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Long Term Examination of the Profitability Estimation Focused on Benefits

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***Abstract*—**Strategic investment decisions are characterized by high innovation potential and long-term effects on the competitiveness of enterprises. Due to the uncertainty and risks involved in this complex decision making process, the need arises for well-structured support activities. A method that considers cost and the long-term added value is the cost-benefit effectiveness estimation. One of those methods is the "profitability estimation focused on benefits – PEFB"-method developed at the Institute of Management Cybernetics at RWTH Aachen University. The method copes with the challenges associated with strategic investment decisions by integrating long-term non-monetary aspects whilst also mapping the chronological sequence of an investment within the organization's target system. Thus, this method is characterized as a holistic approach for the evaluation of costs and benefits of an investment. This participation-oriented method was applied to business environments in many workshops. The results of the workshops are a library of more than 96 cost aspects, as well as 122 benefit aspects. These aspects are preprocessed and comparatively analyzed with regards to their alignment to a series of risk levels. For the first time, an accumulation and a distribution of cost and benefit aspects regarding their impact and probability of occurrence are given. The results give evidence that the PEFB-method combines precise measures of financial accounting with the incorporation of benefits. Finally, the results constitute the basics for using information technology and data science for decision support when applying within the PEFB-method.

***Keywords*—**Cost-benefit analysis, multi-criteria decision, profitability estimation focused on benefits, risk and uncertainty analysis.

I. Introduction

STRATEGIC investment decisions (SID) are defined as "substantial investments that involve high levels of risk, produce hard-to-quantify (or intangible) outcomes and have a significant long term impact on corporate performance [1]." Hence, the process of strategic decision making (SDM) has emerged as an important research field over the past decade [2].

Controlling the complexity and uncertainty surrounding SID presents particular challenges for the management [3]. In addition, SID have an effect on the whole competitiveness of the organization [4], [5]. For this reason, efficient information search and evaluations are necessary [6]. The evaluation of accounting for SID has to pay more attention to scenario-based techniques [7], [8].

Field studies give evidence that traditional profitability analysis assessing SID is supplanted by sophisticated techniques in terms of linking qualitative and (quantitative) financial aspects [1], [9]-[11]. While the quantification and assignment of cost is examined extensively, there are fewer methods for the assignment of long-term benefits [12]. In fact, the evaluation of utilizing quantitative and qualitative criteria in decision making is a challenge when implementing effective decisions [13]. However, involving teams in the decision making process (DMP) improves the quality of the decision [14] and allows for alternative evaluations in the problem solving process [15]. Hence, much of the DMP in companies is decided as a team [16], [17].

The PEFB-method [18], [19] faces challenges with SID. However, since its development there has been no evaluation of the method itself regarding its applicability. Hence, a review of requirements and a comparative analysis of the gathered cost and benefit aspects are required. With these results, the applicability of the PEFB-method is confirmed and the baseline for future research is set up.

II. State of the Art

Research has aimed to answer the questions surrounding which analyses are being used to assess SID [20]. In fact, financial accounting information assists managers to give a quantitative overview of the current company situation and prepare for future decisions [21]. Hence, SID are usually based on economic criteria, often without considering qualitative issues [22]. Even if qualitative criteria is incorporated in the SID, there is a lack of structured and validated methodologies [23], [24]. However, scientists argue that an organization's philosophy itself and organizational context vary across circumstantial settings [25], [26].

The DMP is characterized by different attitudes and different knowledge of uncertainties arising as a result of imprecisions and vagueness of information [27]. In particular, SDM is involved with questions affecting the long-term success of the company, the allocation of significant resources and the trade-off in ambiguous situations as a result of insufficient information [28], [29].

In general, involving teams in decision making (DM) improves the solution quality and generates a wider variety of

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problem solutions [17]. The DM can be supported by group decision making frameworks. Most of the proposed methodology frameworks within the business environment are related to mathematical decision support frameworks [30], [31]. These frameworks are related to Analytical Hierarchy Processes [27] and Fuzzy preference relations [32], [33]. However, the implementation of mathematical models needs experienced customers and sometimes fails due to a lack of skills and its complexity [30], [34]. As a result of these uncertainties and the limitations of skills and abilities, there is a search for new management approaches [3]. The requirements of the new approach are summarized in Table I. This method should provide accuracy of financial accounting decisions (R1) through the incorporation of qualitative criteria (R2). The SID has to be performed in a structured series of steps and provide valid results. In particular, so as to prioritize the sequence of investment, a timeline is required (R3). Furthermore, the treatment of insufficient information and information quality has to be integrated (R4). Finally, the method has to be non-complex and easy to use so as to reduce time and effort expenditure (R5). Finally, the approach has to integrate research and evaluations by financial experts, just like all experts affected within the company (R6).

TABLE I
REQUIREMENTS FOR NEW SID APPROACH

Requirement [R]	*Description of the requirement*
R1	Precise measure of financial accounting
R2	Incorporation of qualitative criteria
R3	Structured and valid methodology
R4	Treating of insufficient information
R5	No remarkable skills to use required
R6	Team decision

III. THE PEFB-METHOD

The PEFB-method is a participation-oriented, cybernetic approach for the evaluation of a SID. Based upon the utility analysis and the profitability analysis of IT-investment [19], [35], [36] both measurable monetary factors and non-monetary aspects are considered and thus requirements (R2) and (R6) are met. Fig. 1 shows an overview of the PEFB-method according to the problem solving process [37]. Hence, the PEFB-method meets the demands of (R3). Moreover, to perform the method, no remarkable skills are required (R5). To demonstrate compliance with the given evidence, a short description of the PEFB-method is shown below. Examination of the requirements of (R1) and (R4) is part of the research design and a realization of the long-term evaluation.

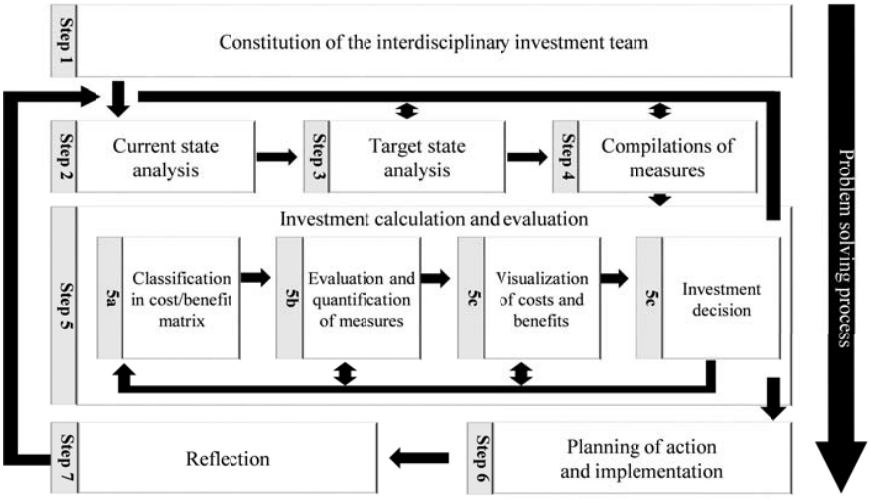

Fig. 1 Steps of the PEFB-method

The following description shows the stages of the PEFB-method [38]. The PEFB-methods consists of seven steps:

1. Constitution of the interdisciplinary investment team,
2. Current situation analysis,
3. Target situation analysis,
4. Compilation of measures,
5. Investment evaluation,
6. Planning of actions and
7. Reflection.

Step 1 consists of building a representative interdisciplinary investment team containing executives and employees involved and affected. Hence, not only are the concerned departments represented, but also the various levels of hierarchy. This team will be responsible for conducting the evaluation, implementation and reflection process.

By building up an interdisciplinary investment team and through the support of a facilitator, a holistic view on the SID is ensured. Within the current state analysis (step 2), skills and competencies inside the enterprise are identified. Furthermore, by means of the target state analysis (step 3), the strategically, tactical and operational objectives of the project are identified and noted on a specification sheet. Step 4 involves a compilation of concrete measures so as to achieve the target level of enterprise.

In step 5, the investment calculation and evaluation is carried out through 4 sub tasks. It encompasses the

classification of costs and benefits, the evaluation and quantification of measures, visualization of cost and benefits as well as the investment decision. The method uses two different portfolios for the classification of costs and benefits (cf. Table II, cf. Table III). Costs and benefits of the investment are defined and assigned in terms of their impact on the project as "direct", "indirect" or "difficult to ascertain" aspects.

Direct costs or benefits are those, which are related to the investment and enable the impact to be measured directly, e.g. acquisition costs or increase of productivity. Accordingly, indirect costs or benefits are a derivate from direct effects, for instance maintenance costs or increased quality. Finally, "difficult to ascertain" costs or benefits contain effects which can only be presumed, like demotivation of employees or improving the image of the company. Moreover, the measures are classified regarding their probabilities of occurrence into the classes high, medium, and low.

TABLE II
COST-PORTFOLIO

	High	Medium	Low
Direct	**9**	**7**	**4**
Indirect	**8**	**5**	**2**
Difficult to ascertain	**6**	**3**	**1**

Corresponding to the introduced impact classes, the measures are assigned in a 3x3-matrix. Each cell of the matrix contains a so called risk level, reaching from 1 to 9. The two portfolios differ in the arrangement of the risk level. Meanwhile, direct costs with high probability are assigned to the risk level 9 (cf. Table II), benefit risk levels are designated contrarily. Direct benefits with high probability of occurrence refer to risk level 1 (cf. Table III).

TABLE III
BENEFIT-PORTFOLIO

	High	Medium	Low
Direct	**1**	**3**	**6**
Indirect	**2**	**5**	**8**
Difficult to ascertain	**4**	**7**	**9**

Within the framework of visualization, the levels define a ranking scale of measures. After the classification and quantification of the aspects, the filled cells of the matrix are aligned in two numerical series. The overall costs (C_m) for each risk level (j) are calculated from the individual cost aspects (c_j) (refer to (1)). The modality for the computation of the overall benefits (B_n) each benefit (b_j) is done similarly (see (2)).

$$C_m = \sum_{j=1}^{(9-m)+1} c_j \quad (1)$$

$$B_n = \sum_{j=1}^{9} b_j \quad (2)$$

The value of each risk level is recorded in a risk oriented PEFB-chart (see Fig. 2). In relation to the possible intersection situations, four general cases can be distinguished. On the one hand, when the cost function is beneath the benefit function in all nine levels, the investment is economically evaluated as recommendable without restrictions. On the other hand, if the cost function is always above the benefit function, the investment is evaluated as definitely uneconomical. Finally, in the case of an intersection of both curves, an interpretation of the risk level is required.

Investment scenarios with an intersection of both graphs in risk level 1 are the most economically reasonable. In terms of the descriptive interpretation, the overall costs are exceeded by direct and highly probable benefits. Contrarily, the worst economically reasonable investment scenario is at the location of the intersection point at the risk level 9. In this intersection point, direct and highly probable costs exceed all possible benefits.

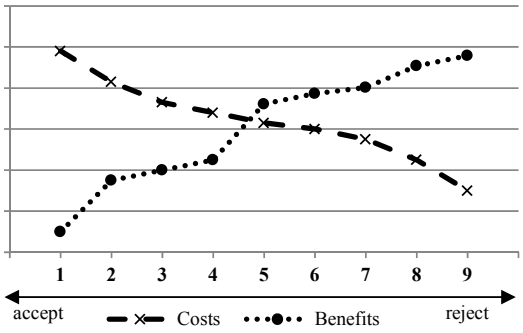

Fig. 2 PEFB-chart

In step 6, the next stage of the investment decision is determined. Depending on the results, this step relates to whether a plan of action or plan implementation is necessary. In particular, the advice regarding the evaluation of strategies is directly incorporated into the transfer process. Finally, the interdisciplinary investment team appraises the experiences gathered during the process (step 7). Accordingly, in the reflection phase a review of the whole investment evaluation process is carried out and appropriate recommendations are made. However, there is need to prove the compliance of the PEFB-method with (R1) and (R4). Thus, further research with regard to the fulfillment of the requirements is needed.

IV. RESEARCH DESIGN

The PEFB-method was applied in research projects as well as industrial projects. To evaluate the method's compliance with the precise measure of financial accounting (R1) and the treatment of insufficient information (R4), a chronological overview is shown in Table IV. Due to non-disclosure agreements, only the results of 14 independent workshops are allowed to be used for public evaluation. Besides the 14 applied PEFB-methods introduced over the last 10 years, the date of application and a short description of the assessed subject are given. In addition, a categorization of the projects is also provided. The categories display the areas of assessment divided into technology and methodology evaluation.

Among the 14 displayed application fields, 7 belong to the category of technology assessment, whereas 4 projects belong to the methodology assessment. In 3 cases a mixture of the methodology approach and a launch of a new technology were assessed. During the application of the PEFB-method, more than 96 costs aspects and 122 benefits were acquired. Due to inconsistencies within specific aspects, there is a need for data processing.

TABLE IV
APPLIED AREAS OF THE PEFB-METHOD

Year	*Project description*	*Area of assessment*	
		Technology	*Methodology*
2006	Launch of a data processing service	X	X
2006	IT outsourcing solutions	X	
2006	Construction of a parking garage		X
2008	Semantic-based knowledge flow system for the European home textiles industry	X	X
2011	Intelligent Mega-Swap-Boxes for Advanced Intermodal Freight Transport	X	
2012	Lead-User method for innovation search		X
2012	Broadcast Search for innovations		X
2012	Ideas competition for innovation search		X
2012	Safety technology for firefighters	X	
2013	Mass produced textile preforms by automated handling and online quality assurance	X	
2013	IT-support during the development of engineering standardization	X	X
2014	Online quality assurance for hot edge/hot air welding	X	
2014	Intelligent Transport System for Innovative Intermodal Freight Transport	X	
2015	Automation of Tricot machines	X	

In order to perform a baseline study of correlating data, aspects aligned into different impact classes were excluded. If aspects are aligned within the same impact class, but dedicated to other probabilities of occurrence, they were adapted manually. These aspects are marked in the cost and benefit library. The adaption was performed either by majority or the lower risk level. Due to non-total order of the different risk levels the average risk level is not calculated.

A. Cost Aspects

Regarding these different types of applications, more than 96 different cost aspects were gathered. Among those, 13 aspects were inconsistent within their aligned impact classes. Hence, these values were canceled for the evaluation. Moreover, 5 aspects were adapted manually (marked). Table V gives an overview of the remaining 83 cost aspects in their original terms. Besides the aspects itself, the number of nomination [n] is illustrated just like the risk level.

The total number of the aggregated costs aspects is 125, thus the average number of cost aspects for one PEFB-application is 8.93. Besides some common aspects like capital costs, the reduction of staff, or the demotivation of the employees, most of the aspects are individual for each project. The average number of nomination is 1.51. The distribution of all cost aspects within the impact classes are presented in Fig. 3.

The impact class of direct costs has a share of 57.83%. This impact class consists of 75.00% of high probability costs (risk level 9). This makes up the majority in this class followed by medium probabilities of 18.75% (risk level 7). In the end direct costs with low probability gain a share of 6.25% (risk level 4). Compared to impact class of direct costs, indirect costs have an overall share of 25.30%. The class consists of a share 38.10% for high probability costs (risk level 8), 33.33% for medium costs (risk level 5) and 28.57% for low probabilities (risk levels 2).

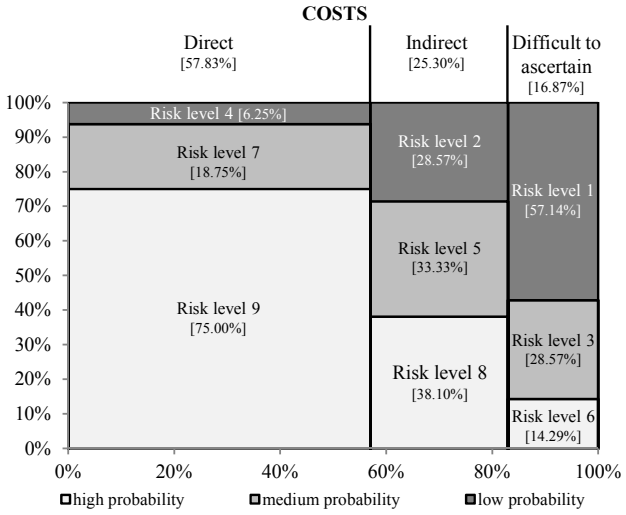

Fig. 3 Marimekko chart of the cost aspect distribution

In particular, the impact class of difficult to ascertain costs has a share of 16.87%. The majority within this impact class is formed by low probabilities with a share of 57.14% (risk level 1). Meanwhile, medium probabilities have a share of 28.57% (risk level 3). Finally, high probabilities (risk level 6) gain a share of 14.29%.

B. Benefit Aspects

In addition, the preparation of the benefit aspects was done in the same way. By data adjustment, 30 benefit aspects with inconsistent impact class alignments were deleted from the overall number of 122 benefit aspects. The remaining 92

benefit aspects are shown in Table VI. The 6 benefit aspects which are manually adjusted are marked.

TABLE V
LIBRARY OF COST ASPECTS

Cost aspects	Number [n]	Risk level
Aboriginal costs	1	9
Acceptance by machine operator	1	1
Additional charges to ensure IT-security while using IT-based standardization	1	5
Adoption of the vehicles (GPS)	1	9
Annual granting costs	1	9
Assembly	2	8
Bad declaration of performance relationships	1	8
Bought-in parts	1	9
Calibration of the equipment	1	4
Capital costs	3	1
Changeover costs	1	1
Choice of suitable intermediary	1	9
Communication effort with solver	1	9
Contract costs	2	9
Contract negotiation	1	9
Costs for sample picture creation	1	9
Debriefing costs	1	5
Demotivation	4	1
Denoting trucks	1	9
Destination charges	3	8
Developing a standard	1	5
Development of IT-platform	1	9
Development prototype	1	7
Digitalization of samples	1	9
Editing workshop results	1	9
Empty running	1	1
Expenses for data utilization (customer)	1	8
Finance costs	3	9
Flexibility boundary	1	4
Flexibility for Just in time	1	3
Formulating a problem	3	9
Formulation of tender	1	9
Garment (jackets, gloves)	1	9
Handling and washing procedure for equipment	1	9
Hardware costs	1	9
Helmet (camera + vision, communication device)	1	9
Hidden costs (generous conditions at contract closing / high debts at later change requests)	1	2
High sill, height of chassis and cam distance	1	2
Higher risk of injuries	2	1
Higher risk of know-how theft through intensive exchange with potential competitors	3	3
Higher risk of standardization employee's distraction	1	1
Higher space requirement	1	9
Higher system complexity	1	9
Image loss	3	3
Insurance for the technical equipment	1	7
Integration existing equipment	1	9
Investment costs	4	9
Lead-User identification und recruitment	1	9
Legal conflict	3	2
Legal counsel	3	9
Less control	1	6
Less flexibility (backload)	1	5
Less staff	8	8
License software	2	9

Cost aspects	Number [n]	Risk level
Limited service offer by contractor	1	2
Low Sill	2	1
Maintenance by users	1	8
More staff	2	7
New specialist jobs	1	8
No accurate service provision by the outsourcing contractor	1	3
Oncosts through downtime and maintenance time	2	5
Premium	2	9
Production	2	5
Provide culture for acceptance of external knowledge	3	5
Psychological context monitoring	1	9
Recalls for fixing issues	1	2
Recurrent expenses through supplier change	1	4
Re-using the equipment	1	8
Rewarding lead-users	1	7
Run workshop	1	9
Sensors	1	9
Service	2	7
Service provision	1	9
Set-up time	1	7
Shuttle costs per year	1	7
Shuttle trains leasing costs per year	1	7
Smart Life Line	1	9
Spare parts	1	2
Starting up maintenance	1	6
Supply of data	1	9
Terminal costs when driver changes	1	7
Trend analysis	1	9
Work of the expert jury	2	9

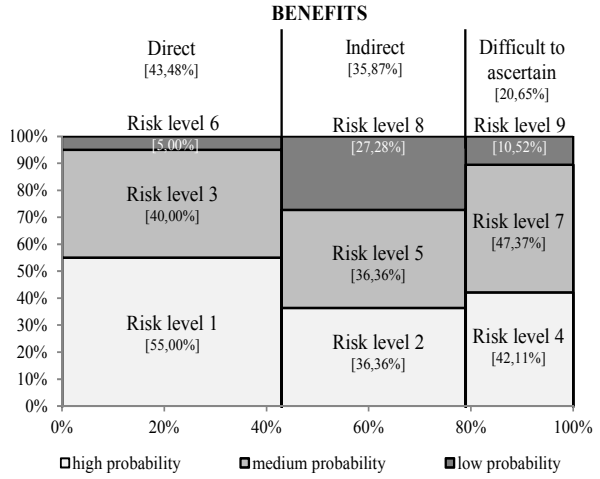

Fig. 4 Marimekko chart of the benefit aspect distribution

Collectively, the total number of aggregated benefit aspects is 131. Like the cost aspects, most of the benefit aspects are mentioned once, thus the average number of nominations is 1.42. The overall average number of benefits aspects for one application is 9.36. Common benefit aspects are, e.g. documentation, image gain or increased flexibility through implementation of technology.

In contrast to the cost aspect distribution, the allocation of the benefit matrix is shown in Fig. 4. The direct benefits gain a share of 43.48%. Within the impact class, high probability benefits (risk level 1) have a share of 55.00% followed by 40.00% with medium probability (risk level 3). Direct benefits with a low probability of occurrence have a share of 5.00% (risk level 6). With respect to the impact class of indirect benefits the share of 35.87%, consist of 36.36% for high probability aspects (risk level 2) as well as 36.36% of medium probability aspects (risk level 5). Aspects with low probabilities have a share of 27.28% (risk level 8). On top of that, the impact class of difficult to ascertain benefits has an overall share of 20.65%. The proportion within the impact class consists of 42.11% for high probabilities (risk level 4), 47.37% for medium probabilities (risk level 7) and 10.52% for low probabilities.

V. Discussion of the Results

The distribution of high probability cost aspects decreases throughout the impact classes (cf. Fig. 3). In contrast, the share of low probability aspects increases with the opportunity to use qualitative aspects. Based on this fact, the increasing uncertainty among the impact classes leads to a risk-averse assessment. Furthermore, the share of the impact classes decreases from direct costs to costs that are difficult to ascertain. One possible reason for the major share of direct costs might stem from an accounting department.

TABLE VI
LIBRARY OF BENEFIT ASPECTS

Benefit aspects	Number [n]	Risk level
Acceptance by Employee	1	4
Amortization period	3	1
Availability secured	1	8
Basis for argumentation	1	1
Better control of action by team leader	1	7
Better procurement conditions	1	3
Better selling effect on Point of sale	1	3
Better view over entire situation	1	1
Central headquarters	1	5
Constructing production line	1	6
Contest's participation rate as competitions indicator	1	5
Cost reduction Supply Chain Management	3	1
Cross-linkage of convoy with headquarters	1	8
Deal closure	2	3
Decrease damage on equipment	1	2
Decrease number of and damages on victims	1	2
Decrease of dependency on single employees with specialist know-how	1	8
Digital ordering pricing	2	3
Documentation	4	8
Door opening conception	1	1
Driver as dispatcher	1	8
Early error detection	1	1
Early involvement in the creation of standards	1	2
Ease of internal changes, reorganization, fusions/takeovers	1	9
Economies of scale on contractor's side causing lower prices	1	6
Efficiency increases	1	3
Employees receive inspiration	1	7
Error management	2	2
Fees	2	1
Focus on core business, core competency	1	7
Grasp Frange	3	1
Higher arctic truck height through gooseneck	1	4
Higher machine workload	2	1
Idea goes into new product	2	3
Image gain / improvement	4	7
Increase of employee satisfaction	1	7
Increase of professionalism (no more self-made solutions)	1	1
Increased acceptance of respective standardization	1	5
Increased customer identification	2	7
Increased efficiency/success rate of rescue/intervention missions	1	3
Increased flexibility	4	4
Increased willingness to pay	1	5
Innovations through maintenance and updates	1	5
Inspiration for solving similar problems	1	2
Insurance possible	1	8
Integration / Interface coverage	1	8
inter-company networking of experts	1	9
Inter-functionality of equipment	1	4
Learning aptitude	1	3
Less controls of incoming goods	1	5
Less damage by hail, birds, trees etc.	1	5
Less risks for accidents on rail	1	2
Less room costs	1	4
Less substandard goods	2	1
Less trucks on road	1	4
Loading height	3	1
Lower transport costs	6	1
Maintenance on demand	1	3
Marketing tool	3	7
Mechanic lifting device	1	2
More flexible Network	1	7
Multilayer field of application	1	5
New product	1	1
Newest level of data security	1	5
No IT-worries, no time exposure	1	2
One open side	1	1
Only one basic material	1	5
Potential through interdisciplinary approach	2	2
Process Reliability	2	1
Production working capital	1	8
Productivity gain of already active standardization employees	1	1
Productivity gain of new standardization employees	1	1
Qualified consulting through outsourcing contractor	1	2
Quality of contact increases with higher number of participants	1	7
Real life experience of sample	2	3
Reduction of market analysis lost	1	3
Reduction of sample cost	1	3
Reduction of stock cost	1	3
Reduction of working capital	1	3
Reduction stock cost	1	8
Vehicle conditioning	1	5
Risk of oil price increase	1	3
Road taxes independency	1	2
Saving of development work	2	1
Savings by low insurance	2	5
Support in tactical decisions	1	4
Tactical support for resource management at scene of accident	1	4
Tailgate	1	2
Total benefits	1	1
Transfer of debts to contractor	1	3
Tri-Modal	3	1
Vehicle store place	1	1

In particular, a share of 75.00% for risk level 9 and 18.75% for risk level 7 represents the precise recording of these cost factors. Analyzing the impact class of indirect costs (25.30%) highlights a change in the distribution of probability share. All probabilities roughly gain a share of around 30.00%. This result represents the transitional period from the quantitative to the qualitative aspects, where cost aspects are not easily provided by the accounting department. Despite that, difficult to ascertain costs gain a share of 16.87%. Actually, this result provides evidence for literary research by describing that cost estimation could be done precisely by accounting departments. Interpretation of the benefit evaluation clearly shows that the relevant requirement is met, including long-term effects on SID Thus, the PEFB-method meets the demand of the precise measure of financial accounting (R1). In contrast, the benefit aspects differ in their share of impact classes and probabilities (cf. Fig. 4). The share of the direct impact class of benefits is

around 14% lower than the share of the direct costs. Indeed, the share of the indirect impact class increases around 13% compared to costs. With a difference of nearly 4%, the impact class of difficult to ascertain benefits is in a similar situation to the costs class. For every class there is a significant difference regarding the distribution of the probabilities of occurrence within the impact classes. Moreover, there is an increase in the share of all probabilities in the impact class of difficult to ascertain aspects. It is likely therefore that this constitutes to the fact that benefits in comparison to costs are surrounded by more uncertainty within the evaluated projects. The benefit distribution reveals that a resolution of insufficient information is ensured (R4).

The overall purpose of the PEFB-method is to gain knowledge regarding the investment decision. Due to reflecting potential impacts, future development becomes more certain. With respect to the challenge of SID, the use of the different impact classes represents qualitative aspects just like quantitative aspects. Hence, the results of the overall distribution of cost and benefit aspects are different.

Regarding the impact of cost and benefit distribution, Fig. 5 shows the relative frequency of the introduced cost and benefit aspects in the PEFB-chart. A sample of one assessed project reveals that the average value of the cost and benefit aspects fluctuates at around +/-10%, hence, the representation of the qualitative analysis is possible. The general intersection point of the evaluated projects is stated at the risk level 3.92.

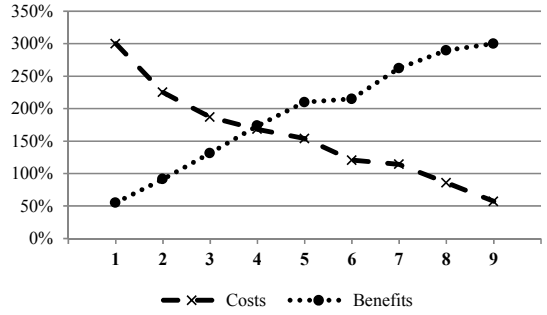

Fig. 5 Relative frequency of cost and benefits aspects in the PEFB-chart

According to the classification of the risk portfolio, there are two interpretations. The SID depends on the probability of benefits with high probability of occurrence and direct benefits with medium probability of occurrence. Indeed, SID are functions from which it is particularly difficult to ascertain benefit aspects with a high probability of occurrence (risk level 4). Secondly, the run of the cost curve illustrates the SID to be a function of all costs aspects with high probability of occurrence just like direct and indirect cost aspects with medium probability of occurrence.

In general, the comparative analysis indicates that the PEFB-method is able to provide a precise measure of cost accounting besides the compilation of long-term effects. Hence, the PEFB-method could be stated as one possible method to assess SID. However, the presented evaluation is only one step to refine the PEFB-method. The purpose is to define a catalogue with aggregated cost and benefit aspects with predefined risk levels. Therefore, the company has to choose the aspect itself and put it in the organizational context.

Referring to the results of the conducted study, it is possible to illustrate for the first time the relationship between benefit and cost aspects as a function of temporal sequences. The results illustrate the importance of indirect benefits in decision making processes. However, these aspects are surrounded by uncertainty, thus there is a need for more information. Modern information technology provides approaches like data science, predictive analysis and big data methods to gather more information. The combination of a participation oriented decision making process and data science is an interesting field of research for the advancement of the PEFB method.

VI. Future Research

In general, progresses in information technology and participation oriented methods need to be linked to future research. Especially, methods of information search like data science are becoming promising approaches increasing information quality and the validity of SID. In order to use data science for information search within the PEFB-method, a methodology to assess information quality has to be developed. The challenge is to identify information sources and their ranking. In addition, future research based upon this evaluation should focus on several aspects. In particular, the visualization of the PEFB-results needs a refining. The interpretation of the intersection point gives no statement regarding profitability. Hence, the challenge is to combine visualization of the results and a sensitivity analysis of the quantified aspects. Moreover, the evaluation of the risk level alignment, the distribution of the quantified aspects and real monetary values should be evaluated, too. In addition, a review of the success rate of implemented technologies or applied methodologies is required.

With regard to the correlating data preparation, 43 aspects were excluded from the evaluation because of inconsistency in the alignment into impact classes. The split of the excluded data is 13 cost aspects and 30 benefit aspects. In fact, the number of benefits is more than 2.3 times higher than the elimination rate of the cost aspects. Hence, the examination of these aspects and the reason for the inconsistency is required.

A promising approach to explain the inconsistency might be the constitution of the interdisciplinary investment team. In particular, the role of the interdisciplinary investment team with regards to risk preference, personal affection and moderating team effects should be examined. Furthermore, the subject of the PEFB-method has to be reviewed in terms of the surrounding uncertainty expressed by the desired target situation.

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