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THE DISCRIMINATION METHOD FOR THE TRANSFORMATION PROCESS OF RESULTS OF RESEARCH PROJECTS INTO PRACTICAL APPLICATIONS

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Abstract
The purpose of this paper is to discuss the usage of discrimination tools in R&D activities especially in Innovative Programme. Based on these tools, in this paper is drawn up a method for project evaluation and their analysis. A case study has been adopted based on projects realized by ITeE-PBI in Radom within the PW-004 Multi-Year Programme. The main obtained results are following: selection of innovation project characteristics, evaluation of rank of project characteristics, prediction of launch data for a innovative solutions, sensitivity analysis. The presented results indicate that this mathematical tools can be very useful for innovation project analysis.

Keywords
innovation project, Innovation Programme, Multi-year Programme PW-004, discrimination methods, prediction, sensitivity analysis.

Introduction

Over recent years innovation policy has risen to the fore. It is now well recognized that among other things competitiveness are dependent on industrial innovation. Government initiatives to support innovation have proliferated. These initiatives named here as a Innovation Programme take many forms supporting R&D units [1]. In Poland, the most popular form of Innovation Programme were Multi-year Programmes, in which the linear model of innovation was implemented.

Scientific units participated in such Innovation Programme usually ended its activity by making products or services with new or different characteristics without their commercialisation.

It means, that only part of innovation chain was realized in such programmes. Lack of realization such phases of chain as a product commercialization, market ready product and market entry[1] indicate to need construction of supporting tools.

These tools should support of science units activity to conversion obtained results into innovation (practical application). It means that adoption of such tools as Performance Measurement System (PMS) in science units is needed.

The most relevant questions that have been related to PMS of R&D are [3]:

- how to design a PMS that fits the characteristics of R&D activities,
- how the PMS should be implemented and which are the major effects of its use,
- how metrics and indicators should be related in an uncertain and unpredictable context like R&D.

The set of metrics and indicators may help to answer the following research question: which features of research project decided of its market success.

[1] According to [2].

Selecting proper dimensions of performance and operative indicators to be used in a PMS for R&D units is a challenging task because of the high level of uncertainty, the relevance of intangible factors, the complexity and the low standardization of R&D activities [3]. However, literature[2] has deeply investigated the problem and gives us several suggestions but only for R&D units of enterprises.

This paper is focused on the last above mentioned question[3]. For this purpose a discrimination method has been proposed. The application of the methodology based on discrimination methods is carried out in a leading Multi-years Programme PW-004.

Results of the empirical research consist of:

- evaluation of rank of project characteristics;
- prediction of date launch;
- making sensitivity analysis.

Last section concludes and outlines some directions for future research.

Innovation Programme PW-004

During 2004-2008 in Institute for Sustainable Technologies- National Research Institute (ITeE-PIB)[4] in Radom was realized the multi-year programme PW-004 entitled "*Development of innovative systems of manufacturing and maintenance 2004-2008*".

The Programme passed by the Council of Ministers on 21st April 2004, as an executory element of strategic governmental programmes for innovativeness development, was generated within the realization of the economy growth policy of the country presented in the programme document "*Enterprise-Development-Labour*" [7].

The Programme was focused on the development of new solution in strategic research fields, in which Poland has a scientific potential, including a laboratory base, technological infrastructure and the possibilities of international co-operation.

Projects realized during this Programme are concentrated on 5 areas such as[5]:

I. Research and test apparatus;
II. Mechatronic technologies and control systems;
III. Material technologies and nanotechnologies;
IV. Environmental technologies;
V. Technologies of environmental and technical safety.

Over 70 scientific units participated in realization of the PW-004 Programme and brought exceptionally extensive scientific and application achievements.

The effects of the Multi-Year Programme include 327 new solutions ready to be commercially implemented (59 of which have already been patented) among which are:

- 142 original devices (test apparatus mainly);
  - 111 production technologies;,
- 74 system solutions particularly for the support and automation of production processes.

Possibilities of practical application of developed products and technologies were verified in 60 model implementations in real maintenance conditions [8].

As a part of PW-004 programme a research task entitled "*Methodology of the transformation of results of scientific research into practical applications*" was also realized. One of among other effects was a quantitative effectiveness analysis by using discrimination tools. The analysis mainly concerns the effectiveness of research realization and the possibilities of their implementation [9].

The idea of the discrimination method

According to [10], discrimination methods require information about the form of projects completion. It was suggested that the effect of the implementation of the projects is expressed by time needed to implementation them.

In the set of projects were distinguished ones with results:

- already implemented or these which implementation is sure (success),
- having a chance for implementation within one year (partial success),
- having a chance for implementation within at least two years or without this chance (failure),

The above definition of implementation effects, allowed to divide populations of research projects into separate classes (groups) with the different degree of advancement of implementation potential.

Every project was considered as multidimensional object described by set of 37 chosen features. Each of them potentially affect the result of implementation.

[2]Some mentioned in [3].
[3]Many authors touched on this problem, for instance [4–6].
[4]Institute for Sustainable Technologies - National Research Institute is a state-owned research and development institution conducting basic and applied research as well as implementation in the field of advanced technologies related to machines manufacturing and maintenance, materials engineering, environmental protection and systems engineering.
[5]www.itee.radom.pl.

The usage of discrimination method depends on distributing the elements of a set of observation among K of classes (groups) so that every of them is characterized by a maximum homogeneity. The elements of these classes are known. In literature such set of observation is called as a learning set.

In the empirical research, the learning set contains historical data of 52 projects. Every i-th element (project) is described by vector $\mathbf{x}_{i.} = [x_{i1}, ..., x_{im}, ..., x_{iM}]$, where component x_{im} means the value of m-th feature of i-th project (i= 1,...,52; $m = 1, ..., 37$).

The distribution of population into classes were possible through defining effects of projects implementation. So, three classes of projects were distinguished ($K = 3$):

1. first class which contains 17 projects with results implemented or those which implementation is highly probable at the moment of the finalization of R&D works,

2. second class which contains 14 projects with results that have a chance to be implemented within one year,

3. third class which contains 21 projects with results that have a chances to be implemented within at least two years.

Using discrimination methods, some features of projects were selected according to following criteria: the most similarity of features of projects within groups and maximum differentiation of them for projects which belong to other groups.

So, selected features influence on project results implementation, are significant from statistical point of view and indicate the success or the failure of the final result. Finally, the main results of discrimination methods are following:

1. Selection of features which significantly influence on the level of advancement of the implementation;

2. Assessment of the importance of features;

3. Construction of classification functions, which enable to make a prediction of degree of advancement of implementation potential and to make a sensitivity analysis.

Assumptions of the analysis

Presented analysis utilizes the database filled by author. Both final reports of every research project and interviews with thematic area managers (from ITeE-PIB) were employed in data collection.

Every task was described by 82 features[6]. Among of them were both quantitative and qualitative characteristics of project[7]. The latter were expressed by binary variables what let the author realize their aggregation. Due to that fact, the number of variables was reduced to mentioned earlier 37 and used in further analyses. Additional, to identification of degree of advancement of results, so called grouping variable y was defined:

- $y = 0$ for the first group of task already implemented;
- $y = 1$ for the second group of tasks that have a chance to be implemented within one year;
- $y = 2$ for the third group of tasks that have a chance to be implemented within at least two years.

Results of the discrimination analysis[8]

As mentioned earlier, every project is described by 37 variables. The literature [13] suggests, that these variables can be classified at least into following major categories:

1. the financial performances of the project;
2. the project's value;
3. the technical performances of the project;
4. the efficiency of R&D activities of the project;
5. the capacity of fitting in the estimated cost and duration of activities;
6. the degree of integration between the R&D and production activities;
7. the degree of integration between the R&D and marketing activities.

By the discrimination analysis, x variables were selected, which significantly differ the projects located in different groups and differ not significantly in the same groups. These variables (see Table 2) influence on implementation time of projects results.

[6]For instance, Griffin and Page recognize that companies and academics use over 75 measures of success in product development [11].

[7]Literature has widely claimed the need to use a mix of quantitative and qualitative metrics in R&D. The former best suited to capture un-measurable aspects and the latter capable of reducing the subjectivity of the evaluation.

[8]For example [12], Chapter 14.

Table 1
Results of choice of **x** variables.

	level p	Tolerance	Meaning and possible values of variables
x0	0,1	0,670	The assessment of implementation maturity (SDW[9]): {1,...,10} where SDW=1 means that the essence of action was identified and described, SDW=10- means that the final product was checked with the possibility of producing them in the replication version.
x8	0,02	0,812	Result of the project as a new device or new material: 0 – no, 1 – yes
x29	0,001	0,685	Making an application for the goal project: 0 – lack of making, 1 – making, 2 – planned making.
x17_1	0,002	0,731	Projects sale value of the license during one year expected by thematic area managers: 0 – lack of predictions, 1 – existence of predictions.
x28	0,01	0,685	Making an application for a developmental research project: 0 – no, 1 – yes.
x15	0,05	0,674	Approximate market value established by thematic area managers / costs of the task
x19_1	0,01	0,648	Value of realized services during one year (predicted by thematic area managers): 0 – lack of predictions, 1 – existence of predictions.
x6	0,05	0,603	Cooperation in the project elaboration stage: 0 – lack of cooperation, 1 – cooperation with higher education institutions, 2 – cooperation with institutions of R&D or with companies.
x11	0,01	0,412	Result of project as a new technology of production : 0 – no, 1 – yes.
x12	0,004	0,393	Result of the project as a computer program: 0 – no, 1 – yes.
x5	0,04	0,667	Influence on the natural environment: 0 – without the influence, 1 – friendly for the environment or assuming the application of recycling.

Tolerance express the redundancy of variables, as a consequence of mutual doubling. The lower tolerance indicate variable which is unnecessary. *Level* $p < 0.1$ indicates the x significant variable.

Source: self study. Results of the STATISTICA.

Finally, 11 from among 37 of x significant variables are selected which influence on the time of the project results implementation[10]. The classification matrix, given in Table 2, prove the good quality of chosen x variables.

Table 2
Classification matrix.

	Percent	G_1:0	G_2:1	G_3:2
G_1:0	94,12	16	0	1
G_2:1	64,29	1	9	4
G_3:2	80,95	0	4	17
Overall	80,77	17	13	22

G_1:0 – the first group of projects with $y = 0$,
G_2:1 – the second group of projects with $y = 1$,
G_3:2 – the third group of projects with y=2.
Source: self study. Results of the STATISTICA.

This classification matrix indicate, that:

- from among 17 projects on the first group ($y = 0$), x variables correctly classify 16 projects, what means 94.12 % of the classification effectiveness (the row G_1:0);
- from among 14 projects on the second group ($y = 1$), 9 of them is correctly classified, what means 64.29 % of the classification effectiveness (the row G_ 2:1);
- from among 21 projects on the third group, only 4 of them is classified incorrectly, what indicates 80.95 % of classification effectiveness (the row G_ 3:2);
- Average of classification effectiveness is high and equals 80.77% (the last row).

So that, selected x variables, given in the Table 1, relatively well identify (recognize) effects of the projects results implementation. These variables represent features of the projects which significantly influence on implementation time.

In the next step of analysis, two essential canonical variables U1 and U2 were received. They are linear combinations of x variables and diversify tasks to groups (Table 3). The first canonical variable U1 diversifies in 66% (cumulative probability), whereas the second variable U2 in 34% (cumulative probability – 66%). It means that in further analysis it should be taken both these variables. In another words, 11 of x variables given in the Table 1, can be replaced in analyses by two canonical variables.

[10]Criteria of variables selection: *level* p< 0.1 with high value of *Tolerance*.

Table 3
Standardized coefficients for canonical variables.

	U1	U2
x0	−0.38	0.38
x8	−0.47	−0.42
x29	0.82	−0.04
x17_1	0.17	0.86
x28	−0.61	0.35
x15	0.46	−0.43
x19_1	−0.70	−0.23
x6	−0.45	−0.49
x11	0.91	−0.31
x12	0.85	−0.59
x5	0.39	−0.52
Eigenvalues	1.71	0.87
Cumulative probability	0.66	1.00

Source: self study. Results of the STATISTICA.

On the basis of results presented in table 3, it was derived the following form of canonical variables U1 and U2:

$$\begin{aligned} U1 = &-0.38 \cdot \dot{x}0 - 0.47 \cdot \dot{x}8 + 0.82 \cdot \dot{x}29 \\ &+ 0.17 \cdot \dot{x}17\_1 - 0.61 \cdot \dot{x}28 + 0.46 \cdot \dot{x}15 \\ &- 0.70 \cdot \dot{x}19\_1 - 0.45 \cdot \dot{x}6 + 0.91 \cdot \dot{x}11 \\ &+ 0.85 \cdot \dot{x}12 + 0.39 \cdot \dot{x}5 \end{aligned} \tag{1}$$

$$\begin{aligned} U2 = &\,0.38 \cdot \dot{x}0 - 0.42 \cdot \dot{x}8 - 0.04 \cdot \dot{x}29 \\ &+ 0.86 \cdot \dot{x}17\_1 + 0.35 \cdot \dot{x}28 - 0.43 \cdot \dot{x}15 \\ &- 0.23 \cdot \dot{x}19\_1 - 0.49 \cdot \dot{x}6 - 0.31 \cdot \dot{x}11 \\ &- 0.59 \cdot \dot{x}12 - 0.52 \cdot \dot{x}5 \end{aligned} \tag{2}$$

where $\dot{x}$ means the standardized x variable. Coefficients value in (1)–(2) indicate rank of x variables in project classification process.

Additional, average values of above variables were calculated for each group (Table 4).

Table 4
Average values of canonical variables (so-called Centroidy group) in individual groups.

	U1	U2
G_1:0	−1.66	−0.54
G_2:1	0.01	1.49
G_3:2	1.33	−0.55

Source: self study. Results of the STATISTICA.

Significant difference between average values of the variable U1 in groups G_1:0 and G_ 3:2 (1.33-(-1,66)) indicates that this variable can diversify projects to group of projects already implemented (G_ 1:0) and to group of projects with the implementation time at least 2 years (G_ 3:2). However, taking into account average values of the variable U2 in group G_2:1 (1,49), notice that the second variable can fulfill the variable U1, distinguishing projects with the implementation time within one year. The confirmation of this fact is graph 1 of objects (projects) in the space of canonical variables. This graph presents groups of objects in the space of the variables U1 and U2.

The main conclusions from this graph are following:

- x variables with positive coefficients of the first canonical variable U1 (Table 3, column first) represents these features, which may increase the time of implementation ("moving" from the group G_1:0 towards groups G_2:1 and G_3:2).
- x variables with positive coefficients of the second canonical variable U2 (Table 3, column second) represents these features, which "move" projects to group G_2:1, with the implementation time within one year.

It is necessary to consider interpretation of the influence of x variables simultaneously in the context first as well as of the second canonical variable.

According to above consideration, the following kind of conclusions are possible to obtain: simultaneous appearance of features represented by x11 and x5 variables (positive values of coefficients of U1 and negative value of U2 respectively) can increase the time of implementation to at least 2 years (direction to the group G_3:2). On similar principles, other conclusions about the influence of individual x variables on the time of implementation might be formulated.

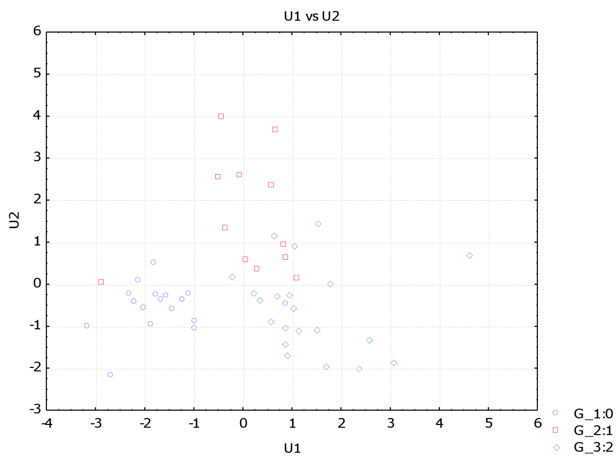

Fig. 1. Research projects in canonical variable space. Source: self study. Results of the STATISTICA.

The next result of discrimination method is a importance (rank) of x variables. It may be described on the basis of so called structural matrix (see Table 5), which contains values of correlation coefficients between individual x variables and canonical variables. For instance, r_{11} means correlation coefficient between the x0 variable and the first canonical variable U1 and equals – 0.37, whereas $r_{21} = 0.01$ means correlation coefficient between the x0 variable and the second canonical variable U2. The highest and the smallest (in the absolute value sense) values of correlation coefficients are marked with bold font.

Table 5
Structural matrix of r_{ij}.

	r_{ij}	U1 ($i = 1$)	U2 ($i = 2$)
x0	r_{i1}	**−0.37**	**0.01**
x8	r_{i2}	−0.21	**−0.38**
x29	r_{i3}	0.29	−0.06
x17_1	r_{i4}	0.10	0.37
x28	r_{i5}	−0.03	0.28
x15	r_{i6}	0.14	−0.12
x19_1	r_{i7}	−0.19	−0.15
x6	r_{i8}	−0.21	−0.16
x11	r_{i9}	0.19	0.27
x12	r_{i10}	**−0.03**	−0.31
x5	r_{i11}	0.11	−0.29

Source: self study. Results of the STATISTICA.

Based on values of correlation coefficients it is possible to determine:

- The importance of every variable x on account of the first canonical variable, i. e. distinguishing implemented projects (G_1:0) from other (G_2:1 and G_3:2);
- The importance of every variable on account of the second canonical variable , i. e. distinguishing projects with the 1 year implementation time (G_2:1) from other (G_1:0 and G_3:2);
- average importance on account of both canonical variables.

The importance of j-th variable on account of the first canonical variable was calculated using the following formula:

$$w_{1j} = \frac{|r_{1j}|}{|r_{11}|}, \tag{3}$$

where

$$r_{11} = \max\{|r_{1j}| : j = 1, ..., 11\} = |-0.37| .$$

The importance of j-th variable on account of the second canonical variable was calculated using the following formula:

$$w_{2j} = \frac{|r_{2j}|}{|r_{22}|}, \tag{4}$$

where

$$r_{22} = \max\{|r_{2j}| : j = 1, ..., 11\} = |-0.38| .$$

Average importance was calculated as a weighted average:

$$\overline{w}_j = \lambda_1 \cdot w_{1j} + \lambda_2 \cdot w_{2j}, \tag{5}$$

where weight λ_i means the percent in which the i-th canonical variable explains the changing of variables x[11].

Such obtained importance are presented in Table 6. For instance, the x8 variable has the highest importance equals 70.83% and so the strongest influence on changing of U1 and U2[12].

Table 6
The importance of x variables.

	w_{1j}	w_{2j}	$\overline{w}_j$
X0	100.00%	2.77%	67.34%
X8	56.07%	100.00%	70.83%
X29	78.52%	16.87%	57.81%
x17_1	28.11%	97.93%	51.57%
X28	8.93%	74.93%	31.10%
X15	37.28%	32.59%	35.70%
x19_1	50.15%	40.61%	46.94%
X6	55.89%	42.12%	51.26%
X11	51.66%	71.13%	58.20%
X12	8.25%	83.10%	33.39%
X5	29.19%	76.45%	45.07%

Source: self study. Results of the STATISTICA.

Prediction of implementation time

Prediction of the implementation time is possible by usage so-called classification functions which are linear combinations of x variables. These functions indicate one of three above mentioned groups to which the project should be classified[13].

The number of functions is the same as the number of groups[14]. Values of coefficients of classification functions are shown in Table 7.

[11] On the basis of Table 3 (the last row) $\lambda_1 = 0.66$, $\lambda_2 = 0.34$.

[12] In literature, usually the importance of each characteristic is obtained by doing pairwise comparisons in opposition to presented here proposition. See for instance [14].

[13] – first group includes projects with the sure implementation,
– second group includes projects with implementation within 1 year,
– third group includes projects with implementation during at least 2 years.

[14] In our case 3.

Table 7
Values of coefficients of classification functions.

	G_1:0	G_2:1	G_3:2
x0	2.94	3.02	2.25
x8	8.91	4.68	5.29
x29	−1.44	0.73	2.67
x17_1	−3.72	2.90	−2.06
x28	2.72	2.18	−0.47
x15	2.31	2.15	4.27
x19_1	1.36	−3.161	−4.45
x6	0.45	−1.39	−0.96
x11	6.00	7.85	11.64
x12	2.87	3.32	8.22
x5	3.90	3.09	6.32
Constant	−19.13	−15.64	−16.82

Source: self study. Results of the STATISTICA.

Therefore we have:

– classification function dealing with the first group:

$$f_1 = 2.94 \cdot x0 + 8.91 \cdot x8 - 1.44 \cdot x29 - 3.72 \cdot x17\_1 + 2.72 \cdot x28 + 2.31 \cdot x15 + 1.36 \cdot x19\_1 + 0.45 \cdot x6 + 6,00 \cdot x11 + 2.87 \cdot x12 + 3.90 \cdot x5 - 19.13, \tag{6}$$

– classification function dealing with the second group:

$$f_2 = 3.02 \cdot x0 + 4.68 \cdot x8 + 0.73 \cdot x29 + 2.90 \cdot x17\_1 + 2.18 \cdot x28 + 2.15 \cdot x15 - 3.16 \cdot x19\_1 - 1.39 \cdot x6 + 7.85 \cdot x11 + 3.32 \cdot x12 + 3.09 \cdot x5 - 15.64, \tag{7}$$

– classification function dealing with the third group:

$$f_3 = 2.25 \cdot x0 + 5.29 \cdot x8 + 2.69 \cdot x29 - 2.06 \cdot x17\_1 - 0.47 \cdot x28 + 4.27 \cdot x15 - 4.45 \cdot x19\_1 - 0.96 \cdot x6 + 11.64 \cdot x11 + 8.22 \cdot x12 + 6.32 \cdot x5 - 16.82. \tag{8}$$

The algorithm of prediction which use above functions may be realized according to the following stages:

Stage 1: to calculate value of every classification function (6)–(8) by inserting appropriate x values that characterize new project;

Stage 2: the function with the greatest value indicate the group, into which project should be classified.

The example of the prediction is presented below.

The example of the prediction

A few projects were excluded from presented here discrimination analysis because of the lack of information about their degree of the implementation maturity (x0). One of these projects was selected to implementation time prediction. Characteristics of this one shows Table 8.

Table 8
Characteristics of the project.

	Engineering production of components of fuels of waste exploitation liquids and plastics	Values of variables
X0	The assessment of implementation maturity (SDW)	Lack of information
X8	Result of the project as a new device or new material	1 – yes
x29	Making an application for the goal project	0 – no
x17_1	Projects sale value of the license during one year expected by thematic area managers	0 – lack of expectations
x28	Making an application for a developmental research project	0 – no
x15	Approximate market value established by thematic area managers / costs of the task	0
x19_1	Value of realized services during one year	0 – lack of expectations
x6	Cooperation in the project elaboration stage	2 – companies
x11	Result of project as a new technology of production	1 – yes
x12	Result of the project as a computer program	0 – no
x5	Influence on the natural environment	1 – friendly for the environment or assuming applying the recycling

Source: self study.

For the above values of x variables and for different value of x0 three classification functions were calculated.

When x0 equals 1, ..., 5, then the third classification function has the greatest value, whereas when x0 equals 6, ..., 10, then the first function has the greatest value.

Table 9 summarizes the obtained results of prediction process. We can conclude that the predicted implementation time changing from two years to the immediate implementation with the changing of x0 from 5 to 6.

Table 9
Prediction of implementation time for different value of SDW.

SDW (x0)	1	2	3	4	5	6	7	8	9	10
Time of implementation (in years)	2	2	2	2	2	0	0	0	0	0

Source: self study.

Sensitivity analysis

In Table 2, the set of variables was given, which significantly influence on the implementation time of the projects results. Among of them are variables, which changing after the completion of the project isn't possible (for instance x6) and variables which changing is possible only after the project completion. The latter group of variables is presented in Table 10.

Table 10
Variables with possibility of change after the completion of the project realization.

Variables	Interpretation of the variables
x0	The assessment of implementation maturity (SDW)
x29	Making an application for the goal project
x17_1	Sale value of the license
x28	Making an application for a developmental research project
x15	(approximate market value) / (costs)
x19_1	Value of projects of realized services during one year

Source: self study.

For instance, the x0 variable determining degree of the commercial maturity may be changed during additional works realized after the completion of the project. The main goal of sensitivity analysis is shown what change of these variables make change of implementation time.

Sensitivity analysis can be realized by using classification functions according to following algorithm:
1. To choose the project to analyses.
2. To calculate the value of all three classification functions for analyzed project.

   The classification function having the greatest value indicates the group, to which project should be classified.
3. To change the value of the some x variables chosen from table 10 in classification functions and check, according to the rule given in point 3, how it will influence on the time of project implementation.

Results achieved in the point 4 of above algorithm can suggest, what actions[15] should be taken after the completion of the project, in order to increase the certainty (or speed up) of their implementation.

Example of the sensitivity analysis

Sensitivity analysis was made for the project with characteristics shown in Table 6. This analysis relies on examining how an implementation time will be changed as a result of changes of the variables value chosen from Table 10. The sensitivity analysis was made for two levels of SDW: 5 and 6. These results are presented in Table 11. The current state of the analyzed project is distinguished by bold font.

The main conclusion of sensitivity analysis in the case of SDW = 6 (see Table 10, column 4) are following:
- decision related to realization of more further works relying on the making an application for the goal project (x29) can increase the implementation the time to at least 2 years.
- decision related to realization of more further works relying on the making an application for a developmental research project (x28) should not influence on the time of implementation;
- increment in the ratio market value per unit of project costs (x15) over 10% can influence on increment in the implementation time.

Table 11
Results of the sensitivity analysis.

Changed factor	Current (bold font) and possible values of the variable	Forecast of the implementation time at SDW = 5 (x0 = 5) (in years)	Forecast of the implementation time at SDW = 6 (x0 = 6) (in years)
1	**2**	**3**	**4**
X29 – Making an application for the goal project	**0 – no**	**2**	**0**
	1 – making	2	2
	2 – planned making	2	2
X28 – Making an application for a developmental research project	**0 – no**	**2**	**0**
	1- making	0	0
X15 – (approximate market value)/(costs)	**0**	**2**	**0**
	10%	2	0
	20%	2	2

Source: self study.

[15]Represented by x variables from Table 10.

Conclusion

Realization of product, technology or service innovation projects is sometimes connected with problems of implementation their results for practical applications. In the case of Poland that kind of problems may be arisen during execution of long-term Innovation Programme. Polish typical Innovation Programme is considered here programme PW-004. Similar problems exist in the situation of other types of research and generally deal with the building a analytical decision support tools with multi-criteria selection projects in enterprises with R&D activities [15].

The purpose of the present paper was description of quantitative tool which usage may answer the following question: what should be done to the implementation results of project with the success?

Discrimination methods were proposed as a tools of multidimensional statistics. These methods assume the existence of objects (here projects) described by many characteristics. Additional, discrimination method allows to make evaluation based on both quantitative and qualitative criteria[16]. The main goal of usage of these method is selection such characteristics, which in the best way, identify kind of project success.

In this article were obtained answer following research questions:

- What appropriate features of project should be selected to supporting decision about practical applications of this results?
- Which from these features are the most important?
- What would happen with the implementation when we change the conditions of the realization of projects?
- Will realized project finish with the transformation of their results into practical applications?

A reason of usage of discriminatory methods is their exceptional effectiveness in the case of the forecasting bankruptcy of enterprises by well known Altman model [16] and [17]. In their case the objects are enterprises described by many financial ratio and their division into groups is determined by degree of bankruptcy risk.

Therefore, it seemed natural that in case of the innovation projects, analogical approach is most recommended. Whether effective? It would be subject of future analysis based on projects realized later within Programme PW-004.

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