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Behavioral Mapping and Post-Occupancy Evaluation of Meeting-Point Design in an International Airport

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***Abstract*—**The meeting behavior is a pervasive kind of interaction, which often occurs between the passenger and the shuttle. However, the meeting point set up at the Taoyuan International Airport is too far from the entry-exit, often causing passengers to stop searching near the entry-exit. When the number of people waiting for the rush hour increases, it often results in chaos in the waiting area. This study tried to find out what is the key factor to promote the rapid finding of each other between the passengers and the pick-ups. Then we implemented several design proposals to improve the meeting behavior of passengers and pick-ups based on behavior mapping and post-occupancy evaluation to enhance their meeting efficiency in unfamiliar environments. The research base is the reception hall of the second terminal of Taoyuan International Airport. Behavioral observation and mapping are implemented on the entry of inbound passengers into the welcome space, including the crowd distribution of the people who rely on the separation wall in the waiting area, the behavior of meeting and the interaction between the inbound passengers and the pick-ups. Then we redesign the space planning and signage design based on post-occupancy evaluation to verify the effectiveness of space plan and signage design. This study found that passengers ignore existing meeting-point designs which are placed on distant pillars at both ends. The position of the screen affects the area where the receiver is stranded, causing the pick-ups to block the passenger's moving line. The pick-ups prefer to wait where it is easy to watch incoming passengers and where it is closest to the mode of transport they take when leaving. Large visitors tend to gather next to landmarks, and smaller groups have a wide waiting area in the lobby. The location of the meeting point chosen by the pick-ups is related to the view of the incoming passenger. Finally, this study proposes an improved design of the meeting point, setting the traffic information in it, so that most passengers can see the traffic information when they enter the country. At the same time, we also redesigned the pick-ups desk to improve the efficiency of passenger meeting.

***Keywords*—**Meeting point design, post-occupancy evaluation, behavioral mapping, international airport.

I. Introduction

MEETING behaviors between passengers and those responsible for their pickup are commonly observed in public places. The purpose of public meeting-point design is to facilitate convenient meetings between passengers and those who pick them up. Public places with multiple exits should have clearly posted meeting-point signs to provide directions guiding passengers to public meeting points [8].

A destination hierarchy contributes to the design of signs, facilities, and information for passengers in public places (Fig. 1). Webinar used London Olympic Stadium to illustrate the concept of destination hierarchy. First, users' behaviors and events are separated upon their entering the stadium, and a basic structure is formed by linking each event to its corresponding location to comprehensively track users' travel routes. This structure is subsequently used to identify the information required in each space, thus helping to construct an effective destination hierarchy and to organize information and images [5]. Establishing a target increases users' ability to identify their direction. For example, increasing the number of landmarks is crucial for users to correctly locate places and obtain spatial information [6].

Meeting locations and times are defined by behaviors and places. Those responsible for passenger pickups tend to plan their routes along places to stop by for their own activities and pickups [1]. For example, airport pickup guides and drivers often encounter disorganized waiting crowds and congested traffic during rush hour, thus demonstrating how pickup activities are limited by time and space. Therefore, the meeting behaviors of people who often perform airport pickups tend to occur in the time slots and locations to which they are accustomed. Moreover, meeting behaviors are also affected by means of transportation. Accordingly, people involved in passenger pickups select meeting locations based on their transportation and travel routes [2]. However, the process preceding a meeting involves various wayfinding and communication behaviors. Wayfinding behaviors denote people's exploration and searching of places prior to arrival at their intended destination [3]. People in unfamiliar places depend on the information given in these places to orient themselves. Regarding communication between passengers and those responsible for their pickup, only nonverbal communication can be used beyond an effective communication range. Nonverbal behaviors constitute 60% of all interpersonal communication, with Mehrabian noting that communication is 7% spoken words, 38% tone of voice, and 55% body language, thus indicating the essential role of body language in interpersonal communication [4].

Airports' arrivals halls are among the public places in which meeting behaviors occur most frequently. This study chose Taoyuan International Airport, which has the highest traffic of all airports in Taiwan, as the research area. Observation was performed in the arrivals hall of Terminal 2. The spatial planning of Taoyuan International Airport's arrivals hall involves a partition wall separating arriving passengers and people organizing airport pickups in the waiting area. Seats are provided in the waiting area. Because of various means of transportation, arriving passengers move at different speeds in different directions. Most arriving passengers wish to leave the airport in the shortest possible time after disembarking, and

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therefore spend a much shorter time at the airport than do departing passengers. After passengers exit the passport control area and enter the arrivals hall, some disperse to parking lots, sidewalks, or bus waiting areas. Those traveling in tour groups gather together in meeting spaces located on either side of the waiting area. The people in the waiting area are predominantly friends of the arriving passengers and pickup providers [9]. Because most people organizing airport pickups are anxious to identify the arriving passengers they are appointed to meet, they gather by the partition wall in front of the seats area. Airports often provide designated meeting points for passengers. However, the current meeting points in Taoyuan International Airport cause passengers to halt at the arrivals hall exit, thus aggravating the disorganized state in the waiting area during peak times. Examining transportation environments and facilities from a user behavior perspective, studies have predominantly applied post-occupancy evaluation to all factors that could affect spatial design [7]. The present study employed this method to explore meeting conditions in the arrivals hall of Taoyuan International Airport.

It is essential to provide a favorable meeting environment and clear sign design to reduce the time required for passengers to locate people they are appointed to meet (and vice versa) in public places. This study designed spatial improvements in the airport based on users' meeting behaviors to increase the efficiency of interaction between passengers and people organizing airport pickups.

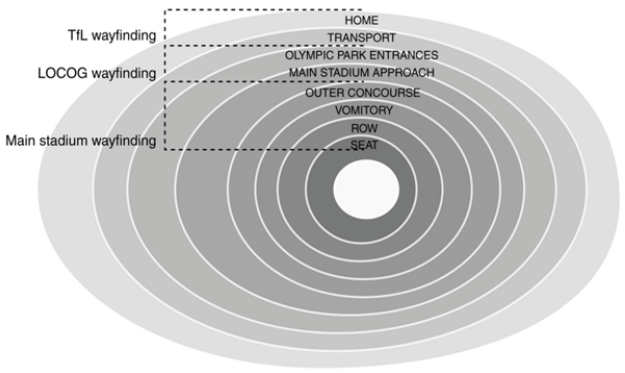

Fig. 1 Destination hierarchy

II. Method

In the preliminary stage of this study, non-participant observation was employed to follow users' meeting behaviors in the arrivals hall, which were recorded using behavior mapping. Semi-structured interviews were then conducted, in which passengers and people organizing airport pickups were requested to evaluate current spatial conditions at the airport. The observed behavioral characteristics and insights provided by the questionnaire survey respondents were compiled for use in providing recommendations on redesign of the airport's arrivals hall, with the aim of improved meeting efficiency. The preliminary stage comprised the following four investigation methods:

1) Observation of the static distribution of arriving passengers and people organizing airport pickups: The observation time was from 9:30 to 19:30 on a weekday. Static views of all people were recorded at 30-minute intervals, with 21 static views recorded in total.
2) Dynamic observation of the traffic flow of arriving passengers and people organizing airport pickups*:* The recorded peak time was from 12:00 to 13:00. Forty observation records each were made for passengers who exhibited meeting behaviors and those who did not, totaling 80 dynamic records.
3) Observation of meeting behaviors between arriving passengers and people organizing airport pickups*:* Behavioral observations were recorded in three separate stages, namely, before, during, and after meetings. Passengers who exhibited meeting behaviors were observed and all their behaviors in the arrivals hall were recorded, for a total of 40 records.
4) Questionnaire survey on current spatial design*:* A semi-structured questionnaire survey was distributed, containing questions on guidance in the wayfinding process and when recognizing each other, reasons for choosing specific meeting points, and recommendations for spatial design improvement. A total of 70 responses were received.

These results helped in identifying design factors that could affect meeting efficiency in the arrivals hall and in proposing redesign strategies. Because meeting behaviors mainly consisted of information gathering and communication, this study reidentified meeting-point signs directing people during information gathering and facilities encountered in the communication stage. This was subsequently used for two design items, namely, meeting-point signs and an airport pickup desk.

In later research stages, experiments were conducted to evaluate the feasibility of the proposed designs. Because of field limitations on installing the experimental designs, a VR device was used to simulate the location with newly designed meeting-point sign and compare it with the original view. Participants were assigned multiple tasks for identifying meeting points to validate design effectiveness, with the results serving as a reference for further meeting-point sign design. Regarding the pickup desk design, people with experience in organizing airport pickups were asked to evaluate the desk after using it.

III. Results

The four main results from the preliminary stage were as follows: The results on arriving passengers' static distribution (Fig. 2) revealed that, because most passengers traveling with large tour groups were led by tour guides, 91.9% of such passengers gathered beside pillars (P2, P3, P4), because this was easier for group members to remember and convenient for tour guides when providing travel-related instructions. In addition, the distance between the pillars and the arrivals gate and seating areas was also a factor affecting this choice of meeting place. The originally designated meeting points in the arrivals hall were next to pillars (S and N) that were relatively

far from the arrivals gate, such that the number of passengers gathering by these two pillars was relatively small, compared with those gathering by other pillars.

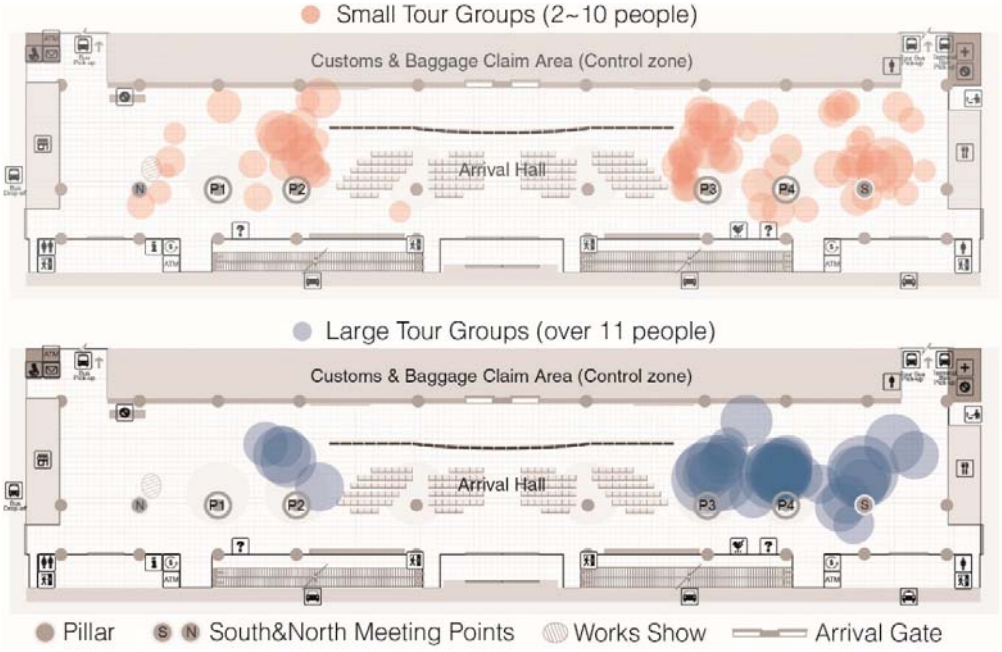

Fig. 2 Distribution of retention locations of passenger groups

Because small groups were able to move around more freely, they were more dispersed in the hall. Compared with large groups, only 60.3% of passengers traveling in small groups gathered beside pillars, with the remaining 39.7% of passengers waiting in random areas. In particular, P1, P2, P3, and P4 were equipped with circular facilities for passenger services, and so many passengers gathered there that other passengers' use of these facilities was impeded. Accordingly, the airport could direct passengers away from P2 and P3 to the original meeting points (S and N) or separate waiting passengers from those using service facilities.

The static distribution of people organizing airport pickups (Fig. 3) revealed that they chose to wait in positions where they could easily see arriving passengers and obtain road traffic information. In particular, the meeting points chosen by people organizing airport pickups were related to the view of arriving passengers from these points. Therefore, positions where information screens were installed influenced where people organizing airport pickups waited. For example, passengers walking past area A and area E were easily blocked from view by people lingering there, thus causing disorganized circulation in these areas. Area A, area C, and area E had the clearest views of the screens and the arrivals gate, whereas area B and area D offered relatively unclear views because they were farther from the gate and the screens, with more oblique viewing angles. Therefore, it is suggested that the screens located on the left and right ends be moved toward the middle, thus possibly solving the problem of arriving passengers' way being blocked by people organizing pickups. Transportation information could be provided at either end of the wall, thus focusing the attention of both passengers and people organizing pickups on the same spot.

Dynamic observation of arriving passengers and people organizing pickups indicated that, of all passengers who exhibited meeting behaviors (Fig. 4), 62.5% went to Exit 2 for cars, 20% went to Exit 7 for tour buses, and the remaining 17.5% went to Exit 1. People organizing pickups tended to wait by the left end and middle of the wall, then depart the airport from Exit 1 and Exit 2. Most of those standing by the right end of the wall were from large tour groups who tend to leave through Exit 7. This indicates that people organizing pickups tended to wait in places close to their transportation stops. In addition, for all the passengers who did not exhibit meeting behaviors (Fig. 5), 32.5% went to Exit 2 for cars and 25% went to Exit 6 for buses, thus, they also tend to use exits located near their chosen means of transportation.

Meeting behaviors consist of a preliminary stage of information gathering, a middle stage of communication, and a final stage of waiting. The most frequent behavior of people organizing pickups was reading the information at hand (Fig. 7). The most frequent behavior among arriving passengers was looking at signs. In the communication stage, guiding with gestures was the most frequently observed form of nonverbal communication among people organizing pickups. The most among passengers was waving.

Of all meeting behaviors, the most frequent among both people organizing pickups and passengers was conversation, at 1.45 times per person. Among people organizing pickups, other frequently observed behaviors were guiding with gestures, recognizing each other, and using cell phones, whereas for passengers, other frequently observed behaviors included recognizing each other, waving, and waiting. In particular,

pointing was a behavior observed in all three stages, whereas guiding with gestures, using cell phones, and conversation mostly occurred in the communication and waiting stages.

The questionnaire survey about the spatial use at the airport (Figs. 8 and 9) indicated that parties who already knew each other would contact each other by phone, guide each other by signs or directions, or choose targets such as the screens and places in proximity to the arrivals gate so that they could locate each other. When people organizing pickups, such as tour agents or drivers, were unable to contact passengers by phone, they would provide directions, lists of names, or symbols for identification by passengers before their meeting.

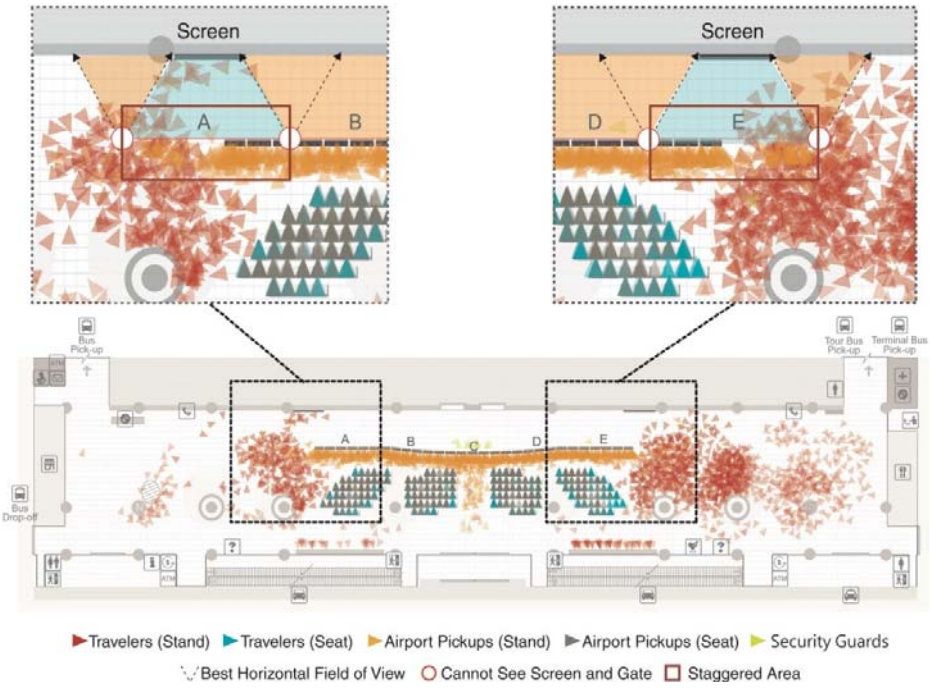

Fig. 3 Distribution of incoming passengers and those in charge of picking up passengers

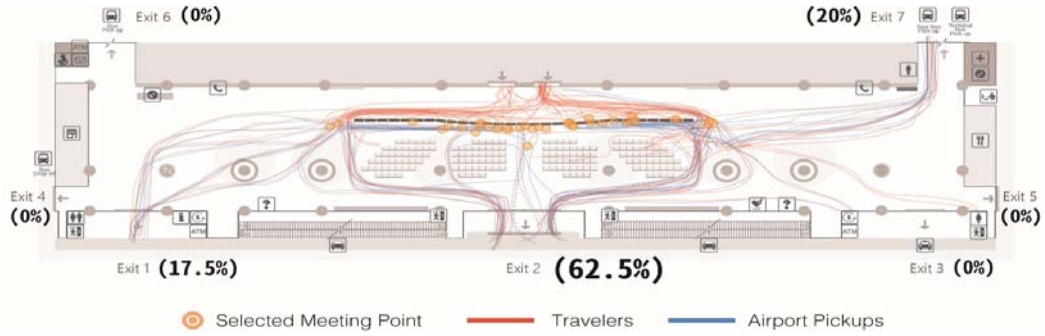

Fig. 4 Flow distribution of passengers exhibiting meeting behaviors

Fig. 5 Flow distribution of passengers not exhibiting meeting behaviors

Behavior Type		Code
Information Collection		Ask the guards (Ag)
		Reading the information at hand (Vi)
		See the screen (Sc)
		Look at the signs (Ls)
		Look around (La)
Communications	Nonverbal	Point at somewhere (Pw)
		Use the meeting tool (Ut)
		Wave (Wa)
		Guide with gestures (Gg)
		Nod (Nd)
	Verbal	Use cell phone (Ph)
		Recognize each other (Id)
		Conversation (Cn)
Others		Prepare Baggage (Pp)
		Waiting for others (Ws)
		Use service facilities (Uf)
		Charge (Cg)

Fig. 6 Coding of meeting behaviors

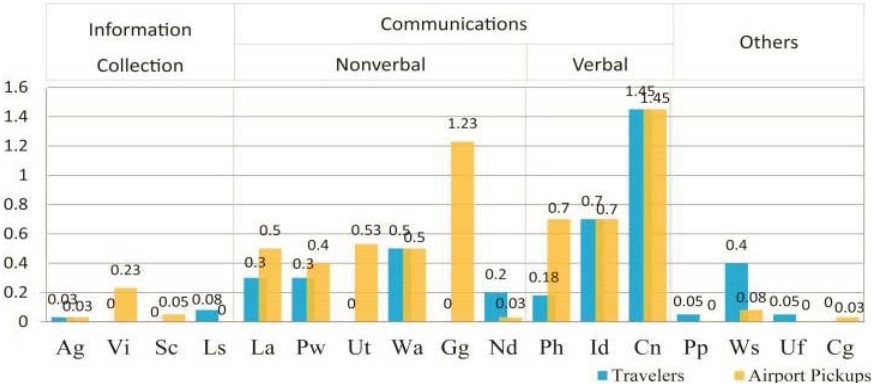

Fig. 7 Frequency of meetings per person

A-1. Behaviors in the stage of seeking	B-2. Factors considered in the selection of a meeting place	C-1. Easy observations on passengers	D-1. Contents of signs
Wi-Fi Connection(Wf) Make a phone call(Mc) Take pictures for Identification(Ti) Placard(Pd) Service Facilities(Sf) People Guide(Pg)	No Certain Position(Np) Depending on the Current situation (Ds) Easy to See the Door(Sd) Close to the Door(Cd) Based on Past Experience and Practice (Beh) Spacious Space to Gather(Ssg)	See the Screen(Sts) See the Door(Sd) See Flight Information(Sfi)	High Recognition(Sts) Complete logo(Co) Numbers(Ns) Color Conspicuous(Cls) High Contrast(Hc) Common Language(Cle) Appropriate(Ap) Perspective All Angle to See(Aas) Guidelines the subject matter(Gsm) Divided Area(Da) Account of people(Aop)
A-2. Features for recognition	B-3. Supporting tools	C-2. Highly recognizable environment features	
Clothes Color(Cc) Meeting Point(Mt) Arrival Gate(Ed) Screen(Sn) Charging Station(Cs) Parking Lot(Pl) Waiting Car(Wc) Store(Se) Rotating Doors(Rd) Logo(Lo) Directional Indicators(Di)	Erecting Bracket(Eb) Place the Card (Pte) Holding the Card(Hn) Change the list in the cover(Clc) Clip Paper(Cpr) Record Form(Rfm) Nameplates (Ncd) Signs of travel agency and driver(Lad)	Obviously Subject Matter(Osm) Hall Entrance(He) Waiting Station(Wsn) Number Clear Identification(Ci)	
B-1. How to describe the features of a meeting place	B-4. Behaviors after meeting	C-3. Favorable facilities for waiting	D-2. Locations of sign
Directions(Dn) Pattern and Logo(Pal) See the Nameplate(Snc)	Make a phone call with the driver(Ccd) Lead to the location of the traffic(Llt) Use of airport facilities(Uaf) Announce important matters(Aim) Check list(Cl)	Seat for Resting(Sr) Wall for leaning(Wl) No Crowded(Nc) Items Placed(Ip)	Spacious(Sps) Short Distance(Sde) Places Easy to Find(Pef) Moving Easy(Me) Close to the Screen(Cts) Close to the Subject Matter(Csm) Close to Traffic Waiting Area(Ctt)
		C-4. Highly accessible service facilities	
		Information(Ie) Equipment Transportation(Tf) Charging Convenient(Ct) Exchange Foreign(Efc) Currency Shopping Stores(St)	
		C-5. Others	D-3. Available equipment
		Announcement of Precautions(Aop) No Reason(Nr)	Public(Pc) Communications Available Seat(As) Charging Equipment(Ce) Shelf Space(Sse) Map(Mp)

Fig. 8 Coding of questionnaire interviews

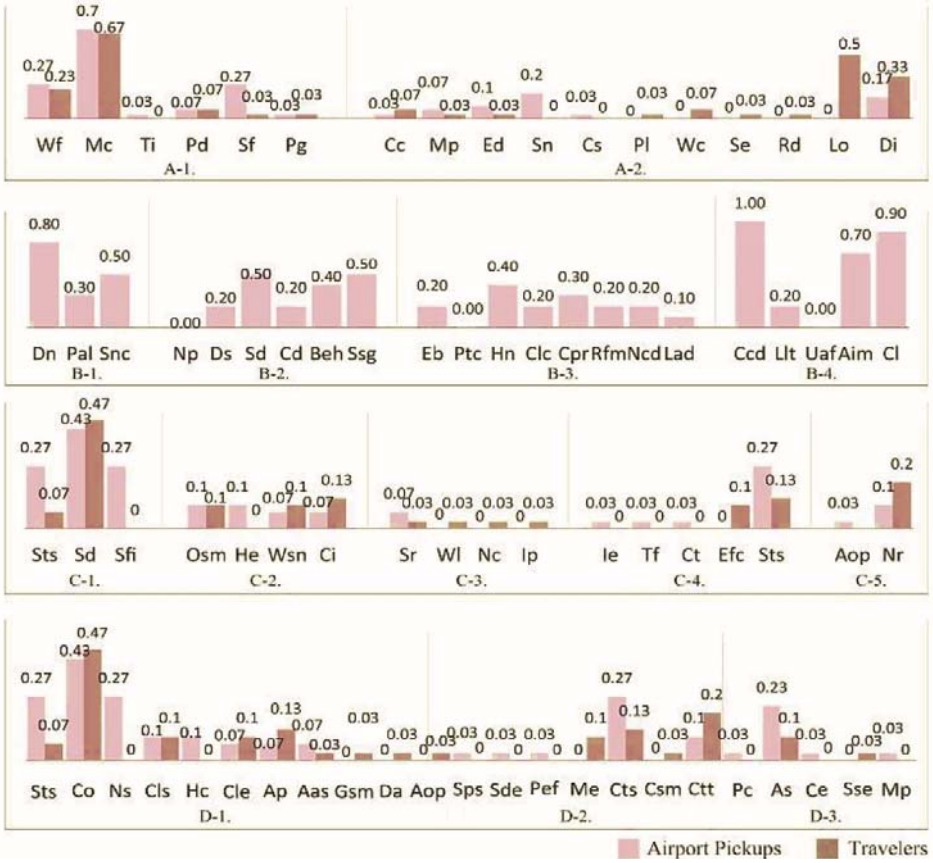

Fig. 9 Results of the questionnaire survey regarding current spatial use

Selection of the meeting point was mainly based on the immediate surroundings, habits, and experience. People organizing pickups used nametags, and signs to assist in the pickup process. After meeting their passengers, people organizing pickups contacted drivers with a high frequency and led the passengers to the designated pickup location. Because the current performance of airport facilities in facilitating meeting behaviors was relatively low, people organizing pickups brought along these aids to overcome possible obstacles in the pickup process. Furthermore, the following tendencies for factors influencing respondents' choice of meeting points were observed. Respondents chose locations with a clear view of the screens, the arrivals gate, and flight information to follow passengers' flight updates. They indicated that if clear signage and targets were provided, people would be able to locate each other more easily. Waiting passengers tended to sit in the waiting area or browse in stores, which were also used as a target for locating people. Accordingly, the focus of meeting-point design was on improving people's ability to locate others and providing clear signs. Meeting points should be established near exits and entrances, with places for sitting or standing provided in nearby areas.

Following behavioral observation and the questionnaire survey, a twofold proposal for new meeting-point design was developed to address current problems. The first focus was on passengers and people organizing pickups in Terminal 2 of Taoyuan International Airport; specifically, changing the meeting-point locations and improving meeting-point information signs. The second focus was exclusively on the people organizing pickups; that is, providing places for them to stand in the arrivals hall and designing a pickup desk to free their hands.

The proposed meeting-point design is presented in Fig. 10. Because most passengers cannot see the more distant meeting points from the arrivals gate, the new meeting points were situated next to pillars P2 and P3. These new meeting points could be easily seen by both arriving passengers and people organizing pickups from any position in the arrivals hall.

Arriving passengers predominantly assumed an eye-level view when entering the hall, and hardly looked down at the floor signs because of the crowdedness of the hall. Therefore, transportation information originally provided in floor signs was moved and placed at eye level.

The meeting points selected by people organizing pickups were predominantly close to the exits, with ready access to transportation. Accordingly, each meeting point in the new design provided information about nearby transportation, with clear signs enabling users to receive all relevant information at a glance, thus improving meeting efficiency.

The pickup desk design is shown in Fig. 11. Because people organizing pickups exhibited frequent nonverbal behaviors, mostly those involving the hands and arms, such as waving, guiding with gestures, and using tools to assist in the meeting

process, the purpose of this desk was to free their hands. People organizing pickups usually carry information enabling passengers to identify them, such as nametags, travel agency logos, or signboards from companies providing pickup services. Therefore, a groove for clipboards was made in the desktop, and a paper holder on the edge of the desk. After identifying passengers through nonverbal communication, people organizing pickups would use verbal communication to confirm their identity, such as checking name lists and filling out information forms, tasks which the desktop enabled them to perform more conveniently. Hooks were also fitted under the desk so that they could hang their personal items.

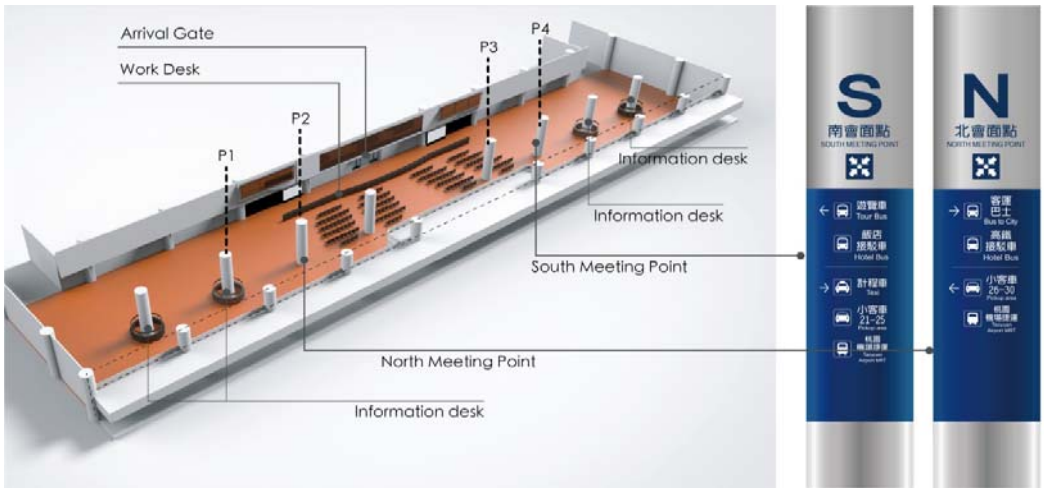

Fig. 10 New meeting-point locations and improved sign design in the arrivals hall of Terminal 2 at Taoyuan International Airport

Fig. 11 Pickup desk design to free hands

IV. Discussion

The first experiment was conducted to test the effectiveness of our meeting-point sign design. Participants were shown two views of the airport using VR and asked to compare the current meeting-point signs with the new design. To investigate the design's effectiveness from the perspective of both sides, both passengers and people organizing pickups participated in the experiment. A total of 30 participants were recruited. We monitored participants' eye movements using VR and recorded factors influencing passengers' judgment and identification behaviors after entering the newly designed arrivals hall. The devices used in this experiment were Gear 360 and Gear VR.

In the simulated view of the arrivals hall of Terminal 2, six different views (points A–F) were presented to participants. Point A was the view from the arrivals gate, namely, the view that arriving passengers had upon entering the hall. Points B–F were views from the five main exits in the hall, namely, the views that people organizing pickups had upon entering the hall. Various questions were asked of the participants, and their responses were recorded. The experiment involved two tasks;

the first was used to understand the indicators and in which order passengers searched for their targets, and the second to compare the time required by passengers to locate the current and newly designed meeting points from points A–F.

Fig. 12 Views from points A–F (comparison of current and newly designed signs)

The results of the first task revealed that all participants were able to locate the targets designated by the questioners. Viewing from point A, participants could see the lightbox located farther away when looking slightly higher than eye level, and they could also see the floor signs when looking down. When they turned to the left or right, they could see the north and south meeting points. According to the participants' responses, some were initially drawn by the blue lightboxes because they were bright and attracted their eye. However, others suggested that the information on the blue lightboxes was excessive, thus requiring much time to read it. Moreover, because the materials used for the printed signs were less bright, these should be installed near point A to ensure a clear view.

The results for the current meeting-point signs in the second task (Fig. 12) were as follows. From point 5 and point 6, the meeting-point signs were mostly blocked from participants' view. From point 11 and point 15, only a small portion of the meeting-point signs was within participants' view, and some were thus unable to locate meeting points according to these signs. A few participants had difficulty locating meeting points when viewing from point 1 and point 2 because the distance from meeting points was too much for them. Regarding the newly designed meeting-point signs, the results were as follows. Most participants were able to locate meeting points in the arrivals hall in a relatively short time and with higher accuracy, compared with the current signs. Inability to locate meeting points was only observed in participants viewing from point 4, because the view from this position contained signs for both the north and south meeting points, and some participants thus noticed one of the signs but overlooked the other. Overall, the new sign design, which included transportation information, demonstrably improved participants' ability to locate meeting points.

Fig. 13 Ten pickup organizers using and evaluating the pickup desk design

The second experiment tested the effectiveness of the proposed pickup desk design, and was conducted during peak hours at the airport. A total of 10 people organizing pickups were recruited to evaluate the design after using the desk (Fig. 13). Participants used the desk with items they had brought along, describing and evaluating the desk while using it. They also provided suggestions for each design function according to their personal habits and experience.

The experiment revealed that most participants' evaluation of each function's usability was influenced by what materials their name lists were printed on. Most participants were first attracted by the desktop groove and instinctively placed their documents in it. Because the paper holder was placed at the back of the desk, participants generally overlooked it, and those who did notice it had to bend down to fix their papers in the holder. Some participants suggested that relevant signs and other information could be provided on the desktop to familiarize users with the desk's functions.

Additionally, we asked the participants to rate each function on a 5-point scale, using the results to calculate the convenience of each function. The participants did not necessarily use every desk function, but rather only the ones they required according to what they had brought with them that day. The results revealed that the desktop design received the highest rating. According to the participants' comments, people organizing pickups prefer to arrange all their documents on the desktop, which provided space for them to write and rest their arms. The hooks were the functions first used by participants, because they were easy to notice and use. The hooks and paper holders were the third highest rated functions; however, the participants indicated that it was not their habit to hang their personal bags on hooks. Moreover, the varying sizes of their bags and worries that they might leave them behind limited participants' use of the hooks. Nevertheless, the usability of this function was acknowledged, because most of the participants thought that the hooks reduced the burden of carrying their personal items. Finally, because the paper holder was placed at the back of the desk without any additional indication, most participants did not know how to use it or were not even aware of it.

V. Conclusions

Regarding sign design, the experiment results indicated that a participants' view influenced whether they could identify meeting-point signs. Using the newly designed signs in the arrivals hall, most participants were able to locate meeting points. Only a few participants failed to locate meeting points when viewing from point B (arrivals gate). This could be because the view from the arrivals gate was too wide and, although participants should be able to see two meeting points from this position, some thought that there was only one, immediately sighting the first and thus overlooking the second. Therefore, providing meeting-point signs with a clear orientation could increase the ability of passengers to correctly locate meeting points. Moreover, the observation results revealed that people organizing pickups and passengers both tended to wait near transportation stops. Therefore, transportation information could also be provided at meeting points to reduce the frequency of requests for information. After adding transportation information to meeting-point signs, most participants were attracted to the design, which led them to notice the information provided on these signs. Furthermore, the experiment indicated that participants had different purposes and needs when viewing from different positions. For example, arriving passengers searched for transportation information and meeting-point signs, whereas people organizing pickups focused only on meeting-point signs. Users' distance from signs also affected their understanding of the information provided on them. Therefore, such information should be determined by different users' requirements.

Evaluation of the proposed pickup desk design suggested that people instinctively used the desktop groove, but tended not to place items on the desktop itself. The groove was the first design function recognized by participants, most of whom placed their documents in it. Although the current groove design is a structure protruding from the desk, a future design might employ a groove cut into the desktop. In addition, the experiment revealed that most users were unaware of the paper holder. Therefore, a future design might place the paper holder at chest level or move it to the side where users sit, thus not requiring them to bend down. Finally, some people organizing pickups recommended that signs or descriptions for each function could be provided on the desktop to familiarize users with these more quickly.

This study examined problems of spatial use in the arrivals

hall of Terminal 2 at Taoyuan International Airport during certain time periods. Based on its observations and analyses, this study provided an improved design for meeting-point locations and signage position and content. Future research could propose more diverse means to demonstrate meeting points by analyzing the meeting behaviors recorded in the present study. Furthermore, this study's proposed design conformed to the airport color system and related design regulations. Given user behaviors and cultural differences, meeting-point design requires much further exploration.

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