

# Analysis on the Causes and Characteristics of Child Loss through Surveys

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**Abstract** Since lost child occurs frequently around us and there is a possibility of leading to an accident or a crime subsequently, it is necessary to study and have a plan for preventing child loss in advance. However, the preceding studies do not systemize the causes of child loss by places or situations, and the policy focuses only on the countermeasures afterward instead of prevention. In such perspective, this study derived the causes of child loss through the analysis of 202 cases by the bottom-up method. In addition, the causes were analyzed by dividing them into as negligence of guardian, breakaway of child, and environmental characteristics. As a result, it is found that children get lost by complex reasons usually with two or three causes combined together. And children got lost when guardians were not able to pay attention to their children, or when children moved away from their guardians. Furthermore, the environmental characteristics act as the catalyst by arousing child loss or making it more difficult for guardian to find the lost child. As a fundamental research, this study may be helpful in developing a environmental design certification system for preventing child loss in advance.

*Keywords: Lost Child, Missing Child, Cause of Lost Child, Characteristics of Lost Child, Survey*

## 1. INTRODUCTION

According to a survey of 500 elementary school students in Korea, 22.1% of them reported temporarily missing or permanently missing, and 1.0% reported abduction in the past.<sup>1</sup> In other words, children go temporarily missing more often than we are aware of, and that number is much higher than abduction. However, since missing children are usually found within 48 hours, its importance is relatively lower than how

it actually needs to be valued. The death of a missing child at Jamsil Olympic Park in 2016<sup>2</sup> shows that temporarily missing child may become permanently missing, or may even involve in crime. In addition, this case shows the need of considering not just the negligence of guardians and breakaway of children, but also in the aspect of physical environment. Moreover, if a particular physical environment has affected a child to get lost, then controlling that physical environment may reduce the rate of child loss.

However, the studies for prevention of child loss are being conducted mainly based on smart devices, and studies on child loss affected by physical environment are insufficient. The regulations and policies on child loss only deal with post-child loss such as the registration of fingerprint, Code Adam<sup>3</sup> and etc. This reveals that related studies and systems are useful

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<sup>1</sup> Kang, B. (2014). Report of Findings on Perception Survey of Missing/Abduction. Child Fund Korea Publication, 2014(3), 1-133.

<sup>2</sup> Lee, M., & Joo, H. "A 5-year-old child died wandering barefoot... indifferent world!" The Chosunilbo, 5 Sept. 2016, Retrieved from news.chosun.com/site/data/html\_dir/2016/09/05/2016090500093.html.

<sup>3</sup> Code Adam is a systematic protocol for the employees of multiuse facilities to follow when a child is reported missing. The procedure requires the employees to monitor all the exits and drop down everything to look for the child. The police are called when the child is not located within 10 minutes.

only when they are prepared right before the loss, and they do not fundamentally help to prevent child loss. Although CPTED (Crime Prevention through Environmental Design) is frequently used for preventing abduction, it does not prevent child loss. Thus, it is essential to develop an environmental design and system that can prevent child loss beforehand. In prior to this, it is necessary to objectively find out that child loss does not occur not only in behavioral aspects such as negligence of guardian and breakaway of child, but it is also essential to consider the causes of child loss in environmental aspects.

This research derives the causes of child loss in three aspects, such as negligence of guardian, breakaway of child, and characteristics of environment through case analysis. In addition, this study identifies the associations between the causes of child loss to see how the causes relate to each other by affecting child loss. The research method is as it follows. First, the literatures related to child loss are reviewed in section 2, and section 3 analyzes cases of child loss in multilateral aspects, and the causes of child loss are derived in the aspects of environment and behaviors of guardian and child. In section 4, the relationship between the causes of child loss is identified through the co-occurrence matrix. Furthermore, in order to determine the relationship between the causes, the combinations of the causes are categorized and the relationship is analyzed thoroughly in each case. In section 5, the types and causes of child loss in each functional spaces were studied based on the previous combinatorial analysis, and the characteristics of child loss was analyzed in the behavioral and environmental aspects. Examining the causes and characteristics of child loss may be helpful in developing environmental design guideline and certification system for preventing child loss in the future.

## 2. THEORETICAL STUDY

'Lost child' refers to a child who has lost his/her way or unable to return home on his/her own due to the lack of cognitive ability or geographic discernment after separation from the guardian. Although child gets lost by various causes, it may be said that it is mainly caused by negligence of guardians, breakaway of children, and characteristics of environment.

### (1) Behavior of Guardian and Child Loss<sup>4</sup>

According to Choi, J. et al. (2020), there are three major negligent behaviors of the guardians. First behavior is when the child is in company with the guardian, but the guardian is unconsciously unable to pay attention to the child due to a momentary change in behavior. For instance, when a guardian is holding a child's hand at the cash register or convenience desk to buy or make inquiries, the guardian eventually releases the child's hand, and not be able to supervise the child. At that moment, the child may leave the guardian, and get lost. In addition, children may lose their guardians by releasing the children's hands while waiting for the guardian to get ready to go somewhere else, shopping or waiting to make purchases.

<sup>4</sup> Since the research on the causes of child loss in the perspective of children was lacking, the possibility of child loss in the aspect of child development was inferred.

Secondly, guardians show negligence when guardian and child are separated from each other, guardian pays attention to something other than his/her child. This behavior may be influenced by environmental characteristics. The results of the research reveal that the behaviors of the guardian watching the children changes according to the environmental properties of the resting space in the amusement space. Most of the guardians kept their eyes on their children in the resting spaces that are arranged in the direction of the amusement space. Conversely, in the resting space arranged in the opposite direction of the amusement space, the majority of the guardians did not watch over their children because they were either using their phones or chatting with their acquaintances. Thirdly, guardians' control of the children's movements and attention to their children were different depending on the age and number of the children. As the age of the child increased (infants, preschool age, and school age), the guardians tended not to hold the children's hands. Furthermore, when the guardian is accompanied with two or more children, the guardian showed carelessness to the older child by only holding the younger child's hand.

This presents that the guardians' level of attention to the child varies depending on particular space and physical environment of the space. Thus, in order to prevent child loss, it is necessary to design a physical environment that prevents children from easily leaving the space, and to plan a space that guardians may keep their eyes on directly to their children.

### (2) Characteristics of Child Development and Child Loss

Since children's cognitive development differs according to ages, their behaviors and psychological characteristics also varies with their ages. Children at ages 1-3 develop autonomy, become more inclined to do anything by themselves, and desire to walk around freely on their own. Children start to play around freely in space by playing hide-and-seek or finding something, which may lead them to lose their guardians. However, restraining the children's environment search leads to difficulty in developing their autonomy and strong tendency to rely on others. The curiosity of children develops at ages 3-5, and they start to enjoy challenging themselves by showing adventurous and exploratory behaviors, which leads them to get lost in the unfamiliar environments. Restricting their curiosity at those ages may adversely affect their cognitive development. From age 4, short-term memories of visual, spatial, and linguistic information begin to develop, and they are able to remember information about a specific time and place with their own memories. This may also result child loss by thinking of the past interests and desiring to explore to that place. However, since the sense of directions does not develop, younger children are unable to find directions by their own memories until ages 7-8.

Since children are unable to recognize that they are lost until the age of 3, younger children may not even be able to make an attempt to return.<sup>5</sup> The typical characteristics of children age 2-7 are centralization and self-centeredness, focusing on perceptual characteristics rather than logical thinking by paying attention to only one characteristic and perceiving the world

<sup>5</sup> Syrotuck, W. G. (2000). *Analysis of Lost Person Behavior: An Aid to Search Planning*. Barkleigh Productions.

from his own perspective. Therefore, children have difficulties finding directions in a logical way, and more likely to get lost as they leave their guardian by focusing on the one interest that draws their attention. This shows that children get lost due to their development characteristics such as curiosity, activeness, autonomy, and self-centered thinking.

Nonetheless, restraining children's exploration due to the concerns about them getting lost may adversely affect children's cognitive development. Hence, environment that allows children to explore freely and guardians to easily watch over their children needs to be provided.

### (3) Physical Environment and Child Loss

As stated in Choi (2017), there are five major environmental characteristics that may lead to child loss in a large-scale park. First, there is a high chance of children to get lost in an environment where children's dynamic behavior is predominant. This is due to active motions and movements of dynamic behavior, which makes it difficult for the guardian to control and take care of the child. Second, rather than the number of the users and the area of the facility, the pedestrian density due to the relationship between the two variables have a greater effect in child loss. As the pedestrian density gets higher, the probability of the children getting concealed by the crowd also gets higher. This makes it more difficult for the guardians to watch over the children. Third, the extremely closed structure causes bottleneck phenomenon in the entrances, which also results child loss. Even if children leave the facility through the entrance, they are more likely to be hidden by the pedestrians due to high pedestrian density, and thus not be exposed to their guardians and others as well. Fourth, there is a high probability of children to get lost in an amusement facility located near the other amusement facilities. This is because when guardian leaves this space or does not pay attention to the child, the child may leave the guardian to the other amusement facilities. The last environmental characteristic that causes child loss is an environment where it is difficult to observe children. The space with low visibility and especially the environment with entrances that are inconspicuous may constrain the guardians to keep eyes on their children.

Wayfinding is one of the significant factors in child loss. If a child has the ability to find a way on their own, it is unlikely that they will get lost. However, if a child does not have the ability to find his/her way back, he/she is likely to be lost. There are environmental factors that influence children's wayfinding, which includes spatial structures, landmarks, colors, and etc.

Cho, M. (2018) mentions about the importance of the visual and perceptual characteristics in the spatial structures for children. She also states that it is helpful to apply the form of concourse in the planar structure, and prefers to prevent inconvenience caused by the low visibility.<sup>6</sup>

Various studies show that landmarks have also been regarded as a significant factor in wayfinding. Beck & Wood (1976) note

landmarks as the influential environmental factors for acquiring spatial knowledge. Since children first acquire the knowledge of landmarks in unfamiliar space, Siegel and White (1975) emphasize the importance of landmarks for acquiring spatial information.

In addition, color appears to play a significant role in wayfinding. A study by Jensen-Osmann & Wiedenauer (2004) discovers that color helps both adults and children when finding their way in unfamiliar environments. In particular, on colored floors, all the participants were able to find the short cuts with fewer mistakes than on the floors without colors.<sup>7</sup>

Child loss is affected not only by the behaviors of guardians and children, but also by the environmental characteristics. Physical environment plays an important role in the wayfinding that affects child loss as well. Therefore, it is essential to design the environment that prevents child loss, and the environment that provides children to easily find their way.

### (4) Distinction of Research

Most national surveys on lost child in various countries are held in the form of reports, which are superficial studies that identify the current status on child loss based on statistics rather than in-depth analysis. There are only a few studies related to child loss, and they only list up the causes of child loss individually. Moreover, the scope of research is limited to specific places and situations, rather than covering various places and situations, which makes it difficult to generalize the results.

Syrotuck (2000) infers the cause and process of child loss by examining the distance and the characteristics of the place of loss through the cases received from the police. However, the number of the cases are very minute (10 cases), which makes it hard to systematize and generalize the results. Cornell & Donald (2006) summarizes the studies related to children's wayfinding, and systematically organizes children's wayfinding skills with child developmental process by age. However, the research does not examine the causes and process of child loss. Choi (2017) uses statistics and simulations of lost children to derive physical environmental characteristics that result child loss. However, since this study only covers large-scale parks, it is difficult to generalize the results on the causes of child loss in various environments. Choi et al (2020) analyzes the causes of child loss in the behavioral aspect by behavioral observation survey. Nonetheless, there is a limitation that the causes of child loss are inferred by observing prominent behaviors of the children and guardians in the child space instead of the actual cases.

Thus, this research determines the causes of child loss in the aspects of guardians, children, and environment based on a total of 202 cases on child loss. Instead of simply listing the causes, it was analyzed by which combinations of causes result child loss. Ultimately, the causes and characteristics of child loss were systemized and generalized based on various cases.

<sup>6</sup> Cho, M. (2018). A Study on the Visual Cognitive Characteristics of the Spatial Configuration in Childrens Rehabilitation Hospitals – Focused on the Pediatric Rehabilitation Outpatient and Therapy Areas. *Journal of the Architectural Institute of Korea Planning & Design*, 34(10), 83-94.

<sup>7</sup> Jansen-Osmann, P., & Wiedenbauer, G. (2004). Wayfinding Performance in and the Spatial Knowledge of a Color-coded Building for Adults and Children. *Spatial Cognition and Computation*, 4(4), 337-358.

### 3. SURVEY ON CHILD LOSS

#### (1) Survey Method

The survey on child loss was conducted through questionnaires and phone interviews with the guardians who had lost their child in the past. The participants were voluntarily recruited through online blogs related to childcare. The questionnaire begins with basic information of lost child, cause of the child loss, reaction of the lost child, and the discovery method of the lost child. The causes of child loss were particularly categorized in the aspect of negligence of guardian, breakaway of child, and environmental characteristics by referring to precedent studies on child loss. In addition, through the pilot survey, the main survey questionnaires of the causes of child loss were amended and supplemented as

shown in Table 1. This survey was conducted with survey questionnaires, and additional questions about the responses on questionnaire through telephone interviews. The questionnaires and interviews were conducted twice on November 2017 and January 2018, and a total of 244 cases on child loss were collected. These cases were eliminated to 202 cases by excluding special cases, false cases, and cases with lack of information.

#### (2) Contents of the Survey on Child Loss

The results from the 202 cases of lost children show that there was no huge difference in genders (47.5% boys and 52.5% girls). They were mostly age 2-5 (78.2%), and most of them were 3 years old (27.7%). In general, active children (58.7%) tend to get lost, but some passive children (6.5%) lost their guardians because they left their guardians who felt reassured. Children

Table 1. Questionnaire Items for Causes of Child Loss

Questionnaire Items for Causes of Child Loss		Precedent Studies								Note
		1	2	3	4	5	6	7	8	
Negligence of Guardian	Guardian is doing something else.	•		•						• Negligence due to 'purchasing, making inquiries, looking around, getting prepared(packaging), using the phone, having a conversation, reading books, and taking care of the other child' are collectively referred to as 'doing something else'
	Guardian leaves the child.	•		•						• Leaving to use the restroom, or to pick up / clean up the food.
	Guardian moves away thinking that the child is following the guardian or the child is able to find his/her way.	•							•	• Taking care of the younger child or moving without holding child's hands in order to carry something. Guardian moving without holding the child's hands by thinking that the child is at his/her age to find his/her way.
	Guardian does not care about the child thinking that the other guardian was taking care of the child									• When there are 2 or more guardians.
Child's Breakaway Due to Developmental Characteristics	Child spontaneously moving towards the element of interest.	•	•	•		•	•		•	• Moving because the child saw the element of interest, and moving by remembering the location of the element of interest in the past are distinguished.
	Child recognizes and moves to the element of interest with the past memories.									
	Child moves alone to a place.(Egocentrism)									• Child moving without thinking about the guardian due to egocentrism, and moving away from the guardian with the guardian in mind due to independence are distinguished.
	Child moves alone by thinking that the guardian would come right after him/her. (Independence)							•	•	
	Child tries to find his/her guardian even though the guardian told the child to wait.				•					•
	Child follows a person who looks or wears like his/her guardian.				•					
	Child moves in the direction of people moving or straight ahead.						•			• Tendency of moving straight ahead without a specific purpose or following the crowd.
	Child moves away from his/her guardian to play or fool around	•					•	•	•	•
Child moves to find his/her guardian because the guardian is out of his/her sight.									• Although guardian was near the child, the child breaks away because the child could not see the guardian.	
Child's Breakaway and Failure in Wayfinding Due to Environmental Characteristics	Child is blocked and pushed by the high density of people.	•	•	•	•					• Occurs in places with high pedestrian density, such as nodal points, bottleneck sections in entrances, facilities that overlap with passageways, and etc.
	Guardian watches over the child from far away because the guardian's space is insufficient or too far away from the child's space	•	•							• Environment that is difficult to watch child.
	Child is covered by visual obstacles.			•	•					• Although child was near the guardian, the guardian could not see the child because he/she was blocked by obstacles.
	Child goes to search for the guardian because the guardian is covered by visual obstacles or crowd.									• Although guardian was near the child, guardian could not see the child because the child was blocked by obstacles.
	Child is unable to return due to many visual obstacles that are higher than the child's height.									• Lack of visibility due to obstacles, and leading child to fail in wayfinding by not being able to clearly recognize the space.
	Child is unable to return due to complex structure or circulation.			•				•	•	• Corresponds to the spatial structure(circulation) with many crossroad
	Child is unable to return due to lack of differentiation in design or architecture.			•				•		• Environment with no differentiation in design elements(interior, material, color, symbol, landmark, and etc.) such as ceilings, floor, and wall
	It is an open structure without door/fence(border) that is easy for the child to leave alone.	•	•							• Open structure and unclear facility boundaries
Guardian is unable to properly watch the child because the surroundings are dark.		•							•	

1. Choi, J. et al. (2020a) 2. Choi, S. et al. (2018) 3. Choi, S. (2017). 4. Choi, S. (2020) 5. Syrotuck, W. G. (2000) 6. Woolnough, P.S. & Cunningham, S. (2020) 7. Sedlak, A., Finkelhor, D., & Brick, M. (2017). 8. Japan Children's Risk Avoidance Institute (2009)

got lost more frequently on the weekends and holidays (56.4%), and in the afternoon (73.0%). This is because children go out with the guardians more often on the weekends and holidays when they do not have to go to school. Furthermore, children tend to get more active after lunch, and children get dismissed from school in the afternoon.

Children lost their guardians most frequently in commercial facilities such as marts (19.8%), and large shopping malls and department stores (17.3%). 43.1% of all the cases were from commercial facilities including general commercial facilities and marketplaces. When the locations were divided into 8 functional spaces<sup>8</sup>, the retail space came out to be the highest percentage of child loss with 29.2%, followed by circulation space (23.3%), and amusement space (17.8%). Similar to the circulation space, in the boarding space (5.4%), children were separated with their guardians unexpectedly when they boarded on the elevator or subway train by themselves.

Table 2. Places of Child Loss

Locations of Child Loss	Frequency	Percentage
Mart	40	19.8%
Shopping Mall / Department Store	35	17.3%
Theme Park / Water Park	22	10.9%
Near Home	19	9.4%
Commercial Facility / Marketplace	12	5.9%
Large-scale Park	10	5.0%
Zoo / Aquarium	9	4.5%
Beach	7	3.5%
Street	7	3.5%
Tourist Attraction	6	3.0%
Kids' Cafe	5	2.5%
Near School or Kindergarten	5	2.5%
Transportation Facility	4	2.0%
Wedding/Reception Hall	4	2.0%
Exhibition Facility	3	1.5%
Accommodation	3	1.5%
Near Relatives' or Friends' house	3	1.5%
Religion Facility	2	1.0%
Ski Resort	2	1.0%
Culture Center	2	1.0%
Fairground	1	0.5%
Mountain	1	0.5%

Table 3. Places of Child Loss by Functional Spaces

Functional Space	Frequency	Percentage
Retail	59	29.2%
Circulation	47	23.3%
Amusement	36	17.8%
Rest	16	7.9%
F&B	14	6.9%
Watching	12	5.9%
Boarding	11	5.4%
Convenience	7	3.5%

When child is lost, the number of visitations to the place was bifurcated by more than 6 times with 42.4% and first time

<sup>8</sup> The 8 functional spaces are Retail space, Amusement space, Rest space, F&B space, Convenience space, Watching space, Circulation space, Boarding space.

visiting with 29.8%. This shows that children tend to get lost in familiar environment by visiting frequently and feeling reassured and in unfamiliar environment by visiting for the first time. As the result of spearman's correlation analysis between the frequency of visits and familiarity of the place at the time of child loss, the r-value came out to be 0.773 (p=0.000). In addition, children often lost their guardians in the crowded environments, but they also were separated in uncongested environments by the guardians feeling comfortable about their children leaving alone.

At the time of the separation, the most common behavior of the guardians appeared to be when they were shopping or looking at interesting factors (19.9%) followed by making a purchase (17.3%), and taking care of the other child (14.8%).

The examination of how lost children cope with the situation presents that most of them tried to search for their guardians (48.0%). However, the children who walk around to find their guardians makes it more difficult for guardians to find their lost children. There were also children who were not aware that they were lost (23.2%), and these children were mostly infants. Lost children were found by the guardians (41.5%), citizens, employees, or others (39.5%), and in some cases lost children found their guardians on their own (8.5%). The children who found their ways back were familiar with the place (46.2%), or they remembered their way back (23.1%). Lost child and guardian took less than 10 minutes (52.8%), or 10-30 minutes (30.3%) to reunite with each other, which shows that reunion takes less than 30 minutes in general.

Table 4. Reactions of Lost Child

Reactions of Lost Child	Frequency	Percentage	Avg. Age
Search for the guardian	93	48.0%	3.8
Do not recognize being lost	45	23.2%	3.1
Ask for help	21	10.8%	5.5
Stay still	20	10.3%	3.7
Wayfinding by oneself (to his/her home, car, customer service, & etc.)	10	5.2%	5.4
Return to where he/she left the space	5	2.6%	4.4

Table 5. Discovery Method of Lost Child

Discovery Method of Lost Child	Frequency	Percentage	Avg. Age
Guardian finds the child	83	41.5%	3.6
Others find the child	79	39.5%	3.6
Child ask others for help	21	10.5%	5.5
Child finds his/her way	17	8.5%	4.8

### (3) Causes of Child Loss

The causes of child loss identified from the surveys were classified into negligence of guardian, breakaway of child, and environmental characteristics. Among the 202 cases, 87.6% were affected by negligence of guardian, 81.7% of them were affected by breakaway of child, and 61.4% of the cases were from

environmental characteristics.<sup>9</sup> This result reveals that child loss is caused not only by negligence of guardian and breakaway of child, but also by environmental characteristics. Moreover, child does not get lost by one cause (8.5%), but child gets lost by a combination of various causes (91.5%) from guardian, child and environment (Table 6). Since child loss affected by the characteristics of guardian and child was 34.2%, and the characteristics of guardian, child, and environment was 39.1%, it shows that environmental characteristics work as the catalyst by inducing child loss and making it more difficult for guardian to find the lost child.

Table 6. Relationship between the Causes of Child Loss by Categories

Relationship between the Causes of Child Loss by Categories	Frequency	Percentage
Guardian & Child & Environment	79	39.1%
Guardian & Child	69	34.2%
Guardian & Environment	23	11.4%
Child & Environment	14	6.9%
Environment	8	4.0%
Guardian	6	3.0%
Child	3	1.5%

Table 7. Causes of Child Loss by Categories (multiple responses allowed)

Cause of Child Loss			Frequency	Percentage		Avg. Age
				202Cases	585Cases	
Guardian	G1	Guardian did something else	117	57.9%	20.3%	3.6
	G2	Guardian left the child	23	11.4%	4.8%	4.0
	G3	Guardian moved away from the child thinking that the child was following him/her or the child was able to find his/her way	42	20.8%	7.2%	4.1
	G4	Guardian did not care about the child thinking that the other guardian was taking care of the child	15	7.4%	2.6%	3.4
Child	C1	Child spontaneously moved to the interesting factors	43	21.3%	7.4%	3.8
	C2	Child recognized and moved to the interesting factor with the past memories	10	5.0%	1.7%	3.6
	C3	Child moved to a place himself/herself before guardian moved (Egocentrism)	9	4.5%	1.5%	2.1
	C4	Child moved alone by thinking that guardian would come right after him/her (Independence/Autonomy)	14	6.9%	2.4%	5.6
	C5	Child tried to find his/her guardian even though the guardian told child to wait	8	4.0%	1.4%	4.8
	C6	Child followed a person who looks or wears like his/her guardian	8	4.0%	1.4%	4.3
	C7	Child moved in the direction of people moving or straight ahead	15	7.4%	2.6%	3.4
	C8	Child moved away from his/her guardian to play or fool around	23	11.4%	3.9%	3.6
	C9	Child moved to find his/her guardian because the guardian is out of his/her sight.	6	3.0%	1.0%	4.3
	C@	Other - The reason for child's behavior or failure to follow his/her guardian are unknown	41	20.3%	7.0%	3.5
Environment	E1	Child was blocked and pushed by the high density of people	50	24.8%	8.5%	3.5
	E2	Child was covered by visual obstacles	33	16.3%	5.6%	3.5
	E3	Guardian watched over the child from far away because the guardian's space is insufficient or too far away from the child's space	7	3.5%	1.2%	3.9
	E4	Child went to search for the guardian because the guardian is covered by visual obstacles or crowd.	20	9.9%	3.4%	4.0
	E5	Child was not able to return due to the complex structure	17	8.4%	2.9%	5.1
	E6	Child was not able to return due to lack of differentiation in design or architecture	26	12.9%	4.4%	4.8
	E7	Child was not able to return due to many visual obstacles that were higher than child's height	7	3.5%	1.2%	3.7
	E8	It was an open structure without door/fence (border) that was easy for child to leave alone	40	19.8%	6.8%	3.7
	E9	It was too dark to watch over child	11	5.4%	1.9%	3.7
<b>Total</b>			585	-	100.0%	3.9

\* 'Other-Child moves away' is coded to 'C@' since it includes cases in which the children get lost by moving away for unknown reasons.

<sup>9</sup> A category is considered to affect child loss when more than breakaway of child, and environmental characteristics is included in the cause of each lost child case.

Table 7 shows the in-depth causes of child loss by categories, and includes all the multiple responses from the questionnaires. The total number of the causes from the 202 cases was 585 with the negligence of guardian of 33.7%, breakaway of child of 30.3%, and environmental characteristics of 35.9%. In 'negligence of guardian', the behavior of guardian at the time of the loss was analyzed comprehensively. As a result, the most common cases was when guardian momentarily loses child's hand, or both are not holding hands, and guardian does something else (20.0%). This type of behavior includes looking at products or interesting elements (28.7%), purchasing or making inquiries (23.5%), taking care of other child (13.9%), and etc.

The most common case from the child loss caused by 'breakaway of child' was when child leaves the guardian by spontaneously moving to the interesting factors (11.4%). In addition, children under age of 3 left their guardians without thinking that their guardians have to be with them all times due to their self-centeredness (4.5%). At the age of 3-12, even though children were aware of staying with their guardians at all times, they move towards the familiar space before their guardians due to their independence (6.9%).

The most common case from the child loss resulted from 'environmental characteristics,' which was when child was blocked and pushed by the crowd with high density (8.5%). Furthermore, in some cases, children lost their guardians because they were covered by the visual obstacles such as partitions and display stands, and guardians were unable to find them (16.3%). Conversely, children were unable to find their guardians due to the visual obstacles (9.9%). The result also shows that many children get lost in the spatial structure where children are able to easily get out on their own (19.8%). Moreover, children aged 3 years or older were unable to find their guardians back when the structure was too complex to find their ways (8.4%), or there was no architectural differentiation (12.9%).

As a result of examining 202 cases of child loss, all the cases show that guardians and children were physically separated before the loss. It indicates that children get lost when they walk alone or try to get back on their own by not holding guardians' hands or walking far away from the guardians.

On the other hand, none of the children got lost by children letting go of guardians' hands. In other words, most of the children were physically separated from their guardians due to their curiosity and activeness. In addition, children were more likely to be lost and to be not found by the guardians in the environments that are easy for children to escape or to be covered by visible obstacles.

#### 4. ANALYSIS OF THE RELATIONSHIP BETWEEN CAUSES OF CHILD LOSS

After examining 202 cases of child loss, it was found that child loss is usually caused by a combination of various causes rather than by a single cause. In this respect, section 4 attempts to

determine what causes are related to each other, and how they have led to child loss.

##### (1) Co-Occurrence Matrix for Causes of Child Loss

Co-Occurrence Matrix is utilized in order to analyze how each cause have influenced each other. This matrix is a technique used to discover the relationship between items that are part of an event, and it is also often used as a data preprocessing method in 'network analysis,' which is one of the data mining techniques. The data, which is the subject of the analysis in this research, becomes the cause of each child loss case. This means that the higher the frequency of co-occurrence between the two causes, the relevance gets higher.

Since 'Other-Child moves away(C@)' is where the reasons of children moving away are unknown, it is not included in the analysis. The results are shown in Figure 1, and there are 6 groups (combination by categories of causes)<sup>10</sup> in total shaded in two colors for convenience. Combinations of the causes in the same category are shaded in green, and the ones of the causes in different categories are in red. The gradations of the color means the relative crossover frequency between the causes within each of the 6 groups.

Combinations of the causes in the same category (green) are as follows. According to the frequency of simultaneous child loss among the 4 causes from the "negligence of guardian," 78.2% of 202 cases were caused by one "guardian" cause. In other words, the causes [G1, G2, G2], which account for most causes of guardian's negligence, did not occur by multiple causes, but it mostly occurred independently. However, in the case of [G4], it always occurred with other causes as secondary causes such as looking at elsewhere or going somewhere else 'thinking that the other guardian is taking care of the child'. That is, since [G4] does not have '0' in the frequency of co-occurrence with other causes, and the frequency with other causes is greater than the frequency of [G4], it can be said that [G4] did not occur independently. From this, it may be interpreted that [G1, G2, G3] are the main causes of child loss, and [G4] is the secondary cause that occurs together with negligence of other guardians. In addition, [G1] and [G2] came out to be independent to each other.

The frequency of co-occurrence of 9 causes of child loss in the category of "breakaway of child" shows that 76.2% of 202 cases were caused by one of the "child" cause. This means that when break away of child affects child loss, it can be said that most child related causes occur independently. Furthermore, in the case of corresponding to multiple causes of "child", child was lost by moving to the interesting factor(C1) and moving in the direction of the people moving or straight ahead(C7) without going back to the guardian, or following a person who looks or wears like the guardian(C6) (3 cases, 1 case).

Furthermore, contrary to the cases where the guardians and children mostly occurred independently, most of the cases led to the child loss with multiple environmental factors(69.3%)

<sup>10</sup> 6 groups : Guardian - Guardian / Child - Child / Environment - Environment / Guardian - Child / Guardian - Environment / Child - Environment

Cause of Lost Child	Guardian				Child									Environment									
	G1	G2	G3	G4	C1	C2	C3	C4	C5	C6	C7	C8	C9	E1	E2	E3	E4	E5	E6	E7	E8	E9	
Guardian	G1	117	0	5	6	24	9	7	5	0	2	9	16	4	28	26	2	15	8	12	7	28	6
	G2	0	23	0	4	4	0	2	0	6	2	1	0	1	3	2	0	0	1	1	0	10	1
	G3	5	0	42	6	9	0	0	8	0	3	6	1	1	9	3	0	5	4	2	0	0	1
	G4	6	4	6	15	2	0	1	0	0	2	2	1	0	5	2	0	2	1	1	0	5	0
Child	C1	24	4	9	2	43	0	0	1	0	1	3	0	0	12	9	0	1	2	3	0	10	4
	C2	9	0	0	0	0	10	0	1	0	0	0	1	0	3	3	0	1	2	0	1	3	0
	C3	7	2	0	1	0	0	9	0	0	0	2	0	0	1	2	0	0	1	0	0	2	2
	C4	5	0	8	0	1	1	0	14	0	1	0	1	0	3	3	0	1	5	4	2	1	0
	C5	0	6	0	0	0	0	0	0	8	0	0	0	0	2	0	1	0	0	0	0	4	1
	C6	2	2	3	2	1	0	0	1	0	8	0	1	0	1	1	1	0	2	2	1	4	1
	C7	9	1	6	2	3	0	2	0	0	0	15	0	1	5	0	0	0	1	1	0	2	1
	C8	16	0	1	1	0	1	0	1	0	1	0	23	0	5	5	2	1	4	5	1	5	1
	C9	4	1	1	0	0	0	0	0	0	0	1	0	6	2	0	0	1	0	1	0	2	0
Environment	E1	28	3	9	5	12	3	1	3	2	1	5	5	2	50	8	3	5	4	6	1	5	4
	E2	26	2	3	2	9	3	2	3	0	1	0	5	0	8	33	0	10	4	4	5	9	2
	E3	2	0	0	0	0	0	0	0	1	1	0	2	0	3	0	7	0	1	4	0	1	1
	E4	15	0	5	2	1	1	0	1	0	0	0	1	1	5	10	0	20	2	1	2	3	1
	E5	8	1	4	1	2	2	1	5	0	2	1	4	0	4	4	1	2	17	7	1	4	3
	E6	12	1	2	1	3	0	0	4	0	2	1	5	1	6	4	4	1	7	26	2	6	2
	E7	7	0	0	0	0	1	0	2	0	1	0	1	0	1	5	0	2	1	2	7	4	0
	E8	28	10	0	5	10	3	2	1	4	4	2	5	2	5	9	1	3	4	6	4	40	3
	E9	6	1	1	0	4	0	2	0	1	1	1	1	0	4	2	1	1	3	2	0	3	11

Figure 1. Co-Occurrence Matrix for Causes of Child Loss (The gradations by frequency are relative in each of 6 groups.)

instead of one independent factor(30.7%) in the case of 9 causes in the category of “environmental characteristics”. For instance, child loss was resulted when child gets covered by visual obstacle(E2), guardian moved away to find the child, and the child moving also moving away to find his/her guardian(E4) (10 cases). In an open structure without a door or fence(E8), child loss also occurred where child who was covered by visual obstacles(E2) broke away from the space when the guardian was not looking (9 cases). Moreover, child who left alone in an open structure(E8) intended to return, but he/she still became lost because the design of the space was not different from the other space(E6), the circulation or structure is complicated(E5), or there are too many visual obstacles within the circulation(E7) (6 cases, 4 cases, 4 cases). When guardian was too far away from the child due to insufficient space for the guardian, child was also lost by getting blocked and pushed by the high density of crowd(E1), and the guardian being unable to observe the child properly. Child was also lost when child is blocked and pushed by the high density of crowd(E1), and the guardian was unable to observe the child properly from far away due to insufficient space (3 cases). In another case, child was lost because there was no design differentiation of the guardian space(E6), and the child could not return to his/her guardian by not being able to recognize the location of the space (4 cases).

Combinations of the causes in different categories (red) are as follows. In the case of “negligence of guardian” and “breakaway of child” acting as the cause is when guardian

leaves the child to briefly do something, and the child leaves the guardian at that time and miss each other. Among these cases, [G1] occurred together with all “child” related causes except for [C5], which has a high frequency. In particular, when guardian is doing something else(G1), there were mainly 24 cases of child moving away towards interesting factor(C1), and 16 cases of child moving unconsciously while playing(C8). Furthermore, there were cases where child moved alone without holding guardian’s hands due to child’s independence and autonomy(C4), and at the same time the guardian moved alone thinking that the child would come right after him/her(G3) (8 cases).

In the cases where “negligence of guardian” and “environmental characteristics” acted together as the cause, children broke away and got lost when guardian was doing something else(G1), or guardian moved away(G2) in the open structure where the door is easy to open or easy for children to go out alone(E8) (28 cases, 10 cases). There was another case when child and guardian walking at a distance(G3), guardian could not find the child because the child is covered by the crowd of people(E1), or the child could not find the guardian because the guardian is covered by the crowd or visual obstacles(E4) (9 cases, 5 cases). Child was also lost due to various environmental causes(E1~E9) while guardians were doing other things(G1).

In the cases where “breakaway of child” and “environmental characteristics” acted together, children were often lost by child moving away towards the interesting factors(C1,



C2) or looking for the guardian who is not visible to the child(C9) in an open structure where children are able to easily escape(E8). In addition, when child and guardian move separately at a distance(G3) or child moves away from the guardian while playing(C8), child was tended to get lost in the complex environmental structure(E5) or the space has no design differentiation(E6), or the space has too many visual obstacles(E7). Lost Child also occurred by child break away from the guardian in the environment with high pedestrian density(E1) with various causes.

**(2) Analysis of Combinations on Causes of Child Loss in each Case**

Since Co-Occurrence Matrix focus on the relationship between two causes only through the results, which and how many causes are combined cannot be identified. An overall consideration of all the causes in each case is needed, and therefore, the relationships of the causes in combinations are thoroughly analyzed. ‘The guardian thought the other guardian was taking care of the child (G4)’ which is a secondary cause, is excluded in the statistics and categorization for the analysis. ‘Other-the child moves away(C@)’ which is one of the causes is included in the statistics, but excluded in the classification since it covers various movements of child for unknown reasons.

As a result of categorization of 202 lost child cases, 127 combinations are derived. In average, each lost child case is caused by 2.8 causes in average. The percentages of cases caused by 2 and 3 causes are 41.6% and 28.7%, and the one by 1 cause is 5.4%. It indicates that most lost child cases are caused not by just one cause but by two or three causes in combination. In addition, combinations of two or three causes are mostly made up of causes in [Guardians & Child] (69 cases, 34.2%) and [Guardians & Child & Environment] (79 cases, 39.1%). The types of such combinations may be visually structured as in Figure 2. It demonstrates 148 out of 202 cases (73.3%) and 103 out of 127 combinations, structuring almost all of the combinations on the causes of child loss.

As a result of analyzing the combinations on the causes of child loss, G1 of “Guardian” category is remarkably noticeable. The most common is G1 & C1 combination, representing 24 out of 202 cases. The causes of “Environment” category combined with this combination are E2 (7 cases), E8 (7 cases), E1 (6 cases), E9 (2 cases), E5 (1 case), and E6 (1 case). While the guardians do something else (G1) with the children moving to the interesting factors (C1), the children may be blocked by visual obstacles (E2) or pushed by the high density of people (E1) and become lost. The number of cases of G1 and C8 combination is 16, also one of the representative combinations. The environmental characteristics that frequently combine with the combination are E2 (5 cases), E8 (5 cases), E1 (3 cases), E5 (2 cases), E6 (2 cases), E3 (1 case), E4 (1 case), and E7 (1 case). While the guardians do something else (G1) with the children moving away to play (C8), the children may be covered by visual obstacles (E2) and be out of the guardians’ sights, or may leave alone in the environment of open structure (E8). The number of cases for the combinations including causes in both the

negligence of guardians and environmental characteristics of G1 & E2 and G1 & E4 are 26 and 15. It indicates children easily get lost when the guardians and children cannot see each other because of visual obstacles.

Table 8. Combinations on Causes of Child Loss in each Case (Top 52.5%)

Rank	Combination of Causes			Frequency	Percentage	Number of Causes
	Guardian	Child	Env.			
1	G1	C@	-	19	9.4%	2
2	G1	C1	-	10	5.0%	2
3	G3	C1	-	5	2.5%	2
4	G3	C@	-	4	2.0%	2
4	G1	C8	-	4	2.0%	2
4	G3	C7	-	4	2.0%	2
4	G1	C@	E8	4	2.0%	3
4	G3	-	E1	4	2.0%	2
9	G1	C1	E1E2	3	1.5%	4
9	G1	C2	-	3	1.5%	2
9	G1	C8	E1	3	1.5%	3
9	G1	-	E4	3	1.5%	2
9	-	C1	E1	3	1.5%	2
9	G3	-	-	3	1.5%	1
15	G1	C1	E1	2	1.0%	3
15	G3	C4	-	2	1.0%	2
15	G1	C3	-	2	1.0%	2
15	G1	C@	E1	2	1.0%	3
15	G2	C@	E8	2	1.0%	3
15	-	-	E6	2	1.0%	1
15	-	C8	-	2	1.0%	1
15	G1	-	E2E4	2	1.0%	3
15	G1	C8	E8	2	1.0%	3
15	G2	C5	E8	2	1.0%	3
15	G2	C5	-	2	1.0%	2
15	G2	-	-	2	1.0%	1
15	C8	-	E1E6	2	1.0%	3
15	G1	C1	E2E8	2	1.0%	4
15	G1	C3	E8	2	1.0%	3
15	G2	C@	-	2	1.0%	2
15	G2	-	E1	2	1.0%	2
31 Combinations				106	52.5%	Avg. 2.3

\* There are 31 combinations of which occurrence frequency is over two each, and it covers the top 52.5% of all. The average number of causes of these 31 combinations is 2.3.

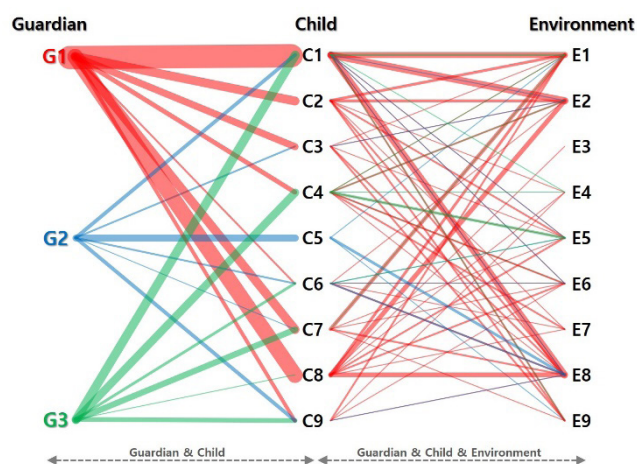


Figure 2. Combinations of Child Loss Causes (Except for G4, C@)

The typical combination of the negligence of guardian G2 with the cause of environmental characteristics is G2&E8, and there are 10 cases containing this combination. The causes in child's breakaway that combine with the combination are C1(3 cases), C5(3 cases), C6(2 cases), C10 (2 cases), and C9 (1 case). The number of cases containing G2&C5 is 7 and G2&C1 is 5, meaning these causes may be related. The child may become lost by moving for an interesting factor (C1), trying to find the guardian (C5), or following someone similar to the guardian (C6) in the environment of open structure easy to leave alone (E8) while the guardian leaves the child (G2).

The typical combination of the negligence of guardian G3 containing the cause of child's breakaway is G3&C1, and there are 9 cases containing the combination. The cause in environmental characteristics that combine with the combination is E1 (2 cases), E4 (1 case), and E9 (1 case). In addition, there are 9 cases containing G3&E1. The children may get lost when the children move to an interesting factor (C1) and gets blocked from the guardian by a high density of people (E1) while the guardians believe the children follow or find the way fine(G3). The combination containing another cause of child's breakaway with G3 is G3&C4, and the number of cases containing the combination is 8. The causes of environmental characteristics that combine with the combination are E5 (3 cases), E1 (1 case), E2 (1 case), E4 (1 case), and E6 (1 cases). In particular, the numbers of cases containing G3&E4 and G3&E5 combinations are 5 and 4 respectively, meaning the causes are highly related. The children may get lost by searching for the guardian out of his/her sight (E4) or failing in wayfinding due to the complexity of structure (E5) after moving separately believing that each of the guardians and children could follow or find the way alright (G3, C4).

## 5. ANALYSIS ON THE CAUSES AND CHARACTERISTICS OF CHILD LOSS IN FUNCTIONAL SPACES

Based on the previous combinations analysis, the types and causes of child loss were examined by the spaces of retail, circulation, amusement, rest, F&B, and convenience, where child loss mainly occurred. In addition, the characteristics of child loss was analyzed in the behavioral and environmental aspects.

It turned out to be retail space where children got lost the most for 59 out of 202 cases(29.2%). In retail space, children tend to get lost while their guardians look around or make purchase. There are 12 cases(20.3%) that children spontaneously moved to interesting factors while guardians did something else (G1&C1). 5 cases are where children moved away to play around (G1&C8), and 4 cases are where children moved for interesting factors they had remembered from the past memories(G1&C2). When the children moved away, they were covered by visual obstacles (E2: 19 cases, 32.2%) so that it was hard for the children and their guardians to find each other. On top of that, since most retail space located in large shopping malls or supermarkets had open structure without any clear border, children easily left by themselves(E8) in 14 cases(23.7%). Such cases due to the lack of space border occurred more frequently at the cash register located outer side of the store than around the display stands inner side. In addition, in case where retail space was located

nearby transitional structure such as escalator or main entrance, children moved to other floor or outside (4 cases, 6.8%). These cases happened to occur at the cash register located outer side of the space. 9 cases (15.3%) are where children failed to get back to their guardians due to lack of design or architectural differentiation in space (E6). In 10 cases, children got lost because children and guardians failed to see each other due to high density of people (E1, 16.9%). It was only around the display stands where people were moving around that these cases occurred rather than at the cash registers where people stood still to wait for their turns. Children got lost by being blocked or pushed by high density of people.

In circulation space (47 cases, 23.3%), 27 out of 47 cases (57.7%) occurred because children and guardians kept distance while walking (G3&Cx)<sup>11</sup>. In 8 out of 27 cases (17.0%), children got lost by moving by themselves without guardians, due to egocentrism while guardians also thought they would find their way well on their own (G3&C4). The number of cases where children failed to follow guardians while guardians moved ahead of children (G3&C1) is 7 and where children walked unconsciously straight ahead (G3&C7) is 6. In 16 cases (34%), children got lost while guardians were doing something else (G1&Cx). To sum up for the cases in circulation space, children became lost in circulation space when they were covered by high density of people while moving by themselves so guardians failed to find their moves (E1: 11 cases, 23.4%). Likewise, children got lost when children were walking apart from guardians since they are covered by the visual obstacles such as columns, walls, or tall furniture (E2: 5 cases, 10.6%). In circulation space, children failed to return to guardians because architectural floor plan of circulation space was too complex (E5: 7 cases, 14.9%), or due to the lack of differentiation of architecture or design (E6: 4 cases, 8.5%).

Cases that took place in amusement space (36 cases, 17.8%) occurred mainly when guardians were doing something else while children moving away (C1&Cx), 16 out of 36 cases (44.4%). In such cases, guardians were taking care of other children, chatting, eating, using cell phone, resting, or waiting. The number of cases where children moved away while guardians left children (G2&Cx) is 6 (16.7%). Out of 6 cases, 4 took place in openly structured space made easy for children to leave on their own (11.1%). Likewise, in amusement space, unclear border without any door or fence (E8: 12 cases) made children to leave while playing around (C8: 11 cases, 30.6%). There were also cases where guardians failed to keep their eyes on children covered by high density of people (E1: 11 cases, 30.6%). In amusement space, if the density of people is too high compared to the size of space, children can get covered by people and visually lost from their guardians especially since children tend to move fast while playing around. There are also cases where guardians failed to watch children by visual obstacles including tall and opaque rides due to small heights of children (E2: 3 cases, 8.3%). 7 cases (19.4%) occurred by guardians failing to keep eyes on children from a distance since guardians' space lacked benches or was located too far from the rides (E3). In addition, children got lost on their way back since there was no

<sup>11</sup> Cx : One of C1, C2, C3, C4, C5, C6, C7, C8, C9, and C@

differentiation in architecture or design (E6: 7 cases, 19.4%), or since the space was too complexly structured (E5: 2 cases, 5.6%).

The primary type of child loss in rest space (16 cases, 7.9%) was the cases where the child left and lost his/her guardian while the guardian was working (G1&Cx) with 10 cases (62.5%) out of 16 cases. The other action performed by the guardians included rest/observing child, finding/organizing/preparing, looking at interesting factors, and etc. In addition, there were 2 cases (12.5%) of children getting lost when the child got permission from one guardian who was taking a break to move away, and the child was covered by visual obstacles and could not find the other guardian (G3&E4). Moreover, there were 4 cases of child became lost by children leaving the space while their guardians were away. On the other hand, child's vision was blocked by visual obstacles such as bookshelves or columns that were higher than the child's height, and he/she moved away from the guardian because he/she was not able to find his/her guardian who was actually nearby (E4: 5 cases, 31.3%). There were other cases where the guardians could not find the child who was blocked by visual obstacles (E2: 3 cases, 18.8%). In addition to visual obstacles, child was blocked by high walking density due to a large number of people moving all at the same time, which led the guardians to miss the child (E1: 3 cases, 18.8%). There were another case of child getting lost due to unclear boundary of facility, which led the child to break away from the facility (E8: 3 cases, 18.8%).

In F&B space (14 cases, 6.9%), the primary type of child loss was the case where the child broke away while the guardian was doing something else (G1&Cx) with 9 cases out of 14 cases (64.3%). At the time, the guardian was ordering/paying, eating, or cleaning the table. There were also 4 cases (28.6%) of child breaking away while the guardian was away (G2&Cx). In F&B space that is not bounded by fences such as food courts or open without doors, there were many cases of child leaving the space while the guardians were picking up the food, cleaning up the table, or returning the dishes (E8&Gx&Cx: 5 cases, 35.7%). In particular, when F&B space is near the transition space such as escalator, entrances, and etc., child tend to break away to other floors or outside, and the discovery of child is delayed (3 cases, 21.4%). Moreover, child was lost by being pushed by the people from high walking density while the guardian was ordering or paying for food (E1: 4 cases, 28.6%). There other cases of child loss when child leaves the restaurant alone to use the restroom while eating, and fails in wayfinding due to no differentiation of design of the restaurant (E6: 3 cases, 21.4%), complex spatial structure of the facility (E5: 3 cases, 21.4%), or unclear sign system (1 case, 7.1%).

In convenience space (7 cases, 3.5%), child was loss only when child left while the guardian was doing something else (G1&Cx). The behaviors of guardians in the convenience space included using the restroom or washing hands, inquiring at the information desk or stroller rental station, finding/organizing/preparing, or using cell phones. When guardian is unable to properly watch the child, the child tends to leave the space for various reasons such as moving towards interesting factors, unconsciously moving forward, playing pranks, and etc. In addition, child left the facility due to unclear boundary of the facility (E8: 4 cases, 57.1%). Child also got lost by spontaneously leaving while the guardian is asking questions to the staff or child getting pushed away by the people moving through the

aisle when stroller rental station or information desk were located in the center of the aisle or on the wall overlapping the aisle instead of located in a closed corner. Moreover, there were many cases in which child escaped the restroom easily because the entrance door was not installed or had an automatic door. When such entrance is connected to outside, child tend to leave outside and made difficult for guardians to find the child (1 case, 14.3%). In addition, since there are too many people using convenience space for the size of the space, many children were swept away by the people, and the guardians were unable to find their children (E1: 3 cases, 42.9%).

## 6. CONCLUSION

Child loss, which frequently occurs around us, has a possibility of leading to an accident or a crime later on. It is necessary to have a plan to prevent child loss in advance by systemically clarifying the causes of child loss. However, the preceding studies do not systemize the causes of child loss by places or situations, and the policy focuses only on the countermeasures afterward instead of prevention. This shows that the policy and the supporting studies are needed for ultimate resolution of child loss. In such perspective, this study derived the causes of child loss through the analysis of 202 cases by the bottom-up method.

As a result of the analysis on 202 child loss cases, it is found that children get lost by complex reasons usually with two or three causes combined together (average 2.8). The most common causes are the negligence of guardians and children's characteristics, and the environmental characteristics, which act as the catalyst arousing child loss or making it harder to find the lost child. The causes derived from these three categories are as follows. In the 'guardian' category, child gets lost when guardian does something else (purchasing, inquiring, and etc.), moves alone, or leaves the area. Child loss due to child's characteristics occurs when child leaves alone for interesting factors, or walks ahead of the guardian due to egocentricity or independence. When child gets lost due to environmental characteristics, there is a high density of people or many visual obstacles, or open structure that is easy for children to leave the space. In addition, child loss takes place when the space is structurally complex or lacks architectural differentiation by making children's wayfinding difficult.

Causes and characteristics of child loss according to functional spaces are as follows. In retail space, children get lost while guardians look around or make purchase. There are a lot of furniture such as display stands and cash register in retail space. When the aisle is too narrow, the density of people can easily get high and, as a result, the high density of people becomes visual obstacles for guardians to watch their children. In circulation space, children get lost when they walk in a distance from their guardians or while wayfinding back to their guardians. Especially when the spatial structure is too complex or the density of people is too high compared to width of aisle, children can get pushed by the crowd or fail to discover each other. In amusement space, children get lost by leaving the space playing around while guardians do something else or step out for a few minutes. In this space, open structure without any border

such as fence or door is the main factor of child loss. Density of people and visual obstacles also affect child loss by making it hard for guardians to keep an eye on their children. In addition, when there is no differentiation in architecture or design in guardians' space located within the amusement space, or the spatial structure is too complex, children find it hard to return to their guardians and, as a result, get lost. In rest space, child was lost when child moved away from the guardian and the child was covered by furniture such as sofas, tables, and bookshelves, and structures such as walls and columns while the guardian was resting. In F&B space, there were many cases of child breaking away when the guardian was picking up the food, cleaning the table, or returning the dishes. Moreover, there were cases where child failed to find their way back because the restaurant had no design differentiation or the spatial structure was complex. In convenience space, child was lost when the location of stroller rental station or information desk was overlapped with the aisle by child spontaneously leaving the guardian or getting pushed by pedestrians while the guardian is asking questions to the staff. In addition, there were many cases in which children easily escaped from the restroom because the door was not installed at the entrance or the door was automatic.

This study is a fundamental research for the prevention of child loss, and the causes of child loss are determined through case studies. It has significance in that it not only considered the aspect of the guardians and children but also of the environment in the process of finding the causes of child loss. Furthermore, it is valuable in that it does not only list the causes but also analyze the relationship between the causes of child loss. Through various analysis on child loss, a series of situations and processes may be examined comprehensively. In addition, based on this fundamental study, environmental design certification system is to be developed in order to prevent child loss in the future. The certification system are expected to decrease the number of lost child. The possibility of accidents and crimes followed by child loss may also be decreased by preventing child loss in advance.

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