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A RESEARCH APPROACH TO THE WAYFINDING BEHAVIOR OF AIRPORT USER

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ABSTRACT

Although there has been an extensive amount of research on wayfinding behavior of users both in outdoor and indoor spaces, there are no studies that investigate how 5 city elements of Lynch, paths, edges, districts, nodes, landmarks; affect wayfinding behaviors of users in interiors. Purpose of this study is to investigate this relationship in an airport and fulfill the gap in the regarding field. The study examines the correlation between 5 city elements of Lynch and changes in user's wayfinding behaviors in a crowded, complex and stressful environment that is occupied by people with time limitation. Airports are chosen as complex spaces that are mostly used for a very short time by large groups of people who are usually stressed and in rush. Being able to navigate easily to aimed destination in a brief period of time is highly important in such places. However, after a detailed literature review, the absence and the necessity of such a study is realized. This study is carried out in İzmir Adnan Menderes Airport in Turkey with 38 participants who used International Departures Terminal. The spatial layout and signage system of the chosen airport is analyzed through questionnaire that includes cognitive mapping technique. It is found that the relationship between wayfinding ability of users and 5 city elements of Lynch can help to achieve successful airport design and affects the users' wayfinding behaviors. Deriving from these findings design suggestions can be developed and future research directions can be discussed.

Keywords: Wayfinding, 5 city elements, behavioral change, airport design, Lynch

1 INTRODUCTION

A number of discussions of wayfinding behaviors in exterior and interior spaces have been proposed in the literature (Arthur and Passini, 1992; Berger, 2005; Blades, 1997; Bronzaft and Dobrow, 1984; Brosset et al., 2008; Canter, 1974; Doğu and Erkip, 2000; Downs and Stea, 1973; Eaton et al, 1992; Hahn and Zitron, 2010; Jansen-Osmann and Fuchs, 2006; Kan Kilic and Hasirci, 2011; Kitchen and Blade, 2002; Lynch, 1960; Mollerup, 2009; Montello, 2005; Passini, 1995; Passini et al., 1998; Pon, 2008; Steyver and Kooijman, 2009; Tolman,1948; Weisman, 1981). The term *wayfinding* has originally been introduced by Lynch (1960); therefore the study of Lynch (1960) can be taken as a milestone in the exterior wayfinding studies. Although there has been an extensive amount of research on wayfinding behavior of users both in exterior and interior spaces, there are no studies that investigate how 5 city elements of Lynch; namely, paths, edges, districts, nodes, and landmarks affect wayfinding

behaviors of users in airports. Therefore, this study fulfills the gap in the regarding field and makes original contribution to the literature. Thus, the purpose of this study is to investigate this relationship in a chosen airport to investigate the help/importance of those 5 city elements for wayfinding in a crowded, complex and stressful environment that is occupied by people with time limitation. Study also discusses how airport spatial layouts and signage systems affect users' wayfinding ability.

Hypotheses of this study are:

H1: 5 city elements of Lynch are applicable to airport spatial layout and they can help airport users to find their way efficiently. Based on this hypothesis, following sub-hypothesis can be developed:

H1a: Spatial layout of an airport affects users' wayfinding ability.

H1b: Signage system in an airport affects airport users' wayfinding ability.

The second hypothesis of this study is:

H2: Stress factors affect airport users' wayfinding ability. Based on this hypothesis, these sub-hypotheses can be developed:

H2a: Time limitation affects airport users' wayfinding ability.

H2b: Travel stress affects airport users' wayfinding ability.

İzmir Adnan Menderes Airport is chosen as a case study as it is a complex space that is mostly used for a very short time by very large groups of people, who are usually stressed and in rush. It has a passenger capacity of 2.5 million per year. Airports are highly important places for people to be able to navigate and reach their aimed destination in a very limited time period. Therefore, firstly, the spatial layout and signage system of İzmir Adnan Menderes Airport is analyzed. Secondly, observation and questionnaire including cognitive mapping technique with airport users are realized. In questionnaire, the subjects were asked to describe how they plan to reach the destination in the airport through cognitive maps.

2 LITERATURE REVIEW

2.1 WAYFINDING BEHAVIOUR OF USERS IN A COMPLEX ENVIRONMENT

Before going into the details of the research it is important to define the main terminology of the study: *Wayfinding* and *cognitive mapping*. The first term is *wayfinding.* The term has originally been used by Lynch (1960) as *'the process of determining and following a path or route between an origin and destination'*. Lynch defined 5 city elements namely, paths, edges, districts, nodes, and landmarks and stated that these help people to form images to navigate themselves easily in an urban environment. Montello (2005) defines navigation as consisting of two components, locomotion and wayfinding. *'Locomotion refers to navigation behavior in response to current sensory-motor input of the immediate surrounding and includes tasks such as steering, obstacle avoidance, and the approach of a visible object in vista space'* (Montello, 2005).

The second term is *cognitive mapping*. It was first proposed by Tolman (1948) who states that cognitive mapping *involves 'various measurement techniques, such as spatial priming and recall, distance and pointing judgments, mental scanning operations and map reproduction tasks'* (Tolman, 1948). Kitchen and Blades (2002) defined cognitive map as a term which refers to *'individual knowledge of spatial and environmental relations, and the cognitive processes associated with the encoding and retrieval of the information from which it is composed'*. Mental or cognitive perception of space is defined in the literature as a process composed of *'a series of physiological transformations by which an individual acquires, codes, stores, recalls, and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment'* (Downs and Stea, 1973).

2.2 WAYFINDING IN INTERIORS

Many researchers worked on spatial layout and signage system in complex interior environments such as hospitals, educational environments, shopping malls and airports (Arthur and Passini, 1992; Berger, 2005; Bronzaft and Dobrow, 1984; Canter, 1974; Doğu and Erkip, 2000; Eaton et al, 1992; Hahn and Zitron, 2010; Kan Kilic and Hasirci, 2011; Mollerup, 2009; Passini, 1995; Passini et al., 1998; Pon, 2008; Weisman, 1981). The spatial layout can be defined with its spatial content, its form, organization and circulation. Signage system is the structural and graphic expression of the required information necessary to overcome wayfinding problems (Passini et al., 1998).

Like other complex built environments, the stress level of airport users are more than other complex interiors' users because of long waiting periods, crowd, increased security demands and time limitation. All these factors influence the wayfinding techniques of airport users. Therefore, airports are well-worth studying wayfinding abilities of users. Familiarity is one of the main factors that affect wayfinding in the immediate surroundings. As cited in Pon (2008), "*First-time flyers are more anxious than the other travelers. Of course, the level of anxiety or excitement depends on the individual. These passengers rely heavily on signage".* Fear, uncertainty and impatience caused by getting out of their comfort zone increase the stress level of airport users. An airport building like other buildings is composed of paths and districts. Especially, paths carry an important role in wayfinding behaviors of airport users controlled by time, flight schedule and personal response times (Pon, 2008).

3 THE CASE STUDY: İZMİR ADNAN MENDERES AIRPORT (ADB)

İzmir Adnan Menderes Airport (ADB) is chosen as a case study (See figure 1, 2) as it is an airport that has been designed by Yakup Hazan and gained the first prize in the design competition in 1998. ADB is a complex space that is used for a very short time by large groups of people, who are usually stressed and in rush.

Figure 1 – ADB, Exterior View (Ege Mimarlık, 2007).

Figure 2 – ADB, Interior View (Ege Mimarlık, 2007).

Hazan's one of the main considerations was to ease the wayfinding behaviors of users. That's why he designed four parallel districts that are divided horizontally according to their functions in order to achieve a smooth transition between different functioned spaces (see figure 3). Hazan (2007) also mentions that colored ventilation pipes carry a big role in design process and aim to carry a landmark quality for users.

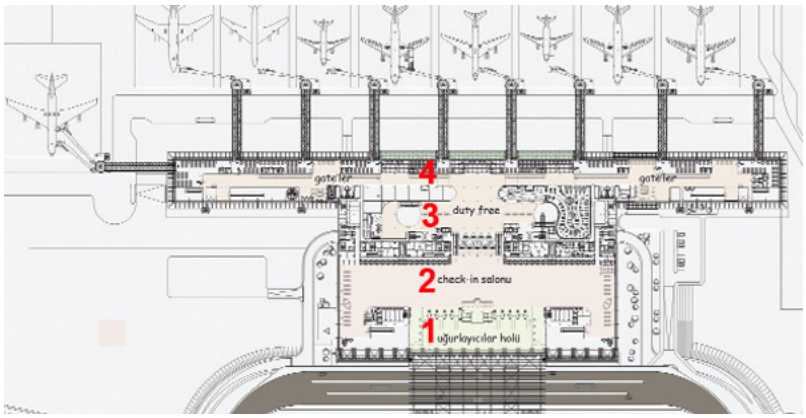

Figure 3 – ADB International Departures Terminal Plan (Ege Mimarlık, 2007).

3.1 PARTICIPANTS

There were 38 subjects (16 female). 26% of the participants were the first-time flyer in this airport. The majority of participants were (34%) between 50 and 65 years old, 29% were between 35 and 50, 18% were between 25 and 35, 11% were between 18 and 25 and the remaining were (8%) between 65 and 80 years old. The participants were from different professions such as doctor, engineer, worker, student etc. Participants were all chosen from İzmir Adnan Menderes Airport, who used International Departures Terminal for Skorje (31%), Frankfurt (23%), Hamburg (18%), Düsseldorf (13%), Athens (9%), Nantez (3%) and K.K.T.C. (3%) at the chosen date and time, namely 6th of April between 9.00 – 11.00; 11.00 – 13.00; 13.00 – 15.00; 15.00 – 17.00.

3.2 INSTRUMENTS

3.2.1 ***Analysis of the Spatial Layout of Adnan Menderes Airport (ADB)***

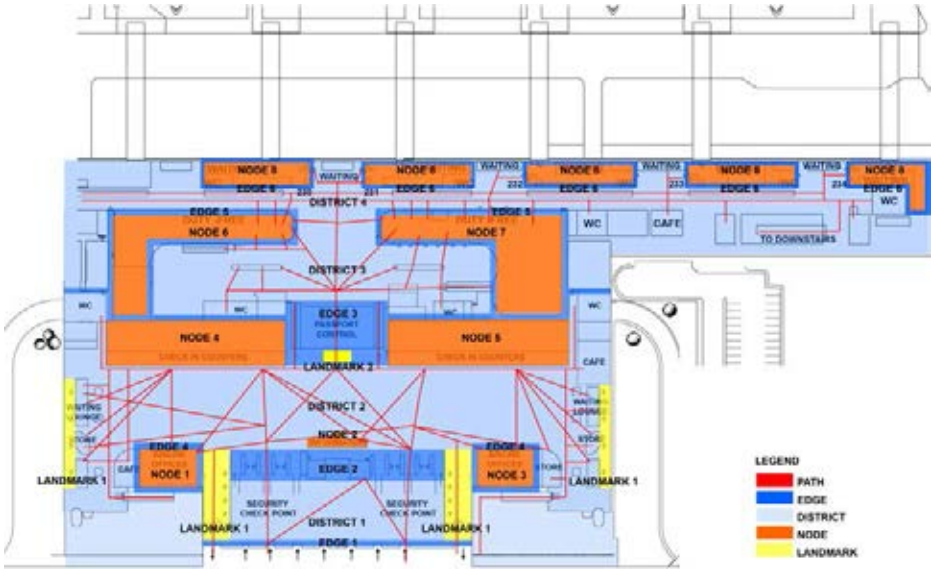

Figure 4 – Analysis of spatial layout of ADB (drawn by authors)

3.2.1.1 Architectural Information in ADB

The following table explains the architectural analysis of ADB that is prepared by us according to Lynch's framework.

PATHS	Routes that users move along to reach a destination point, Can be vertical and horizontal,
EDGES	Boundaries between two districts of the airport, created by regulations, Linear breaks in continuity, Barriers that needed to be crossed, Users go through certain control/inspection, Two types of edges: 1- Security Check Points (Edge1, Edge2, Edge3) 2- Store and Office Areas (Edge 4, Edge5, Edge 6) First type of edges are located horizontally Second type edges are aligned with edges of different functions.
DISTRICTS	Defined areas with certain functions, Laid out horizontally in 4 parts, Divided by first type of edges, Observers mentally enters 'inside of', Can be recognized with a certain character or function.
NODES	8 strategic spots where users can enter, get information or service, Concentrations that gain its importance from being a crossing for certain physical character, Creates focal points in districts.
LANDMARKS	Reference points, Striking, memorable point-references, Two types of landmarks: Distant ones: Can be seen from a distance from many angles Innumerable Signs: Local, visible only in a certain area and from a certain angle

Table 1 – Key wayfinding elements of ADB (prepared by authors).

Deriving from the analysis in the table above, the following table gives informational examples of relationship between ADB and Lynch's framework.

PATHS		Vertical Path

		Horizontal Path
EDGE 1		Airport Entrance
EDGE 2		Security check between entrance and check-in counters
EDGE 3		Passport Check Point

EDGE 4		Airline Offices
EDGE 3		Duty Free Stores
EDGE 3		Airplane Gates
DISTRICT 1		Airport Entrance

DISTRICT 2		Area Between Security Check and Passport Control
DISTRICT 3		Area Between Duty-Free Stores and Gates
DISTRICT 4		Gate Area
NODE 1		Airline Offices (Left Wing)

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NODE 2		Information Desk
NODE 3		Airline Offices (Right Wing)
NODE 4		Check-In Counters (Left Wing)
NODE 5		Check-In Counters (Right Wing)

NODE 6		Duty-Free Stores (Left Wing)
NODE 7		Duty-Free Stores (Right Wing)
NODE 8		Gates (230, 231, 232, 233, 234)
LANDMARK 1		Ventilation Tubes

LANDMARK 2		Flights Time Screen

Table 2 – Lynch's 5 city elements in interior - ADB (prepared by authors).

3.2.1.2 Signage System in ADB

As signs give message and lead users to a certain direction, they carry a vital role in wayfinding behaviors in complex interiors (Berger, 2005) together with the spatial layout in complex environments. According to Lynch (1960), signs can be considered as landmarks. Signs as landmarks can be in two different styles: Innumerable signs and distant signs (See Table 1).

When ADB signage system is analyzed, as it is seen in figure 4 and table 2, the flight time screen in district 2 can be considered as a major landmark as it can be seen from many different angles and visible to all. All other signs are mostly located in between districts, before or after edges, and in front of certain nodes. However these signs are not always sufficient for wayfinding since they are not placed and designed to give clear direction and message to users. As cited in Dogu and Erkip (2000), Lang (1987) states that color and background-foreground relationship have an important role in the design of a successful and legible signage. However, as a result of the color choice (white and orange lettering over dark blue) of the signs of ADB (figure 5) cannot be considered as successful since they are very hard to read especially from a certain distance.

In addition to color, the placement of signs carries an important role in wayfinding behaviors of users. Berger (2005) states that signs which are located on the ground and below the eye level are not preferred by users. The signs in ADB that are located on the floor (figure 6) are not good examples as they are below eye level and hard to realize.

Figure 5 – Sign example

Figure 6 – Sign example on the floor

3.2.2 ***Questionnaire***

The questionnaires were applied in International Departures Terminal at the chosen date and time (See section 3.1). Questionnaire consisted of four parts that aims to collect information regarding age, gender, time and occupation. The first and the third parts of the questionnaire included cognitive mapping technique (see figure 7) and asked users to draw cognitive maps which includes the numbered routes that they followed in District 1, 2, 3 and 4 in the airport. The second and fourth parts included various types of sign photos and investigated which signs were useful for wayfinding in District 1, 2, 3 and 4. The questionnaire also included questions on the number of help taken for wayfinding until they reached their destination.

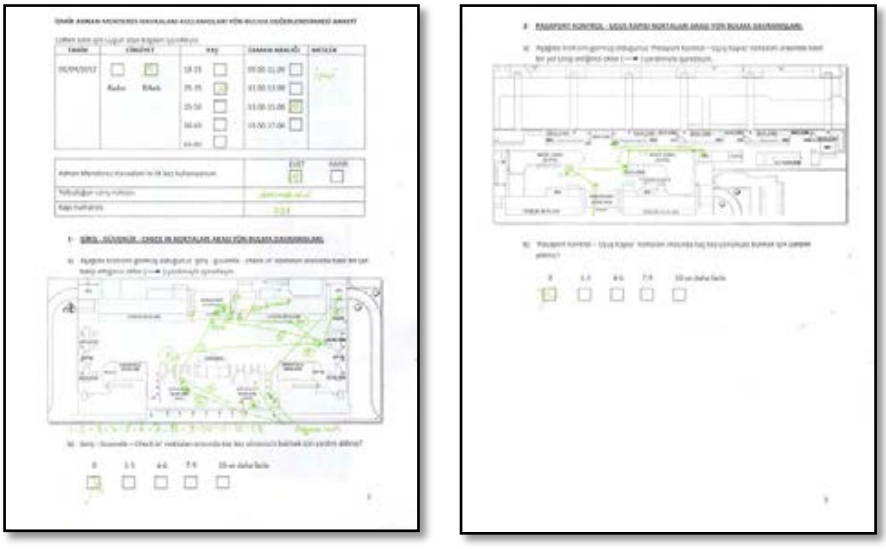

Figure 7 – Cognitive Map Example

3.3 FINDINGS AND DISCUSSION

38 participants completed the questionnaire. 17 items were identified in the cognitive maps such as airport building exterior door (EDGE 1), security check points (right-left) (EDGE 2), airline offices (right-left) (NODE 1-3), information desk (NODE 2), check-in counters (right-left) (NODE 4-5), leisure (wc-cafe-waiting lounge-store) (right-left), passport control (EDGE 3), duty-free shops (right-left) (NODE 6-7), waiting lounge (right-left), leisure (wc-cafe) and gates (NODE 8).

- Left security check point (edge 2) between district 1 and 2 was used by 40% of the participants. The rest used the right security check points (edge 2). It means that all participants had to use edge 1 and 2.
- Left check-in counter (node 4) was used by 50%. The rest used the right one (node 5).
- Information desk (node 2) in district 2 was used by 10%.
- Left leisure place in district 2 was used by 21%, right leisure place in district 2 was used 15% and the rest passed through directly.
- All of the participants used passport control (edge 3).
- Left duty free shop (node 6) was used by 8%; right duty free shop (node 7) was used by 29%. The rest (63%) did not use duty free shops. Left and right duty free shops are located between district 3 and 4.
- Left waiting lounge in district 3 was used by 2%; right waiting lounge in district 3 was used 15%.
- Wc's and cafe in district 4 was used by 34% of the participants.
- All participants used gates (node 8) in district 4. 34% came to the gate directly, 3% of whom left the gate area for other purposes (wc-cafe-duty free shops), 66% of the participants spent their time before reaching to the gates in duty-free shops, WC and cafe.
- There are 10 first-time flyers among the participants. 40% of them had difficulties in finding their way. The rest used minimum number of paths in order to reach their destination.
- 28 participants did not use this airport for the first time. 40% of them had difficulties in finding their way. The rest used minimum number of paths in order to reach their destination.

As it is seen in the analysis of spatial layout of ADB (see figure 4 and table 1-2), and findings regarding to cognitive maps of the airport users, we can define certain paths, edges, districts, nodes and landmarks in İzmir Adnan Menderes Airport spatial layout. Observations and users' cognitive maps results show us four horizontal **districts** and clearly defined **nodes** that help users' wayfinding strategies during decision- making.

One of the user comments also supports first hypothesis of the study:

"The parallel layout of this airport helped me to find my final destination"

Edges that are defined parallel to four districts layout help users' wayfinding as they create clearly defined transition zones in between districts. According to results, ventilation pipes (landmark 1) and the flight time screen (landmark 2) are considered as **landmarks** by airport users. 23% of users required verbal assistance while they were finding their way. And it is seen in their cognitive maps, they were hesitant in their **path** drawings. 77% of the participants drew consistent paths in their cognitive maps in general. When we analyzed paths especially in district 2, they were more scattered because of the scale difference when compared to other districts. This result supports **H1a:** Spatial layout of an airport affect users' wayfinding ability.

Signs in ADB are mostly located in between districts, before or after edges, and in front of certain nodes. However, the locational and physical qualities of these signs are not always sufficient for them to lead users directly to their aimed destination. Therefore, colored ventilation pipes and the flight time screen are needed as landmarks and help users in their wayfinding process. According to questionnaire results, signs that are located on the ground level in ADB are not preferred by users for their wayfinding process. Also absence of sufficient information desk and staff causes airport users to rely on signage system. This result supports **H1b:** Signage system in an airport affect airport users' wayfinding ability.

One of the user comments also supports this hypothesis:

"The signage system directly leads me to my gate without any need to verbal assistance"

Our spatial layout analysis for ADB and result of the questionnaire support **H1:** 5 city elements of Lynch are applicable to airport spatial layout and they can help airport users to find their way efficiently.

According to users' cognitive maps results, it is seen that users' wayfinding strategies can change during decision-making process according to time limitation. We can say that there is a strong relationship between paths that are between certain edges and nodes and time limitation of the users. 47% of the users had time limitation problems and when we analyze their cognitive maps, it is seen that there are less paths in district 2 than district 3 since they wanted to reach directly to their aimed destination (node 8). When they reached their destination and if they still had time, they used the functions in district 3. Time limitation and crowd increased travel stress of the users and it affected their decision-making process. These results support **H2a:** Time limitation affect airport users' wayfinding ability and **H2b:** Travel stress affect airport users wayfinding ability. Such results are also obviously seen in cognitive maps of the users who have time limitation problems. The paths that were drawn by first-time flyer with time limitation problems were more scattered, whereas, the paths that were drawn by more familiar users with time limitation problems were more consistent (see figure 8 and 9). Cognitive map results support **H2:** Travel stress affect airport users' wayfinding ability.

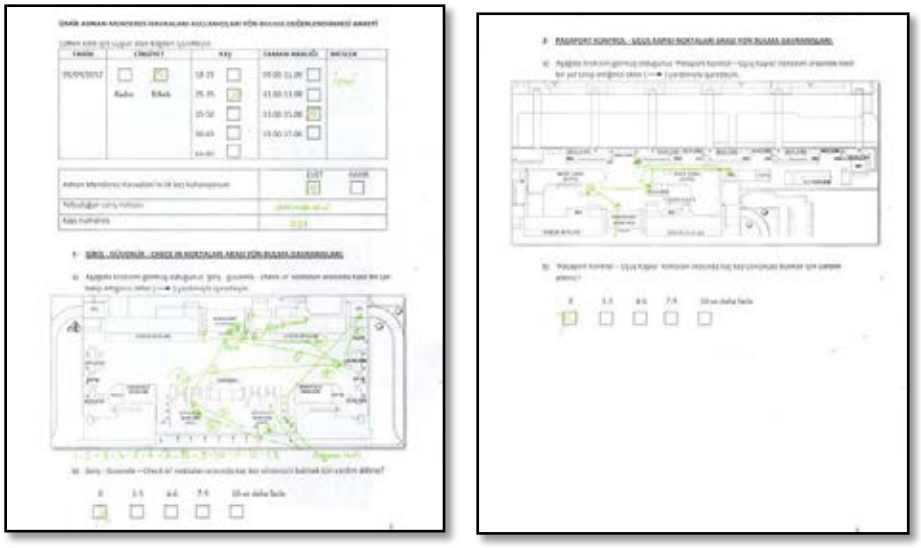

Figure 8 – Questionnaire example for familiar users with time limitation

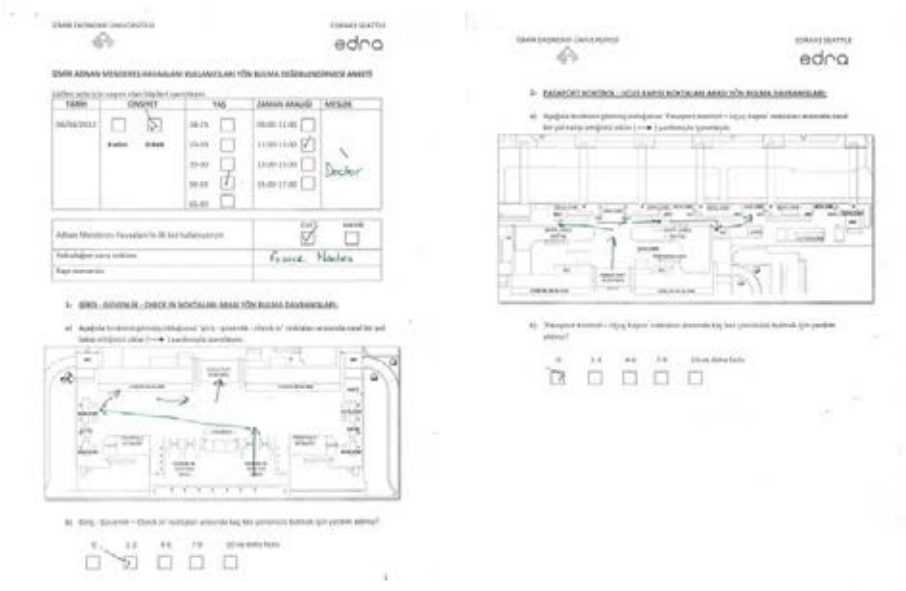

Figure 9 – Questionnaire example for first-time users with time limitation

4 CONCLUSION

As a conclusion, 5 city elements of Lynch are not only for the design of efficient exterior environment wayfinding but also for complex interior environments such as airports to achieve successful design and it can be useful for the wayfinding ability of the users. Airports benefit from these 5 city elements for legible interior environment. It is found that paths, edges, districts, nodes and landmarks can easily be recognized in İzmir Adnan Menderes Airport (ADB) and they affect users' wayfinding abilities. It is seen that spatial layout of ADB is quite successful in terms of wayfinding behavior of users and signage system of ADB cannot efficiently support users in their wayfinding process. It is also found that stress factors such as time limitation and travel stress of the users affect their wayfinding strategies and cause loss of time. However, horizontally located

districts, edges in between, and easily recognizable landmarks help people to find their aimed destination in such a stressful environment.

Based on the research, the following recommendations are listed for the future research directions. First, the research can be conducted on a larger sample group including different user groups such as airport staff, air crew to obtain a large data set. Such information could give us more varied results in relation to participants' gender and age differences. Characteristics such as gender and age could be further dwelled on in detail. However, these criteria were not the focus of this study. Another suggestion for future studies could be the control of the changes of users' preferences and decision-making process according to time limitations by a camera for a long time. The research could be also conducted in different periods of the day and examine how users' wayfinding strategies change according to crowding. A further step might be to choose two different airport designs, which are well-known with their design layout and signage system and comparisons could be done between these two airports. Moreover, universal design issues could be more considered as a focus of a further elaboration of this study.

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