VALIDITY OF THE DIMENSIONAL CONFIGURATION OF THE REDUCED POTENTIAL PERFORMANCE MODEL IN SKI JUMPING

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Abstract:

The aim of the study was to establish the validity of the dimensional configuration of the reduced potential performance model in ski jumping. Two performance models were prepared (models A and B), differing only in terms of their method of determining the weights (dimensional configuration). Model A involves the dependent determination of weights while model B includes the independent determination of weights. The sample consisted of 104 Slovenian ski jumpers from the senior-men's category, junior-men's categories from 17 to 18 and from 15 to 16 years of age and three categories of boys from 13 to 14, from 11 to 12 and up to 10 years of age. Validity of the dimensional configuration of the reduced potential performance model in ski jumping is different for the age categories. The tests of correlation between models A and competitive performance revealed that in some categories (senior-men (R = 0.74**) and boys aged up to 14 (R = 0.51**) the models correlated quite highly and even statistically significantly with actual competitive performance, while in others (junior-men aged up to 18 and 16) this correlation was slightly lower. The correlation between model B and competitive performance revealed that correlation was statistically significant (R = 0.49**) only by category boys up to 14 years of age.

Key words: *ski jumping, model, expert modelling, success*

Introduction

It is possible to study the model of performance theory only by studying and analysing a group of heterogeneous variables influencing the criterion status of individual performance criteria. To solve these types of problems one needs sound knowledge of the subject and the methodology, with the former stemming from the theory of performance in sport and the latter from more recently established expert systems functioning as artificial intelligence methods (Mallach, 1994). Performance and an athlete's preparation system are issues requiring very broad and complex expert engagement and knowledge. Therefore, we tried to transform performance and athlete preparation system into an expert system which, by definition, deals with the problems similarly to an expert and could be of great assistance to sports experts when defining an athlete's performance and preparation.

The main subject of our study is the reduced potential performance model (RPPM) for ski jumpers. As the performance model focuses on the micro level (Jošt, 1998), its main dimensions are set in a way to ensure that the final assessment of the criterion dimension of performance represents the most authentic evaluation possible of one's potential competitive performance.

The expert system is normally designed on the basis of: (a) a knowledge base which is very exclusive in terms of expertise; (b) an inference mechanism which may be universal for different areas of expertise; and (c) a communication interface enabling communication between the expert, the expert system and the user (Mallach, 1994). The biggest problem in creating an expert system is the formation of a knowledge base which, in our case, consists of a tree of criteria, weights and normalisers. The formation of an appropriate knowledge base from the performance theory and athletes' preparation system (Jošt, 1998) relates to the problem of its referentiality and configuration, both dimensional and positional (Table 1).

Referentiality of the knowledge base (the criteria tree) involves the relationship between the dimensions of the performance model and their inter-correlations. It is assumed that a knowledge base is created in a way to ensure an adequate degree of independence of its individual segments.

This means that, when defining the contents of the performance model's referentiality, experts have to take into account the fact that the dimensions of the model in an individual node must be correlated to the minimum possible degree, while the correlation with the derived performance criterion has to be as strong as possible.

The key problem is to establish the validity of the dimensional configuration of the performance model. The dimensional configuration of the knowledge base (weight) defines the significance of the dimensions of performance in view of its ability to explain and anticipate performance. It is divided into elementary dimensional configuration which shows the position of elementary referential axes in view of the performance criterion, and derived dimensional configuration as a result of combining shares of the correlation of the elementary performance dimensions and then of the already derived performance dimensions.

Finally, the study of the configuration of knowledge data is also related to the issue of positional configuration (normalisers) showing the position of an individual athlete in a selected dimension or variable of the performance model. It could be inferred that the dimensional configuration represents a general, legitimate structure of the performance model, while the positional configuration shows the actual state of the configuration of variables of the performance model defined for an individual athlete.

Reduced potential performance model (RPPM) for ski jumpers was set up on the concept of psychosomatic status, a general potential model of competition performance in ski jumping (Jošt & Tušak, 2002). That model was created to encompass the motor and morphological areas of the athletes' psychosomatic status. The basic criteria (tests) are at the bottom of the tree and, in higher nodes, they combine to form weighted and/or derived criteria. Thus, the higher-level criteria depend on those at lower levels (Table 1).

So far (Jošt, Leskovšek, & Ulaga, 1995; Erčulj, 1999; Jošt & Tušak, 2002; Černohorski & Pustovrh, 2005; Pori, Bon, & Šibila, 2005), the theory of expert modelling has resolved the problem of the dimensional configuration of the knowledge base (weights) by creating dependence between the variables. This method was named the **method of the dependent determination of weights** (A) (Table 1). With this method, weights are determined based on a relative share of an individual variable, even when the values of derived criteria are determined. The method of the dependent determination of weights stems from the principle that the sum total of all elementary variables (tests at the elementary level of the tree) in a given performance model has to be 100. Based on the assumed linear correlation between the criteria, the weights of the derived criteria equal the sum total of the weights of the directly subordinated criteria. Directly subordinated criteria may be basic criteria stemming from the given derived criterion, or solely derived criteria stemming from another derived criterion – regardless of their level in the performance model tree.

A more recent method of setting the decision rules is based on the principle of the independent contribution of individual, substantively different variables – the **method of the independent determination of weights** (B) (Table 1). In this method of setting the decision rules the absolute contribution of variables to the score for potential performance is determined. What is determined is the absolute contribution of each basic criterion and/or independent variable and each derived criterion to the score for potential performance, so that each elementary and derived variable is assigned a weight from 0 to 100. When calculating the scores of the derived criteria, the weights determined by the expert are also taken into account. There are no cumulative weights in this method. An expert gives weights independent for each criteria (tests or nodes). Thus, the principle of independence in the determination of significance at higher levels of the performance model is adhered to. With this method the significance of each variable may be determined individually. For example, a variable with a weight of 95 has extremely high significance from the point of view of an athlete's performance, while a variable with a weight of 15 is practically insignificant.

The right side of Table 1 shows normalisers for all basic criteria and/or variables in the performance model by age category (senior men and older junior men; younger junior men and older boys; and younger boys). These normalisers are applied in modelling with the method of the dependent determination of weights (A) and the method of the independent determination of weights (B).

In view of the presented problem of establishing the validity of the dimensional configuration of the performance model in ski jumping, we assume that the correlation between the *RPPM* and *competitive performance* (CP), calculated by methods A and B is statistically significant, namely at the level of 5% risk.

Method

Participants

The sample consisted of 104 Slovenian ski jumpers from the senior-men's category (16 competitors), the category of junior men up to 18 years of age (12 competitors), the category of junior men up to 16 years of age (20 competitors) and the categories of boys up to 14 years of age (30 competitors), up to 12 years of age (18 competitors) and up to 10 years of age (8 competitors) who underwent testing

Table 1. Reduced potential performance model (RPPM) in the motor and morphological areas

REFERENTIALITY OF THE KNOWLEDGE BASE	DIMENSIONAL CONFIGURATION		POSITIONAL CONFIGURATION		
Test code	weights		NORMALISERS		
	method A	method B	senior men and older junior men	younger junior men and older boys	younger boys
MOTOR	100	100			
├─ECOMP	50	100			
│ ├─MUSEN	10	60			
│ │ ├─BEJUMP	7	60	0:0, 91,1:2, 99,8:5, 104,7:8, 110,8:9	0:0, 71,8:2, 82,7:5, 88,8:8, 96,3:9	0:0, 55,4:2, 70,4:5, 78,7:8, 89,1:9
│ │ └─TRNKUP	3	60	0:0, 14:2, 16:5, 18:8, 20:9	0:0, 12:2, 15:5, 16,5:8, 18,2:9	0:0, 10,9:2, 13,1:5, 14,4:8, 15,9:9
│ └─REXCIN	40	100			
│ ├─SPSTR	20	90			
│ │ ├─BRJUMP	6	80	0:0, 274,4:2, 286,8:5, 293,7:8, 302,4:9	0:0, 197:2, 214,9:5, 224,8:8, 237,3:9	0:0, 184,1:2, 197,2:5, 204,5:8, 213,6:9
│ │ └─HIJUMP	14	90	0:0, 47,4:2, 53,2:5, 56,5:8, 60,5:9	0:0, 29,7:2, 36:5, 39,5:8, 43,9:9	0:0, 27,8:2, 33,1:5, 36:8, 39,7:9
│ ├─EXPOW	12	95			
│ │ ├─EXPLO	2.4	95	0:0, 75,8:2, 85,2:5, 90,4:8, 96,9:9	0:0, 58,1:2, 69,1:5, 75,2:8, 82,8:9	0:0, 55,1:2, 66,1:5, 72,2:8, 79,8:9
│ │ └─EXPLO1	9.6	95	0:0, 7:2, 8:5, 8,5:8, 9:9	0:0, 5:2, 6,5:5, 7,5:8, 8:9	0:0, 5:2, 6:5, 6,5:8, 7:9
│ └─ELPOW	8	80			
│ └─S3JUMP	8	80	0:0, 8,779:2, 9,271:5, 9,544:8, 9,886:9	0:0, 6,347:2, 6,911:5, 7,223:8, 7,615:9	0:0, 5,699:2, 6,191:5, 6,464:8, 6,806:9
└─INFMOV	50	100			
├─RECONT	20	80			
│ ├─BALANC	8	80			
│ │ ├─BALSAG	5.6	70	0:0, 18,91:2, 21,35:5, 24,93:8, 29,4:9, 30:10	0:0, 3,29:2, 5,32:5, 6,44:8, 7,85:9, 30:10	0:0, 1,6:2, 3,83:5, 5,06:8, 6,61:9, 30:10
│ │ └─BALFRP	2.4	70	0:0, 4:2, 7:5, 9:8, 12:9, 30:10	0:0, 0,99:2, 7,47:5, 11,07:8, 15,57:9, 30:10	0:0, 1,33:2, 4,38:5, 6,07:8, 8,18:9, 30:10
│ ├─SPEED	4	80			
│ │ ├─TAPPRF	2	80	0:0, 28,4:2, 33,1:5, 35,7:8, 38,9:9	0:0, 27,5:2, 29,9:5, 31,2:8, 32,8:9	0:0, 27,4:2, 29,9:5, 31,2:8, 32,9:9
│ │ └─TAPPLF	2	80	0:0, 28,4:2, 33,1:5, 35,7:8, 38,9:9	0:0, 26,9:2, 28,7:5, 29,8:8, 31,1:9	0:0, 25:2, 27,9:5, 29,5:8, 31,6:9
│ └─FLEXIB	8	80			
│ ├─TRUNKFL	0	75	0:0, 58,9:2, 63,6:5, 66,2:8, 69,4:9	0:0, 52,2:2, 55,8:5, 57,8:8, 60,3:9	0:0, 45,7:2, 49,7:5, 51,9:8, 54,7:9
│ ├─TRUNKFLR	6.4	80	0:0, 220:2, 250:5, 270:8, 300:9	0:0, 200:2, 220:5, 235:8, 250:9	0:0, 195:2, 210:5, 220:8, 225:9
│ └─SHANFL	1.6	75	33:9, 37:8, 40,3:5, 46,1:2, 90:0	40:9, 45:8, 50:5, 55:2, 90:0	40:9, 45:8, 50:5, 55:2, 90:0
└─COORD	30	95			
├─OBSTJP	15	95	5,1:9, 5,4:8, 5,6:5, 6:2, 20:0	5,1:9, 5,5:8, 5,7:5, 6,1:2, 20:0	0:0, 5,7:9, 6,3:8, 6,7:5, 7,5:2, 20:0
├─8BEND	6	90	14,8:9, 15,17:8, 15,46:5, 15,99:2, 30:0	15,94:9, 16,54:8, 17,02:5, 17,89:2, 30:0	17,08:9, 17,97:8, 18,69:5, 19,89:2, 30:0
└─OBCOBACK	9	90	6,06:9, 6,38:8, 6,64:5, 7,11:2, 20:0	6,3:9, 7,8:8, 8:5, 9,5:2, 20:0	6,7:9, 8,17:8, 9,34:5, 11,45:2, 20:0
MORPHOLOGIC	100	100			
├─BASICDIM	50	80			
│ ├─BH	25	40	0:0, 161,6:2, 165,1:5, 166,8:8, 168,7:9, 175,2:10, 181,7:9, 183,5:8, 190,1:5, 198,5:2, 250:0	0:0, 140,3:2, 145,1:5, 145,4:8, 151,9:9, 157,1:10, 162,3:9, 163,7:8, 165,1:5, 167,8:2, 250:0	0:0, 125,5:2, 130,5:5, 136,6:8, 140,7:9, 148,1:10, 155,5:9, 156,6:8, 157,5:5, 159,6:2, 250:0
│ └─BM	25	80	0:0, 45:2, 50,1:5, 54,9:8, 55:9, 62:10, 69:9, 70,1:8, 71,1:5, 80,1:2, 120:0	0:0, 30,1:2, 30,3:5, 30,4:8, 35,9:9, 44,1:10, 52,3:9, 53,7:8, 55,1:5, 57,8:2, 120:0	0:0, 20,8:2, 24,5:5, 25,4:8, 30:9, 36,4:10, 42,8:9, 43,7:8, 44,5:5, 46,3:2, 120:0
└─MORPHOIND	50	90			
├─AEROIND	30	90	0:0, 880:2, 930:5, 980:8, 1030:9	0:0, 900:2, 950:5, 1000:8, 1100:9	0:0, 1000:2, 1050:5, 1100:8, 1180:9
└─TAKEOFIND	20	90	0:0, 185:2, 190:5, 195:8, 200:9	0:0, 180:2, 185:5, 190:8, 195:9	0:0, 180:2, 185:5, 190:8, 195:9
RPPM					
├─MOTOR	60	95			
└─MORPHOLOGIC	40	70			

Legend: method A – method of the dependent determination of weights, method B – method of the independent determination of weights in October 2000 and also participated in Slovenian and international ski-jumping competitions in the 1999/2000 season. The subjects were healthy and had no injuries on the day of measurement.

Instruments

The RPPM model (motor abilities and morphology) encompassed 21 independent (predictor) variables. Two morphological variables were included in the morphological area of RPPM at the elementary level (Table 1): *body height* (BH) and *body mass* (BM), as well as two morphological indexes: *aerodynamic index* (AEROIND) and *take-off index* (TAKEOFIND). At higher levels, the variables were combined in nodes: *morphological index* (MORPHOIND), *basic dimensions* (BASICDIM) and *final score of the morphological area* (MORPHOLOGIC).

Seventeen elementary motor variables were included in the motor area of RPPM (Table 1): *jumping over a bench – muscular endurance of dynamic type of the legs* (BEJUMP), *raising of one's trunk on a bench at an angle of 45 degrees – muscular endurance of dynamic type of the trunk* (TRNKUP), *standing broad jump – test of speed strength* (BRJUMP), *height of vertical take-off – Abalak – test of speed strength* (HIJUMP), *push-off time in vertical jump* (POFFT), *explosiveness* (EXPLO = HIJUMP / POFFT), s*tarting strength – explosive power in the first phase of the push-off* (EXPLO1), *standing triple jump – elastic power* (S3JUMP), *balance in the frontal plane* (BALFRP), *balance in the sagittal plane* (BALSAG), *tapping with the right foot* (TAPPRF), *tapping with the left foot* (TAPPLF), *bending forward on a bench – trunk flexibility* (TRUNKFL), a*ngle between the shank and the ground – flexibility of the ankle joint* (SHANFL), *jumping over obstacles* (OBSTJP), *figure-of-eight with bending* (8BEND) and *obstacle course backwards – co-ordination* (OBCOBACK). At higher levels, the variables were combined in nodes: *motor area score* (MOTOR), *energy component of movement* (ECOMP), *muscular endurance of dynamic type* (MUSEND), *regulation of excitation intensity* (REXCIN), *speed strength* (STSTR), *explosive power* (EXPOW), *elastic power* (ELPOW), *information component of a movement* (INFMOV), *regulation of synergists and antagonists* (RECONT), *balance* (BALANC), *speed* (SPEED), *flexibility (FLEXIB) and movement structuring* (COORD).

In view of the task problem, one dependent, i.e., criterion variable was defined, namely, *competitive performance* (CP) which represents the best competitive achievement or ranking of an individual competitor in the winter season of 1999/2000 in their age category. The results of individual competitions and/or results of competitive systems were taken into account (Jošt & Tušak, 1999). The results are not comparable between the categories, which is why the sample was divided into categories (senior men, junior men up to 18, junior men up to 16, boys up to 14, boys up to 12 and boys up to 10).

Procedure

The SMMS computer programme (Sport Measurement Management System), developed at the Faculty of Sport in Ljubljana, was used to calculate reduced potential performance. The correlation between the *final score* (RPPM) and *competitive performance* (CP) was established with Pearson's correlation coefficient and, in the case of a non-linear variable, with an Eta correlation coefficient (Table 4).

Results

To allow for a better understanding of the results shown below, an example of results of both modelling methods (A and B) used in the study has been provided at the very beginning (Table 2).

Table 2 shows the results of a motor-reduced potential performance model for competitor X in the decision model which was constructed according to the methods of the dependent (A) and independent (B) determination of weights.

Evidently, at the level of elementary variables the scores of competitor X according to both methods of determining weights (A and B) are equal. This is understandable as they only depend on normalisers which are equal in both methods. Some minor differences occurred in the derived variables of the performance model, which is in accordance with the decision rules of an individual model.

Competitor X has a good potential score in the *motor area* (MOTOR) as a result of a high score in the energy (ECOMP) and *information components of movement* (INFMOV), with the *energy component of movement* scoring slightly lower than the *information component of movement.* Within the *energy component of movement, muscular endurance* (MUSEN) received a high score as a consequence of two excellent scores when jumping over the bench (BEJUMP) and *raising the trunk at an angle of 45 degrees* (TRNKUP). Explosive (EXPOW) and elastic power (ELPOW) were evaluated as adequate, which is very inconvenient since the three nodes hold the highest importance in ski jumping. Within explosive power, competitor X was inadequately evaluated in the variable of *starting strength* (EXPLO1) whose weight was 95, which has a strong influence on the competitive performance in ski jumping. Within the *information component of movement* (INFMOV), competitor X scored very highly in the speed of the regulation of synergists and antagonists (SPEED) which was bordering on excellence as the score for *tapping with the left foot* (TAPPLF) was excellent. The competitor's *balance* (BALANC), *flexibility* (FLEXIB) and *co-ordi-*

Table 2. Results of competitor X in the motor area according to methods A and B in the SMMS system

Test code	unit	competitor X					
		SMMS (method A)			SMMS (method B)		
		RESULT	f(x)	SCORE	RESULT	f(x)	SCORE
MOTOR			6.3	good		6.2	good
├─ECOMP			5.8	good		5.5	good
│ ├─MU			10.3	excellent		9.9	excellent
│ │ ├─**SWJUMP**	rep.	122	10.8	excellent	122	10.8	excellent
│ │ └─**TRNKUP**	rep.	20	9.0	excellent	20	9.0	excellent
│ └─REXCIN			4.6	satisfactory		4.3	satisfactory
│ ├─VEPOW			6.3	good		5.6	good
│ │ ├─**BRJUMP**	cm	280	3.4	satisfactory	280	3.4	satisfactory
│ │ └─**HIJUMP**	cm	56	7.5	good	56	7.5	good
│ ├─EXPOW			2.5	satisfactory		3.3	satisfactory
│ │ ├─**EXPLO**	-	84	4.6	satisfactory	84	4.6	satisfactory
│ │ └─**EXPLO1**	m/s²	6.8	1.9	unsatisfactory	6.8	1.9	unsatisfactory
│ └─ELPOW			3.8	satisfactory		3.8	satisfactory
│ └─**S3JUMP**	m	9.07	3.8	satisfactory	9.07	3.8	satisfactory
└─INFMOV			6.8	good		6.8	good
├─RECONT			7.5	good		7.0	good
│ ├─BALANC			8.1	very good		6.9	good
│ │ ├─**BALSAG**	s	30	10.0	excellent	30	10.0	excellent
│ │ └─**BALFRP**	s	5.7	3.7	satisfactory	5.7	3.7	satisfactory
│ ├─VELOC			8.9	very good		8.9	very good
│ │ ├─**TAPPRF**	rep.	38	8.7	very good	38	8.7	very good
│ │ └─**TAPPLF**	rep.	39	9.0	excellent	39	9.0	excellent
│ └─FLEXIB			6.2	good		5.8	good
│ ├─**TRUNKFL**	cm	67	8.2	very good	67	8.2	very good
│ ├─**TRUNKFLR**	/	265	7.3	good	265	7.3	good
│ └─**SHANFL**	degree	49	1.9	unsatisfactory	49	1.9	unsatisfactory
└─COORD			6.4	good		6.4	good
├─**OBSTJP**	s	5.7	4.2	satisfactory	5.7	4.2	satisfactory
├─**8BEND**	s	16.1	2.0	unsatisfactory	16.1	2.0	unsatisfactory
└─**OBCOBACK**	s	4.8	12.9	excellent	4.8	12.9	excellent

Legend: RESULT – raw test results; f (x) – numerical score; SCORE – attribute score; Numerical and descriptive values of scores: 0 ≤ f (x) < 2 = unsatisfactory, 2 ≤ f (x) < 5 = satisfactory, 5 ≤ f (x) < 8 = good, 8 ≤ f (x) < 9 = very good, 9 ≤ f (x) < > 10 = excellent.

nation (COORD) are averagely developed, as they received a good score, while *figure-of-eight with bending* (8BEND) and the *angle between the shank and the ground* (SHANFL) were inadequate.

The following are the results of the correlation between the final score of RPPM model (motor abilities and morphology) and the performance criterion (CP) by competitive category (Table 3).

The correlations between the final score of RPPM and the performance criterion in competitive categories ranged from low to medium high and were only statistically significant in two categories. A comparison of the two weight determination methods revealed that the correlations in scores obtained by method A were slightly higher than those obtained by method B.

In method A, a statistically significant correlation only occurred in the senior-men's category (R=.74**) and the category of boys aged up to 14 (R=.51**) while, in method B, statistically significant differences were only found in boys aged up to 14, where the correlation between the final score RPPM and the performance criterion was medium high (R=.49**). In the category of junior men aged up to 18 method B resulted in a non-linear correlation between the final score of RPPM and the per-

Table 3. Results of Eta (η) and Pearson's (R) correlation coefficient calculated according to methods A and B of weight determination between the final score of RPPM and the competitive performance (CP) as well as testing of the linear correlation between the final score of RPPM and the competitive performance criterion by category. The variables which have a non-linear correlation with the performance criterion are in bold.

Test code	category	N	after transformation					
			method A			method B		
			Eta (η)	R	P (r=eta)	Eta (η)	R	P (r=eta)
RPPM	**senior men**	13	.74	.74**	1.000	.62	.44	.509
│	**junior men up to 18**	11	.61	-.49	.512	.79	.16	**.034**
│	**junior men up to 16**	20	.43	.25	.533	.56	.14	.143
│	**boys up to 14**	27	.69*	.51**	.111	.64*	.49**	.245
├─MORPHOLOGIC └─MOTOR								

* p < 0.05; ** p < 0.01

formance criterion as the Eta coefficient was high (η=.79), while Pearson's correlation coefficient was very low (R=.16), which points to a non-linear correlation between the two variables. In this case, Pearson's correlation coefficient underestimated the correlation which is why the non-linear correlation coefficient had to be applied.

Discussion and conclusions

The use of artificial intelligence methods or more precisely – expert systems – has outlined a new path in systemic thinking when searching for answers to basic questions regarding the theory of athletes' performances. The creation of a knowledge base is truly the most important phase in forming a performance model. This study tried to change the method of forming the dimensional configuration of a knowledge base and/or weight determination, namely by following the principle of the independent contribution of individual, substantively heterogeneous variables. Thus, the principle of the independent determination of significance was adhered to even at higher levels of the performance model.

Two weight determination methods were used for determining the significance of the contribution of the derived variables of the reduced potential performance model to performance in ski jumping. The first method (A) is based on the logic of an interdependent contribution, while the second one (B) is based on an independent contribution of individual elementary and derived variables. Both models measure the same thing and there are no substantial differences between them. Nevertheless, method B holds more promise for the future as it enables the expert to assign a weight to a given variable or a set of variables independently of other variables. In this way, the expert determines the contribution of each elementary and/or derived variable to the final score, irrespective of the previous decision. In the future, it would be reasonable to reorganise the performance model tree in a way that ensures the variables do not correlate beforehand in terms of measured abilities but play an independent role in the performance model.

Validity of the dimensional configuration of the reduced potential performance model in ski jumping is different for the categories. The tests of correlation between models A and competitive performance revealed that in some categories (senior men and boys aged up to 14) the models correlated quite highly and even statistically significantly with actual competitive performance, while in others (junior men aged up to 18 and 16) this correlation was slightly lower. The correlation between model B and competitive performance revealed that correlation differentiated statistically significantly the boys up to 14 years of age only by category. One of the reasons for this may be the small number of subjects, where a strong deviation of only one or two competitors may reduce the final correlation. However, it is more likely that individual performance models will have to be studied as the differences between the competitive categories are also seen in the referentiality of the knowledge base (tree structure) and not only in the positional and dimensional configuration of the knowledge base (normalisers and weights), as has been the case so far. But the results show that the expert modelling procedure in motor and morphology area deserves further research attention.

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VALJANOST DIMENZIJSKE KONFIGURACIJE MODELA REDUCIRANE POTENCIJALNE USPJEŠNOSTI U SKIJAŠKIM SKOKOVIMA

Sažetak

Uvod

Cilj istraživanja bio je utvrditi valjanost dimenzijske konfiguracije modela reducirane potencijalne uspješnosti (RPPM) u skijaškim skokovima. Pripremljena su dva modela uspješnosti (modeli A i B), koji se razlikuju samo po metodi određivanja pondera.

Do sada je teorija ekspertnog modeliranja riješila problem dimenzijske konfiguracije baze znanja (težine) stvaranjem međuzavisnosti varijabli. Ta je metoda nazvana **metodom zavisnog određivanja težina** (A). Ovom metodom težine se određuju na temelju relativnog udjela pojedine varijable, čak i kad su vrijednosti izvedenih kriterija određene. Metoda zavisnog određivanja težina proizlazi iz principa da ukupna suma svih elementarnih varijabli (testova na elementarnoj razini stabla) u danom modelu uspješnosti mora iznositi 100. Bazirano na pretpostavljenoj linearnoj korelaciji između kriterija, težine izvedenih kriterija jednake su ukupnoj sumi težina direktno subordiniranih kriterija. Direktno subordinirani kriteriji mogu biti bazični kriteriji koji proizlaze iz danih izvedenih kriterija, ili sami izvedeni kriteriji koji proizlaze iz drugih izvedenih kriterija – neovisno o njihovoj razini na stablu modela uspješnosti.

Novija metoda postavljanja pravila odlučivanja temelji se na principu nezavisnog doprinosa individualnih, znatno različitih varijabli – **metoda nezavisnog određivanja težina** (B). U ovoj metodi postavljanja pravila odlučivanja određuje se apsolutni doprinos varijabli rezultatu za potencijalnu uspješnost. Ono što se određuje jest apsolutni doprinos svakog bazičnog kriterija i/ili nezavisne varijable i svakog izvedenoga kriterija rezultatu za potencijalnu uspješnost, tako da se svakoj elementarnoj i izvedenoj varijabli dodjeljuje ponder od 0 do 100. Kod računanja rezultata izvedenih kriterija, u obzir se uzimaju i ponderi koje su dodijelili eksperti. U ovoj metodi nema sumiranih težina. Ekspert daje nezavisne težine za svaki kriterij (testovi ili čvorovi). Dakle, zadržava se princip nezavisnosti u određivanju značajnosti na višim razinama modela uspješnosti. Ovom se metodom može individualno odrediti značajnost svake varijable. Na primjer, varijabla težine 95 ima izrazito veliku značajnost sa stajališta uspješnosti sportaša, dok je varijabla težine 15 praktički beznačajna.

Metode

Ispitanici

Uzorak se sastojao od 104 slovenska skijaška skakača iz seniorske kategorije, juniorskih kategorija od 17 do 18 i od 15 do 16 godina te tri kategorije dječaka, od 13 do 14, 11 do 12 te do 10 godina starosti, koji su testirani u listopadu 2000. godine, a nastupali su na slovenskim i međunarodnim natjecanjima u skijaškim skokovima u sezoni 1999./2000.

Postupak

Računalni program SMMS (*Sport Measurement Management System*) razvijen je na Fakultetu za sport u Ljubljani i korišten za računanje reducirane potencijalne uspješnosti. Korelacija između krajnjeg rezultata (RPPM) i natjecateljske uspješnosti (TU) utvrđena je Pearsonovim koeficijentom korelacije te, u slučaju nelinearnih varijabli, koeficijentom korelacije eta.

Rezultati

Korelacije između krajnjeg rezultata RPPM i kriterija uspješnosti u natjecateljskim kategorijama kreću se od niskih do srednje visokih. Testovi korelacije između modela A i natjecateljske uspješnosti pokazali su da su u nekim kategorijama (seniorska kategorija i kategorija dječaka dobi do 14 godina) modeli dosta visoko i čak statistički značajno korelirali sa stvarnom natjecateljskom uspješnošću, dok je u drugim kategorijama (juniorska u dobi do 18 i 16 godina) ta korelacija bila nešto niža. Korelacija između modela B i natjecateljske uspješnosti pokazala je statističku značajnost te korelacije samo za kategoriju dječaka do 14 godina.

Rasprava i zaključci

Korištenje metoda umjetne inteligencije ili, preciznije, ekspertnih sustava, označilo je novi smjer u sistemskom mišljenju pri traženju odgovora na osnovna pitanja iz teorije sportske uspješnosti. Kreiranje baze znanja je zapravo najvažnija faza u oblikovanju modela uspješnosti.

Oba modela mjere isti predmet te među njima nema značajnih razlika. Unatoč tome, metoda B obećava više jer omogućuje ekspertu da određenoj varijabli ili setu varijabli dodijeli ponder, težinu neovisno o drugim varijablama. Na taj način, ekspert određuje doprinos svake elementarne i/ili izvedene varijable krajnjem rezultatu (*score*), bez obzira na prethodnu odluku. Ubuduće, bilo bi uputno reorganizirati stablo modela uspješnosti tako da se osigura da varijable unaprijed ne koreliraju u smislu mjerenih sposobnosti, već da imaju nezavisnu ulogu u modelu uspješnosti.

Valjanost dimenzijske konfiguracije modela reducirane potencijalne uspješnosti u skijaškim skokovima različita je za različite kategorije. Jedan od razloga za to mogao bi biti mali broj ispitanika, pri čemu jako odstupanje već samo jednog ili dva natjecatelja može umanjiti krajnju korelaciju. No, rezultati pokazuju da postupak ekspertnog modeliranja u motoričkom i morfološkom području zaslužuje daljnji istraživački interes.