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TECHNICAL ARTICLE

Analyzing the Users' Satisfaction Levels and Perceptions of the Dubai Water Canal for Future Waterfront Development in UAE

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Dubai was developed from Khor Dubai and the city always focuses on the development of waterfront as a public space. The urban waterfront in Dubai is a highly visible public space for recreational activities but also as an urban landscape for placemaking, environmental pollution reduction, and transportation. The objective of this study is to explore the direction of future development of the Dubai Water Canal. By analyzing the characteristics and behavioural patterns of canal users using a post-occupancy evaluation survey, the study presents the management plan necessary to improve the facility. As a methodology, Post-Occupancy Evaluation (POE) with two-step cluster analysis was used with SPSS Statistics version 20.0. Dubai Water Canal users were classified into friend-based, family-based, and individual-based clusters to investigate the differences in satisfaction levels and perception between clusters. The survey included questions on accessibility, convenience of use, facility management status, safety, and landscape management. The result had shown that family-only parking, convenient pedestrian walkway, signage/distance marker, and pocket parks as green buffer zones are needed to increase the level of satisfaction. Factors to enhance users' satisfaction comprised 1) efficient road system for light exercise, 2) efficient information signage, 3) convenient pedestrian roads with nighttime lighting system, 4) strict separation of pedestrians and cyclists, and 5) nature-friendly landscape and landscape improvement. This study intended to extract elements for future design and management of urban open space projects, similar to the Dubai Water Canal.

Keywords: Dubai Water Canal; Public Space; Waterfront; User Behavior; Post-Occupancy Evaluation

1. Introduction

Dubai was developed from Dubai Creek area, which was known as Khor Dubai in early 20th century (Elsheshtawy, 2009; Boussaa, 2003). Because of its origin of urbanization and historical background of waterfront trade, Dubai always focus on the development of waterfront as a public space intensively (Krane, 2009; Nassar et al., 2014). The identity of port city had started from the time of Sheikh Saeed bin Maktoum (1912–1958), the late father of current ruler Sheikh Mohammed bin Rashid Al Maktoum, since he had led the urbanization of Khor Dubai as waterfront development with residential and commercial areas including hotels, resorts, and markets. Today Dubai has a reputation of continuously growing city with skyscrapers, which expands to the desert areas with flamboyant lifestyle expat communities (Haines, 2011). The rapid development of Dubai was researched in academic papers many times with focus on conspicuous consumption communities (Acuto, 2010; Pacione, 2005), but no research was found how satisfied Dubai residents are. Dubai propagates the image of metropolitan city with constant sprawling developments of big scale projects but somehow each mega project tries to capture some cohesive image of Dubai (Branzi, 2006). Business Bay development, which integrated with Dubai Water Canal as a public space, is to generate a new central business district in Dubai. Business Bay's phase 1 & 2 development area is approximately 9,470,000 m^2 and the first phase's area was approximately 3,700,000 m^2 with a mixed-use development along the Dubai Water Canal (El Amrousi et al., 2019; Bayut, 2020). It was focused on the link to public transportation like buses and metro stations and high-end real estates (Elhakeem & El Amrousi, 2016). Dubai's resilient development is still questionable, but it rebuilds the reputation to attract the significant number of tourists and capitalists again to Dubai (El Amrousi et al., 2018).

Dubai Water Canal was initially developed to link the historic part of Dubai, Shindagah and Al-Bastakiya area of Deira and contemporary urban context of Dubai, Business bay and Downtown, and Jumeirah to mitigate the rapid development of Dubai (Geyer et al., 2017). It facilitates the flow of seawater which usually stopped at Ras Al khor

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area and is designed to enhance the quality of water for marine life by preventing water stagnation (Denley, 2019; Karanam et al., 2018). Dubai Municipality and RTA has expected Dubai Water Canal to inspire Dubai's economies and contribute to urban and economic revitalization (Hannawi et al., 2019) as Central park did to New York city, which was designed by Frederick Law Olmsted with huge water canal and lakes to build history, identity, and sense of community (Ellin, 2010). Even though Dubai Water Canal had cut part of Al Safa Park to generate an urban network along canal, it introduces new waterfront as a public space to the people and fosters respect not only for water and natural resources, but cultural heritages and it integrates people by sense of place (Alawadi, 2014).

The urban waterfront in Dubai is a highly visible public space that functions not only as a park for recreational activities (Ashworth & Page, 2011) but also as an urban landscape for placemaking, environmental pollution reduction, and production and transportation (McDonald, 2017). The Dubai Water Canal, started in 2013 and completed in 2016, is the brainchild of Sheikh Mohammed bin Rashid Al Maktoum, Vice-President and Prime Minister of the United Arab Emirates (UAE) and Ruler of Dubai (Masudi et al., 2021). The Canal was intended to add a unique landmark to Dubai that offers tourist, commercial, and new lifestyle options for residents and visitors alike (Richards & Palmer, 2012). As noted by Mattar Al Tayer of Dubai's Roads and Transport Authority, "Sheikh Mohammed is always keen to roll out creative and cracking visionary ideas that define new concepts for Dubai residents' and tourists' happiness and welfare" (Team KT, 2016; Hammad, 2019). Based on his initial idea, Dubai Water Canal demonstrates how Dubai look for continuous enhancement of its urban image and visibility as he wants to satisfy the cultural diversity and the needs of Dubai residents (Dulaimi & Hariz, 2011). Dubai Water Canal had presented the water not only as a landscape but as a link between Dubai's past as a port city and Dubai's future as a contemporary metropolis with urban comfort and happiness (Al Tayer, 2016).

With the Dubai Water Canal Project, the approach was to integrate Dubai's infrastructure with the natural environment to establish an attractive public space (Khandelwal, 2018; Salingaros & Masden II, 2010). However, in addition to its role as a landmark centered on specific facilities, the Dubai Water Canal also functions as a leisure space suitable for light walks and exercise (Team KT, 2016). It also plays a significant role as an everyday park for nearby residents (**Figure 1**). The objective of this study was to analyze the results of the survey on the satisfaction of Dubai Water Canal as a public space to find out which factors should be

Figure 1: Satellite image of the Dubai Water Canal and Districts' Images. (Source: Authors).

considered first in design and management to increase the satisfaction since Dubai's affable approach to residents and tourists to build the waterfront infrastructure as a public space, but no research was found to prove how efficient this approach is. Unlike previous studies that recognize waterfront users as the same group, this study attempted to identify differences in satisfaction and perception with a post-occupancy evaluation (POE) survey with two-step cluster analysis. Furthermore, based on the difference in perception of each group, factors for future waterfront developments in Dubai are extracted and suggested.

2. Literature: The Dubai Water Canal

Dubai is strategically trying to be oil-independent and continuously enhancing its urban identity and city brand value to attract more capitalists and tourists for its sustainable growth (Stojanova, 2020). All the big developments in Dubai aims to inspire flamboyant lifestyles which project an image as a successful businessman in a competitive global market (Haines, 2011). The Arabic cities in Gulf area are becoming urbanized in different rates with different characteristics and these urbanizations are based on global economies and network beyond their region and cultures (Malkawi, 2008). From the early stage of urbanization with skyscrapers and mega projects, Dubai put an emphasis on waterfront developments as opportunities for economic development and public entertainment (Kubat et al., 2009). Even when Dubai had faced with economic crisis, it never stops extending the boundaries of its waterfront developments such as Palm Jumeirah, as its first series of artificial reclaimed island project extended existing costal line to Arabic Gulf with astonishing design strategy, which is palm tree shape seen from the above with crescent offshore jetty (Gibling, 2013).

Due to comparatively simple cost line, land reclamation became Dubai's most favorite strategy for costal urban development (Grydehøj, 2015). Madinat Jumeirah, 5-star tourist resort project which was completed in 2003, had the design strategy to replicate the local heritage area of Shindagah and Al-Bastakiya with 5.4 km canals, where tourists can enjoy boat and water taxi trips like Abra, traditional boat in Dubai Creek area (Katodrytis & Mitchell, 2015). Not only Madinat Jumeirah, but there are also few more waterfront projects with canal such as Palm Jumeirah and Bluewater Island (Munyal, 2018). This kind of replica traditional design approach with artificial canals attracts expatriate residents in Dubai, which is 85% of Dubai population, with fragmented vocabulary of traditional architecture (Frampton, 2003). These Dubai's waterfront developments proves that the presence of water in the project works not only as a landscape but also as a link between Dubai's past as a port city of fishermen and Dubai's future as a contemporary urban metropolis (Ryan & Ninov, 2011). Regarding Dubai, the image of city was represented by mega projects such as Burj Al-Arab, Burj Khalifa, and Dubai Mall as Istanbul was represented by Hagia Sophia (King, A., 2004).

According to "Dubai Tourism Statistics 2019," Dubai hosted 16.73 million international visitors in 2019 and is ranked as the #4 hospitality city in the world, boasting 126,210 rooms in 741 hotels and hotel apartments (Francis, 2019). Furthermore, Dubai International Airport handled 89.1 million passengers in 2018 and is considered the third most visited airport globally (Dubai Online, 2021). As modern Dubai has its origins in the Dubai creek area, Sheikh Mohammed bin Rashid envisioned connecting the inland creek back to the sea for the happiness and welfare of Dubai residents and tourists. This vision was the starting point for creating the U-shaped waterway that would become the Dubai Water Canal (Kareem, 2019). RTA (Roads and Transport Authority)'s masterplan to construct water canal from Deira demonstrates Sheikh Mohammed bin Rashid's vision to create more real estate developments along the water canal (Almasar, 2016). The five phases RTA's masterplan includes excavation, recreational walkways along the canal, and few iconic bridges to cross the water canal (Geyer et al., 2017). It also covers 12 RTA waterbus stations for efficient water transportation as an alternative way for communing to connect several waterfront projects to Dubai Downtown (Almasar, 2019). As a part of the mass transit network of Dubai, Dubai Water Canal offers an innovative method of public transportation for one million Dubai residents (El Amrousi et al., 2014) (**Table 1**).

A part of backbone highway of Dubai, Sheikh Zayed Road, was lifted to make way and connect previously stagnated water from Business Bay side to the Arabian Gulf of Jumeirah side (Hammad, 2019). The canal width varies between 80 and 120 meters, and the canal cuts across Safa Park and flows into the residential Jumeirah district (Denley, 2019). Its walkway is 12 km long beginning from the Dubai Design District and terminating at the Water Bus station at the end of the canal (Shahbandari, 2016). This design provides ample space to walk, rollerblade, and cycle along the walkway, or to enjoy yoga at Marasi Park. **Table 2** presents additional facts and figures about the Dubai Water Canal.

By linking Business Bay with the Arabian Gulf, the canal has transformed downtown Dubai and the adjacent neighborhoods, including Zabeel, Oud Metha, Karama, Satwa, and Bur Dubai, into an island (Karanam et al., 2018). It is 80 m wide and 6 m deep and has created 6.4 km of boardwalk with smart LED lighting system in the central area of Dubai with a 3 km jogging track and a 12 km cycling path (RTA, 2020) (**Figure 6**). Along the waterfront, many new residential and commercial developments are planned or under construction, including a W Hotel, St. Regis Hotel, and J.W. Marriott Hotel (Team KT, 2016).

The RTA's original plan for the Dubai Water Canal included 1) an international-standard marine transport hub with five stations to serve six million passengers annually; 2) a waterfront development with several leisure and lifestyle shops, including cafes and restaurants; 3) a marina and boardwalk where residents and visitors can spend leisure time; 4) real estate development plans for construction of 960 hotel rooms and more than 5,000 residential units along the canal; 5) a three-floor 300,000 square meter shopping mall with 400 retail outlets and rooftop park facing Al Safa Park; 6) a canal extension to the Jumeirah Beach Park that will add a few kilometers of beachfront; 7) Dubai Marasi marina; 8) a 7 km promenade to connect with the

Table 1: The construction process of the Dubai Water Canal.

Phases	Contents	Images
1	– Elevation of Sheikh Zayed Road, involving construction of the bridge spanning the proposed canal. – Modifications to Interchange-2 & the diversion of all required services under the canal.	
2	– Elevation of Al Wasl Street and Jumeirah Street, including construction of the bridges along these streets. – Construction of interconnections along Al Hadiqa Street and Al Athar Street (all associated diversions of services under the canal along these main roads).	
3	– Canal and Coastal Works involved construction of 3.2 km of the canal itself including the quay walls. – Construction of the coastal peninsula including rock revetments and coastal protection. – Construction in progress for the roads and services diversions in the areas between Al Wasl Street and Jumeirah Street	
4	– Dubai Water Canal Infrastructure Package involved the construction of all infrastructure required specifically for plot development as part of the overall project, including all roads and utilities.	
5	– Dubai Water Canal – Package 5 consisted of completion of all outstanding works within the Business Bay Canal, as required, to provide full navigation of the completed canal: a) Completion of remaining sections of the wall constructed of precast mass concrete gravity type quay walls. b) Completion of utilities diversions/relocations that conflict with the Canal route. c) Reduction/removal of salinity of the hyper-saline water in the Business Bay Lagoons to achieve acceptable levels. d) Flooding of the Canal between Dubai Creek and the Dubai Water Canal.	 

Jumeirah Beach running track, creating a seamless track with smart surveillance cameras and face-recognition technology for safety; 9) greenery throughout the entire development as part of Dubai's nature conservation program; 10) four residential towers next to Al Safa Park with 211 residential units; and 11) a peninsula area with 60 marinas, 957 five-star hotel rooms, 347 retail outlets, plenty of restaurants, and 1,817 residential units (Pereña, 2019).

The objective of Dubai Water Canal is to circulate the sea water, which was blocked in business bay area, and to integrate nature with urban contexts, downtown with Deira, and eventually integrate different ethnical background residents with different age groups and income brackets (Ellin, 2010). It also makes Dubai's strategy to enhance its urban image conspicuous. The waterfront space in the middle of the city will give Dubai a new space of recreation for the neighbouring community (Gupta, 2015). It clearly shows Dubai's intention how to invest in green infrastructure in the city to enhance the public health (De Jong et al., 2019). Open spaces, which was generated by Dubai Water Canal infrastructure, encourage residents and tourists to believe that Dubai is not only focusing iconic buildings and high-end real estate but also on inclusion of people with different cultural and ethnic backgrounds (El Amrousi et al., 2018). This hybrid image of modernity and history can build the image of the city beyond political and

Table 2: Facts and figures of the Dubai Water Canal.

	Sub-category	Figures
Budget	Project cost	2.7 billion AED
Physical facts	Waterfront length	6.4 km
	Width	80 – 120 m
	Depth	4 – 6 m
	Height from the canal bed	7.4 m
	Max water speed	7 knots
Infrastructure	Cycle track total length	12 km
	Jogging track	3 km
	Boardwalk with smart LED	6 km
	# of marine station	9
	# of marine user in 2019	Approx. 1 million
Bridges (pedestrian & vehicular)	Concrete road bridge	3.8 km (Vehicular)
	Steel Suspension Bridge (**Figures 2** and **3**)	122 m (Pedestrian)
	Steel Arch Bridge (**Figure 4**)	205 m (Pedestrian)
	Steel Twisted Truss Bridge (**Figure 5**)	122 m (Pedestrian)
Construction	Main contractors	4
	Sub-contractors	70
	Concrete blocks	12,500
	Excavation volume	3 million m^3
	Quantity of rocks paved	1,500,000 m^3
	Water for canal flooding	7,800,000 m^3
	Saline water treatment	25,000 ton
	Amount of cement used	150,000 ton
	Number of working hours	20 million man-hours
	Total number of workers	4,650 (Peak manpower)
	Reclaimed land area	408,000 m^3

Figure 2: Steel Suspension Bridge, Dubai Water Canal. (Source: Jung, 2020).

Figure 3: Steel Suspension Bridge, Dubai Water Canal. (Source: Jung, 2020).

Figure 4: Steel Arch Bridge, Dubai Water Canal. (Source: Jung, 2020).

Figure 5: Steel Twisted Truss Bridge, Dubai Water Canal. (Source: Jung, 2020).

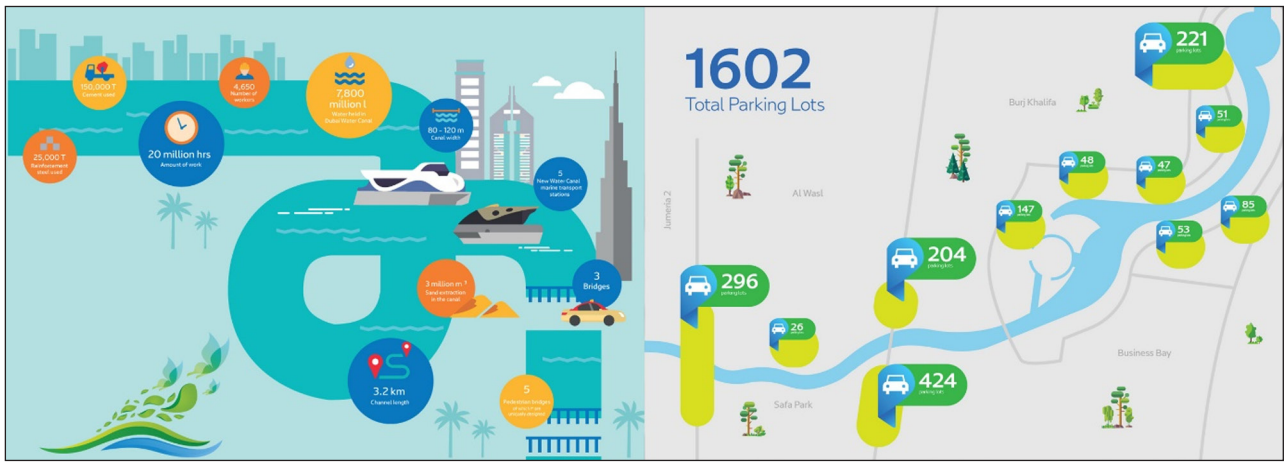

Figure 6: Facts about the Dubai Water Canal and number of adjacent parking lots (Source: Sharif, 2019).

geographical context and helps to replace the absence of the reality which irregularly combines spaces together to define society within the urban context of Dubai (Graham, 2001). Even though conflicts between plural interpretation of the past and flamboyant contemporary symbolism, Dubai Water Canal can provide nostalgic taste of the port city as an origin of Dubai (Steiner, 2010).

3. Methodology

This study aimed to analyze the characteristics of Dubai Water Canal users to extract the essential elements for improving user satisfaction by implementing a two-step cluster analysis since Dubai's affable approach to residents and tourists built the waterfront infrastructure, but no research was found to prove how efficient this approach is. The factors that determine users' satisfaction levels were identified by user group rankings from a POE survey, and will be used for factors future waterfront developments in Dubai. Existing urban open space user surveys and studies generally have limitations related to researcher subjectivity or because users are subdivided according to a single measurement scale (Zoh et al., 2014). Unlike previous studies that recognize waterfront users as the same group, this study attempted to identify differences in satisfaction and perception with a post-occupancy evaluation survey with two-step cluster analysis.

3.1. Data collection for POE survey

In this paper, to overcome these limitations, the characteristics of the majority of people surveyed were subdivided using a statistical program and analyzed based on the differences in perception of each user group. Survey participants were limited to Dubai residents over 19 years old who had visited the Dubai Water Canal two or more times. There was no initial contact by email or any social media, but interview team had the signage for interview next to water fall under the Sheikha Zayed Bridge. Since there are many residents and tourists in Dubai Water Canal after Sunset, the interviewees were selected and being asked for 5 minutes interview on the water canal benches randomly. The quota sampling method was used for the POE survey, and one-on-one interviews via a structured questionnaire were conducted and the participants provided informed consents at the end of the interview. The number of samples was limited to 60 people per survey and the survey was conducted 21 times for six months between July and December 2019. The number of effective samples was 1,242 (total number of Business Bay residents, 191,000), and those who did not respond to the questions were treated as missing values.

3.2. Questionnaire composition and measurement of variables

To understand the general usage status of the Dubai Water Canal, the questionnaire included questions about the day of use (weekday or weekend), the number of times used, users' companions, and means of transportation used to access the canal based on Dubai Municipality Design guideline. The important components that affect use were composed of five measures: 1) accessibility, 2) convenience of use, 3) facility management status, 4) safety, and 5) landscape management (**Table 3**). The detailed items for each component are organized by adopting the Dubai Municipality regulations for urban attractions. First, the accessibility section comprised six items regarding 1) information signage, 2) convenience of public transportation, 3) convenience of walking, 4) sufficient parking spaces, 5) convenience of parking lot use, and 6) convenience of entering and exiting by car. The convenience of use section consisted of nine questions regarding 1) walking and jogging, 2) using bicycles, 3) accessing sports facilities, 4) using rest areas, 5) using public toilets, 6) using the playground facilities, 7) using canal facilities, 8) using the parking lot, and 9) using the barrier-free design level for persons with disabilities. The facility management status section consisted of nine questions regarding 1) pedestrian-only roads, 2) bicycle-only roads, 3) sports facilities, 4) rest areas, 5) public toilets, 6) playgrounds, 7) illegal banners, 8) handicap facilities, and 9) maintenance of green spaces. Finally, the safety section contained eight items regarding 1) traffic, 2) facilities, 3) nighttime lighting conditions, 4) children's playgrounds, 5) public toilets, 6) safety regulation management, 7) pet regulation management, and 8) crime management. The

Table 3: Contents of the questionnaire based on Dubai Municipality guideline.

Category	Contents	Classification of variables
Personal characteristics	Gender, age group, and occupation	Categorical variable
Accessibility	1) information signage, 2) convenience of public transportation, 3) convenience of walking, 4) sufficient parking spaces, 5) convenience of parking lot use, 6) convenience of entering and exiting by car	Continuous variable (Likert scale)
Convenience of use	1) convenience of walking and jogging, 2) convenience of using bicycles, 3) convenience of sports facilities, 4) convenience of using rest area, 5) convenience of using public toilets, 6) convenience of using the playground facilities, 7) convenience of using canal facilities, 8) convenience of using the parking lot, 9) level of barrier-free design for persons with disabilities	
Facility management status	1) management status of pedestrian-only roads, 2) bicycle-only road management status, 3) sports facilities management status, 4) rest area management status, 5) public toilet management status, 6) playground management status, 7) illegal banner management status, 8) handicap facilities management status, 9) green space cleaning status.	
Safety	1) traffic/ pedestrian safety, 2) facility safety, 3) night-time lighting conditions, 4) children's playground safety, 5) public toilet safety, 6) safety regulation management, 7) pet regulation management, 8) crime management.	
Landscape management	1) landscape and marina facilities, 2) nature friendliness, 3) facility harmony, 4) green area management, 5) green area sufficiency	

landscape management section consisted of five items regarding 1) landscape and marina facilities, 2) nature friendliness, 3) facility harmony, 4) green area management, and 5) green area sufficiency. The personal characteristics section includes questions about respondents' gender, age group, and occupation. A five-point Likert scale was implemented as the measurement method.

3.3. Statistical analysis method and procedure

SPSS Statistics version 20.0 was used to analyze the results of the survey. First, frequency analysis was conducted to understand the demographic characteristics of Dubai Water Canal users. Second, because two-step cluster analysis is a useful segmentation technique when the quantity of data is large or categorical data is included (Garson, 2013), this analysis was conducted using the general usage status variables and personal characteristics of Dubai Water Canal users (age, companion, transportation, occupation, day of use). A Chi-square test was conducted to compare the important factors of the Dubai Water Canal from each user cluster.

4. Results

4.1. General characteristics of participants in the POE survey

According to the demographic characteristics of the sample, 618 men and 624 women were surveyed. Seventy-six percent of those surveyed were 20 to 40 years old, approximately 14% were in their 50s, and 9% were in their 60s. Regarding participant occupations, housewives comprised the largest group (20.5%), followed by office workers (15.5%), students (11.7%), sales/service workers (10.2%), government workers (10.2%), and the self-employed (9.5%). Please see **Table 4** for more details.

Table 4: Demographic characteristics of the participants.

Category		Person (Number)	Percent (%)
Gender	Male	618	49.7
	Female	624	50.3
Age group	20s	254	21.8
	30s	320	27.5
	40s	315	27.0
	50s	170	14.6
	60s	106	9.1
Occupation	Self-employed	118	9.5
	Sales/service	127	10.2
	Laborer	11	0.9
	Government	127	10.2
	Office worker	192	15.5
	Management	31	2.5
	Professional	110	8.9
	Housewife	254	20.5
	Student	145	11.7
	Unemployed	114	9.2
	Temporary job	12	0.9

4.2. Clustering and characteristics comparison

The characteristics of each group of Dubai Water Canal users were identified by subdividing them into several similar groups using a two-step cluster analysis, because

this method allows for simultaneous analysis of both continuous and categorical data (Everitt et al., 2011). Information regarding the participants' ages, companions, transportation, occupation, and days of use were used as variables in the cluster analysis. As a result of the analysis, respondents were classified into three clusters. The ratio of the number of users classified among the clusters was 2.37, which was less than 3, confirming that users were properly classified in the correct cluster (**Table 5**).

Clusters were named based on the primary occupations of their members. Cluster 1, the "friend-based cluster," was composed primarily of students in their 20s who visited the canal with friends. Members of this cluster mainly used the canal on foot. Cluster 2, the "family-based cluster," included many office workers and housewives who mainly used the canal with family members. This cluster mainly used the canal on weekends and used it the least among the three clusters. Cluster 3, the "individual-based cluster," primarily included housewives or those who do not have specific jobs and used the canal most frequently among the three clusters. They mainly used the canal on foot, and alone on weekdays rather than on weekends (**Table 6**).

Table 5: Results of two-step cluster analysis.

Category		Cluster 1 (*N* = 337, 27.12%)	Cluster 2 (*N* = 444, 35.73%)	Cluster 3 (*N* = 461, 37.15%)	Total
Age group (X^2 = 15.262, $\rho < 0.000$)	20s	194 (57.6%)	50 (11.3%)	16 (3.5%)	260
	30s	73 (21.7%)	155 (34.9%)	86 (18.6%)	314
	40s	31 (9.2%)	152 (34.2%)	110 (23.9%)	293
	50s	22 (6.5%)	52 (11.7%)	120 (26.1%)	194
	60s	17 (5.0%)	35 (7.9%)	129 (27.9%)	181
Day of use (X^2 = 141.72)	Weekday	205 (60.8%)	177 (39.9%)	262 (56.8%)	644
	Weekend	132 (39.2%)	267 (60.1%)	199 (43.2%)	598
Companion (X^2 = 479.62, $\rho < 0.000$)	Family	52 (15.4%)	341 (76.8%)	110 (23.9%)	510
	Relative	9 (2.7%)	6 (1.4%)	6 (1.3%)	21
	Friend	225 (66.8%)	79 (17.7%)	105 (22.7%)	411
	Neighbor	9 (2.7%)	6 (1.4%)	6 (1.3%)	17
	Colleague	14 (4.1%)	8 (1.8%)	10 (2.2%)	29
	Alone	28 (8.3%)	4 (0.9%)	224 (48.69%)	254
Transportation (X^2 = 484.862, $\rho < 0.000$)	Bus	6 (1.8%)	2 (0.5%)	6 (1.3%)	14
	Metro	7 (2.0%)	2 (0.5%)	7 (1.5%)	16
	Car	35 (10.4%)	111 (25%)	33 (7.2%)	179
	Taxi/careem	10 (3.0%)	2 (0.5%)	15 (3.3%)	27
	Bike	118 (35.0%)	92 (20.7%)	171 (37.0%)	381
	Walk	161 (47.8%)	235 (52.8%)	229 (49.7%)	625
Occupation (X^2 = 50.284, $\rho < 0.000$)	Self-employed	31 (9.2%)	37 (8.3%)	69 (8.5%)	107
	Sales/service	23 (6.8%)	17 (3.8%)	23 (5.0%)	63
	Laborer	2 (0.6%)	2 (0.4%)	1 (0.2%)	5
	Government	38 (11.3%)	11 (2.5%)	32 (6.9%)	81
	Office worker	54 (16.1%)	135 (30.5%)	39 (4.1%)	208
	Management	18 (5.3%)	45 (10.1%)	16 (3.5%)	79
	Professional	18 (5.3%)	36 (8.1%)	44 (9.5%)	98
	Housewife	3 (0.9%)	140 (31.6%)	158 (34.3%)	301
	Student	144 (42.7%)	1 (0.2%)	40 (8.7%)	235
	Unemployed	5 (1.5%)	19 (4.3%)	33 (7.2%)	57
	Temporary job	1 (0.3%)	1 (0.2%)	6 (1.3%)	8

Table 6: Classification of Dubai Water Canal visitors.

Category	Cluster 1 (Friend-based cluster)	Cluster 2 (Family-based cluster)	Cluster 3 (Individual-based cluster)
Age group	20s	30s–40s	40s–60s
Day of use	Weekday	Weekend	Weekday
Companion	Friends	Family	Alone
Transportation	Walk	Walk	Walk
Occupation	Student	Housewife/Office worker	Housewife/Self-employed

4.3. Comparison of important factors among clusters

A Chi-square test (Equation 1), a statistical test used to compare observed results with expected results, was conducted to compare the important factors from each canal user cluster.

$$x_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} \qquad \text{(Equation 1)}$$

The three clusters showed statistically significant differences such as Accessibility ($X^2 = 300.293$, $\rho < 0.000$), Convenience of Use ($X^2 = 160.942$, $\rho < 0.000$), Facility Management Status ($X^2 = 91.973$, $\rho < 0.000$), Safety ($X^2 = 55.924$, $\rho < 0.000$), and Landscape Management ($X^2 = 17.869$, $\rho < 0.05$). First, as a result of examining the differences between clusters for Accessibility, it was revealed that all three groups responded that convenience of walking is important since the majority of the Dubai Water Canal users live within the vicinity of the Business Bay, Downtown, and Jumeirah areas. Unlike other clusters, the family-based cluster often accessed the canal by vehicle; users in this cluster responded regarding the importance of vehicle access including sufficient parking spaces (20.7%) and convenience of parking lot use (17.8%). Second, examining the difference in responses to the Convenience of Use section revealed that, while there were statistical differences by cluster, all three clusters answered that convenience for light exercise, including convenience of walking and jogging (38.0%) and convenience of using bicycles (27.5%), is important. The family-based cluster responded that convenience of using public toilets was important (16.7%) because these visitors were usually accompanied by children. Third, examining the difference in responses to the Facility Management Status section revealed that the importance of the management status of pedestrian roads (33.5%) and bicycle-only roads (26.9%) was highly rated in the friend-based cluster and the individual-based cluster. However, the family-based cluster prioritized rest area management (27.4%) and management of pedestrian roads (23.4%). Fourth, the result of examining differences in responses to the Safety section revealed that traffic/pedestrian safety (39.4%) was evaluated as most important in all three groups, followed by the importance of nighttime lighting conditions (26.4%). This indicates that many users of the Dubai Water Canal are using it intensively during the evenings. Additionally, children's playground safety (16.2%) was rated higher by the family-based cluster than by other groups. Fifth, examining the differences between responses in the Landscape Management section did not reveal much of a difference between clusters compared to other categories. Nature friendliness was high in the friend-based cluster (35.9%) and family-based cluster (29.9%), and landscape and marina facilities were recognized as the most important in the individual-based cluster (26.7%) (**Table 7**).

5.Discussion

The Dubai Water Canal has unique characteristics that distinguish it from other waterfront parks around the world. The customized POE survey described here was designed to extract information regarding the essential requirements for improving the waterfront area. Based on the results of the POE survey of user satisfaction, it was revealed that more 'fine-tuning' of the space and its facilities should be implemented to do justice to the spectacular 2.6 billion AED infrastructure.

This study is significant in that it analyzed the satisfaction level of Dubai Water Canal by user groups and suggested alternatives. However, data collection is limited in Dubai Water Canal, and it only covers Dubai Water Canal in Business Bay area, not all the public spaces, facilities, and programs of Dubai Water Canal. Therefore, in order to extract more detailed waterfront public space elements in the future, a more in-depth analysis process based on long-term user behavior survey and accumulation of data on user satisfaction is required.

6. Conclusion

This study investigated differences in the satisfaction levels and perceptions of three clusters of canal users. By deriving factors based on differences in the perceptions of each cluster, this study extracted important elements that can be used in the future design and management of other urban open space projects such as the Dubai Water Canal. Despite the differences in perception of individual satisfaction factors by cluster, this study derives the following four implications from the five elements of the Dubai Water Canal experience (Accessibility, Convenience of Use, Facility Management Status, Safety, and Landscape Management).

First, in the family-based cluster, vehicle accessibility is important. If parents are accompanied by infants and children, the satisfaction of these visitors can be increased by installing and expanding the family-only parking lot

Table 7: Comparison of factors which affect the importance of use.

Factors	Contents	Cluster 1_337 (Friend-based cluster)	Cluster 1_444 (Family-based cluster)	Cluster 3_461 (Individual-based cluster)
Accessibility	1) information signage	81 (24.0%)	71 (16.0%)	134 (29.1%)
	2) convenience of public transportation	45 (13.40%)	13 (2.9%)	16 (3.5%)
	3) convenience of walking	152 (45.1%)	147 (33.1%)	204 (44.2%)
	4) sufficient parking spaces	22 (6.5%)	92 (20.7%)	40 (8.7%)
	5) convenience of parking lot use	23 (6.8%)	79 (17.8%)	36 (7.8%)
	6) convenience of entering/exiting by car	14 (4.2%)	42 (9.5%)	31 (6.7%)
Convenience of use	1) convenience of walking and jogging	128 (38.0%)	142 (32.0%)	158 (34.2%)
	2) convenience of using bicycles	82 (24.3%)	63 (14.2%)	127 (27.5%)
	3) convenience of sports facilities	1 (0.3%)	11 (2,5%)	12 (2.6%)
	4) convenience of using rest area	55 (16.3%)	64 (14.4%)	72 (15.6%)
	5) convenience of using public toilets	43 (12.8%)	74 (16.7%)	58 (12.6%)
	6) convenience of using the playground	1 (0.3%)	16 (3.6%)	5 (1.1%)
	7) convenience of using canal facilities	8 (2.4%)	14 (3.1%)	15 (3.3%)
	8) convenience of using the parking lot	16 (4.7%)	56 (12.6%)	11 (2.4%)
	9) level of design for disabilities	3 (0.9%)	4 (0.9%)	3 (0.7%)
Facility management status	1) management status of pedestrian roads	113 (33.5%)	104 (23.4%)	145 (31.5%)
	2) bicycle-only road management status	83 (24.6%)	43 (9.7%)	124 (26.9%)
	3) sports facilities management status	9 (2.7%)	16 (3.6%)	21 (4.6%)
	4) rest area management status	42 (12.5%)	122 (27.4%)	54 (11.7%)
	5) public toilet management status	59 (17.5%)	95 (21.4%)	69 (14.9%)
	6) playground management status	3 (0.9%)	19 (4.3%)	3 (0.7%)
	7) illegal banner management status	3 (0.9%)	4 (0.9%)	5 (1.0%)
	8) handicap facilities management status	7 (2.1%)	3 (0.7%)	6 (1.3%)
	9) green space cleaning status	18 (5.3%)	38 (8.6%)	34 (7.4%)
Safety	1) traffic/pedestrian safety	102 (30.3%)	118 (42.3%)	182 (39.4%)
	2) facility safety	30 (8.9%)	40 (9.1%)	40 (8.8%)
	3) night lighting conditions	89 (26.4%)	13 (2.9%)	81 (17.6%)
	4) children's playground safety	4 (1.2%)	72 (16.2%)	7 (1.5%)
	5) public toilet safety	27 (8.0%)	43 (9.7%)	36 (7.8%)
	6) safety regulation management	9 (2.7%)	29 (6.5%)	20 (4.3%)
	7) pet regulation management	22 (6.5%)	20 (4.5%)	54 (11.7%)
	8) crime prevention management	54 (16.0%)	39 (8.8%)	41 (8.9%)
Landscape management	1) landscape and marina facilities	110 (32.6%)	115 (25.9%)	123 (26.7%)
	2) nature friendliness	121 (35.9%)	133 (29.9%)	104 (22.6%)
	3) facility harmony	31 (9.2%)	45 (10.2%)	64 (13.9%)
	4) green area management	48 (14.2%)	83 (18.7%)	93 (20.1%)
	5) green area sufficiency	27 (8.1%)	68 (15.3%)	77 (16.7%)

so that cars can be parked in this exclusive parking area. All three clusters evaluated convenience for walking as the most important factor because the majority of Dubai Water Canal users access it on foot and walk along the pathway to enjoy light exercise with friends, family members, or alone. Based on this analysis, a green buffer zone is needed between residential blocks and the Dubai Water Canal. The only pocket park in the Dubai Water Canal

is Marasi Park, a very popular place for users to gather with their friends and family (**Figure 7**). More convenient access to Al Safa Park should be provided as well. All clusters evaluated information signage as important. At the very least, distance markers should be installed to enhance the canal's usability as in other projects in Dubai, including Kite Beach and La Mer Beach.

Second, the analysis results of the Convenience of Use and Facility Management section indicate that management of convenience of walking and jogging is very important to meet the expected characteristics of the Dubai Water Canal. This is presumably related to the fact that users visit the canal to enjoy exercise such as walking and jogging. In particular, in the case of the individual-based cluster, those who use the canal alone usually visit for cycling, walking, and jogging. Furthermore, based on responses of the family-based cluster, it is predicted that many strollers will be used on the canal walkway. Future improvements, such as installation of flexible flooring, are necessary for convenience based on the findings above. The most necessary improvement factor for families with young children is maintaining the cleanliness of public toilets. In addition, increasing the number of public toilet areas—currently there is only one—is an urgent need.

Third, all three clusters recognized that it was most important that pedestrians and cyclists have separate areas to ensure their safety. Considering the fact that accidents are constantly occurring between pedestrians and people who use wheeled recreational devices, such as bicycles, rollerblades, and scooter, it may be possible to reduce accidents by separating these groups of users. In addition, active publicity is needed to ban electric scooters since there could be a collision with runners, bicycles, and pedestrians within the Dubai Water Canal.

Fourth, many users in the friend-based cluster and family-based cluster visit the canal for the purpose of healing in a nature-friendly space, while people from the individual-based cluster focus only on the marina landscape. The creation and management of large-scale urban parks, including the Dubai Water Canal, provide leisure and cultural spaces for both residents and tourists while also forming an important waterfront space and the green axis of the city. These urban open spaces, therefore, should be designed and managed in a way that reflects the needs of actual users and maximizes their satisfaction.

This paper explores the development and construction of Dubai Water canal. The initial completion was in 2007 but RTA had completed five-phase construction in 2017 to connect Deira (former Khor Dubai area) to the Arabian Gulf through Business Bay. Dubai Water Canal is currently full navigational for boats and all the basic infrastructures including roads, bridges, bicycle roads, and pedestrian walkways were completed to connect adjacent urban contexts. Real estates are booming in Business Bay since Dubai Water Canal had added new waterfront space in the middle of Dubai.

Dubai Water Canal provides a sense of emerging public space which brings sense of sustainable placemaking in Dubai with iconic issue-making buildings and flamboyant lifestyles. The network of pedestrian walkways of Dubai Water Canal had transformed the experience of Dubai from car-oriented city to pedestrian-oriented city. It also initiated the socio-cultural and recreation activities around it. Like many successful water canal public spaces in other countries, Dubai Water Canal provides an innovative urban strategy to interrelate residents in fast developing urban context.

This paper also analyzed the results of the user satisfaction survey of the Dubai Water Canal and extracted the important factors that the canal and other urban parks must have to improve future user satisfaction, such as: 1) efficient road systems for light exercise, 2) efficient information signage, 3) convenient pedestrian roads with a nighttime lighting system, 4) strict separation of pedestrians and cyclists from motorways, and 5) nature-friendly landscape and landscape improvement (pocket parks). This paper is significant in that it analyzed the current status of user satisfaction and needs by clusters based on

Figure 7: Marasi Park in Dubai Water Canal. (Source: Jung, 2021).

canal utilization, and suggested alternatives for enhanced satisfaction in the future. In order to extract more detailed essential elements in the future, it is necessary to conduct a more in-depth analysis based on a survey of long-term user behavior and the accumulation of data on user satisfaction.

Competing Interests

The authors have no competing interests to declare.

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