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Optimizing the Production of Proficient Explosive Detection Dogs: An Analysis of the Criteria in Selecting Puppies for Training

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Abstract— *This study analyzed the criteria utilized by the different K9 providers in selecting puppies for training to optimize the production of proficient explosive detection dogs. Using a mixed-method research design, specifically concurrent triangulation, the research explored the different criteria used by various K9 providers in selecting puppies. Data were collected through guided survey-interview questions. Results showed that most K9 providers in the Philippines selected puppies aged 3-5 months, and both male and female puppies were equally chosen. Although medium-sized breeds are preferred, the results revealed that Labrador Retrieves and Belgian Malinois are the most preferred breeds. Regarding general health, K9 providers place importance on the skin and coat and the nervous system. Moreover, completely immunized puppies are preferred. Among the behavioral factors considered, trainability emerged as the most highly valued. Meanwhile, K9 providers consistently conduct subtests under the environmental tests, along with reward focus and persistence, search test, and sudden appearance subtests. Breeding is the top choice for obtaining puppies; however, procurement is also widely used. K9 providers face various challenges during the selection process, including health concerns, the availability of quality puppies, the selection system and cost. However, despite these challenges, the current practices of K9 providers achieve notable success rates. This study recommends standardizing puppy selection criteria with a scoring system, strengthening breeding programs to produce healthy working lines, and improving the selection process through collaboration between private and government K9 providers. Future research should explore the connection between selection criteria and the success rates of explosive detection dogs.*

Keywords—***Explosive Detection Dog, Philippines, Philippine Coast Guard, Selection Criteria, Working Dog***

I. INTRODUCTION

Dogs play a vital role in ensuring public safety, thwarting terrorist activities, and protecting vital installations. It is widely acknowledged that dogs are currently the most effective mobile sensors for detecting explosives, offering the most effective and adaptable method (Farr et al., 2021; Lazarowski et al., 2020). Despite the availability of advanced explosive detection tools, the demand for explosive detection dogs remains high, and law enforcement agencies, along with private K9 providers from around the globe, continue to train explosive detection dogs. In the Philippines, where advanced technological tools for detecting explosives are limited, the service of explosive detection dogs (EDD) is essential. Consequently, it is crucial that these dogs are proficient, as the risk in explosive detection work is exceptionally high, and failure in detecting improvised explosive devices and other explosive substances could cost thousands of lives. In training working dogs, one area that could improve the production of proficient detection dogs is the selection

process, which decides which dogs will be trained (Bray et al., 2021). The proficiency of explosive detection dogs is closely linked to careful selection of puppies for training, as early detection of key behavioral traits can significantly influence the potential for success.

The Philippine Coast Guard K9 Force selects puppies for training based on the procedure on Canine Selection under HPCG SOP Number 09-10 dated 24 March 2010 (Administration of Coast Guard Working Dogs), which stipulates the requirements of a material dog, including the breed, physical, and behavioral characteristics. Additionally, a Pre-Delivery Inspection (PDI) testing parameter is used to evaluate material dogs prior to acceptance for training. This testing parameter is composed of three stages. Stage 1 involves a drive or performance evaluation and screening for physical conformation; Stage 2 evaluates the veterinary records or veterinary health certificate; and Stage 3 focuses on health screening for contagious and or compromising diseases. Despite the existence of these selection process guidelines, their effectiveness has never been evaluated, and success in training Coast Guard explosive detection dogs remains varied.

Several studies have explored the selection methods and characteristics of dogs likely to succeed as working dogs, but only a few focus specifically on explosive detection dogs. Lazarowski et al. (2020) emphasized that information about the characteristics of explosive detection dogs is predominantly isolated within and across programs, lacking extensive scientific examination and validation. Moreover, Tiira et al. (2020) emphasized the importance of identifying successful working dogs as early as possible, given the high rejection rates and the associated training cost. Likewise, predicting a puppy's future success as a working dog is crucial for working dog programs to optimize placement in detection work, ensuring that resources will be allocated to puppies with a higher chance of success (Lazarowski et al., 2020). Consequently, failing to determine suitable puppies for training can lead to high attrition from training, as noted by Bray et al. (2021).

It is for this reason that this study aimed to analyze the criteria utilized by different K9 providers in selecting puppies for training to optimize the production of proficient explosive detection dogs. The result of this study can provide valuable insights into the factors considered in the selection of puppies for EDD training. Moreover, the results of this study can provide recommendations that can significantly enhance the process of selecting puppies for training, ultimately optimizing the production of proficient explosive detection dogs.

II. MATERIALS AND METHODS

1. Research Design

A mixed-method research design, specifically concurrent triangulation, was used. Primary data were collected through a guided survey-interview to analyze the criteria in selecting puppies for explosive detection training. A narrative literature review was also conducted to determine the practices of K9 providers from other countries in their selection process.

2. Respondents

The respondents of the study identified through purposive sampling were 14 K9 trainers who have been working for at least five years in their respective K9 training organizations. The researcher conducted interviews and a survey with 6 K9 trainers from the government and 6 K9 trainers from private K9 providers that conduct explosive detection dog training within the Luzon provinces. Additionally, 2 K9 trainers from the US and Canada were also interviewed and participated in the survey.

3. Data Collection

A guided survey-interview questionnaire was used to gather data. It was composed of three parts: Part 1 was the respondents' profile; Part 2 consisted of a set of survey questions pertaining to the current method of puppy selection, followed by interview questions that allowed the respondents to elaborate on their answers; and Part 3 included interview questions on success rates and other related issues.

4. Ethical Considerations

The researcher adhered to the importance of ethical standards in this research, particularly in the use of human subjects. All necessary measures were taken to obtain the required permissions from the relevant agencies, authorities, and respondents before commencing the survey. The researcher prioritized respecting the autonomy of respondents by providing them with detailed information about the research project. Consents were obtained from the respondents, and appropriate permissions for the usage of their given data were secured. Confidentiality was ensured by using data solely for research purposes, and the anonymity of the subjects was maintained by not linking them to their responses. All authors whose work is utilized in this paper were properly acknowledged through in-text citations and inclusion in the reference list.

III. RESULTS

Factors in Selecting Puppies for Explosive Detection Training

Physical

Most respondents preferred puppies aged 3-5 months (TABLE 1), considering this stage optimal for developing drive and behavior as well as for gradually introducing stimuli. By contrast, foreign K9 providers and several government K9 providers favored older puppies (6-18 months), noting that at this age, traits such as confidence and individuality are more apparent.

Table 1. Age

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
3-5 mos	0	4	5	9
6-11 mos	2	1	1	4
12-18 mos	2	3	1	6

In terms of size, medium-sized breeds were generally most preferred, followed by small breeds (TABLE 2). These were regarded as easier to handle and more economical to maintain.

Table 2. Size

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Small Breeds	2	4	4	10
Medium Breeds	2	5	6	13
Large Breeds	2	3	3	8

As shown in TABLE 3, all respondents indicated no preference for the sex of puppies, selecting both males and females. This suggests that sex has little influence on selection for explosive detection.

Table 3. Sex

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Male	0	0	0	0
Female	0	0	0	0
Both	2	6	6	14

Health Condition

The respondents were asked to identify the health conditions considered when selecting puppies for training in explosive detection. TABLE 4 presents that the most considered health conditions were skin and coat, and the nervous system and other sensory organs, both with 12 responses each. One respondent stressed that the whole nervous system must function properly to meet the demands of training. Next were the heart and lungs, with 11 responses, which emphasized the importance of cardiopulmonary function for endurance and stamina during training and eventual deployment. Meanwhile, gait and reproductive and urinary systems were the least emphasized, with 8 responses each, indicating that they are considered secondary factors compared to those directly affecting performance, sensory perception, and overall health.

Table 4. Health Considerations

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Skin and Coat	2	4	6	12
Nervous system, senses, and other sensory organs	2	5	5	12
Heart and Lungs	2	4	5	11
Musculoskeletal system	2	4	4	10
Laboratory results	1	5	4	10
Gait	2	4	2	8
Reproductive and Urinary system	2	4	2	8

Additional screening methods, such as PennHip evaluations to detect dysplasia risk, which are done during the pre-training trial, were also reported. Some providers also emphasized the importance of reviewing the medical history of both parents and puppies.

As shown in TABLE 5, all respondents required complete immunization before puppies entered training, reflecting its importance among K9 providers.

Table 5. Immunization

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Complete	2	6	6	14
Partial	0	0	0	0

Behavior

Among the response options provided to respondents, trainability ranked highest with 13 responses (TABLE 6). Additionally, nerve, hunting drive, sociability, intensity of search, and the ability to ignore distracting stimuli, as well as the ability to work effectively in stressful situations, also received high consideration, with each receiving 11 responses. Meanwhile, curiosity and aggression were less considered. In relation to this, aggression was viewed negatively, with providers excluding dogs that exhibit resource guarding. Moreover, some respondents also mentioned that they considered the food drive when selecting puppies.

Table 6. Behavior

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Trainability	2	5	6	13
Nerve	2	3	6	11
Hunting Drive	2	3	6	11
Sociability	2	3	6	11
Intensity of search and ability to ignore distracting stimuli	2	3	6	11
Ability to work effectively in stressful situations	2	4	5	11
Motivation to sniff	2	3	4	9
Curiosity	2	1	4	7
Aggressiveness	2	2	3	7

Genetics (Breed)

Genetics also plays a role in breeding selection for explosive detection. Despite a general preference for medium and small breeds, the Labrador Retriever emerged as the most used breed among respondents, valued for its high drive, stable temperament, adaptability, and approachable appearance (TABLE 7). Belgian Malinois also ranked highly and dominated certain programs, such as the Philippine Coast Guard K9 Force. Other breeds cited included Golden Retrievers, Jack Russell Terriers, German Shepherds, Springer Spaniels, Griffons, and Beagles, indicating multiple breeds can succeed when they demonstrate strong play, prey, and hunt drives. While breed standards may guide the selection for purebred dogs, respondents noted that performance traits often outweigh strict conformation when identifying suitable candidates.

Table 7. Genetic (Breed)

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Labrador Retriever	1	5	6	12
Belgian Malinois	0	5	5	10
Golden Retriever	1	3	3	7
Jack Russel Terrier	0	2	2	10
German Shor-haired Pointer	1	1	1	10
German Shepherd	0	1	2	8

Source

Breeding was the most preferred source of explosive detection dogs among respondents, particularly private and government providers (TABLE 8). Breeding enables greater control over genetic traits, facilitates early monitoring of puppies, and promotes long-term improvement of breeding lines. Foreign K9 provider respondents and some government K9 providers in the Philippines, by contrast, favored procurement, which enables organizations to select dogs that already meet physical and behavioral standards.

Table 8. Source

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Breeding	0	5	6	11
Procurement	2	4	3	9
Donation	0	4	1	5

Test Conducted to Determine a Puppy's Suitability to Undergo Explosive Detection Training

Performance Test

Results, as shown in TABLE 9, indicate that reward focus was the most emphasized subtest with 12 responses. The search test received 11 responses, while reward persistence and reward arousal received 10 and 9 responses, respectively.

Table 9. Performance Test

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Reward focus	2	4	6	12
Search test	2	5	4	11
Reward persistence	2	3	5	10
Reward arousal	2	3	4	9

Emotional Reactivity Test

As shown in TABLE 10, the sudden appearance subtest was the most frequently considered, receiving 10 responses. This is followed by a novel object with 9 responses and the acoustic startle subtest with 8 responses. Meanwhile, the animated object subtest is the least conducted, gaining only 5 responses.

Table 10. Emotional Reactivity Test

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Sudden appearance	2	4	4	10
Novel object	2	4	3	9
Acoustic startle	2	2	4	8
Animated object	2	2	1	5

Environmental Test

Compared to the performance and emotional reactivity tests, subtests from the environmental test are consistently conducted during the selection process. Most respondents emphasized the importance of testing puppies on different kinds of surfaces and stairs, as well as in pedestrian and vehicle traffic, with each receiving 13 responses (TABLE 11). Additionally, noise exposure was also highly rated, with 12 responses, followed by unfamiliar objects, which received 11 responses.

Table 11. Environmental Test

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Different type of surfaces and stairs	2	5	4	13
Pedestrian and vehicle traffic	2	5	6	13
Noises	2	5	5	12
Unfamiliar objects	2	5	4	11

Moreover, some respondents mentioned exposing dogs to noises through speakers to desensitize them before exposure, as well as during walks in town (e.g., shopping malls, schools), and then in operational environments. Meanwhile, another respondent added that they test

puppies in groups of people, in dark places, on high and elevated surfaces, when entering rooms, alighting stairs, using elevators/escalators, and in the presence of other animals.

Challenges Encountered in the Process of Selecting Puppies for Explosive Detection Training

The respondents were also asked about the challenges they faced while selecting prospective puppies for training, with the results shown in TABLE 12.

Table 12. Challenges Encountered During Selection of Puppies

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
Lack of assurance that procured puppies are fully vaccinated and have no hereditary medical conditions	1	3	4	8
Lack of standardized and available assessment tool	0	3	2	7
Limited source of working line dogs	1	3	2	6
High cost of quality puppies	1	2	2	5

Among the challenges faced by K9 providers during the selection process, the lack of assurance that the procured puppies are fully vaccinated and have no underlying medical conditions, as indicated by 8 responses. Although the lack of a standardized and available assessment tool was the second major concern, results showed that this does not appear to be a problem for the foreign K9 provider respondents. Additional challenges include the availability of breeders producing high-quality bloodlines and the logistics of travel.

Success Rates of Puppies for Explosive Detection Based on the Current Selection Method

To determine the effectiveness and reliability of their existing methods of selection, the respondents were asked about the success rates based on the current criteria. As shown in TABLE 13, the majority of respondents reported that the success rate of puppies selected based on their criteria is 76-100%, despite the challenges they encounter.

Table 13. Success Rate

Response Options	Foreign K9 Providers (FKP)	Government K9 Providers (GKP)	Private K9 Providers (PKP)	Total
0-25%	0	0	0	0
26-50%	0	1	1	2
51-75%	1	1	1	3
76-100%	1	4	4	9

IV. DISCUSSION

The study aimed to determine the criteria utilized by K9 providers in selecting puppies for explosive detection training. Regarding physical factors, the preferred age for puppies is 3-5 months. These practices align with findings by Lazarowski et al. (2021), which suggest that detection outcomes can be predicted as early as three months. However, selecting very young puppies carries risks related to incomplete immunization. Nevertheless, a meta-analysis by Jaskinia (2023) found no significant association between age and scent detection accuracy.

Most of the respondents preferred medium-sized breeds. While size may be critical for multipurpose working dogs that require speed, strength, and deterrence (Zink and Schlehr, 2020). It appears less relevant for single-purpose detection dogs, as recent studies (Lazarowski et al., 2018, 2020, 2021; de Miranda Magalhães et al., 2023) emphasize behavioral characteristics rather than size as predictors of effectiveness.

Meanwhile, both male and female puppies are deemed suitable by the respondents. These findings align with those of Salomon et al. (2024) and Lazarowski et al. (2020), who found no significant effect of sex or neutering status on detection success. However, other studies report mixed results: Abdel Fattah and Abdel-Hamid (2020) found male German Shepherds more trainable, Jaskinia (2023) noted a slight performance advantage in females,

and Lazarowski et al. (2018) observed sex distribution differences across detection roles. These inconsistencies suggest that while sex may contribute to performance, it is not a primary determinant of success in explosive detection training.

When it comes to health, the results underscore the central role of health in detection performance. Respondents most frequently emphasized the skin and coat, along with the nervous system and other sensory organs. Healthy skin and coat often reflect the overall well-being of the dog. In relation to this, a study by Harvey et al. (2019) found that dogs with skin problems exhibit more behavioral problems. Additionally, nervous system function ensures quick reactions, coordination, and behavior regulation, all of which are vital for complex detection tasks. Moreover, prior studies confirm that physical fitness and physiology strongly influence efficiency, as heat, fatigue, and respiratory strain can reduce accuracy (Farr et al., 2021; Kane et al., 2024; Fernandez et al., 2024). Thus, maintaining optimal health and conditioning is crucial for resilience and accurate detection outcomes. Additionally, the respondents emphasized the importance of complete immunization. This minimizes the risk of viral diseases, such as canine distemper and canine parainfluenza, which can impair olfactory function (Jenkins et al., 2018) and ensure the long-term suitability of the dog for detection work.

Regarding behavioral traits, trainability emerged as the most valued trait by respondents in selecting puppies for explosive detection. In addition, the consistency with which the respondents demonstrated in choosing other valued behavioral traits of potential explosive detection dogs matches the findings of prior studies that have emphasized the stronger influence of behavioral traits over physical or sensory traits (Bray et al., 2021; Lazarowski et al., 2020, 2021). Meanwhile, aggression was viewed negatively, with providers excluding dogs that exhibit resource guarding, consistent with requirements such as those of the U.S. Transportation Security Administration (TSA), which demand calm, non-aggressive behavior of dogs in crowded environments (Watson, 2020).

The respondents showed a high preference for Labrador Retrievers. This corresponds to the article by Wendt (2024), which noted that the Labrador Retriever is among the most sought-after breeds for explosive detection work, along with German Shorthaired Pointers. Additionally, the Australian Border Force also favors this breed due to their high drive, steady temperament, adaptability to challenging environments, and non-threatening appearance (Australian Border Force, n.d.). Nevertheless, Belgian Malinois closely followed, while other respondents remarked on using Springer Spaniels, Griffons, and Beagles.

Breeding emerged as the top choice for obtaining puppies. For some respondents, this makes selection easier, as they can control which dogs to breed and allow for early observation and evaluation of the puppies. Similarly, the Swedish Armed Forces operates a breeding program to ensure a stable supply of dogs with the right traits, rather than depending on outside breeders (Swedish Armed Forces, 2017). However, maintaining a breeding program comes with disadvantages, including the high cost of maintenance and the need to preserve genetic diversity (Bray et al., 2021). On the contrary, foreign respondents and some government K9 providers prefer to obtain dogs through procurement. This approach is common in North America, with agencies such as the TSA and the Canada Border Services Agency (CBSA) relying heavily on purchased dogs (CBSA, 2021; American Kennel Club, 2020). Nonetheless, procurement has drawbacks, including high rejection rates due to behavioral mismatches, orthopedic health issues in imported dogs, and concerns over transparency and efficiency in acquisition processes (Braye et al., 2021; Wendt, 2024; Cima, 2019)

The importance placed on the different tests conducted by the respondents during the selection process varies. The results showed that the respondents placed high emphasis on environmental adaptability, as indicated by the high ratings the subtests under the environmental test received from the respondents, which is consistent with the study by Lazarowski et al. (2018), wherein it was noted that the majority of the failed dogs in the study failed due to insufficient environmental soundness. However, despite the strong link between environmental soundness and the success of working dogs, early sensitivity to the environment does not necessarily predict failure, as many dogs develop confidence and boldness as they mature (Lazarowski et al., 2021). Moreover, the subtests under the test were also highly considered, emphasizing the importance of knowing if the puppy is consistently motivated and possesses reliable search performance. Conversely, the study by MacLean and Hare (2018) found that while a performance test is valuable for identifying dogs most likely to succeed, it cannot perfectly classify all candidates. Similarly, Lazarowski (2020) noted that performance tests are less predictive than emotional reactivity and environmental tests. Meanwhile, the subtests under the emotional reactivity test, which are used to measure the dogs' stability, adaptability, and resilience to unfamiliar stimuli, were the least emphasized compared to the other two tests. However, a study by Lazarowski et al. (2021) found that emotional reactivity scores are good predictors of whether dogs will be chosen for detection

work, depending on the puppy's age. In fact, the study demonstrated that these scores are valuable at both early ages (3 months old) and later ages (11-14 months old). Nevertheless, the inclusion of these three tests in the criteria for selecting puppies for explosive detection training could enhance the overall accuracy in predicting outcomes for explosive detection dog training.

The lack of assurance that the procured puppies are fully vaccinated and have no medical conditions emerged as a major concern for the K9 providers. However, other challenges, such as the lack of standardized assessment tools, limited availability of working-line dogs, and high cost of quality puppies, also pose problems for K9 providers.

Despite the challenges encountered by the respondents, the majority reported a success rate of 76-100%, while a small number reported a success rate of 52-75%.

V. CONCLUSION

Based on the findings of the study, the researcher arrived at the following conclusions:

The preference for 3-5-month-old, medium-breed puppies, with emphasis on complete immunization, good health, and behavioral traits such as trainability, drive, and stability under stress, highlights the need for a structured health screening and early behavioral assessments. The consistent preference for Labrador Retrievers and reliance on breeding suggest that developing regulated breeding programs can improve reliability and reduce attrition in K9 selection.

The consistent use of performance, emotional reactivity, and environmental tests (particularly reward focus, sudden appearance, and all environmental subtests) underscores their value in predicting working dog potential. Standardizing these testing protocols would strengthen selection accuracy and facilitate comparability across providers

Uncertainties in health condition, the lack of a standardized assessment tool, limited availability of working-line dogs, and high procurement costs remain critical barriers to the successful selection process. In the Philippine setting, these are compounded by a few unreliable breeders, inflated prices, and insufficient government funding. Addressing these systemic issues through enhancements to breeding programs, standardization of health and assessment protocols, and increased institutional support is vital for long-term sustainability.

Despite reported success rates of 76-100% among providers, variability across different K9 programs indicates room for improvement. Coordination between the government and private K9 providers to share best practices could increase the consistency of training outcomes and reduce training failures.

Furthermore, the foreign K9 providers' emphasis on older puppies (6-18 months), thorough health evaluations, and trial-based procurement highlights practices that enhance the reliability of the selection process. Adapting similar approaches, such as a trial period and a more comprehensive health screening, could potentially intensify local K9 programs.

Lastly, future research could explore the connection between specific selection criteria and the success rate of puppies.

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