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A Study of Design Management Guidelines for Private Dog Parks in Bangkok

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Abstract

Urbanization in Bangkok has contributed to a growing number of pet owners, particularly those with dogs, as dogs become emotionally significant companions in modern urban life. Despite the increasing demand, there remains a critical shortage of designated, well-managed private dog parks that address both functional needs and the psychological well-being of dogs and their owners. This study aims to investigate value-based factors influencing dog owners' decisions in utilizing such parks and to develop practical guidelines for the design and management of privately operated dog parks in Bangkok. A quantitative research approach was employed, gathering data from 401 dog owners residing in the Bangkok metropolitan area. A structured questionnaire was designed based on the Value Mapping Tool and relevant literature, encompassing four pre-determined domains: physical space, dog behavior, human-canine relationship, and management and design. These categories were defined during the questionnaire design process using insights from theoretical models and past research. The collected data were analyzed using Exploratory Factor Analysis (EFA), which validated and refined the four domains, revealing them as core components of user expectations. From the factor analysis emerged the **PAWSCAPERS** Guideline—ten thematic principles: Progress, Activity, Welfare, Sphere, Clean, Advisor, Play, Equipment, Relationship, and Scape. These principles serve as a comprehensive framework for the design and management of dog parks that are responsive to user values and needs. This research offers both theoretical and practical contributions, proposing a novel framework tailored to the Bangkok context and providing actionable guidance for private investors, planners, and policymakers. The findings support the need for greater implementation of pet-friendly urban infrastructure and contribute to ongoing discourse on canine welfare, public space design, and urban quality of life.

Keywords

Dog park; Design guidelines; Human-canine relationships; Dog behavior

1. Introduction

In contemporary Bangkok, designated spaces for canine activities are limited. Most public parks are located in suburban areas and lack specific facilities for dogs. As a result, dog owners often are constrained to keeping their pets at home, which can negatively impact the physical and mental health of the animals. A well-designed dog park is essential to promote exercise, socialization, and an improved quality of life for both dogs and their owners.

However, developing effective dog parks faces several challenges, particularly in design management. Limited insight into the behavior and needs of dog owners in Thailand, coupled with the absence of localized guidelines for dog park design and management, have hindered the ability of such facilities to deliver optimal value. This gap in addressing users' unmet needs often results in inefficient land use and a loss of spatial potential.

Recognizing the importance of maximizing the physical value of such spaces through appropriate design management, this study was initiated. It aims to explore existing dog park configurations and identify the factors influencing their selection by dog owners. The goal is to establish design guidelines for privately managed dog parks in Bangkok that align with the needs of local dog owners and ensure the efficient utilization of physical spaces. While international precedents have addressed dog park configurations, tailored, evidence-based design guidelines suitable for Bangkok's private sector context remain absent. This study addresses that gap by systematically identifying value-driven expectations from dog owners through rigorous analytical tools.

1.1 Research questions

The study considered two overarching research questions. First, what are the physical characteristics, management practices, and perceived values of existing dog parks in Bangkok that influence dog owners' decisions to use such spaces? Second, what are the appropriate design, service, and management guidelines for privately operated dog parks that align with the needs and urban context of dog owners in Bangkok?

1.2 Objective

The objective of this research is to study the values influencing the decision-making of dog owners in Bangkok, aiming to create effective and appropriate guidelines for the management, design, and physical utilization of dog parks under private sector management in the Bangkok area. The study aims to develop guidelines that not only are contextually sensitive but empirically validated through a robust analytical methodology involving Value Mapping and Exploratory Factor Analysis (EFA).

2. Literature Review

Research has identified the evolving emotional and social roles of pets, especially dogs, in urban societies. Recent studies (Chen et al., 2022; Middle, 2020; Gómez et al., 2018) confirm that dog parks are essential urban amenities that provide health, social, and behavioral benefits. However, poorly managed parks can cause conflicts or stress. New frameworks are needed to guide dog park design in Bangkok.

This research aims to study the values influencing the decision-making of dog owners in Bangkok, aiming to create effective and appropriate guidelines for the management, design, and physical utilization of dog parks under private sector management in the Bangkok area. According to the objective, the review of related concepts and research are summarized in Figure 1.

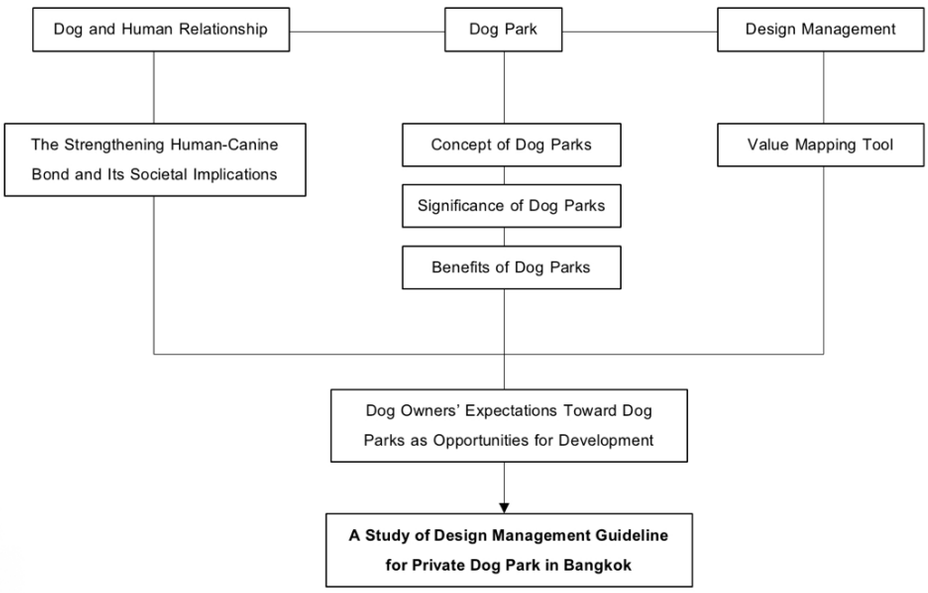


Figure 1. Theoretical framework and related research.

2.1 Dog and human relationship

Over time, societal attitudes toward pet ownership have become more positive, with many people valuing dogs for their companionship throughout life stages (Serpell, 1996). Domestic dogs (Canis familiaris) are naturally social animals that form strong bonds with humans and interact with other dogs (Nitzschner et al., 2012). A study conducted by the American Pet Products Association (2007) revealed that over 60% of U.S. households own at least one pet, highlighting the importance of pets in providing psychological and emotional satisfaction (Bennett et al., 2007; Staats et al., 2008).

In modern society, dogs increasingly are viewed and treated as family members, aligning with the parental behavioral system (Voith, 1985; Berryman et al., 1985; Askew, 2003). This framework positions dog owners as caregivers, nurturing their pets similarly to raising children. This relationship requires significant effort, understanding, and responsibility. The emotional closeness between dogs and their owners influences the well-being of both parties (Crawford et al., 2006; Marinelli et al., 2007).

Research demonstrates the mutual benefits of strong human-canine relationships. For dogs, companionship reduces stress and aids in managing novel stimuli (Odendaal, 1997; Hennessy et al., 1998), while for humans, interacting with dogs promotes stress relief, vitality, and overall mental and physical well-being (Robinson, 2014; Dotson & Hyatt, 2008). The evolving perception of pet ownership underscores the profound impact of the human-animal bond in improving the quality of life for both species.

2.1.1 The strengthening human-canine bond and its societal implications

The emotional bond between humans and dogs has grown stronger, as reflected in the trend of assigning names to pet dogs, symbolizing their role as family members (GfK Custom Research North America, 2008). Stewart (1983) highlighted the resemblance between human-pet relationships and familial ties, categorizing this bond into six dimensions: affection and companionship, life happiness and grief upon pet loss, pets as family members, vitality in life versus unexpected loss, post-loss rituals, and returning to nature. These dimensions illustrate the depth and complexity of the human-dog relationship.

In addition to emotional bonds, dog owners increasingly are investing in their pets, financially. This trend is evidenced by the rising expenditures on dog-related products and services, underscoring the growing importance of dogs in modern human life (Dotson & Hyatt, 2008). Furthermore, dogs facilitate social interactions among humans. Their sociable nature helps strengthen relationships between owners and others (Messent, 1983; Irvine, 2004).

Beyond companionship, human-dog relationships provide significant therapeutic benefits. Dogs offer emotional, physical, and psychological support to children, the elderly, and individuals with physical or mental health challenges (Arkow, 1998; Beck & Katcher, 1996; Melson, 1988). These multifaceted effects highlight the profound influence of human-dog bonds, not only enhancing personal well-being but also promoting social connectivity and communal support.

2.2 Dog park

The late 1960s marked the rise in demand for dedicated spaces where dogs could freely engage in activities alongside their owners, leading to the establishment of the first socially recognized dog park in Berkeley, California ((Kongwiroj, 2021). These parks gained widespread popularity, particularly in urban areas with high population densities, as they offered spaces for exercise, recreation, and social interaction for both dogs and their owners (Harnik & Bridges, 2005). Dog parks, as defined by Doyle (2006), are controlled environments where dogs can interact off-leash with their dog owners, typically featuring fencing, designated entry and exit points, water facilities, and waste disposal amenities. Such spaces provide a safe and stimulating setting for dogs while fostering a sense of community among owners.

Dog parks offer benefits beyond physical activity, enhancing both physical and mental well-being for dogs and their owners (Veitch et al., 2019). These environments encourage social interaction, allowing dogs to engage with their peers while owners connect with fellow dog enthusiasts, creating opportunities for companionship and shared experiences. Allen (2007) describes dog parks as spaces tailored to canine activities, promoting secure and enjoyable interactions. Similarly, Lee et al. (2009) and Brown (2012) emphasize their role in supporting exercise, socialization, and bonding between dogs and humans, making them invaluable in urban communities.

2.2.1 Concept of dog parks

The introduction of leash laws in the 1980s across various U.S. municipalities highlighted the need for dedicated spaces where dogs could exercise and socialize freely. This led to the establishment of the Ohlone Dog Park in Berkeley, California, in 1983, founded by Martha Scott Benedict and Doris Richards (Richards, 2008). Renamed Martha Scott Benedict Memorial Park, it was the first officially approved public dog park in the United States (Allen, 2007). Marymoor Park in Redmond, Washington, allocated over 16,1874 square metric for dog park development during the same period (Krohe, 2005). Despite the proliferation of over 1,000 dog parks across the country, the demand continues to exceed availability, with approximately 90% of existing parks experiencing high usage and overcrowding (Krohe, 2005; Walls, 2009).

Early research on dog parks, such as Wolch & Rowe's (1992) study in Southern California, revealed conflicts between park users and dog owners, highlighting the importance of thoughtful planning and management of public spaces. Lee et al. (2009) expanded on this, examining factors such as proximity, transportation access, and public perceptions that influence dog park usage. These findings underline the need for comprehensive design strategies that address both logistical challenges and the diverse expectations of users.

Jackson (2012) explored dog park interactions through observational studies, focusing on activities, user conflicts, and social norms. His findings emphasized the role of dog owners as "control managers," responsible for regulating their pets' behaviors, such as aggression, mounting, and waste disposal. These behaviors reflect the dual responsibility of owners to foster harmony among both human and canine participants. Jackson's analysis also underscored the importance of understanding user expectations and designing dog parks that accommodate the needs of both dogs and their owners, creating balanced, functional, and inclusive public spaces.

2.2.2 Importance of dog parks

The increasing urbanization and implementation of stricter regulations on dogs in public spaces have created both challenges and opportunities for dog owners. As urban density rises, the demand for safe, controlled environments where dogs and their owners can legally socialize and exercise has grown. Dog parks address this need by providing designated spaces that facilitate these activities Holderness-Roddam, 2020; Lee et al., 2009). These facilities not only allow dogs to engage in physical activities, such as walking and play, but also promote physical health benefits for both pets and their owners (Rahim et al., 2017; McCormack et al., 2011; Veitch et al., 2019; Chen et al., 2022).

Beyond physical benefits, dog parks serve as important social spaces where dogs and their owners can form connections, enhancing social interactions for both parties. These interactions foster stronger neighborhood relationships and a positive sense of community (Middle, 2020; Graham & Glover, 2014; Urbanik & Morgan, 2013; Gómez et al., 2018). Research highlights that these spaces encourage inclusivity, providing a setting where shared experiences contribute to collective well-being (Graham & Glover, 2014; Lee et al., 2009; Rahim et al., 2017; Matisoff & Noonan, 2012).

Additionally, dog parks offer opportunities for dogs and their owners to engage in shared activities that strengthen their bond. The freedom to play, explore, and interact within these environments enhances the overall living experience between humans and their pets (Howell et al., 2015). These spaces also serve as learning hubs, allowing dogs to observe and participate in social interactions, further contributing to their development and adaptability (Kresnye et al., 2019). This dual focus on physical and social benefits highlights the essential role of dog parks in urban communities.

2.2.3 Benefits of dog parks

Dog parks offer numerous benefits to both dogs and their owners by promoting physical activity, mental well-being, and social engagement. For dogs, these spaces provide opportunities for social companionship, mental stimulation, and the development of stress-coping skills (McMillan, as cited in Brown, 2012). Regular exercise and interactions with other dogs and humans help improve social behavior and reduce stress-related issues, leading to better-managed pets and fewer dog-related incidents (Allen, 2007). Additionally, by providing designated areas for dogs to play and exercise, dog parks minimize unauthorized access to restricted spaces, ensuring public areas are utilized appropriately. Effective design strategies for dog parks further enhance these benefits, as exemplified by the transformation of neglected urban sites into vibrant community spaces, such as a Los Angeles case study (Terrain Group Open Space Solution, 2019).

Beyond canine benefits, dog parks foster social interaction and community engagement among dog owners. These spaces act as hubs for interpersonal relationships, improving urban quality of life through shared

activities and responsible pet ownership education (Gómez et al., 2018). By encouraging exercise, relaxation, and nature appreciation, dog parks benefit individuals while contributing to broader community well-being. Urbanik & Morgan (2013) highlighted the park role in strengthening the human-dog bond, while Walsh et al. (2011) emphasized the importance in promoting canine health and community vitality. Furthermore, these spaces often enhance property values and serve as valuable recreational resources, showcasing their positive impact on urban environments.

2.3 Value Mapping Tool

The Value Mapping Tool (VMT), developed at the University of Cambridge, is a structured and visual approach to identify 'value uncaptured' in the form of failed value exchanges: value missed, destroyed, surplus, and absence. It provides a framework for assessing value exchanges from the perspective of all relevant stakeholders, including economic actors and broader entities such as society and the environment. By identifying forms of uncaptured value—namely missed, destroyed, surplus, and absent value—the tool enables more comprehensive analysis of system inefficiencies and areas for improvement. (Bocken et al., 2013)

The application of the Value Mapping Tool (VMT) in this research context facilitates the identification of uncaptured value dimensions across diverse stakeholder interactions within privately managed dog parks. Its systemic orientation allows for a holistic exploration of stakeholder expectations, particularly in service-based environments such as recreational pet infrastructure. VMT has been widely adopted in fields such as sustainable design, innovation management, and stakeholder-centered strategy development (Bocken et al., 2013), validating its relevance to design-oriented social research.

Complementing the use of VMT, Exploratory Factor Analysis (EFA) was selected as a robust statistical tool to uncover latent structures embedded in complex behavioral datasets collected through user surveys. EFA enables the empirical validation of theoretical constructs derived from the literature, assisting in the inductive formation of a conceptual framework. Its applicability to user-experience and design-related studies further justifies its use in extracting interpretable factors that informed the development of the PAWSCAPERS Guideline.

The VMT operates through seven analytical questions that guide the investigation of a selected unit, such as a product, service, or organization. These questions address stakeholder roles, intended functions, current value captured, as well as value deficits and potential opportunities. This approach allows for the systematic mapping of value flows and gaps across a network.

3. Methodology

3.1 Sample group

The sample group for this study consisted of 401 dog owners aged 18 years and above residing in the Bangkok metropolitan area. A purposive sampling technique was adopted to intentionally target dog owners who actively engage with privately operated dog parks. This non-probability sampling method was chosen to ensure the inclusion of information-rich participants whose behavioral patterns and experiences are directly aligned with the study's objectives. The inclusion criteria emphasized respondents' familiarity with the design, management, and service aspects of private dog park environments, particularly those that promote canine well-being through structured activities and regular usage.

The research aimed to explore the value-based factors influencing dog owners' decisions to utilize privately managed dog parks in Bangkok. Data collection was conducted through a structured questionnaire designed to examine behavior, preferences, satisfaction, and expectations. The survey instrument was developed based on secondary data and an extensive review of literature on dog park design, ensuring alignment with user value domains.

3.2 Research tools

The research utilized a survey questionnaire developed based on preliminary studies, including theories, concepts, relevant research, and in-depth interviews. The questionnaire explored various dimensions of value influencing dog owners' preferences for activity spaces for their pets and their expectations of dog parks. These data were intended to provide insights for developing dog park facilities.

To ensure a structured and quantifiable assessment, the questionnaire employed a Likert-type rating scale (Likert, 1932) to gather information on behaviors, satisfaction levels, and expectations from dog owners aged 18 and above in Bangkok. This structured approach ensured comprehensive data collection to analyze and understand user needs and preferences effectively.

In this study, the Value Mapping Tool was applied to support the design of a questionnaire aimed at exploring value-related expectations of dog park users in Bangkok. The four thematic domains used in the survey—physical space, behavior, relationships, and management—were defined based on a combination of theoretical constructs and literature review, then validated through Exploratory Factor Analysis (EFA). The tool also contributed to the interpretation of empirical findings and to the development of strategic recommendations for the planning and management of privately operated dog parks. Furthermore, the Value Mapping Tool was applied to classify responses into Value Captured, Value Missed, and Value Opportunity categories, identifying user desires. This tool was used as a supplementary research tool to gain deeper insights of dog owners' perceptions and attitudes regarding dog park design and management. Using a quantitative methodology, the research aimed to create effective and appropriate guidelines for the management, design, and physical utilization of dog parks under private sector management in the Bangkok area.

3.3 Data analysis

To ensure analytical rigor and the validity of the findings, the data collected from the structured questionnaire were subjected to a three-stage statistical procedure, comprising descriptive statistics, suitability testing for factor analysis, and Exploratory Factor Analysis (EFA). The statistical analysis was conducted using SPSS software (IBM SPSS Statistics version 26) for each of the three stages:

Stage 1: Descriptive Statistical Analysis:

Descriptive statistics, including mean and standard deviation, were employed to summarize respondent characteristics and to provide a preliminary overview of patterns in behavioral expectations related to dog park design and use. This stage served to highlight central tendencies and variability in participant responses across thematic categories.

Stage 2: Assessment of Factorability:

Prior to factor extraction, the adequacy of the dataset for factor analysis was evaluated through two diagnostic tests. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was applied to assess whether the partial correlations among variables were sufficiently small, indicating that the dataset was suitable for dimensional reduction. In parallel, Bartlett's Test of Sphericity was conducted to determine whether the correlation

matrix significantly differed from an identity matrix, thereby justifying the application of EFA. Both tests yielded results exceeding commonly accepted thresholds, affirming the appropriateness of proceeding with factor analysis.

Stage 3: Exploratory Factor Analysis (EFA):

EFA was conducted using Principal Component Analysis (PCA) as the extraction method, with Varimax rotation applied to maximize interpretability and achieve orthogonality of the extracted components. The criterion for factor retention was based on eigenvalues greater than 1.0, and only factor loadings of 0.40 or higher were considered statistically meaningful as suggested by Stevens (1992) using a cut-off this number, irrespective of sample size, for interpretative purposes. The analysis resulted in the identification of latent constructs that captured the core dimensions of user expectations. These empirically derived factors subsequently were synthesized and integrated into the conceptual development of the PAWSCAPERS Guideline, ensuring that the proposed framework was grounded in user data and statistically validated.

3.4 Summary of research methodology and procedures

The research methodology and procedures are summarized in Figure 2.

Research Question	Objective	Theories/Concept	Key Variables	Collecting Data		Analysis
				Research Procedure	Sample Group	
What are the physical characteristics, management practices, and perceived values of existing dog parks in Bangkok that influence dog owners' decisions to use such spaces? Furthermore, what are the appropriate design, service, and management guidelines for privately operated dog parks that align with the needs and urban context of dog owners in Bangkok?	The objective of this research is to study the values influencing the decision-making of dog owners in Bangkok, aiming to create effective and appropriate guidelines for the management, design, and physical utilization of dog parks under private sector management in the Bangkok area	Dog and Human Relationship • The Strengthening Human-Canine Bond and Its Societal Implications Dog Park • Concept of Dog Parks • Significance of Dog Parks • Benefits of Dog Park Design Management • Value Mapping Tool	Independent Variables • Physical Characteristics of Dog Parks Based on Changing Behavioral Patterns Dependent Variables • Value Capture • Value Failures • Value Opportunities	Scope of Research Review of Theories, Concepts, and Related Literature Questionnaires	The sample group for this study consisted of dog owners aged 18 years and above residing in Bangkok (401 dog owners). The participants were selected based on their involvement in activities and behaviors that promote the health and well-being of their dogs. • Dog Owners' Expectations Regarding Dog Park Spaces • Dog Owners' Expectations Regarding Dog Behavior in Dog Parks • Dog Owners' Expectations Regarding Relationships in Dog Parks • Dog Owners' Expectations Regarding the Management and Design of Dog Parks	Analyze and interpret the data to propose effective and appropriate Design Management Guideline for Private Dog Park in Bangkok

Figure 2. Summary of research methodology and procedures.

4. Results

The analysis of dog owners' expectations aims to identify opportunities for improving the design and management of privately managed dog parks in Bangkok. The study utilized Exploratory Factor Analysis (EFA) to extract key factors based on data collected from a survey on privately managed dog parks. The survey comprised 65 questions divided into four sections and was administered to 401 respondents.

EFA was conducted to identify the core components related to the management and design of dog park spaces. SPSS software was used to process the data and determine the primary factors. The analysis involved segmenting the 65 survey items into four categories to facilitate the identification of critical factors influencing the expectations of dog owners toward dog park facilities. These findings provide actionable insights for enhancing the design and management strategies of privately managed dog parks in Bangkok.

4.1 Dog owners' expectations regarding dog park spaces

The categorization of survey questions involved an analysis aimed at identifying which of the 14 survey questions can be grouped based on their respective components. This was achieved using the Method of Rotation. Through Varimax Rotation analysis, the results are presented in Table 1.

Table 1. Varimax Rotation –Dog Owners' Expectations Regarding Dog Park Spaces

	Group			*Group of Observed Variables*
	1	2	3	
A1	0.649			***Activity*** The allocation of space for activities for dogs and their owners.
A5	0.592			
A8	0.569			
A11	0.545			
A14	0.536			
A7	0.533			
A13	0.526			
A3	0.513			
A12		0.748		***Safety*** Measures or management strategies to ensure safety within the space.
A9		0.600		
A6		0.558		
A4		0.530		
A10		0.441		
A2			0.720	***Equipment*** Equipment used for activities within the space.
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				

From Table 1, the clustering and grouping analysis of observed variables revealed that dog owners' expectations regarding dog park physical spaces could be categorized into three key components:

(1) Activity Space (Activity) – This group focuses on the allocation and design of spaces for activities involving both dogs and their owners. The clustering analysis identified eight questionnaire items associated with this factor.

(2) Safety Measures (Safety) – This group emphasizes security measures and management strategies to ensure safety and convenience for both dogs and users. The clustering process grouped five questionnaire items under this factor.

(3) Equipment and Facilities (Equipment) – This group highlights the importance of activity-related equipment within the dog park. The analysis identified one questionnaire item associated with this factor.

These three components represent the primary determinants of user expectations, providing valuable insights for the design, management, and development of dog-friendly urban spaces.

Table 2. Average and Standard Deviation - Dog Owners' Expectations Regarding Dog Park Spaces

Group of Observed Variables	*Number of Questions*	*Average*[1]	*S.D.*
ACTIVITY	8	4.568	0.500
SAFETY	5	4.601	0.496
EQUIPMENT	1	4.628	0.499

[1]based on a scale of 0-5, with higher values representing greater expectation levels.

Table 2 summarizes the analysis of dog owners' expectations for dog park areas, indicating that three key components could be identified as follows:

(1) Activity – This component consists of eight grouped questions and represents the of expectations regarding activity in dog park space. The analysis showed a high overall expectation level, with an average score of 4.568.

(2) Safety – This component consists of five grouped questions emphasizing safety and convenience for dogs and users. The analysis showed a high overall expectation level, with an average score of 4.601.

(3) Equipment – This component consists of one grouped question related to expectations regarding equipment for activities within the dog park. Results indicated a high overall expectation level, with an average score of 4.628.

4.2 Dog owners' expectations regarding dog behavior in dog parks

The categorization of survey questions involved an analysis aimed at identifying which of the 8 survey questions can be grouped based on their respective components. This was achieved using the Method of Rotation. Through Varimax Rotation analysis, the results are presented in Table 3.

Table 3. Varimax Rotation –Dog Owners' Expectations Regarding Dog Behavior in Dog Parks

	Group		*Group of Observed Variables*
	1	2	
B5	0.699		***Pawformance*** Organizing various activities in the dog park that focus on developing new skills, as well as promoting positive behaviors in dogs. This helps dogs adapt better to new environments and exhibit appropriate social behaviors when interacting with other dogs and their owners.
B1	0.689		
B8	0.613		
B4	0.603		
B2	0.560		
B7	0.490		
B6		0.805	***Progress*** Processes or activities that promote the development of a dog's abilities and behaviors.
B3		0.690	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization			

As shown in Table 3, the clustering and grouping analysis of observed variables indicated that dog owners' expectations regarding dog behavior in dog parks could be categorized into two main components:

(1) Skill Enhancement and Behavioral Development (Pawformance) – This category focuses on organizing activities within dog parks aimed at developing new skills and fostering positive behavior in dogs. The goal is to help dogs adapt to new environments and exhibit appropriate social behaviors when interacting with other dogs and owners. The clustering analysis identified six questionnaire items associated with this factor.

(2) Capability and Behavioral Improvement (Progress) – This category emphasizes processes and activities that support the enhancement of dogs' abilities and behaviors. The clustering analysis grouped two questionnaire items under this factor.

These findings highlight key aspects of dog behavior management in dog parks, providing valuable insights for designing programs and facilities that promote socialization, skill-building, and well-being among dogs and their owners.

Table 4. Average and Standard Deviation - Dog Owners' Expectations Regarding Dog Behavior in Dog Parks

Group of Observed Variables	*Number of Questions*	*Average*[1]	*S.D.*
PAWFORMANCE	6	4.558	0.522
PROGRESS	2	4.606	0.523

[1]based on a scale of 0-5, with higher values representing greater expectation levels.

Table 4, summarizes the analysis of dog owners' expectations for dog behavior in dog parks, identifying two key components as follows:

(1) Pawformance – This group consists of six questions related to the development of skills and behaviors in dogs. The analysis of dog owners' expectations regarding the behavior of their dogs in the dog park revealed that the overall expectation for skill and behavior development was high, with an average score of 4.558.

(2) Progress – This group includes two questions focused on fostering relationships and behaviors in dogs. The analysis showed that dog owners had high expectations for the development of their dogs' abilities and behavior in the dog park, with an average score of 4.606.

4.3 Dog owners' expectations regarding relationships in dog parks

The categorization of survey questions involved an analysis aimed at identifying which of the 13 survey questions can be grouped based on their respective components. This was achieved using the Method of Rotation. Through Varimax Rotation analysis, the results are presented in Table 5.

Table 5. Varimax Rotation –Dog Owners' Expectations Regarding Relationships in Dog Parks

	Group			*Group of Observed Variables*
	1	2	3	
C1	0.763			***Relationship*** The process of building a strong bond between dogs and their owners through joint activities.
C4	0.609			
C7	0.594			
C5	0.573			
C8	0.539			
C12	0.525			
C13	0.519			
C2	0.485			
C11	0.477			
C6		0.468		***Welfare*** The care of the dog's health and the promotion of positive behaviors.
C9		0.622		
C10		0.469		
C3			0.587	***Play*** Focuses on play activities for dogs that enhance bonding and foster a strong relationship between dogs and their owners.
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				

As shown in Table 5, the clustering and grouping analysis of observed variables revealed that dog owners' expectations regarding dog park spaces could be categorized into three key components:

(1) Building a Strong Bond with Dogs (Relationship) – This category emphasizes strengthening the relationship between dogs and their owners through shared activities within the dog park. The clustering analysis identified nine questionnaire items associated with this factor.

(2) Dog Welfare and Behavioral Care (Welfare) – This category focuses on healthcare, safety, behavioral reinforcement, and convenience for both dogs and visitors. The clustering process grouped three questionnaire items under this factor.

(3) Interactive Play in Dog Parks (Play) – This category highlights the importance of play activities that enhance the bond and positive interactions between dogs and their owners. The clustering analysis identified one questionnaire item associated with this factor.

These findings provide insights into key considerations for dog park design and management, supporting the development of engaging, safe, and well-structured environments that foster meaningful interactions between dogs and their owners.

Table 6. Average and Standard Deviation - Dog Owners' Expectations Regarding Relationships in Dog Parks

Group of Observed Variables	*Number of Questions*	*Average1*	*S.D.*
RELATIONSHIP	9	4.562	0.524
WELFARE	3	4.546	0.661
PLAY	1	4.646	0.501

[1]based on a scale of 0-5, with higher values representing greater expectation levels.

Table 6 summarizes the analysis of dog owners' expectations regarding relationships in dog parks, identifying three key components as follows:

(1) Relationship – This group consists of nine questions related to creating a strong bond between dogs and their owners through shared activities. The analysis of dog owners' expectations regarding the relationship between the dog and the owner in the dog park revealed that the overall expectation for building this relationship was high, with an average score of 4.562.

(2) Welfare – This group focuses on the care of dogs, particularly health maintenance and the enhancement of good behavior. It is based on three questions that emphasize safety and the provision of convenience for both dogs and park users. The analysis showed that dog owners had high expectations for dog welfare in the dog park, with an average score of 4.546.

(3) Play – This group consists of one question emphasizing play activities for dogs that foster strong bonding and relationships between dogs and their owners. The analysis revealed that dog owners had high expectations for opportunities for play in the dog park, with an average score of 4.656.

4.4 Dog owners' expectations regarding the management and design of dog parks

The categorization of survey questions involves an analysis aimed at identifying which of the 30 survey questions can be grouped based on their respective components. This was achieved using the Method of Rotation. Through Varimax Rotation analysis, the results are presented in Table 7.

Table 7. Varimax Rotation –Dog Owners' Expectations Regarding the Design and Management of Dog Parks

	Group									*Group of Observed Variables*
	1	2	3	4	5	6	7	8	9	
D10	0.761									***Secure*** The process of maintaining safety and providing comfort for dogs and their owners.
D6	0.609									
D16	0.520									
D1	0.460									
D20	0.427									
D29		0.776								***Playground*** A dog park with designated areas for dogs to engage in various activities.
D24		0.700								
D25		0.650								
D15		0.439								

Table 7. Varimax Rotation –Dog Owners' Expectations Regarding the Design and Management of Dog Parks. (continued)

	Group									*Group of Observed Variables*
	1	2	3	4	5	6	7	8	9	
D28			0.721							***Clean*** The management and upkeep of cleanliness in the dog park in all aspects.
D18			0.620							
D22			0.460							
D12			0.448							
D4			0.386							
D11			0.362							
D26			0.347							
D19				0.590						***Relax*** Rest areas and the organization of special activities within the dog park.
D7				0.520						
D23				0.466						
D8					0.730					***Sphere*** An environment that encompasses and supports all aspects of a dog's life within the dog park.
D17					0.436					
D5					0.418					
D30					0.405					
D3					0.369					
D21						0.671				***Smart*** The management of the dog park through smart technologies that may be used to facilitate services.
D27						0.448				
D2							0.791			***Scape*** The landscape design of the dog park that takes into account its suitability for dogs.
D14								0.700		***Info*** Providing information and advice on dog park care and maintenance.
D9									0.621	***Advisor*** Having knowledgeable and responsible staff members to care for the dogs.
D13									0.483	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.										

As shown in Table 7, the clustering and grouping analysis of observed variables revealed that dog owners' expectations regarding the management and design of dog parks could be categorized into nine key components:

(1) Safety and Comfort (Secure) – Focuses on safety measures and convenience for both dogs and their owners. This factor was identified based on five questionnaire items.

(2) Integrated Activity Spaces (Playground) – Emphasizes the availability of diverse play areas within the dog park, including water-based activities and botanical gardens. This factor was identified based on four questionnaire items.

(3) Cleanliness Management (Clean) – Highlights comprehensive cleanliness measures across different areas of the dog park, such as waste disposal areas, activity zones, and relaxation spaces. This factor was identified based on seven questionnaire items.
(4) Relaxation and Special Activity Zones (Relax) – Focuses on rest areas and special activities, including zones for rehabilitation and recovery for dogs with health concerns. This factor was identified based on three questionnaire items.
(5) Comprehensive Service Areas (Sphere) – Represents a holistic environment that supports all aspects of a dog's life within the park. This factor was identified based on five questionnaire items.
(6) Smart Dog Park Management (Smart) – Emphasizes technology-driven management solutions that enhance the efficiency and convenience of dog park operations. This factor was identified based on two questionnaire items.
(7) Landscape Design (Scape) – Highlights the importance of landscape architecture in creating an aesthetic, functional, and comfortable environment for both dogs and their owners. This factor was identified based on one questionnaire item.
(8) Information and Guidance (Info) – Focuses on providing relevant educational content and guidance on dog care within the park. This factor was identified based on one questionnaire item.
(9) Knowledgeable Staff and Advisors (Advisor) – Emphasizes the need for trained personnel who can provide assistance, supervision, and support in dog-related activities, such as water-based exercises. This factor was identified based on two questionnaire items.

These findings provide valuable insights for enhancing the design, management, and functionality of dog parks, ensuring they meet user expectations while promoting safety, cleanliness, engagement, and overall well-being for dogs and their owners.

Table 8. Average and Standard Deviation - Dog Owners' Expectations Regarding the Design and Management of Dog Parks

Group of Observed Variables	*Number of Questions*	*Average*[1]	*S.D.*
SECURE	5	4.595	0.508
PLAYGROUND	4	4.516	0.532
CLEAN	7	4.621	0.509
RELAX	3	4.624	0.490
SPHERE	5	4.627	0.499
SMART	2	4.621	0.509
SCAPE	1	4.726	0.452
INFO	1	4.633	0.492
ADVISOR	2	4.636	0.478

[1]based on a scale of 0-5, with higher values representing greater expectation levels.

Table 8 summarizes the analysis of dog owners' expectations regarding the design and management of dog parks, identifying nine key components as follows:

(1) Secure – This group consists of five questions related to the security and comfort provided in dog park design and management. The analysis of dog owners' expectations regarding security and comfort in the dog park revealed that the overall expectation was high, with an average score of 4.595.

(2) Playground – This group is formed by four questions regarding the provision of activity areas or park landscapes. The analysis showed that dog owners had high expectations for such spaces, with an average score of 4.516.

(3) Clean – This group includes seven questions related to the cleanliness and safety of the dog park. The analysis revealed that dog owners had high expectations for maintaining cleanliness and safety, with an average score of 4.621.

(4) Relax – This group is formed by three questions focusing on the creation of a relaxing environment in the dog park. The analysis showed that dog owners had high expectations for a relaxing atmosphere, with an average score of 4.624.

(5) Sphere – This group consists of five questions about providing comprehensive services for dogs in the park. The analysis revealed that dog owners had high expectations for full-service areas in the dog park, with an average score of 4.627.

(6) Smart – This group is formed by two questions regarding the smart management of the dog park. The analysis showed that dog owners had high expectations for intelligent management practices, with an average score of 4.621.

(7) Scape – This group is formed by one question about the landscape design of the dog park. The analysis revealed that dog owners had high expectations for landscape design, with an average score of 4.726.

(8) Info – This group consists of one question regarding providing information about dog care within the park. The analysis showed that dog owners had high expectations for this information, with an average score of 4.633.

(9) Advisor – This group is formed by two questions about having knowledgeable staff in the dog park. The analysis revealed that dog owners had high expectations for staff expertise, with an average score of 4.636.

4.5 Analysis of dog owners' expectations for dog parks as an opportunity for development

The analysis of dog owners' expectations for dog parks provides valuable insights into potential areas for improvement and development of these spaces. Key findings indicate that dog owners prioritize the provision of well-equipped, dog-friendly facilities, emphasizing the importance of safety and activity areas within the park. Additionally, dog owners expect areas that promote positive dog behavior and relationship-building, highlighting the role of both physical and social aspects in creating effective dog parks. These insights are crucial for guiding the development of spaces that meet the diverse needs of both dogs and their owners.

In terms of specific expectations, the sample group places the highest priority on well-designed spaces that foster interaction, with joint play between owners and their dogs being the top concern. The development of dogs' behavior and skills were highly valued. Design and management elements, such as the park's landscape

design, knowledgeable staff, and the provision of comprehensive services, also were seen as important. Cleanliness, safety, and the maintenance of a comfortable and engaging environment were identified as key factors in shaping a successful dog park. These findings suggest that a holistic approach to park design and management is essential to meet the diverse needs of dog owners and their pets.

5. Discussion and Suggestions

The objective of this research was to develop guidelines for managing the design and physical space utilization of dog parks under private sector management, which would be effective and appropriate for dog owners in the Bangkok area.

Based on an analysis of a 65 questions regarding dog owners' expectations of dog parks, with 401 respondents, in order to identify opportunities for developing dog parks, using Exploratory Factor Analysis (EFA), the results led to the formulation of the PAWSCPAERS Guideline for the management and design of dog parks under private sector management in Bangkok. The PAWSCPAERS Guideline aims to create an environment that responds to the needs of both dogs and their owners in multiple dimensions. PAWSCAPERS is a comprehensive set of guidelines derived from data analysis, structured around user expectations. Table 9 summarizes each principle of the PAWSCAPERS Guideline, providing a brief description, suggested implementation strategies in the context of privately managed dog parks, and supporting data from the survey results. This structured format enhances clarity and enables evidence-based application.

The formation of the PAWSCAPERS Guideline was systematically derived from the empirical findings of the Exploratory Factor Analysis (EFA). Each principle corresponds directly to a distinct factor extracted from the EFA, ensuring that the framework is evidence-based and reflective of user expectations. For clarity, the acronym PAWSCAPERS—comprising ten thematic components—represents: Progress, Activity, Welfare, Sphere, Clean, Advisor, Play, Equipment, Relationship, and Scape (Table 9)..

Table 9. Summary of the PAWSCAPERS Guideline with Definitions, Implementation Strategies, and Supporting Survey Data

Element	*Description*	*Implementation in Private Dog Parks*	*Average Score from Survey*
P - Progress	Develop dogs' abilities and behaviors through structured activities	Training zones, agility courses, obstacle courses	4.606
A - Activity	Provide areas for physical and mental stimulation	Designated running spaces, interactive play areas	4.568
W - Welfare	Ensure health and safety for dogs and their owners	Veterinary check-up stations, shaded rest areas	4.546
S - Sphere	Create an all-in-one service environment	Integrated grooming, cafes, retail stores	4.627
C - Clean	Maintain high hygiene standards	Waste disposal stations, sanitation schedules	4.621
A - Advisor	Provide knowledgeable staff for guidance	Trainers, behavior specialists on-site	4.636
P - Play	Promote social interaction through play activities	Group play areas, breed-specific zones	4.646
E - Equipment	Offer high-quality play and training equipment	Durable agility structures, sensory paths	4.628
R - Relationship	Strengthen owner-dog bonding	Joint activities, social seating spaces	4.562
S - Scape	Design aesthetic and functional landscapes	Natural elements, accessibility features	4.726

Table 9 serves as a comprehensive design and management guideline for private dog parks in Bangkok. Each element is grounded in empirical data and reflects the specific expectations of dog owners, as demonstrated by high average scores across all categories. The results emphasize the demand for well-designed, interactive, and well-staffed environments. Implementing the PAWSCAPERS Guideline allows private sector stakeholders to align with user priorities and create dog parks that are safe, engaging, and supportive of canine-human well-being.

PAWSCAPERS can be interpreted as follows: PAW represents the "dog's paw," symbolizing pets, while SCAPERS refers to "landscape management" (Landscapers). Together, they form a guideline for developing spaces that integrate comfort, safety, behavior promotion, health care, and the creation of relationships between dogs and their owners.

The main goal of the PAWSCAPERS Guideline is to design dog parks that encompass four key areas:

(1) Physical – Allocating appropriate spaces and equipment for dog activities

The study emphasizes the importance of ACTIVITY and EQUIPMENT allocation in dog parks, particularly for dog and owner activities. The findings suggest that dog parks should prioritize designated spaces for different activities, with a focus on accommodating dogs of various sizes. As noted by Melnick (2013), creating separate exercise areas for dogs based on their size, alongside social spaces for owners, can enhance the functionality of dog parks. This aligns with case studies on dog park design in Australia (Fairfax County Park Authority, 2021), as well as insights from National Geographic Thailand (2017) and Kongwiroj (2021). Regular exercise is crucial for dogs' physical health and well-being, with specific activities recommended for small, medium, and large dogs, such as off-leash play, swimming, and agility training.

Additionally, the study highlights the importance of maintaining equipment in dog parks. Effective management should include routine inspections and maintenance to ensure safety and prevent deterioration. Key considerations include checking agility structures, protecting grass or synthetic surfaces, and developing proactive maintenance plans. Regular evaluations and upkeep are essential for sustaining the park's quality and ensuring that it remains safe and enjoyable for all users. Proper planning and investment in maintenance contribute to the long-term success of dog parks, making them beneficial spaces for both dogs and their owners (Kongwiroj, 2021).

(2) Behavior – Promoting and developing the behavior and abilities of dogs

The study findings indicate that dog owners have high expectations regarding the PROGRESS of their dogs' abilities and behavior through the use of dog park facilities. This suggests that dog parks should incorporate structured programs or activity designs that promote positive behavioral reinforcement and enhanced skill development in dogs.

This aligns with Weitzman (2019), who emphasized that dogs require outdoor activities to alleviate stress and maintain overall well-being. Regular exercise contributes to physical and mental health, mobility improvement, and weight management (Westgarth et al., 2014; Weitzman, 2019). According to the American Animal Hospital Association, pet exercise recommendations suggest 30-45 minutes of daily physical activity, depending on the dog's health and age (cited in Brooks et al., 2014).

Therefore, owners should actively support daily exercise for their dogs, with walking, running, or engaging in play activities in safe environments being the most effective forms of physical activity. Structured activities in dog parks can enhance dogs' adaptability, obedience, and social behavior, ensuring a well-balanced lifestyle for both the pets and their owners.

(3) Well-Being – Creating relationships and taking care of the physical and mental health of both dogs and their owners

The study findings indicate that building a RELATIONSHIP with dogs, while interactive PLAY between dogs and their owners in dog parks is essential. These results suggest that dog park environments and activities play a crucial role in fostering a strong bond between dogs and their owners, providing a relaxing space for shared activities and quality time.

The study highlights that interactive activities, such as joint play sessions and designated rest areas for owners with clear visibility of their dogs, contribute to a positive experience for both parties. These findings align with Odendaal (1997) and Hennessy et al. (1998), who found that a strong human-dog relationship positively influences both the physical and psychological well-being of dogs.

Furthermore, dog owners place importance on dog WELFARE. This reflects the need for comprehensive care in both behavioral and health aspects. In line with these findings, Robinson (2014) highlighted that human-canine interactions help reduce stress in humans, while Dotson & Hyatt (2008) suggested that engaging in activities with dogs contributes to emotional well-being, increased vitality, and overall health benefits.

These results emphasize the critical role of well-designed dog parks in supporting both canine welfare and human well-being, ensuring a positive and enriching experience for both dogs and their owners.

(4) Design and Management – Designing and managing the dog park in a comprehensive and sustainable manner

First, SCAPE is an important element of functional and dog-friendly spatial planning. Dog parks should prioritize usability, ensuring that the physical environment caters primarily to dogs while also providing comfort for owners. According to Melnick (2013), key design elements include shaded areas, appropriate surface materials, designated social spaces, access to clean drinking water, safety measures, and optimal space utilization. Studies such as in Australia reinforce the need for dedicated activity spaces tailored to different dog sizes and play styles to enhance usability and safety.

Beyond spatial planning, dog owners also expect SPHERE to support all aspects of their pets' needs. This includes the integration of grooming services, pet-friendly cafes, and retail spaces offering pet supplies, making the park a convenient and engaging destination for pet owners. Additionally, the availability of knowledgeable staff (ADVISOR) is crucial. Trained personnel should be available on-site to provide behavioral guidance, assist with dog training, ensure emergency preparedness, and oversee disease prevention measures such as surface disinfection and health monitoring. Funding mechanisms for these services vary across contexts; however, they are commonly supported through a combination of user fees, municipal budgets, and contributions from developers. Consideration of these funding sources is essential for ensuring the sustainable operation and maintenance of dog parks in future implementations. The presence of experienced advisors enhances user confidence and fosters responsible pet ownership.

CLEAN is another critical factor. Maintaining high sanitation standards requires well-organized waste disposal stations, systematic cleaning schedules, and easy access to pet health services. Research by Allen (2007) and Ploychompoo (Sutthigavilgul, (2012) underscores the impact of hygiene management on the success of dog parks, noting that poor sanitation—such as inadequate waste disposal facilities—can lead to unpleasant odors, unsanitary conditions, and deter visitors. To address this, dog parks should establish pet restroom facilities at a ratio of one per 100 square meters, provide clear signage on waste disposal guidelines, ensure an adequate supply of waste bags, and allocate sufficient budget and resources for continuous maintenance.

In conclusion, the study emphasizes that effective landscape design, well-integrated services, professional advisory support, and stringent cleanliness management are essential for creating a safe, functional, and enjoyable dog park environment. These components not only enhance the experience for both dogs and owners but also contribute to long-term sustainability and user satisfaction. The principal theoretical contribution of this study lies in its integration of quantitative behavioral analytics with strategic design thinking—effectively bridging the disciplines of urban planning, environmental psychology, and user-centered spatial design. The development of the PAWSCAPERS Guideline exemplifies an empirical-to-conceptual translation process that is rarely observed in the context of pet-inclusive urban infrastructure. This model offers a structured, data-driven framework that not only reflects user values but also advances discourse on evidence-based design methodologies for specialized recreational environments.

5.1 Limitation

While this study presents valuable insights into the development of dog parks in Bangkok, there are several limitations worth noting. First, the research focuses solely on dog owners residing in Bangkok, which may limit the generalizability of the findings to other geographic or cultural contexts. Second, the data collection relied exclusively on self-reported surveys, which may be subject to response bias or social desirability effects. Third, although Exploratory Factor Analysis (EFA) was applied to extract meaningful factors, complementary qualitative methods such as interviews or on-site observations could provide richer, more nuanced insights. Future research could consider broader regional samples and mixed methods approaches to validate and enhance the applicability of the PAWSCAPERS Guideline.

5.2 Conclusion

The PAWSCAPERS Guideline provides a structured framework for the management and design of dog parks under private sector management in Bangkok, ensuring a balanced and comprehensive environment for both dogs and their owners. The physical design emphasizes safe and suitable areas for play and rest, while behavior promotion ensures structured activities that support skill development and socialization. In terms of well-being, the guideline highlights the importance of both physical and mental health for pets and their owners, incorporating spaces for relaxation and interaction. Lastly, the management and design aspects focus on long-term sustainability, efficient space utilization, and environmental responsibility.

This study offers several contributions in three areas:

(1) Theoretical Contribution

This research makes a significant theoretical contribution by introducing the PAWSCAPERS Guideline, a novel framework tailored for the management and design of dog parks under private sector management. It enriches existing literature on pet-friendly urban spaces by incorporating design and management principles specifically suited to Bangkok's context. Furthermore, the study advances behavioral and environmental psychology by exploring the impact of structured dog park designs on canine well-being, social behavior, and owner satisfaction, offering valuable insights for future urban development *and pet-focused initiatives.*

(2) Practical Contribution

This study delivers practical contributions by offering actionable guidelines for dog park operators, urban planners, and private investors aiming to create high-quality, sustainable dog parks. It provides evidence-based insights into dog owners' needs and expectations, enabling the design of more engaging and user-friendly

parks. Additionally, the research supports policy recommendations for urban development authorities, advocating for the integration of dog-friendly spaces in city planning to enhance urban living standards and community well-being.

(3) Implications for Stakeholders

This research presents important findings for various stakeholders. Dog owners gain valuable insights into selecting and utilizing dog parks to enhance their pets' physical and mental well-being. Private dog park operators and investors benefit from detailed design and management elements that improve park usability, safety, and customer satisfaction. Urban planners and policymakers can adopt this framework to promote the development of inclusive and pet-friendly urban spaces. Veterinarians and dog experts are provided with structured guidelines to advance canine health and socialization. Additionally, researchers are offered a foundation for exploring the impact of urban dog parks on pet welfare and community engagement.

As a result, this study presents a comprehensive model for private-sector dog park management, with potential for further exploration in several areas. Future research could include comparative studies of dog park designs across different urban settings to refine the PAWSCAPERS Guideline for global application, as well as longitudinal studies to evaluate the long-term effects of well-designed dog parks on canine behavior, owner satisfaction, and community integration. Additionally, exploring the integration of technology, such as smart monitoring systems, could enhance park operations and safety. By applying the PAWSCAPERS Guideline, dog parks can evolve into safer, more engaging spaces, fostering improved urban living standards and promoting greater social inclusion in pet-friendly environments. Future research should consider cross-cultural comparative studies to evaluate the adaptability and relevance of the PAWSCAPERS Guideline across varying urban typologies and socio-cultural contexts. Additionally, longitudinal intervention-based studies could be employed to assess the sustained efficacy of the model in improving canine welfare, user satisfaction, and spatial inclusivity. Such inquiries not only would validate the long-term utility of the framework but also inform policy formulation and strategic planning for pet-friendly urban environments on a broader scale.

Ethics Statement

All research procedures involving human participants were done in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Participation in the study was voluntary and informed consent was obtained for all research components that involved human participants, in accordance with standard ethical practice.

Human Subjects

All research procedures involving human participants were done in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standard. Participation in the study was voluntary and informed consent was obtained for all research components that involved human participants, in accordance with standard ethical practice.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Due to privacy and ethical restrictions related to human participants, the data are not publicly available.

Use of Generative Artificial Intelligence (AI) and AI-Assisted Technologies

Generative artificial intelligence (AI) tools were used solely for language editing and improving readability. No AI tools were used for data analysis, interpretation, or generation of research findings. The authors take full responsibility for the content of the manuscript.

Author Contributions

Conceptualization, P.C.; methodology, P.C., J.W., and T.J.; validation, P.C., J.W., and T.J.; formal analysis, P.C. and T.J.; investigation, P.C.; resources, P.C.; data curation, P.C.; writing - original draft, P.C.; writing - review & editing, P.C.; visualization, P.C.; supervision, P.C., J.W., S.K., T.J., and K.M.; project administration, P.C.; funding acquisition, P.C. All authors have read and agreed to the published version of the manuscript.

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