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International Journal on Sustainable Tropical Design Research and Practice

Editorial Preface

DESIGN WITH CARBON IN MIND

SREETHERAN MARUTHAVEERAN [1,2]
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Sustainability has become a focus in the world of architecture and design, inspiring designers to rethink how they design today. In fact, Earth Day is an annual reminder to the designers of their responsibilities to protect the environment and to change how the designers design to mitigate environmental issues. Designers have the capability and responsibility to provide solutions that minimize the environmental impact when they design particularly in reducing the carbon footprint. A carbon footprint is the total amount of carbon released into the air by an individual, organization, or community. Designers need to work closely with other professionals in order to mitigate CO_2 at local and international level at the same time be equipped with information regarding environmental issues. It is no longer a choice to reduce carbon emissions; it is a necessity and not an impossibility in today's time and much important designers need to start to design with carbon in mind.

With governments and companies around the world asserting a climate emergency and setting out strategies to radically cut carbon emissions, it is just not acceptable for designers to be unaware or uncaring about the carbon impact of their designs. Whether it is a piece of fabric, packaging, a device or a building, each decision right from the start has carbon consequences.

I would also like to thank all of the authors who contributed to this issue. Ten articles have been published where some of these articles are directly or indirectly related to issues related to this year's Earth Day theme. It is timely, designers need to engage themselves in resolving global issues e.g. towards the reduction of CO_2, flash flood, global warning, food security etc. through research, practice and innovations. It is also hoped that in the future ALAM CIPTA would like to receive more issues related to how designers solve environmental issues in the future. On behalf of the editors, I would like to acknowledge my gratitude to all the authors and reviewers who have contributed to this issue.

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INNOVATION ON 360° VIDEO APPLICATION AS A NEW NORM IN DEVELOPING HISTORICAL TOURISM AND ITS ACCEPTANCE AMONG VIEWERS: THE CASE OF MALAYSIA NATIONAL MUSEUM

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planning,
development

ABSTRACT

Lack of maximising the technology in today's tourism ways of doing things is the main concern of one development and success in tourism sectors. Previous studies have proven the success rate of using the current innovation and trends in tourism sector help to increase in terms of the visibility of the tourist attractions and numbers of visitors in one tourist location. Hence, in the present study, it focuses on National Museum planning in its initiative to adopt new technology for the betterment of Malaysia National Museum popularity. Museum is a must visit location of one country as it acts to introduce ways of live and culture of its people. Yet, many of local and international visitors tend to neglect the importance of visiting museums. This is due to the portrayal of physical static museum leads towards unattractive environment and not aware of the high potential in understanding historical background of the place that they visited. Recent years, the numbers of people visiting national museum in Malaysia specifically are reducing. It is impacted due to the present movement order control since March 2020. The limitation of physical visitation to a tourist spot such as national museum has worsen the situation. Therefore, the present study aims to explore the use and application of 360º view technology in Malaysia National Museum. The present study collected images and 360° videos using device namely Insta360 ONE R Twin Edition. Once completed, questionnaire was distributed to collect 50 viewers use and satisfaction on the onsite national museum videos and images output. Results explained that viewers agreed and enjoy using the 360° video to explore the museum virtually. Furthermore, it also assisted visitor to expect what they will see and go for future visit as results shows the viewer acceptance and intention to use the 360° video is positively significant.

1. INTRODUCTION

Innovation on *360°* view application, is the current trend of visual documentation in portraying one location view without physically be at the location. This allows an access to the viewer to experience the view of *360°* VR to give the feel of the environment experience digitally. This helps the user to do advance research before physical visitation at on any tourist spot listed. The visibility assists in terms of preparing the visitor on what to expect at the location to prevent loses or disappointments among them. Previous study shown on how *360°* view helps in promoting its tourism products. Many of the studies conducted are relating to developed countries such as Japan, United States of America, and many European countries (Pasanen et al., 2019); Kelling, Väätäjä, & Kauhanen, 2017; Corbillon, De Simone, & Simon, 2017). Yet, the usage and application in developing countries such as Malaysia are still low. The challenges of adopting this new norm have been increasing recently due to the situation of pandemic Covid-19 that break in Malaysia early 2020. Due to this, many sectors including tourism industries are impacted. Scholars started to conduct much research in terms of how to continuously make the industries relevant and competitive during the pandemic eras.

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Physical visits were halted, and state-to-state border crossing was prohibited. Not only are overseas travels prohibited, but there are also stringent controls in place to prevent the epidemic from spreading. Due to the large number of new instances of covid-19, MKN issues a severe mobility control order in the Klang Valley. One of the tourism items that has been harmed is National Museums (MOTAC, 2021). Struggles reach this unit to ensure visibility and visitor numbers, as it is also not a popular tourist product among visitors, as museums are often associated with being unattractive. As a result, it is predicted that the national museum would adapt its digital marketing strategy in line with other museums around the world that have adopted digital marketing strategies such as virtual reality and 360-degree view applications. National Museum is expected to become one of Malaysia's most popular tourism goods as a result of this technological adaption and a combination of Search Engine Optimization (SEO).

The application applied on the present innovation is on *360°* media. It is consisting of *360°* videos and images, developing the application will help the Malaysia National Museum to enhance traditional applications with immersive content. This will later be used by the tourism agency in promoting national museum as tourism products in visiting Malaysia. The embedded of *360°* video into a travel application will provide viewers tour as they plan an actual vacation. It helps the prospective tourists on a virtual walkthrough of their upcoming vacation. Hence, the use of this application will be beneficial for tourism marketing (Adachi, Cramer, & Song, 2020). Although *360°* media support true stereoscopic Virtual Reality (VR) playback through compatibility with VR platforms like Google Cardboard, it can also be displayed in a simple "magic window" that can be viewed from desktop browsers and mobile apps without any special VR hardware. Therefore, it is much accessible to public without the VR hardware availability. Therefore, the present study aims to satisfy below objectives: -

Research Objective 1:

To explore perception on usage of 360° view application using Insta360 ONE R Twin Edition - 4K Wide Angle Mod on Malaysia National Museum.

Research Objective 2:

To apply 360° visual documentations using Insta360 ONE R Twin Edition - 4K Wide Angle Mod on Malaysia National Museum.

Research Objective 3:

To identify the acceptance and use of 360° visual documentations using Insta360 ONE R Twin Edition - 4K Wide Angle Mod towards Malaysia National Museum visitors.

The next section of the present paper described further on the related literature of the present study to further understands the important usage of 360° view application using Insta360 ONE R Twin Edition (4K Wide Angle Mod) on Malaysia National Museum as one of the tourism products. It also discussed the implications of the application in tourism industry in Malaysia.

2. LITERATURE REVIEW

2.1 Historical Tourism

Chaigassem and Tunming, (2019) research on the Heritage and Historical tourism in Thailand that offers visitors opportunities to learn about the local culture at authentic sites with respect to the Ecosystem Services, local culture, and wisdom. In order to promote the sustainability of the tourism sites and to foster a sense of protectiveness and ownership among people in the community, these sites are usually managed by the locals, which has been one of many ways to healthily run tourism businesses, facilitate local economies, and to fairly distribute revenues (Ministry of Tourism & Sports, 2017). Thailand famous historical tourism at Khao Phra Wihan national park in Sisaket province is one of the examples which publish the tourism images and bring greater understanding and awareness of the historical site as a universal cultural heritage. Moreover, tourism innovative management can also be used to promote the tourism and the learning in tourist destination. It is the art of communication and presentation that stimulates the interest of tourists to make them understand the value and the importance of tourist destination. Due to this reason, the digital medium will help in assisting the communication digitally to create and stimulate people understanding before its physical visit to any historical sites.

1.2 Malaysia National Museum

The Malaysia of National Museum was first initiated by the First Prime Minister of Malaysia Yang Teramat Mulia Tunku Abdul Rahman Putra Al-Haj. During World War II, it was accidently bombed by the Allied Forces on 10th March 1945. The traditional Malay house and Malay motifs was used on the architecture of the museum to portray the history and crafts of Malaysia. At present, the museum is administered by the Department of Museum Malaysia (Muzium Negara, 2021).

Exhibitions available are inclusive (1) Prehistory Gallery (2) Malay Kingdoms Gallery, (3) Colonial Era Gallery, and (4) Malaysia Today, the extensive galleries give the ideas to the visitors in understanding the uniqueness of Malaysia through its history. The intentions of giving ideas to the visitors to increase the belongingness, warm and welcome in Malaysia. Malaysia National Museum has taken their initiatives in digitalising the materials available including the exhibition conducted by museum. This inclusive on their recent exhibition such as "Kuasa Emas" or The Power of Gold which has been digitalised as in 360° videos. The initiative was hoped to attract more people to witness themselves on the available exhibit. Therefore, aggressive steps taken by Malaysia Museums Management in ensuring the visibility of Malaysian treasure grasp by the new generations.

1.3 The use of 360° videos in Tourism Industry

Study conducted in tourism education using 360° video was tested and found that there is an improvement in terms of user's experience and satisfaction through the application (Arrasyid et al., 2020). Items collected in documenting the visuals are (1) Photos 360°

camera (Normal) (2) 360⁰ camera-based learning videos (New Normal). According to Rahimizhian, Ozturen and Ilkan, (2020), whose conducted studies on the application of 360º videos in Hong Kong tourism has proven significant impact between 360º video and viewers' attitudes and behavioural intentions to visit the tourist spots. Since 2018, there are about 5,900 studies found relating to historical tourism and 360º videos used in promoting the location. However, about 2500 studies are relating to Malaysia tourism, this is to show the positive development and commitment of the country towards digitalisation in promoting its tourism products. Developed countries has left us far behind as they have already used the technology earlier then developing countries such as Malaysia.

***Table 1**: Sample of studies relating the usage of 360º videos and Tourism Spots*

No	Year Published	Topics Relating to 360⁰ view videos and Tourism Spots	References
1	2017	Impact of device, context of use, and content on viewing experience of 360-degree tourism video	Kelling, Väätäjä, & Kauhanen, 2017
2	2018	Comparing virtual reality tourism to real-life experience: Effects of presence and engagement on attitude and enjoyment	Wagler, & Hanus, 2018
3	2019	Comparing Tablet and Virtual Reality Glasses for Watching Nature Tourism Videos	Pasanen, Pesonen, Murphy, Heinonen, & Mikkonen, 2019
4	2020	Using virtual reality for tourism marketing: A mediating role of self-presence	Adachi, Cramer & Song, 2020
5	2020	Emerging realm of 360-degree technology to promote tourism destination	Rahimizhian, Ozturen, & Ilkan, 2020
6	2021	The effectiveness of virtual vs real-life marine tourism experiences in encouraging conservation behaviour.	Hofman, Hughes & Walters, 2021

Therefore, 360º video application is expected to be beneficial tool in shaping consumer attitudes, behavioural involvement, and intentions towards visiting the tourist spots in Malaysia specifically the National Museum of Malaysia. Further review has been done to list of studies conducted relating to 360º video used in tourism sector as per Table 1. Topics relating to the present studies reviewed from 2017 – 2021. It shows the relevancy of the study conducted are to date and on demand. In addition, the increase numbers of studies on 360º video used conducted by researchers has represents demand and usage of the 360º video. Many of the studies conducted from many of the countries, including Malaysia in promoting tourism. Studies on the use of 360º view videos in tourism sectors increases about 73%. Whilst recent studies relating to this topic updated until March 2021 showing continuous study with 434 studies.

***Table 2**: Sample of studies relating the usage of 3600 view videos and Tourism Spots*

No	Year of study conducted	Total Studies
1	2017	2,870
2	2018	3,090
3	2019	3,450
4	2020	3,940
5	2021 – March 2021	434

1.4 360º view Videos with Insta360 ONE R Twin Edition (4K Wide Angle Mod) Features

Insta360 ONE R has more than 10 features. It helps users enjoying 360º view Videos that allows shots taken from drone with simple steps. Insta360 brings a new innovation in developing 360º Videos that allows users to maximise the output results, by whether static or moving images. Features available are as follows: -

1) Super 5.7K 360º Capture
2) 4K Wide Angle
3) FlowState Stabilization
4) Waterproof to 5m
5) Invisible Selfie Stick
6) Auto Frame
7) Hyperlapse
8) Point to Track
9) Voice Control
10) Slow Motion
11) HDR Photo +Video
12) Night Shot

1.5 360º view Videos with Insta360 ONE R Twin Edition (4K Wide Angle Mod) Advantages

a) Gateway to new marketing platform

The new media tools such as Insta360 act as a platform in marketing product and places. Tourism sector specifically change the ways to market one tourism sector to applied with the new platform such as 360-degree videos. Sample of tourism spot in promoting countries best place to visit using the application such as U.S National Parks Virtual and Museum of Fine Arts in Vienna – Austria 360⁰, AirPano.com is a website consist of world virtual tour with many tourism spots such as Saint Petersburg, Russia, Sharks feeding in Bahamas and Victoria Falls in Africa.

Unlimited possibilities for viewers

The new technology introduces using Insta 360^0 provide a new possibility for viewers to reach the impossible views that traditional camera able to perform. Extreme activities such as surfing, cycling, hiking, or canoeing were easily be captured and at the same time, the coverage of environment view is also now able to be captured in just a video.

b) Customer loyalty

The immersive videos captured led users or viewers to continuously surfing and viewing the video. Studies shows viewers tend to attach at longer time when viewing 3600 videos compared to static images (Xu, Dong, Wu, Sun, Shi, Yu & Gao, 2018). It attracts more attention among viewers to know and view more on through 360^0 videos (Sheikh, Brown, Watson & Evans, 2016).

c) 360^0 Media Advertising

According to Rahimizhian, Ozturen & Ilkan (2020), the use of 360^0 videos in marketing plans allows destination marketers to give their customers a virtual adventure before their actual trip. This shown wider usage among advertisers in attracting more tourist specifically in promoting tourist spot.

1.6 360^O view Videos with Insta360 ONE R Twin Edition (4K Wide Angle Mod) Disadvantages

a) Technical limitations

It does not allow to frame the action to hide a less-than-ideal environment or set. It also difficult to hide cuts in videos developed. During the shoot, user will not be able to zoom in and out. There are work-around (i.e. volumetric capture paired with positional tracking) and it works better with camera rig still. If movement needed it must be motivated for intake while driving in a car to prevent sickness amongst the viewers. The camera rigs that are currently on the market perform poorly in low lights too. Objects need to remain a minimum distance of 3 feet from the camera to avoid warping. Additionally, any objects further than 20 feet away from the camera lose their stereoscopic depth.

b) Pricing

Because they require 360-degree set dressing and a labour-intensive editing process (for stitching, specifically), professional 360 videos can be expensive to produce

1.7 360^O view Videos with Insta360 ONE R Twin Edition Acceptance and Use (Technology Acceptance Model)

Technology Acceptance Model (TAM) was used in the present study to test the acceptance and use of 360-degree video developed specifically for National Museum. There are 4 variables adapted from TAM namely (1) Perceived Usefulness, (2) Perceived Ease of Use, (3) Perceived Enjoyment and (4) Behavioural Intention to use the 360-degree video (5) Actual Use of 360-degree video. This was supported by previous study that represents TAM used in identifying of the acceptance and use of the new technology of consumer-generated media usage for travel decision-making, perceived usefulness was positively connected to visitors' intention, and mobile social tourism shopping intention.

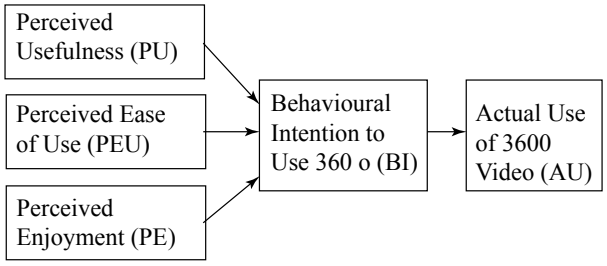


***Figure1**: Model of Acceptance and Use 360 º video in Malaysia National Museum Adapted from Davis, 1989; Venkatesh, 2003*

Perceived usefulness and ease of use was classified as principal representatives of extrinsic motivators of one technology acceptance (Davis, 1989) perceived enjoyment also related to intrinsic motivation that will lead to continuance intention to use technology specifically in the present study which is 360 º video and indirectly lead user to use the video (Venkatesh, 2003). Hypothesis of the present research developed are as below: -

H1: There's a significant difference between Perceived Usefulness towards Behaviour Intention to Use 360-degree video in Malaysia National Museum.

H2: There's a significant difference between Perceived Ease of Use towards Behaviour Intention to Use 360-degree video in Malaysia National Museum.

H3: There's a significant difference between Perceived Enjoyment towards Behaviour Intention to Use 360-degree video in Malaysia National Museum.

H4: There's a significant difference between Behaviour Intention to Use 360 º video towards Actual Use of the video in Malaysia National Museum.

To meet objectives of the present studies, data collection conducted through interviews, visual documentations and surveys using adapted model of acceptance and use of 360 º view applications conducted. Details of the process of data collection further explained in the next section.

3. MATERIALS AND METHODS

3.1 Interview

Altogether 6 interviews were covered during July-August 2020. Table 3 summarizes the respondents background involved in the present study. It shows the reported attributes of the interviewees position, as well as the contribution towards the tourism sector relating to national museum. All interviewees were kept anonymous

and no position or organisation name was reported, respecting the requirements of General Data Protection Regulations (GDPR). Interviews has been conducted for about 15 minutes for each session.

***Table 3**: Summary of Respondents Background (Interview)*

No	Respondent	Gender	Interview Location	Interview Duration
1	Museum Officer 1	Male	National Museum Malaysia	15 minutes
2	Museum Officer 2	Female	National Museum Malaysia	15 minutes
3	Museum Officer 3	Female	National Museum Malaysia	15 minutes
4	Visitor 1	Female	Google Meet	15minutes
5	Visitor 2	Male	Google Meet	15 minutes
6	Visitor 3	Male	Google Meet	15 minutes

In order to obtain perception among the users and personnel working in National Museum Malaysia relating to 360 º use as tools in promoting tourism product, an interview was conducted. All interviewees will be viewing the 360 º video output before questions asked during the session. List of questions ask in each session are as in table 4. Both museum officers and visitors will use the same set of questions and results from the interview will be later compared for both groups.

***Table 4**: Interview Questions*

No	Interview Questions
1	Have you heard new tech tool name 360º videos?
2	Have you use Insta360 ONE R Twin Edition before? If Yes, could you please share the experience of using it?
3	After viewing the 360º videos using Insta360 ONE R Twin. How do you feel towards the output?
4	What is your opinion, if the application of 360º Videos applied on National Museum in Malaysia used in promoting the museum?
5	Do you agree if this application use as a tool to promote tourism product such as our National Museum?

3.2 360º View Application on Malaysia National Museum

In order to give actual experience on 360º application to Malaysia National Museums viewers, the present study will be applying on Insta360 one R – dual lens 360 model camera. The camera offered basic functions and features uses 360 technologies to create traditional flat video, HDR video, time-lapse mode, and bullet time video. Camera allowed to record up to 5.7K resolution and compatible with smartphone to control the camera with the remote-control application provided by camera manufacturer. Moreover, it also has the ability to capture standard photos, HDR photos, Burst, Interval photos, night shot and pure shot with raw photo format. This 360º views technology provides an overall experience and atmosphere of the Malaysia National Museum.

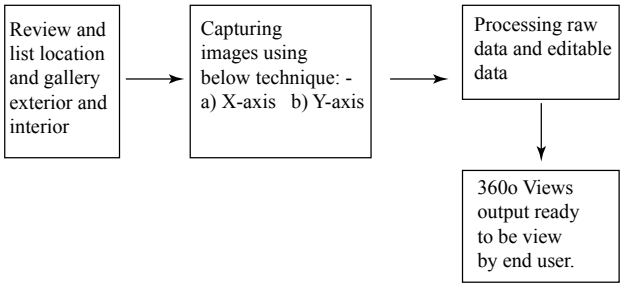
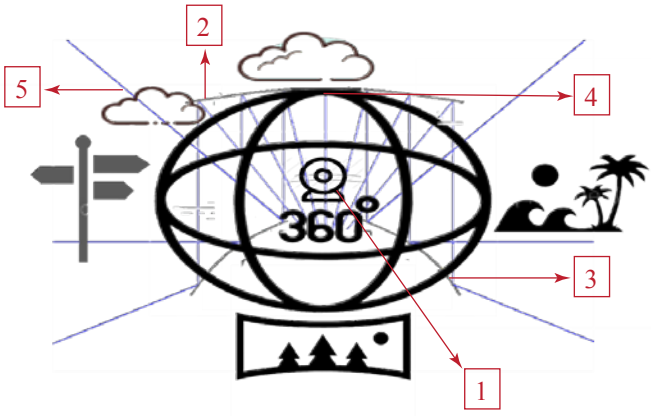


***Figure 2:** Schematic of an omnidirectional camera with two mirrors*

Figure 2 shown the camera can capture images and video from all direction falling onto the focal point, covering a full sphere excluding the top and bottom of the sphere. Data will be collected at the Malaysia National Museum capturing the actual images exterior and the interior of galleries available. Figure 3 shows on the data collection process in recording at the museum using Insta360 ONE R Twin Edition.



1.Camera 2. Upper view 3. Lower view
4. Black spot 5. Field of view (light blue)

***Figure 3:** Data Collection Process using 360o Video through Insta360 ONE R Twin Edition*

3.3 Qualitative Method – Interview

Few samples were selected consist of museums officers and visitors relating to its level of awareness on the existence of 360º video technology. Interview has been conducted for 15 minutes to each informer to record its understanding relating to the technology and the application of the technology to Malaysia National Museums. There are 5 questions asked and 6 of them has participated, the process stop after obtaining saturated answer from them. In addition, the visual data was also collected on site to record its 360º videos using the X and Y axis techniques.

3.4 Quantitative Method – Cross Sectional Surveys

After the task was completed, the questionnaire was given to users to find out their experience with the 360º video application being tested. It was done to identify what the users see and feel when performing the prearranged task. Convenient sampling was used

in the present study for quick check on the user's experience. The questionnaire contains of 50 viewers representing the three aspects of acceptance and use of 360^0 videos in Malaysia National Museum that visited the museum. Sample was collected randomly from 4 January 2021 – 10 January 2021, after the first MCO announced by Malaysia government in National Museum. Low visitor, has cause limited sample that presence at the National Museum.

The questionnaire consists of five question items related to the acceptance and use of 360^0 technology was used. Each parameter was placed in a set of statement offered to users in the form of a Likert-scale questionnaire. Each item in the questionnaire aims to show the level of usability according to user acceptance which was scored on a 5-point Likert scale through a set of cross-sectional survey.

3.5 Instrumentation

Table 5 & 6 are the instrument use for the present study adapted from El-Gohary (2021). Sections are divided into two section (A & B) that represents demographic and variable in Technology Acceptance Model (TAM) which are Perceive Usefulness, Perceive Ease of Use, Behavioural Intention and Use Behaviour and Perceived Enjoyment (Huang et al., 2016).

***Table 5**: Section A: Demographic*

Items	Items
A.1	Gender
A.2	Age
A,3	Marital Status
A.4	Education
A.5	Occupation
A.6	Income

***Table 6:** Section B: Technology Acceptance Model (TAM)*

No.	Items	References
Perceive Usefulness (PU)		
PU.1	Using 360^0 video of Malaysia National Museum in advance is useful for my visit.	El-Gohary, 2012
PU.2	Using 360^0 video of Malaysia National Museum fasten my search for my visit.	
PU.3	Using 360^0 video of Malaysia National Museum increase my knowledge on what to expect before visiting.	
PU.4	Using 360^0 video of Malaysia National Museum is helpful as tourist.	
Perceive Ease of Use (PEOU)		
PEOU1	Easy to use and navigate the 360^0 videos of Malaysia National Museum.	El-Gohary, 2012
PEOU2	Learn to use of 360^0 video technology would be easy for me to explore artefacts available in the Malaysia National Museum	
PEOU3	It will be easy for me to become resourceful about Malaysia National Museum by using the 360^0 technology.	
PEOU4	I found that 360^0 videos are easy to use for my search on Malaysia National Museum.	
Perceived Enjoyment (PE)		
PE1	I enjoyed using 360^0 videos on Malaysia National Museum.	Huang, Backman, Backman & Chang, 2016
PE2	I found it fun using 360^0 videos on Malaysia National Museum.	
PE3	I feel pleased using 360^0 videos on Malaysia National Museum.	
PE4	The 360^0 videos on Malaysia National Museum makes me feel excited & energetic.	
Behavioural Intention (BI)		
BI.1	I intend to use 360^0 videos before my visit to Malaysia National Museum.	El-Gohary, 2012
BI.2	I intend to use 360^0 videos to see available artefacts in Malaysia National Museum.	
BI.3	I intend to use 360^0 videos to see guide me on Malaysia National Museum floor plan arrangements.	
BI.4	I intend to use 360^0 videos to explore Malaysia National Museum exhibition.	
Actual Use (AU)		
UB.1	I use 360^0 videos before my visit to Malaysia National Museum	
UB.2	I use 360^0 videos to see available artefacts in Malaysia National Museum	El-Gohary, 2012
UB.3	I use 360^0 videos to see guide me on Malaysia National Museum floor plan arrangements.	
UB.4	I use 360^0 videos to see guide me on Malaysia National Museum floor plan arrangements.	

4. FINDINGS

4.1 Interview Findings

Findings from interview conducted relating to their perception on the usage of 360 videos using Insta360 on Gallery C National Museums. Many of them agrees that the videos are attractive and interactive. It hopes to attract more visitor in visiting our national museum. Therefore, through interview conducted from 6 respondents including museum officers and visitors, findings are concluded in table 5 below, answers given are based on questions available in table 4.

***Table 5**: Summary of respondent's interview results*

Respondent/ Questions	Age	Q1	Q2	Q3	Q4	Q5
Respondent 1	46	Yes	No	Interesting but the feeling does not the same compared to be physically at museum	I agree on this new application to be adopt in museum, yet only teasers will do. Not for all items, as if all goes digital, it will reduce visitor's interest to physically experience.	Somehow Agree
Respondent 2	32	Yes	No	Interesting but the feeling does not the same compared to be physically at museum, yet it's useful to target younger audience.	It will attract younger generations to come and visit museum at time	Agree

Respondent 3	35	Yes	No	Like the features available as videos are readily seen o phone. Users will experience and aware about the artefacts through online. It helps foreign visitors to expect what they will see when visiting museum,	Easier for us to view and get the information without have to come to museum	Agree
Respondent 4	15	Yes	No	The tech is wonderful; I simply love it. I hope that school will also give an exposure to students at school in adopting 360 degree videos.	It will be good for students to understand history better, especially to those who are not staying in Klang Valley. They can still have learnt history interactively from home. It will be good if live chat provided by museums to get live answers from available curators.	Agree
Respondent 5	18	Yes	No	I love to visit museum due to its environment and its history. Yet 360-degree videos are another steps forward as many of the museum in overseas such as in London. They have virtual museums too. Yet, visitors have kept coming to museum as one of their best spot.	It's good initiative if our national museum moves to digitalise museums galleries as this will help users to visit their website frequently to shows interest. As the message to understands country history will still be achieved.	Agree
Respondent 6	18	Yes	No			Agree

Table 5.0 above are summary of interview results conducted to museum officers and visitors. Interviewees age ranging from 15 years old to 46 years old. All of them have heard about the technology called 360-degree videos and gadget called Insta360 but none of them has experience using mentioned tech. After giving an introduction on the idea of 360-degree videos, most of the respondent give positive feedback and many agreed it should be applied to Malaysia national museum as this will be fitting the new norms that demanding technology and digitalisation.

4.2 360- degree Output Captured Using Insta360 ONE R

Gallery C divided into 24 small sections in the National Museum. The output for each section was captured using Y and X axis as per Figure 3 below. Output shown and capture are as per Table 6.

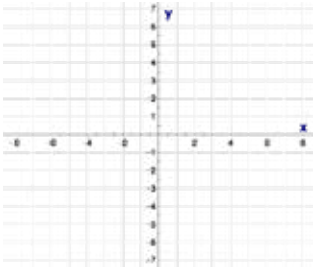


***Figure 3**: Image captured using X and Y-axis*

***Table 6**: Summary of Output sample from Gallery C, Malaysia National museum using Insta360 –Y -axis*

No	Section	Y- axis
1	Dutch in Malacca	
2	Johor Sultanate	
3	Weld Quay penang	
4	Perjanjian Pangkor	
5	Japanese Invasion in Malaya & Currency	

***Table 7:** Summary of Output sample from Gallery C, Malaysia National Museum using Insta360 –X-axis*

Main Entrance	Port de Santiago A Famosa	Tin and Orde
		

4.3 Technology Acceptance Model Survey Results

Objective 3 of the present study aims to identify the acceptance and use of 360º visual documentations using Insta360 ONE R Twin Edition - 4K Wide Angle Mod towards Malaysia National Museum visitors. The questionnaire distributed was tested on its reliability. The Cronbach alpha results for 5 main variables consisting of 1) Perceived Usefulness (a=0.89), 2) Perceived Ease of Use (a=0.85), 3) Perceived Enjoyment (a=0.86), 4) Behavioural Intention to use (a=0.88) and 5) Use of Technology (a=0.89). This proven on items consistencies for each of the variable in the instrument developed. Survey was distributed among visitors and data collected has been further analysed in SPSS using Pearson Correlation Coefficient (r) analysis testing to inspects on its relationship between variables. The relationship strength has been tabulated in table 8 using Pearson Correlation test. The present study lies between 0.3 - 0.5 which indicate a moderate positive linear relationship between the two-variable tested (Fan, et. al. Therefore, all hypotheses withdrawn earlier are accepted.

Table 8: *Summary of Pearson Correlation results on factors contributed towards the use of the 360º Video Application*

Hypothesis	Relationship	Pearson Correlation Coefficient *r*	Sig.	Hypothesis Testing
H1	Perceive Usefulness – Behavioural Intention to use 360º Video Application	0.500	0.000	Accepted
H2	Perceive Ease of Use – Behavioural Intention to use 360º Video Application	0.329	0.000	Accepted
H3	Perceive Enjoyment – Behavioural Intention to use 360º Video Application	0.421	0.000	Accepted
H4	Behavioural Intention - 360º Video Application Use	0.450	0.000	Accepted

5. CONCLUSION & DISCUSSION

In the world of education, various technologies have been applied to the education system. As such, technological revolution has paved the way for the use of new approaches practiced in the teaching and learning process today (Piovet al., 2012). Every technology that exists today has its own implications and the same applies here, as this technology can be used as a support for education as well as improving the quality of student learning. The use of videos emphasising visuals in reality will increase the motivation of school students to understand and explore what is being learnt. The use of these 360º videos has the potential to attract the attention of students and thus, enhance their cognitive abilities to pay attention to what is being watched. With the application of this video form in the teaching and learning process, it is expected to improve the efficiency and effectiveness of the learning outcomes. This is because teachers are able to prepare better and in an advanced manner with regard to conducting the process. In addition, this method allows the teacher to find information relevant to better facilitate teaching as well as convey information to the students effectively. With the use of 360º Videos as teaching tools, the teaching and learning process will be more interesting and far more effective. Therefore, they just need to apply the necessary tools into the teaching and learning process. This will aid the aforementioned process by making it easier, simpler, and more concise as well as enjoyable because the students will be exposed to pictures and visuals that are live, interesting and easily comprehensible.

5.1 Implications for the Tourism Sector

The user-friendly, cost-effective and fast-natured design of social media has allowed for information sharing that is now more focused on visuals and videos that are high-tech in nature (Chan & Guillet, 2011). This can be applied to the tourism industry. According to Alrashid (2012), the development of the tourism industry today is influenced by the characteristics of technology, which eases business transactions for parties that offer services to tourists. Apart from that, Au (2010) and Jonscher (2011) argue that the advantage that comes with the use of high-tech videos in marketing should not be ignored by the tourism industry, if they wish to remain viable competitors. This utilisation refers to the elements and the virtual environmental techniques including the use of 360 degrees that can be incorporated into the videos to produce more interesting and advanced visual effects. With the use of such video technology, the tourism sector will be able to channel the attention of tourists into choosing the appropriate products. This is because such technology-driven videos will enlighten users via visuals and provide the necessary information. It also provides tourists the opportunity for in-depth scrutiny of the video as if they were experiencing it in real time. Such technology needs to be utilised in the tourism sector to promote travel, as tourists would be impressed and excited to travel to the featured locations (Yang Firoz & Wan Sulaiman, 2017). Hence, this video can be promotional in nature for tourists to decide on a travel destination (Yang et. al, 2017). As tourists have different backgrounds, they can then make their own choices through technology. For example, Arif & Haggen (2013) state that the main factor that affects the choice of accommodation is the comprehension of the information in the video. These videos, which are of interactive form, can facilitate user response is a favourite feature for tourists. Furthermore, this enables the tourists to decide by considering the additional feedback of other previous tourists. This means that high-tech videos like this have positive implications and in effect, improve the economy of the nation.

5.2 Implication for the Community

The 360º video is a platform that has been designed to be shared to the public or the communities. Therefore, high-tech videos can attract the interest of the local community because it can provide the appropriate information and a clear visual of what they need. With the use of high-tech videos, the shared information will excite the audience into following the journey till the end. This video form can draw the audience based on its interactive nature and its capacity to access other navigations (Hammoud, 2006). This is appropriate for civilians, all levels of society, and the community, especially those in rural areas. The features of the high-tech videos should be user-friendly and easily comprehensible to accommodate for the members of society that are lacking in the

technological front. These people will then be more comfortable with the use of 360 videos because it does not confuse spectators with the choices that are to be made. Furthermore, the video can be seen from various angles without the need to press any buttons. This makes it easier for users or the people who want a customer-friendly tools.

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RECASTING THE URBAN MEMORY OF AL- TAHRIR SQUARE, BAGHDAD, IRAQ

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ABSTRACT

Al-Tahrir Square is the most effective Square in Baghdad, has many cultural and urban landmarks, and the most famous is the Freedom Memorial. As a valuable public space, this Square has faced urban transformation and dilution of social identity due to the collective memory and the built environment changing its meaning. This research aims at uncovering recent urban memory and reproducing collective memory in urban public spaces. Qualitative research was applied through a field study and interviews with 40 participants aged 18 and 75. Most of the people we interviewed thought that their part in the research helped them to understand how urban memory works now. This study shows that events and political activities created the memory of the place in the urban public space under study and that the place's transformation into a place of attraction and conflict between the forces of its original use led to the creation of a kind of new memory place.

1. INTRODUCTION

These days, prompt urban memory, especially in the capital, has led to new transformations in the built environment, events, users' defined spaces, and placemaking. Consequently, there has been an alteration of meaning and social memory. Public spaces such as squares in the capital city have become unattractive places for people and occupy spaces just for cars without memory and sense. (Barnett 2013). Today's public spaces are not for people to gather. They are just paths for vehicles and empty social spaces. Public spaces are now a locus for travel exchange. It changes places' urban and social memory because physical environments and social meaning change(Popović, Marić, and Vaništa Lazarević 2021).

Al Tahrir Square, the case of this study, is one of Baghdad's more critical practical squares and memorial places. It suffers neglect in social life, placing meaning and making arrangements for cars, separated from the Genius loci. Regardless of its place values and intentions, it has become a place to pass through. Before 2019, Al-Tahrir Square was merely a movement connecting various city parts. Since Al-Tahrir Square was built in 1953, It has suffered numerous urban challenges, including sporadic markets, street sellers, traffic congestion, and the deterioration of the physical environment. It necessitates a thorough examination of the critical characteristics of this historic urban place, which serves as a repository for urban memory.

The area surrounding Tahrir Square is called the Bab Al-Sharqi. The old city center of Baghdad, Bab Al-Sharqi, consists of a well-organized network of streets and lanes. On the east bank of the Tigris is the Al-Rusafa area, often known as the Rasafa zone. Both Al Rusafa and Karkh, located on the western bank of the Tigris River, are accessible by some bridges. The Jumariyah bridge directly connects the Bab Al-Sharqi district to the Karkh district. Changes were made to the site's physical environment and appearance, including alterations to its structure and form connected to its place identity and visual memory. Due to its location in the heart of Baghdad, Bab Al-Sharqi is predominantly a business district. It also attracts both local and international tourists and visitors. In the 1990s, the creation of public spaces, roads, facilities, and transit lines affected the district's image and sense of place. (Hajiyat, Kozlowski, and Abu Bakar 2021). Bab Al-Sharqi is one of the ancient districts of Baghdad on the Rusafa side of central Baghdad. The shape of a tower, a church, was taken after the British occupation of Baghdad in 1917 and demolished in 1937. The Bab Sharqi area is considered one of the most densely populated areas in Baghdad, as it includes

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markets, ancient buildings, mosques, and churches, such as the Armenian Gregor Church, which is one of the most beautiful churches in Baghdad. The Armenian Orthodox It also includes the Freedom Monument, one of the works of the famous Iraqi sculptor Jawad Selim. Bab Al Sharqi is a meeting point and distribution point for transportation and buses coming from and to most of the outskirts of Baghdad (Al-Tameemi, 2019)

Tahrir Square has seen major social, political, and urban upheavals in recent Iraqi history. From 1948 through 2021, various events took place in this location. Al-Tahrir Square is an urban area for freedom, a place where people may gather to protest and demonstrate before the proclamation of the Iraqi Republic in 1958. It also witnessed significant urban and architectural transformations in the history of contemporary Iraqi architecture, combining the political, urban, and social memories of residents of the capital, particularly the Bab al-Sharqi district.

The visual distortion surrounding the Square caused by the spread of slums, street vendors, and Friday markets distorted urban memory due to the distortion of the Square's architectural context, as well as the overlap of many activities, causing the Square to lose its original identity, especially between 1980 and 2003.

Recasting urban memories has left an indelible mark on cities. The ability to reshape people's recollections of places is often overlooked and underrated as valuable to cities. We work to create urban environments that are pleasant, profitable, and human-friendly regularly. (Cheshmehzangi, 2021). Besides, cultural, political, and social events that attempt to refer to the importance of memory in social and political culture have brought numerous conflicts about remembering and forgetting the past. Thus, when historical amnesia appears to be at an all-time high, visualizing alternate futures aids in the valorization of individual and collective memory(Rose-Redwood, Alderman, and Azaryahu 2008a). Recasting urban memories can comprehensively view the past (memory and history) without losing the historical identities of different eras as the principal method of capital restoration in current urban areas and an interventionist strategy. As a result, a new identity emerges in line with people's present living conditions (Hwang, 2014). Given the historic nature of Al Tahrir Square, recasting urban memories can aid in the si te's rehabilitation by strengthening the identity of such historical sites to build a sense of belonging to the city, foster social unity, and boost people's involvement (Uğuz, 2008).

The issue is the lack of a cognitive framework for the impact of political and social events on Recasting the urban memory of the city's public spaces. This study looks at how urban memory is recast based on the types of events in urban space. In particular, the political and protest events that reimagined the mental image of Al Tahrir Square, which caused us to build a new urban memory for the place and history, led to an impact on the physical environs. Based on prior studies on collective memory, this paper explicitly explores urban memory, not just a mental image but also a recent human creation, such as gathering places, spaces, and monuments. It allows people to feel more connected to their surroundings. Even a specific idea's view of urban space can have a significant impact. Depending on the features and events of the city, urban memory recasting can be developed or done. It improves and enriches a city's urban quality. Although planning and architectural aspects are essential in an urban setting, events are also important. As a result, a location's landmarks influence how it is seen and remembered.

To achieve this goal, adopting distinct community experiences for many types of users' residents, visitors, and protesters in urban space, the study explores the features of urban memory in a metropolitan area at Al-Tahrir Square. The process of forming a mental image of a specific urban memory.

This paper studies a new understanding of collective memory for Al-Tahrir Square landmarks. We interviewed three sorts of people from Al-Tahrir Square, the first type of residents, the second type of visitors, and the third type of protesters. We documented their shifting knowledge of urban memory in this study, primarily through qualitative research. This research looks at how people define and interpret the recasting memory of the place and what aspects of the area compel them to recall the past and associated memories.

This approach allows the researcher to shed light on urban features that enable memory visualization in spaces with accumulated events. That creates a shift in the perception of place, activities, values, and relationships with each other and allows for objective analyses of the personal stories and narratives of the community using Tahrir Square.

2. RECASTING URBAN MEMORIES

In Greek mythology, Clio is the muse of history. Memory and history are considered synonymous, but nowadays, the research finds them as fundamentally opposite. The name Clio derives from the Greek verb kleo (Greek: "recount," "narrate," and "make famous"(Ringas, Christopoulou, and Stefanidakis 2011).

Through numerous events, the objective of recasting memory is to re-understand the built environment around public space. Collective awareness is affected by time, place, nature of use, and events that occupy urban space, generating a new collective perception(Othman, Nishimura, and Kubota 2013). The event is the primary generator of urban space memory. It is linked to the type of event, such as a political, sporting, or economic event, allowing us to connect urban memory to urban space(Lak and Hakimian 2019). The work of Bergson offers critical insights into how this division occurred and a sense of temporality that may lose in spatial metaphors, argue the researchers. They suggest a sense of time-space as both fragmented and dynamic; a sense of instability and displacement in collective memory(Crang and Travlou 2001).

Public areas in cities provide a diverse range of experiences and opportunities for action. The event is a significant yet largely overlooked component of people's urban experiences. The research

examines what happens in Al-Tahrir Square and how people use public places. It demonstrates the possibilities of public areas(Stevens, 2007). For that, the observer's relationship with the city and the aspects of the environment influence the city's imaginability and the ability to create a strong image(Ringas et al. 2011). These events play a significant role in the construction of urban memory. As more of these images are created, the city's imaginability diminishes. While the current environment shapes public space, the event aids the city's imaginability with elements rememberable on urban and architectural scales(Postalci, 2001).

Many theories attempt to define identity. Some of those linked to place-identity are the following:

The first theory (Place-Identity): Proshansky and Fabian divide how people see their environment into two groups. The first group is about feelings, values, memories, and settings. The second is how these places (home, school, neighborhood, etc.) are connected. This theory says that the way people see a place is affected by how they see it. (Proshansky and Fabian, 1987). The second theory is that a place is often associated with a particular group of people, a certain lifestyle, and social status. This can be shown in many regions with specific dominant characteristics, such as the Islamic character of the Middle Eastern countries. The Social-Identity Theory posits that individuals can be affected by the general traits of their group. (Harwood 2020).

As Lappegard (2007) described, the third theory is the identity process theory, a dynamic, social product of the interaction of memory, consciousness, and organized construal. This comes along with Correa's (1983) definition of identity, as he says, "Identity is a process and not a found object." This theory combines the ideas of a place's identity as a process implicit in people's perceptions (memory, consciousness, etc.) of the place. (Grey and O'Toole, 2018).

In this regard, Individual or collective memory is possible. The recollections of our particular or personal experiences of spaces shape our memory-images of space. A series of experiences collectively remembered by a group of people who share it and participate in molding it is known as collective memory. The more people recall the event, the more the memory takes on a collective quality(Rose-Redwood, Alderman, and Azaryahu 2008b).

In addition to scientifically assessing urban morphology, urban direction, and its changes and trends, the spatial-temporal dimension of urban design can also reveal the long-term consequences of the economy and urban planning on urban morphology(Cai et al. 2007). This analysis provides the foundation for capturing large-scale collective activities and expanding our perception of urban structure from the spatial to the spatial-temporal dimension. It will be helpful for planners to understand how individuals utilize time and interact with urban space in metropolitan areas. (Jiang, Ferreira, and Gonzalez 2012) For all that, the recasting of urban memory takes place over a brief time. For the first time, the residents of urban space will be orientated by political events, social events, and urban memories rather than by the built environment, which does not have any memories or images from the past. Three factors may influence one's recasting urban memory and perception of the environment, as shown in Figure 1.

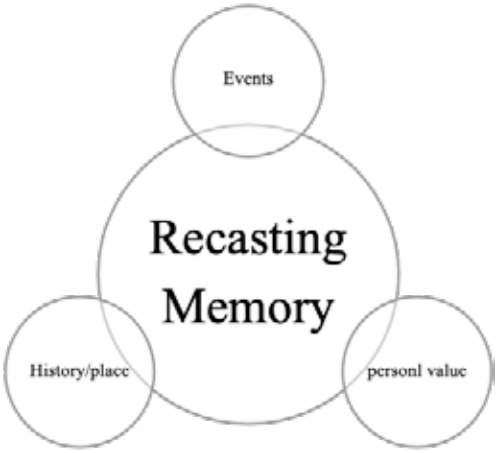

Figure 1: *Framework Source: The*

3. MATERIAL

3.1 Al-Tahrir Square History

Al-Tahrir Square is one of the most important squares in Baghdad, Iraq's capital. In 1953, it was located in the Bab al-Sharqi neighborhood. On the east side, the Freedom Monument is opposite the east side, and the fence on the right side has changed. The King Faisal II Bridge is rebuilding on the right side. Ummah Park sits on the eastern side of Al-Jumhuriya Street, once known as King Ghazi Street, and runs parallel to Al-Rasheed Street. There is a former Turkish restaurant building and several libraries in the Square, notably the Al-Nahda Library.

Al-Tahrir Square is considered one of the largest squares in Baghdad on the side of Rusafa and is located in the main center of modern Baghdad (see Figure 2). It is also called Bab al-Sharqi or Bab al-Sharji in the local dialect, about one of the old Baghdad gates called (Kalwadhi Gate) or (Bab al-Basaliyah) or (Bab al-Khaleej) and mentioned on the map drawn by Felix Jones and Mr. Collinkwood in 1854 AD(Ahmed. Sousa 1953).

Figure 2: *The map drawn by Felix Jones and Mr. Collinkwood in 1854 AD Source: (Ahmed. Sousa 1953) p.15*

The entrance to Al-Khayyam Street comes from Al-Saadoun Street. Al-Tahrir Square is remarkable by its location, close to Abi Nawas Street, famous for night-lovers, where modern cafes are spread, including red, yellow, green, and blue. These names are because neon lights distinguish them from others, and there was the famous Al-Baghdadi Cafe. Al-Tahrir Square is significant for its location. It is the intersection of Al-Saadoun Street, Al-Gomhouria Street, Al-Khayyam Street, Al-Rasheed Street, and Al-Bab Al-Sharqi Street, which is one of the most important streets in terms of tourism, entertainment, and commercial crowded with visitors, pedestrians, cars, and beautifully unforgettable meetings, as well as the spread of restaurants and cafes scattered throughout the city(Al-Chalabi, 2016).

A bazaar in Tahrir Square offers rare coins and small, rare antiquities that are not on show. The seller uses his intuition to determine the genuine buyer, as he knows their past value. Their pricing was low compared to their actual value, which is incalculable. Roman, Umayyad, Abbasid, and Ottoman coins are the most well-known items they deal with. There is a big market for selling military uniforms and all accouterments, such as head coverings, bands, military shoes, ranks, decorations, and anything else that comes to mind, and the market is displaying to this day even foreign military attire.

The history of Al-Tahrir Square is convoluted. In the 1950s, it served as a parking lot, but in 1961, it transformed into the Freedom Monument. These moves established Al-Tahrir Square as a symbol of the Iraqi people's fight and triumph, establishing it as a symbol of a new liberation era. The central location of Al-Tahrir Square in Baghdad caused has consistently been chosen as a protest venue, especially when it was the center point for social meetings. The Square has a long history of political demonstrations and has become a symbol of liberation, as reflected by the Freedom Monument, and is accessible from both Al-Karkh and Al-Rusafa, Baghdad's two sides, via motorways and bridges that decrease the distance(Al-Tameemi, 2019).

3.2 Landmarks surrounding Al-Tahrir Square

Al-Tahrir Square is surrounded by many landmarks with architectural and urban characteristics, as shown in figure 3. That significantly impacted the alteration and development of the area's urban memory. Al-Tahrir Square is surrounded by many landmarks with architectural and urban characteristics, as shown in figure 3. That significantly impacted the alteration and development of the area's urban memory. The impact has two main parts; The first part is at the level of the physical urban environment through the accumulation of urban additions over multiple periods, such as the Marjan Building, the Al-Khayyam building, and the Freedom Monument. They were in changing periods, which affected urban memory. The second part is related to the change in the designations of the urban landmarks surrounding the Square due to the political and social events that turned into multiple symbols that recasting the collective urban memory of Al-Tahrir Square, as described by Chalabi in his encyclopedia. (Al-Chalabi 2016)

It can the following essential features can describe based on its historical appearance:

- Ummah Park, with its founding year of 1936 and completion year of 1953. Figure 4.
- Architect Muhammad Jaafar Allawi designed the Marjan Building in 1941. Figure 5.
- In 1961, the Freedom Monument Baghdad's most important memorial. Figure 6.
- In the 1970s, the Al-Khayyam building.
- The Turkish restaurant building towards the end of the 1970s and the beginning of the 1980s. Figure 7.

Because of the mental images associated with events, especially political ones, from 1961 to the present, these landmarks represented a significant recasting of urban memory at different times.

Perhaps the most prominent of these signs is the Freedom Monument, which was created to express the people's interaction with political events and their struggle during the ownership period. This monument continues to carry the symbols of the urban memory of the Square so far, in addition to its artistic value because it was created by one of the greatest Iraqi sculptors, Jawad Selim. The idea was a protest banner raised on concrete supports, embodying the architect who designed this banner, Professor Rifa'a Chadirji, an idea rooted in the memory of the Square that carried Jawad Selim's sculptures, and both the gesture and the sculptures became the basis of the memory surrounding the Square, being the first protest square in the capital, Baghdad.

4. METHOD

This study used a qualitative method to examine the perspectives of participants and users of urban space (Tahrir Square) and its surroundings to understand better the dimensions of the idea of recasting urban memory at ages ranging from 18 to 75 years. According to the information gathered during the research process in the previous literature, the general geopolitical situation, particularly at the level of political events, and the resulting changes in urban space concepts and the production of new indicators for Al-Tahrir Square and the area surrounding it.

The research methodology is based on the interviews which were recorded. Their content was transcribed into written form, re-read, and categorized according to the background generated by the participants, which included three classifications. The first classification includes residents, visitors (general users), and protesters; the second classification includes the age group of the participants; and the third classification includes the scientific and

cultural background of the participants. They arrived at relevant concepts in the arena (public places) that helped build a theoretical model to reformulate urban memory according to their answers through analyzing and exploring information using Excel and Word. It took about three months of analyzing and reviewing the data to come up with the final results of this data.

The events of 2019 formed Al-Tahrir Square symbol of its launch, and the protesters' expression of their demands, as well as the considerable social repercussions, it is a continuous event in the transformation of society's memory and a different narrative between generations in the process of recasting the urban memory.

The requirement to comprehend mental image alterations and recasting urban memory. The end product was a set of questions for the interview:

1. What does Tahrir Square represent?
2. From the surroundings of the Square, what is the most influential of the surrounding landmarks
   A. Freedom Monument
   B. Murjan Building
   C. Turkish restaurant building
   D. Ummah park.

Figure 3: *Al-Tahrir square, Source: ArcGIS Earth1.3 map*

Figure 4: *Ummah Park*

Figure 5: *Marjan Building1941-2022, Source: Encyclopedia of Iraqi Architecture*

Figure 6. *the Freedom Monument 1961-2022, Source: Encyclopedia of Iraqi Architecture*

Figure 7: *The Turkish restaurant1970 -2022 , Source: google image*

3. What was the most significant transformation in Al-Tahrir Square in 1961, 2003, or 2019?
4. When you arrive at Tahrir Square, what memories are recalled in your mind?
5. What are the most indicative symbols of Tahrir Square?

Residents and visitors in the Al-Tahrir Square urban space and the protesters and general users participated in the study. They ranged in age from 18 to 75 years old and would choose through random sampling. Interviews have been done under the Freedom memorial and area surrounding Al-Tahrir Square; the stay in the Square is approximately 4 hours per day between 10 am and 2 pm. All attendees participated in cultural and recreational events in the Al-Tahrir Square urban environment. Face-to-face in-depth interviews with the participants, with the questions above asked. They were asked to explain their memories of the Square (past and present). As Morse explains, 40 people were surveyed for information, which was chosen using simple random sampling when qualitative research aims to comprehend the essence of an experience (Morse 1994)I begin with the starge of reflection, in which the project is merely a good idea, and proceed to the stage of planning (including writing the proposal.

Table 1: Characteristics of interviewees (Authors).

Age	residents	protesters	general users	percentage
18 - 25	0	3	2	12.5%
25 - 35	0	10	5	37.5%
35 - 45	2	5	3	25%
45 - 55	4	0	1	12.5%
55 - 75	3	0	2	12.5%

The total number of participants: 40 people.

All the data was collected in the winter and spring of 2021. Table 1 summarizes the characteristics of the participants. Each respondent completed all open-ended and semi-structured questions; each interview lasted 30–40 minutes and focused on people's backgrounds, memories of the place, how they remember Al-Tahrir Square's past and present, their experiences as users of the space, and their perspectives on the meaning and memory of the urban space and Square.

All interviewees were asked if they agreed to record and transcribe the interview. They were also provided with a signed, informed permission document to ensure they would not be recognized again.

To analyze the data, a qualitative content analysis was performed. The significance of essential concepts and themes was handled after reading the interview transcripts numerous times and noting phrases and concepts. Researchers first jotted down their findings to identify broad thematic variables and separate meaning segments for coding purposes.

Finally, researchers used "prolonged engagement" between the researcher and the participants in order for the former to gain an adequate understanding of the organization and to establish a trusting relationship between the parties through the exchange of contact information and clear messages (Sozialforschung/Forum and Undefined 2001).

5. FINDINGS

Table 2 summarize the results from the 40 participants. The participants in the research interviews in Al-Tahrir Square revealed various features of collective memory, particularly at the level of transformations in understanding the mental image of Tahrir Square over time. The research identified the main categories related to the proposed concepts for recasting urban memory through several approaches based on these responses.

- The first way is the nature of urban space/events/personal values.
- The second way is to understand the overlap between previous urban memory (experience memory) and current urban memory (event memory) before switching to recasting urban memory.
- The third way refers to physical urban features such as the nature of use for events in the Al-Tahrir Square urban space, the age of buildings and architectural styles, accessibility, and road network.
- The fourth way is the change in symbolic connotations in Al-Tahrir Square because of its impact on the participants' understanding of the nature of memory related to the Square and its features.

5.1 Tahrir Square's spatial memory

As shown in Figure 8, The physical environment of Al-Tahrir Square and the events are the most important things for the research participants. The urban memory of the place is through the landmarks, buildings, and streets surrounding the urban space. In addition to the Al-Tahrir Square tunnel, which was associated with the memories of

the eighties and nineties generation (participants aged 40-55), it was a marketplace and promenade spot for this generation.

The participants, aged 18-35, most protesters, described the Tahrir Square tunnel as becoming a landmark and an artistic monument for the protests and an art museum for the drawings of young protesters in 2019 and called it the Homeland Art Tunnel, as shown in Figure 9.

For all participants of various generations and users, the Freedom Monument had absolute mental power. It is the emblem of the Square, the capital, and Iraq in general. It is a memorial dedicated to the memory of free generations.

The participants indicate that the Freedom Monument and the extension of the Uammh park to the Al-Tahrir square provide a kind of mental storage and timeline for the urban memory of the Iraqi architectural context. The Uammh park's buildings include the Al-Tyran Square, the Armenian Church, the Marjan building, the Kayam building to the Freedom Monument, and the Turkish restaurant building opposite the Square. With the transformations of the architectural context and the change of nomenclature associated with the events, such as changing the name of King Ghazi Park to Uammh Park in 1958, and the King Ghazi Bridge to the Jumhuriya Bridge, in addition to the transfer of the statue of the former Prime Minister of Iraq, Abdul Mohsen Al-Saadoun, from Nation Park to Victory Square in Baghdad. It was rooted in the participants' memories from the old ages (55-75) and long memories of all the arena's events.

The participants, primarily (18-75) from different groups, indicate the size of transformation of the concept of the Square for them and its impact on their mental image after the recent protests. Perhaps the most prominent landmark is the building of the Turkish restaurant, which was a giant barrier in the urban area, according to their description, into a flame of memories.

Table 2: Summary of Results from the Interview (Authors)

The number of participants per 40	Motives	Keywords	Subthemes	Thema
mentioned by 26	Physical urban features include the nature of use for events in the Al-Tahrir Square urban space, the age of buildings and architectural styles, accessibility, and road network.	-Tahrir Square's spatial memory -Turkish restaurant building -Freedom Monument -Ummah park.	-Landmark meaning -Street names -Building's indication	Place
mentioned by 40	Understand the overlap between previous urban memory (experience memory) and current urban memory (event memory) before switching to recasting urban memory	Tahrir Square's efficacy and memory of events	-Political - Social -Cultural -Art	Events
mentioned by 18	The change in symbolic connotations in Al-Tahrir Square because of its impact on the participant's understanding of the memory nature related to the Square and its features.	History in the Square	Urban experience -National celebrations -Landmark build-up	History
mentioned by 32	The nature of urban space/events/personal values	Individual values and the value of memories	-Cultural qualifications -Experience memory	Individual values
			-Resident -Visitors -Protesting	User activity

The protests and a monument comparable to the Freedom Monument to Jawad Salim, especially with the change of its name to (Mount Uhud) as shown in figure 11, were an indication of the steadfastness of the protesters. It was the most significant sign for them, especially after the government's recent decision to turn it into a museum called the October Revolution Museum 2019, which is under design and final approval for transforming the building to suit the event.

Figure 8: *The physical environment of Al Tahrir Square1961-2022 Source: Google image*

A quote talk from a 71-year-old participant. “The Square represented the days of the monarchy and the beginning of the Republic when I was a child, and I still remember those days of the Iran war. It was a place we met before heading to our military units. Now it has changed and has become more and more crowded. It has become a center for demonstrations and gatherings for different generations. However, I still visit the Square, visit a traditional coffee shop see the Freedom Monument, the days of the Republic, and the monument’s opening in the sixties. However, it is neglected now! The Turkish restaurant used to be a restaurant overlooking all of Baghdad at its height. Since 2003, we have been turning into a neglected place; now, it symbolizes the people’s strength and demands for their rights”. but A quote from a 19-year-old participant, “The Square represents the place of protest and the place of expressing the people’s will. I see the Turkish restaurant building as the most important (Mount Uhud) because it symbolized the demonstrations in 2019, and I still remember them as an act of social participation and meeting new friends. It is not only a place to regulate traffic”.That shows the difference in urban memory between the two generations.

Figure 9: *Al-Tahrir Square Tunnel, Source: Taken by the authors*

Figure 10: *The physical environment of Al-Tahrir Square (Jummhuria street) , Source: Taken by the authors*

5.2 Tahrir Square’s efficacy and memory of events

Interviews with residents, shop owners, visitors, and protesters in Al-Tahrir Square and its surroundings showed that commercial activities contradict the events of the recent protests, as sellers or residents preferred that the protests take place on certain days of the week, such as Friday, which is the holiday of most shops in the urban area. The participants agreed that the government measures accompanying the protests, such as blocking roads and others, had a significant impact on the ease of access to the area and the movement of goods and customers simultaneously. One of the participants indicated that he comes to the electronics market adjacent to Tahrir Square every time he faces difficulty accessing it due to the political and protest events in the Square and cutting off most of the access roads to the market.

Some participants said that cultural and artistic events related to political events have significantly flourished, especially among the protesting youth group and some Iraqi intellectuals who go to the

arena to create a state of sustainability for the event, as described by one of the participants. Especially in the Ummah Park, its establishment has hosted many cultural and social activities, with many artworks, most notably the monument to motherhood by the great Iraqi artist Muhammad Ghani Hikmat. The events of the first protests in 2014.

5.3 History in the Square

Almost all the participants in the meetings considered that Tahrir Square is a witness to the contemporary history of Iraq. It is associated with the extension of political life in the modern Iraqi state and its transformations in the monarchy. A quote talk from a 38-year-old participant "A square is a place I visit every Friday for shopping and to teach my children about the meaning of the Freedom Monument to make them feel their patriotism. I see the Freedom Monument as a symbol for all of Baghdad and Iraq, not just for Tahrir Square". It witnessed the royal era through the designations surrounding the urban arena, such as King Ghazi Park and King Ghazi Bridge, the establishment of the Republic in 1958, and the transformation of urban labels into the Ummah Park and the Jumhuriya Bridge. The accompanying transformation in the participants' memories and the mental image's nature to the establishment of the Iraqi Republic in 1958.

In 1963, 1968, and 2003, Al-Tahrir Square witnessed political coups and the regime's demise. All of these historical events were mentioned by the participants. However, they all agreed that the most painful historical era was the period following 2003, when urban space and surrounding markets were subjected to numerous terrorist acts and bombings, killing many shop owners, residents, and visitors to urban space. Finally, the participants agreed that the restoration of the Square's position represents a historical turning point because it was the start of the demonstrations that resulted in a significant contemporary historical event that is rememberable.

5.4 Individual values and the value of memories

Given the social and demographic status of the participants, the views of the different groups differed. Participants with higher education, especially younger men from 18-45, believed that the Square was an emblem of freedom and a symbol of democracy or a place of bloodshed for freedom. A quote from a 27-year-old participant "I am a protester. I want to find a job, this Square is my life, and I will come every day until they hear my voice".

At the same time, others considered Al-Tahrir Square a suitable space for daily needs and shopping, especially for the older age group between 55-75. Others also referred to selling different products and considered Al-Tahrir Square the middle gathering of different markets.

6. DISCUSSION AND CONCLUSION

This study explores the features contributing to the recasting of urban memory to help urban renewal policies in Al-Tahrir Square. The study indicates that events are the main engine for expressing the place's values, activities, events, and personal values. The study Expression of urban memory places a multi-way through the memory of the experience, the memory of the event (effectiveness).

The study is based on the experience of urban space users and identified the most critical factors influencing the formation and recasting of collective memory through the overlap of experience and events in the expression of subjective and objective aspects.

The results show that factors such as the event and place referred to the objective aspect, and the activity's history and nature referred to the subjective aspect. Those are very important in recasting the urban memory of urban space. The concept of transformation can also confirm as an essential part of recasting memory and cultural and social transformation.

The paper showed that one of the most important mechanisms for recasting urban memory is the event and the making event. Change is the main feature in generating transformations and creating collective memories. However, this event must be within a specific environment full of connotations through urban landmarks such as historical architectural elements and the architectural context surrounding the event-generating environment and access roads within the master planning of urban space and the city.

The changing of names for architectural and urban elements within the study area and the shift's ineffectiveness within the different buildings resulted from the change of the events. The participants also pointed out that they considered some elements, such as the building of the Turkish restaurant (Mount Uhud now), to be the essential element in the place, and the Freedom Monument was considered an objective and subjective value for the participants.

This research has revealed that urban values exist. They are the primary collective memory connotations in recasting urban memory by recasting the mental and conceptual images due to the nature of the events and transformations through the spatial-temporal history of urban space.

To generate for us a collective memory of the image of urban landmarks. This memory is considered the key to the development and urban renewal of the area around Al-Tahrir Square. The participants believe that another feature contributing to the reformulation and continuity of the urban memory of Tahrir Square is the identity of freedom and the fight against corruption, which the Square carries and its connection to urban stories, narratives, and events since the establishment of Tahrir Square till now. The collective awareness of Baghdadi and the Iraqi citizens, in general, is established that Tahrir Square is linked to a set of concepts such as justice, fighting corruption, and protest, which is the people's space, and their voices increase the decline of values.

The physical and spatial dimensions carry direct connotations, especially in the Freedom Monument at the history level. The Uhud Mountain building has now joined it through the event in 2019. The power of feelings belonging to all citizens in the capital because

it became stuck in their urban memory as a gathering place. Their connection to the images of the event from the stories and events within Tahrir Square.

Second: The vital issue in the minds of people in history. The important historical events that Tahrir Square went through and the social and political transformations found their way into the users' minds and became entrenched in their urban and visual memories. Al-Tahrir Square has witnessed many celebrations, national holidays, and various political events reviewed in the study. The qualitative study and the meetings with people showed that the collective memory is directly related to the contemporary history of Iraq and the revolutions and political protests that the Square witnessed.

Next, according to the events and activities, the results define the concept of recasting urban memory between the two ends of the memory. By recasting a dynamic memory of the events,

variable in significance according to the generation of the participants, a collective memory establishes the story of the Al-Tahrir square. The urban space is the scene of events, social, political, and commercial events. Moreover, Al-Tahrir Square has become the primary urban space focus within the city.

This strengthened new values for Tahrir Square, including increased social and cultural activities and a protest center for everyone with a political or social issue. The Square has become the primary communication between the people and the government. All of this has increased the value of the urban focus of Al-Tahrir Square and its role in transformations in our understanding of the spatial environment through recasting urban memory and recasting the semantics of urban and architectural elements through experimental memory and event memory figure 11.

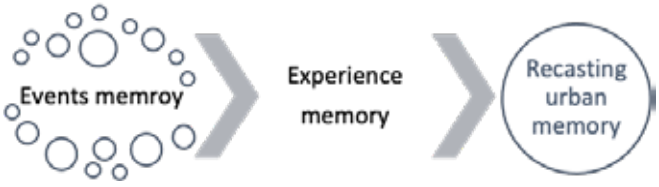

Figure 11: *Process of recasting the urban memory Source: The authors.*

Finally, the study explores other aspects that may affect the formulation of urban memory: subjective value and image memory value, self, and its effect on the collective consciousness. Some consider it an urban value and a highly symbolic significance because of the political event that it embraces from one stage to another, the impact of this event on urban and architectural transformations, and its impact on recasting the urban memory of the community. Others consider it the value of a commercial urban focus because it mediates a group of markets in central Baghdad. In terms of artistic and cultural production, the Freedom Monument and the Motherhood Monument near the Square, various activities, especially painting activities and celebrations in Tahrir Square and the Tahrir Square tunnel.

In short, the practical result of the study is the formation of a theoretical model not only for specialists in urban design but also for the directors of municipalities and service departments in Baghdad and urban planners to enhance urban management through the process of participating in understanding urban memory and recasting it through the process of urban renewal as shown in Figure 12.

This study identifies a practical approach to understanding how recasting urban memory assists urban development and renewal projects by creating its conceptual framework. Therefore, this study gave officials the ability to understand the vision of society in urban transformations by studying urban memory and identifying the most prominent features that help recast it. Through transformations in understanding of urban, architectural symbols in Al-Tahrir Square, urban space surrounding, the transformations of use resulting from recent protests, and the actual value of users, which have accumulated through successive political events since the establishment of the Al-Tahrir square, which regenerates a renewed and effective collective memory in the urban space-making, the recasting of urban and architectural features in the study area.

Recasting urban memory helps to integrate generations by achieving a common ground for understanding the characteristics of collective urban memory. It is possible to recasting urban memory by renovating the architectural facades of the buildings overlooking the urban space of Tahrir Square and even the ways of accessing them, in addition to stimulating the renewed memory by finding mechanisms for naming streets and buildings in line with the events in people's memories.

The identity of the Square is the identity of the young people protesting against corruption and demanding their rights. Therefore, Al-Tahrir square must be an urban space where people can express their concerns and aspirations. It is achieved through the use of urban space. And architectural interaction with new trends in the memories of young people. It determines the mechanisms for recasting urban memory through urban renewal and development policies. Leaving space for them to express their ideas, as happened with the Tahrir Square tunnel, which became an art exhibition documenting the youth protest movement in 2019.

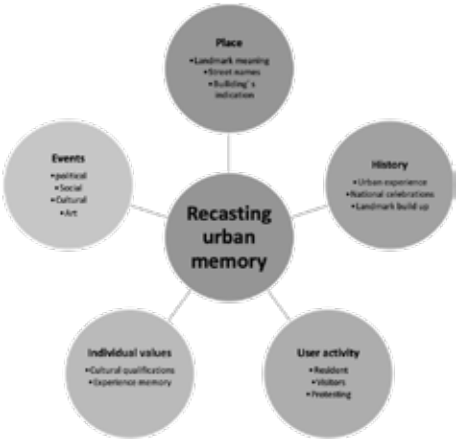

Figure 12: *Theoretical model for recasting urban memory Source: The authors*

The concept of urban recasting in Al-Tahrir Square was linked to an emphasis on the development and renovation of the Turkish restaurant building to suit the changing events in the Square. It was a museum documenting the events of all the protest movements since the establishment of Al-Tahrir square.

The proposed framework is just a starting point for future studies that aim to improve the quality of the place by understanding the mechanisms of recasting urban memory, including in urban renewal and development policies.

Discover other values for different squares, such as Paradise Square, the symbol of the fall of the dictatorship in Iraq in 2003, Al-Wathba Square in central Baghdad, or Other historical squares in any urban renewal and development project.

Adopting citizen participation in urban decision-making since it is their city and their memories, and thus, they are the foundation for every urban renaissance.

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ALAM CIPTA
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THE USE OF BIOMIMICRY IN ARCHITECTURE FOR SUSTAINABLE BUILDING DESIGN: A SYSTEMATIC REVIEW

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ABSTRACT

The environmental problems getting more chronic every day direct academics to design buildings considering the influence of nature. One of the most important methods of sustainable building design is biomimicry. The aim of this article is to examine the studies on the use of biomimicry in architecture, to raise awareness about sustainable building design and to create a guide for future researchers. It has been determined that most of the studies examined are in search of solutions for sustainable building design by examining nature. Studies on biomimicry, especially in architectural education, try to raise awareness to understand its importance in terms of sustainability by including this subject in architectural education instead of examining nature. The combination of simulation technique and field research technique is the most preferred method for the use of biomimicry in sustainable building design. It is thought that this study will be a guide on how to reveal the mysteries of nature for sustainable building design and the criteria that should be emphasized in order to reveal these mysteries. In addition, it is thought that it will create awareness about the use of biomimicry in architecture in sustainable building design.

1. INTRODUCTION

Environmental problems such as depletion of natural resources, global warnings and increase in energy consumption have directed architects and designers to sustainable building. Reduced number of natural resources, environmental problems getting chronic and increased energy consumption direct architects and designers to eco-friendly and sustainable building. The main purpose of sustainable building is to reduce the negative impact of people on the natural environment. Buildings that are not designed according to the climate and topography criteria of their location consume high levels of energy to provide indoor comfort (Eray & Kutlu, 2021). Brownell and Swackhamer (2015) suggest that one of the most important design practices designers as well as architects and scientists who observe nature should prefer is biomimicry. The main purpose of the use of biomimicry in architecture is to design a building inspired by the adaptations of organisms or systems in nature to their environment (Ergün & Aykal, 2022; Sheikh & Asghar, 2019).

The concept of biomimicry was introduced by Otto Herbert Schmitt, a biophysicist and engineer, during 1950s but it was developed by Benyus (Vincent et al., 2006). Biomimicry consists of the Latin terms “bios” and “mimicos”. Biomimetic or biomimicry (the term “biomimicry” will be used in this study) observes the nature and gets influences by it to solve people’s problems. Tavsan, Tavsan, and Sonmez (2015) briefly defined biomimicry as the innovation influenced by nature, which suggests that biomimicry is an extensive reflection of nature.

Engin et al., (2020) stated that nature has taken on an inspiring role in design fields from the past to the present. Designing buildings inspired by nature has been going on since ancient times. However, the reflections of nature have been in different dimensions in the modern and ancient periods. It was limited with the dimensions or shape of a natural form in ancient buildings (Ramzy, 2015). Exploration of pillars resembling to palm tree or displaying lily pad motives in ancient Egypt proves the aforenoted result.

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One of the most important reasons for using biomimicry in contemporary architecture is to design sustainable buildings. Inspired by systems and processes based on biology in contemporary architecture and used in building designs (Benyus, 1997; Zari, 2007). Benyus (1997) evaluated the use of biomimicry in building design in three stages, from shallow (limited scope) to deep (extensive scope), according to the level of inspiration from nature (Figure 1).

***Figure 1**: Stages of using nature in architecture*

Organism level is the use of the traits of any plant, animal or organism during the process of creating building form, being the basic stage of imitating nature. Behavioral level is the imitation of a creature's methods of adapting to the nature within the building design. Ecosystem level is the level of imitating more than one condition required for a creature for the ecosystem it is present in, and it is the most extensive level of imitating nature (Ahmar 2011). There are five potential dimensions for each level of natural influence. A sample was formed for the organism level in Table 1 about the form of determining these dimensions (Zari, 2007).

***Table 1:** Definition and samples of five potential dimensions regarding the imitation within the organism level*

Dimensions of imitation within the building	Definition	Example
Form	What does it look like?	Building form appears like a turtle.
Material	Which material was used for the construction?	Construction of the building with a material imitating the skin of a termite
Structure=-facade	How was it constructed?	The building skeleton was formed in the same manner of human skeleton.
Process	How does it work?	The building generates O2 using the methods a plant performs to generate the same.
Function	What can it do?	The building acts like a termite, generating soil by recycling cellulose waste.

The basis of biomimicry is to be inspired by organisms or processes in nature. However, the features to be inspired are sometimes hidden. The way in which these mysteries are uncovered and used for sustainable building design differs among researchers (Benyus, 1997; Chayaamor-Heil & Hannachi-Belkadi, 2017).

Hershcovich et al., (2021) analyzed the tissues of organisms such as sponge and cacti in a computer environment. Later, inspired by these textures, he proposed a building envelope that would reduce building energy consumption. Xing et al., (2018)analyzed plant cell walls and building envelope comparatively in their study. Revealing the mystery in the design principles of plant cell walls, he made a suggestion for the application of the building envelope. Mandeel et al., (2021) made a building design proposal for a hot and dry climate by analyzing the external form and working mechanism of the Bottlebrush plant. These example can be increased (Table 4).

The aim of this paper is to systematically review the use of biomimicry in academia, to draw conclusions from them, to make suggestions in this context and to raise awareness about the sustainable building design of biomimicry in architecture. Accordingly, two significant outputs were aimed:

- to perform assessment and collection by facilitating the access to the data such as purpose, methods and biomimicry dimension within the academic studies on biomimicry;
- to form a guide about the researchers working in this field.

Uchiyama, Blanco, and Kohsaka (2020) aimed in their study to compare biomimicry models in urban and architectural design even if they reviewed the literature on biomimicry in a systematic manner. Therefore, they conducted a basic process of grouping without detailing architectural studies (Table 4).

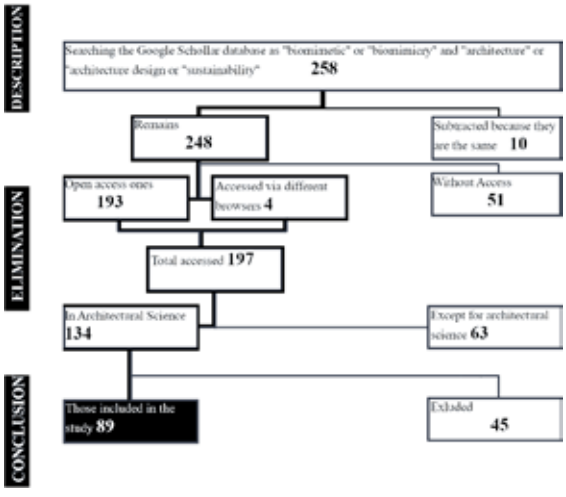
2. METHOD

To provide an overview of the current research, a systematic literature search was first conducted using the following research terms and combining them with Boolean operators (AND and OR): biomimetic*, biomimicry*, architecture*, architecture design*, and sustainability*. The method of using available information was used as an archive research method. During the data collection phase, "Google Scholar" was utilized as the main database, and "ResearchGate", "Academia" and "Mendeley" were also utilized. Although it was not possible to determine all current and newly published data, keywords were used to perform scanning between 18 February - 22 May 2021 to minimize skipping data. The main reason for choosing these databases is to reach as much data as possible without being dependent on any indexing. While the work done in the field of biomimicry in architecture was already limited, limiting it to indexing would greatly reduce the number of data to be included in the study.

During the initial scanning on Google Scholar, a total of 4950 results were found using the keywords "biomimetic" or "biomimicry" in all languages.

To reach the most accurate and comprehensive results about the use of biomimicry in the field of architecture from this wide scope, a limitation has been made in this framework. Although there was no resource and time limitation in the review, only English was reviewed to make the study universal. In addition, keywords only for determining the works in the field of architecture; review was done as "biomimetic" or "biomimicry" and "architecture" or "architecture design" or "sustainability". The filtering of the studies determined in line with the determined framework was done as seen in Table 2.

***Table 2**: Process of scanning academic studies (Cited from Halaç & Ergün, 2020)*



In the first step, which is shown as the "definition" stage, the first filtering was made depending on the keyword and language selection, and a total of 258 studies were determined.

The identified 258 studies were subjected to 4-stage filtering in the screening section. These filters are sequentially;

- detected more than once in different searches,
- that were close to access,
- that were out of the scope of architecture,
- applied in architecture as those not related to biomimicry (Table 2).

Ten out of 258 academic studies found during the literature review had the same content but appeared differently; therefore, one of them was excluded from the scope. Among remaining 248 studies, 51 were close to access. Studies that could not be accessed were excluded. 63 of these studies were not included in the scope of the study because they were related to branches of science such as engineering and biology. 45 of the remaining 134 academic studies were not included in the scope of the study because they were outside the field of biomimicry in architecture. Consequently, 89 studies were included.

The remaining 89 studies' details regarding "authors' names", "studies' type", "year of publication", "the biomimicry subject reviewed in the relevant study", and "purpose and methods" were obtained from every found study.

Data analysis was performed in two steps. In the first step, analysis of descriptive statistics was performed as "year of publication", "country of preparing the publication" and "data type". In the second step, the data were grouped according to the 5 dimensions of biomimicry determined by Zari (2007). As noted in Table 1, these dimensions are "form", "material", "process", "structure" and "function". Some data are gathered under the general heading of biomimicry because it covers more than one field. Data related to the use of biomimicry in architectural education were analyzed under the title of biomimicry in architectural education. The main reason for the separation of this group is that although it is not within the scope of the dimensions of biomimicry in architecture. It is related to the main purpose of this study. The research of biomimicry within the scope of architectural education will contribute to the awareness of students in this regard and to use it in building designs. After all the analysis, necessary lessons were learned and suggestions were made in this field (Table 4 - 5).

3. RESULTS AND EVALUATION

This section was examined under two sub-headings as "descriptive statistics" and "literature-based data analysis and assessment". The section "descriptive statistics" presented the general numerical descriptions and assessments regarding the data included in the scope. The section "literature-based data analysis and assessment" presented the detailed review of 89 architectural studies.

3.1. Descriptive Statistics

Results indicated that the studies in the present research were conducted by the academics in 33 different countries, and only one study was conducted in 18 of these countries. The distribution of studies per countries (n=16) indicate that the highest number of studies were conducted by the academics in Egypt (18%) working in eight different universities (Figure 2).

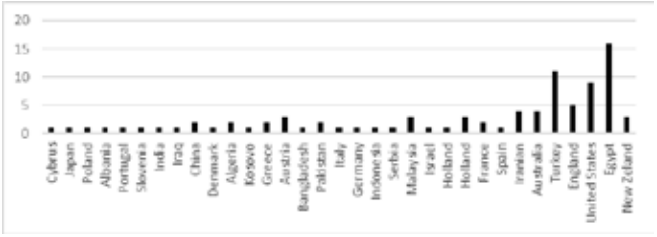


Figure 2: *Distribution of studies per countries*

In addition to Egypt; Iran and Malaysia, two Asian countries, had three (4.5%) and four (3.4%) studies, respectively. Furthermore, relevant studies were also found from the European countries such as Turkey (12.4%) and England (5.6%) and countries from Northern America such as USA (0.1%) and Canada (3.4%), suggesting that different architectural studies on mimicry were conducted in different parts of the world but few academics from a limited number of countries have focused on this topic.

Figure 3: *Distribution of studies per continents*

The fact that such studies have been carried out in countries with the highest energy consumption in Europe, Asia and North America may suggest that researchers in these countries are looking for building design methods that can reduce energy consumption (Akova, 2003).

According to research based on the Google scholar database, the first study on biomimicry in architecture was conducted in the USA in 1997 (Benyus, 1997). No relevant study that was conducted in ten years after 1997 was found, and three studies conducted between 2007 and 2010 were performed by Pedersen Zari (Zari, 2007, 2010; Zari & Storey, 2007). Other than them, the only study conducted in 2009 was performed in USA by Carro (2009), which suggests that biomimicry was studied by different academics from different regions after 2010. Year-based distribution graph suggests that the number of relevant studies increases particularly after 2011, supporting the aforenoted point. Analyses indicate that these studies were conducted the most in 2019 (%19.1). Considering these results, it is safe to state that biomimicry-related architectural studies have been increasing rapidly in recent years (Figure 4).

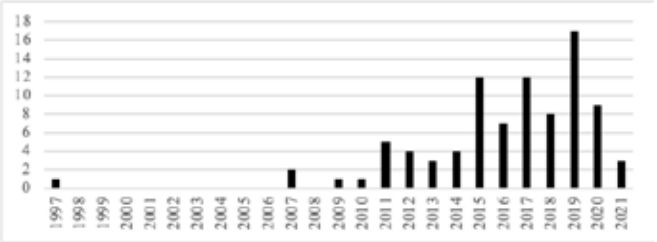


Figure 4: *Distribution of studies per years*

Nguyen et al. (2019) note that the use of local architecture in sustainability has been increasing since 2007. Comparison between the results of these two studies indicates that architects have been searching for different methods for sustainable building in recent years. It is clear that one of these methods is to be inspired by nature.

Most of the included studies were in the type of articles (44.94%; n=40), followed by full-text reports (34.83%; n=31) (Figure 5).

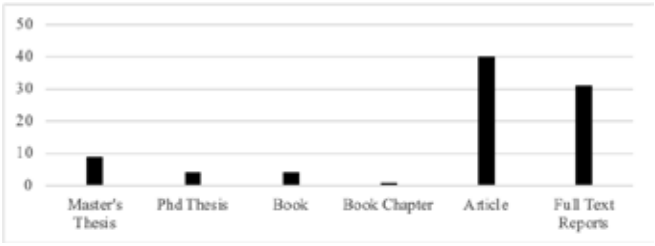


Figure 5: *Distribution of studies per the data type*

Analyses suggest that only two of the full text reports were presented in the same symposium, while the others were presented in separate symposiums. Only three of the articles in this study were published in the same journals. (Table 3). Among the remaining articles, two were from the same journals.

Table 3: *Journals and symposiums with the highest number of studies on biomimicry*

Renewable and Sustainable Energy Reviews	Al-Obaidi et al., 2017; López et al., 2017; Yuan et al., 2017
Architecture Research	Makram, 2019; Nkandu, 2018; M. M. Shahda, 2019
Architectural Science Review	Fecheyr-Lippens & Bhiwapurkar, 2017; Gamage & Hyde, 2012; Zari, 2010
Ecaade 2015: Real Time - Extending the Reach of Computation, Vol 2	Klemmt et al., 2015; S. Yazici, 2015

These results show that there is not enough scientific field about biomimicry in architecture. In addition, these results show that the number of studies and the importance given to biomimicry in architecture is still quite insufficient.

3.2. Literature-Based Data Analysis and Assessment

A total of 89 studies were grouped in two tables based on their scopes and purposes; "biomimicry dimensions" and "general frame of biomimicry" in the same table, and "biomimicry in architectural education" in the other. The section of biomimicry dimensions consists of five different groups: "form", "material", "process", "structure" and "function". These groups were formed based on the dimensions of biomimicry (Table 4 - 5).

Table 4: *Grouping the studies based on biomimicry dimensions: form and material*

Dimension	References	Author Name	Data Type	Objective	Method
FORM	(Mandeel et al., 2021)	Mandeel et al.	Full Text Report	To propose a nature-influenced building form performing minimum energy consumption in Al Basrah, Iraq	Simulation method (Quantitative method)
	(Kudumović et al., 2011)	Kudumović et al.	Full Text Report	To examine how the shell form can be used and modeled in architectural designing	Simulation method (Quantitative method)
	(Agirbas, 2019)	Agirbas	Full Text Report	To propose a ceramic form utilizing the influence of fractals in nature.	Simulation method (Quantitative method)
	(Le, 2020)	Le	Article	To determine the relationship between the fractals in nature and sustainable traditional buildings in Vietnam and to examine the impact of these fractals in the use of sustainable buildings in future	Simulation method (Quantitative method)
	(Colic-Damjanovic & Gadjanski, 2016)	Colic-Damjanovic, Gadjanski	Full Text Report	To explain the design and analyses of the form influenced by the nature while utilizing the digital application technologies of Fablab	Simulation method (Quantitative method)
	(Zulherman et al., 2019)	Zulherman et al.	Full Text Report	To examine facade designs for Lapau Panjang building considering the influence of nature	Field study (Quantitative method)
	(Xhexhi, 2020)	Xhexhi	Article	To explain the use of natural forms in architecture in time.	Historical research method (Qualitative method)
MATERYAL	(Nessim, 2015)	Nessim	Article	To propose a building envelope that is influenced by human skin ensuring heat control and that will reduce the energy consumption without using any electronic or mechanical material.	Simulation method (Quantitative method)
	(Achal et al., 2016)	Achal et al.	Article	To discuss the proposals regarding sustainable construction materials using the biomineralization technology considering the influence of nature.	Field study (Quantitative method)
	(B. Yazici & Gül, 2021)	Yazici & Gül	Article	To present acoustic metamaterial proposals considering the influence of nature.	Simulation method (Quantitative method)
	(Hershcovich et al., 2021)	Hershcovich et al.	Article	To present proposals based on facade coating materials with the influence of organisms' external forms to reduce energy consumption.	Field study and simulation method (Quantitative method)

Table 4: *(Continuation) Grouping the studies based on biomimicry dimensions: process and structure*

Dimension	References	Author	Data Type	Objective	Method
PROCESS	(López et al., 2017)	Lopez et al.	Article	To form a designing guide to adapt the working mechanism of plant leaves to building facades based on climatic characteristics in order to reduce energy consumption.	Field study and simulation method (Quantitative method)
	(Xing et al., 2018)	Xing et al.	Article	To present building envelope design proposals considering the working mechanism of plant cell walls.	Simulation method (Quantitative method)
	(Elghazi et al., 2017)	Elghazi et al.	Full Text Report	To present building facade design proposals considering the working mechanism of systems for the nastic movements.	Simulation method (Quantitative method)
	(Haque, 2019)	Haque	MA Thesis	To present roof system design proposals considering the influence of nature to ensure visual comfort and energy save in multi-purpose rooms	Simulation method (Quantitative method)
	(Nessim, 2016)	Nessim	PHD Thesis	To examine human skin for smart building envelope design that is lively and permeable and to adapt this design to architectural structure.	Experimental research method, field study and simulation method (Quantitative method)
STRUCTURE	(Sheikh & Asghar, 2019)	Sheikh, Asghar	Article	To present biomimetic facade design proposals by utilizing the structural form of oxalis oregano leaves to improve the energy-efficiency of buildings with highly dynamic facades in hot and humid regions	Field study and simulation method (Quantitative method)
	(Al-Sehail, 2017)	Al-Sehail	Article	To determine the impact of master architecture designed considering the structural forms in the nature on vital sustainability.	Field study and observation (Mixed method)
	(Scuderi, 2015)	Scuderi	Article	To present proposals for conducting the rehabilitation of external building skeleton of social houses with the influence of nature in mind.	Field study (Quantitative method)
	(El Fattah, 2015)	El Fattah	MA Thesis	To present proposals for designing the load-bearing facade structure considering the similar function and influence of femur	Simulation method (Quantitative method)
	(Minsolmaz Yeler, 2015)	Minsolmaz Yeler	Article	To perform literature review for the buildings designed while considering the influence of natural organism structure.	Archive research method (Other method)
	(Klemmt et al., 2015)	Klemmt et al.	Full Text Report	To create an algorithm that serves as developing morphologies with architecture and is similar to the veins in leaves.	Experimental research method (Quantitative method)

Table 4: *(Continuation) Grouping the studies based on biomimicry dimensions: function*

Dimension	References	Author	Data Type	Objective	Method
FUNCTION	(Sara & Noureddine, 2015)	Sara, Noureddine	Full Text Report	To aim developing a new methodology considering the buildings designed with the influence of nature for energy-efficient building designs in warm and dry climates.	Qualitative research method (Qualitative method)
	(Chung, 2011)	Chung	PHD Thesis	To use biodynamics in architectural design considering the influence of nature.	Experimental research method and simulation method (Quantitative method)
	(Khelil & Zemmouri, 2019)	Khelil, Zemmouri	Article	To determine the use of nature-influenced technologies for a typical urban settlement in Southeast Algeria and to present designing proposals for passive ventilation and cooling system while implementing biomimicry principles.	Simulation method (Quantitative method)
	(Nalcaci & Nalcaci, 2020)	Nalcaci and Nalcaci	Full Text Report	To present facade design proposals that reduce energy use considering the adaptation of polar bear to external environment.	Simulation method (Quantitative method)
	(Fecheyr-Lippens & Bhiwapurkar, 2017)	Fecheyr-Lippens, Bhiwapurkar	Article	To design building envelope that reduces energy use after examining the biological characteristics of dynastes hercules and African reed frog.	Simulation method (Quantitative method)
	(Khosromanesh & Asefi, 2020)	Khosromanesh, Asefi	Article	To reduce energy consumption by presenting a proposal based on biokinetic building facade design that positions itself to sun and by examining ice plant seed.	Simulation method (Quantitative method)

Table 4: *(Continuation) Studies on the general framework of biomimicry in architecture*

Dimension	References	Author	Data Type	Objective	Method
GENERAL	(Makram & Ouf, 2019)	Makram, Ouf	Full Text Report	To examine the role of biomimicry and biophilia in forming a sustainable environment.	Archive research method (Other method)
	(Nkandu, 2018)	Nkandu	Article	To reveal the criteria of biomimicry based on sustainable building by analyzing three levels of biomimicry on five buildings.	Field study and observation (Mixed method)
	(Al-Obaidi et al., 2017)	Al-Obaidi et al.	Article	To ensure the development of sustainable facade designs through buildings with biomimetic facade designs considering the influence of nature and to provide solutions to technical problems.	Field study and archive research method (Mixed method)
	(Chayaamor-Heil & Hannachi-Belkadi, 2017)	Chayaamor-Heil et al.	Article	To increase researchers' awareness in terms of biomimetry by performing comparative analyses for nature-influenced buildings.	Simulation method and field study (Quantitative method)
	(Fahmy, 2018)	Fahmy	Full Text Report	To introduce biomimicry by reviewing the nature-influenced buildings.	Observation (Qualitative method)
	(Gamage & Hyde, 2012)	Gamage and Hyde	Article	To present optimal ecological model for sustainable building by examining the advantages of biomimicry and designing strategies.	Qualitative research method (Qualitative method)
	(Chayaamor-Heil, 2018)	Chayaamor-Heil	Full Text Report	To examine the impact of nature-influenced algorithms and digital advancements on biomimicry in architectural and urban design.	Field study and qualitative research method (Mixed method)
	(Clements-Croome, 2013)	Clements-Croome	Book section	To examine the methods of transferring to architecture by reviewing the characteristics of living beings and non-alive objects as well as their adaptation to their location.	Qualitative research method (Qualitative method)
	(Hu, 2017)	Hu	Full Text Report	To explain biomimicry through occupational practice and certain studies from the relevant field.	Archive research method (Other methods)
	(Poulsen Rydborg et al., 2019)	Poulsen et al.	Full Text Report	To explain the ecosystem level of biomimicry based on the ecosystem in oceanic climate and to take lessons for sustainable buildings.	Qualitative research method (Qualitative method)

Table 4: *(Continuation) Studies on the general framework of biomimicry in architecture*

Dimension	References	Author	Data Type	Objective	Method
GENERAL	(Bayhan & Karaca, 2019)	Bayhan, Karaca	Full Text Report	To guide researchers by performing SWOT analysis about biomimicry and kinetic architecture.	Qualitative research method (Qualitative method)
	(Kosanović et al., 2020)	Kosanovic et al.	Full Text Report	To present proposals about the use of biomimicry in architecture.	Qualitative research method (Qualitative method)
	(Kozlov, 2017)	Kozlov	Full Text Report	To determine the examples regarding the "history" of biomimicry, its basic theoretical and practical benefits and its potential practices in contemporary architectural design.	Archive research method and historical researches (Mixed method)
	(Feizabadi et al., 2012)	Feizabadi	Article	To determine the manners of using these organisms in contemporary architectural buildings influenced by natural organisms.	Archive research method and field study (Mixed method)
	(Fiorelli, 2017)	Fiorelli	Article	To determine the designing principles to be used for social isolation while considering the influence of insects.	Simulation method (Quantitative method)
	(Ibrahim, 2015)	Ibrahim	Article	To discover the use of nature in architecture for sustainable building and to analyze modern buildings in Egypt.	Field study and observation (Mixed method)
	(Abdelsabour, 2019)	Abdelsabour	Article	To assess the use of biomorphic design methodologies to form innovative structural forms, systems and construction methods considering the influence of nature.	Observation (Qualitative method)
	(Karabetça, 2015)	Karabetça	Full Text Report	To provide information about the use of biomimicry as a designing method in architecture	Qualitative research method (Qualitative method)
	(Abaeian et al., 2016)	Aaeian et al.	Article	To form a guide for researchers by determining the designing criteria for nature-influenced buildings to ensure thermal comfort in warm and dry climates	Qualitative research method (Qualitative method)
	(Ferwati et al., 2019)	Ferwati et al.	Article	To develop the frame of natural influence on designs at urban and building scale.	Field study and archive research method (Mixed method)

Table 4: *(Continuation) Studies on the general framework of biomimicry in architecture*

Dimension	References	Author	Data Type	Objective	Method
GENERAL	(Uchiyama et al., 2020)	Uchiyama et al.	Article	To guide the efforts of practicing by performing systematic review for the studies on biomimicry in architectural and urban design.	Archive research method (Other methods)
	(Januszkiewicz, 2019)	Januszkiewicz	Full Text Report	To present building design proposals that will reduce the impacts of climate change considering the influence of nature.	Simulation method (Quantitative method)
	(Saleh & Jaafar, 2020)	Saleh, Jaafar	Full Text Report	To reveal the role of natural organisms' growth characteristics in ensuring the functional development of architecture and environmental sustainability.	Simulation method (Quantitative methods)
	(Meriem & Mohamed, 2016)	Meriem, Mohamed	Full Text Report	To reflect the importance of digital technology in nature-based building designs and to provide a new biomimicry-based perspective to designers for sustainable building.	Qualitative research method (Mixed method)
	(Gamage & Hyde, 2011)	Gamage, Hyde	Full Text Report	To explain new environmental theories and designing approaches such as biomimicry that searches for ecological solutions by mimicking the forms, processes and ecosystems of nature for a sustainable building.	Qualitative research method (Qualitative method)
	(M. Shahda et al., 2014)	Shahda et al.	Article	To present proposals about the methodological frame of using the behavioral level of biomimicry in building designs.	Simulation method and field study (Quantitative method)
	(Gruber & Imhof, 2017)	Gruber, Imhof	Article	To present proposals with biomimicry-based designing approach utilizing the growth contact in biology.	Simulation method and experimental research method (Quantitative method)
	(Kokturk & Altun, 2018)	Kokturk, Altun	Book	To make a broad definition based on various perspectives about the use of biomimicry in architecture.	Simulation method and field study (Quantitative method)
	(Yuan et al., 2017)	Yuan et al.	Article	As a study based on the examination of bionic technologies for building functions, buildings and materials, to determine the designing criteria necessary for bionic-green architecture by analyzing the bionic building energy efficiency, bionic-green architectural practices and typical cases.	Qualitative research method (Qualitative method)

Table 4: *(Continuation) Studies on the general framework of biomimicry in architecture*

Dimension	References	Author	Data Type	Objective	Method
GENERAL	(B. V. D. Nguyen et al., 2018)	Nguyen et al.	Full Text Report	To present a digital-physical modeling aiming to explore the tectonic combination of origami folding patterns and micro-kinetic movements considering the influence of nature.	Simulation method (Quantitative method)
	(Garcia-Holguera et al., 2012)	Garcia-Holguera et al.	Full Text Report	To improve the use of ecosystem biomimicry using the ecological system diagrams.	Theoretical research method (Quantitative method)
	(Prakash & Sharma, 2017)	Prakash, Sharma	Article	To reveal the impact of biomimicry dimensions and principles on building sustainability through the buildings designed with the influence of nature.	Historical qualitative research method and field study (Mixed method)
	(Royall, 2013)	Royall	Article	To draw the outlines of a concrete theoretical and practical definition for biomimicry and examine architectural practices.	Field study and simulation analysis
	(Carro, 2009)	Carro	MA Thesis	To discover the organisms that can be added to the sustainable architecture in nature and re-interpreted.	Simulation method and field study (Quantitative method)
	(El Ahmar, 2011)	El Ahmar	MA Thesis	To establish a relationship between biomimicry and morphogenetically-calculated designing for a more sustainable architecture.	Field study and qualitative research method (Mixed method)
	(Nurbhai, 2015)	Nurbhai	MA Thesis	1. To determine whether the influence of natural forms and processes is adequate. 2. To reveal the biomimicry theories and practices in architecture using a philosophical perspective	Archive research method (Other methods)
	(Gruber et al., 2011)	Gruber et al.	Book	To provide extensive information about the use of nature in various scientific disciplines, particularly architecture.	Qualitative research method, simulation method and field study (Mixed method)
	(Gruber, 2014)	Gruber	Book	To provide extensive information about the use of biomimicry in architecture and to reveal its use in architecture throughout the history.	Historical researches and field study (Mixed method)
	(Chu, 2014)	Chu	PHD Thesis	To discover the place of nature in the design-based projects of R. Buckminster Fuller considering the influence of nature.	Simulation method and field study (Quantitative method)

Table 4: *(Continuation) Studies on the general framework of biomimicry in architecture*

Dimension	References	Author	Data Type	Objective	Method
GENERAL	(Gamage, 2015)	Gamage	PHD Thesis	To form a biomimicry approach within the eco-design practice by determining how biomimicry is conceptualized and used as a design-based approach in architectural eco-design practice.	Survey research method and archive research method (Mixed method)
	(Cruz, 2016)	Cruz	MA Thesis	To present a proper method proposal to determine the best biomimicry practices on the global scale and to ensure a sustainable building utilizing biomimicry.	Field study (Quantitative method)
	(Button, 2016)	Button	MA Thesis	To present examples about the use of plants, bacteria and other organisms for certain methods such as the collection of water, wind and solar energy and waste management, and to present proposals regarding their use in architecture.	Simulation method and field study (Quantitative method)
	(Ortiz, 2020)	Ortiz	MA Thesis	To group the names regarding the methods of using natural influence in architecture through different examples and based on the purposes of use.	Simulation method and theoretical research method (Quantitative method)
	(Pasıc, 2014)	Pasic	MA Thesis	To examine the importance of using biology in architecture and the reasons for biology being integral to architecture.	Qualitative research method (Qualitative method)
	(Zari, 2007)	Zari	Full Text Report	To define the levels of biomimicry in architecture and the dimension at every level in a comprehensive manner.	Qualitative research method (Qualitative method)
	(Zari & Storey, 2007)	Zari, Storey	Article	To clarify different approaches regarding biomimicry in architecture and to present a series of principles that may constitute the basis of ecosystem-based biomimicry.	Qualitative research method (Qualitative method)
	(Benyus, 1997)	Benyus	Book	To create a guide about biomimicry as the common field of interest for different scientific disciplines.	Qualitative research method (Qualitative method)
	(Zari, 2010)	Zari	Article	To examine the ecosystem level of biomimicry as well as its use as an instrument to reduce the impacts of climate change and to increase the adaptation to these impacts.	Qualitative research method (Qualitative method)
	(Makram, 2019)	Makram	Article	To define the methods of being influenced by nature in architectural building design for a sustainable life.	Qualitative research method (Qualitative method)
	(Mohamed, 2018)	Mohamed	Article	To form face-based proposals that reduce energy consumption considering the influence of nature in the stage of designing building.	Field study and simulation method (Quantitative method)

Table 5*: Biomimicry in architectural education*

References	Author	Data Type	Objective	Method
(Omar et al., 2019)	Omar et al.	Full Text Report	To form the necessary criteria for adopting biomimicry within the education of architectural design.	Field study (Quantitative method)
(Amer, 2019)	Amer	Article	To show the importance and potential of biomimicry as a designing method on students' designs.	Survey researches method (Quantitative method)
(S. Yazici, 2015)	Yazici	Full Text Report	To assess an undergraduate elective course entitled "Sustainable Design and Environment Through Biomimicry" in the scope of biomimetic designing strategies and calculated design.	Field study (Quantitative method)
(Varinlioğlu et al., 2018)	Varinlioğlu et al.	Article	To increase students' power of designing with the nature-influenced digital designing instruments and to discuss the results that emerged within the studio course entitled "ARCH 202" aiming to teach new methods.	Field study and simulation method (Mixed method)
(M. M. Shahda, 2019)	Shahda	Article	To improve architecture students' skills of understanding buildings' structure using biomimicry.	Field study (Quantitative method)
(Stevens et al., 2020)	Stevens	Article	To determine the criteria necessary for increasing the levels of natural influence on students for more sustainable architectural building analyses.	Qualitative research method (Qualitative method)
(Dickinson, 2012)	Dickinson	Full Text Report	Using the connections between sustainability, biomimicry and digital technology, to explore sustainable skyscraper forms and building typologies within the course "Sustainable Skyscraper".	Simulation method and field study (Quantitative method)
(Tavsan et al., 2015)	Tavsan et al.	Full Text Report	To teach biomimicry method to students by mentioning the contributions of alive animals' characteristics to architectural building designs to ensure students develop different solutions with the influence of nature in mind.	Field study and qualitative method (Mixed method)
(Asghar & Naqvi, 2019)	Asghar, Naqvi	Article	To help students adopt the concept of biomimicry as well as digital approaches so that they can design more innovative architectural buildings.	Simulation method and field study (Quantitative method)

(Bakri et al., 2013)	Bakri et al.	Full Text Report	To teach biomimicry levels and define the potential of biomimicry in generating creative ideas.	Field study and simulation method (Quantitative method)
(Symeonidou, 2019)	Symenonidou	Article	Based on the results of different researches, to reveal the geometric principles behind natural buildings along with students and to determine the relevant challenges while performing calculations.	Simulation method (Quantitative method)

3.2.1. Analysis and assessment of studies per their purposes

Studies that have been reviewed, 56.17% (50/89) focused on the general frame of biomimicry while 31.46% (28/89) examined a certain dimension of biomimicry (form=7, material=4, process=5, structure=6 and function=6) (Table 4). The remaining 11 studies are related to the use of biomimicry in architecture education (Table 5).

Most of the studies on the form dimension of biomimicry in architecture have focused on designing the building envelope that will reduce the energy consumption of buildings to minimum (Le, 2020; Mandeel et al., 2021; Zulherman et al., 2019). Considering that one of the most important building elements affecting the sustainability of buildings is the building envelope it can be evaluated that designing a building form inspired by nature will make significant contributions to sustainability (El-Darwish & Gomaa, 2017). 75% of the studies on the material dimension of biomimicry are about energy conservation of materials to be used in buildings (Achal et al., 2016; Hershcovich et al., 2021; Nessim, 2015). Considering the need to improve the insulation and air tightness of the outer shell of the building in order to reduce the energy consumption of the materials to be used, the importance of producing materials inspired by nature emerges. All of the studies on the process dimension of biomimicry in architecture, and about 60% of the studies on the structure dimension are about reducing energy consumption in building designs. These results show the importance of being inspired by the structure or working mechanisms of the objects in nature for sustainable building design in ensuring the sustainability of buildings. Approximately 50% (23/50) of the studies include more than one dimension of biomimicry aimed at building design inspired by nature. One of the most important common purpose of studies on biomimicry in architectural education is to raise awareness of students' design inspired by nature and to teach the relationship between biomimicry and sustainability (Asghar and Naqvi 2019; Bakri et al. 2013; Dickinson 2012; Tavsan et al. 2015).

Although the scope of the studies and the way of inspiration from nature are quite different from each other in the groupings, it seems that the main purpose of the general is sustainable building design. However, the fact that a significant part of the studies still focus on the definition of biomimicry shows that this method is still not fully understood.

3.2.2. Analysis and assessment of studies per their methods

The research method is the collection of methods used to determine, analyze and process the data regarding an academic study (Büyüköztürk et al., 2008). Research methods are basically divided into two: qualitative and quantitative. Method which qualitative and quantitative techniques are collectively used are known as mixed method. Other than these, archive research method as well as information and communication technologies can be defined as other methods (Nguyen et al. 2019). Certain scientific people particularly grouped the methods utilized in architectural academic studies. Groat and Wang (2013) divided the researches into seven different groups: "historical", "qualitative", "correlation", "experimental and semi-experimental", "simulation", "logical argumentation" and "field study". "Historical", "logical argumentation" and "qualitative researches" are qualitative methods, while "correlation" is a mixed method, and "field study", "experimental and semi-experimental" and "simulation" researches are quantitative methods.

Methods of researches within the study were analyzed based on this grouping (Figure 6).

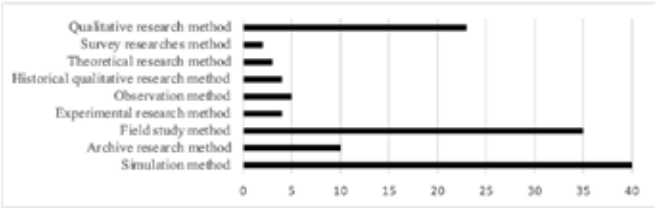


Figure 6: *Distribution of research methods used in studies*

Simulation method was used the most (32%; n=40) in the analyzed studies. These results support the idea that recent advancement in computer software has played an active role in the orientation of increase regarding biomimicry. Furthermore, 36% of studies utilized more than one method. "Simulation method", "field study" and "qualitative methods" were used the most in studies (78%). These results indicate that both qualitative and quantitative methods were used in the architectural studies on biomimicry (Figure 7).

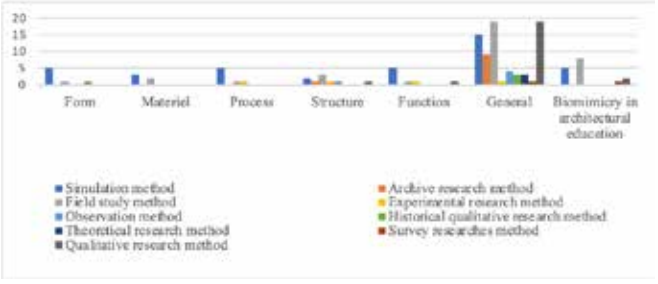


Figure 7: *Distribution of studies per the research methods*

The method is used in the biomimicry-related dimensions of architecture suggest that simulation method was used the most in 71% of the studies on "form" and "process", 60% of the studies on "material" use, and 63% of the studies on "function". 45% of the studies using the simulation technique aimed at sustainable building design. In the simulation technique, the geographical and climatic characteristics of a certain region can be prepared in the computer environment . Since the building can be designed in the virtual world before it is built in the real world, it can be designed to consume minimal energy. Therefore, the use of simulation technique can be recommended in studies aiming at sustainable building design. However, in the studies, the simulation technique was generally used together with the field study technique. Therefore, it suggests that using these two methods together can give the most accurate result.

4. DISCUSSION AND RECOMMENDATION

As a result of the analyzes and evaluations made, various suggestions are listed below for researchers who will work on the use of biomimicry in architecture and sustainability in the future. These are;

- energy consumption can be significantly reduced and energy production can be achieved by being inspired by the working mechanisms of materials in nature in building design. An example of this is the design of an energy efficient building by examining the orientation of the sunflower according to the angle of incidence of the sun. In cold climates, solar orientation can reduce energy consumption. In addition, energy production can be achieved by utilizing solar heat. This energy production can be achieved by the orientation of the photovoltaic panels according to the angle of incidence of the sun.
- by examining the protective layers of living things in nature, inspiration for the insulation of structures can be obtained. For example, the structure of the fat layer and feathers of polar bears living in very cold climates can be examined and adapted to the facade design. With the right analysis and adaptation, the formation of thermal bridges in the building envelope can be significantly prevented.
- by examining the skeletal system of living things, it can be adapted to the building structure of buildings. This adaptation will assist in structural analysis while improving the strength of structures. An example of this is the ability to cross large openings by examining the skeleton of a living thing.
- the energy efficient building envelope can be designed with inspiration from the working mechanisms of natural organisms. For example, the skins of cutaneous respiration organism creatures can be examined. This may contribute to the passive ventilation and lighting of the building.
- for sustainable building design, taking inspiration from nature, instead of just one feature of the organism, various features can be examined together. Because examining only one of these features may not be enough to reveal the real mystery in the natural adaptation of the organism.
- it can be suggested to use field study and simulation techniques together to design a sustainable building inspired by nature. It is thought that using these two techniques together will provide the most accurate result.
- in addition to such structural suggestions in energy-efficient building designs, it is necessary to raise awareness of architectural students in the field of biomimicry in architecture. Along with this awareness, the development of abilities related to being inspired by nature is also an important phenomenon for sustainable buildings. For the development of this awareness and skills, courses related to biomimicry in architecture should be added to the curriculum of graduate education, including undergraduate education in architecture. In addition, especially in undergraduate education, students should be encouraged to design projects inspired by nature.

5. CONCLUSION

The decrease in natural resources and the increase in energy consumption have increased the interest in sustainable building design. Biomimicry is one of the most important methods of sustainable building design. In this article, studies on the use of biomimicry in architecture are reviewed. As a result of the investigations, it has been determined that the inspiration from nature for sustainable building design can start from a single dimension of the organism level and more than one dimension can be investigated together at the ecosystem level. In addition, some studies encourage students, who are the architects of the future, to design sustainable buildings by creating awareness about the use of biomimicry in architecture. To reveal the mysteries of organisms or systems in nature or to raise awareness in this field, simulation technique and field study technique were used in general. Identifying the mystery of how organisms or systems adapt to nature is key to sustainable building design. Although studies in this area have increased in recent years, they are still insufficient. However, according to the analyzes made, the authors strongly believe that studies on the use of biomimicry in architectural building design will increase in the future. Bringing together and analyzing and evaluating the previous studies in this field is a guide for researchers.

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DAMAGES AND POLICY SOLUTIONS FOR PEDESTRIAN BRIDGES IN TEHRAN, IRAN

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ABSTRACT

Numerous pedestrian bridges are the result of a car-oriented approach in the Tehran transportation network. Considering the vast maintenance costs and unacceptable functional efficiency, it is essential to change the planning approach from car to pedestrian in Tehran. This study attempted to the pathology of pedestrian bridges in Tehran and provide effective and timely policy solutions for them using the Content Identifying Method (CIM) and summarizing necessary measures from different studies. Solutions will be offered at different levels, from short to long-term solutions. This study concludes that pedestrian bridges should be re-evaluated in terms of location, design, continuous transportation network, and maintenance to improve quality of life. These solutions should be implied at the proper period with consideration of the needs of citizens and the existing issues of pedestrian bridges. They can be done based on management mechanisms by creating inter-sectoral coordination between related organizations and institutions.

1. INTRODUCTION

Tehran, as a Metropolis in recent decades, due to many reasons, especially rapid and irregular growth and also because of loading more than the capacity of the land, confronts many issues and challenges in urban management. Finding a comprehensive solution for these issues is a challenging task. As part of this network in urban areas, one of these issues is related to the transportation network, especially pedestrian bridges. According to the FHWA report, some principles provided for an urban transportation network are cohesion, directness, accessibility, alternatives, safety, security, and the network's comfort (FHWA, 2016). Ensuring that people experience these properties in their urban areas can assure that urban areas can affect the quality of life and their inhabitants' sense of connection (Cullen, 1961). As a part of this network, logically, pedestrian bridges must meet these principles. Although the pedestrian bridges in Tehran, over time, were just built for a safe route from rider passages, today, for many reasons, they created different problems for citizens and urban management. Pedestrian bridges are the product of a car-oriented attitude that began in the 20th century. Because they can completely separate pedestrians from riders, and significantly reduce accident statistics (Soltani, 2013). Pedestrian bridges also have the potential to enhance the visual qualities of urban spaces (Sharbati, 2015).

On the other hand, pedestrian bridges can be a space for urban advertising and a source of income for the relevant organs. Also, their simple structure provides them with a simple process of construction. The location and construction of these bridges are subject to the regulation and rules of each country. It has been over half a century since the first pedestrian bridge was constructed in Tehran, and now it has around 850 pedestrian bridges over the city. However, the evidence shows that the functional efficiency of these bridges is not at an acceptable level. Some studies claim that around 50% of the bridges in Tehran do not have the desirable performance (Ahmadi, 2002) (Fig.1).

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***Figure 1**: Low Functional Efficiency of Pedestrian Bridges in Tehran*

Another research in Jakarta, Indonesia, shows that the use of bridges is an unfair approach that consumes more time and energy from pedestrians and, at the same time, does not match all the conditions and requirements of them and finally, due to this reason, citizens use 65% of the pedestrian bridges in the city (Leather et al., 2011). Another study in Tehran in 2017 showed that level passages generally are more desirable for citizens than crossing the same passage using pedestrian bridges. The same study claims that mechanized pedestrian bridges are preferable to ordinary ones (Kashanijou et al., 2019). On the other hand, according to Blackburn et al. (2016), pedestrians are among the most vulnerable road users, accounting for approximately 16 percent of all roadway fatalities nationally. Unofficial statistics indicate the daily death of thirteen pedestrians in Iran. While according to international estimates, the largest age group of pedestrians killed in traffic accidents are people over 50 and then children ten years and younger, and it is precisely these people who, for various reasons, may be less likely to use pedestrian bridges (Mohammadzadeh, 2016). The impossibility of using disabled people and mothers who carry their children's strollers is another issue that has made it difficult for pedestrian bridges in urban spaces. However, municipalities must adapt urban spaces for all people, even those with disabilities (Rules and Regulation of Urban Planning and Architecture for People with Physical Disabilities, 2009). However, a review of the rules and regulations for the design of pedestrian bridges in various countries, including the United States, the United Kingdom, and Ireland, have emphasized using ramps and elevators for mechanization of pedestrian bridges and these documents do not mention escalators as a suitable solution to facilitate citizens' use of the pedestrian bridge. In Tehran, most mechanized bridges have utilized escalators (see Fig.2).

***Figure 2**: Utilizing Escalator for Mechanized Pedestrian Bridges in Tehran*

Disturbing the urban landscape is another issue created due to not paying attention to the aesthetic criteria in the design process of bridges on the one hand and the existence of many bridges in urban spaces that blinding some natural or valuable landscapes on the other hand. A study on designing and constructing pedestrian bridges in Tehran shows that planners and designers only try to provide a passage for pedestrians without attention to their aesthetic qualities, especially their relationship with the background around them. It means that these bridges are constructed only based on one or two design standards, without considering the visual characteristics of the surrounding environment and harmonizing them with each other. This process cannot be considered a context-sensitive design process (Sahraeinejad, 2014) (Fig.3). Also, pedestrian bridges in Tehran disturb the skyline in the urban landscape and act as a visual disturbance. At the same time, in mechanized bridges, due to the bulky structure of escalators, a negative, ugly and unsafe space is created under them, which in many cases becomes a place for garbage collection or the establishment of vendors and homeless people.

***Figure 3**: Design Standards for Pedestrian Bridges in Tehran Urban Areas (Pedestrian Bridges in Tehran are not Context Sensitive)*

Meanwhile, according to the report of the Tehran Beautification Organization in 2018, the average construction cost for each ordinary pedestrian bridge is more than five billion Rials , and each mechanized pedestrian bridge costs about 35 billion Rials. One of the most crucial challenges that urban management faces is providing high costs for constructing and maintaining pedestrian bridges in the Tehran metropolitan, consequently confusing the bridge management process. In addition, the heavy maintenance costs of pedestrian bridges have caused urban managers to install billboards on the bridge deck to generate revenue and provide these costs. In turn, advertisements on the bridges create dangers inside or around the bridge. Advertisements affect the primary function of pedestrian bridges, and in some cases, the safety of pedestrians has been wholly disrupted due to the complete coverage of the bridge deck. In addition, advertising will disrupt drivers' focus, especially on highways, and lead to accidents (Khaki et al., 2012:13). These all affect the safety of bridges and their mental impact on citizens and the quality of sidewalk space, finally reducing the functional efficiency of pedestrian bridges (Fig. 4). Therefore, according to this amount of costs and the failure to achieve the expected performance, it is necessary to re-evaluate the issue of pedestrian bridges in Tehran, both in terms of policies and also the need for reviewing in the location, technical terms, and conditions of construction and maintenance.

***Figure 4**: Advertising on Pedestrian Bridges in Tehran*

Solving the problems of pedestrian bridges is a multidimensional issue that needs to be explored in all its dimensions. Therefore, there are three main questions for this study; the first is what are the damages and consequences due to the presence of numerous pedestrian bridges in the metropolis of Tehran? Second, what are the proper alternatives for pedestrian bridges in Tehran's urban spaces? Moreover, the third is what are the practical solutions to prevent the development of these damages?

2. RESEARCH METHODOLOGY

This study is based on the Content Identifying Method (CIM). The data required for this research was gathered through library and documentary studies (definitions, concepts, theories, and approaches related to the subject of pedestrian bridges and their performance in urban spaces) as well as field studies (Study of the condition of pedestrian bridges will be collected in different urban spaces of Tehran and compared with successful global experiences in this field). Then, based on the obtained data, the pathology of the current condition of pedestrian bridges in Tehran's urban areas and then the adaptation of the current situation to the theories and approaches have been done. Finally, solutions will be offered at different levels (short, medium, and long-term) by summarizing the necessary measures from different studies.

According to these studies, the pathology of pedestrian bridges in Tehran is summarized in Fig.5.

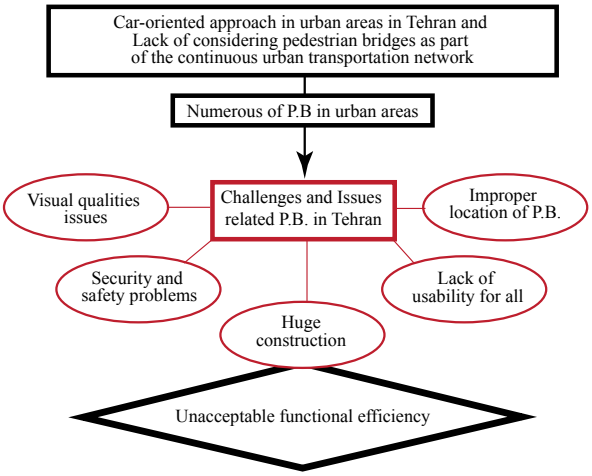

***Figure 5**: Pathology of the current condition of pedestrian bridges in Tehran (Source: Authors)*

According to this diagram, the most important reason regarding the unacceptable functional efficiency of pedestrian bridges in Tehran resulted from their different challenges and issues, which resulted from numerous pedestrian bridges in urban areas. Finally, all these problems are related to having a car-oriented approach in planning urban areas and neglecting pedestrian bridges as part of the continuous network of urban passages.

Aside from specific issues and problems related to pedestrian bridges, on a larger scale, it seems that the urban management of Tehran metropolis, like others in developed countries; needs to change the approach from car-oriented to pedestrian-oriented because experiences have shown that the continuation of the past approach will not lead the success. With the adoption of this policy, pedestrian bridges will change dramatically because they are a phenomenon resulting from the car-oriented ideology. In the pedestrian-oriented approach that, for the past half-century, it has received much attention in different countries of the world, priority is given to pedestrian movement; therefore, the comfort, safety, and security of pedestrians and paving the way for a continuous pedestrian network in urban areas are as a necessity (Park et al., 2014; Wood et al., 2010). In the car-oriented approach, pedestrians guide by bridges or underpasses to minimize any disturbance in the movement of cars; at the cost of maintaining the comfort and safety of the rider, the pedestrian faces problems that can sometimes have social and psychological dimensions. However, in the pedestrian-oriented approach, the comfort, safety, and security of pedestrians are given priority over-riders, and then using the level difference

to cross the passages loses its position as a critical solution. Thus, by force, urban management must pursue one of the following two general policies: The first policy is maintaining the current situation by a car-oriented approach and just making minor corrections to it, and the second is changing the approach from car-oriented to car pedestrian-oriented. The consequences of this change in attitude can be summarized in Fig. 6:

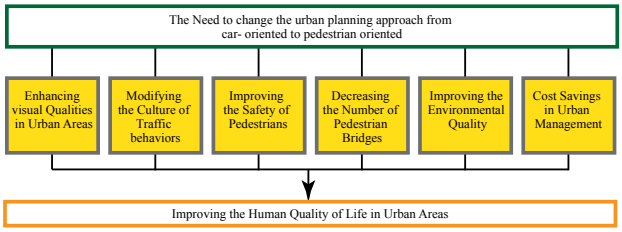

Figure 6: *Consequences of Changing the Approach of Urban Management concerning Pedestrian Bridges in Tehran*

According to this diagram, to improve the human quality of life in urban areas in Tehran, we need to change our planning approach from car-oriented to pedestrian-oriented in order to enhance the visual qualities, modify the culture of traffic behavior, improve the safety of pedestrians, improve environmental quality, decrease the number of pedestrian bridges in urban areas and finally save cost in urban management processes.

3. POLICY SOLUTIONS

The proposed solutions to implement this policy can be classified at different levels as short, medium, and long-term solutions as follows:

In the short-term solutions (period of one to three years), it may check all the pedestrian bridges in terms of location and efficiency: This should be done by preparing a control checklist. It will eventually lead to removing or modifying bridges that do not have a proper location or acceptable performance. This checklist should include some criteria such as the type and width of rider access, Average speed of passing vehicles, number of passing vehicles per hour, ability to see vehicles by pedestrians and vice versa, Number of pedestrians using the bridge during peak hours, land uses around the bridge, reviewing the design process of brides that should be in a context-sensitive manner and also the method of mechanization of bridges in order to regard the rights of disabled citizens, that all needs to be completed by trained people at the right time using the information available in the Deputy Minister of Transportation and Traffic. Moreover, it is necessary to conduct a practical study to update alternative methods for pedestrian bridges that match the physical, cultural, and economic situation in different urban areas.

In the Medium-term solutions (period of three to five years) primarily, it is necessary to establish intersectional coordination between urban management organizations in order to determine the critical measures for the development of the pedestrian's facilities plan and prepare a specific and timed plan that explains the position of pedestrian bridges in this plan. The second is to prioritize alternative solutions instead of pedestrian bridges such as constructing underpasses, calming traffic by creating physical barriers, and using smart traffic tools. Applying these alternatives and providing a comfortable and continuous transportation network is also effective for increasing social interactions and the vitality of urban spaces. At the same time, it will prevent visual disturbance caused by numerous pedestrian bridges and other issues that result from them, as mentioned earlier. Each alternative solution may have some advantages and disadvantages, as shown in Table 1.

Table 1: *Advantages and disadvantages of proposed Alternative Solutions to Pedestrian Bridges.*

Alternative Solution	Advantages	Disadvantages
Use the Underpass	-Possibility of commercialization -No disturbance in the urban landscape -the Increased psychological desire to use	-Difficulty of executive operations -Impossibility of use in all passages - safety problems
Calming Traffic by Creating Physical Barriers	-Eliminate P.B. and reduce maintenance and maintenance costs - Ease of use for all citizens -No disturbance in the urban landscape - Increasing the use of citizens	-Negative effect on traffic on busy roads -Impossibility of use in all passages -Reducing the safety factor of pedestrians
Use of Smart Traffic Tools	- Eliminate P.B. and Provide no possibility of crossing on foot in a level manner - Creating suitable conditions for the safe passage of all citizens, especially the disabled and the elderly	Need to provide technical infrastructure - Lack of a culture of use among citizens

Then in the third step, culture building in the field of improving the traffic behaviors of citizens through mass media, education in schools, and face-to-face citizenship education, also improving existing pedestrian bridges for their aesthetic qualities and promoting their safety and security and finally removing advertising from pedestrian bridges and, if necessary, using façade advertisements, around the bridge. In the long-term solutions (5 to 15 years), the first step is changing from a car-oriented to a pedestrian-oriented approach in urban areas, creating a continuous network of pedestrian crossings independent of the rider network, and considering the pedestrian bridges as a part of this network. Therefore, pedestrian bridges should be constructed only in areas with no better alternative solution for safe pedestrian crossing across the rides. Achieving these results requires changes in the structures and decision-making processes and the attitude of urban management regarding pedestrian bridges. Also, reviewing the policies for loading public buildings along highways to minimize the need for pedestrian crossings is the second long-term solution. The final solution is using the possibility of combining pedestrian bridges with surrounding architectural elements, especially for the pedestrian bridges around commercial complexes and service centers. This solution, in addition to improving the bridges' position to an element integrated with architectural elements, also removes the maintenance cost of the bridges from the municipalities.

4. DISCUSSION

First, in parallel to Development and Research Management (2011), it seems necessary to change the attitude among city managers to create and expand pedestrian bridges. Minnesota Local Road Research Board in 2014 suggested pedestrian bridges are just one treatment among appropriate treatment options for crossing locations such as Crosswalk Markings, Warning Signs, Center Median with Refuge Island, School Crossing Guards, or underpass, which are selected based on the pedestrian crossing evaluation criteria. Jesse Cohn and Elliot Sperling (2016) believe that providing pedestrian accommodation in urban areas leads to some direct benefits, such as connectivity and safety, and some indirect benefits such as accessibility, health, sustainability, cost savings, social equity, and enhancing the functional efficiency of pedestrian accommodation. Moreover, Nazemi and Mohagheghnasab (2014) emphasized the need to review the design, construction, and use of pedestrian bridges in Tehran's urban areas. This study proposes that we need to change the approach in urban planning from car to pedestrian oriented and consider pedestrian bridges part of a continuous network of urban passages. According to WPI-Pedestrian Bridge Study, the Seattle Department of Transportation (2014), and also Sahraeinejad (2019), pedestrian bridges should fit into the existing landscape and not disturb the skyline in the urban landscape. To achieve this, the design of the bridges must be sensitive to the urban context in which it is located. This study proposed that if there is a necessity for installing a pedestrian bridge, it must be designed in a context-sensitive manner. Moeini (2014) offer solutions regarding the considerable number of pedestrian bridges in urban areas, such as utilizing underpass or using physical barrier instead of pedestrian bridges. This study proposed prioritizing alternative solutions such as underpasses, calming traffic by creating physical barriers, and using smart traffic tools instead of pedestrian bridges in urban areas.

5. CONCLUSION

This study concludes that pedestrian bridges are proposed as a suitable solution for pedestrian movement and road-crossing in the city. However, they become an issue for both citizens and urban management part. Urban areas have an important responsibility to be accessible, functional, and safe with aesthetic qualities for all to walk. In a car-oriented approach, pedestrians are part of a continuous transportation network and consider their safety more than their accessibility. In a pedestrian-oriented approach, improving pedestrian safety and accessibility is a key issue for planners, designers, and citizens. (Planning and Designing for pedestrians, 2002) Therefore this study concludes that primarily, to reduce problems regarding the pedestrian bridges in urban areas in Tehran, the most important action as a long-term solution is changing from a car-oriented to a pedestrian-oriented approach in urban management in order to establish continuity in the urban transportation network by considering alternative options instead of pedestrian bridges.

In addition, the need to apply policy solutions at different levels to change the approaches and solve the problems of pedestrian bridges in urban areas and also enhance the quality of life; these solutions should be implied at the proper periods with consideration of the needs of citizens and the existing issues of pedestrian bridges. The above policies can be based on management mechanisms and by creating inter-sectoral coordination between related organizations and institutions. However, to solve these problems, it is necessary to take all these solutions in full cooperation with all involved organizations and areas of Tehran Municipality and the form of a specific and planned agenda.

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AMBIENT SOUND IN HEALTHCARE SETTINGS AND ITS EFFECTS ON PATIENTS AND STAFF: A SYSTEMATIC REVIEW

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ABSTRACT

Sound can affect patients, staff, and visitors in healthcare settings in many ways. The purpose of this review was to synthesize and investigate sound in healthcare settings and the effects of these sounds. Relevant studies published between January 2017 and June 2022 were searched through a systematic literature review process using the Google Scholar, PubMed, Scopus, Web of Science, and Wiley Online Library databases. A total of 25 papers met the inclusion criteria. The study results cover three main areas: perceived sound sources and sound levels; associations between healthcare settings and sound; and sound's effects on patients and staff. This study shows that in terms of sound, the environment in hospitals, nursing homes, and outpatient centers is boisterous. Among other findings, associations were identified between sound and types of healthcare services; activities and behaviors; architectural features and materials; and mobile communication devices. Most studies report that sound has adverse effects on patients and staff, while nursing home-related studies report the positive attitudes of residents to musical activities. By evaluating the multiple sound-related solutions available, this review indicates that future research in this area should focus on the long-term effectiveness of interventions and the provision of standards of practice for optimal sound environments, based on different healthcare settings.

1. INTRODUCTION

Healthcare settings can provide treatment and care to patients or residents. One source of sound in healthcare settings is people, including conversations between patients and family members, patients' painful voices, and discussions among hospital staff (Juang, Lee, Yang, & Chang, 2010). Other sources of sound are ventilators, air conditioners, medical equipment, alarm systems, and others (Johansson, Bergbom, Waye, Ryherd, & Lindahl, 2012). The World Health Organization (WHO) has issued guidelines on the maximum noise levels in hospitals. The guidelines recommend that the noise in inpatient wards should not exceed 30 decibels (dB), while the noise in operating rooms and intensive care units should be kept as low as possible (Busch-Vishniac et al., 2005). In practice, it is almost impossible for hospitals to fully comply with these proposed noise volume guidelines (Iyendo, 2017). The specific acoustic environment in a healthcare facility includes not only the sounds it produces itself but also the characteristic auditory image of the facility (Theodore, 2018). Positive sounds in an acoustic environment create a sense of safety and familiarity, while harmful sounds inevitably bring helplessness and anxiety (Johansson et al., 2012). Sound in healthcare settings is one factor to consider when attempting to guarantee a greater sense of physical and psychological safety among patients, residents, staff, and visitors (Bogaert, 2022).

A growing body of sound-related evidence produced in recent decades suggests that sound may affect patient outcomes or the mood of healthcare workers (Greenfield, Karam, & Iqbal O'Meara, 2020; Sreetharan, Schlesinger, & Schutz, 2021). Hospital patients and nursing home residents have weaker physical capabilities than those visiting other places, so they are more susceptible to noise interference (Jamshidi, Parker, & Hashemi, 2020). Noise in the hospital may increase patients' complications and adversely affect their health, cognitive ability, and physical recovery (Cabrera & Lee, 2000). Meanwhile, noise also affects the functional status of medical staff. Medical staff who have been exposed to noise for a long time tend to have decreased attention and make more judgment errors. Besides that, noise may lead to a decline in empathy and an inability to maintain the patience needed to communicate with patients effectively (Juang et al., 2010). Healthcare facilities must promote

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a healthy work environment for staff and a healing environment for patients and residents (Choiniere, 2010).

One current solution is to measure various sound sources and sound levels in healthcare settings to implement noise-reduction efforts (Oleksy & Schlesinger, 2019). For example, researchers have compared the sound levels of wards with different configurations and facilities to identify the main factors causing the differences. Others have added acoustic panels to improve the architectural design and thus achieve sound absorption (Farrehi, Nallamothu, & Navvab, 2016; Tegnestedt et al., 2013). Another solution is to add a soundscape to the hospital setting to create a healthy environment (Devos et al., 2019). A comfortable healthcare setting can reduce a patient's discomfort (Seyedfatemi, Rafii, Rezaei, & Kolcaba, 2014). Some studies have proposed that designing musical sound environments in conjunction with geographic locations creates a positive experience for patients and staff (Thorgaard et al., 2005). Therefore, the role of sound in healthcare settings must be better understood to identify positive sounds that would improve these settings (Watts, Khan, & Pheasant, 2016).

The current literature review focuses on reviews of noise issues in hospital settings (Brown, Rutherford, & Crawford, 2014; de Lima Andrade et al., 2021; Iyendo, 2017; Konkani & Oakley, 2012). Reviews have been undertaken on the sound environment in long-term care facilities and nursing homes (Graham, 2020; Janus et al., 2021). The above studies address the acoustic environment in a particular type of healthcare facility and its impact on patient health. This paper focuses on a wide range of services and healthcare settings, such as hospitals, rehabilitation centres, nursing homes, and long-term care facilities, to bridge the evidence gap on sound in a broader range of healthcare settings and provide insights for future research in this area. This systematic evaluation aims to identify and synthesize sound sources and sound levels, as perceived by patients and staff in healthcare settings, to systematically understand the associations between healthcare settings and sound, as well as the impacts these sounds have on patients and staff. The main research questions of this study are as follows:

RQ1: What sound levels are found in healthcare settings?
RQ2: What is the association between healthcare settings and sound?
RQ3: How does perceived sound affect patients and staff?

2. METHOD

2.1 Data Sources and Search Strategy

According to the guidelines provided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Moher et al., 2009), the authors electronically searched the published literature using the Google Scholar, PubMed, Scopus, Web of Science, and Wiley Online Library databases. The timeline ran from January 1, 2018, to June 1, 2022, a sufficient period to understand the latest research progress. The search string for this review consisted of two sets of keywords related to healthcare settings and sound. The specific search strategy employed was as follows: ("healthcare settings" OR "healthcare facilities" OR "hospital " OR "nursing homes" OR "long-term care" OR "outpatient ") AND ("sound" OR "noise" OR "acoustic" OR "auditorium" OR "soundscape" OR "music").

2.2 Inclusion and Exclusion Criteria

For this review, inclusion and exclusion criteria were constructed based on the PICOS model (Table 1). The study population was patients, residents, and professionals in hospitals, nursing homes, and long-term care facilities. The review did not include those receiving healthcare services in private settings or at home. The studies reviewed were sound-related measurements and interventions, excluding records about sound in medical diagnoses. It is important to note that sound was also included in the review when discussed in combination with other factors. All the studies had to be measured or experimental to improve the validity and quality of the review's results. The study designs included observational studies, cross-sectional studies, and randomized/non-randomized trials but excluded review studies, case reports, medical studies, and conference abstracts. All the studies were written in English and peer-reviewed.

Table 1: *Inclusion and exclusion criteria based on the PICOS model*

Criteria	Inclusion	Exclusion
Population	Patient, resident, and professional populations in hospitals, outpatient clinics, nursing homes, and long-term care facilities	Target population not clearly defined; study population accessing healthcare in non-healthcare settings, private offices, or homes
Interventions	Sound-related measurements and interventions in healthcare settings	Sound in medical diagnoses and cochlear implant-related studies
Comparisons	Separate groups, or comparisons with a clear rationale	
Outcomes	Results related to sound measurements or to the study population	Studies describing sound only, without field measurements or experiments
Study designs	Observational studies, cross-sectional studies, comparative trials - both randomized and non-randomized trials	Review studies, case reports, medical studies, conference abstracts

2.3 Study Selection

The study selection was done jointly by two authors and began with the title and abstract of each article being read to determine if the study met the inclusion criteria. Duplicates were automatically removed using Endnote. The full text of each initially screened study was then read and critically evaluated to determine whether the article should be included in the discussion and analysis for this review. Disagreements were resolved by joint discussion among the three authors.

2.4 Data extraction and analysis

This systematic review developed a data-extraction table, which involved the first author independently extracting material and information related to the research questions from 25 studies. The study characteristics in the data-extraction table included basic data, descriptive data, and outcome data (Munn, Tufanaru, & Aromataris, 2014). More specifically, the extracted basic data included the author/s, year of publication, and country. The extracted descriptive data involved the healthcare setting, purpose, study design, sample size and population, as well as the key findings (Table 2).

Table 2: *Study characteristics and CCAT scores*

Authors	Country	Healthcare Settings	Objective	Study Design	Sample Size and Population	Key Findings	CCAT score/40 (%)
D'Souza et al. (2017)	India	NICU	To determine and describe the ambient noise levels in the acute NICU of tertiary referral hospitals.	Descriptive	N/A	There is a high level of ambient noise in an NICU. The noise generated by the equipment is beyond the scope of repair.	23 (57)
Disher et al. (2017)	Canada	NICU and PICU	To determine baseline sound levels, sound level patterns, as well as potential barriers and facilitators to sound-level reduction.	Mixed-methods	12 staff and parents of currently hospitalized children or infants	The greatest variation in the sound of the ICU environment may come from design and equipment purchase decisions.	25 (63)
Fasih-Ramandi and Nadri (2017)	Iran	ICU	To evaluate the background noise to which ICU patients are typically exposed by means of a noise standard curve.	Cross-sectional	N/A	The sound levels, noise criterion, and preferred noise criteria curves in the ICU exceed the national and international recommended standards for hospital environments.	21 (53)
Giv et al. (2017)	Iran	Operating rooms	To evaluate and measure noise pollution in operating rooms during different surgical procedures.	Cross-sectional	N/A	The highest level of operating room noise pollution is higher than the current standard. Falling object noise is the main source of noise pollution.	27 (68)
Jaiswal et al. (2017)	United States	Patient rooms	To compare ambient sound and light levels and sound level changes in ICU and non-ICU.	Observational	N/A	Quieter non-ICU wards have as much sound level variation as ICU.	32 (80)
Ramm et al. (2017)	Australia	NICU	To compare noise levels recorded in pods and open NICU environments.	Repeated measurements	N/A	Noise levels in both areas exceeded the recommended range. The pods are quieter. Busy periods such as check-in and handover can cause noise peaks.	28 (70)
Wang et al. (2017)	China	Operating rooms	To describe the noise level in the operating room of a tertiary care hospital in China.	Cross-sectional	N/A	High noise levels were found in all operating rooms and consistently exceeded the currently accepted standards.	25 (63)
Aletta et al. (2018)	Belgium	Nursing home	To outline the noise sensitivity and sound perceptions of staff in their work environment.	Cross-sectional	214 staff members	Investigating other personal factors of staff may be important in determining an individual's perception of an acoustic environment.	34 (85)
Baqar et al. (2018)	Pakistan	Public-sector hospital and private-sector hospital	To investigate the noise pollution levels in public and private hospitals in Lahore.	Repeated measurements	N/A	All public and private hospitals recorded noise levels exceeding the permissible limits. The noise levels in public hospitals were higher than those in private hospitals throughout the day.	25 (63)
Alzoubi and Attia (2019)	Jordanian	Patient room	To assess the acoustic privacy and acoustic comfort of a patient's room during the stay.	Repeated measurements	N/A	The doors tested in this study did not meet international standards and the door construction should be reconsidered.	24 (60)

Authors	Country	Healthcare Settings	Objective	Study Design	Sample Size and Population	Key Findings	CCAT score/40 (%)
Bevan et al. (2019)	United Kingdom	Pediatric medical ward	To measure the quality of sleep and noise levels in a hospital and compare these measurements to the home environment.	Observational within case-controlled	40 children (19 male (average age 9.3) and 16 mothers (average age 37.9)	Poor sleep quality for children and their mothers in children's wards may affect children's behavior, recovery and pain tolerance while increasing parental burden and stress.	38 (95)
Bliefnick et al. (2019)	United States	Patient rooms and nursing stations in the hospital.	To discover acoustic indicators that correlate with patients' perceptions of hospital soundscape conditions.	Repeated measurements	N/A	None of the five units achieved a good rating.	26 (65)
Loupa et al. (2019)	Greece	General hospital	To investigate indoor noise conditions in Greek general hospitals	Repeated measurements	N/A	Noise levels varied considerably over time. The noise exposure levels were all below the guideline values for the lowest exposure action values recommended for the workplace.	33 (83)
Wu et al. (2019)	China	General wards	To identify the effects of heat and sound on environmental comfort in heating zones in northern China.	Mixed-methods	220 participants (M = 49, SD = 15.01, 110 males and 110 females)	Acoustic comfort in the ward was satisfactory due to the acceptable range of measured sound levels. The thermal environment can improve the evaluation of acoustic comfort.	24 (60)
Yarar et al., 2019	Turkey	Operating room, clinics, outpatient in the hospital	To determine the noise levels in different parts of a hospital in maternity and pediatric education and research. hospital	Descriptive	N/A	The noise levels measured in this study were far higher than the international recommended noise levels.	30 (75)
Zijlstra et al. (2019)	Netherlands	Outpatient infusion center	To evaluate the effect of non-talking rules on actual sound levels and the perceptions of patients in outpatient infusion centers.	Quasi-randomized trial	263 participates (M = 53, SD = 14.33, 126 patients in non-talking conditions and 137 patients in talking conditions).	Behavioral rules are not sufficient to reduce sound levels and improve the perceptions of patients in outpatient infusion centers.	25 (63)
Chaudhary et al. (2020)	India	ICU	To evaluate and compare the effectiveness of ear plugs and eye masks with ocean sound on sleep quality in ICU patients.	Crossover randomized controlled trial	68 participants with at least 24 hours of ICU stay	Ear plugs and eye masks are more effective than ocean sound in improving sleep quality in ICU patients.	24 (60)

Authors	Country	Healthcare Settings	Objective	Study Design	Sample Size and Population	Key Findings	CCAT score/40 (%)
Greenfield et al. (2020)	Canada	PICU	To describe the light and sound characteristics of the rooms of critically ill children.	Prospective observational cohort study	100 critically ill patients aged 0 to 18 requiring respiratory or cardiovascular support.	Sound levels barely changed during the day and night. Most patients experienced significant sound peaks overnight.	28 (70)
Hughes Driscoll et al. (2020)	United States	Labor and delivery unit	To assess the impact of mobile communication devices and clinical mobility on noise levels in the labor and delivery unit of a medical center.	Cross-sectional	N/A	The use of a clinical mobile platform for smartphones as an alternative to overhead paging communications is associated with a significant reduction in transient noise.	27 (68)
Xie et al. (2020)	China	Nursing units	To investigate the subjective perceptions of residents and caregivers, as well as the objective acoustic parameters of each care unit.	Mixed-methods	75 residents and 30 members of the nursing staff	Residents spent the majority of their waking hours in bedrooms and nursing stations. Both residents and staff ranked the sound environment as the second most important factor in the physical environment after air quality.	25 (63)
Cui et al. (2021)	China	Nursing home	To investigate the sound perceptions and preferences of the elderly in the main indoor public spaces of the nursing home,	Mixed-methods	348 elderly people	This study may help to improve the quality of life of elderly people in nursing homes and provide a reference for the construction and design of nursing facilities.	24 (60)
Darbyshire and Duncan Young (2021)	United Kingdom	ICU	To collect sound level data from a general adult intensive care unit.	Observational	N/A	In the ICU, environmentally sound protection may need to focus on reducing disturbances rather than reducing the overall decibel values.	29 (73)
Mu et al., 2021	China	Comprehensive activity hall of nursing home	To evaluate the perceptions and preferences for sound among elderly nursing home residents.	Mixed-methods	320 elderly people	The overall environment and facilities of the nursing home were good, featuring a large integrated activity hall, but the acoustic environment in the activity hall was not ideal.	31 (78)
Capriolo et al. (2022)	United States	NICU	To determine the effects of neonatal intensive care unit design and environmental factors on neonatal sound exposure.	Observational	N/A	Smartphone application may help to audit an NICU's voice exposure in quality-improvement efforts.	28 (70)
Foo et al. (2022)	Australia	Acute, non-ICU hospital setting	To examine environmental and operational factors that disrupt sleep in an acute non-ICU hospital setting.	Randomized controlled trial	60 patients (20 in shared ward, 20 in single ward, 20 in sleep laboratory)	Noise levels and frequent operational interruptions are significant barriers to sleep.	30 (75)

ICU, intensive care unit; M, mean age; N/A, not applicable; NICU, neonatal intensive care unit; PICU, pediatric intensive care unit; SD, standard deviation.

2.5 Quality Assessment

Following the study selection described above, the Crowe critical appraisal tool (CCAT) was used to assess the quality of the selected literature (Crowe, 2013). The CCAT emphasizes using a research design appropriate to the research question rather than how good the research design is. The compass scores each paper on eight categories: preliminaries, introduction, design, sampling, data collection, ethical matters, results, and discussion. Each category was scored in whole numbers from 0 to 5, with a total maximum score of 40 for a paper. Following the thorough review, the quality assessment scores and percentages for all the reviewed studies are listed in Table 2.

3. RESULTS

Figure 1 shows the PRISMA flowchart of the study selection process. Using the initial search strategy, the authors identified 4,796 papers in the databases in the first stage. In the second stage, 3,031 duplicate records were automatically removed using Endnote software, and the titles and abstracts of 1,527 records were further screened manually, based on the inclusion and exclusion criteria. The third stage involved the full-text reading of 238 articles. Studies were excluded for the following reasons: they were non-general healthcare institutions, the study populations were patients with specific diseases, they featured treatment-related sound-level assessments, and they were review articles. In total, 25 articles were identified after this phase.

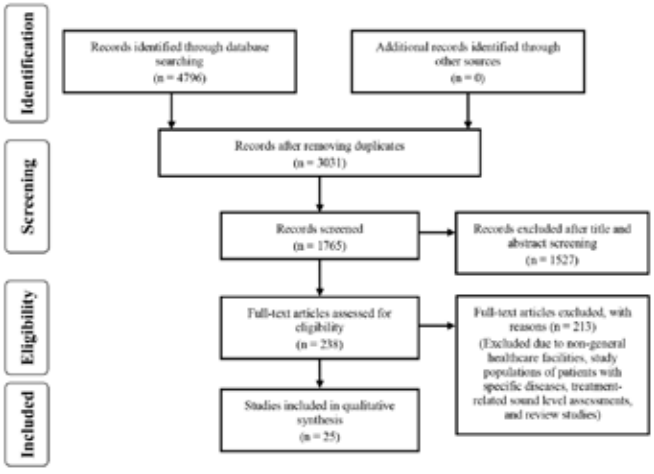

Figure 1: *PRISMA flow diagram*

In this review, there were five cross-sectional studies, seven descriptive studies, four observational studies, one prospective observational cohort study, three randomized controlled trials, and five mixed-methods studies. Twelve studies were conducted in Asian countries, four in the United States, three in Europe, two in the United Kingdom, two in Canada, and two in Australia. Eleven studies contained population samples with a minimum sample size of 12 participants (Disher et al., 2017), five studies had sample sizes between 40 and 100, and the remaining five had sample sizes greater than 200. Most studies were of moderate quality. According to the CCAT scores, four studies were above 80%, nineteen were between 60% and 80%, and two were below 60%.

3.1 Perceived sound in healthcare settings (RQ1)

Eighteen studies reported on sound levels in hospital settings. One study measured the equivalent continuous A-weighted sound pressure level (LAeq) over 24 hours in five units in the same hospital. All the units were deemed to have achieved a good rating for the sound environment. The minimum values ranged from 33 to 45 dB(A) and the maximum values ranged from 89 to 99 dB(A) (Bliefnick, Ryherd, & Jackson, 2019). Another study measured a minimum noise level of 52.51 ± 2.37 dB and a maximum noise level of 81.25 ± 3.21 dB in hospitals, well above the internationally recommended standards (Yarar, Temizsoy, & Günay, 2019). The study obtained sound measurements of 45-65 dB in hospitals in the heating zones of northern China (Wu, Meng, Li, & Mu, 2019). The average sound level in the pediatric ward of a UK children's hospital was 48.6 dB(A), compared to 34.7 dB(A) in a bedroom at home (Bevan et al., 2019). One study measured sound pressure levels indoors and outdoors in a general hospital in Greece. The highest noise levels, 73 and 79 dB(A), occurred in the blood donation unit and laundry room, respectively (Loupa, Katikaridis, Karali, & Rapsomanikis, 2019). One research investigation found that noise pollution was significantly higher in public hospitals than in private hospitals (Baqar et al., 2018). In acute hospital wards, overhead speaker announcements were the most common noise disturbance (Foo, O'Driscoll, Ogeil, Lubman, & Young, 2022). In delivery units, 77% of all sound levels measuring 60 dB or more were generated through overhead paging systems (Hughes Driscoll, Cleveland, Gurmu, Crimmins, & El-Metwally, 2020). A study by Wang et al. (2017) measured the noise levels in operating rooms at 64.2 (±2.1) dB(A), with a range of 59.2 - 72.3 dB(A). The maximum noise pollution associated with orthopedic surgery was 79 dB, and the lowest noise pollution related to cardiac and laparoscopic surgery ranged from 63 to 65 dB (Giv, Sani, Alizadeh, Valinejadi, & Majdabadi, 2017).

In addition, eight studies related to hospital settings discussed sound levels and noise-producing sources in intensive care units (ICU). A study by Fasih-Ramandi and Nadri (2017) found that the noise exposure levels of ICU patients were consistently higher than the recommended range. One study found that ICU wards were louder than non-ICU wards (Jaiswal, Garcia, & Owens, 2017). The average sound level in one ICU was 47.4 dB(A) over the full time range (Darbyshire & Duncan Young, 2021). Furthermore, there was a slight diurnal variation in the sound levels in a pediatric intensive care unit (PICU) (Greenfield et al., 2020). An NICU could reach a maximum average noise level of 72.1 dB(A) during the week, while ventilators with alarms produced a maximum noise level higher than 82.14 dB(A) (D'Souza et al., 2017). Disher et al. (2017) measured upgrades in three types of NICU wards with high, medium, and low acuity. They found that both the maximum and minimum sound levels occurred in the low-acuity NICU wards, with a range of 43 - 61 dB(A). Two studies evaluated the ambient noise levels in a pod and an open-plan NICU in the same hospital. The sound levels in the open plan area in the first study were approximately 3 dB higher than in the pod (Ramm, Mannix, Parry, & Gaffney, 2017). The second study also obtained the highest sound levels from the open pod; they ranged from 53.8 - 78.9 dB (Capriolo et al., 2022).

An outpatient infusion center had sound levels of 39.7 dB(A) at night and above 39.7 dB(A) during treatment (Zijlstra, Hagedoorn,

Krijnen, Van Der Schans, & Mobach, 2019). Four studies focused on noise levels in the nursing home environment. Three categories of sound levels were generated by the combined-activity spaces in nursing homes: resting and reading activities at less than 35 dB(A); low-decibel activities at less than 50 dB(A); and high-decibel activities at greater than 60 dB(A) (Mu, Kang, & Wu, 2021). The study by Cui, Zhang, and Li (2021) investigated the range of sound in the main areas inside a nursing home. The living space reached a maximum sound level of 60 dB(A) or more; the sunroom 45 dB(A), and the bedrooms 30 - 40 dB(A); the health center corridor sound levels did not exceed 60 dB(A) during working hours (Xie, Zhong, & Liu, 2020). A soundscape survey of nursing home staff found that those in the nursing unit had the lowest perception of sound (Aletta et al., 2018).

3.2 Associations between healthcare settings and sound (RQ2)

This paper supports the existence of an association between healthcare settings and sound through the assessment of the characteristics of healthcare settings and sound-related outcomes. Four studies illustrated the association between different healthcare services and sound. An ICU is unlikely to meet the recommended sound level standards in the absence of human factors. The ICU is a site with high sound levels, where equipment was found to cause the most significant variations in ambient sound (Disher et al., 2017). A descriptive study found that devices in a neonatal intensive care unit (NICU) produced noise beyond the repair range. Of these devices, ventilators with alarms caused the most noise (D'Souza et al., 2017). A cross-sectional study evaluated the sound levels in an ICU. As each bed in the ward was connected to medical equipment, the sound level was higher at lower frequencies (Fasih-Ramandi & Nadri, 2017). In addition, a cross-sectional study reported the association between the operating room and sound. The study measurements were taken during nearly five consecutive procedures of the same category performed in the operating room each day, reflecting the noisy environment of the operating room. Staff-related activities and conversations were found to be a major component of operating room noise (Wang et al., 2017).

Two studies identified associations between activities and behaviours and sound in healthcare settings. One study found that musical activities can improve the comfort of the sound environment in nursing homes. The study used questionnaires and field measurements to assess the sound-related perceptions and preferences of elderly nursing home residents. During music-related activities in the activity hall, older participants found the sounds of singing and dancing more comfortable than chess and card playing (Mu et al., 2021). A quasi-randomized controlled trial asked one group of patients not to talk to other patients and visitors, while another group was asked to talk. The results suggested that the behavioural rule of non-speaking reduced the sound levels in outpatient infusion centres, but the observed differences were minimal and insufficient to improve patient perceptions (Zijlstra et al., 2019).

Three studies demonstrated the association between architectural features/materials and sound. One study compared two NICU environments in the same hospital. The sound levels in the pod environment were statistically significantly lower than in the open NICU (Ramm et al., 2017). Building materials were associated with acoustic privacy and acoustic comfort in patient rooms. The study results showed that the sound transmission class (STC) of hospital ward walls was 45 dB and the external walls were thick enough to prevent sound transmission. In contrast, the sound transmission level of doors was 11 dB lower than the standard, which negatively affected indoor sound pressure levels (Alzoubi & Attia, 2019). Greenfield et al. (2020) found that the sound levels of new and existing paediatric wards were almost the same, even though both new rooms differed significantly from the existing ones in size and construction materials.

Two studies evaluated the association between mobile communication devices and sound levels. One study found that using a clinical mobile platform for smartphones as an alternative to overhead paging communication significantly reduced transient noise (Hughes Driscoll et al., 2020). Another observational study found that using a smartphone app could identify environmental factors in the NICU that could be improved and help to reduce sound exposure (Capriolo et al., 2022).

3.3 Effects of sound in healthcare settings on patients and staff (RQ3)

Sleep. The average night time sound levels in one hospital's general wards and telemetry floors reached the range of outdoor. They impacted the sleep environment of non-ICU patients (Jaiswal et al., 2017). A randomized controlled trial randomly assigned participants with poor sleep quality in an ICU setting to two groups. One consisted of participants wearing earplugs and eye masks, while the other group was provided with 30 minutes of ocean sound through headphones. The earplugs, eye masks, and ocean sound significantly improved the sleep quality of the ICU patients. Comparing the effects, earplugs and eye masks were more effective than ocean sound (Chaudhary, Kumari, & Neetu, 2020). Another randomized controlled trial documented disturbances to healthy sleep in a large tertiary care hospital. One group of patients was admitted to a shared room (n=20), one group was admitted to a single room (n=20), and the other group (a control) (n=20) was admitted to a sleep laboratory. The noise levels recorded for all three groups were consistently above the World Health Organization recommendations. Seventy percent of ward patients identified noise as a source of sleep disruption (Foo et al., 2022).

An observational study investigated differences in sleep measures at home and in a hospital through two main observations: total sleep time and sleep efficiency. The results indicated that children and mothers slept less in the hospital than at home and had relatively poorer sleep quality. The mean bedside sound level (48.2 dBA) exceeded the WHO guideline of 30 dBA (Bevan et al., 2019). The background noise levels of nursing home residents even increased by 3 to 12 dBA during sleeping hours. Noise levels in occupied bedrooms exceeded the standards for both waking and sleeping hours (Xie et al., 2020).

Health. One study measured sound for two areas of an NICU and found that the dB levels in the pod environment were statistically significantly lower than in the open-plan design NICU. The overall noise levels in both areas exceeded the recommended levels. Peak

levels reached 74.5 dB in the NICU and 75.9 dB in the pod, which has profound implications for vulnerable newborns in such a room (Ramm et al., 2017). One study monitored noise in 10 different locations in a general hospital, finding that percussive sounds and noise from metal surfaces and medical equipment were prevalent in areas where patients were present or receiving treatment, such as the emergency room and outpatient department. In the pulmonary and children's wards, noise from equipment and other activities was higher than the recommended environmental guidelines for rehabilitation; patient recovery was adversely affected (Loupa et al., 2019).

Mood. Patients with a non-speaking preference exhibited higher levels of anxiety than those with a speaking preference and those without a preference. Furthermore, patients with a non-speaking preference perceived more crowding and noise (Zijlstra et al., 2019). However, nursing home residents rated background and foreground music in their activity hall as positive. The sounds of music-related activities brought comfort to the residents (Mu et al., 2021).

Attention. A cross-sectional study found that anaesthesia monitors produced numerous distracting alarms and alerts when operating room noise was being monitored. Surgical instruments were also found to produce sudden and noticeable noise (Wang et al., 2017).

4. DISCUSSIONS

This systematic review identified 25 articles exploring sound in healthcare settings and its impacts on patients and staff. Twenty studies were related to hospitals, four were nursing home studies, and one was an outpatient study. Outpatient centres are typically used by patients requiring short-term care and medical services, so most studies in the review focused on populations exposed to sound for extended periods. Twenty-three studies measured and analysed sound levels and sources, with the sound environment being discussed most frequently in the ICU (n = 8). In our review, sound levels were generally higher in ICU units than in non-ICU units, with slight diurnal variations. One study comparing ICUs of different configurations found that the sound-level reduction was unsatisfactory, despite the shortcomings involved in improving the otherwise open-space structure (Capriolo et al., 2022; Ramm et al., 2017). This reflects the complexity of the ICU sound environment, where the unavoidable variety of devices and specific disturbance events are the main factors contributing to persistently high noise levels. The amount of procedural work in the operating room contributes to the noisy sound, so the solutions proposed in the existing studies involve adapting and optimizing the medical procedures in ICU and operating room environments. However, medical procedures are only part of the noise problem and create some difficulties as a solution (Theodore, 2018; Yarar et al., 2019).

This study found associations between types of services; activities and behaviours; building features and materials; and mobile communication devices and sound in healthcare settings. Healthcare services represented by ICUs and operating rooms were strongly associated with high noise levels. A positive correlation has been identified between musical activities and the comfort level of sound environments in nursing homes. Non-speaking behavioural rules are associated with reduced sound levels in outpatient centres. Moreover, there is evidence that improvements to a building's physical structure and materials can effectively control noise, but varying results have been obtained. One study showed significantly lower sound levels in a pod environment than in an open NICU (Ramm et al., 2017), while another prospective study found little difference between the sound levels of the wards of the two structures (Greenfield et al., 2020). Finally, the existing studies reveal that it is challenging to reduce background noise by changing the devices needed for patient care. In comparison, mobile communication devices can not only replace noise-generating paging communication in clinical settings (Hughes Driscoll et al., 2020) but also recognize sounds in the environment through apps to identify parts that need improvement (Capriolo et al., 2022). Mobile technology-related interventions could provide feasible solutions for acoustic environments and deserve further attention.

Additionally, sound in healthcare settings can affect patients' sleep, physical health, and mood, as well as staff attention. Most studies in this review (n = 5) focused on sleep issues, with two randomized controlled trials, two observational studies, and one mixed-methods study. Although intervention studies have demonstrated sleep disturbance due to high noise levels and specific events in healthcare settings, limitations remain. Specifically, frequent night time sound peaks are a significant factor in sleep disruption. Nevertheless, the available studies do not propose targeted interventions for this. In addition, none of the studies report the long-term effectiveness of such an intervention, which presents a challenge when addressing patients' sleep problems. Only one study mentioned the impact of sound on staff in terms of their attention, which mainly involved distractions caused by operating room equipment and frequent alarms (Wang et al., 2017).

Sound in healthcare settings is usually discussed in combination with other factors. Examples include sound and light (Greenfield et al., 2020; Jaiswal et al., 2017), sound and room configuration (Ramm et al., 2017), as well as sound and thermal environment (Wu et al., 2019). None of these studies provide practical standards for optimal sound environments, although observations and measurements were made for each of these considerations.

Based on these studies, sound effects in healthcare settings have primarily been regarded as negative. However, a recent nursing home-related study showed that residents could perceive positive effects of sound from various activities in the activity halls (Mu et al., 2021). In our review, the number of studies on nursing homes was only one-fifth of the number of studies in hospital settings. Institutional nursing homes are more enduring care settings than hospitals, and they play a decisive role in people's understanding of and engagement with voice (Greubel, 2020). More attention to the acoustic environment in nursing homes and long-term care facilities is still needed in the future. This article has a limitation. Most of the studies included in the review did not have a study population. The included studies may not be sufficiently comprehensive when examining the impacts of sound in healthcare settings on patients and staff.

5. CONCLUSION

This study reports a systematic review of the literature on sound in healthcare settings. Twenty-five of the papers reviewed explored perceived sound sources or sound levels in healthcare settings, or the effects of sound on patients and staff in terms of sleep, physical health, mood, and attention. The review attempted to discuss relevant studies from a broad perspective to obtain evidence of variations between different healthcare settings. The results indicate that sound in all healthcare settings is boisterous. Most studies in hospital settings discussed the noise inevitably generated by medical equipment in ICUs and operating rooms. Although considering building-related factors was effective in improving the acoustic environment of hospitals, the results of solutions regarding sound were not significant. The review found positive resident evaluations of sound only in the context of musical events in nursing homes. Current evidence is limited, and the evaluation of long-term solutions is lacking. Future standards of practice should provide optimal acoustic environments for patients and staff, based on different healthcare settings.

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UNDERSTANDING THE EXPECTATIONS OF VISITORS IN PLANNING AND MANAGING THE FACILITIES OF PUBLIC PARKS

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ABSTRACT

Public parks play a significant role in the promotion of human well-being, nature protection and as a medium for ecosystem regeneration. Nonetheless, the provision and management of facilities in Malaysia's public parks has been inconsistently and inadequately administered due to budgetary constraints. To optimise a limited budget whilst safeguarding the multidimensional benefits of parks, this paper aims to identify and classify park facilities according to its vitality. The research was conducted in two stages, involving observation and a questionnaire survey. In total, 1,658 respondents who had experience of visiting the public parks in Malaysia took part in the survey. Exploratory factor analysis (EFA) and reliability analysis were deployed using the Statistical Package for the Social Sciences (SPSS) software to classify the park facilities whilst measuring the consistency of the classification. Nineteen identified facilities were classified into two constructs, namely essential facilities and value-added facilities. The research outcome serves as a guide to plan and manage public parks within budget limitations. Moreover, future research from the perspective of motive and satisfaction in relation to visiting a park is recommended to validate the provision and maintenance of essential and value-added facilities.

1. INTRODUCTION

Public parks play a vital role to tackle environmental issues and to diminish some of the challenges related to climate change (Ibrahim et al., 2020). These parks act as a natural buffer that contribute to sustainable development (Hussain et al., 2010). They are effective in reducing the effects of urban heat islands, mitigating flooding and water pollution, as well as maintaining the ecosystem of flora and fauna. Besides that, public parks provide avenues for people to conduct recreational, leisure, and social activities within their communities (Talal & Santelmann, 2021). They offer healthy and active lifestyles by providing opportunities for physical and mental recovery as well as social interactions in an outdoor environment (Ishak et al., 2018). Parks also provide a crucial role as recreational spaces and an indirect source of health resources during the COVID-19 pandemic (Volence et al., 2021). Hussain et al. (2010) claim that plants in the parks purify the environment by reducing air pollution. Besides beautifying the city, parks help reduce mental stress and increase thinking concentration of the visitors. Likewise, a study by Moyle and Weiler (2016) reveal that park visitation increases positive perceptions among park visitors. According to Younis et al. (2008), the parks also improve the urban communities' socio-economic conditions. These studies have shown the benefits and importance of parks. Nevertheless, these benefits are possessed only when parks are fully utilised by the public (Park, 2020). Therefore, it is crucial to identify the factors influencing the utilisation of public parks.

Talal and Santelmann (2021)'s investigation on the access and use of public parks found that the majority of visitors seek improvements in terms of the provision and maintenance of park facilities such as washrooms, rubbish bins, playgrounds, etc. A recent study of Fontán-Vela et al. (2021) confirmed the association between park maintenance and park use. The study suggested for more investment in public parks to increase park maintenance. Hence, the quantity

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and quality of facilities in public parks are of paramount importance to escalate park use (Park, 2020). Parks are dynamic structures that change continuously with ecological, sociological and economic conditions (Güngör & Polat, 2018). Nonetheless, good park upkeep and maintenance are important park characteristics in fostering park visitation (Mertens et al., 2019). The presence of playground slides, absence of rubbish/graffiti, and the presence of swings and walking paths are important park characteristics that are also crucial in inviting park visitors (Veitch et al., 2017). Furthermore, maintenance is necessary to preserve the attractiveness of public parks because maintenance and attractiveness of parks provide a first impression of parks to the public (Narh et al., 2020).

Studies have also revealed that the growth of green space in Berlin, Germany, has been negatively impacted by lower investment in green spaces as a result of financial constraints on municipal budgets (Kabisch, 2015). According to Reeves (2000), the condition of urban public parks in Britain have deteriorated over the past 30 years as a result of annual budget cuts due to the lack of recognition of parks services. In Malaysia, however, provision and maintenance are affected by financial issues faced by the local authorities, impacting the quality of park facilities (Ishak et al., 2021). The issue has been unresolved for more than a decade, leading to the underutilisation and even abandonment of public parks. Wahid (2005) claimed that a public park located in Kuala Lumpur is abandoned. In this particular public park, the public toilet has no water supply, the park's landscape is not maintained, and rubbish is littered the park. Aznari Mohamed (2011) reported that the public park in Kampung EXPO is abandoned because there is no maintenance concern from the relevant authority. The park then becomes a hotspot for drug and vice activities. Sharifudin (2014) stated that a public park in Cheras requires attention from the authority of the Kuala Lumpur City Hall. The amenities and facilities have been damaged due to vandalism and lack of maintenance. Likewise, Hussein et al. (2016) revealed that design and maintenance of parks are the issues faced by the community because of inappropriate park design by the planners, as well as inadequate maintenance and management by the local authorities.

The budgetary issue faced by the local authorities appears unresolvable. Therefore, a balance between budget control and park facilities provision or maintenance is required. This balance can be achieved by investigating visitors' expectations towards public park facilities, whereby the provision and maintenance of park facilities should be more heavily weighted on facilities that are more desired by the visitors. Thus, this paper aims to identify and classify park facilities using exploratory factor analysis (EFA). The classification of park facilities would be used as a guideline for the planning and maintenance of public parks.

2. BACKGROUND

Design, planning and management of public parks that consider user demands and preferences usually stimulate park visitation (Zainol & Au-Yong, 2016). The experience and satisfaction of park visitors depend on the availability of facilities in the green space area. Thus, it is necessary for the relevant authorities to consider appropriate provision and management of facilities in order to enable park users to engage in their respective recreational targets (Ahmad Shafee & Kamaruddin, 2019). Recreational target is a form of goal where users visit a park with the intention to earn benefits in aspects of physical, mental, and social well-being (Ayala-Azcárraga et al., 2019). Hence, the accessibility of facilities should be in favour of people's needs, demands and preferences, failing which, users may become frustrated and in a worst case scenario the green space may go underutilised or abandoned (Abdullah et al., 1999; Ali & Nawawi, 2006).

Ali and Nawawi (2006) pointed out that the evolving significance of public parks is greatly established on the preferences of activities by the visitors as well as the commitment to maintenance by the relevant authorities. The maintenance of park facilities is vital to sustain the satisfaction of users (Liu & Xiao, 2020). The inclusion of preferred activities in the park indirectly reveals which facilities are being utilised when participating in activities. Commonly, the preferred activities are coded in two categories namely, sedentary and vigorous physical activity (Parra et al., 2019; Pineda, 2014).

The socio-ecological framework in Figure 1 considers not only human behaviour but also how individuals interact with their environment, because the environment may have an impact on whether people participate and use the urban green space. The socio-ecological framework integrates the impact of people's environments with the broader societal context. As a result, it makes a distinction between different levels of influence on a person's behaviour, which can be broken down into two categories: (1) individual factors, such as age and education, as well as social and familial connections, and (2) environmental factors, such as the physical and cultural environment (Giles-Corti et al., 2005).

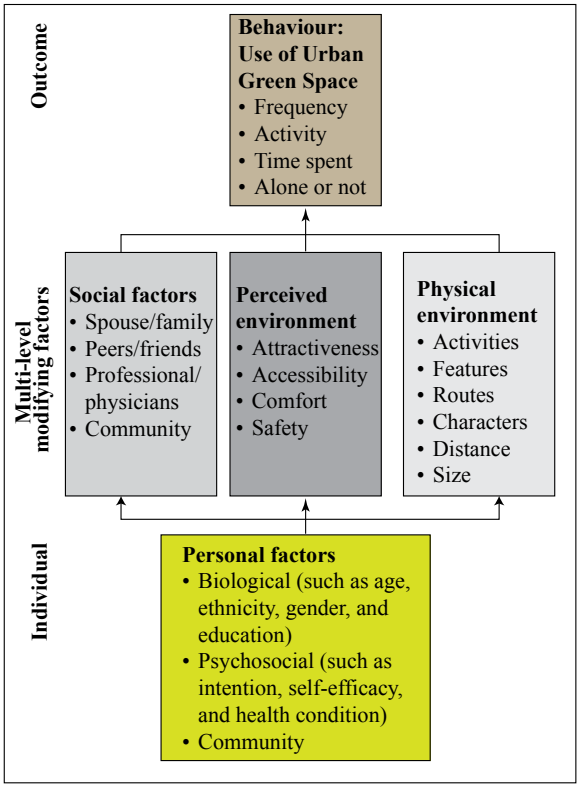

Figure 1: *A socio-ecological framework of the use of urban green space. Inspired by Sallis et al. (1993), Giles-Corti et al. (2005), Hutzler (2007), and Schipperijn (2010).*

According to Schipperijn (2010), the behaviour 'use of green space' can be seen as the result of various interactions between social factors, the perceived environment, the physical environment (i.e., the features of the green space itself) and personal factors. The framework illustrates how multiple levels of modifying factors interact with individual behaviours to influence how people use urban green spaces (Hutzler, 2007; Sallis et al., 1993).

In the Malaysian context, family activities are the most desired activities among many visitors, and they need support of facilities for all ages like playground, picnic facilities, and walkways (Cohen et al., 2016). These are followed by passive observation and social activities that consist of social interaction, which require the presence of a lake or natural scenery. Physical activities follows this, which requires the presence of a soccer field, basketball court, jogging path, etc. (Maulan, 2008, 2015). In addition, users request extra provision of outdoor gym, swimming pool, bicycle track and camping site to facilitate their activities (Maulan, 2008). Goh and Mahmood (2016) also emphasised that adequate public amenities and facilities such as signage, restaurants, souvenir shops and parking are crucial to the satisfaction of users. Hence, the public park is deemed as a hub for recreational and sports activities for the community (Ishak et al., 2021).

In line with how preferred activities indicate the utilisation of park facilities, motives or reasons to visit park are also effective indications of facilities that may be preferred by the public. For instance, Sreetheran (2017) characterised eight (8) motives of park visits, such as to breathe clean air; to release stress and relax; to workout, play sports, and stay fit; to do things with family and friends; to enjoy nature; to find peace and quiet; to meet people; and to take shortcuts. The motives that require facilities have been identified as exercise, playing sports, and staying fit. Thus, sport facilities seem to be closely related and probably highly demanded. For instance, tracks and pathways serve primary sport activities (jogging and walking) in parks (Mohamad Muslim et al., 2018; Mohd Shobri et al., 2021). Well maintained tracks and pathways essentially reduce the risk of any unwanted accidents (Abdelhamid & Elfakharany, 2020).

Othman et al. (2008) revealed that safe and beautiful parks is preferred; conversely, an unsafe and badly maintained park is not preferred. Playgrounds, gazebos, signage, water fountains and flower beds are found to be strongly preferred landscape elements; on the contrary, hazardous uncovered drains and dull looking guard houses are not preferred landscape elements (Norlizawati et al., 2007; Othman et al., 2008). Additionally, the presence of a lake, planting beds, fauna, trees, natural stones, palms, lawn, groundcover, shrubs and trails are features appreciated by users (Danjaji et al., 2018; Rouhi et al., 2017). Regrettably, not all features are upkept to an extent that could satisfy users due to poor maintenance.

Jibril and Elfartas (2018) in a study of park utilisation among Malaysian ethnic groups demonstrated that in the place of preferred activities like social and physical engagements, the quality of attributes in the park is significant to the enjoyment of park visitors. They comprise attributes related to aesthetic, safety, lighting, maintenance and cleanliness. Liu and Xiao (2020) also highlighted that park size, vegetation, recreation, recreation facility, aesthetic, maintenance of facilities and plant equipment, as well as cleanliness of the park are common factors found affecting visitor satisfaction levels. Ishak et al. (2021) further emphasised that the provision and maintenance of park facilities significantly influence the utilisation of public parks. It is necessary to provide park facilities that cater to the needs of community health and ensure that these facilities are well-maintained (Ishak et al., 2018). Therefore, the precise provision and maintenance of park facilities are of utmost importance and further investigation into these aspects is advisable.

3. RESEARCH METHOD

This study adopted mixed method research to identify and classify park facilities based on the expectations of park visitors. In particular, the first stage of the study involved an observation survey around the public parks located in Malaysia to itemise the facilities available and provided in the parks prior to the data gathering. Although some researchers such as Zainudin (2011) asserted that the use of the method would be more appropriate for studies involving human behaviour, observation in this research sought for non-living objects and non-visual aspects of the environment, such as lighting that was essential in influencing the attractiveness and usability of the parks. The observation was subsequently complemented by an online questionnaire survey, which helped in collecting respondents' perceptions and expectations towards the facilities of public parks (Graziano & Raulin, 2010). It also reached a wider geographical area, covering the entire Malaysian population within a shorter timeframe. Some previous research of similar areas also used the questionnaire survey method to investigate preferences and needs for public parks (Abdelhamid & Elfakharany, 2020; Ahmad Shafee & Kamaruddin, 2019). Typically, the questions were structured in five-point Likert's scale, where respondents were asked to rate the importance of park facilities in the aspects of provision and maintenance. The research targeted the Malaysian population as respondents, who are also deemed potential visitors of the public parks. According to the Department of Statistics Malaysia (2021), the population of Malaysia in 2021 was projected at 32.7 million. Based on this, the required minimal sample size was 385 (Krejcie & Morgan, 1970). In order to boost the number of responses, the questionnaire was randomly distributed to any Malaysians that had visited public parks via Google Form. The survey link was shared through social media platforms, including Facebook, LinkedIn, Twitter, etc. As a requirement, potential respondents could only proceed with the survey if they had experience of visiting public parks. The survey ultimately managed to collect 1,658 valid responses, which is acceptable in terms of data generalisability. Nevertheless, the limitation of the study was inevitable. The study intended to generalise the facilities of public parks in Malaysia without specifying to a park. Thus, the findings would be able to provide a general idea about the facilities provided in the public parks, but they might not accurately suit to a localised park based on the local community demand. In the data analysis stage, the Statistical Package for the Social Sciences (SPSS) software was used to run the relevant analyses. Referring to research done by Ruengtam (2017), the EFA was adopted in the data analysis stage to reduce the amount of variables to a smaller set of underlying summary variables, so called "construct". Principal component analysis was selected over other extracting methods as it is recommended when no priori theory or model exists (Gorsuch, 1983). It is also suitable

for establishing preliminary solutions in EFA (Pett et al., 2003). Meanwhile, Williams et al. (2010) highlighted that it is excellent to run factor analysis with a sample size of 1,000 or more. The output of EFA would help to identify and classify the underlying construct of park facilities in Malaysia. In addition to the EFA, Cronbach's alpha coefficient test was conducted to assess the reliability of the survey data (Leech et al., 2011).

4. RESULTS

It was crucial to identify the park facilities available and provided before the questionnaire was designed and distributed. Thus, observation of the facilities available in existing public parks within Malaysia was executed. In total, nineteen (19) park facilities were identified through this observation, as shown in Figure 2, including:

i. Natural landscape (hill, lake, stream, river, pond, etc.) (Figure 2a)
ii. Designed landscape – softscape (flower bed, mown grass, etc.)
iii. Designed landscape – hardscape (water fountain, retaining wall, fencing, etc.)
iv. Children playground (Figure 2c)
v. Water activity facilities
vi. Track/path (jogging/walking) (Figure 2b)
vii. Outdoor gym facilities (Figure 2h)
viii. Recreational facilities (cycling, horse riding, etc.)
ix. Outdoor sport facilities (football, basketball, volleyball, tennis, etc.)
x. Indoor sport facilities (badminton, futsal, table tennis, etc.)
xi. Park furniture (benches, gazebo, etc.) (Figure 2g)
xii. Picnic/camping area
xiii. Washroom (Figure 2f)
xiv. Prayer room (Figure 2d)
xv. Signage (Figure 2i)
xvi. Park lighting
xvii. Rubbish bin (Figure 2e)
xviii. Drinking fountain
xix. Kiosk/vending machine


A


B


C


D


E

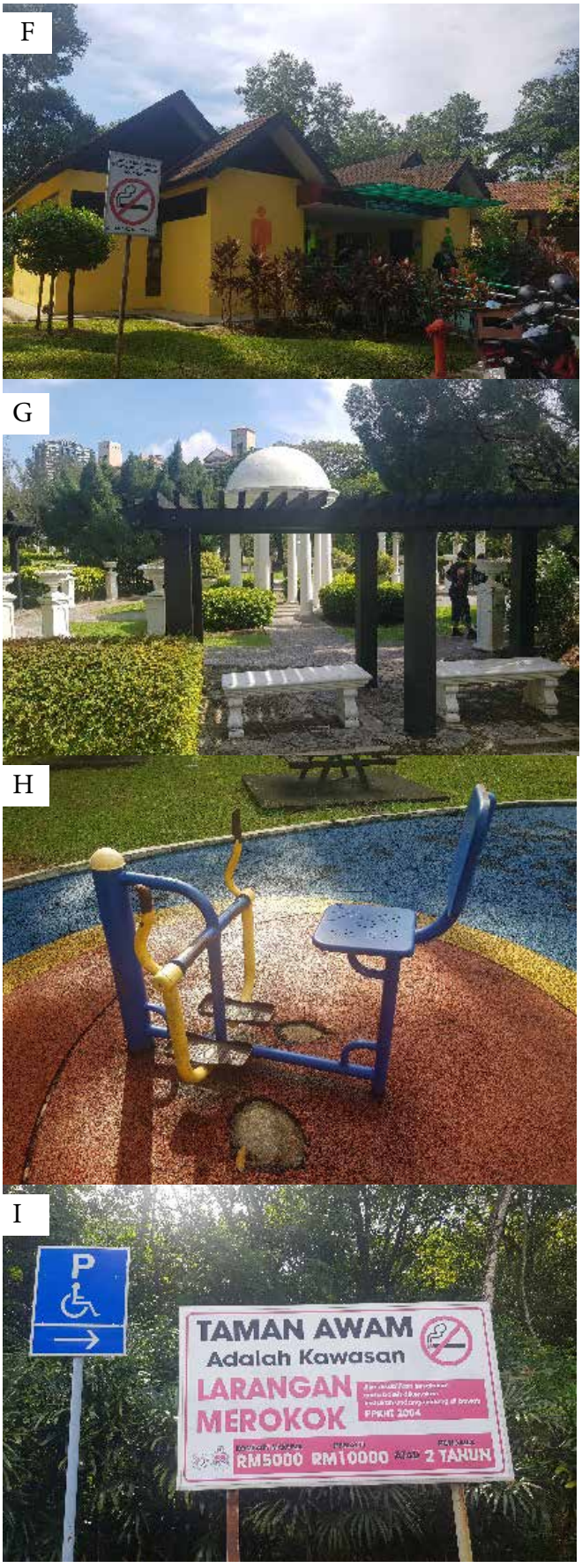

Figure 2: *Facilities in public parks*

The questionnaire then covered all the identified park facilities for further investigation in the survey. Prior to answering the objective of research, the various demographic profiles of the questionnaire survey respondents were recorded and tabulated in Table 1. The research took into consideration respondents from different demographic profiles, with the intention to acquire equal feedback from the community. Overall, the respondents were from different genders, ethnicities, age groups and income groups.

Table 1: *Demographic profiles of the respondents*

Description		Frequency	Percentage
Gender			
·	Male	645	38.9
·	Female	1,013	61.1
Ethnic			
·	Malay	900	54.3
·	Chinese	601	36.2
·	Indian	113	6.8
·	Sabah/Sarawak native	39	2.4
·	Others	5	0.3
Age			
·	Below 21	255	13.6
·	21-30	1,069	64.5
·	31-40	144	8.7
·	41-50	130	7.8
·	51-60	50	3.0
·	Above 60	40	2.4
Monthly income (Malaysian Ringgit, RM)			
·	Below RM2,000	1,095	66.0
·	RM2,000-RM2,999	210	12.7
·	RM3,000-RM3,999	144	8.7
·	RM4,000 and above	209	12.6

As the aim of this paper was to be achieved by interpreting the EFA outputs, essential coefficients of the EFA were presented. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to examine the suitability of the respondent data for the EFA. The KMO index of the research data was 0.955 (>0.50); while the Bartlett's Test of Sphericity significance value was 0.000 ($p<0.05$), both indicating that the data was suitable for the EFA (Williams et al., 2010).

In the extraction of the EFA, the analysis output demonstrated two components where initial eigenvalues of more than 1 were the constructs in this EFA (Ruengtam, 2017). The percentage of explained variance was 58.87%, as shown in Table 2. According to Williams et al. (2010), an explained variance ranging from 50-60% is acceptable in social science and humanity research.

In order to generate a more interpretable and simplified finding, rotation was done to the EFA. This research adopted the Oblique Oblimin rotation because the rotation produced correlated constructs, which is often seen as producing more accurate results for research involving human behaviours or perceptions (Williams et al., 2010). The rotation outputs were tabulated in Table 2. Furthermore, a reliability analysis was conducted towards all variables and constructs respectively using Cronbach's alpha coefficient. The coefficients were 0.927, 0.895, and 0.942 for Construct 1, Construct 2 and all variables respectively. All of them were deemed acceptable with coefficients greater than 0.70 (Leech et al., 2011). In addition, the correlation coefficient between Construct 1 and Construct 2 was 0.611.

Table 2: *Factor loading of the EFA and total variance explained*

Park facilities	Construct		Initial Eigenvalues		
	1	2	Total	% of Variance	Cumulative %
Rubbish bin	.902		9.431	49.636	49.636
Park lighting	.875				
Washroom	.867				
Signage	.839				
Park furniture	.802				
Track/path	.789				
Natural landscape	.748				
Designed landscape – softscape	.633				
Designed landscape – hardscape	.525				
Prayer room	.492				
Indoor sport facilities		.919	1.755	9.234	58.870
Water activity facilities		.853			
Recreational facilities		.815			
Outdoor sport facilities		.792			
Outdoor gym facilities		.619			
Kiosk/ vending machine		.578			
Drinking fountain		.481			
Children playground		.460			
Picnic/ camping area	.335	.429			
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.					
a. Rotation converged in 6 iterations.					

5. DISCUSSION

According to the results, the EFA classifies the nineteen (19) park facilities into two constructs. None of the items were omitted from the EFA as their factor loadings are more than 0.4, which indicate the importance for these items to be included in the respective constructs (Williams et al., 2010). Construct 1 consists of rubbish bin, park lighting, washroom, signage, park furniture, track/path, natural landscape, designed landscape – softscape, designed landscape – hardscape and prayer room; while Construct 2 includes indoor sport facilities, water activity facilities, recreational facilities, outdoor sport facilities, outdoor gym facilities, kiosk/vending machine, drinking fountain, children playground and picnic/camping area.

Based on the outcome of the observation, the park facilities listed in Construct 1 are available and have been provided in all observed parks in Malaysia. They are basic facilities in public parks that meet the common needs of the public (Hussain et al., 2010; Ishak et al., 2018; Volence et al., 2021). Nonetheless, the park facilities grouped in the Construct 2 are selectively available and provided in some observed parks. Therefore, the park facilities under Construct 1 are considered as essential park facilities, while the park facilities under Construct 2 are deemed value-added park facilities. The classification of park facilities is tabulated in Table 3.

Table 3: *Classification of park facilities*

Classification	Park facilities
Essential park facilities	Rubbish bin
	Park lighting
	Washroom
	Signage
	Park furniture
	Track/path
	Natural landscape
	Designed landscape – softscape
	Designed landscape – hardscape
	Prayer room
Value-added park facilities	Indoor sport facilities
	Water activity facilities
	Recreational facilities
	Outdoor sport facilities
	Outdoor gym facilities
	Kiosk/vending machine
	Drinking fountain
	Children playground
	Picnic/camping area

The classification of park facilities can be used as a guide for the planning and management of public parks. In order to meet the expectations of potential visitors, the development of new public parks must provide essential park facilities. These classifications add to the park characteristics studied by previous scholars (Mertens et al., 2019; Veitch et al., 2017). Moreover, these classifications will allow stakeholders to focus on which facilities are to be prioritised and addressed first. Meanwhile, a community survey can be implemented to determine and consider the inclusion and management of desired value-added park facilities prior to the development of a public park within a specific community. Future research is suggested to study the planning and management of park facilities based on the motives behind visits to parks as shown in the conceptual framework in Figure 3. The suggestion is inspired by Sreetheran (2017), who mentioned that the motives behind park visits are important to discover whether certain park facilities are required.

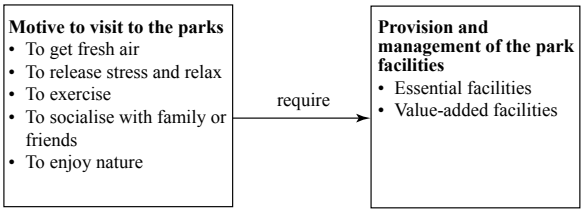

Figure 3*: Conceptual framework 1 for future research*

In the aspect of quality, the conditions of all the park facilities are varied across different parks. This scenario can be due to the distinct level of maintenance implementation from the respective local authorities. In reference to the classification of park facilities, the maintenance of essential park facilities must be emphasised. Moreover, future research is recommended to investigate the relationship between park performance and the maintenance of park facilities, as shown in Figure 4. The research outcome anticipates to develop maintenance priorities towards park facilities, which will assist park management teams to prioritise the maintenance of park facilities, especially when there is financial constraint (Ishak et al., 2021).

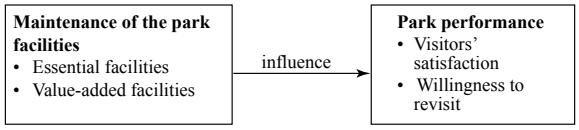

***Figure 4**: Conceptual framework 2 for future research*

5.1 Management Implications

The findings of this paper are essential as a guide to the authorities that plan and manage public parks, particularly in the aspect of the provision and maintenance of park facilities. These results support the findings by Mertens et al. (2019) and Veitch et al. (2017) who emphasised the park's characteristics to foster visitation. To ensure the sustainability of public parks, the provision and maintenance of park facilities should be visitor-oriented. Emphasis on essential park facilities is mandatory, while the provision and subsequent maintenance of value-added park facilities can be based on the preference of local visitors to the respective parks and budget availability. Budget availability should be the sole hindrance towards upgrading or maintaining existing parks. All related stakeholders should further discuss the options available to overcome budget limitations. Co-governance in park maintenance can be an option in addressing budgetary challenges and public involvement should also be considered (Molin & Konijnendijk van den Bosch, 2014). Another option is to allow the zero waste or circular economy concepts to be implemented as these are efficient techniques in park maintenance (Mumford, 2017). Consequently, the utilisation of public parks can be improved.

6. CONCLUSION

A well-developed public park is beneficial to multiple aspects such as environmental and social. However, this becomes meaningless if the park is not optimally utilised. In order to increase the utilisation of public parks, it is necessary to understand the expectations of visitors towards park facilities. Hence, this paper intends to list and classify park facilities based on visitors' demand. The findings determine nineteen (19) facilities available in public parks and group them into two classifications, namely essential park facilities and value-added park facilities. This classification of park facilities can be a helpful guide for local authorities to plan and maintain the facilities. Likewise, a community survey is recommended to determine and consider the inclusion as well as management of desired value-added park facilities prior to the development of a public park within a specific community. Furthermore, future research is recommended in the hope that the research outcomes can formulate a planning and maintenance policy for the public parks to the relevant authorities. The policy is targeted to improve the provision and maintenance of public parks. The utilisation of public parks can then be escalated. Consequently, the benefits of public parks in tackling environmental issues and enhancing the wellbeing of the public can be realised.

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THE ROLE OF PHYSICAL AND VISUAL ELEMENTS IN CREATING STREETSCAPES: CASES IN KUALA LUMPUR CITY, MALAYSIA

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ABSTRACT

Evaluating the role of physical elements in creating visually pleasing streetscapes has not been deeply addressed in recent research flow, especially for the context of Kuala Lumpur City. The gap is also accentuated by Kuala Lumpur City Hall as disharmony and inconsistency in streetscapes and lacking visual coherence in most streets in Kuala Lumpur. Therefore, the current paper seeks to evaluate the role of physical and visual elements in creating visually pleasing streetscapes of Bukit Bintang and Tuanku Abdul Rahman using a self-administered questionnaire survey. The respondents of the study comprise 330 passers-by aging from 18 to 50 years old, who visit the streets, reside, or work there. The results demonstrate that transparency, the quality that makes the function of a building visually accessible, and seating places play the most and the least important role in creating streetscapes in the study areas respectively. Comparison of the results in two streets highlights that harmony between and consistency in the facades of modern and traditional buildings, simplicity in design elements of facades, inviting building entrances, and covered walkways contribute to creating attractive streetscapes. Overall, the findings build foundations for restoring the visual coherence, which results in resilient streetscapes in cities.

1. INTRODUCTION

Various studies on the design of built environment have given a due attention to a street as a public space (Lynch, 1960; Moughtin, 2003). People may regularly visit streets and communicate with friends, neighbors, co-workers, and even strangers (Mehta, 2007). A street is deemed as a dynamic public space that instills the sense of movement (Carmona et al., 2003). Observers' evaluation of streetscapes mainly relates to the physical and visual elements of streets such as buildings and landscape features. Although a plethora of studies such as Askari & Dola (2009), Askari et al. (2014), Askari & Soltani (2018), and Santosa et al. (2018) evaluated the role of visual elements and features, determining the role of physical and visual elements in improving streetscapes in Southeast Asian urban contexts, especially Kuala Lumpur is still a gap (Oranratmanee & Sachakul, 2014). On top of that, piecemeal development has negatively tarnished the quality of streetscapes in Kuala Lumpur, which is represented by physical character, continuity of streets, building frontages, street lighting, and other forms of street furniture (Kuala Lumpur City Hall, 2008).

The theoretical base of the paper builds upon the studies of Jacobs (1993) and Sucher (2010) that worked on streetscape and its physical elements. In this regard, the paper focuses on the visual and physical features such as building facades, trees, seating spaces, and transparency. Having this considered, the first part of the paper reviews the relevant issues concerning streetscapes. The second part discusses research methods and data collection procedures. Last, the paper presents results, discussions, conclusions, and contribution to the field.

2. RESEARCH AIM

The aim of the current paper is to improve streetscapes in the city of Kuala Lumpur. In light of that, the objective is to evaluate the role of physical and visual elements in creating visually pleasing streetscapes in the city of Kuala Lumpur.

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3. PHYSICAL ELEMENTS OF A STREETSCAPE

Streetscapes play an important role in defining characteristics of urban areas (Nasar, 1990 and Shamsuddin, 2011). From another viewpoint, streetscape is considered a street view that relates to a complex of physical elements, people, vehicles, and urban infills (Rozaly et al., 2018). Streetscape, a significant part of townscape in cities, relies on tangible and intangible characteristics. Tangible refers to physical elements of the area, while intangible relates to behavior of people and culture within the area (Said & Hamzah, 2020). Rosnan et al. (2021) in a study on Raja Alang Street, found out that streetscape can be a strategy for creating socially livable places for people. They stated that streetscape improvement directly fosters traffic issues, pedestrian friendly circulation, landscape and hardscape of areas in cities. A well-designed streetscape leads to a better quality of life. Designing visually pleasing urban streetscapes contributes to fostering desirable living environments, legible city images, and place identity (Ab Rahman et al., 2017).

There is a relatively high correlation between measures of streetscape quality and respondent preference (Talen et al., 2022). Analysis of a streetscape is essentially an individual's interpretation of what appears to be visually significant (Tucker et al., 2004). Physical elements of an environment play an important role in constructing its identity (Proshansky, 1978). Esthetic evaluation of a streetscape mainly relates to street furniture and buildings (Warnaby, 2009) that create or enhance urban distinctiveness and experience (Carmona et al., 2003). Physical elements of a streetscape are a group of elements that shape streets as the community gathering places. Appleyard (1981) and Madanipour (1996) contended that physical characteristics of a streetscape fall under building facades, urban patterns and landscape features.

Streetscape, as the combination of hard and soft elements, contributes to creating a street's environment and view (Anuar & Asif, 2020). They pointed out that streetscape relates to visual elements and characters of a street, which comprises green spaces, pedestrians, and street furniture. Othman & Othman (2018) in a study documenting the public's scenic preferences for future urban streetscape, asserted that colorful landscape elements including natural and man-made components place higher preferences for streetscapes. Soft and hard landscape, categorized under urban street furniture, have a very important role in adding meaning to the city identification and facilities of the societal life (Bulut & Atabeyoğlu, 2007). Street furniture has a major effect on improving urban decoration, organizing of the city and imparting identity to it (Bulduk, 2012).

Green infrastructure significantly imparts quality to urban streetscapes in cities (Zairuddin et al., 2020). Soft-landscape includes natural aspects, which play an important role in place settings. Soft-landscape features are divided into two groups of natural and man-made with three sub-elements of water features, vegetation, and topography (London Borough of Croydon, 2009 and Ja'afar et al., 2012). Planting proper trees with suitable distance according to guidelines and choice of trees compatible with the planting placement prevent any future problem and give esthetic values to streetscapes (Kadir & Othman, 2012). Natural elements, such as shrubs, are unique urban elements in a tropical country like Malaysia where lush green environments are intrinsic characteristics.

In most cities in Malaysia, old trees impart unique tropical characters to streetscapes. This premise is well observable in traditional streets where mature trees together with historically-significant buildings are important parts of city heritage (Shamsuddin, 2011). Hard-landscape features are the man-made (e.g. benches and street lamps) features designed to complement the soft-landscape features (Hussain & Ahmad, 2010). These elements are the characteristics that offer a connection between people, give areas a certain functional and esthetic meaning, have various quantities, and identify and complete the area (Bulut & Atabeyoğlu, 2007). Seating opportunities of a street as benches, chairs or other surfaces provided by a public agency or a private business, near activity-supporting businesses, have a strong interrelationship with liveliness and improve the memorability of streetscapes (Jacobs & Appleyard, 1996). Placement of a bench is an important feature of pedestrian amenities that influences a streetscape (Shaftoe, 2008).

Building façades outline the connection between public and private domains and their continuity defines urban spaces. Harmonious rhythm of articulated building facades plays a considerable role in improving urban streetscapes (Shokouhi & Gharai, 2006). Lower facades create an important linkage between scales, buildings, and people. For the buildings regarded as a unified entity, the lower facades should own a brilliant and friendly design (Gehl et al., 2008). Transparency is the visual quality that affects streetscape and plays an important role in public sightseeing (Frank, 2010). Transparency along frontages forms a connection between the edge and the space it surrounds. It also gives a close control over urban open spaces, permits frontages to enjoy the visual qualities of urban open space and secures users in a space (Mehta, 2009). Definition along the streets edge is important to enhance the consecutiveness of buildings along streets. The level of transparency from the private to the public realm should be adequate and the stores should have large windows with displays giving the user an idea of what is in. In traditional streets of Malaysia, five-foot walkways are the urban elements that impart a rich sense of transparency to the experience of streetscapes (Shamsuddin, 2011).

Change of the physical elements of streets has negatively affected the soft and hard landscape of the streets in old cities in Malaysia owing to rapid urbanization and modernization (Ja'afar et al., 2012). A review of the research conducted on historical zones in the City Center of Kuala Lumpur reveals that inconsistency among the physical elements of building facades negatively influences streetscapes (Askari & Dola, 2009 and Ja'afar et al., 2012). More specifically, the piecemeal building development in Kuala Lumpur has extensively affected the quality of streetscapes represented by building frontages, soft landscape, and hardscape. In other words, lack of streetscape visual consistency in Kuala Lumpur leads to unmemorable streets (Kuala Lumpur City Hall, 2008).

4. PROGRAMS IMPROVING STREETSCAPES OF KUALA LUMPUR

Considering the context of Kuala Lumpur, Think City carried out projects related to conservation and city vibrancy. In a project named "The Light Project", the city was planned to be lit up with curated public arts and performances. Specifically, the project aimed to foster local art markets and bring creativity into Klang Valley. In another

project, "Feasibility Study of Sultan Abdul Samad Complex", the institute aimed to analyze the site and develop potential space use in order to vibrate the space. In order to obtain more sustainable walkways, C40 team in cooperation with Kuala Lumpur City Hall performed revitalizing Kuala Lumpur Klang River waterfront into resilient sustainable pedestrian areas. The project was aimed at highlighting the historical and cultural identity of the area, improving street furniture, vibrating the river bank, and shading the sidewalks using native species revegetation. It, focused on regenerating the area, has contributed to a comfortable place embellished with high-quality streetscape features aesthetically pleasing (Zuraimi & Radzuan, 2020).

In the vicinity of Bukit Bintang Street, the Raintree Plaza project was rejuvenated by improving streetscapes and intensification of its landscape with the installation of lights and signage. At the intersection of Sultan Ismail and Bukit Bintang Streets, new projects such as Mass Rapid Transit entrance stations and buildings such as Wolo and Chatz Brasserie were constructed to contribute to the streetscapes of the area. In addition, two mega projects of Zepp Kuala Lumpur, LaLaport Bukit Bintang City Center impart aesthetic values to the surrounding areas. In a program planned out by Kuala Lumpur City Hall, the area located in a 1 km radius from the Masjid Jamek, where Tunku Abdul Rahman Street is located, is revived. Complying with the goals of a sustainable city, Kuala Lumpur City Hall is looking for a mega project to pedestrianize the street and transform it into "green public transport-pedestrian shopping district".

5. METHODOLOGY

As supported by Yin (2003), observation in this study acts like primary data. In this phase, the researcher through personal notes and visuals documented the real scenario in the study areas. The field observations occurred between 10 am to 1 pm to study the existing situations with maximum visual accessibility to physical and visual elements and key urban issues of the study areas. The observed features of streetscapes were building facades, trees and shrubs, seating places, and visual access to the buildings. Mehta (2007, 2008, 2009), Ja'afar & Usman (2009), Mehta & Bosson (2009), Sulaiman et al. (2008), and Ujang (2012) used this method to portray existing situation of streetscapes. A self-administered questionnaire survey (English and Malay) measured people's evaluations of the role of physical elements in forming streetscapes in the study areas. Mehta & Bosson (2009), Askari et al. (2014), and Askari & Soltani (2018) used a questionnaire survey in eliciting people's evaluations of physical and visual elements of the study areas. The questionnaire includes 28 questions about trees and shrubs, seating spaces, building facades and frontages, and visual accessibility, which are used as the independent variables for Pearson Correlation Analysis Test. Moreover, six questions evaluate the public's opinions about creating a memorable streetscape, which are considered the dependent variable for the test. Totally, 330 passers-by, shoppers, workers, shopkeepers, shop owners, and Malaysian residents participated in the survey, ranging from 18 to 50 years old and above with an equal ratio of male and female. Similar to the studies by Johnson & Christensen (2011) and Ja'afar & Usman (2009), the researcher used time-interval sampling method that surveyed the passers-by every 10 minutes. The surveys happened in two months on weekdays, weekends, and public holidays in the morning, afternoon, and evening. The survey measured public evaluations using five scales of strongly agree, agree, not sure, disagree and strongly disagree and very much attractive to not attractive. The role of physical and visual elements in creating attractive streetscapes was determined using Pearson Correlation Analysis Test. The results showed that Cronbach's Alpha was 0.705 for soft-landscape elements, 0.767 for hard-landscape elements, 0.794 for building facades, 0.728 for transparency, and 0.85 for Tunku Abdul Rahman streetscape. In addition, the Reliability Test illustrated 0.772 for soft-landscape elements, 0.783 for hard-landscape elements, 0.808 for building facades, 0.725 for transparency, and 0.725 for Bukit Bintang streetscape.

5.1 The Study Streets

Bukit Bintang and Tuanku Abdul Rahman streets that lie in the heart of Kuala Lumpur City, are considered to be the study areas. The reason why these two streets are chosen is that they well represent the typical streets of Kuala Lumpur where there are Shophouses, a mix of modern and traditional buildings, shopping malls, tall rain trees, vernacular bushes, and urban vibrancy. Therefore, it is strongly sensed that the findings of the study of these two streets can be generalized to most urban areas in the city and even the entire country. The streets are well-known for popular shopping areas receiving the highest concentration of pedestrians, shoppers, and tourists (Kuala Lumpur City Hall, 2008 cited in Ujang, 2012). Bukit Bintang Street (Figure 1) is within Bukit Bintang shopping district stretching from Pudu Street to Raja Chulan Street and intersects with Sultan Ismail Street. It changed into Kuala Lumpur Golden Triangle in the early 1980's. Visited by foreign tourists, Bintang Walk, approximately one kilometer of pedestrian walkway where hotels stand along modern shopping malls, vibrates the street. The monorail transport links the area to other places, as an access point to local shoppers, tourists and visitors (Ujang, 2008). On top of that, it is deemed as the main shopping street of a newly developed central area in the city.

***Figure 1**: Bukit Bintang Street (Map data @2022 Google Imagery @2022, CNES / Airbus, Maxar Technologies).*

Tuanku Abdul Rahman Street (Figure. 2) is located in Tuanku Abdul Rahman shopping district from Sultan Ismail to Raja Laut Streets, the traditional street with remarkable socio-cultural values and historical importance in the heart of Kuala Lumpur (Kuala Lumpur City Hall, 2008). All in all, it is the former main shopping street of Kuala Lumpur (until the 1960s).

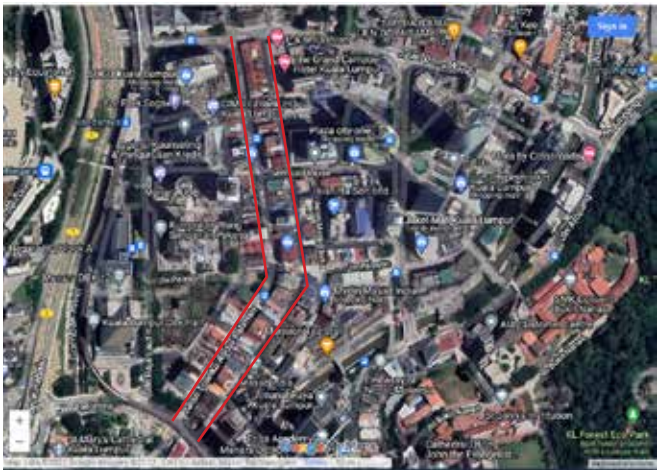

Figure 2: *Tuanku Abdul Rahman Street (Map data @2022 Google Imagery @2022, CNES / Airbus, Maxar Technologies).*

6. RESULTS

6.1 Field Observation: Bukit Bintang Street

The area expanded from Tun Razak Street to Pavilion shopping mall (Fig. 3 (a)) overflows with tall old rain trees, flowers, bushes, and water fountains. Abundance and proper placing green features intertwined with the design elements of buildings make the entrances welcoming. From StarHill Gallery to Bukit Bintang intersection (Fig. 3 (b)), there is a long line of rain trees, flowers, bushes, and water fountains along the street. Part c overflows with many tall rain trees and indigenous bushes from Bukit Bintang intersection to Bulan Street. In part d, two rows of tall rain trees, short bushes, and water fountains flank the area from Bulan Street to Pudu Street. In part a, along the Pavilion shopping mall, seating spaces surrounded with rain trees offers a serene place for sitting and relaxing. There is at least one garbage bin located in a proper place every 300-500 meters. The areas located in parts b, c and d are devoid of public seating opportunities, but restaurants and cafes, and there are garbage bins in proper distances. In parts a & b, awnings in both sides of the street attached to building entrances adorn building facades and offer visual and physical comfort. Most buildings are modern and have interesting constituting elements of facades, proportional use of large glass windows and vertical and horizontal elements that define the entrances. Large windows of galleries, shopping malls, cafes, restaurants, and hotels increase transparency of the buildings. In part B, most buildings are old and have simplicity in their repeated elements, which causes visual monotony. In parts c and d, there are 5-foot walkways covered by awning in both sides of the street, most buildings are renovated, and building facades are rhythmic, especially in old parts of the street (Figure 3).

Figure 3(a)*: Tun Razak Street to Pavilion.*

Figure 3(b): *StarHill Gallery to Bukit Bintang Intersection.*

Figure 3 (c): *Bukit Bintang Intersection to Bulan Street.*

***Figure 3 (d)**: Bulan to Pudu Street.*

***Figure 3:** Bukit Bintang Street (Soltani, 2017)*

6.2 Field Observation: Tuanku Abdul Rahman Street

The area from Maju to Dangi Wangi Junctions in part a is covered with many tall old rain trees. Green spaces in front of most modern buildings act like design elements by imparting salient characteristics to entrances and create a strong sense of invitation to the buildings (Figure 4). In part b, shading rain trees flank both sides of the street and create a welcoming entrance of SOGO Complex. There are many tall bulky rain trees located along part b, from Dangi Wangi Junction to Esfahan Street. Different types of shrubs characterize building frontages on the right side of the street. There are a quite number of rain trees along part c, from Esfahan to Bunus Street (Figure 4). There is a meager line of shrubs in the entrance of buildings in part d, from Bunus to Raja Laut Streets. Although there are not many rain trees in this part, the front side of Coliseum Building overflows with many tall old rain trees. In part a, seating spaces covered with cloth awnings along the building at Maju Junction offer cozy places for passers-by. There are abundant public seating spaces on the right side of SOGO Complex (part b). In part c, there are adequate public seating spaces on the right side of the street next to rain trees. The area in part d is devoid of public seating spaces and there is just an open space next to Coliseum building offering places for sitting. The design of street in part a, tallies with hygienic standards and there is at least one garbage bin every 300-500 meters. In more details, the area from Maju Junction to Dang Wangi Junction in part b, the area from Esfahan to Bunus Streets in part c, and the area from Bunus to Raja Laut Streets in part d are clean and overflow with a garbage bin every 300-500 meters (Figure 4). In part a, entrances of most buildings and stores in both sides of the street do not have awnings. The five-foot walkways prevent rain from penetrating into the buildings. On the right side of the street, along the Pertama Complex, vertical and horizontal design elements make modern buildings outstanding. Large windows of the shopping malls, hotels, and restaurants make them recognizable for the people passing by. In part B, awnings and covered five-foot walkways flank both sides of the street. Most Shophouse facades designed with "British Colonial Style" include repeated, rhythmic, and colorful elements. Large displays of shopping malls and Shophouses contribute to creating transparent streetscapes. Renovated building facades in front of SOGO Complex, cleanliness, and consistency of building facades play an important role in creating attractive streetscapes of the area. In Fig. 4 (c and d), covered five-foot sidewalks attached to buildings are wide enough and contribute to creating memorable streetscapes. Most building facades are renovated and have colorful, rhythmic, and repeated elements.

***Figure 4(a & b)**: Maju to Dang Wangi Junction*

Figure 4(c): *Dangi Wangi Junction to Esfahan Street*

Figure 4 (d): *Esfahan to Bunus Streets*

Figure 4 (e): *Bunus to Raja Laut Streets*

Figure 4*: Tuanku Abdul Rahman Street (Soltani, 2017)*

Alike Bukit Bintang Street, existing soft-landscape such as tall old rain trees and shrubs, highly-glazed and well-designed facades, which increase transparency, harmonic juxtaposition of modern and traditional buildings, variety in horizontal and vertical elements of facades, proper colors and materials of facades, seating opportunities, five-foot walkways, and inviting entrances mostly covered with awnings significantly contribute to creating memorable streetscape of Tuanku Abdul Rahman. Overall, the observation pinpoints that soft-landscape, building facades, seating opportunities, and transparency play a vital role in forming streetscapes.

6.3 Role Of Physical Elements In Forming Streetscapes

Pearson Correlation Test (Table 1) indicates that there is a correlation between soft-landscape (r=0.494, p< 0.01), seating spaces (r= 0.367, p<0.01), building facades (r= 0.494, p<0.01), transparency (r= 0.497, p<0.01), and streetscape of Bukit Bintang. Transparency contributes to forming Bukit Bintang streetscape most. Soft-landscape and building facades play a similar role in forming memorably attractive streetscape of Bukit Bintang.

Streetscape		Soft-landscape	Seating spaces	Building facades	Transparency
Bukit Bintang	Pearson Correlation	.494(**)	.367(**)	.494(**)	.497(**)
	Sig. (2-tailed)	.000	.000	.000	.000
Tunku Abdul Rahman	Pearson Correlation	.499(**)	.389(**)	.566(**)	.685(**)
	Sig. (2-tailed)	.000	.000	.000	.000
N		330	330	330	330

Table 1: *Correlation between physical elements and streetscapes*

*** Correlation is significant at the 0.01 level (2-tailed). Source: SPSS 22 by Soltani (2017).*

Table 1 indicates that there is a correlation between soft-landscape (r= 0.499, p< 0.01), seating spaces (r= 0.389, p<0.01), building facades (r= 0.566, p<0.01), transparency (r= 0.685, p<0.01), and streetscape of Tunku Abdul Rahman. The results show that transparency play the most important role in the streetscape of Tunku Abdul Rahman. The results show that seating opportunities do not have a strong impact on streetscape of Tunku Abdul Rahman. Yet, building facades and soft-landscape significantly impact on the streetscape. The results support what Shokouhi & Gharai (2006) emphasized that harmony and rhythm of the elements of facades play an important role in strengthening streetscapes. Although Mehta (2009), stressed the role of seating opportunities in forming streetscapes, this study shows that seating opportunities influence the streetscape of two exemplary areas in Kuala Lumpur City less than other physical factors and elements. Comparing the results, the variety of seating opportunities, five- foot walkways, consistency between physical elements, proper height of tall old rain trees, ornate historical building facades consistent in shape,

and dimension and juxtaposition of modern and historical building facades in Tunku Abdul Rahman Street create more memorable streetscape than in Bukit Bintang Street. Overall, the findings show that building facades and soft-landscape features of Tunku Abdul Rahman Street have a more significant impact on its streetscape than those in Bukit Bintang Street. As shown in the Correlation Test, the reason why the physical elements play stronger impact on the quality of urbanscape of Tunku Abdul Rahman Street than on that of Bukit Bintang Street might be what Loodin & Thufvesson (2022) in their study revealed that classical architecture plays a more significant role on the quality of streetscapes than modern one. This is exactly what is more conspicuous on Tunku Abdul Rahman Street than on Bukit Bintang Street. In a study, Askari & Soltani (2018) only focused on how building facades contribute to attractive streetscapes in two exemplary representative streets in Kuala Lumpur. The gap still exists that what other physical and visual elements form streetscapes in cities. In light of that, the current paper, conducting a quite different attribute, evaluates to what extent these elements contribute to distinctive streetscapes, which distinguishes the paper from the previous studies in either the same urban context or any other similar ones.

7. CONCLUSION

The findings outline that streetscape transparency, which is the visual accessibility to buildings as the result of harmony among constituting physical elements, proper placing trees and shrubs, and building facades play the most significant role in creating attractive streetscapes. In line with the objectives of Think City and Kuala Lumpur City Hall to promote the quality of streetscapes, incorporating the findings of the paper in the process of urban restoration and rejuvenation assists urban designers in creating more sustainably livable cities. In addition to that, the paper presents a series of findings in relation to the interplay between the elements of streetscapes that imply designed-based suggestions for making more memorable streets in cities either in Malaysia or even in other similar urban contexts. In fact, as Ab Rahman et al. (2017) and Rosnan et al. (2021) determined, the findings of the paper contribute to creating identifiable places in cities and improving urban quality of life.

The exploration of these factors in the current paper contributes to environmental perception and evaluation of the physical elements of built environment. The findings insinuate that harmony of building facades has a more effective impact on creating attractive streetscapes than their mere outlook. The findings are internationally extrapolative to the future restoration and development of similar urban settings due to the representative nature of the study areas. In other words, the paper offers insights into a better understanding of how people assess the role of physical elements in creating attractive streetscapes in cities based on the notions of environmental psychology towards the built environment. Last, the paper suggests a study on the role of spatial arrangement of the physical elements and attributes in vibrating streetscapes of cities.

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REST AREA MOSQUE CIRCULATION SYSTEM DESIGN MODELWITH DESIGN THINKING APPROACH

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ABSTRACT

Along with the times in various aspects, developments also occur in buildings where Muslims worship, namely mosques, especially in the rest area. Developments in factors of value and meaning that affect parts of the function are no longer a place of worship but also a place of temporary rest and commerce by residents around the mosque area. The impact of this phenomenon raises the assumption that there will be an increase in visitors at a particular time and space so that the mosque's capacity is not sufficient. One of the affected space elements is space circulation so that space users will have limited space. That raises the question of whether the circulation aspect will be affected by this phenomenon. As a response to this phenomenon, a design thinking approach is used at the empathize stage as an initial effort to find out the needs and desires of space users from problems that occur using participatory observation and structured interviews. The research results at this stage can obtain accurate and valid information through the analysis process to be defined at the next stage of design thinking.

1. INTRODUCTION

This research was conducted based on the development of values and meanings that continue to occur in buildings where Muslims worship, to adjust the primary function of worship needs in the context of space and time, and secondary functions such as social and economic values. Functional factors in the mosque can affect the identity of the mosque and become the identity of a particular place; identity is obtained from the background of the mosque, the mosque construction process, the style used, and the geographical factor of the location of the mosque (Harahap et al., 2020). So that mosques built in specific locations are flexible, marked by many of these facilities in public space buildings with the term *Mushalla* (buildings or worship spaces with a smaller scale compared to mosques).

This phenomenon also occurs in mosques located on toll road rest areas (Tax on Location) in Indonesia; these mosques have specific values and meanings that are no longer only as places of worship (religious values) but also develop as temporary shelters to rest (social value) and the welfare of the community around the mosque by doing business (economic value). It is known that operating hours are full service 24 hours a week, and the high intensity of mosque visitor mobility will lead to the assumption of space problems, especially the circulation system so that it will affect the limited space and capacity of the mosque.

Several studies discuss circulation in mosques, such as "Designing the *Manasik Haji* Mosque and Rest Area Based on Community Aspirations in Triharjo Kulon Progo Village" (Risfanda, 2020). This study, alluding to the problem of the mosque's circulation system from the *manasik haji* (a demonstration of the implementation of the pilgrimage according to its pillars and carried out before going to the holy land) and applying a participatory design approach by involving the local community by emphasizing the circulation of men and women who are separated from the beginning of entering the mosque area to the end of leaving the mosque area and paying attention to *taharah wudhu* (the process of purification when you want to pray) in the form of reinforcing the boundaries of the sacred area and its circulation path. As a result, the zoning system is divided to strengthen the relationship between space functions to facilitate space integration and form a circulation pattern. Another study, "Review of Visitor Behavior on Circulation Patterns of the Great Mosque of Central Java," (Nabilah et al., 2018). In this study, the results of the hypothesis were identified, stating that visitors to a mosque with a large number of facilities would find it challenging to achieve the circulation goal. From the collection of questionnaire data, the results obtained are that visitors have no difficulty determining circulation. However, there are obstacles

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brought based on the analysis result, such as the use of information signs that are needed and placed strategically and informatively. Based on the exposure of assumptions and previous research, this research is needed to respond to the problems and evaluate previous research problems—paying attention to circulation paths for male and female room users, designing circulation paths with sacred boundary properties, and applying strategic planning and informative information signs.

From several studies that have been described, there are problems similar to this study. Namely, the circulation path between men and women is still the same, causing problems with circulation obstruction and causing cross circulation. It is necessary to design a separate circulation path between men and women from the beginning to enter the mosque area, as well as the appropriateness of the application of strategic and informative information signs so that they can be easily seen, read, understood, and trusted, making it easier for room users to understand circulation patterns and achieve ease and comfort—mosque space users.

The Decree of the Director-General of Highways No. 76/KPTS/1999 explains that the rest area is a place devoted to toll road users with various supporting facilities for the needs of rest area visitors and fulfills the requirements not to interfere with the smoothness and safety of other toll road users. Another definition, according to the Decree of the Minister of Transportation Number 65 of 1993, states that a rest area is a place to rest and park vehicles with various facilities provided for rest area visitors, and its primary function is to restore the driver's prime condition, to reduce the possibility of accidents (Firhandy, 2018).

As explained in the rest area's definition, visitors can find various supporting facilities in the rest area, one of which is a mosque. (Munawir, 1984) in (Suryanto & Saepulloh, 2016) explains that a mosque is a place for Muslims to carry out worship activities prioritized in a jama'ah (together) manner but are also allowed individually. In the continuous process, it can increase solidarity and also as a means to stay in touch. The mosque is *sajada-yasjudu-sujudan*, which means prostration, namely *wada'a jabhathahu bil ardi muta'abbidin*, which puts the forehead to the earth to worship. In addition, there are also definitions by several scholars, such as by *Al-Nasafi* in *Tafsir al- Nasafi* Volume 4, Then by *Al-Qadhi Iyadh* in *Tafsir al-Jami Lil Ahkam Al-Qur'an* and Az- Zarkasyi That in I'lam al-Sajid bi Ahkam al Masajid that the mosque is a place to carry out all kinds of ritual worship activities with the value of obedience and obedience to *Allah Subhanahu Wa Ta'ala*. In the end, the mosque is a place of worship and has many functions such as a mosque rest area, namely as a place to support social activities, such as a place to socialize, and a place for economic activities. Certain mosques function as education places, community information centers, places for marriage contracts, and health activities (Suryanto & Saepulloh, 2016).

Circulation is a traffic pattern or movement contained in an area or building, to achieve optimal circulation, it is necessary to consider aspects of flexibility, economy and functionality (Harris, 1975). So it can be concluded that from several definitions of circulation, it can be an understanding to achieve ideal circulation, circulation must be able to become a liaison between spaces within the building and between spaces inside and outside the building, and can increase the optimal effectiveness of space user activities related to goods or vehicles by considering the value of flexibility, ergonomics which includes the value of ergonomics (covering aspects of security, comfort, health and efficiency), then consideration of economic and functional values (Tofani, 2011). In an ongoing process related to the problems in this research regarding the ergonomics of the flexibility of the circulation user's space in mosque facilities, then the need for optimal information signs and recommendations for additional facilities specifically for mosque visitor activities that can potentially cause circulation problems.

In the process of this research, it also examines other research that discusses circulation problems in mosques, including "Mosque Space Circulation Patterns in Makassar Case Study: Babul Khaer Mosque" (Usman & Oktawati, 2019). What is a research discipline of architecture, with a qualitative approach related to the layout and circulation of the mosque, which discusses the comfort of space users when worshiping? It was identified that the circulation at the Babul Khaer Mosque is currently uncomfortable for space users during worship. Solving the problem in this study was carried out by rearranging the space, namely maximizing the area of the mosque's space and providing additional functions in spaces that rarely occur so that the space can function optimally. In addition, a re-circulation system is also carried out, namely separating the circulation of men and women to avoid cross circulation from the beginning of entering the mosque, then heading to the wudhu area, to the prayer area, and leaving the mosque area. Finally, designing a particular wudhu area for children and the elderly and reconditioning the parking area.

Several studies have explained that there are problems similar to this research, such as the circulation path between men and women is still in the same circulation path, so from this phenomenon, the circulation between spaces becomes biased and sometimes constrained by the area and number of the area, and will cause problems with circulation obstruction such as the occurrence of cross circulation. So, it is necessary to consider separate circulation paths between men and women from the beginning of entering the mosque area to leaving the mosque area, as well as optimizing the space and supporting facilities of the mosque area on the factor of area, number, and users of facilities such as children and the elderly in certain areas. Finally, consider applying strategic and informative information signs to make it easier for space users to understand circulation patterns and achieve convenience and comfort when worshiping.

Knowing that intensive activity in the rest area will affect the circulation in each facility in the main rest area of the mosque. (Karso, 2010) circulation is a path or space for a movement designed to connect certain areas to facilitate activities with adjusted sizes and needs. (Ching, 2012) In the book Architecture, Form, Space, and Order, Third Edition, several circulation patterns can be applied to the mosque rest area by adjusting the needs. Linear circulation, circulation that can be the primary regulator for several spaces. Radial Circulation, a combination of several linear circulations starting or ending at a particular central point. Spiral Circulation, single circulation tends to be attracted and increasingly away from the starting point. Grid Circulation, circulation that forms a square

or rectangle caused by two parallel paths that intersect. Network Circulation occurs due to the configuration of paths that connect specific points that are interconnected in space—lastly, Composite circulation is a combination of other circulations adapted to space requirements (Karso, 2010).

A mosque rest area is a place with intensive mobility activities, so it is assumed that at every prayer time, there will be a buildup of visitors in several areas of the mosque that affect the circulation path so that it will produce circulation that is not ergonomic. The mosque area where circulation problems occur can be sorted according to the flow of space users' needs for prayer activities. First, in the mosque entrance area, this area depends on the area and number of circulation paths, knowing that rest area visitors will come simultaneously at the time of prayer, thus requiring a reasonably wide circulation path with the number adjusted to the category of mosque visitors, can be categorized into two categories, namely men and women who are separated. Furthermore, the footwear storage area is also an area for removing footwear, sufficient area is needed for the two separate categories, because in the process of removing footwear it takes a long time, so that if the area is by activity needs, it can reduce the potential for obstructed circulation. After removing footwear, the next area is the wudhu area which is separated. A unique path is needed with sacred boundaries for both categories to avoid cross-circulation, which can invalidate wudhu and potentially obstruct the circulation path. The size and number and the placement of the entrance and exit of the mosque need to be considered so that the circulation path remains conducive for users of the mosque space when they come to enter the central area of the mosque to worship, to leave the central area of the mosque and leave the mosque area.

2. METHOD

This study uses a qualitative paradigm with observation and interview instruments; sample selection was carried out purposively based on criteria (Soewardikoen, 2019). The object of research is the al-Mi'raj Mosque KM 97 Cipularang Toll Road. In this study, the initial stage or the empathize stage, the data collection process was carried out by making direct observations of the object of research on each mosque visitor activity, then conducting in-depth interviews with visitors and also to mosque managers.

The process is human-centered or involves humans as the center in every stage of the design process. Design thinking originates and is intended for humans. (Mortensen, 2019). Starting with empathy, discovering user needs by understanding beliefs, values, motivations, behaviors, constraints, advantages, and challenges. The stages in the next research are the Define, Ideate, Prototype, Test, and continued with evaluation and iteration at certain adjustment stages, which have not been carried out in this study. The process for analysis is to summarize all the data obtained from the results of participatory observations and in-depth interviews to then draw conclusions according to the interactive analysis model, namely data collection, data reduction, data presentation and conclusion.

3. RESULTS AND DISCUSSION

The process of collecting data through participatory observation and structured interviews was carried out on June 20, 2021, at the al-Mi'raj Mosque KM 97 Cipularang, from 12.00 WIB to 19.00 WIB. During this period, data were collected by making direct observations regarding the activities and behavior of mosque visitors when they were prospective users of the mosque space when they were users of the mosque space and after as users of the mosque space, which had an impact on the mosque's circulation facilities. Observations began at the stage of prospective mosque room users entering the mosque area, it is known that there is one circulation path to enter and exit the mosque area, but there are also prospective mosque room users who use the parking area in the south of the mosque, for circulation paths if there are no cars who parked. However, when it rains, or the mosque parking area is filled with cars, a buildup of circulation hinders circulation, which is not ergonomic, as shown in the following picture.

Figure 1: *Circulation conditions in line when it rains, and the car park is filled.*

Furthermore, after the circulation path enters and exits the mosque area, circulation problems occur in the mosque entrance area, namely in the area of the removal of footwear and the development of footwear, from the limited size and number of areas and not designed with adjustments to the duration of the user when carrying out activities in that area, then there is a user of the area space. There are also other facilities such as free mineral drinking water provided in the refrigerator and a display case to collect items left behind by mosque visitors. In addition, there are also accessible mineral drinking water facilities provided in the refrigerator and a display case for a collection of mosque visitors' belongings that were left behind. Some of the available facilities cause space circulation to be increasingly hampered because many facilities are offered in a minimal area, so various patterns of space user behavior hinder the circulation path.

The next problem arises from the problems mentioned in the research "Designing the Manasik Haji Mosque and Rest Area Based on Community Aspirations in Triharjo Kulon Progo Village" (Risfanda, 2020) namely the problem of the circulation path between men and women being one and the circulation path of the sacred boundary for space users who have wudhu. These problems occur in the al-Mi'raj Mosque, as shown in the following picture.

Figure 2: *Circulation conditions in the mosque entrance area.*

The DKM (Mosque Prosperity Council) Mosque al-Mi'raj has renovated some of the mosque's rooms, including the mosque entrance area in the form of a staircase with sufficient circulation in and out of the mosque. However, observations identified that the design product was not effective. It is known that the stairs have fewer users compared to the previous circulation described. To access the entrance stairs, visitors have to rotate the mosque to feel it is inefficient and choose a straight-line circulation.

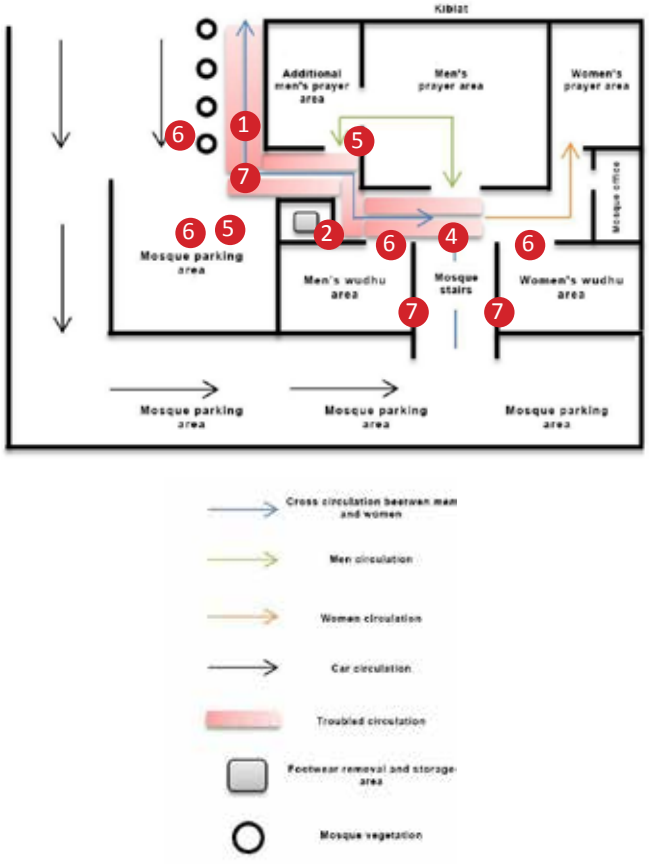

Figure 3: *Circulation in the al-Mi'raj mosque area.*
(Marking on the plan according to the number on the figures)

The following circulation flow is in the wudhu area. There are no significant problems with the process of using space to carry out wudhu activities. However, in circulation after the wudhu activity, there are problems, namely the impact of circulation after the area takes off footwear between men and women crossed the circulation in front of the entrance to the central area of the mosque, causing cross-circulation. Of course, this circulation hurts room users who have already performed wudhu, especially for men, as shown in the following picture.

Figure 4: *Circulation of the central circulation of the mosque entrance.*

The successive stage is in the participatory observation process; it was found that some users of the space for women had difficulty finding the wudhu area for women and the women's prayer area; sometimes, women entered the men's wudhu area and entered the men's prayer area. This phenomenon happened in the research "Review of Visitor Behavior on Circulation Patterns of the Great Mosque of Central Java" (Nabilah et al., 2018); the al-Mi'raj Mosque requires strategic and informative information signs to prevent space users from getting to the predetermined circulation.

Circulation in the mosque room is not a significant problem; due to the current COVID-19 pandemic condition, prayer activities are conditioned by a distance of about 1 meter for each room user. Then the circulation problem arises when space users finish praying, there is a south door of the mosque, which is used as the mosque's exit, but the area is also used as a mosque prayer area for space users who do not get a place in the mosque's main room. Problems that arise from the circulation door can interfere with space users during prayer, and the impact of the end of the circulation will again result in a buildup of circulation in the area of off footwear and then continue in the area along the circulation path in and out of the mosque, as in the following image.

***Figure 5**: Circulation of the mosque's side door and the mosque's footwear area.*

After conducting participatory observations, a structured interview process was carried out to obtain more detailed information about the circulation in the mosque. Interviews were conducted with Mr. Riki as an imam (a person who leads congregational prayers) and the manager of DKM Masjid al-Mi'raj, and Mrs. Yuni as treasurer of DKM Masjid al-Mi'raj. Data obtained from the interview process with Mrs. Yuni shows that circulation conditions on weekdays tend to be crowded and remain conducive. Conditions are not conducive during Friday prayer times. Space users exceed the mosque's capacity, so that circulation is not conducive until the weekend. On weekends, visitors are always crowded even though outside prayer times and the circulation flow is not conducive when entering prayer time. In addition to this phenomenon, there is also the condition of the mosque's circulation becoming very unfavorable, namely during the mudik tradition (an once a year routine for Indonesian people to return to their hometown) and when they returned from their hometown, with various needs of visitors who came to worship, to rest for a while, to take advantage of the toilet facilities. However, during the current COVID-19 pandemic with the Indonesian government's call for a ban on mudik, the circulation conditions at the al-Mi'raj mosque are more conducive.

The following process is carried out to Mr. Riki; the data obtained from the current circulation condition is an effort to solve circulation problems. It was explained that the al-Mi'raj mosque had renovated the widening of the mosque area to increase the mosque's capacity and relocate the toilet area and wudhu area. It was known that initially, men and women were in the same area for the toilet area and the wudhu area. Moreover, the problem of circulation paths that are not ergonomic because access to circulation from the area to the mosque entrance is very far, making it difficult for space users. Efforts to renovate the widening of the mosque area and relocating the toilet area and wudhu area do not entirely solve the problem of space, especially the circulation system. Instead, it gives rise to other circulation problems as described.

Interviews were also conducted with several mosque visitors; from the results of the interviews, it was found that most of the mosque visitors had the primary purpose of worship, then followed by a short break in the mosque area or the mosque car parking area, as well as utilizing the mosque's toilet facilities. The impression of visitors to the al-Mi'raj mosque that each facility is superior to cleanliness and coolness makes mosque visitors comfortable.

***Figure 6**: Circulation of the central circulation of the mosque entrance.*

Then information was obtained regarding the facilities and circulation of the mosque; mosque visitors thought that it was necessary to renovate the circulation path aspect because the size of the central circulation was too narrow, so that there was still a buildup of visitors in certain areas, especially in the mosque's footwear storage area, which felt the facilities lacked function. Optimal, because most mosque visitors do not leave their footwear, there is still cross-circulation between men and women after wudhu. Continuous

circulation after the room users finish praying, there are room users who are confused about determining access to circulation out of the main room of the mosque, there are two alternative circulations, namely through the entrance of the mosque and the side door of the mosque, but both accesses are expected to have circulation problems still when accessed on specific time. For access to the entrance, it is suspected that a room user who wants to leave will run into a room user who wants to enter, resulting in an inhibition of circulation. Access to the side door will also hamper circulation because access to the side door is directly connected to the footwear storage area, which often occurs when mosque visitors accumulate.

Further information revealed that mosque visitors find it difficult and confused to reach the toilet facilities because the place is hidden and difficult to reach, and the information signs are less informative regarding the placement, size, and content of the information signs, which are dominated by written descriptions and minimal symbols related to the function of the facility.

Figure 7: *Circulation of information signs and locations of toilet facilities that are difficult to reach.*

Analysis of the results of observations, in-depth interviews, there is a correlation between the two, namely there is a discrepancy between the activity needs of mosque visitors and the circulation conditions of the existing mosque facilities, so it is necessary to consider the ergonomics factor of the circulation area and information signs to facilitate the circulation process so that there is no accumulation of mosque visitors and causes obstruction of circulation. mosque rest area which is supported by ergonomic provisions of circulation area and provision of information signs. The design thinking approach is applied at the empathize stage, as an initial effort to understand the needs, thoughts, emotions and motivations of space users to define the problems of the rest area mosque circulation system.

4. CONCLUSION

Research carried out using a design thinking approach at the empathize stage resulted in the circulation of the al-Mi'raj mosque rest area KM 97 Cipularang is affected by the phenomenon of space user activities in certain aspects of space and time. It is proven from the data collection process using participatory observation methods, and structured interviews, resulting in circulation problems in the mosque area regarding circulation flows based on the hierarchy of space user needs that are not optimally facilitated by the DKM al-Mi'raj mosque, resulting in problems with the circulation of space in the mosque area. In the ongoing process, further research is needed to identify problems more critically so that research can be continued to the next stage of design thinking, namely the define stage.

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Mrs. Yuni as treasurer of Masjid al-Mi'raj.

The visitors of the al-Mi'raj masjid mosque.

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A FIELD STUDY ON ADAPTIVE THERMAL COMFORT IN A NATURALLY VENTILATED DESIGN STUDIO CLASS IN THE POST-PANDEMIC PERIOD

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ABSTRACT

Design studios are where design students spend most of their time learning theory and practices. For this reason, thermal comfort conditions in studios are crucial to provide a suitable environment for education. Especially in the post-pandemic period, thermal comfort conditions have become more critical in educational buildings. The present study focuses on the adaptive thermal comfort condition in an architectural design studio in the Mediterranean climate of Izmir/Turkey. The study aims to evaluate the comfort conditions of the students and determine the effect of mask use on thermal sensation in the post-pandemic period. For this purpose, air temperature, relative humidity, and air velocity measurements were collected during the studio hours in the spring semester when the heating and cooling systems were not working. Additionally, a thermal sensation survey was conducted with 42 students. The results showed that the thermal comfort level was within the 90% acceptability limits according to the ASHRAE Standard-55. According to the survey results, the use of masks by the students did not have a significant effect on thermal perception.

1. INTRODUCTION

Along with the COVID-19 pandemic, universities adopted online learning methods over the past two years. The efficiency compared to face-to-face education created great debates in the education community and became an eminent research subject (Ali, 2020; Gillis & Krull, 2020). With the decrease in Covid-19 cases, face-to-face education started again in Turkey at the beginning of 2022. Going back to the classrooms drew attention to the indoor air quality (IAQ) and thermal comfort conditions during the education. As for the faculties of architecture, design studios are where students spend most of their time studying, eating, and even sleeping (Anthony, 1991; Cuff, 1992). It can be assumed that the studios are the main activity spaces in the life of every design student (Oh et al., 2013). Therefore, it is crucial to provide comfortable indoor conditions for these spaces.

Many studies have been carried out on adaptive thermal comfort sensations in education buildings during the pandemic and post-pandemic periods. Alonso et al. (2021) analyzed the effects of the COVID-19 pandemic on thermal comfort and indoor air quality. They compared the conditions before and during the pandemic period in winter. According to their study, thermal comfort was insufficient, and comfort conditions worsened during the pandemic. Shrestha et al. (2021) investigated the adaptive thermal comfort in school buildings in autumn in Nepal. According to this study, at an average temperature of 27°C, most students felt comfortable. Miranda et al. (2022) focused on the ventilation and thermal comfort conditions in classrooms during the pandemic period. When the outside temperature was below 6 °C, the dissatisfaction rates were between 25% - 72%. Conversely, dissatisfaction rates were lower than 10% when the outdoor temperature was above 12°C.

Barbhuiya and Barbhuiya (2013) analyzed thermal comfort and energy consumption in an educational building in the UK. According to their study, thermal comfort levels affected the performance and well-being of occupants, along with their morale. When the comfort levels were not met, occupants' complaints about indoor conditions increased. Singh et al. (2019) reviewed thermal comfort studies in classrooms. According to the results, students at all education stages felt comfortable on the cooler side of the thermal sensation

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scale. There was no consistency between temperature changes and thermal sensation vote. They suggested thermal comfort equations based on the adaptive approach for different school age groups. Taheri Pouresfahani (2021) studied thermal comfort and IAQ in schools before and during COVID-19 by conducting interviews. The results showed that operable windows could significantly impact indoor air quality, health, safety, and student performance. Mohammadi and Nasrabadi (2021) showed the thermal comfort conditions from March to October in the hot and arid climate of Birjand. According to the results, October was the only month when the thermal comfort conditions were met. It was suggested that thermal comfort has dimensions and indices that might be used to regulate energy consumption. López-Pérez et al. (2019) presented thermal comfort conditions in 27 classrooms in Mexico for the cooling period. The study showed that occupants felt more comfortable when natural ventilation was provided than in the air conditioning mode.

Tang et al. (2022) examined the effect of using a face mask on thermal comfort during the COVID-19 period in Guangzhou, China. According to the study, more than 70% of subjects wearing masks said that they were uncomfortable at the university library. Also, subjects wearing masks preferred cooler temperatures. In this study, surveys and interviews were conducted, and the results showed that operable windows could negatively or positively impact indoor air quality, health and safety, and student performance.

In Table 1, thermal comfort field studies in the literature related to the thermal comfort of primary, high school, and university students are summarized. According to this table, the number of students participating in the survey, operative temperature, measured relative humidity value, air velocity, used ventilation system, location, and climate parameters of the building were examined. The comfort temperature varies according to the climate type. These studies are preliminary information and control data for the analysis made for this study, which was carried out in an architectural studio at Izmir Institute of Technology.

***Table 1**: Previous thermal comfort field studies with students*

Study	Space Type	Location	Season	Ventilation mode	T_o (°C)	RH (%)	V_a (m/s)	Clo	Participants
(Yao et al., 2010)	University	Chongqing	Cooling and Heating	Natural ventilation	28-24-14.3	96	0.01-0.53	0.27-0.44-1.42	
(Jung et al., 2011)	University	Korea	Cooling and Heating		24	47.4	0.04	0.72	951
(Teli et al., 2012)	School	England	Heating	Natural ventilation	20-28.8		<0.1	0.35	230
(CAO et al., 2012)	School	Shanghai	All year	Natural ventilation	11.3-30.6				16458
(D. Wang et al., 2017)	School	Northwest China	Heating		13.4-14.3	<60		1.5-1.7	1126
(Fang et al., 2018)	University	Hong Kong	Cooling	Air-conditioning system	24.58 °C			0.42	946
(Udrea et al., 2018)	University	Bucharest		Natural ventilation					765
(Jindal, 2018)	School	India	Tropics	Natural ventilation	27.1	55.5-81.9	0.2-1	0.82	130
(Yang et al., 2018)	School	Sweden	Heating		20-24	20-30	<0.1	0.85	150
(Kim & de Dear, 2018)	School	Australia	Subtropical	Natural ventilation	24.5-24.7			0.42-0.51	4866
(Albatayneh et al., 2019)	University	England	Cooling and Heating	Air-conditioning system	(18 °C–24 °C)				
(Liu et al., 2020)	School	Tianjin	Autumn-Winter		19.51-19.01	41.54-32.20	0.04-0.03	1.1	439
(Kumar et al., 2020)	University	India	Autumn-Winter		18-24	62	0.16	0.95	1332
(Dahlan et al., 2020)	University	Malaya	Tropics		17-35	59-43	0.1-0.7	0.7	10
(Talukdar et al., 2020)	School	Bangladesh	Tropics	Natural ventilation	30.9	78.4	0.8	0.6	286
(Xu et al., 2020)	University	New South Wales							106
(Heracleous & Michael, 2020)	School	Cyprus	Cooling and Heating		30-18	32-58	<0.1	0.5-1	317
(Noda et al., 2020)	School	Brazil	Tropics	Air-conditioning system	26.76	67.6	<0.01	0.44	97
(Korsavi & Montazami, 2020)	School	UK	Cooling and Heating	Natural ventilation	20.02-28.0	43-94	0.05-9.6	0.30-0.74	805
(X. Wang et al., 2021)	University	Xian			17-28	51-76		1.06-0.48	1973
(Shrestha et al., 2021)	School	Nepal	Autumn	Natural ventilation	27	70-83	0.1	0.48	818
(Aparicio-Ruiz et al., 2021)	School	Seville	Cooling		24-27	44		0.3	67
(Guevara et al., 2021)	School	Ecuador	Tropics	Air-conditioning system	18-27.5	51.4-89.3	0.1-0.3	0.85	415

This study presents the results of the fieldwork carried out in Izmir-Turkey in the spring term based on the adaptive thermal comfort approach. In addition to indoor air temperature, relative humidity and air velocity measurements were made in the design studio. A survey is made every hour during the measurements and compared with ASHRAE standards for thermal comfort. In addition, this study aims to understand students' perception of the thermal environment of the classroom, especially with current adaptive thermal comfort

guidelines. Additionally, it is aimed to investigate the effect of face masks on thermal sensation perception in a classroom.

2. METHODOLOGY

2.1 Climatic Conditions

The case building is in Urla, İzmir. According to Köppen Climate Classification, İzmir is under the "Csa" section, which is considered hot and temperate in terms of climate features (Rubel & Kottek, 2010). The mean dry-bulb air temperature is 15°C – 38°C on summer days, while on winter days, it changes between -2°C – 16°C. The monthly average relative humidity is 50% all year, while 70% on the winter days (MGM, 2022). The necessary outdoor temperature and relative humidity values were recorded with a data logger during the study period.

2.2 Case Classroom

The case classroom is located on the second floor of the A Block Building of the Faculty of Architecture at İzmir Institute of Technology. There are four user-controlled air conditioner units on the ceiling and no mechanical ventilation system. The classroom locations on the building façade and plan are given in Figure 1.

***Figure 1**: Location of the classroom on the plan and façade view of the building*

The classroom has 220 m² of floor area with three east-facing windows and two north-facing double pane windows. In Table 2, the dimensions of the walls, windows and doors of the classroom are presented.

***Table 2**: Architectural components of the classroom*

Architectural Component	Walls	Windows	Door
East	18.4x3.5 m	3 pieces of 2x2 m	-
West	18.4x3.5 m	-	1 piece of 1.8x2.20
South	12.1x3.5 m	-	-
North	12.1x3.5 m	1 piece of 1x3 m & 1 piece of 2x2 m	-
Area	213.5 m²	19 m²	4 m²

2.3 Data Collection

Indoor field measurements and questionnaire surveys were conducted simultaneously in the classroom. The data collection was carried out when first-year industrial design students participated in a design studio activity from 9:00 am in the morning to 12:00 pm on 19th of April 2022. All data collection materials were placed in the classroom 15 min before the studio started. Before data collection, students were briefly informed of their thermal sensation survey participation that was to be carried out. During the study, the occupants were left free to control the windows, and the AC units were preferred to be kept closed.

2.3.1 Obtaining Thermal Data

Field measurements included seven parameters: outdoor air temperature (T_{out}), indoor air temperature (T_a), indoor relative humidity (RH), and indoor air velocity (V_a). For outdoor environmental parameters, data were obtained by AZ-7798 data logger placed on the outer east wall of the classroom. RH, $T_{a,}$ and V_a data were recorded by two AZ-7798 data loggers and a Trotec TA300 anemometer placed at three points 1.2 m above the floor level (Figure 2).

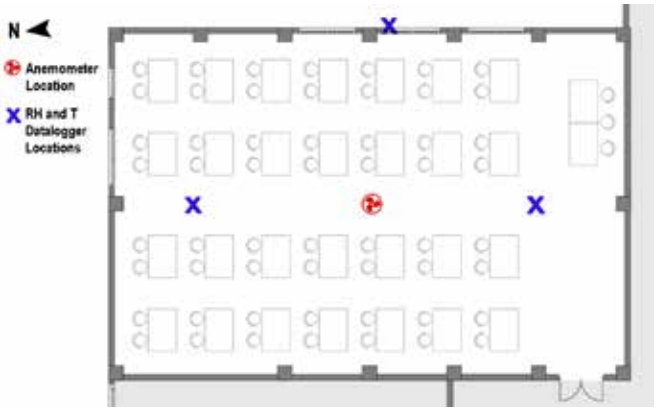

***Figure 2**: Locations of the data collecting devices*

All the recorded data were collected at one-minute intervals. Calculation of mean radiant temperature (T_r) and operative temperature (T_o) was done according to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 55–2019 Thermal Environmental Conditions for Human Occupancy in Informative - Appendix C – Acceptable Approximation for operative Temperature as in Equations 1 and 2 (ASHRAE, 2019).

$$T_r = 0.99 \times T_a - 0.01 \quad [E.1]$$

$$T_o = (T_r + T_a)/2 \quad [E.2]$$

2.3.2 Thermal Sensation Survey

The thermal sensation survey's questions were prepared by the guidance of the ASHRAE-55 "E.1 Point in Time Survey" (ASHRAE, 2019). The question "Are you wearing a face mask?" was included at the beginning of each form. The questionnaires were filled three times during the studio hours, respectively at 10:00 am, 11:00 am, and 12:00 pm. At each hour, students were asked to answer the question, "What is your general thermal sensation?". 42 first-year design students aged between 18 and 21 were included in the study (126 answers for the thermal environment). All 42 students answered all survey questions at each hour. Following the answers of "Describe each item that you are wearing right now?" and "What is your activity level right now?", the mean metabolic rate was determined as 1 met, and the mean clothing insulation as 1 clo complying with the procedures in ASHRAE Handbook Fundamentals: Thermal Comfort (ASHRAE, 2009). The photographs of the design studio during the data collection are given in Figure 3.

***Figure 3**: Condition of the design studio during the data collection*

2.4 Thermal Comfort Evaluation

Individual thermal sensation votes (TSV) collected from the survey were valued according to the ASHRAE's seven-point scale, which contains a number representing each response given in Table 3. The effect of wearing a face mask on the thermal sensation was determined by a two-tailed t-test that compared the mean TSVs of the face mask-wearing and not wearing students. The results of the thermal sensation survey were matched with the corresponding mean thermal data, predicted mean vote (PMV), and predicted percentage of dissatisfaction (PPD). PMV and PPD values were calculated using the Center for Built Environment's Thermal Comfort Tool and the adaptive chart that denoted the classroom conditions at 10:00 am, 11:00 am, and 12:00 pm (Tartarini et al., 2020).

Table 3 *ASHRAE seven-point scale for thermal sensation (ASHRAE, 2019)*

Hot	Warm	Slightly Warm	Neutral	Slightly Cool	Cool	Cold
+3	+2	+1	0	-1	-2	-3

3. RESULTS AND DISCUSSION

The mean environmental and thermal factors measured during the study were presented in Table 4. During the measurement period, the mean indoor air temperature was stable at around 20.4°C with 51.5% relative humidity and 0.29 $m \cdot s^{-1}$ V_a, while the mean outdoor air temperature was 13.8°C with 67.3% RH. The thermal neutrality ($T_{n,i}$) of the studied classroom is also presented in Table 3 according to the calculation of Auliciems et al. (1998), as it refers to the highest percentage of occupants who can be predicted to vote "neutral (0)" on the ASHRAE seven-point thermal sensation scale (de Dear et al., 2015).

The number of subjective thermal sensation votes corresponding to each thermal sensation category was shown in Table 5, while the means of the comfort values were included in Table 6. TSV According to the thermal sensation survey results, the students' mean thermal sensation vote was -0.29, close to the neutral on the ASHRAE's seven-point scale. The higher temperature and lower relative humidity levels of external conditions resulted in better comfort votes by the occupants, as the significance of these factors was suggested in the previous studies in Malaysia and Nepal (Maarof & Jones, 2019; Shrestha et al., 2021). However, when compared with the mean PMV (-0.65) and PPD (14%) values, it was seen that subjective votes were higher at each measurement period. This result agrees with a similar study conducted in Izmir during winter and summer (Çalış et al., 2017). As the students could adapt themselves by changing clothes and operating the windows, subjective votes were closer to the neutral value than the PMV.

***Table 4;** Mean environmental and thermal values*

Hour	T_{out} (°C)	T_a (°C)	T_r (°C)	T_o (°C)	RH (%)	V_a ($m \cdot s^{-1}$)	$T_{n,i}$
10:00	13.5±1.1	20.5±0.1	20.3±0.1	20.4±0.1	51.8±1.3	0.46±0.15	20.4
11:00	13.4±0.5	20.5±0.1	20.3±0.1	20.4±0.1	51.7±0.4	0.22±0.14	20.4
12:00	14.4±0.6	20.2±0.2	20.0±0.2	20.1±0.2	50.9±0.8	0.20±0.14	20.2
Mean	13.8±0.8	20.4±0.2	20.2±0.1	20.3±0.1	51.5±0.8	0.29±0.14	20.3

T_{out}: outdoor air temperature; T_a: indoor air temperature; T_r: mean radiant temperature; T_o: operative temperature; RH: indoor relative humidity; V_a: indoor air velocity; $T_{n,I}$: Thermal neutrality

After the Covid-19 pandemic, the students were free to use face masks according to their preferences in Turkey in 2022. Half of the students preferred to wear face masks during the study, while the others did not. The mean votes of the students wearing face masks were -0.35 and the rest -0.24. According to this result, there was no significant difference between the means of the answers (t: 62, p: 0.55). Therefore, the use of face masks did not affect the thermal sensation in the study.

Table 5: *Number of votes for each thermal sensation category*

Wearing Mask	Hour	cold -3	cool -2	slightly cool -1	neutral 0	slightly warm +1	warm +2	hot +3
No	**10:00**	0	0	10	8	3	0	0
	11:00	0	3	3	11	3	1	0
	12:00	1	1	2	14	3	0	0
	total	1	4	15	33	9	1	0
Yes	**10:00**	0	0	6	11	4	0	0
	11:00	1	3	6	7	3	0	1
	12:00	1	4	5	8	1	2	0
	total	2	7	17	26	8	2	1

Table 6: *Mean subjective thermal comfort values*

Hour	TSV	TSV_{yes}	TSV_{no}	PMV	PPD (%)	Participant Number
10:00	-0.21±0.7	-0.10±0.7	-0.33±0.7	-0.69	15	42
11:00	-0.31±1.2	-0.43±1.3	-0.19±1.0	-0.59	12	42
12:00	-0.36±1.1	-0.52±1.3	-0.19±0.9	-0.66	14	42
Mean	-0.29±0.7	-0.35±0.7	-0.24±0.7	-0.65	14	42

TSV: Thermal sensation vote; TSV_{yes}: Thermal sensation vote for students with face mask; TSV_{no}: Thermal sensation vote for students without face mask; PMV: Predicted mean vote; PPD: Predicted percentage of dissatisfied

Adaptation crucially influences thermal comfort sensation, as shown in the previous study in Malaysia and Japan (Zaki et al., 2017). There was no heating or cooling system in operation during the study, and the natural ventilation was under the occupants' control. The students were free to adapt to the thermal environment by adjusting clothes and drinking beverages. Thus, the result of the thermal conditions during the three measurement periods of the study fell within the 90% acceptability limits according to the ASHRAE Standard-55 (ASHRAE, 2019). The adaptive chart denoting the measurement periods of the study is shown in Figure 4.

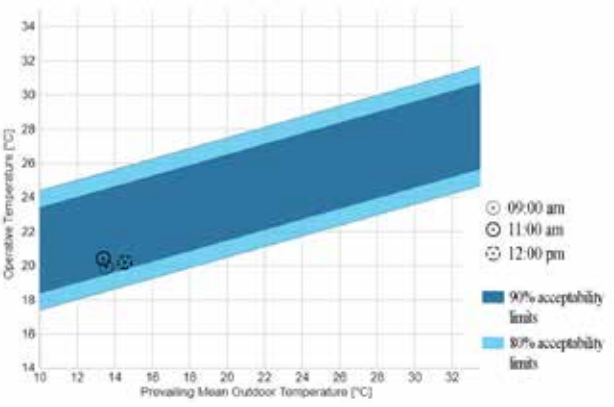

Figure 4*: Adaptive chart that shows the acceptability limits with conditions indicated corresponding to the survey periods*

The study was limited to one design studio class and three hours of the data collection period due to the conditions of post-pandemic hybrid (distance and face-to-face) education. Similarly, other studies on thermal comfort were conducted using a brief period of data. Martinez-Molina et al. (2022) reported the correlations between human thermal sensation votes and indoor environmental conditions in a historic religious building based on the measurements between 12:00 and 13:30 pm, which corresponded to the visiting hours. Papazoglou et al. (2019) investigated thermal comfort perception in a non-air-conditioned school building using thermal sensation survey results, air velocity, and temperature measurements during a 1.5 hours period. Harčárová and Vilčeková (2022) evaluated the thermal comfort and indoor air quality of four office spaces from two buildings consisting of an hour period of measurements from each. Considering these studies from the literature, despite the brief measurement period, the effect of mask use and behavioral adaptability on thermal sensation during a design studio class reported in the present study contributed to the thermal comfort study area.

4. CONCLUSION

In this study, thermal comfort conditions in a design studio classroom in İzmir were investigated. The study included three hours of measurements and thermal sensation surveys with 42 students in the spring semester in the post-pandemic period. The results showed that the students' sensation votes were higher than the PMV values, as the occupants could adapt to the thermal environment by window control, adjusting clothes, and drinking beverages.

As a reference to the post-pandemic period, half of the students preferred to use face masks during studio hours. According to the results, there was no significant difference in the thermal sensation of the students using a face mask and the rest. As the overall evaluation, the thermal comfort conditions of the design studio fell within the 90% acceptability limits according to the ASHRAE Standard-55. The study was limited to a spring day, without the occupants' demand for cooling or heating. Further studies are needed to show the thermal comfort conditions during the classes in the winter and summer conditions.

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HYBRID LEARNING IN PHOTOGRAPHY CLASS AMIDST PANDEMICS

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ABSTRACT

Arguably, recreating virtual space has been a slow-developing concept to many skeptical creative media communities and scholars. With the rapid growth of new media technologies, analogue or digital, society must exercise critical thinking in how these realizes the former impossibilities. Contemporarily, technologies are embedded in our everyday life, and yet we were not certain if these strongly transformed us. Unexpectedly, the COVID-19 pandemic radically disrupted every aspect of life, including education, and as a result educational institution demanding for new systems and structures that ensure uninterrupted learning for all students. We were forced to modify our activities, and it is a fact that many struggles and postponed. It is an entirely diverse challenge experienced by creative media educators. The direct hands-on instructions needed to be converted to live and/or recorded virtual simulation. Countless educational institutions have experimented with a hybrid learning approach to deliver teaching and evaluated their learning outcomes. In this article, I will share my experience in hybrid learning for one of the visual communication design courses, specifically photography.

1. INTRODUCTION

There are many innovative learning designs to be used and applied across disciplines. Both lecturer and practitioner have their own challenges in sharing effective practice and create learning activities (Masson et al, 2008). Unexpectedly, the COVID-19 pandemic radically disrupted every aspect of life, including education, and as a result educational institution demanding for new systems and structures that ensure uninterrupted learning for all students. Schools and universities are exploring numerous educational models to meet the needs of their students (Microsoft, 2021). I as a lecturer and practitioner simultaneously, found online teaching is rather difficult for design studio courses due to the lack knowledge of theoretical education framework, so most of studio courses I teach relies on common sense to deliver the teaching material effectively. Classroom in digital and online formats has existed for more than a decade and learning spaces is still highly conceptualized as physical learning spaces that is going online or becoming digital (Hilli et al, 2019). One of many educational terms that recently explored excessively is Hybrid Education, which is a teaching and learning model that meets the needs of students, teachers, and staff with integrated education technology tools that address blended learning, professional development, staff support, the learning gap, social-emotional learning, flexible scheduling, and attendance e.g., Microsoft Teams. In early 2020, Hybrid Education has shifted from an esoteric notion to the de-facto norm. We found ourselves where majority of our activities is hybridized. This forces all professional fields, layers of society and educational institution to go through hybridization process in such short amount of time. We share spaces with families, co-workers and bringing classes into our homes and students into theirs (Cohen et al, 2020). In Hybrid Education, learning comes first, and can include many of the instructional approaches we are familiar with, this includes Online Learning, Distance Learning, Remote Learning, Blended Learning, Flipped Learning, and finally Hybrid Learning (Davis, 2020). A hybrid learning environment is a mix of all the models. A hybrid approach to learning builds on the successes of these models to intentionally create a learner-centered experience that is "profoundly personalized, relevant, and engaging. Hybrid Learning focuses on authentic, relevant learning that provides students with voice, choice, and agency that incorporates peer tutoring, student self-assessment, and collaboration among

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instructors and students to design and carry out the best learning experience (Microsoft, 2021). Hybridity is highlighting challenges and opportunities that transpire in blurring boundaries between learning, working, playing, living and other experiences that emerge. Boundaries of online and offline, on-site, and off-site, synchronous, and a-synchronous, formal, and informal, vocation, and recreational and more (Cohen et al, 2020). There are two dimensions of hybridity in learning spaces, first, the interweaving of formal and informal social structures in an activity system. The second dimension is the combination of physical and digital tools mediating an individual's interaction with the world and society. Hybrid learning also allows learners to meet with course instructors and their peers face-to-face to discuss, debate, question, and acquire instruction (Alnajdi, 2014). Arguably, there are two approaches in Hybrid Learning: Andragogy and Pedagogy. The andragogical approach engages learners in the learning experience that focuses more on self-directed style, while the Pedagogical provides instruction to teaching and learning strategies and focuses on traditional classroom learning (Wong, 2008).

Hybrid learning is necessary because face-to-face learning and online learning each have their shortcomings (Wong, 2008). In the pandemic situation, the face-to-face scenario must be transferred virtually via ubiquitous conferencing applications and discussions conducted online. There is also a notion of Hybrid Learning Spaces (HLS) which share an affinity to Blended Learning, but it is not to be confused as one because it is not an instructional strategy that reverses the traditional learning environment and moves instructional content outside the classroom, it is something different in its own right (Hilli et al, 2019). Later in this article's analysis shows the result of how hybrid learning is an excellent addition to support student's independent study. Consciously, educators should have realized that technology as a medium that can simplify and assist the learning process to the maximum, the prerequisite in 21st-century education and there are many innovations and inventions in the form of multimedia devices that can support the contemporary world of education 4.0 (Hediansah and Dwi Surjono, 2020). Thus, HLS is a learning context that moves beyond online and offline spaces, but also challenges the divisions between teacher/student roles and analogue/digital communication media, which offers new 'complex hybrid breeds' that provides new possibilities for collaboration in higher education (Hilli eta al, 2019). With media technology support, it is possible to transport teaching space virtually by using analogue media, converts them to digital contents, then deliver and/or store the contents then finally creates online interaction.

2. LITERATURE REVIEW

2.1 Hybrid Learning Model, Hybrid Learning Spaces and Future Learning Space

Why transporting teaching space is imperative to the Visual Communication Design study program? Arguably, there is a misconception surrounding the idea of teaching Design in Universities, which commonly a 70:30 Theory to Practice ratio, but realistically contradictory to what is considered effective of 70:30 ratio Practice to Theory. This brings us to consider Design studies are partially and undeniably vocational because the study program has several mandatory workshop or studio courses to prepare students with practical skills required by the industry. Therefore, this pandemic situation forces the lecturer to deliver most of the studio courses to the online platform, which requires observing learning objectives from a design perspective. From a design perspective, a learning environment is broader than the archetypical classroom that the agents and roles are clear: the teacher is the expert and students are the learners to acquire knowledge, but rather a two-way communication such as brainstorming, discussion and project feedback. The space is physical with a familiar setup, but if this scenario is broadened to a learning environment that crosses the boundary, it becomes much more complex. It is becoming necessary to design the learning space in advance, aligning all elements as well as perspectives into a coherent and adaptive whole. However, applying the concept of learning space needs to be done carefully, as we naively believe that this could automatically lead to the intended learning outcomes because of its innovative, collaborative, powerful and real-life attributes to future educational practices (Zitter and Hoeve, 2012). Truthfully, these promising words of motivation need to be broken down into several understandings of what we are trying to achieve, and several technicalities of how we attempt to reach the goal.

Let us begin with several understandings on how we can achieve Hybrid Learning is to know the type of design framework. Based on the 5i Design Framework for a Hybrid Course suggested by Anthony Wong, Hybrid Learning Model (HLM) used in this article is leaning more towards the Interaction and Independent, because online studio course involves a high level of group interactivities that includes learning communities and peer review. For HLM in this article, students are also suggested to work and think independently by searching online information as discussed in the assignment brief by the lecturer (Wong, 2008). Due to the pandemic, the situation present in this article does not allow face-to-face teaching and learning, however, there was nothing changed in the way it was delivered, as if it were done as face-to-face. This article is suggesting new HLM based on digital media studies, due to the complex nature of the creative media learning environment, which need to consider all possibilities to successfully deliver studio courses, including the usage of Hybrid Learning Spaces (HLS) that will be in deeper discussion and the focus of this article.

Technology is permeating physical spaces and so spaces we teach, and learning is changing. Simultaneously, internet-connected technology (IoT) creates interfaces of virtual spaces and real-world phenomena. These dynamics grows hybridity presence, hence distinctively blurring boundaries in the context of learning and activity. HLS is potentially beginning to be recognized by education systems in promoting significant learning and increasingly use pedagogical HLM (Cohen et al, 2020). One of contributing

examples that make bold attempts to formulate a design language for HLS is Liat Eyal and Einat Gil in Levinsky College in Tel Aviv, Israel, which they proposed design patterns set in academic settings for Future Learning Spaces (FLS) and has been operating for one and a half years (Eyal and Gil, 2020). FLS is a dynamic and technology-rich learning environment that enables teaching and learning using innovative pedagogical methods, it is a new theoretical concept in the higher education landscape. FLS enables a collaborative and interactive learning experience by using diverse technologies in which parties involved can share responsibility for the content, technology, and space. There are three reasons why space is important to teaching and learning, firstly, it is a mediator and moderator between instructor and student behavior. Secondly, it emphasizes the way of space is used as designed activity by the lecturer. Lastly, the physical characteristics of space such as size, layout and colors hold potential and meaning to how space is used (Eyal and Gil, 2020). For that reason, this article will illustrate the teaching format conducted in Digital Photography and Videography class at the Visual Communication Design study program at Sampoerna University, because it corresponds to the HLS/FLS criterion above. One of four design-patterns of FLS that matched to this article's activity and also suggested by Eyal and Gil (2020) is design-pattern number two, which is Teaching in an Interactive Orchestrated Learning Space; Creating learning stations with exploratory tasks while each group works separately and in parallel to the other groups on different aspects of the subject. Eyal and Gil pointed out that by using these design-patterns, the lecturer addresses challenge variations in implementing innovative pedagogy such as equal participation, documentation of learning, focusing attention and concentration in learning, and looking at a variety of perspectives and dynamism in class management (Eyal and Gil, 2020). Furthermore, this article will evaluate the best learning result from three students enrolling in the course, by interviewing each of the students separately. These students used different type of cameras and light source for their still-life photography assignment, which we will see that the outcome of the interviews is a reasonable comparative analysis.

2.2 Mitigating Circumstances in Photography Technology

We decided to change how we teach, which means that we need to compromise and customize the academic rules of conduct as well. The purpose of academic rules of conduct has always been to broaden student success opportunity, giving more headroom for students to personalize learning strategies throughout their three to four years of study. One of the rules that this article focuses on and has a direct influence on student's learning outcomes is mitigating circumstances. Mitigating or extenuating circumstances is to decrease harmful situation that can affect students' achievement and aspirations, where these situations are beyond student's control that usually takes adverse effects on their personal and academic life in one way or another (Achinewu-Nworgu and Nworgu, 2015). It is worth note-taking that HLS/FLS needs to be accompanied by an in-class mitigation policy allowing students to utilize whatever photography tools available for them. A pandemic is a circumstance beyond student's control that can harm student performance in their course work. Another reason why mitigation for photography students is necessary to be applied in the pandemic situation is that the required tools are ubiquitous and affordable e.g., instead of using a DSLR camera, they are allowed to use smartphone camera because they have no access to the university's equipment. However, one of the biggest challenges is that this type of mitigation policy has a direct impact on the course delivery, which typically the lecturer needs to uncover many probable photography scenarios and outcomes to the students. The lecturer must allow students to submit claims for mitigating circumstances ensuring student success and maintain the highest standard of education, which in some cases student requires rapid and direct feedback before an assignment production or submission. Some situations that are not normally acceptable for mitigating or extenuating circumstances i.e., the pressure of work, minor illness, or self-induced conditions (colds, hangover etc.) and many more (Achinewu-Nworgu and Nworgu, 2015). If there are conditions that the lecturer is unsure if the situations are acceptable, the recommendation would be referring to the Higher Education Institution's (HEIs) mitigation policy. If HEI has not released mitigation policies, the lecturer should immediately create a class mitigation policy on the study program level.

In this article, the mitigation is based on global force majeure and urgency, which is impossible for HEI to design mitigation policy on such short notice. Decision on mitigating design students that enrolled in photography class is based on the recommendation by industry practitioner, Raja Siregar, which allows students to use a smartphone camera. Thus, this photography class allows students to use any camera including a smartphone's camera by considering the quality of current smartphone cameras are par to the industry standard Digital Single-Lens Reflex (DSLR). He admitted that he captured pictures using a smartphone camera for personal use just to get a quick and good result. This is also a good practice for students to attune to practice basic photography whenever and wherever possible. The base of this recommendation is that, contemporarily, the most smartphone has already embedded with competitive analogue camera quality into it, which is also supported digitally by software e.g., camera digital zoom. One of the most successful smartphones and camera collaboration to date that demonstrates high-quality image result is Huawei and Leica on their Huawei P40 Series smartphone, which also received an award from Technical Press Image Association (TIPA) in 2020 for the Best Photo Smartphone. Contemporarily, there are other smartphones following this path such as Vivo and Zeiss on their X60 Series, and Sony also with Zeiss on the Xperia Series, as well as OnePlus and Hasselblad on OP9 Series. From an educational perspective, such technological development, the smartphone industry creates major impacts in supporting learning success for design students, especially if they can make these smartphones more affordable and accessible in price e.g., the educational price for students or bridging partnership with HEI.

3. METHOD

Current education must be able to describe a better meaning for students as students and teachers as educators. This is inversely proportional to the education situation which has not been able to become an effective facilitator of the learning process. Instructional (learning) is a stage used by educators to direct students in certain conceptual conditions to help them achieve learning targets (Hediansah and Dwi Surjono, 2020). The conceptual condition presented in the article refers to emulating photography studio by using multimedia devices. Decisions on investments in HLS are critical for institutions as its implementation is costly given the spaces making all learning options available for learners. Thus, one of the most crucial indicators to assess cost-effectiveness in learning space implementation is through satisfaction and experience of learners (Xiao et al, 2020), which we will see in the result and analysis. Expectantly, this article can be one of the guidelines for teacher and lecturer that requires HLS/FLS in their teaching's circumstance and explore the full potential of this concept. Now that we have already broken down our understandings of the learning space concept, this next guideline consists of several technicalities on how we attempt to reach the goal.

Frankly, emulating teaching space based on the HLS/FLS method is much more difficult than described by words. The lecturer that plans to conduct HLS/FLS for creative courses must fully understand the fundamental concept of sharing learning space virtually, this includes classroom, lab, and studio, and how can this be conceptually effective in delivering the material. This is where the mixture of digital media and pedagogical mindsets come into play. Initially, the lecturer needs to understand the concept analogue to digital signal conversion, because this is an attempt to convert face-to-face activities into lecturer and student audio-visual communication. Analogue means the hardware signal that is used and digital means the converted signal received from the hardware as seen on Figure 1.

Figure 1: *Analogue input to digital output (A/D Conversion), simply known as Hardware to Software conversion.*

Firstly, the lecturer needs to understand the specificity of media technologies that can support specifically the lecturing concept. The media specificity ranges from the input and output hardware feature that is available in the equipment used. Currently, the standard video conversion is through High-Definition Multimedia Interface (HDMI) cables, these cables are available in various formats, i.e., HDMI, Mini HDMI, and Micro HDMI. It is imperative to use HDMI as the video conversion format for online learning, as it is presenting better screen resolution for media streaming. On the other hand, standard audio conversion is by using an audio interface or also known as a sound card connected through Universal Serial Bus (USB) cables, i.e., USB, Mini USB, and Micro USB as seen on Figure 2. For audio conversion, there is a second type of cable, which is jack cable or specifically TS, TRS, and TRRS, which also comes in various sizes, the one that used in this experiment is the TRS type with 2.5 mm cable as seen on Figure 3. It is recommended to use an audio interface as the main audio signal receiver as it has a hardware audio processor that guarantees clarity in verbal instruction.

Figure 2*: HDMI cable varieties.*

Figure 3: *Variety of TS, TRS, and TRRS audio cable sizes.*

As shown in Figure 4, Sony NXCAM has HDMI output and Canon 6D has Mini HDMI output, these are cameras used as visual instruction. These outputs are converted by using two Video Capture devices with a USB cable for each of them. These capture devices are detected automatically by the computer as camera inputs. Similarly, for the audio, Zoom H4N is used as an audio interface connected with a USB cable, and to the audio interface, a 2.5mm lavalier microphone is plugged into it. These outputs will be detected and collected by Open Broadcasting Software (OBS) as input signals for OBS Virtual Cam, which it will need to be manually replaced by the built-in webcam in the computer through Microsoft Teams device settings. OBS is also capable of recording the session, this is very useful to evaluate the teaching delivery which will be explained in the next paragraph. Before the class, the lecturer must conduct media setup and testing to ensure teaching continuity as well as avoiding technical difficulties that can cause an abrupt halt to the student learning experience. The recommended scenario is recording while rehearsing the class to ensure effective delivery of the material

by evaluating each recorded session. The recorded session will provide a new dimension to the 'hybrid' of Hybrid Pedagogy that some of its focuses are physical learning space/digital learning space and analogue/digital materials and technologies [7]. Additionally, evaluating the material, the teacher or lecturer must evaluate the equipment's technicalities, e.g., battery life, this is crucial if the equipment depending on batteries to be powered.

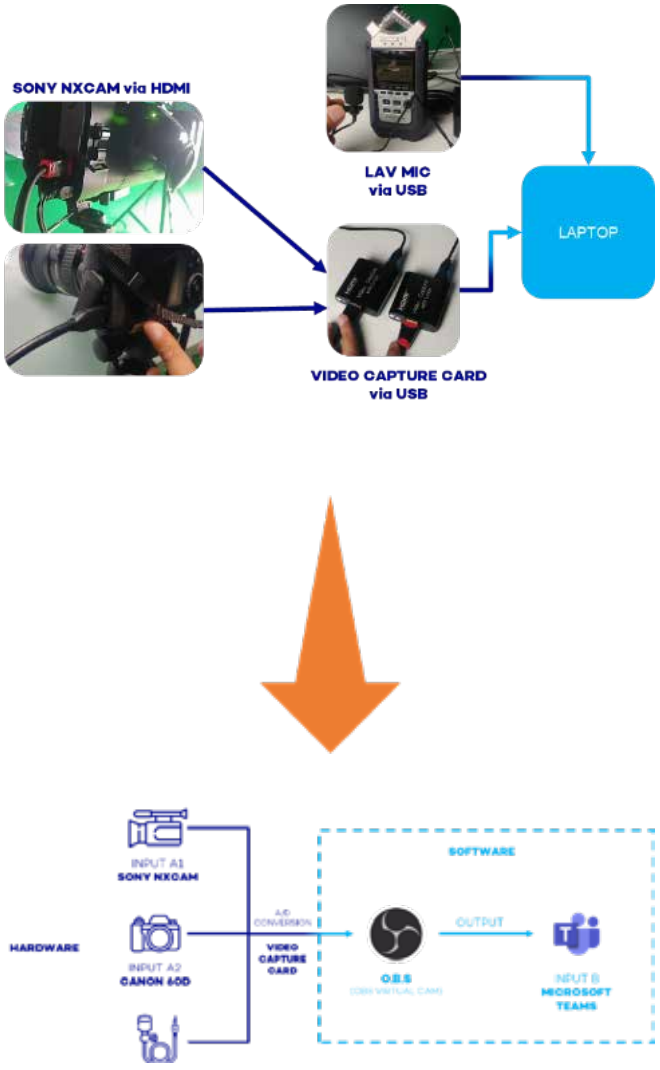

Figure 4: *Understanding what the inputs and outputs on the media tools are. Then, planning analogue to digital conversion scheme.*

Secondly, teaching floor plans needs to be well-prepared, so the lecturer has good mobility around the space. This can be done by using any software that can generate shapes or basic illustration. As seen in Figure 5, the teaching space has been prepared so the lecturer has good mobility around the area, as well as not block students view from the NXCAM camera. The layout was done using Microsoft PowerPoint because that is what available on my computer, but this is possibly done by using Microsoft Paint as well.

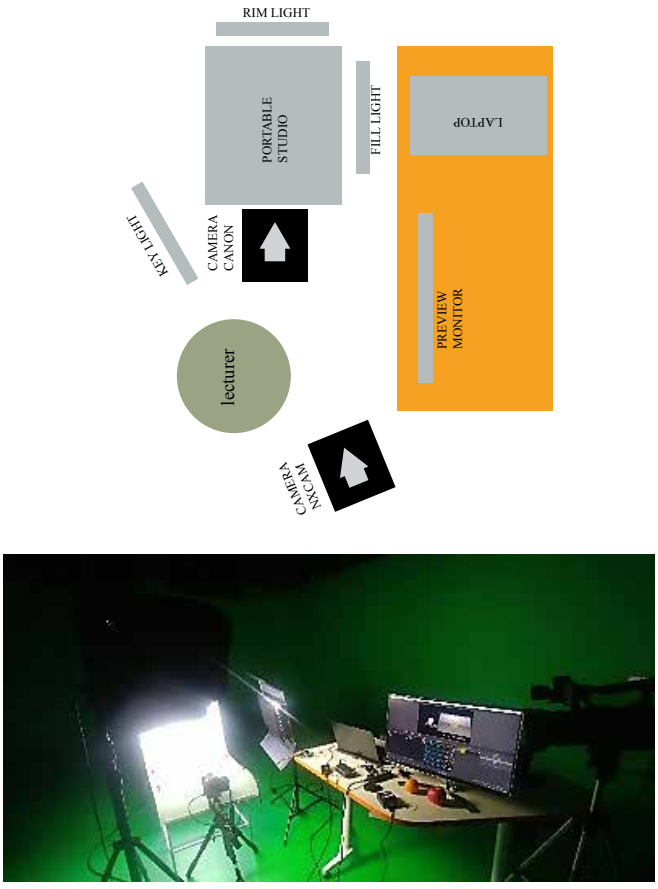

Figure 5: *Left side is the prepared floor plan. Right side is the actual setup.*

Thirdly, the lecturer must set up a broadcasting interface, so it is possible to control the camera views digitally via keyboard shortcuts and interchangeable during the class. It is encouraged to customize the view, letting the students understand what has been done in the overall setup and how it impacted what is captured as shown in Figure 6. At this point, teaching rehearsal is crucial, assuring the lecturer that the material delivery is equivalent to face-to-face class, which is making sure students can see what they need to see. Finally, keep reminding ourselves of the importance of user-experience when it comes to preparing the equipment because by constantly troubleshooting, we can accidentally make the framework more technical than what it needs.

Figure 6: *OBS scenes setup.*

4. RESULTS AND DISCUSSION

Below is the teaching and learning result of the mentioned photography class delivered through an online meeting application using HLS / FLS principles specifically design-pattern number two. It is seen in Figure 7, she applied photography techniques to her Still-Life photography assignment as accurately as what is instructed in class with excellent result, which is shown in Figure 8. Although there are many other examples to be presented in this article, however, the chosen ones are the best representing the learning outcome of the class, which are lighting and composition in photography.

Figure 7: *Learning result from the students (Left to Right): Keke Putri Komalasari, Shareen Rhema Angela Gumulya, and Eros Kuncoro.*

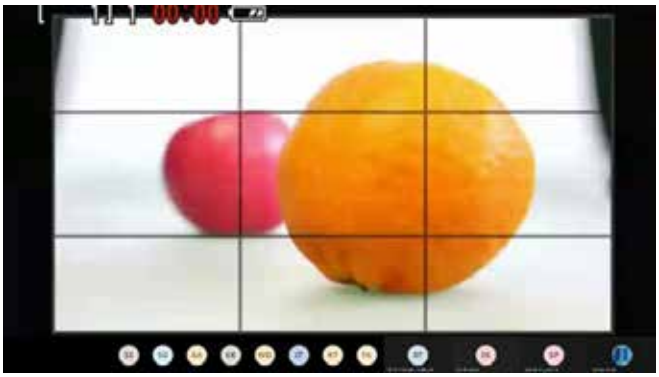

Figure 8: *Camera angle shown in the virtual classroom by using OBS Virtual Camera.*

The chosen works were also produced using different type of cameras, i.e., a DSLR Camera, a Mirrorless Camera, and a Smartphone Camera. The method of analyzing the result is by collecting survey of all students then interviewing each top 3 students separately via Microsoft Teams chat and with the same set of question:

Students	What type of camera are you using?	What type of lighting are you using?	Do you own the equipment?	Do you have access to a photography studio?	Do you find the online photography lighting class useful?	How do you rate the online photography lighting class?	Grade
1 (A)	DSLR	Natural Light	Yes	No	Yes	5	90%
2	Mobile Phone	Custom Lighting	Yes	No	Maybe	3	90%
3 (C)	DSLR	Natural Light	Yes	Yes	Maybe	4	89%
4	Mirrorless	Natural Light	Yes	Yes	Yes	5	83%
5	Mobile Phone	Natural Light	Yes	No	Yes	4	76.5%
6	Mobile Phone	Natural Light	No	No	Maybe	4	75.4%
7	Mobile Phone	Natural Light	Yes	Yes	Yes	4	73%
8 (B)	Mirrorless	Custom Lighting	No	No	Yes	5	80%

Table 1*: Students Survey Result*

As seen on Table 1, Student A agrees that although she was not in the campus photography studio, the teaching delivery by using the HLS/ FLS method has helped her understood photography techniques and basic studio setup. Student A was using her own Canon EOS 600D and only using natural light (sunlight) for her photography assignments, thus by using a DSLR camera, her work is the best result out of the three examples above. It is still interesting that she can manage to produce the result by relying on natural light, it is difficult as it is not portable lighting, instead, she moves the set up near the window where the light source located. On the other hand, the second-best example is by Student B, in which he used a mirrorless camera, specifically Olympus EPL 6 and a flashlight for his assignment. Student B does not own a camera, instead, he had

borrowed it from his friend, and it is already challenging for Student B to completely pass the semester. He admitted that HLS / FLS helped his understanding of lighting in photography, sadly he does not have access to professional equipment, thus he cannot practice the knowledge right away. Lastly, the third-best example is by Student C, which was using a smartphone camera specifically Oppo A31, which shows the distinctive contrast color of smartphone's digital camera processing. She uses a combination of natural light, a smartphone's flashlight and/or a simple study desk lamp to light the scene. During the interview, it is so encouraging to know that Shareen believes her smartphone and limited lighting source can produce good images, and that confidence shows in her work. Student C admitted that the lighting course that uses HLS / FLS does help her understood basic lighting principles. In conclusion, although these students do not have access to a professional photography studio, and type of camera is not the learning barrier, but it is the photo light source that they have limited access to. Thus, applying mitigation policy to online photography classes is imperative and harmless to the production quality. As we see with the result above, even when the students are using minimum lighting as natural light and flashlight, the quality is not compromised by the naked eye. It is for future recommendation to provide students with information on the affordable and accessible light source for their photography assignments. Currently, there are many options of affordable and portable LED lighting available. Despite having no access to proper lightings, the image quality submitted by students are beyond expectation, it shows student's strong determination in reaching high learning standard especially during the pandemic. Even if the class expectation is decreased, the lecturer must have similar, if not, more confidence and determination as to the students. Overall students result as below:

Now that we have assessed the result using chosen students' satisfaction and learning experience as indicators, the cost of equipment used to setup HLS/FLS is arguably effective remembering the online class is very rich in content thus it gives a huge impact on the quality of student's independent study. Potentially, this method opens broader possibilities in creative media teaching with the support of rapidly developing technology and research and exploration of HLS / FLS in education must be well documented to upgrade the adaptability of delivering the highest standard of education. The student's interview above is also a result of one of the 5i Design Framework, which is Independent, because of successful Interaction of the Interactive Orchestrated Learning Space from FLS design-pattern number two. The learning independence is becoming automatically reliable, which means by blurring the context of learning and activity, it is also increasing its consistency. I am recommending to all design lecturers to experiment with modern media technology by following the combination of the 5i Design Framework and FLS Design-Pattern methodology. It will open a bigger educational context, not only alternative methodologies but also customizable teaching and learning experience. Another variable that directly affects HLS / FLS in this article is mitigation on student's capability to achieve what is required by the assignment, e.g., mitigating on equipment used by students. Mitigate expectations and avoiding the mindset of decreasing learning quality but rather shifting it to discover new normality in setting newer higher education standards. If education is the benchmark to the power of knowledge, then we are not exercising the power enough that we do not have versatility in using the knowledge itself and be hybrid.

5. CONCLUSION

The end of the COVID-19 pandemic is yet to be confirmed, and there are many challenges in the education sector, specifically in creative media education to deliver the course effectively. As an educator, we need to stay positive and motivated to deliver teaching and achieve successful learning outcomes in creative ways. We need to adapt to modern technologies and sacrifice a little bit of teaching authenticity to survive and rest assured that the student success will follow. Also, as a reminder for HEI to always look forward to the global pandemic when designing teaching and learning policy, especially one that could help mitigate students with their hands-on and/or vocational courses. By imposing education standards into a much more adaptable environment, with online class and mitigating circumstances, we must aware and have a strong assumption that there will be unforeseen drawbacks to the situation. One issue that is highly possible to occur is that our students are not completely equipped with the skills that the creative industry needs if the industry itself does not change post-pandemic. However, creative industry transformation amidst pandemic is an entirely different discussion, HEI has to prepare supplementary support after students graduated. Indonesia's Ministry of Education and Culture program of Kampus Merdeka might be the solution by decentralizing higher education focus to the creative industry professionals including study to internship credit exchange, practising independent project and entrepreneurship. By exercising this program, students are expected to level with the industry-standard despite the learning customization during their study throughout the pandemic.

The future of HLS/FLS is very bright, not only portable and *softwarized*, but education can also be as experimental as embedding Virtual Reality and Augmented Reality technology as part of the teaching and learning tools to attempt creating immersive education. Not limited to discuss and explore the deliberately growing Adobe E-learning Community, where the community shares a variation of free e-learning projects including Virtual Reality and Interactive eLearning. Therefore, the future work of this article will discuss and experiment with 360 cameras to record and in delivering teaching materials, as well as using VR goggles as the learning tools. These are attempts to drive education as far as technology develops and to not being aware of unforeseen events such as a pandemic or any possible worse situation that might severely impact the educational field. Sequentially, the future article will also analyze feedbacks from more students to have more unique variables.

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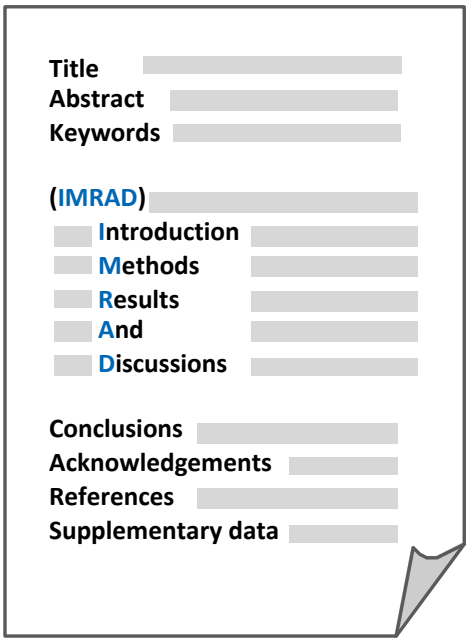

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