Decision Tree-Based Classification Model for Identification of Effective Leadership Indicators

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Abstract. This study was aimed at identifying effective leadership abilities as appreciated by soldiers in the Lithuanian armed forces. Leader behavior was measured using an adapted version of the Leader Behavior Description Questionnaire (LBDQ), which was originally developed by Andrew W. Halpin from Ohio State University. Data were collected from soldiers holding different ranks and doing professional military service in all units of the Lithuanian armed forces and were analyzed using the IBM SPSS version 20 software application. For our data analysis, the Chi-square Automatic Interaction Detector (CHAID) decision tree growing method was used with three class dependent variables. The CHAID algorithm helped in specifying the best splits for each of twelve potential predictors and then select the predictors whose splits presented the most serious differences in the sub-populations of the sample. In the Chi-squared significance test, the lowest p-value was achieved. The model structures obtained after analysis are presented.

Keywords: *CHAID growing method; decision tree model; leadership; leadership style; leader behavior.*

1 Introduction

Leaders in a military organization are usually identified with managerial personnel; so to be a leading serviceman (commander, officer) means to appropriately deal with subordinate soldiers, that is to know and be able to inspire them to conduct joint activities (sometimes under very difficult environmental conditions) in order to achieve the established objective. The leader's (officer's) behavior is appropriate when he is held up as an example to others, not when he only exercises his power and gives orders. Although leadership in a military organization is usually based on situational leadership and subordinates' motivation, the practical application of leadership theories and leadership itself can be effective only if the chosen leadership style and the ways, forms and means of influence are suitable to the subordinates [1]. The Lithuanian army seeks to develop a military leadership identity as a way to promote mission success.

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It is difficult to obviously identify what leadership is and provide an accurate definition, for there is no one unique approach towards the notion of leadership [2]. There are many skills and features that young officers must obtain and develop to become effective military leaders. There are three main characteristics for good military leaders: leadership, decision-making, and situational awareness. It is, therefore, understandable that all militaries are trained to cultivate these skills (see e.g. Urban and Urbanová in [3]).

For military officers the main rule is that they must lead. The first purpose is to lead effectively. This means that they must be able to make decisions timely and clearly identify the situation they are in. This knowledge directed us to select and conduct a study of effective leadership indicators. J.M. Burns in his book Leadership states that: "Leadership is one of the most common and least understood phenomena in the world" (Popper in [4]). Leadership is a feature that many assert to know when they see it but generally have difficulty describing. Maybe this is because leadership is vast and has so many features that require analysis, review and research. The nature of this work will be to focus on how leadership may be measured and documented (see Bekesiene, *et al*. in [5]).

If needed, those measures could be used as additional guidance when deciding what specialization should be suggested to young officers. The authors will examine only a few of the most noticeable theories and methodologies for measuring leadership. As a manager, according to Henry Mintzberg, a military commander is responsible for many things: coordination, logistics, and management of information, finances, and others. But one of their main roles is leadership: inspiring people to perform tasks to the best of their capability (Popper in [4]).

An emotional leader is generally more common in military environments where tangible incentives are less common and intangibles dominate. An emotional leader is one who "may be described by images such as charismatic, visionary, and inspirational" (Popper in [4]). He leads primarily by eliciting positive emotional responses from his subordinates. This is the type of leader who is capable of arousing emotions so strong that "people are even willing to sacrifice their lives for the leader" (Popper in [4]).

Some universal theories hold the implicit assumption that successful or effective leadership does not necessarily result from the specific situation in which the leader operates. Moreover, leadership is invariant within as well as between roles. Various circumstances affecting the leader are not classified as calling for different leadership approaches. As they offer that there is "only one

best way how to lead", such perspectives attempt to offer universal prescriptions for leadership.

On the other hand, other methodologies suggest that effective leadership depends on unambiguous features of the leader's position as much as on the peculiarities of the original task and the individual qualities of the subordinates. These methodologies propose certain situational variables. When these variables are evaluated, they provide a situational analysis on which leadership recommendations can be based. These theories therefore provide dependent recommendations for leadership. Perspectives vary in the way the leadership construct is hypothesized. It is possible to view leadership mainly in terms of relatively established and long-term characteristics of people. Leadership can be viewed as a quantifiable and measureable property possessed in different amounts by different people. Other than that, it is also possible to focus on recognizable leader behaviors rather than on characteristic qualities. From this point of view, leadership exists mainly in the activities of the leader. The relationship between officers and subordinates stems from the personal knowledge of the leader, his experience, authority and abilities to affect the internal and external environment, and to make use of his power in combination with his way of applying it to lead others. Methods used for leading subordinates are based on classification from the point of view of how the leader uses his authority, of whether the leader is a woman or a man (Bekesiene, *et al*. in [6] and Vališ, *et al*. in [7]).

The goal of this study was to designate effective leadership indicators that measure Lithuanian armed forces soldiers' behavior. Specifically, this study had the following research objectives: 1) to construct measurement subscales of soldiers' leadership behavior using the LBDQ Form XII instrument, in particular, 2) to analyze the twelve factors of the LBDQ Form XII instrument, 3) to examine the reliability and validity of the instrument using Cronbach's alpha coefficient and confirmatory factor analysis, and 4) to achieve better predictive accuracy to construct decision trees (DT) for identification of potential leadership behavior predictors.

2 Research Methodology

2.1 Data Collection

The data used in this study were collected from professional military service soldiers who were serving in Lithuanian army units during the time of the research. In total, 204 professional military service soldiers with different military ranks and from all parts of the Lithuanian armed forces participated in

this research. The participants were selected on an easy sample basis. They had to complete the Leader Behavior Description Questionnaire (LBDQ Form XII).

Table 1 Description of Subscales of LBDQ.

Subscale	Description	Label in model
Superior orientation	- maintains cordial relations with superiors; has influence over their decisions; is striving for higher status	AB1
Integration	- maintains a closely knit organization; demonstrates inter-member relations	AB2
Predictive accuracy	- displays foresight and ability to predict outcome accurately	AB3
Product emphasis	- formulates the team goals; constantly seeks for better results; applies pressure for productive output	AB4
Consideration	- regards the comfort, well-being, status, and contributions of subordinates	AB5
Role assumption	- actively exercises the leadership role rather than surrendering leadership to others	AB6
Tolerance and freedom	- allows subordinates the scope for initiative, decision and action	AB7
Initiation of structure	- defines own role and lets subordinates know what is expected	AB8
Persuasiveness	- uses persuasion and arguments effectively; exhibits strong convictions	AB9
Tolerance of uncertainty	- is able to tolerate uncertainty and postponement without anxiety or upset	AB10
Demand Reconciliation	- reconciles conflicting demands	AB11
Representation	- speaks and acts as the representative of the group and indicates its importance in the organization	AB12

2.2 Instrument

Leader Behavior Description Questionnaire Form XII (LBDQ Form XII) and personal data sheets (PDS) were the survey tools applied for data collection in this research. LBDQ Form XII was developed by Stogdill in [8] as a modification of the original LBDQ, authored by Halpin and published by the Fisher College of Business in 1963. This tool was developed in order to get descriptions of leader behavior as monitored by supporters within the framework of 12 factors or subscales. The 12 subscales from AB1 to AB12 and definitions as given by Stogdill in [9] are shown in Table 1.

Therefore, the entire concept covers 12 expressions of different leadership features. The questionnaire for measuring the opinion leadership levels by LBDQ Form XII was adapted for this research. The respondents who participated in this survey had to describe how often their leader exhibits (or does not exhibit) the leader behavior described in the form while working in the group.

The presented LBDQ Form XII includes 100 items, which replicate different work situations. Along with every item the respondent had to mark one of the five letters: A – behavior is always demonstrated (a score of 5); B – behavior is often demonstrated (a score of 4); C – behavior is occasionally demonstrated (a score of 3); D – behavior is seldom demonstrated (a score of 2); E – behavior is never demonstrated (a score of 1). There are 20 items (6; 12; 16; 26; 36; 42; 46; 53; 56; 57; 61; 62; 65; 66; 68; 71; 87; 91; 92; 97) that are scored in reverse order by the LBDQ Form XII, and before the leadership feature analysis was done all of them were counted.

2.3 Construct Validity

Construct validity calls for explanations with evidently specified theoretical boundaries [10] and deals with crucial attributes rather than with the scores the instrument produces [11]. The validation safeguards a relevant analysis and tests the predicated relationships built on hypothetical thoughts.

2.3.1 Convergent Validity

Construct validity was tested using the convergent validity method. A theoretical viewpoint is presented to explain some fact and this fact refers to a complex concept that comprises several interrelated factors. In this research, convergent validity was assessed by factor loading, composite reliability (CR) and average variance extracted (AVE) (Fornell and Larcker in [12]).

Confirmatory factor analysis (CFA) was carried out to estimate the factor loading of variables. The factor loadings represent the level of the regression path from a latent variable to its indicators. Therefore, in this paper, all latent variables had a different number of indicators (the questionnaire items). By the rule of Hair, *et al*. in [13], a suitable factor loading value exceeds 0.5. When it is equal to 0.7 or higher it is considered a proper value for an indicator.

Another criterion to check convergent validity is the level of CR. According to Hair, *et al*. in [13], an acceptable value of CR is 0.7 and higher. Also, Cronbach's alpha coefficient can be used to test reliability (see Bollen and Long in [14] and Garson in [15]).

The third method to review construct validity is by applying AVE to measure the level of variance of a construct versus the level due to measurement errors. Values exceeding 0.7 are considered very good, whereas a level of 0.5 or higher is fully sufficient (see Hair, *et al*. in [13]).

2.3.2 Discriminant Validity

Discriminant validity is used to ensure that there is no significant variance between different variables that could have the same aim. Discriminant validity indicates the differentiation between one construct and another in the same model. To evaluate discriminate validity, the AVE and the squared correlation between two constructs are compared. According to Fornell and Larcker in [12] the square root of AVE should be greater than the correlations connecting the constructs.

2.4 Data Analysis

The IBM SPSS version 20 software application and structural equation modeling (SEM) using the Analysis of Moment Structures (AMOS 24) program were used. The alpha level or level of statistical significance for rejecting the null hypothesis was set at 0.05 for the overall study. The study specifically focused on the effects that the independent variables of gender, educational level, and years of experience of soldiers with different military ranks have on the perceptions of leader behavior as scored on the LBDQ Form XII subscales [16]. Additionally, the effects of the independent variable subordinates as experienced by superintendents of soldiers with different military ranks were analyzed. Finally, the effects of the independent variable leadership behavior on different military ranks members' perceptions was studied.

Three statistical procedures were used in analyzing the data to answer the questions of this research. The analytic procedures were:

1. Descriptive analyses were used to obtain the distribution of respondents based on the following demographic variables: gender, years of service, and education level. Additionally, the following variables were used to conduct a comparative analysis for military ranks: participants' years of service and influence of education, gender, and subordinates.
2. Confirmatory factor analysis (CFA) using the AMOS data-fitting program in [17] was applied to further confirm the construct validity of the items and constructs used in the research. Reliability analysis was done using Cronbach's alpha.
3. The Chi-square automatic interaction detector (CHAID) decision tree growing method was used with three class dependent variables to determine the best splits for each of eight potential leadership behavior predictors [18].

2.4.1 Descriptive Data Analysis

In total, 204 professional military service soldiers with different military ranks and from all parts of the Lithuanian armed forces participated in this research. The participants were selected on an easy sample basis. They had to fill in the Leader Behavior Description Questionnaire (LBDQ Form XII) and answer socio-demographical questions. The demographic and social characteristics of the respondents are presented in the tables below. In Table 2, their demographic information is presented. The gender distribution shows that 168 (82.4%) out of 204 respondents were male and only 36 (17.6%) were female. The majority had a bachelor's degree, i.e. 56.9% (N = 116).

Table 2 Demographic information on participants analyzed.

	Demographic variable	**Frequency**	**Percentage**
Total	All respondents	204	100.0
Gender	Male	168	82.4
	Female	36	17.6
Service	≤ 5 years of experience	44	21.6
	6-11 years of experience	16	7.8
	12-17 years of experience	96	47.1
	≥ 18 years of experience	48	23.5
Education level	Secondary	8	3.9
	Bachelor	116	56.9
	Higher education	4	2.0
	Unfinished higher education	4	2.0
	Master's degree	68	33.3
	Higher than Master's degree	4	2.0
Military range	Enlisted grade	20	9.8
	Junior officers	48	21.6
	Senior officers	136	68.6

In Table 2, we can see the summarized and categorized number of years the research participants were employed in the armed forces. The service distribution shows that the vast majority of respondents, comprising about 47.1% (N = 96) had been working in the Lithuania army for a time period of more than twelve years. Meanwhile, 23.5 % (N = 48) of respondents had been working in the armed forces for a time period of more than eighteen years and 7.8% (N = 16) for a 6-11 year period. 21.6 % (N = 44) of respondents spent from one year to five years in the Lithuania army. In this survey, the participants' military degree was also disclosed. More than half of them, i.e. 68.6% (N = 136), were senior officers, about one fifth of them, i.e. 21.6% (N = 48) were junior officers, and only 9.8% (N = 20) were enlisted grade.

Moreover, a comparative analysis of the participants was done based on years of service and education level. This analysis was done with taking into account the participants' gender or possibility to have a subordinate. The results are shown in Figures 1, where we can see that none of the enlisted grade participants had subordinates and there was no influence of education level or years of service Figure 1(a). Another result presented is gender. In this study, only female participants that were senior officers and were serving about twenty years had an education level higher than master's degree. The education level of male senior officers was bachelor for those who had served about nineteen years and master's degree for those who had served more than eighteen years Figure 1(b).

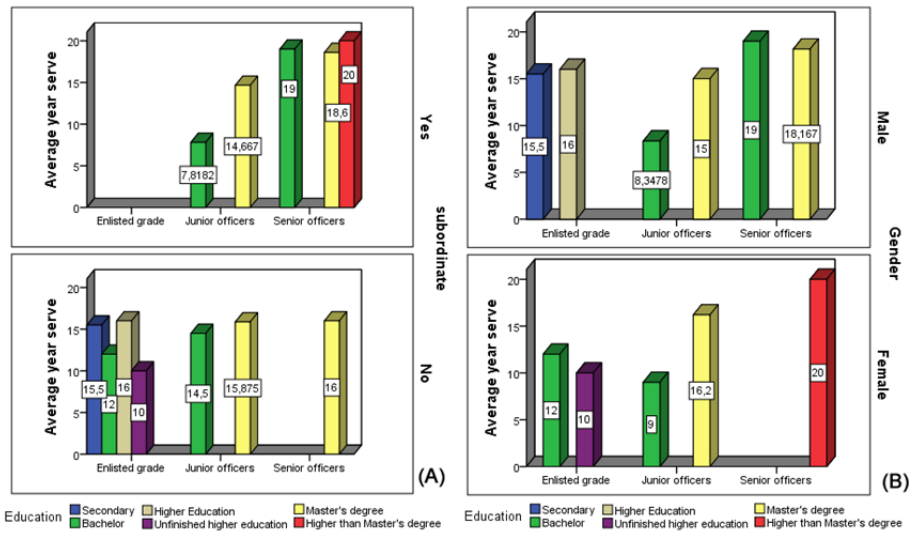


Figure 1 Comparative analysis by military rank for research participants' years of service and education influenced by variables (a) subordinates and (b) gender.

The numbers of the descriptive analysis suggest that the research participants were quite knowledgeable in terms of decision-making and structural characteristics of their particular working environments (see e.g. [19]).

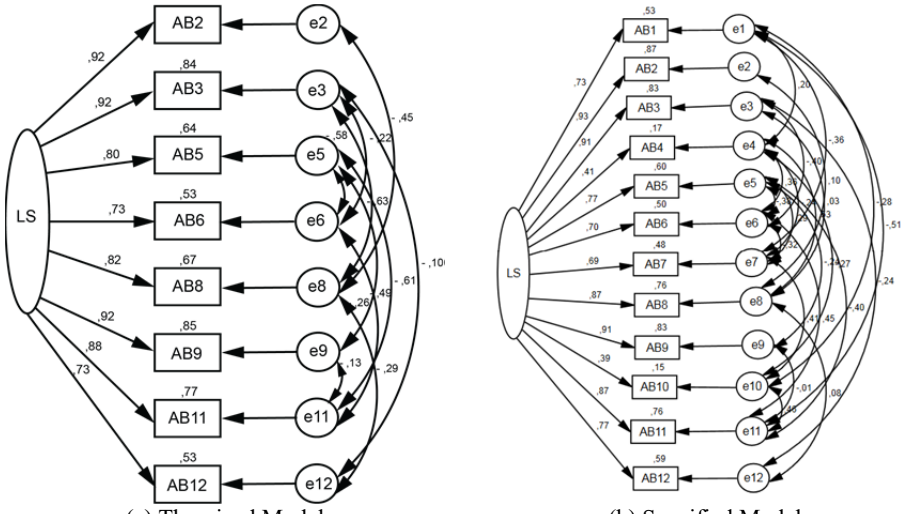
2.4.2 Confirmatory Factor Analysis

The reliability result for the commander-leader behavior description components showed that Cronbach's alpha coefficient variation interval ranged from 0.70 to 0.95 (Table 3). These results led us to continue with the SEM analysis, which was performed by AMOS 24. The construct validity was proved by using the procedures of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), which are parts of structural equation modeling (SEM).

[15] The CFA concept was used to test the psychometric characteristics of the questions in order to validate the reliability and invariance of the factor structure when applied to different groups. The EFA tests and the CFA tests were conducted for 204 soldiers with different military ranks. The exploratory factor analysis tests on the questionnaire indicated good reliability, because the Cronbach's alpha coefficient for the 100 questions, which include twelve measureable factors, was actually very high, i.e. 0.918.

Table 3 Reliability results for commander-leader behavior.

Label	Measurable factors	Number of variables	Cronbach's Alfa for scale
AB1	Superior orientation	10	0.700
AB2	Integration	5	0.901
AB3	Predictive accuracy	5	0.852
AB4	Product emphasis	10	0.814
AB5	Consideration	10	0.893
AB6	Role assumption	10	0.824
AB7	Tolerance and freedom	10	0.921
AB8	Initiation of structure	10	0.899
AB9	Persuasiveness	10	0.949
AB10	Tolerance of uncertainty	10	0.762
AB11	Demand reconciliation	5	0.837
AB12	Representation	5	0.847



(a) Theorized Model (b) Specified Model

Figure 2 Diagram with standardized indicator loadings for predicted effective leadership style in the Lithuania armed forces generated by AMOS 24 with variables (a) theorized model and (b) specified model.

The confirmatory factor analysis helped to test the importance of measurable factors to latent variable leadership style (LS) for the respondents. As mentioned above, the twelve leadership indicators that were scored on the LBDQ Form XII subscales for this research were tested for LS influence and for ten of them the importance of factor loadings to latent LS variables were proved. Only for AB10 (0.385) and AB4 (0.445) the standardized regression weights were too low to be included for future model construction. In the end, only for the eight that showed the highest importance (AB2, AB3, AB5, AB6, AB8, AB9, AB11 and AB12) a specified leadership style (SLS) model was constructed. The generated theorized leadership style model (TLS) path weights are presented in Figure 2(a). The specified leadership style model path weights are presented in Figure 2(b).

The path analyses were done by AMOS 24 software for both models in order to predict effective leadership style in the Lithuania armed forces. The calculations are presented as diagrams with standardized indicator loadings. Moreover, the fit for the TLS and the SLS model structures was analyzed and the main results of CFA are shown in Table 4.

Table 4 Goodness-of-fit statistics of the theorized and specified models.

Index Fit	Recommended value [13]	Theorized model	Specified model
CMIN/DF	≤3	5.345	0.626
Probability level	> 0,05	0.000	0.793
RMSEA	≤ 0,08	0.146	0.000
GFI	≥ 0,9	0.889	0.992
RMR	< 0,5	2.045	0.306
NFI	≥ 0,9	0.934	0.996
CFI	≥ 0,9	0.945	1.000
TLI	≥ 0,9	0.886	1.006

The confirmatory factor analysis procedures at first tested the twelve predictive indicators of the theorized leadership style model. The LDBQ subscales were tested as the TLS model and the eight predictive indicators were tested as the SLS model, but only if the minimum SLS values were achieved. The goodness-of-fit statistics of the TLS and the SLS model calculation results are shown in Table 4. After the CFA analysis it became clear that the overall TLS model fit did not appear quite good. The statistics for the TLS model showed that the estimated $\chi 2$ was 195.629 (df = 33) and the null hypothesis of a good fit was rejected at a level of 0.05 ($p < 0.000$). The estimated root mean square error of approximation (RMSEA) of 0.146 was too high and the null hypothesis of a good fit was rejected at a level of 0.05 ($p < 0.000$).

Another situation occurred for the SLS model, the overall model fit the data quite well. Based on the goodness of fit statistics, the estimated $\chi 2$ was 6,260

(df = 10) and the null hypothesis of a good fit at a level of 0.05 ($p < 0.793$) was not rejected. The estimated root mean square error of approximation and the comparative fit index indicated that the modified model (SM) fit the data well, because RMSEA equals 0.000 ($p < 0.793$) and CFI equals 1.00. The model fit calculations are presented in Table 4. This analysis lets us know that effective leadership style in the Lithuania armed forces generated by AMOS 24 software can be represented by eight subscales from the Leader Behavior Description Questionnaire.

2.4.3 Measures Reliability and Validity

Convergent validity was chosen as the method to test construct validity. Therefore, the reliability and validity of the measures were tested by calculating the composite reliability (CR) of the constructs and the average variance extracted (AVE). The method to check construct validity applies AVE because it measures the level variance taken by a construct against the level due to measurement errors. AVE values at a level of 0.5 and higher are acceptable and values over 0.7 are considered very good. The level of CR is another guideline to review convergent validity. According to Hair, *et al.* [13], an acceptable value of CR is 0.7 and higher.

This resulted in the following values: AB2 – *Demonstrates inter-member relations* (CR = 0.929, AVE = 0.724); AB3 – *Displays foresight and ability to predict outcome accurately* (CR = 0.895, AVE = 0.633); AB5 – *Regards comfort, well-being* (CR = 0.914, AVE = 0.525); AB6 – *Status, and contributions of subordinates* (CR = 0.909, AVE = 0.505); AB8 – *Actively carries out the leadership role rather that surrendering leadership to others* (CR = 0.865, AVE = 0.412); AB9 – *Uses persuasion and arguments effectively (*CR = 0.958, AVE = 0.698); AB11 – *Reconciles conflicting demands* (CR = 0.886, AVE = 0.610); AB12 – *Behaves and acts as a representative of the group and indicates its importance in the organization* (CR = 0.893, AVE = 0.627).

Finally, all of Cronbach's alphas calculated for the latent variables, as reported in Table 5, were higher than 0.7 and therefore at a satisfactory level. Hence, the three conditions for convergent validity based on factor loading, AVE, and CR were fulfilled. All in all, from these results it is evident that the variables used to indicate effective leadership style in the Lithuania armed forces in this research are reliable and valid (Table 5).

One more analysis was done to analyze the discriminant validity, which helps to ensure significant variance between different variables. For the same reason, the differences between one and other constructs in the same model are indicated.

For this reason the discriminant validity was evaluated based on the Leader Behavior Description Questionnaire subscales as latent variable correlation matrix: the correlations between the constructs are reported in the lower left off-diagonal elements in the matrix (Table 6); the square roots of the AVE values were also calculated for each of the constructs along the diagonal. By the rule the average variance shared between a construct and its measures should be higher than the variance shared between one construct and other constructs in the model [12]. Discriminants are reasoned to be valid when the diagonal elements (square root AVE) are greater than the off-diagonal elements in the corresponding rows and columns. Discriminant validity was satisfactory (see Table 6). The measures show very good reliability and validity and this fact allowed us to continue with the DT analysis.

Table 5 Cronbach's alpha, factor loading and convergent validity.

Label	Measurable factors	Number of variables	Cronbach's alfa for scale	AVE	CR
AB2	Integration	5	0.901	0.724	0.929
AB3	Predictive accuracy	5	0.852	0.633	0.895
AB5	Consideration	10	0.893	0.525	0.914
AB6	Role assumption	10	0.824	0.505	0.909
AB8	Initiation of structure	10	0.899	0.533	0.918
AB9	Persuasiveness	10	0.949	0.698	0.958
AB11	Demand reconciliation	5	0.837	0.610	0.886
AB12	Representation	5	0.847	0.627	0.893

Table 6 Discriminant validity.

Label	AB2	AB3	AB5	AB6	AB8	AB9	AB11	AB12
AB2	**0.851***							
AB3	0.843	**0.796***						
AB5	0.750	0.722	**0.725***					
AB6	0.674	0.527	0.334	**0.711***				
AB8	0.855	0.796	0.638	0.614	**0.730***			
AB9	0.850	0.850	0.619	0.679	0.770	**0.835***		
AB11	0.794	0.818	0.524	0.719	0.706	0.833	**0.781***	
AB12	0.689	0.645	0.562	0.551	0.720	0.675	0.652	**0.792***

Note: *The square root of AVE is on the diagonal.

2.4.4 Model Variables and Tree Design

The data that describe leader behavior were collected in the Lithuanian armed forces in the 2016 year. The data were obtained from the Leader Behavior Description Questionnaire (LBDQ Form XII) and answers to socio-

demographical questions. After comprehensive analysis by AMOS 24 software, where structural equation modeling was used for path analyses for future investigations, only eight subscales were chosen for leader behavior identification instead of twelve. Next, the data were reorganized based on eleven independent variables and three categories of dependent variables, which in this study are the specific categories of the participants' military ranks. The final data set for decision tree modeling by SPSS 20 consisted of 204 observations.

Table 7 Description of variables used in DT model.

Variable type	Study variables	Definitions for variables	Name	Values
Dependent	Military range	The participants' military rank	**MR**	1 = Enlisted grade 2 = Junior officers 3 = Senior officers
Independent	Leader behavior	Maintains a closely linked organization; demonstrates mutual relations	**AB2**	scale
		Displays foresight and ability to accurately predict the outcome	**AB3**	scale
		Regards the comfort, well-being, status, and contributions of subordinates	**AB5**	scale
		Actively exercises the leading role rather that giving up leadership to others	**AB6**	scale
		Defines own role and allows subordinates to know what is expected	**AB8**	scale
		Uses effective persuasion and arguments; exhibits strong convictions	**AB9**	scale
		Reconciles conflicting demands	**AB11**	scale
		Speaks, behaves and acts as group representative and indicates its importance in the organization	**AB12**	scale
	Influence	Participants' position in serving place. Have or no the subordinate?	**SUB**	1 =Yes 2 = No
		Participants education level	**EDU**	1 = Secondary; 2 = Bachelor; 3 = Higher Education; 4 = Unfinished higher education; 5 = Master's degree; 6 = Higher than Master's degree;
		Participants gender	**GEN**	1 = Male; 2 = Female

The variables included in this study are presented in Table 7. The participants' military ranks (MR) based on their specifications were selected as dependent variable. The MR were divided into three categories: 1 = enlisted grade; 2 =

junior officer; 3 = senior officers. The independent variables that were obtained from the LBDQ Form XII subscales (AB2, AB3, AB5, AB6, AB8, AB9, AB11 and AB12) were chosen for evaluation of specific leadership behavior for the participants divided into three categories by military rank. This was done because in a previous study, the amount of importance of all leadership behavior subscales was checked but only eight of these independent variables showed statistically significant influence on leader behavior for Lithuanian armed forces soldiers.

To individualize the leadership behavior differences for the three military rank categories, additional variables were chosen: gender (GEN); education level (EDU); subordinates (SUB). These three independent variables were used as influence variables in the decision tree models. The variables GEN and SUB were measured in the nominal dichotomous scale. The EDU was measured in the ordinal six position scale, where the lowest education level was secondary and the highest higher than a master's degree. The purpose of this study was to investigate the differences in variance across levels of the dependent variable MR.

3 Research Results

IBM SPSS Decision Trees help in identifying groups, discover relationships between them and predict future events. A decision tree model consists of a set of rules for dividing a large collection of observations into small homogeneous groups with respect to a particular target variable. Decision algorithms automatically determine which variables are the most important and subsequently sort the observations into the correct output category.

The CHAID tree selected to predict effective leadership indicators (with the used dataset) in the Lithuania armed forces is represented in Table 8. Due to the technical conditions specified in the model's execution, the minimum p-value required for splitting and merging was set to 0.05, with a minimum number of records in the parent branches of 25 and a minimum in the child branches of 10. All variables in the tree growth algorithm are treated as either categorical or ordinal, thus no standardization was required for this step.

According to the design of the research, four different combinations (four decision tree models) were analyzed. The specifications section in Table 8 provides information on the settings used to generate each of the four tree models, including the variables used in this analysis. Section 3 (*Research Results*) displayed in Table 8 provides information on the total number of nodes and the number of terminal nodes, depth of the tree (number of levels below the root node), and independent variables included in the final model. As can be

expected, eight effective leadership indicators were specified as independent variables, but for each model three different numbers of them were included in the final model.

Table 8 Description of decision three models.

Summary for Models		Influence variables			
		None	**Gender**	**Education**	**Subordinate**
Specifications	Growing method	CHAID			
	Dependent variable	Military Rank			
	Independent variables	AB2, AB3, AB5, AB6, AB8, AB9, AB11, AB12			
	Cross-validation	Yes	Yes	Yes	Yes
	Maximum tree depth	3	3	3	3
	Minimum cases in parent node	25	25	25	25
	Minimum cases in child node	10	10	10	10
Results	Independent variables included	AB2, AB12, AB11, AB8	AB9, AB3, AB11, AB8	AB2, AB12, AB11, AB9	AB2, AB12, AB11, AB9, AB8
	Number of nodes	17	16	16	17
	Number of terminal nodes	12	11	12	12
	Depth	3	3	3	3

The influence variables GEN, EDU and SUB were used for interpretation of the differences in variance across levels of the dependent variable MR. With a categorical dependent variable, cases belonging to the same dependent variable class and the same predictor variable were grouped together in a cell. The corresponding influence values are grouped to form the cell weight for that particular cell. A contingency table was formed and the cell weights were used in the analysis. In this table the classes of the dependent variables are in the columns and the categories of the predictor variables being studied are in the rows. To indicate the differences, the analysis started without influence variables and then it was repeated with the selected variables, GEN, EDU and SUB.

AB3, AB5, AB6 and AB9 were variables that did not contribute significantly to the first model; thus they were automatically excluded from the final model. When the decision tree model was constructed with influence of variable GEN, the result was different, because this time variable AB3 was included in the model, whereas AB2, AB5, AB6, AB8 and AB12, did not have a significant influence on the second model. The third decision tree model was built with influence of variable EDU and AB3, AB5, AB6 and AB8 were automatically dropped from the final model. The fourth model was the last one, which was

built under influence of variable SUB. In this model only three of the independent variables, AB3, AB5 and AB6, were not included.

Table 9 Decision tree model classification.

Observed	Percent correct predicted by influence			
	None	Gender	Education	Subordinate
Enlisted grade	0.0%	40.0%	0.0%	40.0%
Junior officer	100%	88.6%	91.4%	88.6%
Senior officer	63.6%	45.5%	63.6%	63.6%
Overall percentage	82.4%	74.5%	76.5%	78.4%
Risk estimate	22.3%	25.5%	23.5%	21.6%
Growing method: CHAID, dependent variable: MR				

In Table 9, information about these four model classification problems and the risk estimates is presented. The model without influence variables classified approximately 82.4% of the soldiers correctly. However, there is one possible problem with this model: for those respondents with 'enlisted grade', it scored a bad prediction rating of 0.0%. It seems that 'enlisted grade' was inaccurately classified as 'junior officer' or 'senior officer'. The second model with GEN influence classified 74.5% of the soldiers correctly. It scored a low prediction rating of 40.0% for 'enlisted grade', which means that 60% of 'enlisted grade' soldiers were classified incorrectly. The third model with EDU influence classified 76.5% of the soldiers correctly. It scored a 0.0% prediction rating for 'enlisted grade'. The fourth model with SUB influence classified 78.4% of the soldiers correctly. It scored a low prediction rating of 40.0% for 'enlisted grade', the same as in the second model. The scores for 'senior officer' in the first, in the third and in the fourth model were identical (63.6%), but in the second model the score for 'senior officer' was only 45.5%. Only for 'junior officer' very good scores appear: 100% in the first model, 88.6% in the second model, 91.4% in the third model, and 88.6% in the fourth model.

The outcomes in the classification table are dependable according to the risk estimate. The risk estimate indicates that the categories predicted by the model were wrong in 22.3% of the cases for the first model, in 25.5% of the cases for the second model, in 23.5% of the cases for the third model, and in 21.6% of the cases for the fourth model. So the 'risk' of misclassifying soldiers approximately varied from 22% to 24%. Also we can analyze how independent leader behavior variables were used to grow the decision tree for the fourth model, which had a low risk estimate and used five independent variables under the SUB influence. This tree diagram is presented in Figure 3.

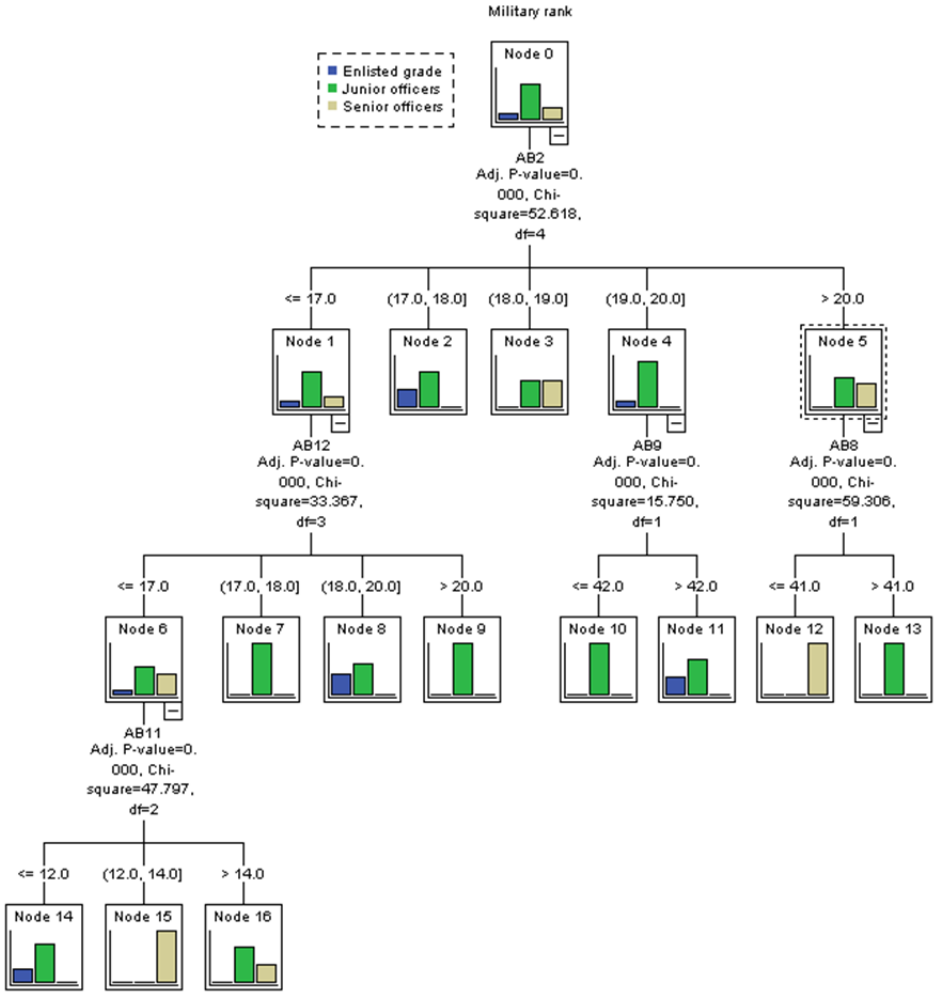


Figure 3 Decision tree histogram for the fourth model with SUB used as influence variable.

According to the CHAID decision tree growing method for the fourth model, the demonstrated inter-member relations (AB2) were the first recommended split that should be applied (p-value of 0.000). This corresponds to the result of the CFA model (the path coefficient was 0.92), since inter-member relations contributed significantly to predicting leadership behavior in that model as well. In our dataset, the three military rank categories appeared to be distributed differently across 5 categories: Node 1 – AB2 ≤ 17; Node 2 – AB2 = (17-18]; Node 3 – AB2 = (18-19]; Node 4 – AB2 = (19-20] and Node 5 – AB2 > 20 (Figure 3).

Three different variables were used for the second split. They were used dependently on the number of inter-member relations identified in the first split. AB12 – *Indicates importance of the group in the organization* (p-value 0.000) for Node 1 – AB2 ≤ 17, the flag for Node 4 indicating AB9 – *Uses persuasion and arguments effectively* (p-value 0.000), and the flag for Node 5 indicating AB8 – *Defines his own role and makes subordinates know what is expected* (p-value 0.000) (Figure 3). In the CFA model, all three variables were considered relevant (Figure 1).

The third split AB11 – *Reconciles conflicting demands* was chosen for Node 6, where low (≤ 17) leadership behavior for AB12 was indicated. Possible interpretations of this can be found from the information in Table 10.

Table 10 Description for fourth DT model.

Node	Enlisted grade		Junior officers		Senior officers		Total		Predicted category
	N	Percent	N	Percent	N	Percent	N	Percent	
0	20	9.8%	140	68.6%	44	21.6%	204	100.0%	Junior off.
1	12	11.5%	72	69.2%	20	19.2%	104	51.0%	Junior off.
2	4	33.3%	8	66.7%	0	0.0%	12	5.9%	Enlisted gr.
3	0	0.0%	8	50.0%	8	50.0%	16	7.8%	Junior off.
4	4	11.1%	32	88.9%	0	0.0%	36	17.6%	Junior off.
5	0	0.0%	20	55.6%	16	44.4%	36	17.6%	Junior off.
6	4	7.7%	28	53.8%	20	38.5%	52	25.5%	Junior off.
7	0	0.0%	20	100.0%	0	0.0%	20	9.8%	Junior off.
8	8	40.0%	12	60.0%	0	0.0%	20	9.8%	Junior off.
9	0	0.0%	12	100.0%	0	0.0%	12	5.9%	Junior off.
10	0	0.0%	24	100.0%	0	0.0%	24	11.8%	Junior off.
11	4	33.3%	8	66.7%	0	0.0%	12	5.9%	Enlisted gr.
12	0	0.0%	0	0.0%	16	100.0%	16	7.8%	Senior off.
13	0	0.0%	20	100.0%	0	0.0%	20	9.8%	Junior off.
14	4	25.0%	12	75.0%	0	0.0%	16	7.8%	Junior off.
15	0	0.0%	0	0.0%	12	100.0%	12	5.9%	Senior off.
16	0	0.0%	16	66.7%	8	33.3%	24	11.8%	Junior off.

4 Conclusions

This research proposed a process to identify effective military leadership by information collected from the LBDQ Form XII and answers to socio-demographical questions. The collected data were used to create a prediction model by using the decision tree algorithm. In this investigation, confirmatory factor analysis by the AMOS 24 data-fitting program was done in order to confirm the construct validity of items and constructs applied in the research.

Through the confirmatory factor analysis, the characteristics used for prediction were eight out of twelve leadership indicators that could be viewed as strong leadership style indicators in the Lithuania military forces. From the CFA

analysis, the indicators that could not provide a basis for effective leadership were: AB10 – *Is able to tolerate both unreliability and procrastination without anxiety or being upset* (r = 0.38, α = 0.14); AB4 – *Applies pressure for productive output* (r =0.46, α = 0.21); AB1 – *Is striving for higher status* (r = 0.68, α = 0.48); AB7 – *Offers subordinates the scope for initiative, decision and action* (r = 0.68, α = 0.25).

The CHAID decision tree growing algorithm for the identification of effective leadership lets us recognize how independent leader behavior variables are used to classify the respondents from three military ranks. Prediction models created by using three influence variables (gender, education and subordinates) let us recognize the precision of the classification. Also, the influence variables showed that different leader behavior variables were used to grow these decision trees. The precision of the predictions was measured. With the influence of the subordinates variable 78.4% was correctly predicted with the lowest risk estimate, i.e. 21.6%. The statistically significant characteristics used for predicting main leadership behavior for three military ranks in the fourth model (data influenced by variable SUB) were: AB2 – *Maintains a closely knit organization*; AB12 – *Speaks, behaves and acts as a representative of the group and indicates its importance in the organization* (r = 0.73, α = 0.53); AB11 – *Reconciles conflicting demands* (r = 0.88, α = 0.77); AB9 – *Uses persuasion and arguments effectively* (r = 0.92, α = 0.85); AB8 – *Defines own role and lets subordinates know what is expected from them* (r = 0.82, α = 0.67).

This research helped us understand what type of leadership indicators can influence soldiers classified not only by military rank but also with different influence variables taken into account.

Our modern army is in need of leaders who are not afraid to take initiative and who are capable of raising a degree of confidence in those around them [20,21]. From this point of view, our future research aims to improve the identification of military leaders in the Lithuanian military forces. Moreover, the results of the CHAID decision tree algorithm will be used to generate a rule-based understanding. In addition, we would like to develop an ontology combined with the rules for creating a military leader recommendation system. It may also be worthwhile to apply and adopt fuzzy regression models such as those in [22].

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