RISK-SENSITIVE INVESTMENT PROJECT PLANNING, IN A SELECTED MANUFACTURING COMPANY

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Introduction/background: The research problem undertaken in the publication was the selection of appropriate risk assessment methods and tools that can be applied in the planning of investment projects in a company that is the largest producer of secondary aluminium casting alloys in Central Europe. Due to the identified need, it was assumed that the results of the application of these methods and tools should support rational decision-making on the implementation of strategic investment projects.
Aim of the paper: The research presented in the publication was aimed at developing a risk-sensitive investment project planning procedure geared towards rational strategic decision-making, tailored to the specific characteristics of the company in question.
Materials and methods: The research involved free-form interviews, a literature study, a case study and a review of company records.
Results and conclusions: The result of the research was to accurately identify the needs of the company, the competences of its employees and the essence of risk assessment methods and tools, and to select and incorporate them appropriately in the investment project planning procedure developed.

Keywords: investment projects, risk assessment, rational decisions.

1. Introduction

Investment projects are inevitably accompanied by risks, the effects of which may affect the effectiveness of their implementation. For this reason, it is extremely important to carry out risk considerations - in the planning process - before deciding to implement such projects. There is a rich body of research in the literature in this area, describing good practices and solutions, including but not limited to many risk management methods and tools that can be applied to investment project planning. However, the multiplicity of methods and tools proposed makes it difficult to identify which are the best in relation to the realities of a particular enterprise. This implies the need for their rational selection for application in practice (Łada, Kozarkiewicz,

2010, p. 177; Brzozowski, 2014, p. 14). The basis for this selection should be a thorough recognition of the needs of the enterprise, the competencies of the employees, as well as the essence of the methods and tools themselves (Tyrańska, 2018, pp. 115-116; Antoszkiewicz, 2007, pp. 17-18). Only such recognition implies a rational selection of methods and tools to the specifics of the enterprise, and then to the development of a procedure for their application in practice.

This publication presents the results of a study aimed at developing such a procedure, which was carried out for a multi-site manufacturing company operating in Poland, which is the largest producer of secondary aluminium casting alloys in Central Europe. This enterprise carries out a number of investment projects, the planning of which is carried out on the basis of a specific procedure in which methods and tools for assessing the economic efficiency of projects and risk management are applied. However, the results of applying these methods and tools are not sufficient when it comes to assessing the risks of projects of a strategic nature, which tend to be capital-intensive. This makes it difficult to make decisions about the implementation of these projects. For this reason, the *research problem* has become the selection of appropriate risk assessment methods and tools, the results of which can provide criteria for making decisions on the implementation of strategic investment projects. The *main objective of the research* was to develop a procedure for planning investment projects taking into account risk, adapted to this specificity of this company, aimed at making rational strategic decisions.

2. Scope of research and research methods

In order to solve the formulated research problem and achieve the objective, the scope of the research comprised two stages in which several methods were used.

In stage I, an analysis of the research problem was carried out, aimed at identifying:

- needs for which risk assessment methods and tools are to be used, taking into account the possibility of using those already known and applied within the company,
- the competence (knowledge and experience) of those who will use risk assessment methods and tools within the company,
- selected risk assessment methods and tools that meet specific needs and are tailored to the competences of those using them.

The research methods used in this phase included free-form interviews with company executives and employees, a review of documentation used in the company's investment project planning process and a literature study.

In stage II of the research, the results obtained from the analysis of the research problem carried out in stage I were synthesised. The result was the development of a procedure for planning investment projects taking into account risk, adapted to the specific characteristics of this company. To verify this procedure, a case study was conducted to assess its usefulness in the practice of strategic investment project planning and decision making.

3. Results

3.1. Results of stage I of the research

In order to identify the needs to be met by appropriate risk assessment methods and tools, as well as the competences of the employees who will use them, free-form interviews were conducted with managers and employees[1], involved in the company's investment project planning process. A review of the company's documentation was also carried out[2]. On this basis, it was determined, among other things, how the investment project planning process takes place in the company, who is involved, what documents are prepared and what information is used as a basis for decision-making (Figure 1).

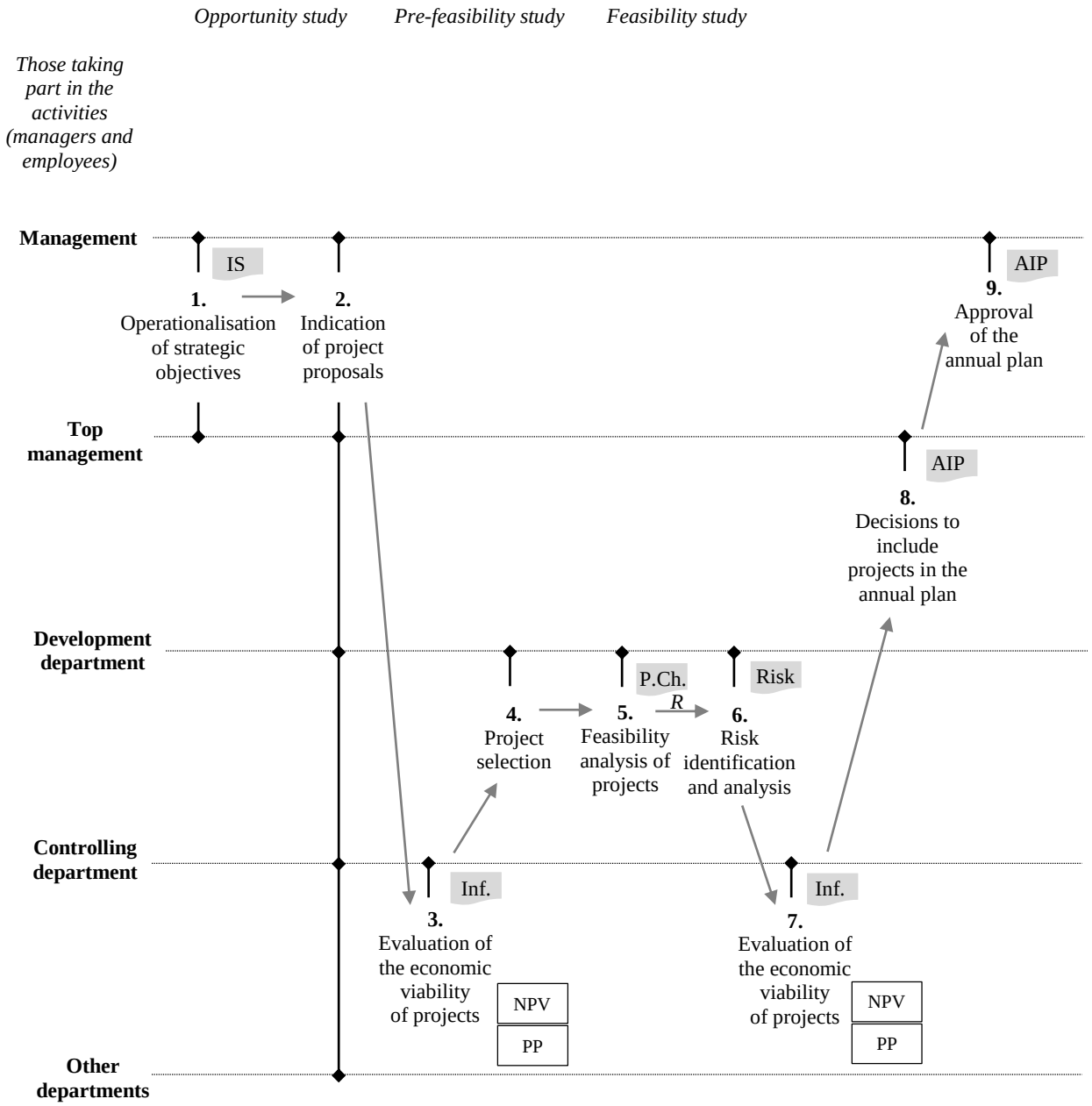
The basis of the company's investment project planning process is the 'Investment Strategy', which is developed by the Board of Directors and the management of its plants. In this process, first of all, the 'Investment Strategy' is operationalised, i.e. the definition of the objectives to be achieved in the coming year. Then, as part of an opportunity study, strategic projects are proposed, the implementation of which should influence the achievement of these objectives, as well as adaptation and ongoing projects that arise from the identified needs of the company. These projects are divided by importance and by size (Table 1).

Subsequently, a pre-feasibility study is carried out to pre-select the proposed investment projects. Since the overriding objective of the 'Investment Strategy' is to maximise the value of the company, the pre-selection is carried out on the basis of an assessment of the economic efficiency of the projects, which is carried out by the staff of the controlling department. In particular, for so-called current and small projects, the evaluation of economic efficiency is carried out on the basis of the payback period (PP) method by simply relating the investment expenditure to the expected annual revenue. By contrast, for all other projects, and obligatorily for strategic and large (capital-intensive) projects, the evaluation of economic efficiency is carried out on the basis of the net present value (NPV) method, taking into account all updated receipts and expenditures. Based on the results of the assessment, those projects are rejected for which:

- PP is greater than the depreciation period of the associated basic fixed assets,
- NPV is less than zero, unless they are adaptation projects, necessary for implementation.

The remaining proposed projects are further analysed, as part of a feasibility study. In particular, an "Investment Project Charter" document is prepared for each project (Table 2).

[1] Development director, managers and staff of development, controlling, operational, quality departments.
[2] "Investment process charter", "Investment project charter", "Investment project risk management charter", "Annual Investment Plan".



Identification:

Documentation:

- IS — Investment strategy
- Inf. — Information on the results
- P.Ch — Investment project charter
- Risk — Risk management charter
- AIP — Annual Investment Plan

Method:

- NPV — Net present value
- PP — Payback period

R: Recommendations

Figure 1. The current course of the investment project planning process in the surveyed company

Source: Own study based on interviews and company documentation.

Table 1.
Breakdown of investment projects in the company

Breakdown criterion	INVESTMENT PROJECTS
Importance of projects	**STRATEGIC** proposed by the Board of Directors and the company's top management, resulting from the adopted investment strategy, i.e. the assumed increase in sales of products, increase in profitability, improvement of product quality, the desire to conquer new markets or the possibility of using new input materials, e.g. the construction of new process lines, the construction of new plants, the modernisation of existing plants.
	ADAPTIVE proposed by the Board of Directors and the company's top management, resulting from the need to comply with changing legal requirements, i.e. environmental legislation, by reducing gas and dust emissions, reducing waste generation and improving efficiency.
	CURRENT proposed by employees and their direct managers, resulting from the current needs to replace (rebuild) worn-out machinery and equipment, in particular through the purchase of new machinery or the transfer of used machinery from another plant (possible modernisation) and their subsequent installation, as well as those resulting from so-called 'bottom-up' initiatives aimed at solving current problems, e.g. the use of machinery known to the company to melt scrap grades with different characteristics.
Size of projects	**SMALL** requiring financing for investment expenditure < PLN 100 000
	AVERAGE requiring financing for investment expenditure > 100 000 PLN < 500 000 PLN
	LARGE requiring financing for investment expenditure > PLN 500 000

Source: Own study based on interviews and company documentation.

"Charters..." are prepared by the development department staff, on the basis of feasibility studies (technical, legal, financial, time, efficiency), which are carried out by interdisciplinary teams consisting of managers and staff from departments appropriate to the specifics of the projects (e.g. consisting of the Plant Manager and staff from the development, operations, controlling, quality departments).

Then, once the 'Charters ...' have been developed for all the proposed projects, based on the more detailed information contained therein:

- Controlling staff reassess the economic viability of the proposed projects, using the same methods as in the pre-feasibility study (PP, NPV);
- Development staff for each project produce a document entitled 'Investment project risk management charter' (Table 3).

In summary, the outcome of the feasibility study is the preparation for each project:

- "Investment project charter";
- information on the results of the economic viability assessment (PP or NPV),
- "Investment project risk management charters".

On this basis, top management decides whether to reject individual projects or to include them in the 'Annual Investment Plan', which is approved by the company's Board of Directors.

Table 2.
"Investment project charter" - template and example

Name of the project	… E.g. Modernisation of Plant X	
Project location	… E.g. Plant X, production hall	
Scope of the project	… E.g. Stage 1. Dismantling of equipment to be decommissioned; Stage 2. reconstruction of the technological system - assembly and start-up of production on new production equipment.	
Project deadlines	… E.g. Phase 1. 1-9.III.2023; Phase 2. 10.IV - 28.V.2023	
Project feasibility study	Risks/weaknesses	Opportunities/strengths
Technical feasibility	… E.g. The implementation of the project on the shop floor, while production activities are taking place, may affect its disruption, breakdowns, accidents or the creation of defects in products.	… E.g. The technological layout allows the dismantling of equipment to be decommissioned without interrupting production on the remaining equipment.
Legal enforceability	… E.g. ▪ Building Permit required; ▪ Water Law Permit required; ▪ Required adaptation of the Plant to the new BAT Conclusions for the non-ferrous metals industry.	… E.g. ▪ The projected technological layout is well recognised; ▪ The proposed technology is not associated with the generation of hazardous industrial wastewater.
Financial feasibility	… E.g. ▪ Disruption to the supply of production equipment in the event of payment bottlenecks; ▪ Variable loan rates - upside risk	… E.g. ▪ Financed with 60% of the company's own funds at its disposal; ▪ The interest on the bank loan will reduce the tax base.
Time feasibility	… E.g. Delays in obtaining the required permits.	… E.g. Employ a company with the capacity to make up for any delays.
Performance feasibility	… E.g. In case of failure, possible loss of production of up to 50 t/day.	… E.g. The capacity of the new line will allow production ahead of schedule.
Recommendation:	… E.g. Project eligible.	
Date of analysis ...	**Compiled by the team** …	

Source: Own study based on company documentation.

Table 3.
"Investment project risk management charter" - template and example

Context (internal/external)	**Risk identification**	**Risk analysis**		**Risk response**
		Effect of occurrence	**Probability of occurrence**	
...	...	...	...	...
E.g.				
Technical infrastructure of the project	Lack of appropriate tools and equipment to carry out certain installation work	Investment project delays; Failure to keep to the project budget	Small, <0.2	Securing the possible rental of tools and equipment

Source: Own study based on company documentation.

In the course of the interviews, the top management emphasised that the way in which investment projects are planned in the company is adequate, in particular for investment projects defined as current and small and adaptation projects. However, for strategic and large projects, the information obtained about their risks is insufficient. It was highlighted that this poses a problem and causes difficulty in deciding whether to include projects in the 'Annual Investment Plan'. In particular, it was pointed out that the most important criterion for the selection of strategic projects for this plan is their positive impact on the growth of the company's value. This means that projects with the highest NPV level are included, but without including information on what the risk of not achieving this level is and what it is due to (what are the main factors of this risk and how they affect the NPV). Meanwhile, such information is very important and should be taken into account in decisions. In addition, executives also pointed out that making rational decisions on the implementation of strategic investment projects would be greatly facilitated by the definition of uniform standards, based on a criterion combining the results of assessing economic efficiency and the risk of not achieving them.

In summary, with regard to the identification of the need, the research found that it concerns supplementing the company's existing approach to planning strategic investment projects with methods and tools aimed at:

- identifying risk factors that have a significant impact on their economic efficiency and indicating this impact,
- assessing the risk of not achieving economic results,
- supporting decision-making on the basis of a criterion combining the results of the economic efficiency evaluation and the risk of not achieving them.

It should be emphasised, the NPV method is used in the planning of investment projects in the company, and the people who apply it are competent. It is well known and understood by:

- controlling staff, who assess the economic viability of projects with it,
- management, who decide on the basis of this to include projects in the 'Annual Investment Plan'.

Therefore, in the selection of methods and tools to meet the identified need, it was assumed that those based on NPV should be included.

In the next step of the stage I of the research, a literature study was conducted. It was oriented towards the identification of methods and tools that would meet a specific need and be adapted to the competences of those using them. Thus, with regard to:

- identification of significant risk factors and an indication of their impact on the economic viability of the project, it was concluded that the use of methods and tools could be considered:
  - ✓ inventive (creative thinking) methods, especially brainstorming, the Delphi method or the analysis of historical event data (their results can be collated in a so-called risk checklist), which allow risk factors to be identified (Kumpiałowska, 2011, p. 51; Borkowski, 2008, pp. 47-49; Liu, Low, 2009, pp. 170-186; Santanen et al., 2004, pp. 167-198; Pritchard, 2002, pp. 89-96; 109-115; 117-123),
  - ✓ quantitative, notably sensitivity, scenario or correlation analysis, which make it possible to indicate the impact of risk factors on NPV (Cabala, 2001, pp. 149-159; Bijańska, Wodarski, 2014, pp. 61; Sierpińska, Jachna, 2007,pp. 512, 516; Bijańska, 2015, pp. 45-46),
- assess the risk of not achieving the economic effects of projects measured by NPV, it has been found that the use of quantitative methods can be considered, especially the probabilistic-statistical method or Monte Carlo simulation (Sobczyk, 2010, pp. 44-62; Borkowski, 2008, pp. 128-129; Wiśniewski, 2013, pp. 65-80; Pawlak, 2012, pp. 83-94; Marcinek et al., 2010, pp. 53-138; Sierpińska, Jachna, 2007, pp. 512-513, 516-518; Sierpińska, Jachna, 2004, pp. 394-401; Zarzecki, 2002, p. 257; Zachorowska, 2006, pp. 74-76, 90-98; Bijańska, Wodarski, 2014, pp. 276-278; Bijańska, 2019, pp. 157-158; 165-176; 177-189),
- support decision-making on the basis of a criterion combining the results of the evaluation of economic efficiency and the risk of not achieving them, the use of quantitative tools can be considered, especially standards based on the results of probabilistic-statistical methods or Monte Carlo simulations (Bijańska, Wodarski, 2014, p. 62).

For the selection of the appropriate ones, their essence was first presented to the top management. Then, taking into account the concept of methodological pluralism and the principle of triangulation[3] (Stępień, 2016, pp. 48-62; Stańczyk, 2011, p. 78), it was decided that to:

- identify risk factors that have a significant impact on NPV and brainstorming, sensitivity analysis, scenario analysis methods will be used to indicate this impact,
- assess the risk of not achieving economic outcomes as measured by NPV, a probabilistic-statistical method will be used,

[3] Methodological pluralism implies a willingness to use methods and tools derived from different disciplines, with the criteria for their selection being relevance, simplicity, precision. The principle of triangulation boils down to the need to use more methods and tools and to combine quantitative and qualitative methods and tools.

- support decision making a standards tool based on the results of a probabilistic-statistical method will be used, relevant to the realities of the company.

3.2. Results of the stage II of the research

The synthesis of the results obtained from the analysis of the research problem allowed a new procedure to be developed for the company to plan investment projects taking into account risk. The procedure adopted changes to the feasibility study relating to strategic and large-scale projects for which additional analyses and calculations are required. These changes are highlighted in bold (Figure 2).

In the existing way of project planning, after feasibility studies, economic viability assessment and risk identification and analysis, the proposed projects must be divided into two groups. The first should include adaptation and ongoing projects for which no additional analysis and calculations need to be carried out, and the second group should include strategic projects that require it.

It was assumed that, as a first step, a brainstorming exercise should be carried out for each strategic project (in an interdisciplinary, appropriately selected team that participated in the previous analyses), aimed at identifying the risk factors that have a significant impact on the NPV level. The basis for the identification of these factors should be the 'Investment Project Risk Management Charter' and the assumptions made to assess its economic viability using the NPV method. It is important that the factors are measurable, as their level should be indicated, which will be the basis for the NPV sensitivity analysis. The result of this analysis should be knowledge of the impact of specific changes in the level of a given risk factor on the economic efficiency of the project.

As a second step, a scenario analysis should be carried out, the essence of which is to examine the impact of simultaneous changes (relative to the assumptions used to assess the economic viability of the project using the NPV method, defining the baseline scenario) in all risk factors on the NPV of the project. The procedure assumes that these will be changes defined in two additional scenarios (optimistic and pessimistic), which should be adopted arbitrarily by the company's top management or their designated persons with the relevant competences.

A probabilistic-statistical method should then be used, based on probability calculus and statistical measures, and in particular on:

- the expected net present value μNPV, which provides information on the average economic effect of the project after taking into account all the scenarios of its implementation and the probability of their occurrence,
- the standard deviation of the net present value σNPV, which presents information about the risk of not achieving the economic result of the project.

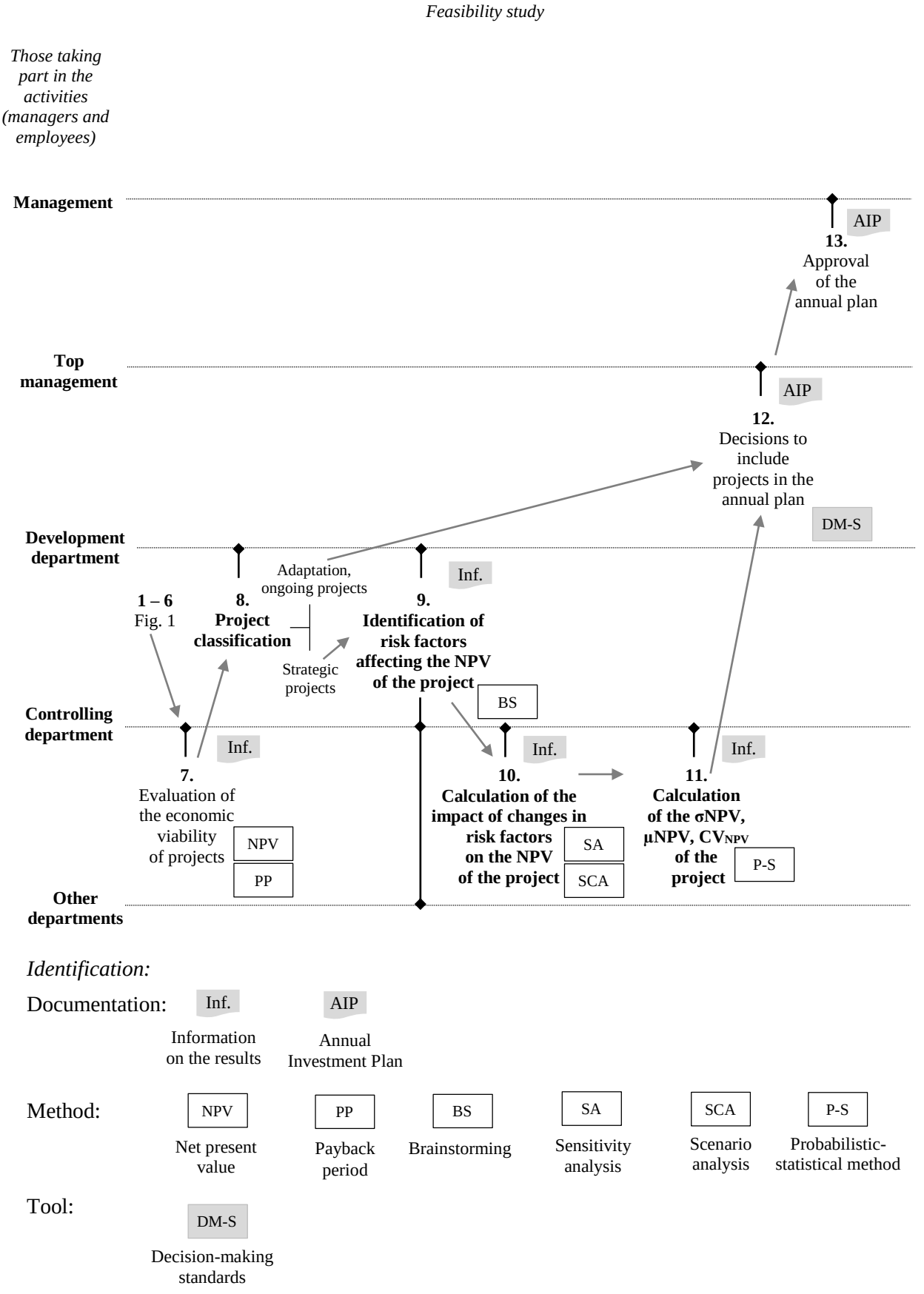


Figure 2. Investment project planning procedure, taking into account methods and tool for risk assessment and strategic investment decision-making. Own study taking into account interviews and company documentation.

The basis for calculating the statistical measures indicated is the results of the scenario analysis, in particular the values of the project's net cash flows in the baseline, optimistic and pessimistic scenarios. For these, the probability of occurrence should be determined and then the expected net cash flows of the project should be calculated according to the formula:

$$E_{tj}=D_{tj}\cdot P_{tj}, \tag{1}$$

where:

E_{tj} – i-th level of expected net cash flows at time unit t = 1, ..., n,

D_{tj} – i-th level of net cash flow in time unit t = 1, 2, …, n,

P_{tj} - probability of occurrence of i - this level of D_t.

Subsequently, the expected value of the net cash flows for each unit of time should be determined according to the formula:

$$E_t=\sum_{j=1}^{u} D_{tj}\cdot P_{tj}, \tag{2}$$

where:

E_t - expected value of net cash flows at time unit t = 1, 2, …, n,

u - number of D_t levels tested,

other designations as above.

Then, calculate:

- the expected net present value, according to the formula:

$$\mu NPV=\sum_{t=1}^{n}\frac{E_t}{(1+i)^t} \tag{3}$$

where:

μNPV - expected net present value,

i - discount rate, other designations as above,

- the standard deviation of the net present value, according to the formula:

$$\sigma NPV=\sqrt{\sum_{t=1}^{n}\frac{\sigma_t^2}{(1+i)^{2t}}}, \tag{4}$$

where:

σNPV - standard deviation of the net present value,

σ_t^2 - cash flow variance determined from the formula:

$$\sigma_t^2=(D_{tj}-E_t)^t\cdot P_{tj}. \tag{5}$$

The information obtained in terms of μNPV and σNPV supports risk assessment and rational decision-making for the implementation of investment projects, on the basis of the developed standards (Table 5), based on the NPV coefficient of variation, which is calculated according to the formula:

$$CV_{NPV} = \frac{\sigma NPV}{\mu NPV} \tag{6}$$

where:

CV_{NPV} - coefficient of variation of net present value,

other designations as above.

It was assumed that the CV_{NPV} ranges corresponding to the risk assessment and specific decisions should be set arbitrarily for a given year by top management, appropriate to the company's situation.

Table 5.

Decision-making standards - formula and example

CV_{NPV} level	**Risk assessment**	**DECISION**
... E.g. 0.1 - 1.5	Small, acceptable risk	IMPLEMENTATION and risk monitoring
... E.g. 1.6 - 2.9	Medium acceptable risk	ADJOURNMENT for risk prevention
... E.g. > 3.0	Large, unacceptable risks	DISCONTINUANCE to avoid risks

Source: Own study taking into account the interviews.

A decision defined in the standards as:

- IMPLEMENTATION means the inclusion of the project in the 'Annual Investment Plan' and its execution in accordance with the developed documentation, while monitoring the risk factors,
- ADJOURNMENT means going back to the analyses and revisiting the considerations aimed at determining additional preventive actions or waiting for conditions to change, which will either alleviate negative impacts or reduce the likelihood of risk factors,
- DISCONTINUANCE means rejection of the project and any further work related to it.

In order to verify the usefulness of the developed procedure, a case study was carried out, referring to the 'Automated aluminium scrap sorting line' project planned in the company, with the required investment outlays at the level of PLN 79 million. According to the opinion of experts and representatives of aluminium recycling companies, the line being the subject of the project would be the most technically advanced in Europe.

The main objective of the project is to improve the quality of the furnace charge by automating the sorting processes for aluminium scrap. Due to the desire to gain a competitive advantage as a result of implementing the project, the publication did not present an 'Investment Project Charter', containing a detailed description of the feasibility studies. As the recommendations gave a positive opinion on the implementation of the project, the controlling staff carried out an assessment of its economic efficiency (Table 6). In it, they assumed appropriate levels of net financial performance shaping elements[4], a capital expenditure, an 8-year calculation period and a discount rate of 7.5%, derived from the cost of equity capital assumed to finance the project. The calculations show that the NPV of the project is PLN 17,322.5k, which means that it is economically efficient.

Table 6.
Synthetic summary of calculations for assessing the economic viability of the project

	Units of the calculation period, years							
Elements of the assessment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Net financial result [k PLN]	5 524.2	5 524.2	5 524.2	5 524.2	5 726.7	5 726.7	5 726.7	5 726.7
Investment expenditure [k PLN]	79 000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adjustment of depreciation expense [k PLN].	10 000.0	10 000.0	10 000.0	10 000.0	9 750.0	9 750.0	9 750.0	9 750.0
Net cash flow [k PLN]	-63 475.8	15 524.2	15 524.2	15 524.2	15 476.7	15 476.7	15 476.7	15 476.7
Discount factor	0.9302	0.8653	0.8050	0.7488	0.6966	0.6480	0.6028	0.5607
Discounted net cash flows [k PLN]	-59 047.3	13 433.6	12 496.4	11 624.5	10 780.4	10 028.3	9 328.7	8 677.8
NPV [k PLN]	-59 047.3	-45 613.7	-33 117.3	-21 492.8	-10 712.3	-684.0	8 644.6	17 322.5

Source: Own study based on company data.

To complete the information on this project, a brainstorming exercise was then conducted aimed at identifying risk factors relevant to the economic viability of the project, as well as their current level (Table 7).

Table 7.
Risk factors affecting the economic viability of the project

Risk factor	Current level
Fastmarkets MB - prices/aluminium alloys 226 [PLN/t]	10 600
Cost of electricity [PLN]	450
Transport cost [PLN/t]	230
Scrap acquisition cost [EUR/t]	7 375
Salary costs [k PLN]	350
Sales volume [t]	7 000
Investment expenditure [k PLN]	79 000

Source: Own study based on company data.

A sensitivity analysis of NPV was then carried out, with an assumed +/- 30% variation in the development of individual risk factors. The results made it possible to identify the factors with the greatest impact on the development of NPV (Table 8).

[4] Prices, sales volumes, fixed and variable costs, tax.

Table 8.
Sensitivity analysis of NPV to changes in project risk factors

	NPV as a result of changes in individual risk factors by assumed % level, [k PLN]						
Risk/change factors	**-30%**	**-20%**	**-10%**	**0%**	**+10%**	**+20%**	**+30%**
Fastmarkets MB - prices	**-105 352.1**	**-61 890.9**	**-18 429.7**	17 322.5	52 526.0	87 729.6	122 933.1
Cost per kWh of electricity	23 419.0	21 829.6	20 240.3	17 322.5	17 061.5	15 472.1	13 882.7
Transport costs	20 985.1	20 207.1	19 429.0	17 322.5	17 872.8	17 094.7	16 316.6
Cost of acquiring scrap metal	92 122.9	67 632.2	43 141.6	17 322.5	**-5 839.8**	**-33 799.3**	**-64 034.7**
Cost of salaries	17 820.6	17 654.6	17 488.5	17 322.5	17 156.4	16 990.3	16 824.3
Sales volumes	**-7 585.7**	717.0	9 019.7	17 322.5	25 625.2	33 927.9	42 230.6
Investment expenditure	17 553.8	17 476.7	17 399.6	17 322.5	17 245.3	17 168.2	17 091.1

Source: Own study.

The biggest influences (changes > 5 million PLN) on the NPV are, in turn, the Fastmarkets MB price quotations for aluminium alloys 226, the product that will be sold as a result of the project, the average acquisition cost of scrap and the sales volume. If a decision is made to go ahead with this project, the manager who will manage it must pay attention to these factors. The price quotations for aluminium alloys and the average acquisition cost of scrap are of particular importance, as unfavourable (yet small) changes in their development result in a loss of economic efficiency of the project and large losses with a negative impact on the value of the company.

Further, for the scenario analysis, possible changes in the development of specific risk factors affecting the NPV were estimated. Both historical and forecast data were used. It was assumed that favourable changes in the development of these factors define the optimistic scenario, while unfavourable changes define the pessimistic scenario (Table 9).

Table 9.
Level of risk factors in project scenarios

	Scenario		
Risk factors	**optimistic**	**base**	**pessimistic**
Fastmarkets MB - prices / aluminium alloys 226 [PLN/t]	13 780	10 600	6 220
Cost per kWh of electricity [PLN]	150	450	1 350
Transport cost [PLN/t]	185	230	460
Scrap acquisition cost [PLN/t]	5 530	7 375	8 850
Salary costs [k PLN]	245	350	420
Sales volume [t]	9 940	7 000	5 040
Investment expenditure [k PLN]	75 100	79 000	83 000

Source: Own study based on company data.

An assessment of the economic viability was carried out for the assumptions thus made in the development of the risk factors. If the project had been implemented under the conditions:

- optimistic scenario, the NPV would be PLN 156,098.0k, which means that it would be economically efficient (Table 10),
- pessimistic scenario, the NPV would be PLN -116,649.61k, meaning that it would be economically inefficient (Table 11).

Table 10.
Synthetic summary of calculations for assessing the economic viability of the project in the optimistic scenario

	Units of the calculation period, years							
Elements of the assessment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Net financial result [k PLN]	29 087.6	29 086.8	29 086.0	29 085.2	29 286.8	29 286.0	29 285.2	29 284.4
Investment expenditure [k PLN]	75 100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adjustment of depreciation expense [k PLN]	9 512.5	9 512.5	9 512.5	9 512.5	9 262.5	9 262.5	9 262.5	9 262.5
Net cash flow [k PLN]	-36 499.9	38 599.3	38 598.5	38 597.7	38 549.3	38 548.5	38 547.7	38 546.9
Discount factor	0.9302	0.8653	0.8050	0.7488	0.6966	0.6480	0.6028	0.5607
Discounted net cash flows [k PLN]	-33 953.4	33 401.2	31 070.2	28 901.9	26 851.9	24 978.0	23 234.8	21 613.3
NPV [k PLN]	-33 953.4	-552.2	30 518.0	59 420.0	86 271.9	111 249.8	134 484.7	**156 098.0**

Source: Own study.

Table 11.
Synthetic summary of calculations for assessing the economic viability of the project in the pessimistic scenario

	Units of the calculation period, years							
Elements of the assessment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Net financial result [k PLN]	-17 236.9	-17 236.9	-17 236.9	-17 236.9	-16 986.9	-16 986.9	-16 986.9	-16 986.9
Investment expenditure [k PLN]	82 900.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adjustment of depreciation expense [k PLN]	10 487.5	10 487.5	10 487.5	10 487.5	10 237.5	10 237.5	10 237.5	10 237.5
Net cash flow [k PLN]	-89 649.4	-6 749.4	-6 749.4	-6 749.4	-6 749.4	-6 749.4	-6 749.4	-6 749.4
Discount factor	0.9302	0.8653	0.8050	0.7488	0.6966	0.6480	0.6028	0.5607
Discounted net cash flows [k PLN]	-83 394.8	-5 840.5	-5 433.0	-5 054.0	-4 701.4	-4 373.4	-4 068.2	-3 784.4
NPV [k PLN]	-83 394.8	-89 235.3	-94 668.3	-99 722.2	-104 423.6	-108 796.9	-112 865.2	**-116 649.6**

Source: Own study.

The probability of these scenarios was assumed to be 0.15 and the baseline scenario 0.7. This allowed calculations to be carried out that were geared towards indicating μNPV, σNPV and CV_{NPV} (Table 12).

Table 12.
Synthetic summary of project risk assessment calculations

		Units of the calculation period, years							
Elements of the assessment		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Expected net cash flows of the scenarios [k PLN]	opt	-5 475.0	5 789.9	5 789.8	5 789.6	5 782.4	5 782.3	5 782.2	5 782,0
	base	-44 433.1	10 866.9	10 866.9	10 866.9	10 833.7	10 833.7	10 833.7	10 833,7
	pes	-13 447.4	-1 012.4	-1 012.4	-1 012.4	-1 012.4	-1 012.4	-1 012.4	-1 012,4
Expected net cash flow [k PLN]		-63 355,5	15 644.4	15 644.3	15 644.2	15 603.7	15 603.6	15 603.4	15 603.3
Discounted expected net cash flows [k PLN]		-58 935,3	13 537.6	12 593.0	11 714.4	10 868.9	10 110.5	9 405.0	8 748.8
μNPV [k PLN]									**18 042.98**

Cont. table 12.

Variation of scenarios [k PLN]	opt	108 183 029.3	79 038 802.5	79 034 061.2	79 029 320.1	78 975 525.1	78 970 785.8	78 966 046.6	78 961 307,5
	base	10 137.7	10 117.2	10 096.8	10 076.4	11 287.1	11 265.5	11 243.9	11 222,4
	pes	103 705 715.0	75 222 485.5	75 221 669.3	75 220 853.0	74 949 040.6	74 948 225.8	74 947 411.0	74 946 596,3
Variation [k PLN]			211 898 882.0	154 271 405.2	154 265 827.3	154 260 249.5	153 935 852.8	153 930 277.1	153 924 701.5
σNPV [k PLN]									**26 999.3**
CVNPV									**1.5**

Own study.

Assuming that certain decision-making norms based on CV_{NPV} (Table 5) would be adopted in the company, the calculations obtained allow the conclusion that the project has low risk and can be implemented in accordance with the developed documentation (with simultaneous monitoring of risk factors), i.e. a decision can be taken to include it in the "Annual Investment Plan".

4. Discussion

After reading the considerations of the procedure developed, especially the methods and tool that complement it with the risk assessment aspect of strategic projects, it can be debated that they are based on an abstractly mapped reality and ignore many phenomena that may occur. In particular, with regard to:

- brainstorming methods, it is possible to discuss, among other things, whether it is too subjective, whether those taking part have the right knowledge and experience, whether they have prepared properly,
- methods of sensitivity analysis, it is possible to discuss, among other things, the validity of assuming changes in the development of only one risk factor from the value assumed in the baseline scenario, with the value of the other factors remaining unchanged, as they can change simultaneously,
- methods of scenario analysis, it is possible to discuss, among other things, about assuming unidirectional changes in the development of risk factors (respectively favourable in an optimistic scenario and unfavourable in a pessimistic scenario), which is hardly realistic in reality,
- probabilistic-statistical method, it is possible to discuss, among other things, about the way in which the probability of scenarios is determined, or the number of scenarios, which is small,
- tools in the form of decision standards, it is possible to discuss, among other things, about the arbitrary setting of the CVNPV level, which determines the risk assessment and indicates the corresponding decision.

The authors are aware of these problems and that other approaches, such as the Delphi method or Monte Carlo simulation, could have been used to obtain a broader context of the phenomenon under study and more accurate results. However, these were found to be more difficult, time- and capital-intensive, which could discourage their use. Therefore, it was considered, due to the selection criteria adopted (derived from the concept of methodological pluralism and the principle of triangulation), that the methods and tool included in the procedure were characterised as sufficient:

- relevance, which means that the methods and tools chosen are tailored to the needs of the specific company, taking into account the methods already in use,
- simplicity, meaning the selection of methods and tools appropriate to the competences of those who will use them, without the need for specialised external bodies,
- precision, meaning the selection of methods and tools that provide unambiguous, well- defined results to support rational decision-making.

As part of the discussion, the question can also be formulated whether the developed procedure has a generalised character and can be used by other companies? According to the Authors of the publication, yes, but after it has been adapted to their specifics, e.g. staff resources, their competences (which affects the correctness of the use of the methods), or the financial situation, the projects implemented so far and their risks (which affects the decision-making standards).

5. Summary

The results of the considerations presented in the publication were aimed at solving the research problem, defined as the selection of appropriate methods and tools for risk assessment, the results of the application of which may constitute criteria for making decisions on the implementation of investment projects of a strategic nature in a production enterprise, which is the largest producer of secondary aluminium casting alloys in Central Europe. On the basis of the conducted research, including the analysis of the research problem and the synthesis of the results obtained within its framework, it was possible to develop a procedure for planning investment projects taking into account risk, adapted to this specificity of this enterprise, aimed at making rational strategic decisions. Verification of the usefulness of the developed procedure in the course of the case study makes it possible to conclude that the selected methods and tools are appropriate, meet the identified need and are adapted to the competences of those who are to use them to assess the risks of strategic investment projects and make rational decisions about their implementation.

Although, as mentioned in the discussion, the selected methods and tools for risk assessment, are based on an abstractly mapped reality, given the criteria adopted for their selection, it can be concluded that they are characterised by sufficient relevance, simplicity and precision. Furthermore, in the authors' opinion, their logical combination into a single whole provides a solution aimed at risk assessment and investment decision-making that may also suit the needs of other companies.

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