

Article

Evaluation of Traditional and Indigenous Horse Breeds for Wider Intended Use: Case Study from Slovenia

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Abstract: In this work, a new multi-criteria model for the evaluation of traditional and indigenous horse breeds, the HORQUAL model, was developed by applying the DEX (Decision Expert) method. The idea for this study culminated from brainstorming among researchers who had the importance of conserving traditional and indigenous horse breeds in Slovenia and their universal uses (recreative and sport) in mind. The conservation of native domestic animal breeds is one of the important indicators of sustainable agricultural development in particular countries. Here, the assessment process considered the horse breeds in terms of lifestyle, expectations, requirements and experiences. The development process was based on the multi-criteria decision analysis approach, and it was applied to seven traditional and indigenous Slovenian horse breeds. The horse breeds were classified into four groups of breed ratings according to the chosen criteria. The horse breeds were categorised as follows: “does not correspond to the criteria”, “less correspondence with the criteria”, “corresponds to the criteria” and “completely corresponds to the criteria”. The results of the HORQUAL model clearly show that it is easier and more effective to choose the most suitable breeds for specific purposes (i.e., recreative/sport horses with the potential for breeding along with acceptable costs, favourable temperament and suitable price) as they can easily be analysed or compared with each other, according to the criteria chosen in this paper. The rating by group takes the criteria for the multi-attribute evaluation that were identified by an expert group into account and balances between the assessment of recreational and sports needs for riders and the life expectancy for breeders. Additionally, incorporating the Plus-minus-1 analysis proved to be a useful support tool to analyse the assessments and to further improve horse breeding plans.

Keywords: traditional horse breeds; indigenous horse breeds; multi-criteria model; DEX method



Citation: Prišenk, J.; Filipič, N.; Rozman, Č.; Pažek, K.; Turk, J. Evaluation of Traditional and Indigenous Horse Breeds for Wider Intended Use: Case Study from Slovenia. *Sustainability* **2022**, *14*, 1971. <https://doi.org/10.3390/su14041971>

Academic Editor: George K. Symeon

Received: 18 November 2021

Accepted: 7 February 2022

Published: 9 February 2022

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1. Introduction

In Slovenia, there is a rich history of horse breeding as the country already had quality horse breeds in the 15th century, such as the “Kras” horse, which was later crossed with other breeds [1]. Traditional breeds are those that do not originate from the Republic of Slovenia, or their origin have not been proven. In this study, trotting horses, the Ljutomer Trotter and the Haflinger, are presented as traditional breeds. Indigenous breeds are those for which it has been proven, on the basis of historical sources, that they originated from the Republic of Slovenia, or, in other words, the Republic of Slovenia was the original environment for the development of the breeds. The indigenous breeds discussed here are the Lipizzaner horse, the Slovenian Cold-Blooded horse, the Posavec horse and the Bosnian Mountain horse. Nowadays, the choice of breed is quite important, and it is difficult to make a decision that optimises riding, economic and breeding benefits. The present study is important because the population of traditional and indigenous horse breeds is shrinking. We expect that the study results can be used to aid conservation decision makers in improving traditional and indigenous horse breeding plans. This can help Slovenian horse breeds be considered more attractive, and ideally, their populations will be preserved.

Today, the value of indigenous breeds—from genetic conservation to socioeconomic and cultural heritage viewpoints—is fairly well-known (e.g., [2]). Despite the numerous values of farm animal breeds (e.g., sustainability and culture), economic value is often prioritised over socioeconomic importance or cultural heritage [3,4].

There are many different breed options and crossbreeds with unique characteristics. The aim of this study was to examine if the DEX (Decision Expert) method is appropriate for the assessment of different horse breeds and if the method gives clear directions regarding what can be recognised as important assets in the purchasing process. The aim of this research is to fill the gap in research studies where authors apply the multi-criteria decision modelling approach to horse breeding. Because the multi-criteria evaluation of horse breeds is a new methodological approach, the criteria have not yet been specified. Thus, the novel academic aspect of this paper is that it specifies the criteria that are important for riders and horse breeders. Lastly, the results give clear indications of where the threats and opportunities exist for breeding traditional and indigenous horses. The group of experts who contributed to this work are of different professions working under the Institute of Economic and Breeding Technology of Sport Horses, established by the University of Maribor, Faculty of Agriculture and Life Sciences.

In the assessment research field, multi-criteria decision analysis (also known as MCDA) is often employed as an ex-ante evaluation tool for the examination of alternative projects or strategic solutions [5]. The method has been applied to numerous real-life decision and evaluation problems in agriculture [6–8], rural development and environmental protection [9–13]. Decision making is a process that accompanies us through everyday life and in a kind of sequence, in which we have to choose between a given version or the possibility of choosing what, in certain conditions, best suits the set goals or criteria. In some cases, we want to evaluate the variants—to classify them from the best to the worst [14]. This methodology, also known as DEX methodology, is suitable to assess horse breeds. The DEX method is often used in the multi-criteria decision analysis. It begins with the creation of a collection with the help of software tools for modelling preferential knowledge for multiparameter decision making. In 1988, the DEX method was developed in cooperation with the Faculty of Organisational Sciences of the University of Maribor and the Jožef Štefan Institute in Ljubljana. Eventually, researchers became familiar with the topic of the computer program DEXi itself, which was developed with the help of the Ministry of Education and Sports in 1999; it is based on the DEX methodology and operates in a developed environment. An important aspect of the program is its open-access online version, which can be used anytime, anywhere and by anyone.

The paper is organized into four sections. First, the study area and data sources are defined; this is followed by a description of the methodology and development process. Next, the application of the assessment tool is demonstrated and discussed. The paper concludes with our main findings, recognising some limitations of the approach used and giving recommendations for further research.

2. Materials and Methods

2.1. Model Development Process

2.1.1. Data Sources

Based on the input data, in order to capture the influence of several horse breed factors simultaneously, we developed a multi-criteria decision model for the evaluation of traditional and indigenous horse breeds. We defined the main criteria or attributes as follows: (i) appearance/temperament/training, (ii) cost/use and (iii) environmental adaptation.

Traditional breeds are those that do not originate from the Republic of Slovenia, or their origins have not been proven. Two trotting horses, the Ljutomer Trotter and the Haflinger, are considered for this survey's purpose. These breeds have been continuously bred in the Republic of Slovenia for 30 to 50 years. There is Slovenian breeding documentation for the breeds, showing that the breeds have been kept for at least five generations, and breeding plans are performed for them.

Indigenous breeds are those that, based on historical sources, have been proven to originate from the Republic of Slovenia, or, in other words, the Republic of Slovenia was the original environment for breed development, and Slovenian breeding documentation for them exists. These breeds have origins dating back at least five generations. In this survey, the Lipizzaner horse, Slovenian Cold-Blooded horse, Posavina horse and Bosnian Mountain horse were considered.

The data were collected from national breeding plans for the horse breeds that are assessed in this survey. The national breeding plans are confirmed by veterinarians, agricultural and political actors, and they are reviewed every 5 to 10 years. For clarity throughout the paper, we denoted our developed model as the HORQUAL model.

2.1.2. Criteria Identification

For the research task, we determined the following basic criteria: horse exterior, temperament, intrinsic value, skills/abilities and adaptability to the environment. Based on these basic criteria, we determined the second-level criteria. The process can go further and further until the decision maker or assessor meets their individual needs. We refer to the distribution of criteria as a tree of criteria or an attribute tree. Some authors [15,16] state that an attribute tree can have one or more criteria among the main attributes, and each main attribute can include several subattributes. In Figure 1, the criteria are presented as an attribute tree with short explanations of the attributes listed.

Attribute tree	
Attribute	Description
Assessment of horse breed	Characteristics by which the individual breed of horse was assessed
Horse Exterior / Temperament / Training	Appearance, temperament and schooling of the breed.
Exterior	Exterior of horse
Height	The average height of an adult horse in a withers.
Body weight	Average weight of an adult horse.
Appearance	The appearance of a horse.
Life expectancy	Average lifespan of an adult horse.
Temperament	Horse nervous system indicator.
Character	Horse mental state indicator.
Obedience	The patience and obedience of the horse.
Problems of behavior	Potential behavioral problems.
Schooling	Teaching and usability of the breed.
Susceptibility or readability	It determines how demanding learning the breed is.
Duration	How long a breed can be used for schooling.
Costs / Dedicated usability	Cost and time required for a particular breed.
Costs	Total cost for the horse.
Costs for basic living needs	Costs for the basic living needs of the breed.
Equipment costs	The cost of equipment for a horse of the selected breed.
Feed ration costs	The cost of feed for the horse of the selected breed.
Foal price	The price of a foal of the selected breed.
Purpose	Time spent on the horse
Sport	Time for horse recreation.
Dressage activity	Time for dressage horse activity per day.
Breeding technology	Time and technology for breeding
Adaptability to the environment	Adaptability to the environment where the selected horse breed is bred.
Breeding environment	Determine the geographical location of the farm for the horse breed.
Source environment	Flexibility of weather and feeding conditions of the horse.

Figure 1. Attribute tree with short descriptions of all attributes [17].

In our research, the hierarchical attribute tree was structured with the aggregate attributes on the higher level, followed by the aggregate subattributes on the lower level. The hierarchy of the HORQUAL model (attributes and utility functions) is based on a preliminary literature review of breeding plans and indicators of performance for horses. The aggregation process is based on the utility functions. In the DEX program, the utility functions are represented by decision rules, which are acquired from the researchers (more details in the next subsection).

The second step of the HORQUAL model development was based on a value scale definition for each attribute and subattribute (Figure 2). The value scale is discrete and typically consists of words [18]. According to scale values, decision makers can choose one option for each attribute to assess the individual characteristics of the horses.

Attribute	Scale
Assessment of horse breed	does not correspond to criteria; less correspond to criteria; correspond to criteria; full correspond to criteria
Horse Exterior / Temperament / Training	unacceptable; poorly variable; acceptable; very acceptable
Exterior	inappropriate; appropriate; very appropriate
Height	unacceptable; acceptable; very acceptable
Body weight	unacceptable; acceptable; very acceptable
Appearance	inappropriate; appropriate; very appropriate
Life expectancy	low; average; high
Temperament	not susceptible; less susceptible; susceptible
Character	unacceptable; acceptable; very acceptable
Obedience	low; medium; high
Problems of behavior	unacceptable; acceptable; very acceptable
Schooling	inappropriate; less appropriate; appropriate; very appropriate
Susceptibility or readability	difficult to learn; teachable; easy to learn
Duration	low; medium; high
Costs / Dedicated usability	unacceptable; poorly accepted; acceptable; very acceptable
Costs	high; average; low
Costs for basic living needs	high; average; low
Equipment costs	high; average; low
Feed ration costs	high; average; low
Foal price	high; average; low
Purpose	unacceptable; acceptable; very acceptable
Sport	unacceptable; acceptable; very acceptable
Dressage activity	unacceptable; acceptable; very acceptable
Breeding technology	very demanding; moderately demanding; undemanding
Adaptability to the environment	inappropriate; less appropriate; appropriate; excellent
Breeding environment	flat area; hilly; mountain
Source environment	flat area; hilly; mountain

Figure 2. Defined scales of the attributes [17].

2.2. Definition of Utility Function

The next step was to define the decision rules (i.e., utility functions—UF). The aggregation process is based on the utility functions. In the DEX program, the utility functions are represented by decision rules, which are acquired from the literature [8]. The decision rules describe the value of an aggregate attribute for each combination of input attributes and express the relative importance of individual attributes [19]. The relative importance of an individual attribute is represented by the weight value. Setting the weights (approx. 33%) defines the relationship between “Exterior”, “Temperament” and “Schooling” attributes since they have a similar impact on the final assessment [20], as shown in Figure 3.

The screenshot shows the DEX software interface. A window titled 'Decision rules Horse Exterior / Temperament / Training' is open, displaying a list of rules. A sub-window titled 'Weights: Horse Exterior / Temperament / Training' is also open, showing the weight settings for the attributes. The 'Weights' window has a table with the following data:

Attribute	0	50	100	Required	Current
Exterior	[Slider]	[Slider]	[Slider]	33	34
Temperament	[Slider]	[Slider]	[Slider]	33	34
Schooling	[Slider]	[Slider]	[Slider]	33	33

The 'Weights' window also includes options for 'Rounding' (down, no, up) and 'Normalization' (Sum 100, Max 100).

Figure 3. Weight values of the attributes “Exterior”, “Temperament” and “Schooling” [17].

The authors assumed that the relative importance of “Exterior”, “Temperament” and “Schooling” attributes were balanced in the determination process of the final assessment. In the survey, the weights should be 33.33% for all attributes; the reason for a potential imbalance lies in the normalisation process, which is automatically performed by the DEX programme. This occurs because some attribute scales can have more values than others [21].

The first and last decision rules were strictly defined by the experts. For example, if the assessment of “Exterior” is *inappropriate*, “Temperament” is *not susceptible* and “Schooling” is *less than less appropriate*, the assessment of the “Horse Exterior/Temperament/Training” is *unacceptable* (Figure 4). Some decision rules are expressed in a more complex form, such as “≥”, which means *equal or better*. Decision rules were defined for all aggregate attributes of the hierarchy; thus, the final sum gives 38 utility functions.

Decision rules				
Exterior 34%	Temperament 34%	Schooling 33%	Horse Exterior / Temperament / Training	
1	inappropriate	not susceptible	<=less appropriate	unacceptable
2	inappropriate	<=less susceptible	inappropriate	unacceptable
3	<=appropriate	not susceptible	inappropriate	unacceptable
4	inappropriate	not susceptible	>=appropriate	poorly variable
5	inappropriate	<=less susceptible	appropriate	poorly variable
6	<=appropriate	not susceptible	appropriate	poorly variable
7	inappropriate	less susceptible	less appropriate:appropriate	poorly variable
8	inappropriate	>=less susceptible	less appropriate	poorly variable
9	<=appropriate	less susceptible	less appropriate	poorly variable
10	inappropriate	susceptible	<=less appropriate	poorly variable
11	<=appropriate	susceptible	inappropriate	poorly variable
12	appropriate	not susceptible	less appropriate:appropriate	poorly variable
13	appropriate	<=less susceptible	less appropriate	poorly variable
14	>=appropriate	not susceptible	less appropriate	poorly variable
15	appropriate	less susceptible	<=less appropriate	poorly variable
16	appropriate	>=less susceptible	inappropriate	poorly variable
17	>=appropriate	less susceptible	inappropriate	poorly variable
18	very appropriate	not susceptible	<=less appropriate	poorly variable
19	very appropriate	<=less susceptible	inappropriate	poorly variable
20	inappropriate	>=less susceptible	very appropriate	acceptable
21	<=appropriate	less susceptible	very appropriate	acceptable
22	inappropriate	susceptible	>=appropriate	acceptable
23	<=appropriate	susceptible	appropriate	acceptable
24	appropriate	<=less susceptible	very appropriate	acceptable
25	>=appropriate	not susceptible	very appropriate	acceptable
26	appropriate	less susceptible	>=appropriate	acceptable
27	appropriate	>=less susceptible	appropriate	acceptable
28	>=appropriate	less susceptible	appropriate	acceptable
29	appropriate	susceptible	less appropriate:appropriate	acceptable
30	>=appropriate	susceptible	less appropriate	acceptable
31	very appropriate	not susceptible	>=appropriate	acceptable
32	very appropriate	<=less susceptible	appropriate	acceptable
33	very appropriate	less susceptible	less appropriate:appropriate	acceptable
34	very appropriate	>=less susceptible	less appropriate	acceptable
35	very appropriate	susceptible	<=less appropriate	acceptable
36	>=appropriate	susceptible	very appropriate	very acceptable
37	very appropriate	>=less susceptible	very appropriate	very acceptable
38	very appropriate	susceptible	>=appropriate	very acceptable

Figure 4. Decisions rules of the attributes “Exterior”, “Temperament” and “Schooling” [17].

3. Results and Discussion

The qualitative discrete criteria used in the DEXi program are values described in words, so it is not possible to use numerical values, and the numerical values of qualitative events must be used instead. Based on the obtained results of the evaluation of all seven selected traditional and indigenous horse breeds, the final evaluation of individual horses can be seen as well as the evaluation of the main criteria and subcriteria (Figure 5).

Option	Trotting horses	Ljutomer trotter	Haflinger	Lipizzaner horse	Slovenian Cold-Blooded horse	Posavec horse	Bosnian Mountain horse
Assessment of horse breed	less correspond to criteria	less correspond to criteria	correspond to criteria	less correspond to criteria	less correspond to criteria	less correspond to criteria	less correspond to criteria
.. Horse Exterior / Temperament / Training	very acceptable	very acceptable	very acceptable	very acceptable	acceptable	acceptable	acceptable
... Exterior	very appropriate	very appropriate	appropriate	very appropriate	very appropriate	appropriate	appropriate
... Height	very acceptable	very acceptable	acceptable	very acceptable	very acceptable	acceptable	acceptable
... Body weight	acceptable	acceptable	acceptable	acceptable	very acceptable	very acceptable	acceptable
... Appearance	very appropriate	very appropriate	very appropriate	very appropriate	very appropriate	appropriate	appropriate
... Life expectancy	high	high	low	high	average	average	average
.. Temperament	less susceptible	less susceptible	susceptible	susceptible	less susceptible	susceptible	susceptible
... Character	acceptable	acceptable	very acceptable	very acceptable	very acceptable	very acceptable	very acceptable
... Obedience	medium	medium	high	high	medium	high	high
... Problems of behavior	very acceptable	very acceptable	very acceptable	acceptable	acceptable	very acceptable	acceptable
... Schooling	very appropriate	very appropriate	very appropriate	very appropriate	appropriate	appropriate	less appropriate
... Susceptibility or readability	easy to learn	easy to learn	easy to learn	easy to learn	teachable	easy to learn	teachable
... Duration	high	high	high	high	high	medium	low
.. Costs / Dedicated usability	unacceptable	unacceptable	unacceptable	unacceptable	unacceptable	unacceptable	unacceptable
... Costs	average	average	high	high	high	high	low
... Costs for basic living needs	high	high	high	high	high	high	average
... Equipment costs	high	high	high	high	high	high	average
... Feed ration costs	high	high	high	high	high	average	average
... Foal price	low	low	average	average	average	average	low
.. Purpose	very acceptable	very acceptable	very acceptable	acceptable	acceptable	acceptable	acceptable
... Sport	very acceptable	very acceptable	very acceptable	very acceptable	acceptable	unacceptable	unacceptable
... Dressage activity	very acceptable	very acceptable	very acceptable	acceptable	unacceptable	unacceptable	unacceptable
.. Breeding technology	undemanding	undemanding	moderately demanding	very demanding	moderately demanding	undemanding	undemanding
.. Adaptability to the environment	inappropriate	inappropriate	appropriate	inappropriate	appropriate	less appropriate	appropriate
... Breeding environment	flat area	flat area	hilly	flat area	hilly	flat area	hilly
... Source environment	flat area	flat area	mountain	flat area	hilly	hilly	mountain

Figure 5. Results of the HORQUAL model for evaluating the traditional and indigenous horse breeds [17].

Figure 5 demonstrates that only one variant (the Haflinger horse) was estimated as “corresponds to criteria” while the others received the worst possible assessment (“less correspondence with the criteria”). The Haflinger horse received a medium assessment in two of three subattributes on the first level (“Adaptability to the environment” and “Horse Exterior/Temperament/Training”). According to the utility function represented in Section 2.2, the final assessment of this type of horse is higher compared to the others. These results are suitable but not enough to identify possibilities for the improvement of the results. This is important and can help decision makers (in this case, veterinarians, breeders, riders and others) understand how to improve breeding plans and give them clear benchmarks. The DEX methodology offers this opportunity in creating the Plus-minus-1 analyses, which we present in some depth in the next subsection.

Common to all assessed horse breeds is the unfavourable assessment of costs, which were assessed as unacceptable due to high costs for equipment and feed. The breeds with a favourable “Horse Exterior” assessment are appropriate for sport purposes. Particularly, the Ljutomer Trotter, Haflinger and Lipizzaner horses are well suited for sport purposes and dressage or trotting discipline. An important factor in a higher final assessment is the subcriterion “Adaptability to the environment”. In this regard, only the Haflinger horse had an appropriate assessment. The “Horse/Temperament/Training” is the most important final assessment.

Plus-Minus-1 Analysis (PS-1)

A PS-1 analysis describes changes in certain basic attributes, by one degree upwards or downwards (if possible), that are independent of other attributes [8]. In Figures 6–8, the results of the PS-1 for the three types of horse breeds are presented.

Only three types of horses (Haflinger horse, Slovenian Cold-Blooded horse and Bosnian Mountain horse) have “opportunities” and “threats” to improve or to impair their final assessment. For example, if the attributes “Obedience”, “Problems of behaviour”, “Susceptibility or readability” and “Breeding environment” will improve by one degree and other attributes stay at the same level, the final assessment of the Slovenian Cold-Blooded horse and the Bosnian Mountain horse will improve from “less correspondence with the criteria” to “corresponds to the criteria”. It can be seen in the case of the Haflinger horse that the attributes “Susceptibility or readability” and “Duration” represent the threats. If the

assessment of one of these attributes falls by one degree, the final assessment will worsen from “corresponds to the criteria” to “less correspondence with the criteria”.

Plus-Minus-1 analysis			
Attribute	-1	Haflinger	+1
Assessment of horse breed			
Height		correspond to criteria	
Body weight		acceptable	
Appearance		very appropriate]
Life expectancy		[low	
Character		very acceptable]
Obedience		high]
Problems of behavior		very acceptable]
Susceptibility or readability	less correspond to criteria	easy to learn]
Duration	less correspond to criteria	high]
Equipment costs		[high	
Feed ration costs		[high	
Foal price		average	
Sport		very acceptable]
Dressage activity		very acceptable]
Breeding technology		moderately demanding	
Breeding environment		hilly	
Source environment		mountain]

Figure 6. Plus-minus-1 analysis for the Haflinger horse [17].

Plus-Minus-1 analysis			
Attribute	-1	Slovenian Cold-Blooded horse	+1
Assessment of horse breed			
Height		less correspond to criteria	
Body weight		very acceptable]
Appearance		very appropriate]
Life expectancy		average	
Character		very acceptable]
Obedience		medium	correspond to criteria
Problems of behavior		acceptable	correspond to criteria
Susceptibility or readability		teachable	correspond to criteria
Duration		high]
Equipment costs		[high	
Feed ration costs		[high	
Foal price		average	
Sport		acceptable	
Dressage activity		[unacceptable	
Breeding technology		moderately demanding	
Breeding environment		hilly	
Source environment		hilly	

Figure 7. Plus-minus-1 analysis for the Slovenian Cold-Blooded horse [17].

From the PS-1 analysis, it can be seen that the Bosnian Mountain horse and the Slovenian Cold-Blooded horse have opportunities for improving their final assessment while in the case of the Haflinger horse, there are two threats that can impair the final assessment. These data are useful for experts who devise breeding plans as they emphasize which breeds and attributes to focus on.

Plus-Minus-1 analysis	
Attribute	-1 Bosnian Mountain horse +1
Assessment of horse breed	less correspond to criteria
Height	acceptable
Body weight	acceptable
Appearance	appropriate
Life expectancy	average
Character	very acceptable]
Obedience	high]
Problems of behavior	acceptable
Susceptibility or readability	teachable
Duration	[low
Equipment costs	average
Feed ration costs	average
Foal price	low]
Sport	[unacceptable
Dressage activity	[unacceptable
Breeding technology	undemanding]
Breeding environment	hilly correspond to criteria
Source environment	mountain]

Figure 8. Plus-minus-1 analysis for the Bosnian Mountain horse [17].

4. Conclusions

With the HORQUAL model, it is easy and effective to choose the most suitable horse breeds for certain purposes since the breeds and their attributes can be analysed and compared with each other as well as to choose between traditional and indigenous breeds of horses. We adapted the HORQUAL model to each individual breed as they differ in terms of lifestyle, expectations, requirements and experience. In this way, decision makers will be able to decide on appropriate breeds for specific purposes more easily and reliably. The DEX methodology can help examine the traits of the given breeds and compare their characteristics. Additionally, the results of the PS-1 clearly state the opportunities for breeding improvements.

The final evaluation of the breed choice is influenced by a number of composite criteria with corresponding subcriteria and their value stocks. We recognise some limitations of the study, which lie in the transformation process of numerical (quantitative) to descriptive (qualitative) attributes.

The crucial aim of the study was to evaluate native horse breeds from Slovenia, according to criteria related to breeding plans and the individual attributes of horse breeds to give a final assessment of how indigenous and traditional horse breeds are suitable for wider use. Additionally, with the PS-1 analysis, we identified possibilities for improving the horses' characteristics. According to these statements, some criteria (such as exterior, temperament, training performance and adaptability to the environment) were recognised as relevant. Other criteria (costs and purpose) pertain to the individual assessment of the horses carried out by decision makers. However, with a combination of both, the HORQUAL model is a user-friendly decision tool that gives decision makers the option to weigh their individual needs in the final decision/assessment. Due to the relatively easy applicability of the DEX methodology, the decision maker can change (add or remove criteria) and adapt the model to specific conditions.

This process can be enhanced with some expertise to handle the hierarchical assessment defining the weights of attributes. The application of the HORQUAL model in this research area is relatively new, and it proved to be a useful decision support tool here.

Author Contributions: Conceptualisation, J.P. and Č.R.; methodology, N.F., J.P. and Č.R.; software, N.F.; validation, J.P., N.F. and Č.R.; formal analysis, N.F., J.P. and Č.R.; investigation, N.F.; resources, N.F. and J.P.; data curation, N.F.; writing—original draft preparation, J.P., N.F., Č.R., K.P. and J.T.;

writing—review and editing, J.T.; supervision, Č.R. and J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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