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Application of cost management methodologies for sustainable cost reductions of purchased parts
Comparison and evaluation of different methods in the industrial application

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Summary

Research questions: Which cost instruments are most suitable in industrial practice to achieve cost savings in the procurement function? Which parameters influence the decision on the appropriate cost management methodology? How can sustainable cost reductions for purchased parts be achieved?

Methods: Description and comparison of different cost management methodologies in a literature review. Conducting of an online survey within an empirical study with N = 141 participants. The empirical research results are analysed to evaluate the industrial application and used parameters with statistical testing.

Results: The application of cost instruments depends on the three variables purchasing volume, part characteristic and item typology. The recommended methods in dependence of the variables are displayed in the developed *Cost Management Methodology Portfolio Matrix*.

Structure of the article: Introduction; Literature Review; Research Questions; Methodology; Empirical Results; Conclusions; About the Author; Bibliography

Introduction

The present article aims at describing and comparing cost management methodologies and evaluating the industrial application with quantitative research. The focus is on the methods *Performance Pricing*, *Total Cost of Ownership*, *Cost-Breakdown Analysis* and *Price Comparison* and the influencing parameters.

Procurement has the challenge to get an overview of the price structure for a variety of parts in a short period of time. This paper will analyse the relevance of the sourcing function for the company's success and gives an overview of existing literature and their targets. Several methods and approaches exist to assess the adequacy of prices for outsourced goods. These methods can be generally differentiated into bottom-up and top-down approaches. In literature, there is only limited scientific discussion of instruments like Performance Pricing (Rüch, 2016), Total Cost of Ownership (Bremen, 2010) or price structure analyses (Arnolds, 2016). Many authors address the limited attention in scholarly literature which is in contrast to the regular use and application in industrial practice (Rüch, 2016; Arnolds, 2016; VDI, 2017 and Proch, 2013) or question the practical relevance of scientific models (Bremen, 2010). As the cited research papers describe, analyse and evaluate each approach individually, no research exists which compares and examines the application of all methods. Therefore, this paper has the goal to list strengths and weaknesses of each different method in their use. The conducted survey is aimed to show which instruments are most used in the industrial practice under consideration of different parameters. In addition, the research will give an answer, as to whether small enterprises are also able to conduct detailed cost analyses or if these approaches are only limited to large corporations with sufficient resources. For purchasing functions as well as interdisciplinary cost analytic teams this research paper offers guidance to which methods are applied considering several parameters.

Literature Review

Procurement can be seen as part of Supply Chain Management (SCM) and is defined in this paper with the purchasing and sourcing function. There are different scientific interpretations of the two terms, in this work purchasing is short-term focused on the operative processes in the procurement of external goods. Sourcing includes long-term oriented instruments like qualification of low-cost country suppliers. In general, the requirements on the procurement function have increased significantly during the last decades due to several reasons (Stollenwerk, 2016, p.17).

Mainly the increasing cost pressure through new market entrants from developing countries and the resulting intensified competition because of globalisation have led to a different view on the opportunities of global sourcing. Companies in the old industrial nations nowadays are confronted with high labour costs and have to relocate their manufacturing plants, increase their productivity or outsource parts to suppliers (Stollenwerk, 2016, p.17).

As more and more parts are outsourced after make-or-buy considerations requirements related to the procurement function have changed. The rising strategic relevance of procurement to a company's success brings business risks in various aspects. Companies are currently facing a dynamic, global environment and increased supply and demand volatility (Nicoletti, 2018, p. 56).

Some risks can be calculated others remain unforeseeable such as geopolitical decisions, currency fluctuations or natural disasters (Nicoletti, 2018, p. 56). To remain competitive on the global market, firms concentrate on their core competencies and increasingly answer the question 'make-or-buy' by outsourcing goods (Rüch, 2016, p. 55).

The increasing amount of purchased parts results in a growing dependency on single suppliers and their tier-one or tier-two sub-suppliers. Tier one suppliers are the sub-suppliers of your suppliers, tier-two suppliers are even one step before in the value chain. This shift of technological know-how to the suppliers boosts the knowledge gap between the buying and selling parties (Sanchez, 2013).

This article describes ways how to evaluate the value creation and prices for external goods with the four methods *Performance Pricing*, *Cost-Breakdown Analysis*, *Total Cost of Ownership* and *Price Comparison*.

Performance Pricing

Performance Pricing (PP) is a method initially developed by the consulting group McKinsey in the 1990s as an instrument for achieving short-term cost reductions in the purchasing department (Proch, 2017). The first scientific papers and application fields concern mainly the automotive industry, where a study done by Newman and Krehbiel (2007) showed that for Original Equipment Manufacturers (OEMs) 85 per cent of all purchased direct materials can be analysed with Price Performance Analyses (Newman & Krehbiel, 2007).

PP is a statistical methodology that aims at establishing a mathematical correlation between prices of a set of purchased products (product family or commodity) and one or more properties that characterise the functionality of purchased parts (Güthenke & Möller, 2007). The benchmarking of parts is only based on technical price and value drivers that the user has pre-selected (Münch, 2015). The application is not only limited to simple, but also complex parts and services (VDI, 2018).

Different variants of PP exist as instruments, the most important are Single Linear Performance Pricing (LPP), Multiple-Linear Performance Pricing (MLPP) and Non-Linear Performance Pricing (NLPP). If the part price is above the average price and the benchmark price of the regression function, the differences can be explained by technical, business or other gaps. The commercial or business gaps are caused by a high margin of the supplier, outsourced value-added steps to sub-suppliers, overly high material cost and cross-subsidisation of other parts (Möller, 2007, p.144).

The identification of commercial and technical cost saving potentials has to be discussed with the technical department or external suppliers (Möller, 2009).

The calculated potential is dependent on the type of savings calculation. The calculation of cost savings can be done with the regression line (market line) or the benchmark line (best practice line). The benchmark line represents the more ambitious target by doing a second regression with 20 per cent of the data with the best price-performance ratio, which can be seen in the scatter plot of Figure 1 on the next page. The VDI, an association of German engineers, developed a guideline for the industrial application, as the approaches of how to use the method differ from company to company (VDI, 2017).

Figure 1: Scatter plot with the results of a Performance Pricing Analysis (VDI, 2017, p.21)

Cost-Breakdown Analysis

The literature states various names for cost-breakdown analyses. Cost-based price modeling (Schuh, 2017), cost engineering (Keller, 2017), product cost analysis (Freibichler, 2015), price structure analysis (Weigl, 2013 and Arnolds, 2016) and open book (Heß, 2008).

All of those bottom-up methods have the task to check the appropriateness of purchase prices offered by suppliers and are also used to calculate target prices for internal and external parts or processes. Each cost component is explained by detailed cost-breakdown of the cost structure along the value chain of a product including all value-adding steps (Schuh, 2017, p.169).

A cost-breakdown analysis is mapping the overall manufacturing process into individual steps and sums up the cost drivers to develop a cost model. In addition to the above-mentioned cost categories direct labour, equipment cost, indirect material used in production and different overhead costs are also often considered (Freibichler, 2015, p.68).

The increasing transparency on costs is not only valuable for evaluating external supplier prices, but also to assess the internal cost situation during the product development process (Freibichler, 2015, p.67).

The applicability of cost-breakdowns is advisable for products that are crucial for a company's business and where the buying company has sufficient technical knowledge to develop a cost model. The model is mainly used in strong buying positions as you can only then request detailed cost-breakdowns, also called open book from the supplier during the request for proposal (RfP) phase (Schuh, 2017, p.170). Before completing a detailed cost-breakdown it has to be checked if the parts are of strategic relevance to justify time and effort put into the analysis (Arnolds, 2016, p.101). To conduct product costing analyses, external consultants can be hired or internal experts with sufficient in-house knowledge can be used. According to Schuh (2013) a cost structure analysis consists of four steps. Create a complete part list, analyse each single part and allocate the costs, calculate the costs of the complete part and identify cost saving potentials (Schuh, 2013, p.326). Basis of the product cost analysis is a detailed finding of all costs for the manufacturing of a product. The calculation shows how much a product should cost considering profit margin, overhead costs, labour and manufacturing costs (Freibichler, 2015, p.68). The general structure of a product cost analysis according to Freibichler (2015) can be seen in Table 1.

Table 1

Structure of a product cost analysis (Freibichler, 2015, p.71)

	Material costs
+	Manufacturing costs
=	**Production costs**
+	Administration overheads
+	Selling overheads
+	Research and development costs
=	**Prime cost**
+	Profit
=	**Selling price**

Total Cost of Ownership

The concept of total cost analysis was developed in the 1980s by external consultants of the Gartner Group for evaluation of alternative investment decisions. This concept is known under the term Total Cost of Ownership (TCO) and encompasses all hidden, resulting and visible costs associated with the acquisition and subsequent use of a product or service from a supplier (Stollenwerk, 2016, p.154).

According to Ellram (1995) the application of TCO enables the transparent breakdown of part-related additional costs for purchased items. TCO is not only an analytical approach for strategic procurement but a philosophy with two major approaches to determining TCO which are dollar-based and value-based ways of proceeding (Ellram, 1995).

The dollar-based method considers actual costs and allocates cost data for each of the relevant TCO elements. The approach is suitable for parts of high value and results are precise and easy to interpret. A value-based TCO model also contains non-monetary factors and information of a supplier assessment. These models become rather complex, as qualitative data are transformed into quantitative information and only a relative comparison is possible (Ellram, 1995).

TCO can be used for evaluating make-or-buy decisions, in the supplier selection process or for order quantity optimisation. It also enables to measure the performance of the procurement function and can be used in the sales, controlling and engineering department. Furthermore, the TCO perspective helps to justify selling prices if costs over the complete life cycle deviate from own cost calculations (Bremen, 2010, p.33).

The model of TCO is mainly used for investment and make-or-buy decisions in larger companies, which was shown in an empirical analysis conducted by Bremen in 2010.

In a modified form the concept is also applied in small and medium-sized enterprises (SME) from an industrial perspective (Alard, Bremen, Oehmen, & Schneider, 2010, p.491ff.). The TCO model is also used to help companies to evaluate and classify their suppliers and incorporates the costs occurred during the life cycle with each supplier (Imeri, 2013, p.70).

The application of TCO is particularly worthwhile in the areas of transportation, parts logistics, set-up times, production processes and administration/ indirect costs with extensive positive effects in other areas (Schuh, 2017, p182).

Price Comparison

Price comparison is an easy method to evaluate the price situation for purchased parts by sending out Request for Proposals (RfP), also called Request for Quotations (RfQ) and analysing quotations received from suppliers. Conducting a bid comparison is a flexible and comparatively simple method of analysing and comparing the price situation for different components or material groups. In order to achieve better purchase prices, it investigates the price situation on the market. Whereas so far all of the explained methods are very time consuming, the main advantage of a price comparison is its simplicity and less time needed for an analysis (Schuh, 2017, p.178).

The method easily enables to evaluate the appropriateness of supplier prices. In most companies the comparison of quotations is a standard process before placing an order, as company regulations define to have at least two or three quotations from different suppliers in order to get the best price on the market. Price comparisons offer easy but also limited results in contrast to other so far described methods. The major limitation is that only prices are compared, but there is no evidence that the paid price is justified, because no information on cost or profit margins can be derived (Rüch, 2016, p.57).

Also, only identical or similar parts can be compared, but not complete commodity groups. The success of an RfQ is dependent on the part specifications and the quotation suppliers are sending. It is a good way to get a market overview and find the best-in-class suppliers. This method of benchmarking is also useful for the determination of own purchasing results and can help to derive measures for cost optimisation (Schuh, 2013, p.112ff.).

Critical Evaluation of Existing Theories

All four methods are mainly used in the procurement department, whereas cost-breakdowns are also applied during the product development process by technical departments. The needed time is strongly correlated with the effort for conducting each method. PP, TCO and Cost-Breakdowns are methods that require detailed technical and mathematical knowledge of the methodology and request specific skills of the user. Therefore, these methods are time-consuming and only Price Comparison can be done in a short period of time. Cost-Breakdown Analysis and TCO are bottom-up analyses, PP and Price Comparisons top-down approaches. The invested effort for each instrument varies, detailed Cost-Breakdown Analyses require most

effort, as well as PP and TCO. The simplest way to review prices is with a Price Comparison. All approaches can be used for project-specific one-time requirements and serial or repeat parts with minor restrictions for serial parts and TCO analyses. In the literature all methods can be used in small and medium-sized enterprises (SME) and large corporations, but detailed mathematical models of PP and Cost-Breakdown are mainly used in large companies with enough resources and know-how. These two models also have the main disadvantage that sustainable results are only achievable in a collaborative supplier-buyer relationship as joint cooperation is needed.

Especially in the open book concept of cost-breakdown a supplier must be willing to reveal his internal cost structure. TCO and Price Comparisons can also be used on a supplier market. The main strength of PP is that a complete part family can be analysed. A cost-breakdown only examines a single part, as does TCO. Price Comparison can be used for group of items, but then a greater effort is needed to inquire and compare all parts. Data sources for all methods are external supplier quotations, exception is again the PPA, where mainly internal data or old purchase orders are analysed. Methods with a large effort are best suitable for strategic items with a high value. A summary of all methodologies and their targets can be seen in Table 2. To find out which method is most suitable for a company the main goal for the application is decisive. As all methods are used for sustainable cost reductions, they review prices. But PP and Cost-Breakdowns can also be used to determine future costs, PP with a price formula and Cost-Breakdowns with detailed knowledge of all cost influencing elements of a purchased part.

In addition, both methodologies are also able to determine areas of improvement for product design optimisation. Strength of the TCO analysis is that all costs caused in the value chain of a product are considered. As every method has its strengths and limitations, there is not one single approach that can be used for all type of items or different targets. The users must define their goals before the application and then decide for an appropriate instrument.

Table 2

Targets of different cost management methods

Goal	Performance Pricing	Total Cost of Ownership	Cost-Breakdown Analysis	Price Comparison
Review supplier prices	Yes	Yes	Yes	Yes
Determine future costs	Yes	No	Yes	No
Consider total costs	No	Yes	No	No
Assess supplier margin	No	No	Yes	No
Product cost optimisation	Yes	No	Yes	Yes
Sustainable cost reduction	Yes	Yes	Yes	Yes
Product design optimisation	Yes	No	Yes	No
Strategic supplier development	Yes	No	Yes	No
Evaluate make-or-buy decisions	No	Yes	Yes	Yes

Research Questions

The literature research and the comparison of existing methods have clearly shown that there is limited knowledge on which instruments are used for achieving cost reductions in industrial practice for external purchased parts. The literature base describes each theoretical approach but no empirical study that proves the application, exists. The use of instruments depends on various parameters and the respective goals that have been described in the chapters before. This results in following leading research question.

Which cost instruments are most suitable in industrial practice to achieve cost savings in the procurement function?

Scientific papers only focus on each single instrument, which are PP, Cost-Breakdown or TCO-Analysis as independent approaches. No research develops and analyses the possibility of a holistic approach using all methodologies in order to achieve more sustainable results in the procurement function. Only some authors state that PP can help to determine for which areas a detailed cost and value analysis can help and establish a connection between top-down and bottom-up based concepts (Proch, 2013; BME, 2015). That's why the second research goal of the thesis wants to prove if top-down and bottom-up approaches are used together in a holistic concept.

How do industrial companies use a holistic concept with top-down and bottom-up approaches to achieve cost reductions for external parts?

Parameters that influence the decision for an instrument are the business model, number of employees, part characteristics, purpose of an analysis, cost focus, buyer-supplier relationship, type of items and type of purchasing organisation. To prove the influence of the part characteristics following question is formulated.

Is there a relationship between the part characteristics of a purchased part and the used cost management methodologies?

The item typology developed by Kraljic (1983) can be used to find out the application of methods related to the strategic relevance of the purchased parts. Kraljic categorises parts with a high importance of purchasing into strategic and leverage items, whereas non-critical and bottleneck items have a low importance. This paper examines this categorisation and analyses if the item typology has an impact on the decision of cost management methodologies with following research sub-question.

How is the item typology determining the selection of methods to evaluate the appropriateness of external supplier prices?

The last perception is on the profit impact of the procurement function itself and evaluates the amount of purchasing volume and evaluates if the procurement function is equipped with enough resources to conduct time-consuming cost management methodologies.

Is there a difference between companies with a high importance of purchasing and companies with a small purchasing volume and the use of cost management methodologies?

Methodology

The chapter methodology describes how the empirical study has been designed in order to answer the formulated research questions. One hundred and fifty-two people participated in the created online survey (Table 3). Of all participants, N = 141 completed the whole survey which is also the final sample.

Table 3

Frequency table for industry classification and country of headquarters of participants

	N = 141	%
Industry		
Mechanical and plant engineering	79	56.0
Electrical engineering	8	5.7
Automotive	24	17.0
Chemical	7	5.0
Medical technology	7	5.0
Others	16	11.3
Total	141	100.0
Country of headquarters		
Germany	99	70.2
Rest of Europe	23	16.3
US	11	7.8
Asia	6	4.3
No answer	2	1.4
Total	141	100.0

A detailed overview of the industries the participants' companies are operating can be seen in Table 3. Most of the participants (with *n* = 79) work in companies of mechanical and plant engineering and in the automotive sector (*n* = 24). The table also shows the origin country where the companies' participants work. Companies with its headquarters in Germany (*n* = 99) account for 70 per cent. Rest of Europe equals *n* = 23 participants or 16 per cent. Only a small percentage of participants comes from the US and Asia (second part of Table 3).

The research was conducted through an anonymous online survey using the web-administered platform www.umfrageonline.com. The research took place over a period of two months running from mid-August to mid-October 2019. The research is only conducted once and not repeated and the survey is done in the two languages English and German. During the eight-week period the survey was promoted in different ways. The survey consisted of 14 questions with a duration of five minutes.The population frame consisted of respondents that are members of professional associations (e.g. BME, VDI and CIPS) and personal contacts of the author.

This sampling method is the main limitation of this research. A specific problem of online surveys is a random sample bias. The participants are selected passively in a convenience sample based on non-random criteria and not every individual has the same chance of being included in the sample. This type of sampling is easier and cheaper to access, but conclusions about the whole population are limited. With only a convenience sample, it is not possible to produce generally valid results. In this study, a mixture of convenience sample, purposive sample and snowball sampling was used.

In the purposive sample, strategic purchasers were targeted through search functions of the social networks XING and LinkedIn, in order to address the right target group. This approach was based on a random selection of employees in the strategic procurement function, but the main limitation is its assumption that all purchasing managers are members within the LinkedIn and XING network, which is not the case. Therefore, people which are not part of business-related social networks had no chance of being surveyed.

Empirical Results

This chapter shows the results related to the developed the research questions. The first research question asks for the suitability of cost methods in industrial companies. The results show that in reality cost-breakdowns are not the preferred instrument to evaluate supplier prices related to the business model (Table 4). Instead, price comparison is more often best rated with 37.9 per cent compared to 33.6 per cent of participants which decided for cost-breakdowns as the best instrument.

Table 4

Frequency table for best methods chosen by all participants

	Frequency	Valid Percent	Cumulative Percent
Cost-Breakdowns	47	33.6	33.6
Price Comparison	53	37.9	71.4
TCO	28	20.0	91.4
PP	8	5.7	97.1
Others	4	2.9	100.0
Total	140	100.0	
Missing	1		
	141		

Hypothesis two states that a holistic concept of bottom-up and top-down approaches instead of using each method by oneself is most used in industrial practice. The results of the survey show the number of participants (or companies) that use one or both approaches. The majority of participants with *n* = 100 answered that they use a combination of bottom-up and top-down approaches, which equals 70 per cent.

For the purpose of this study, the dependent variable part characteristic is also tested for the amount of methods used by the participants (Table 5). An independent t-test is done to test hypothesis three, the difference between the mean values *M* = 5.0 and *M* = 6.1 specifies a range of values within which the means of the populations may lie.

Table 5

Descriptive statistics of the group variable part characteristics and number of used methods

Part Characteristic	N	M	SD	SEM
Serial/ repeat parts	105	6.057	2.645	.258
Project-specific one-time requirements	36	5.000	2.651	.442

Levene's test for equality of variances shows that the variances of the two samples groups do not differ (p = *.994*) (Table 6).

The p-value of the t-test for equality of means shows siginificance (t (139) = 2.07, p = .04). In conclusion, the group with serial parts (M = 6.06, SD = 2.65) is significantly different than the one-time requirements group (M = 5.00, SD = 2.65). The two groups differ and we can confirm the hypothesis three.

The next hypothesis four examines differences in the item typology. Kraljic categorises parts with a high importance of purchasing into strategic and leverage items, so we have to transform our two scale variables with the sum of answers for strategic and leverage items into a new variable called 'items with high profit impact'. The same has to be applied for non-critical and bottleneck items in SPSS to items with low importance of purchasing. The hypothesis is following.

Non-critical and bottleneck- items will have a lower usage of cost reduction instruments than strategic and leverage items.

To test the hypothesis, we conduct an independent samples t-test for the two transformed scale variables. From the sample statistics of Table 7 we can conclude that the means of items with high profit impact (M = 3.447, SD 1.791) do differ significantly from those with low profit impact (M = 2.340, SD = 1.281). Table 8 shows that for t (140), p < 0.001 so we can conclude there is a statistically significant difference between parts with a high profit impact (means strategic and leverage items) and parts with a low profit impact (means non-critical and bottleneck items). In addition, items with a high profit impact also have a higher use of methods compared to the sample group, which can be seen on the positive indicator with M = 1.106 (see Table 8) and hypothesis four is strongly supported.

Table 6
Independent samples t-test for the variables part characteristics and used methods

	t-test for Equality of Means				
	Sig. (2-tailed)	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
				Lower	*Upper*
Equal variances assumed	*.040*	*1.057*	*.511*	*.04648*	*2.068*
Equal variances not assumed	*.043*	*1.057*	*.511*	*.03373*	*2.081*

Table 7

Descriptive statistics for parts with high and low profit impact

	M	N	SD	SEM
Items with high profit impact	3.447	141	1.791	.151
Items with low profit impact	2.340	141	1.281	.108

Table 8

Results of independent samples t-test for parts with high and low profit impact

	M	SD	SEM	Lower	Upper	t	df	Sig. (2-tailed)
Items with high profit impact - Items with low profit impact	1.106	1.589	.134	.842	1.371	8.269	140	.000

The last hypothesis five states that companies with a high purchasing volume will have a higher use of cost management methodologies than companies with a low volume.

We cannot find empirical evidence with statistical testing for a linear correlation between the purchasing volume and the number of methods used. But the mean scores do vary for the amount of purchasing volume in for low purchasing volumes (Table 9). Companies with a small purchasing volume of *under 10 M. euro* only use on average of *M* = 4.2 methodologies for all items, whereas this number is rising until M = 6.3 methods for companies with a volume between *501 – 1,000 M. euro*.

The results of hypothesis testing enable conclusions to be drawn about the research questions of the theoretical part. The distribution of frequencies shows that the method most commonly used and best rated is not cost-breakdown, but price comparison. An analysis of all survey answers shows that the usage as well as the rating of methods has price comparison as the leading instrument due to its simplicity. Therefore, the first hypothesis is rejected. The second hypothesis deals with the question of which type of approach is used more often, top-down, bottom-up or a combination of both. Again, frequency distribution is conducted and shows that two thirds of all participants use both approaches together. This supports the formulated hypothesis. The third hypothesis examines the relationship between the part characteristic and the use of cost methodologies. Hypothesis three proves that there is a relationship between part characteristic and the use of methods. Hypothesis four examines the relation between item typology and the use of cost methods. The assumption states that items of strategic relevance will have a higher use of methods than items with a low profit impact. A paired samples t-test shows that there is a statistically significant difference between the two variables and for parts with strategic relevance a higher use of methods is proven. The fifth hypothesis is related to the company size and the use of cost methods. Considering the purchasing volume in a hypothesis we see that we can find evidence for a difference in means.

Table 9
Descriptive table for comparison of means by purchasing volume and sum of methods

	N	M	SD	SEM	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
< 10 Mio. €	5	4.200	3.347	1.497	.045	8.355	.00	8.00
10 - 100 Mio. €	39	5.359	3.191	.511	4.325	6.393	.00	12.00
101 - 500 Mio. €	53	6.019	2.033	.279	5.458	6.579	2.00	11.00
501 - 1,000 Mio. €	14	6.286	2.972	.794	4.570	8.002	.00	11.00
> 1,000 Mio. €	29	5.931	2.764	.513	4.880	6.982	1.00	11.00
Total	140	5.779	2.685	.227	5.330	6.227	.00	12.00

Summary

This final chapter will give answers to the defined research questions and summarise the theoretical and empirical findings. These findings will be illustrated in the developed *Cost Management Methodology Portfolio Matrix* and the reader can find conclusions for practical implementation. At the end, the work will give recommendations regarding the future direction of research activities in this specific area.

This thesis has the goal to describe and compare existing cost management methods in order to later evaluate them in industrial application with quantitative research. The theoretical comparison has come to the conclusion that different parameters determine the usage of specific methods. According to the literature research the main drivers for selection of the appropriate methodology are purpose, effort, part characteristics, company size and item typology.

By concentrating on manufacturing and industrial companies a survey was designed to collect data for the purpose of this research and to analyse whether industrial companies apply cost management methodologies for sustainable cost reductions of purchased parts. Five hypotheses are designed to test the usage of the four methodologies Price Comparison, Total Cost of Ownership (TCO), Performance Pricing (PP) and Cost-Breakdown Analysis.

In addition, the dependent variables for the usage of these instruments, defined in the theoretical part of this article, are tested. The survey results show, that the variables company size and percentage of purchasing cost related to total costs do not influence the usage of cost methodologies. Instead, statistical testing proves the influence of the parameters part characteristic, purchasing volume and item typology. The importance of a purchased part clearly defines the amount of cost methodologies companies use. In general, the research also showed that most companies use a mixture of bottom-up and top-down approaches, which is a meaningful result for further research. The methodologies most used are Price Comparison and Cost-Breakdown Analysis, whereas TCO and PP are less used and also not very familiar to most of the survey participants.

The different parameters to distinguish and classify methods are clustered into the five sections *Time, Methodology, Company, Data and Object*. This clustering will be evaluated with the results of the data analysis and testing of hypothesis. The results of the survey show that price comparison is the most used cost methodology. Reflections on this result lead to the conclusion that the simplicity and speed of the method are of advantage in contrast to other methods. Another outcome of the data analysis is the realisation that companies use both top-down and bottom-up approaches in order to achieve sustainable cost reductions. In reality, most times a mixture of instruments that complement each other is used.

In the empirical research no evidence is found that the number of employees and company size or the relation of purchasing costs does have significant influence on the use of cost methodologies. Instead, the parameters part characteristic, purchasing volume and importance of purchasing items are the key characteristics for choosing the appropriate cost management methodology. These empirical results will be summarised in Figure 2 and Figure 3.

The study shows that the part characteristic determines the amount of methods used. In order to summarise the results of this academic paper, the *Cost Management Methodology Portfolio Matrix* is developed to illustrate the results. The two cases repeat/ serial parts and project-specific one-time requirements are differentiated and stand for each figure.

The part characteristics defined by Kraljic (1983) will be the basis for displaying the results and divide the four-field matrix into leverage items, strategic items, non-critical items and bottleneck items.

The third parameter of illustration is the purchasing volume. The study has shown that there is a significant difference in the number of used methods between companies with high and low purchasing volume. This leads to the definition of three purchasing volume grades which are *less than 10 million euro*, *ten to 100 million euro* and *more than 100 million euro*. The three parameters are the basis of the developed matrix for illustration of survey results. The number of methods is based on the statistical results of the survey, but the type of method is chosen with regard to the theoretical part, as the research shows that part characteristic does not correlate with the preferred cost method.

The matrix is structured with the typology of four main purchasing categories for classification of purchased items developed by Kraljic (1983) and modified for the purpose of illustration of results. The vertical axis represents the importance of purchasing for the selling party and the abscissa shows the complexity of the supply market. Figure 2 stands for serial parts, Figure 3 for project-specific one-time requirements.

Legend: Methods		Purchasing volume
PC	= Price Comparison	▲ = < 10 Mio. €
TCO	= Total Cost of Ownership	▲ = 10 – 100 Mio. €
LPP	= Linear Performance Pricing	▲ = > 100 Mio. €
CB	= Cost-Breakdown	

Figure 2: Cost Management Methodology Portfolio Matrix for serial/ repeat parts

The colored triangles represent the use of a methodology depending on the purchasing volume. All four methods are displayed in each quadrant, but not always every method is used.

Non-critical items only have on average 1.1 used methods, which is the reason for the low number of proposed methods in the bottom left of the matrix. Bottleneck items have on average 1.2 used methods, leverage items 1.6 and strategic items rank highest with 1.9. Serial parts and one-time requirements also differ in the average amount of uses, with an average of six methods for serial parts compared to five methods, which is the reason for the lower number of triangles in Figure 3. The two figures do differ in their amount of used methods and also the distribution. The purchasing volume affects the amount of methods, because for a volume lower than ten million euro, the empirical research has shown that only four methods are used. This is the reason for the lower number of blue triangles in both figures.

Companies with a purchasing volume between ten and 100 million euro use on average five methods in all four quadrants (red triangles). Companies with more than 100 million euro purchasing volume use up to six methods which are displayed with black triangles in the matrix. The described values are the empirical result of the study but represent only a recommendation for the allocation of methods to the four quadrants, as also the theoretical results are taken into account.

Figure 3: Cost Management Methodology Portfolio Matrix for one-time requirements

The empirical study has shown that Price Comparison is the most applied method in industrial practice and therefore most allocated in both figures. In particular, for items of low strategic importance only Price Comparisons are conducted, regardless of the part characteristic and purchasing volume. This is the reason why both figures use the method Price Comparison in their lower quadrants. For serial/ repeat parts more and also different methods are used. Cost-Breakdown Analysis, TCO and also PP can all be used for serial parts with strategic relevance. For a large quantity of items, the Performance Pricing approach is recommended, which is only known by large companies and therefore not considered for a purchasing volume below 100 million euro. PP can be best used for serial parts but in general purchasing managers are not very familiar with the method and need special training. The bigger the size of a company the more detailed and advanced is the Cost-Breakdown method and also more applied. Large companies use a Cost-Breakdown Analysis for almost all serial parts of their procurement volume, the TCO-approach is most suitable for one-time requirements. The matrix does not consider the targets of the different cost management methods, only the use. Therefore, the summary of goals done in the literature review should also be taken into account.

Limitations of the Research

The main limitation is the assumption of a random sample, when conducting a mixture of convenience, snowball and purposive sampling. As a result, the possibility of a random sample bias within the survey cannot be completely excluded. The chance of wrong responses from participants outside the procurement function is small, but exists. Ten per cent of all participants, or 14 in total do not work in a field of activity in the procurement and might have misunderstood or misinterpreted the questions.

Another issue of the survey has been the wording of questions nine to 13, which leads to interferences in the testing of the assumptions. Question nine asked for the familiarity with methods, question ten rated the methods from one (no suitability) to five (very good suitability), question 11 asked for the best suitable method related to the business model and question 12 for the use of methods under consideration of the item typology. Hypothesis three has been tested with question 11, all other hypotheses are related to question 12, which allowed to count the amount of answers and to convert them to scale variables. Wrong decision on statistical tests is possible, for hypothesis a linear relation was assumed but cannot be proved.

Achievements of the Research

The initial motivation for this article was the limited literature for cost methodologies in English (especially for PP) and a lack of knowledge on the industrial application of methods. Both research needs are satisfied with the results of this academic paper, as the reader will get an overview of all cost management methods and the industrial use is empirically evaluated. This article contains the first research which evaluates the parameters that influence the choice of the cost instruments Price Comparison, Cost-Breakdown Analysis, TCO and PP. Also, all methods are structured according to their purpose. These results are connected with the empirical findings in a developed *Cost Management Methodology Portfolio Matrix* that represents the main achievement of the research. This matrix gives the reader a recommendation of which instruments are to be used after consideration of the part characteristic, purchasing volume and item typology. In addition, this study has proven the assumption that a holistic approach of top-down and bottom-up instruments is best suitable in industrial practice.

Further Research Fields

Purpose of this paper is to stimulate further research in this area and to give recommendations for future research fields. The research evaluated the use of cost instruments depending on different parameters which are part characteristic, purchasing volume and item typology. Proch (2013) also stated that the type of industry has to be considered. This research focused on mechanical and plant engineering and in general the industrial area, so a comparison with other industries is still outstanding.

Performance Pricing is a fairly unknown approach which is confirmed within this study. Despite the achievable results with linear or non-linear tools of the Performance Pricing method many companies do not apply this approach. Reasons according to the literature are the high effort and the needed technical know-how to evaluate the analysis. The underlying assumptions are also difficult to interpret which is why so many companies do not consider this method. To prove the success of this instrument, an investigation on the performance of purchasing departments successfully applying the described cost method is needed. This research should concentrate on the parameters effort and resulting savings. The research can also take into account the influence of a supplier-buyer relationship, which is as well not considered in this research. A possible assumption would be that saving results are higher in co-operative supplier-buyer relationships than in adversarial.

In addition, the correlation of the combinations of bottom-up and top-down methods is not analysed in this research. For the definition of a pair of methods the correlation between different instruments can be analysed. For testing this assumption, data of this research can be used. The study was conducted in a theoretical and empirical part with the analysis of quantitative data. A research done with best practice examples in the industrial application can prove the effectiveness of each method and would be a useful addition. Another parameter that can be taken into account is the type of purchasing organisation (Vögele, 2008, p.137). Depending on the stage of development of the procurement function, the result in savings achievements differ. The assumption is that achieved savings and the type of purchasing organisation correlate, as large corporations are more advanced in the procurement function than small and medium-sized companies.

About the Author

Fabian Schmidt studied Business Administration and Engineering with a specialization in International Technical Sales at the Baden-Wuerttemberg Cooperative State University in Ravensburg. After that, he worked as a Purchasing Manager for the company Coperion before entering the part-time MBA-program at the Professional School of Business and Technology in Kempten. He currently works as a Strategic Category Manager for pressure and gas equipment for Coperion in Weingarten.

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