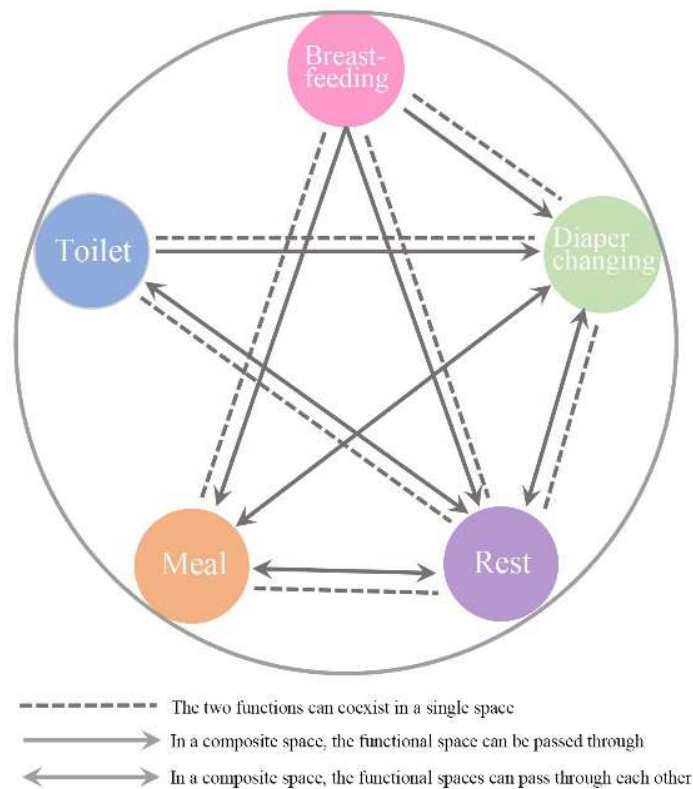


Figure 9. Relationship diagram between five functional spatial units.

4.2. Spatial Types of MIS

After knowing and understanding each functional spatial unit, we analyze the relationship between spatial units (Figure 9). Then, we explore the combination relationship between functional spatial units under the two spatial forms and study the spatial types of MIS in combination with the utility of space.

4.2.1. MIS Composed of Single Functional Spatial Unit

MIS Composed of Breastfeeding Spatial Unit: as an independent MIS, the space size should not be too small. It should be considered that the baby carriage can be pushed into it. Considering a mother with one or more children, folding seats can be set in this space. Based on the above considerations, it is recommended that the minimum net size of this type of MIS should be greater than 1800mm x 1200mm (Figure 10a). The location setting is more flexible, which can be adjacent to the public toilet, in the children's supplies area, or women's supplies area.

MIS Composed of Diaper Changing Spatial Unit: considering the utilization rate of space and the saving of space resources, the commercial space with the family toilet, should be combined with the toilet to form a family toilet with complete internal facilities, which is convenient for families.

The space size should not be too small. It should be considered that the baby carriage can be pushed into it (Figure 10b).

4.2.2. MIS Composed of Two Basic Functional Spatial Units

The MIS composed of a breastfeeding spatial unit and a diaper changing spatial unit, it can meet the two functions of breastfeeding and diaper changing. The two spatial units can be set in a single space, and the public areas of the two functional spatial units can be partially overlapped from each other according to space size. This type of MIS should be considered for families with multiple children to form a small family nursery, and the use area should not be less than 4 m² (Figure 10c).

The two basic spatial units can also be set in a large space to form a composite space to meet the needs of multiple groups of baby carriers to breastfeed and change diapers at the same time. One or more breastfeeding spatial units can be set in this type of space, which can be set independently to ensure the privacy and a quiet environment. The diaper changing spatial unit is set as a semi-private space so that the two functional spatial units can be fully used. The space area can be controlled within 4-10 m², forming a small and intensive infant care space (Figure 10d).

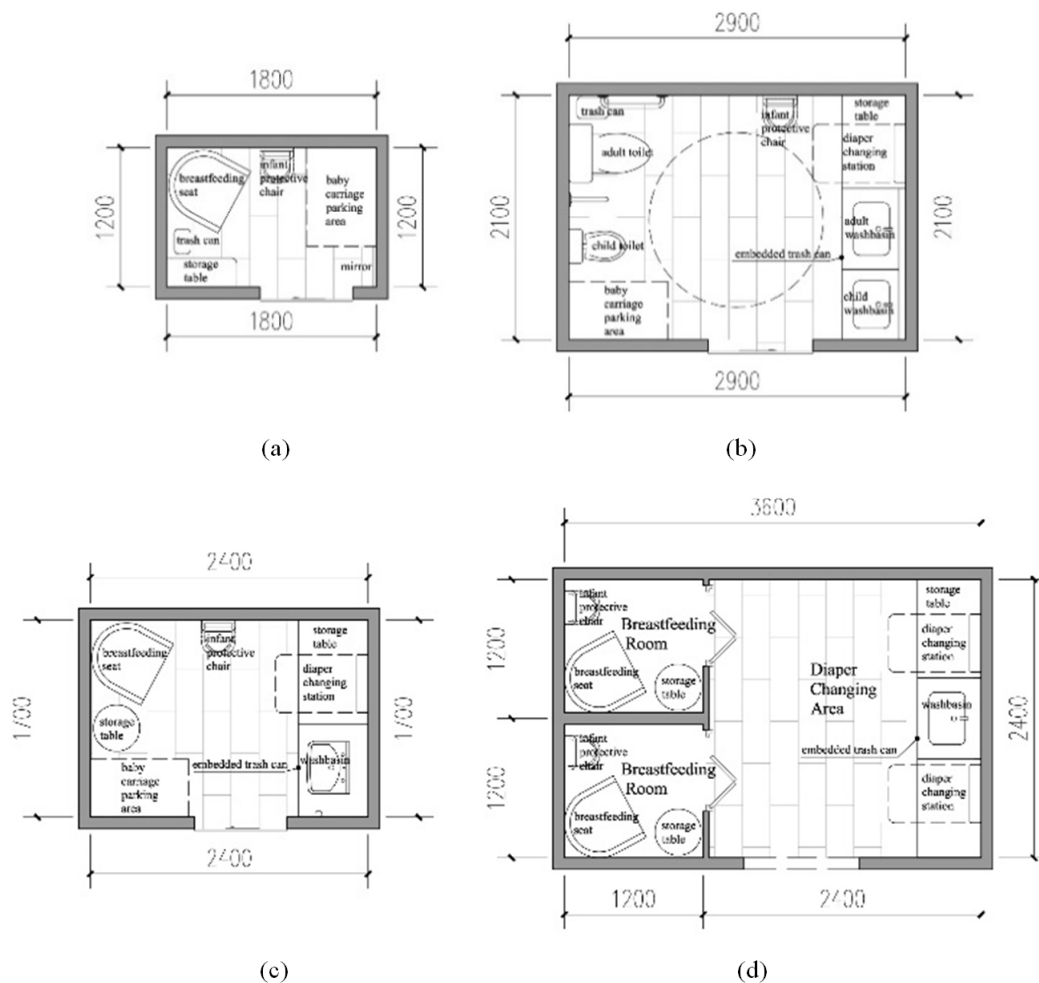


Figure 10. Plans of different types of MIS.

4.2.3. MIS Composed of Two Basic Functional Spatial Units and Additional Functional Spatial Units

The MIS composed of a breastfeeding spatial unit, a diaper changing spatial unit and a meal preparation spatial unit: it can meet the functions of breastfeeding and changing diapers, and eating for infants. The three functional spatial units should be relatively independent and closely connected. The MIS has complete functions and clear zoning. It should be suitable for commercial spaces with a building area of more than 10000 m² or a daily passenger flow of more than 10000 people, the use area of the MIS should be ≥ 20 m² [15].

The MIS composed of a breastfeeding spatial unit, diaper changing spatial unit, meal preparation spatial unit, and rest spatial unit: it is a multi-functional large comfortable baby-rearing space. It can be set in areas or floors with

children's products, children's paradise, and other business forms to improve the quality of commercial space, and allow people with babies to stay in commercial space for a long time, to promote consumption. This type of MIS is more widely used, including all types of baby-rearing people: mother/father/grandparent takes infant alone, husband and wife take care of one or more children together, mother and grandparent/nanny take care of one or more children together, etc. Therefore, the functional zoning of this type of space should be clearer and streamlined needs to reduce cross, so that users can reasonably use each spatial unit according to their own needs, reducing the disturbance to other users. Reasonable design helps to improve the utilization rate of the space and maintain the comfort of the space (Figure 11).

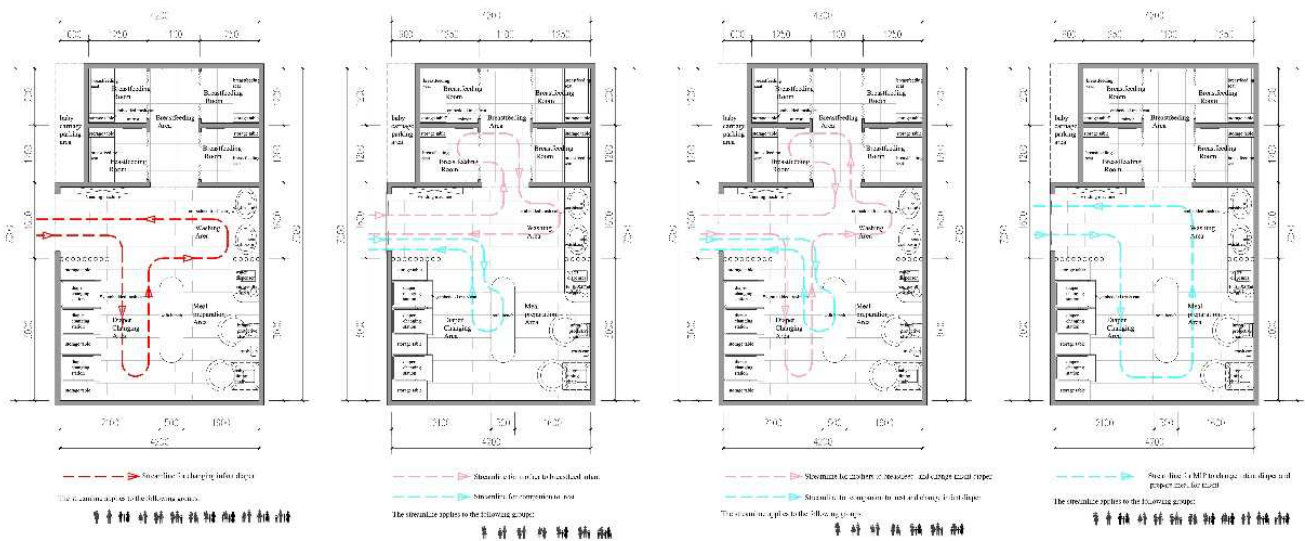


Figure 11. Plan and streamline analysis of MIS.

4.3. Principles of Combination and Configuration of MIS

Based on meeting the requirements of national basic norms and based on the field investigation and research, this paper puts forward the following principles for the combination and configuration of MIS in commercial space:

4.3.1. Principle of Rationality and Flexibility of Function Combination

The basic functions of MIS should be combined reasonably and the additional functions should be set flexibly. In the commercial space, when setting up a family toilet, the internal facilities configuration shall be reasonably considered in combination with the commercial format and users. The need of changing diapers for infants should be considered in the family toilet. In small and medium-sized commercial spaces, the combination of an independent breastfeeding space and the family toilet can be adopted to meet the two basic needs of breastfeeding and diaper changing for MIP. In large and medium-sized commercial spaces, based on meeting the basic needs of breastfeeding and diaper changing, the scale of MIS

should be determined in combination with the scale and format of commercial space, and other additional functions should be flexibly set in combination with the needs of commercial space, to effectively improve the service quality of commercial space.

4.3.2. Principle of High Efficiency and Sharing of Space Configuration

MIS should be configured efficiently in layers and regions in combination with commercial formats and commercial space layout. The combination of MIS should be reasonably configured according to the frequency of MIP on the floor. When there are many floors, the MIS can be set on separate floors to ensure that it can be used on the upper or lower floors [16]. For large and medium-sized commercial spaces with relatively concentrated streamline, MIS can be centrally set on each floor; For the large commercial space with a long streamline, the MIS with multiple functional combinations can be set up in different regions on each floor, to ensure that the MIP can find the applicable MIS conveniently and quickly.

5. Conclusion

The design premise of MIS is utility, which meets the basic functional needs of users. Starting from the user needs of MIP, this paper analyzes and studies the current state of MIS in commercial space in Beijing, combs the basic functional spatial units, analyzes the relationship between various spatial units, studies the combination types between functional spatial units, and puts forward principles for the combination and configuration of MIS in commercial space, to solve the problems of MIS in commercial space. The rational design of spatial type is the first step of humanized care for MIP in commercial space. Based on the utility spatial type, further research on the specific facilities, scale details and environmental atmosphere in MIS can more specifically express the humanized care for MIP, to promote the progress and development of urban civilization.

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