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Topic: **The development of a method for the identification of innovation from suppliers based on a supplier assessment illustrated on the example of the company TRILUX GmbH & Co. KG**

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List of abbrevations

APQP advanced product quality planning

AVE average variance extracted

BP business problem

CB-SEM covariance-based structural equation modelling

CELMA Federation of National Manufacturers Association for Luminaries and Electrotechnical Components for Luminaries in the European Union

CEO chief executive officer

CR composite reliability

D/A/CH Germany (D), Austria (A), Switzerland (CH)

ECG electronic control gear

ESI early supplier involvement

FMEA failure mode and effects analysis

ITC Innovation and Technology Centre at TRILUX

KPI key performance indicator

LED	light-emitting diode
MoLiBe	Monatliche Lieferantenbewertung (monthly supplier evaluation)
NDA	non-disclosure agreement
NPD	new product development
NPDP	new product development process
OEM	original equipment manufacturer
OLED	organic light-emitting diode
PCS	preferred customer status
PLS-SEM	partial least squares structural equation modelling
R^2	coefficient of determination
R&D	research and development
ROI	return of investment
SEM	partial least squares structural equation modelling
SRMS	Supplier Relationship Management System
TRILUX	TRILUX GmbH & Co. KG
USP	unique selling proposition
WCM	world class manufacturing
ZVEI	Zentralverband Elektrotechnik und Elektroindustrie e.V German Electrical and Electronic Manufacturers' Association

1 Introduction: supplier innovativeness evaluation as a path for innovation identification

1.1 Opening context: raising pressure for supplier innovativeness evaluation

"Globalization and increased competition may squeeze margins and profits."[1] Furthermore the focus on core competences leads companies to a state, where 60% till 80% of the total cost of a company are assigned to the purchasing expense.[2] Therefore decisions about purchasing strategies and operations are primary determinant of a company's profitability.[3] Furthermore Sivadas and Dwyer argue that "(…) nearly 50% of the new products introduced in the marketplace each year fail, causing considerable financial loss and embarrassment to their promoters."[4] Additionally according to Ragatz et al. within that last decade, the fast pace of technological change shortened product life cycles and globalization of markets have resulted in renewed executive focus on new product development process (NPDP).[5] In such highly competitive environment each enterprise need to identify any kind of opportunity in order to improve its performance.[6] "By using supplier's additional resources, skills and capabilities, especially greater design responsibilities, companies can develop and maintain a competitive advantage by reducing costs and cycle time and by offering more customized product characteristics or better product quality."[7] The idea of getting innovations from suppliers is not a new idea, but rarely organizations implement this idea into its reality to its full expansion.[8] A reason for a such low implementation rate according to Sucky is the fact that "supplier selection decision at the strategic level are focused on strategic items with both a high supply risk and high profit impact."[9] Therefore a key step in order to optimize its business process is the supply partner selection.[10] However Wagner shows additional the importance of different approach of managing an innovation supplier and productivity supplier.[11] Also the expectations of an enterprise are different towards an innovation supplier than a

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[1] Berghman et al. (2012), p. 27.
[2] See Ballmer (2003), p. 947.
[3] See de Boer et al. (2001), p. 75.
[4] Sivadas/Dwyer (2000), p. 31.
[5] See Ragatz et al. (2002), p. 389.
[6] See Wu/Barnes (2011), p. 256.
[7] Fliess/Becker (2006), p. 28.
[8] See Disselkamp (2012), p. 47.
[9] Sucky (2005), p. 1.
[10] See Mikhailov (2002), p. 394.
[11] See Wagner (2009), p. 8.

productivity supplier, namely the involvement concerns the integration of the capabilities of the innovation supplier to the new product development process (NPDP) into the industrial production of the enterprise.[12] This includes tasks, responsibilities, service regarding the product and last but not least the process in partial way.[13]

However before the buyer company is even able to select its supplier, it has to identify the innovative one among its own supplier base. Bruno et al. states that "the supplier evaluation process allows the selection of suitable suppliers in order to develop a supply relationship system able to rapidly react to market requirements and to innovation dynamics."[14] In contrast, Wagner argues that "despite critically of selecting suppliers for innovation activities, firms traditionally limit their assessment of the suppliers' technological and commercial capabilities."[15] For that reason there is an urgent need for a more systematic and transparent approach to the selection process of innovative suppliers at enterprises. Although there is an increasing number of researchers who aim to develop different kind of methodologies to cope with this problem.[16] "Nevertheless, while the number of applications is growing, there is little empirical evidence of the practical usefulness of such tools."[17] Therefore the following thesis has the purpose to deliver insight about such evaluation process with the emphasis on the problems emerging during a practical implementation, on the strengths and weaknesses of such a solution and last but not least on the input from practitioners and managers involved in the decision making process in the purchasing department. As an example for the illustration will be used the evaluation process of a supplier innovativeness assessment at a German enterprise from an industry with a high disruptive potential due to the technological impact of the light-emitting diode (LED) - TRILUX GmbH & Co. KG (TRILUX).

1.2 Introduction of instruments: innovation metrics as a tool for supplier innovation capabilities assessment

"Measurement implies commensurability: that there is at least some level on which entities are qualitatively similar, so that comparison can be made in quantitative terms."[18]

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[12] See Wagner (2009), p. 8.
[13] See Johnsen (2009), p. 187.
[14] Bruno et al. (2012), p. 159.
[15] Wagner (2009), p. 8.
[16] See Bruno et al. (2012), p. 159.
[17] Bruno (2012) p. 159.
[18] Fagerberg (2006), p. 149.

Additionally analysis and decision making takes not irrelevant timely and credible measures.[19] According to Hauser et al. good innovation metrics are important for the following reasons:[20]

1. Documentation of the value of research and development (R&D) for justifying investments and effective allocation of limited company resources
2. Source of objective data for managers in order to make informed decision with a long term outlook about usually risk-involved innovation projects
3. Alignment employees' behaviour with the company goals through employee evaluation on specific innovation metrics

On the opposite the consequence of bad metrics lead to poor diagnosis which results in poor or wrong business decisions with unintended consequences at a company level.[21] For that reason in order to understand the innovation metrics, it takes a step back and a closer investigation on the phenomena which is measured, namely innovation. The Austrian economist Schumpeter defined innovation over 70 years ago as:[22]

1. The introduction of a good (product), which is new to consumers, or one of higher quality than was available in the past.
2. Methods of production, which are new to a particular branch of industry. These are not necessarily based on new scientific discoveries and may have, for example, already been used in other industrial sectors.
3. The opening of new markets.
4. The use of new sources of supply.
5. New forms of competition, that leads to the restructuring of an industry.

In other words innovation can be defined as follows: "Innovation is a process through which the nation creates and transforms new knowledge and technologies into useful products, services and processes for national and global markets – leading to both value creation for stakeholders and higher standards of living."[23] Such a description of innovativeness evaluation reflects the current state of the phenomena, which is very complex and has multiple dimensions and also implies the need for an improved measurement, which fits the raising knowledge economy, because "currently available

[19] See Milbergs/Vonortas (2004), p. 2.
[20] See Hauser (1997), p. 1.
[21] See Milbergs/Vonortas (2004), p. 2.
[22] Schumpeter (1961), p. 19.
[23] Milbergs/Vonortas (2004), p. 2.

measurements largely reflect the industrial era"[24], where the final aim is a "successful exploitation of new ideas."[25] As a result the whole evaluation process of the innovativeness of the supplier regarding its competence and practice is a very complex issue for most enterprises, which additionally has high impact of the innovation capability of its own enterprise.[26]

On the contrary "the literature is characterised by a diversity of approaches, prescriptions and practices that can be confusing and contradictory."[27] For that reason the key problem with innovation metrics is the underlying conceptualization of the measured object, the feasibility of the measurement itself last but not least the meaning of the measurement concept.[28] As consequence of the complexity most enterprises focus only of obvious metrics of innovation in terms of spend, speed to market, numbers of new products and miss the process in-between[29], where such a view on metrics is very limited and do not measure the company's overall innovation capability.[30] As a result Muller et al. argues that such metrics neglect the business concept innovation.[31] Therefore a good innovation metric framework combines the following 3 views according to Muller et al.:[32]

1. Resource view - with the aim of balancing the company's limited resources.
2. Capability view - namely the assessment of the company's own competencies, culture and condition for fostering innovation.
3. Leadership view - the degree to which a company's leaders supports innovation activities in the organization.

Although an optimal selection of innovation metrics is a customized product according to needs and aims of the particular company. "A generalized measurement framework specified at the level of the organization would provide a useful basis for managers to monitor and evaluate their innovation processes, diagnose limitations and prescribe remedies."[33]

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[24] Milbergs/Vonortas (2004), p. 2.
[25] Luxembourg (2005), p. 46.
[26] See Adams et al. (2006), p. 21.
[27] Adams et al. (2006), p. 21.
[28] See Fagerberg (2006), p. 149.
[29] See Adams et al. (2006), p. 22.
[30] See Muller et al. (2005), p.2.
[31] See Muller et al. (2005), p.2.
[32] Muller et al. (2005), p.2.
[33] See Adams et al. (2006), p. 2.

1.3 Research objectives of the thesis: what are the benefits of reliable and valid innovation metrics for a company?

As described in previous sections in a global economy, which is constantly changing and more demanding, in order to stay competitive on the market a company has to secure a sustainable supply of continuous innovations. Moreover in recent decades a major shift in the innovation process took place. "In an environment characterized by open innovation, the locus of innovation is moving out of the laboratory of a single, self-contained firm and into a network of collaborating partners."[34] Among the different partners a very important role in this picture are playing the suppliers. Especially suppliers constantly able to deliver innovation to its customer. As an example most patents in the automotive industry nowadays are registered by the suppliers.[35] On the company level at the moment at TRILUX there is a need of a holistic and systematic tool in order to evaluate the capabilities of a supplier base to identify prospects for new product development work. For that reason the focus is to deliver a best-researched method that allows the purchasing department, especially category management function, to efficiently contribute to the early supplier involvement in a new product development project.[36] Therefore the research will focus on the investigation of the criteria, which could help to estimate a supplier regarding its capabilities for innovation and in the next step the design of a supplier questionnaire with the chosen criteria.

However since 50 years an ongoing debate among researchers about the issue of separation the management research and the management practice takes place.[37] On the one hand researchers warn that such a separation is "likely to result in irrelevant theory and in untheorized and invalid practice."[38] On the other hand some academics remains sceptical of the involvement of practitioners into an academic research and academia due to "double hurdle" rate, namely the lack of relevance and rigor.[39] As a result academics applying joint venture research methods still have to justify such a methodological choice.[40] Therefore in order to deliver most beneficial results for both worlds, the scholar and the practitioner,

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[34] Schiele (2012), p. 44.
[35] See Schiele (2012), p. 44.
[36] See Schiele (2010), p. 139.
[37] See Schiele/Krummaker (2011), p. 1137.
[38] Hodgkinson et al. (2001), p. 391.
[39] See Schiele/Krummaker (2011), p. 1137.
[40] See Schiele/Krummaker (2011), p. 1137.

this thesis will apply the methodology of a design-focused and theory-based problem solving approach combined with a participatory action research approach. The aim of using these methodologies for conducting this research is the issue of closing the gap of relevance between knowledge production and knowledge transfer[41] and test the usefulness of a developed holistic framework covering range of activities in order to turn supplier ideas into useful and marketable products. For the statistical analysis a partial least square method will be applied by using SmartPLS software due to the fact of a small sample size.

The main objectives of the thesis are:

1. Description of the manufacturing industry from a perspective of a leading company from Germany for lighting solutions during a disruptive technology emergence, namely the LED.
2. Development of a method in order to assess innovativeness of the supplier base of a company in the manufacturing industry, which allow the purchasing department an effective judgement about suppliers' innovation capabilities.
3. Conducting insight to the current body of research work about the application results of the chosen innovation metrics (criteria) within the supplier questionnaire tested at a pilot supplier base of an enterprise in the manufacturing industry in Germany.
4. Supporting the scholar-practitioner joint venture research approach by delivering relevant results according to rigorous academic criteria.

1.4 Problem definition: how to identify suppliers with innovation potential for new product development projects for an enterprise?

"As more and more companies are outsourcing parts of their new product development (NPD) activities to suppliers, it is not surprising to find that research into how to manage supplier involvement in NPD and innovation has greatly expanded during the last 30 years."[42] In order to secure steady creation process of new products, which increase sales, profits and competitive strength "(…) many organizations are entering business alliances to overcome the inherent risk associated with new product development and to manage the innovation process and outcome better."[43] Therefore an "effective integration of suppliers

[41] See Schiele/Krummaker (2011), p. 1137.
[42] Johnsen (2009), p. 187.
[43] Sivadas/Dwyer (2000), p. 31.

into the product value/supply chain will be a key factor for some manufacturers in achieving the improvements necessary to remain competitive."[44] Where the key success factors are: quality, time-to-market, cost-price-relationship, customer-oriented full service solutions and last but not least innovation capabilities.[45] In a modern world companies must exploit their innovative capabilities to develop new businesses if they are to successfully confront the disruptive effects of emerging technologies, empowered customers, new market entrants, shorter product life cycles, geopolitical instability, and market globalization.[46] "In every industry, the leading companies are the innovators."[47] However reaching the status of industry leader do not automatically secure a sustain innovation supply. For that reason the real problem is not the lack of innovators, but a lack of sustainability of innovation in a particular company, which aims for a leadership position in the particular industry.[48] Although there are new expectations regarding the supplier base, there is still a lack of practical evidence for application solutions. At this point the previous research covering the topic of fostering innovations from and with suppliers left a gap for reliable and valid models of innovation assessment of their supplier base. Moreover, a one-to-one copycat approach of such models from multinational companies is not meeting the particular needs of the particular industry namely the lighting industry and its own supplier base characteristics. Previous research shown, that there are not more than 12 innovative suppliers per company and usually a collaboration time period between a supplier and its customer last approximately 10 years before a shared new product development project get started.[49] As a result the issue of scare pool of only few innovative suppliers rise, sometimes even only two or three for a particular category. Therefore there is an urgent need to identify innovative suppliers in order to enable the development of a future oriented supplier-customer relationship as soon as possible. As consequence it is highly important to develop a method of supplier base assessment customized for companies like TRILUX in order to identify innovative suppliers, because a constant innovation supply secures a company's ability to stand the pressure of producers from low-wage countries. Furthermore as more firms develop their own relevant and validate innovation metrics the market in person of managers, investors and analyst will be

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[44] Ragatz et al. (2002), p. 389.
[45] See Ballmer (2003), p. 947.
[46] See Muller et al. (2005), p. 1.
[47] Muller et al. (2005), p. 1.
[48] See Muller et al. (2005), p. 1.
[49] See Schiele (2010), p. 45.

able to assess particular company's innovation capabilities with an ease like current applied concepts of market share, leverage and economic value added.[50]

1.5 Description of the company: TRILUX GmbH & Co. KG[51]

1.5.1 General information about the enterprise and its purchasing department

TRILUX GmbH & Co. KG (limited liability company) further called TRILUX was founded in 1912 in Menden, North Rhine-Westphalia in Germany by Wilhelm Lenze. The delivered solutions convince its customers with intelligent technologies for higher energy efficiency, unique design and high-end quality. Additionally TRILUX offers much more than only a lighting product, it supports its customers from the idea generation through the design of the solution and its application till the service of the implemented product. TRILUX currently employs 5.500 employees worldwide, within 1.500 employees only in Germany. The headquarter is in Arnsberg, North Rhine-Westphalia, but TRILUX production facilities are in the following countries: Germany, Spain, India, Philippines, China, where the European one are responsible for the luminaries segment and the rest of the world for the electronics segment. Moreover, the company operates (sales) in 12 countries: Belgium, France, Great Britain, Italy, the Netherlands, Austria, Poland, Switzerland, Slovakia, Spain, Czech Republic and Hungary. TRILUX established 5 major retail cooperations for each continent and more than 100 sales partnerships. TRILUX operations covers 2 main strategic business areas: luminaries and electronics. In the luminaries segment TRILUX is the market leader in Germany and in the top 3 in Europe in terms of market share. In the electronics sector it is no. 4 in Europe. The luminaries business segment is divided into following segments fields divided by application: indoor lighting, outdoor lighting, medical lighting, shop lighting, water-proof luminaries and last but not least project solutions. TRILUX turnover share by origin for the best year in the history of the company (2011) for its luminaries segment was: 51% Germany, 42% Europe, 7 % rest of the world. Splitting the turnover share for 2011 by application it was like follow: retail 22%, education 20%, office 16%, health 16%, industry 14%, outdoor lighting 10%.

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[50] See Muller et al. (2005), p.10.
[51] See "TRILUX fact sheet 2013" prepared and delivered by public relations department

Innovation was always a big issue for the company. Here is a brief historical overview of recent innovation milestones:

2004 TRILUX introduced to the market the first downlight with LED

2008 TRILUX change its complete indoor lighting portfolio on electronic control gear (ECG) as first lighting manufacturer

2009 TRILUX introduced the first real energy-efficient LED for indoor lighting and outdoor lighting

2010 TRILUX introduced the first functional organic light-emitting diode (OLED) with application possibilities in the office

TRILUX main research areas are: light and health, offices of the future, innovative control concepts. The company also poses an extensive in-house electro-technical laboratory within the largest “Ulbricht sphere” in Europe. The "Ulbricht sphere" is an integrating sphere consisting hollow spherical cavity with an interior covered with white reflective interior with small holes for entrance and exit of the light. Due to its construction the light within the "Ulbricht sphere" is evenly distributed over all angles and therefore the total power (flux) of a light source is measured without inaccuracy caused by the light source itself.

Pic. 1: Ulbricht sphere

Source: retrieved from http://www.nyteknik.se/nyheter/energi_miljo/energi/article3522851.ece (access 30.01.2014)

Furthermore due to its leading position with efficient lighting TRILUX is the official partner of “Energy Efficiency Made in Germany” an initiative of the Federal Ministry for Economics and Technology in Germany. TRILUX partnership strategy covers following

areas: committees and associations (ZVEI - German Electrical and Electronic Manufacturers' Association, CELMA - Federation of National Manufacturers Association for Luminaries and Electrotechnical Components for Luminaries in the European Union); components technology partnership with CREE, SHARP; luminaries technology partnership with PHILIPS, SAMSUNG and last but not least in the field of standardisation and research it is the founding member of The Zhaga consortium and a photometry representative in this organization. "The Zhaga is developing specifications that enable the interchangeability of LED light sources made by multiple different manufacturers. Furthermore The Zhaga specifications, known as Books, describe the interfaces between LED luminaries and LED light engines."[52] Additionally to this TRILUX cooperates with OSRAM AG, BJB GmbH & Co. KG and MERCK in the raising field of OLED. More than 90% of all investments are used for LED products, which resulted in several design award like Good Design Award, reddot design award, Product Design Award. Since 2011 TRILUX established the so called TRILUX Academy in Arnsberg, where it offers seminars for professionals from the lighting industry e.g. own employees, suppliers, buyers etc.

The purchasing department is functional divided in 5 areas presented in the table 1:

#	**Purchasing Unit**	**Function**
1.	General Purchasing (allgemeiner Einkauf)	[redacted]
2.	Operational Purchasing (operativer Einkauf)	[redacted]
3.	Project Purchasing (Projekteinkauf)	[redacted]
4.	Asia Purchasing (Einkauf Asien)	[redacted]
5.	Category Management (strategischer Einkauf)	[redacted]

[52] retreived from http://www.zhagastandard.org/about-us/ (access 13.02.2014)

		[redacted]

Tab. 1: Overview of purchasing department at TRILUX (based on TRILUX's organigram)

The category management itself is divided into following commodities and each commodity is led by a category manager.

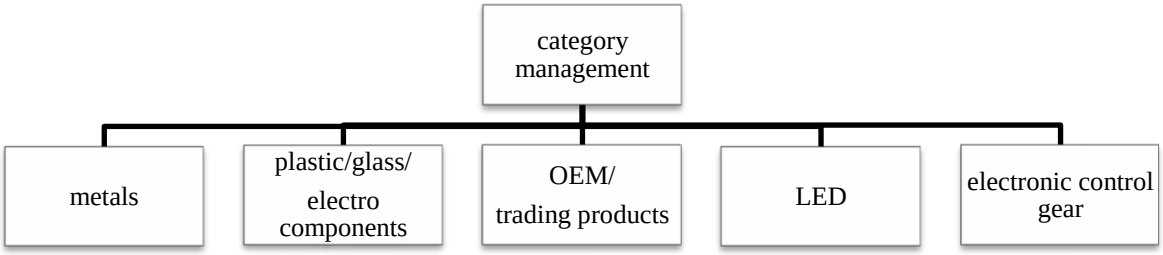

Fig. 1: Overview of category management department by commodity

Source: TRILUX's organigram

In order to stay competitive and constantly innovative the company created in 2012 an Innovation and Technology Centre (ITC) with the function of an innovation hub for its all business units. Moreover this unit also conducts research and development (R&D) activities in particular technologies. Although TRILUX purchasing management does want to tap into the innovation stream of its suppliers, currently there is no tool or procedure for a supplier assessment regarding innovativeness at the purchasing department established. The current process is more informal and person depending, because of the tacit knowledge, which is held by each category manager for the particular commodity. Therefore the aim of this thesis is to develop a method for an innovative supplier identification and create a tool, which can be used on a regular basis in order to conduct continuous supplier assessment in an automated manner.

1.5.2 MoLiBe (Monatliche Lieferantenbewertung): current supplier assessment method

[redacted] [53].

This supplier portal is a new web based tool created with two different goals:

1. Become the main supplier communication tool and therefore automate the current communication process done mostly manually
2. Be an effective working instrument for national or international TRILUX Group suppliers for placing its offers and managing the supplier-buyer relationship efficient

1.6 Outlook of the proceedings during the research project

The main steps of survey research project are[54]:

#	General step description	Particular working step within the thesis project
1.	Formulating the study objectives	Objective: innovativeness assessment of suppliers in an automated manner
2.	Developing the survey instrument	Questionnaire items (indicators) development (pre-step: numerous question pool development)
3.	Pretesting the questionnaire with expert judges	Getting feedback about the questionnaire from each category manager and other experts
4.	Selecting data collection method	Web-based survey tool

[53] Pool4Tool AG company description retrieved from http://www.pool4tool.com/cms/en/europe/company/ (access 18.12.2013)
[54] See Agarwal (2011), p.2.

5.	Pilot testing the questionnaire with sample from the study population	Pilot testing with chosen suppliers ■■■■■■■■■■ ■■■■■■■■■■■■■■■■■■■■
6.	Collecting the main data from the study population and entering it in the excel sheet	Collecting the data from web-based survey tool and entering it into an excel sheet in order to prepare the data in the right format for the statistical analysis with SmartPLS
7.	Analyzing the gathered data and writing and disseminating results	Feeding the gathered data into chosen analysis tool (here: SmartPLS) and running the analysis and in next step report about the results and write recommendations for TRILUX

Tab. 2: Project plan (based on van Aken et al. (2006), p. 54 and Agarwal (2011) p. 2)

2 Literature review on supplier assessment: introducing the theoretical framework

2.1 Supplier innovation assessment: defining the main steps

2.1.1 Introduction into supplier assessment: basic information

The first section of the literature review chapter will provide the reader with an overview of the different aspects, which have to be considered during a supplier innovation assessment process. In the first step an introduction and basic information is provided. The second part describes the underlying theoretical foundations critical for a innovativeness assessment of supplier capabilities. Hereby the focus is on the preferred customer status (PCS) and the cluster approach. In the third step the target of an innovativeness assessment will be described, which is the corner stone of a conceptual development of a reliable and valid supplier assessment method according to Janker.[55] Therefore in this part the reasons for a continuous evaluation of a supplier base and the arising benefits for the supplier and the customer company will be described. The first section ends with an introduction about the way of the information sourcing with the help of the information technologies. The second section of this chapter will provide the reader with a description of ideal innovation metrics with it characteristics as an instrument for valid innovation measurement.

[55] See Janker (2008), p. 80.

Therefore the reader gets also a description of key aspects of innovation metrics. In the third section the reader will be introduced to classifications of criteria and its importance for the supplier innovativeness assessment. In the fourth section the reader gets a description of a supplier classification regarding its innovation potential in order to get insight about the potential outcome of supplier assessment done and its possible categorization.

The supplier assessment is not a standalone task and in order to understand its meaning and process there is a need of definition of the single steps, which take place before and after the supplier assessment. According to Kindermann and Herschel the supplier evaluation is the foundation for supplier management[56] and additional Simpson et al. argues that a proper supplier assessment is decisive for the company's future.[57] Hoffmann and Lumbe during a benchmark study among automotive manufactures support the statement, that a detailed supplier evaluation of the strategic important suppliers was a cornerstone of operational success.[58] If a supplier evaluation is to be considered as a statement of a problem than it can be divide in 5 major steps in order to solve the problem behind it, namely how to make the supplier selection easier and more accurate?[59]
Glantsching introduce the following breakdown shown in table 3[60]:

#	Step	Description
1.	Definition of the aim of the supplier assessment	here: the identification of innovative supplier
2.	Analysis of data about a supplier	Its include tasks like: choice for method, choice of criteria, operationalization of criteria, collecting of information. A prerequisite for well done supplier assessment is a high quality of supplier information research.[61]

[56] See Kindermann/Herschel (2000), p. 123.
[57] See Simpson et al.(2002), p. 39.
[58] See Hoffmann/Lumbe (2000), p. 92.
[59] See Glantschnig (1994), p. 15.
[60] Glantschnig (1994), p. 15.
[61] See Glantschnig (1994), p. 15; See Janker (2008), p. 55.

3.	Rating of a supplier	According to the input from the analysis step the outcome e.g. score for particular supplier. For this particular project it is an innovation index, which is also the basis for the next step.
4.	Supplier choice	According to the outcome of the rating (innovation index) and the needs of the customer company a decision maker can make a decision.
5.	Supplier controlling	After the decision about the supplier choice fall in order to improve the quality of the supplier-customer relationship in regular period of time (e.g. half year, one year) an re-assessment is going to be done also with the not chosen supplier as benchmark. As already mention above a very important issue is the quality of the input used for the supplier assessment.

Tab. 3: Overview of steps during a supplier assessment

Source: Glatsching (1994), p. 19

Furthermore there are also some important requirements for a successful supplier assessment method[62]:

1. Taking into account the aims of the purchasing function
2. Taking into account the current purchasing situation
3. Extensive involvement of different supplier criteria
4. Automation of the supplier evaluation and supplier choice
5. Minor cost and time effort involved in the evaluation process
6. An impartial outcome of the assessment
7. Deduction of managerial recommendation

[62] Glantschnig (1994), p. 19.

2.1.2 Introducing theoretical foundations for innovation assessment: evaluation frameworks based on the preferred customer status (PCS) and the cluster approach

"For a firm resources and products are two sides of the same coin."[63] For that reason the combination of characteristics of firms resources in broad understanding contribute to a sustainable competitive advantage.[64] However, most researchers do not have much to say about the inter-firm relationship like the buyer-supplier relationship.[65] Taking this state into account several extensions, which allow suppliers be considered as valuable company's resource base, have been presented.[66] Therefore by selecting the best fit suppliers and developing with them a symmetric buyer-supplier relationship on different levels can strength both sides of the relationship and result in better access to resources in consequence creating also a unique selling proposition (USP) for the buyer company.[67]

Moreover, taking into account the scarcity in some industrial markets, it allows the supplier to be more selective regarding its collaborations.[68] However, independent from how close the relationship or the overall scarcity of suppliers in the business-to-business markets is, "the firm still has to compete with other firms who are seeking similar close relations."[69] As a result companies which are able to build up close relationships with its strategic suppliers achieve often better returns and higher profits[70], where the critical steps are the reduction of the supplier base to few chosen one and the involvement of the chosen suppliers into the most early stages possible of the new product development process.[71] As consequence it might be very difficult for the competitors to make up for such supplier base advantage in a short time period.[72] As an outcome buyer companies which manage to set up a close buyer-supplier relationship get usually favourable treatment from its suppliers and therefore enjoy the PCS, where operational dimension of the supplying firm

[63] Wernerfelt (1984), p. 171.
[64] See Priem/Butler (2001), p. 23.
[65] See Steinle/Schiele (2008), p. 5.
[66] See Steinle/Schiele (2008), p. 5.
[67] See Wognum et al. (2002), p. 341-342.
[68] See Schiele et al. (2012), p. 1179.
[69] Takeishi (2001), p. 403.
[70] See Takeishi (2001), p. 404.
[71] See Takeishi (2001), p. 404.
[72] See Hunt/Davis (2008), p. 16.

and relational dimension between buyer-supplier ends in strategic dimension for the buyer company e.g. innovation leadership.[73]

The PCS itself is studied since 1980 and according to Nollet et al. during this time period it was differently named.[74] e.g. "interesting customer"[75], "customer of choice"[76] According to Schiele et al. the PCS is described as follows: "A supplier awards a buyer with preferred customer status if this customer is perceived as attractive and if the supplier is currently more satisfied with this customer than with alternative customers"[77] The PCS can have many facets like supply continuity during environmental disasters like flood, delegating the best personnel for the new product development projects for the buyer company as a resident engineer, expand the testing time at supplier labs, product customization, where the last three can directly lead to a better outcome of innovation activities.[78] Furthermore Nollet et al. propose to classify the benefits into five main categories: product quality and innovation, support, delivery reliability, costs and price.[79] Nollet et al. introduce also a four step approach in order to achieve the PCS: 1. initial attraction, 2. performance (meeting supplier's requirements), 3. engagement and 4. sustainability.[80]

Regarding the internal characteristics (buyer-company oriented) the external circumstances namely the cluster membership play also a role. Porter defines a cluster as "(…) geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities (…)."[81] Steinle and Schiele argue that suppliers in the same industry cluster seem to enjoy more often the PCS, especially if production shortages or requests for changes occurred.[82] Additionally companies outside the cluster which where dependant on technology delivered by suppliers out of the specific cluster were not able to establish a strong buyer-supplier relationship with strategic important suppliers.[83] Therefore according to Steinle and Schiele a major advantage of a cluster membership is the ease of achieving the PCS with the local

[73] See Schiele/Kummaker (2011), p. 1141.
[74] See Nollet et al. (2012), p. 1187.
[75] Christiansen/Maltz (2002), p.179.
[76] Bew (2007), p. 1.
[77] Schiele et al. (2012), p. 1181.
[78] See Steinle/Schiele (2008), p.11.
[79] See Nollet et al. (2012), p. 1187.
[80] See Nollet et al. (2012), p. 1186.
[81] Porter (2008), p. 199.
[82] See Steinle/Schiele (2008), p.10.
[83] See Steinle/Schiele (2008), p.10.

suppliers.[84] Especially, in the case that the number of innovative suppliers is very small, usually not more than a dozen suppliers per company with an average cooperation duration of more than 10 years.[85] Therefore in order to develop a method for innovative supplier identification it takes a new category criteria described by Schiele as "strategic supplier selection criteria" with the aim to estimate a PCS of the buyer firm[86], where the PCS can be the cornerstone of integration of innovative suppliers into new product development projects of the buyer company and operational excellence of collaboration between the supplier and the buyer company.[87]

2.1.3 Evaluation goal: why evaluating a supplier regarding innovation capabilities makes sense?

The general function of supplier assessment is to check how far a supplier fulfils the requirements for the products or service which are needed at the customer company.[88] Therefore in the process of the method development for identification innovative supplier the aim is to capture all relevant factors, operationalize them and build a relative importance among them in order to make a decision possible which supplier for what reason to choose.[89] Furthermore the benefits of a supplier assessment are for both parties involved in the process.[90] The manufacturer knows with which supplier to take the next step, here starting a new product development process and with which supplier it does not make any sense.[91] The supplier in countermove gets a feedback from a customer company and a recommendation of action, which it has to undertake in order to improve the supplier-customer relationship.[92] "Approximately one in ten product concepts succeeds commercially while only one in four development projects is commercial success."[93] Therefore "new product development is one of the riskiest endeavours of modern cooperation."[94] As consequence supplier assessment regarding its innovation capabilities is important for the following reasons. By solid metrics which address a specific issue, here

[84] See Steinle/Schiele (2008), p.11.
[85] See Schiele (2010), p.7; See Schiele et al. (2012), p. 44.
[86] See Schiele et al. (2012), p.48.
[87] See Schiele et al. (2012), p.48.
[88] See Glantschnig (1994), p.13.
[89] See Glantschnig (1994), p.13.
[90] See Glantschnig (1994), p.13.
[91] See Glantschnig (1994), p.13.
[92] See Glantschnig (1994), p.13.
[93] Cooper et al. (2004), p. 31.
[94] Cooper et al. (2004), p. 31.

innovation, it helps to align the innovation aims with the business aims and therefore gain management support for innovation projects.[95] Furthermore according to solid metrics it sets goals for the supplier and narrow the expectations of the customer company, therefore it helps to align the targets of both parties, supplier willingness to perform with customer company need of the service or product.[96] Next it can be a tool to help identify gaps in the current state and therefore it can also help the decision maker to allocate the proper resources to close the gap and track the outcome of such action.[97] Much more important it provides the customer company with a better understanding of its own supplier base, therefore with the strength and weaknesses of the particular supplier.[98] As suppliers play more important role in the supply chain an effective recognizing, harnessing and fostering of suppliers capabilities can become a strategic source of value for the customer company[99] and by increasing a manufacture's familiarity with its suppliers, its developing manufacturer's pool of knowledge about innovations.[100] Main aims for supplier assessment is the objectification and therefore also the optimization of the supplier choice.[101]

2.1.4 Evaluation process: two main approaches of information sourcing about a supplier

"Unlike the past, the performance of an enterprise now depends much on performance and relationship of its customer-suppliers in the value chain."[102] "Supplier selection and evaluation is increasingly seen as a strategic issue for companies."[103] Selecting the wrong supplier can end up for the company in project delays and in consequence in financial lost.[104] In today's global and open innovation economy strategic supplier selection and evaluation cannot be made solely on traditional criteria like cost, quality and delivery.[105] “Many companies accept that information technology enables their competitive edge, but their efforts to partner it with business aims are failing.”[106] One possible reason for failing

[95] See Azadegan (2011), p. 52.
[96] See Azadegan (2011), p. 52.
[97] See Azadegan (2011), p. 52
[98] See Azadegan (2011), p. 52
[99] See Azadegan (2011), p. 49
[100] See Azadegan (2011), p. 52
[101] See Glantschnig (1994), p. 19.
[102] Choy et al. (2005), p.1.
[103] Araz/Ozkarahan (2007), p. 585.
[104] See Araz/Ozkarahan (2007), p. 585.
[105] See Araz/Ozkarahan (2007), p. 585.
[106] Sauer/Willcocks (2002), p. 41.

at combining information technology and business might be, that the strategy as the aim became a moving target.[107] Therefore the technologies which enables communication have a big impact of all areas of business activities (internal or external), where one of such activity is "the integration of business process across the supply chain by facilitating the information flows, which are necessary for coordinating the business activity." [108] Therefore the main aim of supplier assessment is the information gathering from different sources, choice of the information, preparation of the information and judgement of the information in order to create transparency about the past, current and future performance of the particular supplier.[109]As result an inter-company integration and coordination via information technology has become a key way of improving the supply chain performance. [110] In overall the supply chain management focuses on how to utilise suppliers' processes, technology and capabilities in order to gain competitive advantage, therefore it often requires the integration of inter- and intra-organisational relationships and coordination different types of information sources into one system.[111] An organisation tend to invest in electronic tools to lower transaction costs and improve information flows, thus improved planning and more coordinated actions to reduce uncertainty.[112] However, a very important step before the start of information tool implementation is the understanding of the companies automation needs and different potential options of creating such tool including its benefits and challenges, where at the end the company is also able to handle the chosen instrument.[113] Such a solution can be a portal on the Internet, where the buyer and supplier are able through the web access the site in order to fill in or inform about the current status in the particular area.[114] The most important advantage of such web based solution is the fact that it provides a unified structure for all supply chain activities in real-time.[115] A special kind of function of such tool is the supplier performance evaluation module in order to simplified the selection process of a supplier for a given commodity.[116] However, there are also in the lean supply literature tools methodologies

[107] See Sauer/Willcocks (2002), p. 41.
[108] Rippa (2009), p. 121.
[109] See Janker (2008), p.80.
[110] See Rippa (2009), p. 121.
[111] See Rippa (2009), p. 121-122.
[112] See Rippa (2009), p. 121-122.
[113] See Rippa (2009), p. 122.
[114] See Rippa (2009), p. 124.
[115] See Rippa (2009), p. 124.
[116] See Rippa (2009), p. 124.

discussed, where the buyer-supplier relationship and its development is evaluated in order to track and manage the relationship.[117]

2.2 Description of the ideal innovation metrics characteristics as an instrument for valid innovation measurement

"Performance management is a thing, which is often discuss, but rarely defined."[118] Neely et al. defines performance management as "defined as the process of quantifying the efficiency and effectiveness of action."[119], where the two crucial dimensions in the performance management are the effectiveness (internal) and the efficiency (external).[120] "Effectiveness refers to the extent to which customer requirements are met, while efficiency is a measure of how economically the firm's resources are utilized, when providing a given level of customer satisfaction."[121] The differentiation into external and internal dimension is so far important, because its link the type reasons for pursuing an action. Furthermore performance measure is according to Neely et al. "a metric used to quantify the efficiency and/or effectiveness of an action"[122], where the set of metrics is a performance measurement system.[123]

Therefore a performance measurement system can be examined a three different levels[124]:

1. the performance measures itself
2. the performance measurement system as whole
3. the performance measurement system within a given application context (environment)

Taking this into account a performance measurement at a metric level can be analysed be asking the following questions[125]:

1. What performance measurement is used? (What does it measure?)
2. Why are this measures used? (What are the benefits of the particular measures?)
3. How much does is costs?

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[117] See Rippa (2009), p. 124.
[118] Neely et al. (1995), p. 1228.
[119] Neely et al. (1995), p. 1229.
[120] See Neely et al. (1995), p. 1228.
[121] Neely et al. (1995), p. 1228.
[122] Neely et al. (1995), p. 1229.
[123] See Neely et al. (1995), p. 1229.
[124] See Neely et al. (1995), p. 1229.
[125] See Neely et al. (1995), p. 1229.

On the next level, the level of the performance system itself, following questions seem to be important according to Neely et al.[126]:

1. Does the measures conflict with which other?
2. Have been all appropriate metrics been covered?
3. Does the metrics follow the short-term and long-term goals of the organization?

At the highest level the system can be analysed by asking following questions:

1. Does the metrics reinforce the strategy of the organization?
2. Does the metrics match with organizational culture?
3. Is the customer/competition metrics balanced?

After introducing the key terms and their relation among each other in the following part of this section the focus will lay on the measurement of innovation. "Quantifying, evaluating and benchmarking innovation competence and practice is as significant and complex issue for many contemporary organizations."[127] Without a proper instalment of performance measurement system regarding the innovation capabilities of suppliers, it is a challenge to optimally manage its supplier base according to the criterion: innovation.[128] "A generalised measurement framework specified at the level of the organization would provide a useful basis for managers to monitor and evaluate their innovation process, diagnose limitations and prescribe remedies."[129] While there are areas of overlaps among different frameworks introduced by other researchers, not one model covers every dimension[130], therefore Adams et al. introduce a synthesized framework with the following seven categories: inputs, knowledge management, strategy, organization and culture, portfolio management, project management and commercialization.[131] However, Muller et al. argues that the optimal selection and value of metrics varies from company to company, from industry to industry, there is no one size fits all.[132] Therefore in order to develop efficient and effective innovation measurement system Muller et al. recommend the following guideline during the design process:

1. Build comprehensive set of metrics

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[126] See Neely et al. (1995), p. 1229.
[127] Adams et al (2006), p. 21.
[128] Adams et al. (2006), p. 21.
[129] Adams et al. (2006), p. 22.
[130] See Adams et al. (2006), p.26.
[131] See Adams et al. (2006), p. 26.
[132] See Muller et al. (2005), p. 6.

2. Assess existing metrics
3. Avoid complex metrics
4. Resist the temptation to track every conceivable parameter
5. Include customer driven metrics
6. Reconcile metrics with existing methodologies

Besides the characteristics innovation metrics must fulfil also some analytical findings regarding technological advance and innovation namely[133]:

1. Innovation is much more than technology - many other complementary resources are essential for market success;
2. Innovation is like human health, there isn't any single measurement adequate to capture innovation' multiplicity of features;
3. The drive for innovation must include consideration of the demand side which determines the rate of investment and diffusion (take-up) of new products and services;
4. Non-linear dynamics characterize the entire innovation value chain end-to-end at the national level and at the firm level.

Therefore it is important to investigate besides innovation input and output also the innovation process itself.[134]

2.3 Supplier innovation criteria classification: organizing the available criteria

"To evaluate performance systematically, managers need to decide what to measure, at which organizational levels, and when." [135] Additionally according to Dervitsiotis "innovation's key dimensions address the quality, the quantity and the speed of introducing innovations."[136] Muller et al. propose to look at the innovation metrics from the following 3 perspectives: resource view, capability view, leadership view, which all together describe an innovation ecosystem.[137] Moreover the metrics classified into the resource view and capability view are divided into 3 additional aspects: input metric and output metric and a process, which is steering the way from input to output metric.[138] The last perspective

[133] See Muller et al. (2005), p. 4-5.
[134] See Muller et al. (2005), p. 4-5.
[135] Cordero (1990), p. 185; See Dervitsiotis (2010), p. 903.
[136] Dervitsiotis (2010), p. 903.
[137] See Muller et al. (2005), p. 4-5.
[138] See Muller et al. (2005), p. 5.

namely the leadership view plays a role of an environment for resources and capabilities in order to catalyst the process from given innovation input into demanded innovation output.[139] In addition according to Cordero outputs are measured in order to estimate its support in achieving the target (effectiveness) and inputs in order to estimate the appropriate amount of resources to produce the desired output (efficiency).[140] Moreover, Dervitsiotis propose to classify inputs as innovation enablers and drivers and outputs as innovation results.[141] Therefore a complete evaluation of innovation performance is not possible without measuring inputs (effectiveness) and outputs (efficiency).[142] As well as the overall performance regarding innovation is based on technical (e.g. R&D) and commercial metrics (e.g. marketing, manufacturing).[143] Muller et al. defines resource view inputs metrics as measure of resources allocated by the company to innovation activities.[144] Therefore inputs are capital, talent, time e.g. R&D expenditures dedicated to innovation activities, numbers of employees with entrepreneurial past, amount of time dedicated by employees to innovation activities.[145] In contrary resource view outputs metrics measure the success of innovation activities e.g. the number of new products, amount of revenue generated with new products.[146] Both areas has to be measured in order to close a validation loop and estimate the return of investment (ROI)[147] or innovation excellence according to Dervitsiotis.[148] Muller et al. argues that the capability view inputs and outputs are preconditions and renewal, where preconditions are the conditions that support creating innovations and the renewal are to opportunities created due to the supporting conditions.[149] Therefore the capability view metrics focus on innovation culture and innovation competence e.g. percentage of suppliers' employees with access to innovation tools and training as input metric and as output metric e.g. the number of new products or services, number of new markets or numbers of new competencies among its supplier base etc.[150] As stated above the leadership view plays an environmental role, therefore it focus is according to Muller et al. on the involvement of the executives in strategic innovation

[139] See Muller et al. (2005), p. 5.
[140] See Cordero (1990), p. 185.
[141] See Dervitsiotis (2010), p. 906.
[142] See Cordero (1990), p. 185.
[143] See Cordero (1990), p. 185.
[144] See Muller et al. (2005), p. 5.
[145] See Muller et al. (2005), p. 5.
[146] See Muller et al. (2005), p. 5.
[147] See Muller et al. (2005), p. 5.
[148] See Dervitsiotis (2010), p. 906.
[149] See Muller et al. (2005), p. 5.
[150] See Muller et al. (2005), p. 5.

rather than day-to-day operations and therefore the metrics are e.g. percentage of managers with training in the innovation concepts and tools, amount of cases, where executives are supporters of innovation activities or projects.[151] Last but not least the process has a mixer role, where it combines the inputs (resources, capabilities) within a leadership environment into outputs (resources, capabilities).

2.4 Supplier classification according to its innovation potential

"For companies operating under unfavourable macroeconomic conditions, such as high wage/high tax countries in central Europe, innovation has become a central theme for survival."[152] Therefore the purchasing department of the buyer company is confronted with a new task, the understanding of suppliers competence and selection of the high potential innovative suppliers which are able to contribute to the overall innovativeness of the buyer company.[153] According to Schiele innovative suppliers can be characterised by the following sentence: "specialized, technically competent firms, located in the proximity of the buyer, being embedded in trusted and intensive relationship."[154] Furthermore Schiele introduce an innovation matrix of suppliers, where the above named characteristic of suppliers were operationalised into the PCS of the buyer's company at the particular supplier (standard customer vs. preferred customer) and competitiveness of the supplier itself among all available suppliers on the market (low vs. high).[155] As a result Schiele's classification contains 4 categories of suppliers: Squire, Quacksalver, Black Knight and the King, which will be briefly described below in the table 4.

[151] See Muller et al. (2005), p. 5.
[152] See Schiele (2006), p. 925.
[153] See Schiele (2006), p. 925.
[154] Schiele (2006), p. 925.
[155] See Schiele (2012), p. 48.

Buyer's status with the supplier		Low	high
	Preferred customer	**Squire** **supplier development strategy** work with supplier to increase competitiveness	**King** **collaboration strategy** work with supplier in order to achieve competitive advantage for the buyer firm
	Standard customer	**Quacksalver** **replacement strategy** seek new suppliers that offer some advantages	**Black Knight** **bonding strategy** pursue concerted program to earn preferred customer status with supplier
		Competitiveness of supplier	

Tab. 4: Preferred customer matrix and generic strategy buying firm

Source: Schiele (2012) p. 48

"From a technology development perspective, the firm's status with the supplier is most relevant for highly competitive, technology-leading suppliers."[156] Therefore the most prospective suppliers concerning of achievement a PCS with a highly competitive supplier are the Squire and the Black Knight.[157] On the one hand the Squire treats the buyer company already as a preferred customer, but in order to increase its competitiveness and become a King for the buyer company it needs support from it.[158] In the contrary the Black Knight is already a highly competitive supplier with leading technology, but the buyer company does not enjoy a PCS with it so far, therefore the focus with such a supplier is on a concentrated program to earn the PCS with arguments like hard commercial reasons, ease of access to the buyer firm personnel or involvement in the early stage of the new product development in order to convince the supplier.[159] Taking this characteristics into account there are different strategies applicable in these supplier relationships to reach the state of a PCS with a highly competent : 1. a supplier development strategy to transform a Squire into a King, 2. a bonding strategy in order to foster a trusted and tighter relationship with

[156] Schiele (2012), p. 48.
[157] Schiele (2012), p. 48.
[158] Schiele (2012), p. 48.
[159] See Schiele (2012), p. 48.

the Black Knight and turn it into a King and if it is not possible to achieve the PCS with the Black Knight than the only reasonable option is to replace such a supplier with a Squire, which has a more prospective outlook of developing into a King position, therefore this action is called a replacement strategy.[160] The reasoning behind the development of the suppliers into the a King position with a PCS for the buyer company is, that according to Schiele it might be more effective and efficient than competing about few Kings at a given supplier commodity group with other buyer companies on the market.[161] Last but not least the Quacksalver left, which is not a leader in the given field and the buyer firm has not a PCS with it and therefore due to no sense of collaboration with such a supplier, it is better to out phase such a supplier.[162] Furthermore "if such a supplier provides a critical component, it may be time to seek out a new supplier."[163] Therefore due to the shift of the supplier orientation from upstream to downstream supply chain the supplier selection plays a crucial role for the success of the customer's new product developments regarding the speed and innovativeness and it force buyer companies to critical and strategic supplier selection.[164] In the end buyer-companies which understood the customer orientation towards it supplier base will be better scoring regarding identification, attraction, engagement of innovative suppliers into its supply chain, which translates into competitive advantage and financial benefits in the future.[165]

3 Methodology: combining design-focused and theory-based business problem solving approach with a participatory action research approach

3.1 Design-focused and theory-based business problem solving: the way from a problem mess to a tangible solution

The third chapter describes the development of a survey instrument by applying 2 research methodologies in order prepare a questionnaire to do a survey research. The reader gets a description of a questionnaire indicator set development as a pre-stage for developing the survey instrument itself and it also contains the pre-testing results of the questionnaire with the expert judges namely the interviews with category managers. For the questionnaire

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[160] See Schiele (2012), p. 48.
[161] See Schiele (2012), p. 49; See Takeishi (2001), p. 403.
[162] See Schiele (2012), p. 49.
[163] Schiele (2012), p. 49.
[164] See Wagner (2009), p. 8-9; See Schiele (2010), p. 965.
[165] See Wagner (2009), p.8.

indicator set development the design-focused problem solving and theory-based business approach problem solving is applied. Here is the aim to implement the gained knowledge through the extensive literature review into the final research product: a questionnaire to apply it on the pilot group of suppliers. For the pre-testing of the questionnaire with the category managers the participatory action research is applied as a powerful strategy to advance both science and practice and minimize the total number of questions in the questionnaire to most relevant for the category management managers.

The design-focused and theory-based business problem solving methodology can be divided in 3 main subareas.[166]

Fig. 2: 3 main subareas of design-focused and theory-based business problem solving methodology

Source: van Aken, 2012, p. 5.

This particular section focus on the first step: problem exploration and solution design. Although the change implementation is showed as the next step, it is the reason for this thesis project, because the purchasing department management and within the category management unit does want to implement a new way of a supplier assessment into its current supplier assessment system in order to identify much more innovative suppliers into its supply chain for NPD projects. The organisational learning part is the part, where the developed solution is applied by all members of the particular organisation unit (here: category management unit) and "the organization learns to realize improved performance on the basis of the designed solution".[167] Taking this into account the focus is on a survey design with a theory-based input. It means that the input comes from a solid and extensive literature review presented in the chapter 2 of the thesis and is extended by additional input from the practitioners namely the employees of the company dealing with innovation as an issue on daily basis, purchasing managers, constructors, electro-technical laboratory employees, product managers, innovation scouts, etc. Such a procedure according to the

[166] See van Aken et al.(2012), p. 5.
[167] van Aken (2012), p. 4.

introduce methodology helps to avoid a copy-paste scheme of the theory into the practice and enable a customization of the final solution as much as possible to the current situation of the company.[168] ”Theory is by definition general and must always be contextualized for use in actual problem solving.”[169] Therefore theory-based means a comprehensive, critical and creative use of theory, where[170]:

- comprehensive implies an extensive and systematic literature review as whole.
- critical implies a judgement of existing and appropriate literature on the basis of given evidence in the literature in order to solve the business case and taking the literature’s into account.
- creative implies building up on given theory in order to come up with new solutions (”appealing designs”) for a particular business case (”context”).

Resuming the essence of a design-focused and theory-based approach is to: “defining the problem, capture data and exploring solutions in the messy, political and sensitive world of real-life business.”[171] and therefore this methodology approach suits well to thesis project done within a real life business environment within a company. As a side effect the researcher develops a tacit knowledge in order to apply the codified knowledge available in the different academic sources.[172] This research method is well fitted for all development and improvement projects with the purpose of measuring performance or rise efficiency and effectiveness levels of given business system, department or a company on one or more criteria.[173] In the best case scenario the outcome of a such project has a financial impact in terms of profit rise, but it is common that such a project focuses on improvement of the operational side of the business in terms of efficiency and effectiveness.[174]

[168] See van Aken (2012), p. 5.
[169] van Aken et al. (2012), p. 5.
[170] See van Aken (2012), p. 5.
[171] van Aken (2012), p. 6.
[172] See van Aken (2012), p. 6.
[173] See van Aken (2012), p. 6.
[174] See van Aken (2012), p. 7.

3.2 Criteria for a business problem solving task

According to van Aken et al. a business problem (BP) can be defined "as result of certain perception of a state of affairs in the real world with which one or more important stakeholders are dissatisfied."[175] Van Aken et al characterize a BP as follows [176]:

- a BP is an outcome of decisions of influential stakeholders
- stakeholders are dissatisfied due to comparison the performance of the business system according to implicit or explicit performance indicators with some implicit or explicit standard or norm and furthermore these stakeholders are convinced about a feasible significant improvement in acceptable time and effort
- BP are open-ended, there is not the only one and right solution to a particular business problem
- BP are charged with values, interest and power, therefore the business problem depends on value judgements of stakeholders, their interest and last but not least the power to protect the interests
- usually BP are solved within constraints of time and effort, therefore designing and analysis is done until a satisfying solution which is good enough to solve the issue
- BP are selected out of current problem pool ("mess") and are solved through "change muddle", therefore the actual solution is happening during a continuous try and error process.

Therefore business problem concentrate on a "real problem" not a "perception problem" due to the stakeholder situation judgement or a "target problem", where project target is unattainable due to overreaching norms.[177] Furthermore the analysis is happening in a business context, therefore it is an "analysis for design" in order to support the solution design.[178] "So all kinds of decisions on the scope, level of detail and perspectives to be used in the analysis are to be based on a need-to-know-for design."[179]

[175] van Aken (2012), p. 8.
[176] See van Aken (2012), p. 8.
[177] See van Aken (2012), p. 10.
[178] See van Aken (2012), p. 11.
[179] van Aken (2012), p. 11.

3.3 The project steps: a methodological approach

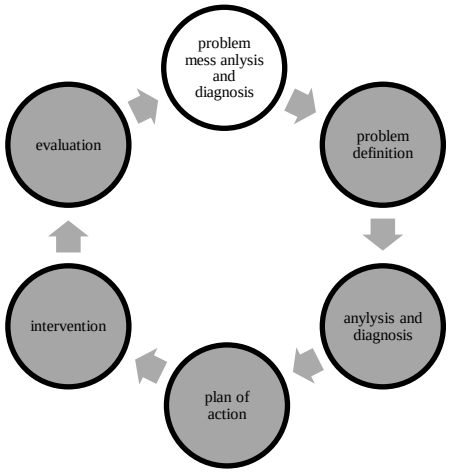

Fig. 3: Projects steps according to the regulative cycle by Van Strein (1997)

Source: van Aken et al. (2012), p. 13

According to van Aken et al. the methodological approach of design-focused and theory-based business problem solving method in the figure 3 for presented business and research problem goes as follows. It starts with the problem mess (context), where the management (principal) ergo owner of the problem notices due to benchmarking with others market competitors that the achieved results in the particular area need improvement of performance[180]. Therefore the initial problem statement sounds as follows: how to identify innovative suppliers for product development project among own supplier base in order to increase innovation transfer from suppliers within own supply chain? The next step namely the problem definition is crucial for the project and not static[181]. The problem definition scopes the problem mess in order to define a special type of problem within the company[182]. Therefore a concentration on one aspect and choice of a particular issue within the problem mess take place[183]. For this project the problem definition is: the development of a method for identification of innovative suppliers at TRILUX in order increase innovation transfer into the company.

[180] See van Aken (2012), p.11, p. 47.
[181] See van Aken (2012), p. 13.
[182] See van Aken (2012), p. 33.
[183] See van Aken (2012), p. 48.

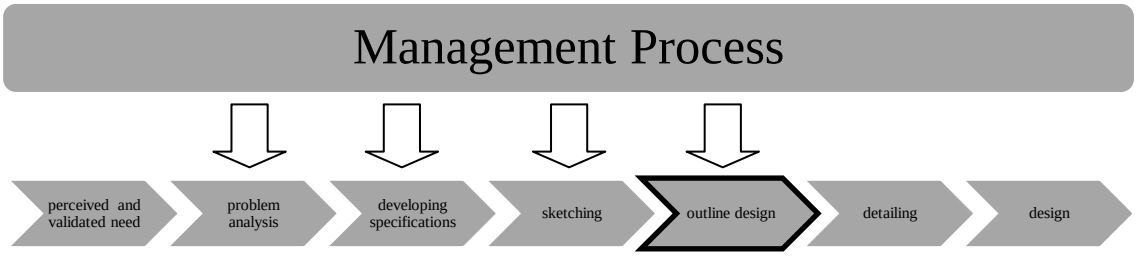

Fig. 4: A general model for a design process (based on van Aken et. al (2012), p. 24)

It is followed by an analysis in order to generate ideas for the solution design[184] and diagnosis that aims to validate the problem and its cause and consequence for the company[185]. At the end this analytical step produce specific knowledge on the problem and its nature. [186] Therefore the analysis and diagnosis the following questions were investigated: what are the characteristics of innovative suppliers? Is there a pattern in a buyer-supplier relationship regarding the innovativeness of the supplier? Which key performance indicators (KPI) to measure the efficiency and the effectiveness of supplier innovativeness in a buyer–supplier relationships fits the given problem definition the best? How to estimate the weight of each KPI and the theme block (group of KPI) for the innovation index? What are linkages between the particular KPI's and the innovation index as the final outcome? Which paradigm to choose e.g. preferred customer status, R&D spend? How to operationalise them? Which stakeholders at the company to ask? What is valuable input from the stakeholders? As shown on in the figure 4 it is broken into problem analysis and developing specifications[187]. During the next step namely plan of action the solution is designed.[188] It is broken down into sketching, detailing and outline design as shown on the figure 4.[189] Therefore within this project it deals with the development indicator set for the evaluation purpose of the buyer-supplier relationships regarding the innovativeness of the given supplier according to the literature review. Furthermore one collects the input from the practitioners about the questionnaire in order to customize it and rise its accuracy. The final product is questionnaire with the input from the literature review and the practitioners itself with a proposal of weight for the different theme blocks and the single question in a block in order to estimate in a scientific way of work an

[184] See van Aken (2012), p. 92, p. 94.
[185] See van Aken (2012), p. 63.
[186] See van Aken (2012), p. 14.
[187] See van Aken (2012, p. 25.
[188] See van Aken (2012), p. 14.
[189] See van Aken (2012), p. 25.

innovation index for a particular supplier of the company. This questionnaire form is tested with the chosen strategic suppliers of the company (pilot phase) and evaluate the given responses in order to collect valid research insight. For the purpose integrity also the next step are briefly presented although they are out of scope of the thesis project. The intervention is the part, where the organisation learn to use the new instrument to its full extension and realize the planed improvement.[190]

The supplier innovativeness assessment is only one item of a bigger project namely the implementation of a supplier relation management system (SRMS) provided by ■■■■■■■■ for TRILUX, therefore intervention part is implementation of the questionnaire into the SRMS. The last step namely the evaluation part is the insight about the chosen weight of the particular indicators and the particular indicator block itself in the questionnaire. This insight is collected by acquiring the data from all suppliers, which will be registered through the new SRMS in the future, and helps to realize the full potential of the new system by recalibrating the weight of each indicator.[191]

3.4 Designing the solution: 5 criteria of a business problem

According to van Aken et al. the solution of business problems has 5 characteristics[192]:

- performance-focused which means that performance improvement is the most important criterion
- design-oriented which means that project plan as a control instrument is in place
- theory-based which means high quality knowledge has to be used as source
- justified which means the explanation to problem owner the proposed design solution
- client-centred means ones deals respectful with people within the business system

Performance-focused means not just intellectual exercise project, but in real business context applicable solution with the aim for a performance improvement for the particular company created through the diagnosis and analysis of the business problem.[193] Design-oriented means that although a project plan is in place as a central steering instrument, it is

[190] See van Aken (2012), p. 4, p. 14.
[191] See van Aken (2012), p. 14.
[192] van Aken (2012), p.11.
[193] See van Aken (2012), p.15.

not to be treat as written in stone statement.[194] Furthermore the plan has only an outline function and is going to be developed in detail, filled with new insights along as the business project envelope.[195] Theory-based means "that one use valid, state-of-the-art knowledge for the analysis and design activities"[196] and it implies the consciousness about the quality of the used knowledge as source.[197] Therefore the knowledge body covers 3 application areas: object, realization and process knowledge, what in consequence means a comprehensive, critical and creative use of theory.[198] The critical use of the literature implies the respect to general theory and to the context-specific knowledge. "Management literature written by managers or consultants for managers or consultants often does not meet these criteria."[199] Justified means the proposes solution to the organization has to be well argued with reason why it will work and followed with an cost-benefit analysis.[200] Finally client-centred stands for a consensus seeking solving approach to reach a common ground for the solution between the different stakeholder at business system involved in the project e.g. the principal, the problem owner, the user of the proposed solution.[201]

3.5 Designing the solution: the innovation questionnaire

3.5.1 The choice of indicators: the way from a set of indicators to a questionnaire

In the first step after the project start the company was screened for already done research by the employees responsible for technology management within the company. Therefore employees from the following departments were contacted: Innovation and Technology Centre (ITC) including R&D activities, construction department, purchasing department within especially the category management, which is the problem owner as unit in first place. The outcome of this action was the collection of the expectations of the employees about the future tool. This input was also base for the specification including also the briefing about the problem mess from the management. In the second step an intensive literature research made it possible to prepare a set of more than 40 indicators, which were operationalised into potential questions for the questionnaire. The next step was a question

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[194] See van Aken (2012), p.15.
[195] See van Aken (2012), p.15.
[196] van Aken (2012), p.15.
[197] See van Aken (2012), p.15.
[198] See van Aken (2012), p.15.
[199] van Aken (2012), p.15.
[200] See van Aken (2012, p.15.
[201] See van Aken (2012), p.15.

proposal consultation with each category manager from the category management unit in order to gain practical inside about the particular commodity and the usefulness of the prepared questions regarding the specific commodity. The outcome of this step was a selection of questions for the final questionnaire version. The aim was to find the most broaden consensus between all commodities and it specific dynamics in form of a questionnaire version, which can be applied cross-over all commodities. At this point the ITC and the construction department gave their feedback about the questionnaire. As a final product a questionnaire with 27 questions was designed in order to test it in the pilot phase. The total of 27 questions is divided in following 4 theme blocks: performance - 10 questions, cost and finance - 2 questions , service and soft facts - 6 questions and last but not least systems and strategy - 9 questions[202].

Each theme block is constructed as follows:

- category management questions
- supplier representative questions
- registration form input (provided by the supplier during the registration to the SRMS)

Registration form questions basically act as a transfer tool for data already filled in by the supplier during the registration process on SRMS in order to put it in context. e.g. headquarter location and therefore distance between supplier and the customer (here: TRILUX) headquarter in Arnsberg. As showed above each theme block has a different amount of questions (indicators) due to the facts gathered during the extensive literature review. Furthermore at least 30% of answers in each block regarding a supplier are based on category manager estimation in order to create a 360 degree perspective on a supplier and additionally perform a reality check about the supplier statements provided by its employees.

3.5.2 Performance: supplier's first impression metrics within a NPD project

Within this theme block there are 9 questions: 2 category management questions, 1 registration form question and 6 supplier questions. The category management questions are: overall performance and product portfolio. In the overall performance question answers range from "cannot provide the requested services and no qualified support is

[202] See Schumacher et al. (2008), p. 53-54.

available" to "all services are provide and the support proactively contributes with innovative approaches". The overall performance question is much more a subjective one, because it as an opinion of the category manager about the supplier based upon previous experience in the past with the supplier and its employees. The "MoLiBe" evaluation,

[redacted]

Taking this into account this specific question has a subjective flaw on it, although the category managers try to be as much as possible fair about the collaboration and the supplier performance. Furthermore in case that this evaluation is done on a yearly basis, there is a risk of bias caused by the current status in the supplier relationship, mostly in a negative way. e.g. there is a current issue with the supplier, which cannot be handled as the category manager wish to and therefore the supplier can subjectively score a lower value because of such a bias. However it is an overall issue regarding evaluations by humans. The second question concerns the product portfolio and is much more objective one and ranges from "technologically obsolete; product range not adequate" to "technologically superior; product range fits completely". The registration form question concerns about possessed certificates ranging from "none" to ISO 9001, ISO 16949, ISO 14001. A difference in this questions is, that the interviewee can mark the questions, which are fulfilled and the scores adds up to 100%. Furthermore the answer ISO 9001 is valued at 50%, because according to the statement of the quality assurance employee

[redacted]

It happens due to the fact that ISO 16949 is an automotive industry certificate and the suppliers, which have it, charge usually a premium for their products. According to Schiele the ISO 16949 certificate is an indicator for an innovative supplier, because this certificate implicates the involvement of the supplier and the 2nd tier supplier into the R&D process.[203] Pekovic and Galia by using two French employer surveys investigated the impact of quality system on innovation by using the method of propensity matching.[204] The conclusion out of the survey is that the ISO 9000 impact positively certain areas of

[203] Schiele (2010), p. 32.
[204] See Pekovic/Galia (2009), p. 829.

innovation performance.[205] Furthermore the results indicates that firms with top quality certificates impact positively certain areas of innovation performance.[206] ISO 14001 is concerning environmental issues and is getting more and more traction. Resuming the study by Pekovic and Galia implies that in order to increase innovativeness in the own supply chain a company in a manufacturing industry should scout for suppliers with mature quality management systems in place confirmed by the particular certificate e.g. ISO 9001, ISO 16949[207] A limitation to the finding is that there is no support for causality between innovation and quality.[208] There is also no certainty if the results apply to other countries and if early adopters of QMS score worse or better than firms with well established QMS.[209]The supplier questions section starts with project management skills an essential capability for a new product development project. [210] The higher the qualifications, the higher the chance for a satisfying outcome for the supplier and the customer. e.g. new product [211] The focus in this question lies on the process and function itself and not on the particular project manager, because project management functions can be handled by a chief executive officer (CEO), sales force or a different employee depending on the industry and the size of the supplier.[212] Due to fact that innovation is an outcome of a long project process and not a product taken from the shelf, the project management qualifications can lead to differentiation criterion. Song et al. study among Japanese firms on 788 new product developments and its commercialization in the timeframe of past 4 years proved, that project management skills were one out five crucial skills, which positively influence the product success.[213] Therefore according to Song et al. "the selection of project managers must be done exceedingly well"[214] ergo the customer should also carefully select its suppliers regarding project management skills in order to raise the chance of well handle project. e.g. no delay, no over budgeting etc. The next investigated aspect is project reporting manner, because communication has been always an important aspect in new product collaborations, therefore the reporting style and circle

[205] See Pekovic/Galia (2009), p. 829.
[206] See Pekovic/Galia (2009), p. 829.
[207] See Pekovic/Galia (2009), p. 829.
[208] See Pekovic/Galia (2009), p. 838.
[209] See Pekovic/ Galia (2009), p. 838.
[210] See Schiele (2010), p. 32; See Schumacher et al.(2008), p. 271.
[211] See Song et al. (1997), p.90.
[212] statement by category manager ■■■■■■■■■■ own resources interview 05.2013
[213] See Song et al. (1997), p.90.
[214] Song et al. (1997), p.99.

is an important indicator for successful innovation project.[215] Innovative supplier are able to communicate very open with its customer about joint NPD projects and within the organisation with the management to gain it support for the NPD activities.[216] According to Cooper et al. 72,4 % out of 105 enterprises (51% of them in manufacture industry) in the survey of best performers score very high at this indicator and 48% of worst performers do not understand the NPD process and its dynamics.[217] Failure Mode and Effects analysis (FMEA) and Advanced Product Quality Planning (APQP) or other method e.g fishbone, modflow, 5-why etc. regarding quality management process applied during a NPD project implies a well handled project, which with high certainty leads a satisfying innovation outcome.[218] "In too many companies, projects moves into development without serious scrutiny: once a project begins there is a very little chance that it will be ever killed".[219] The next aspect is the "overall innovation culture" therefore tap into the working habitus of the supplier during a potential NPD project and its organisation capabilities in the search for new ideas. "Modern innovation processes require firms to master highly specific knowledge about different users, technologies, and markets."[220] A company should look at open innovation as a close collaboration with external partners – customers, consumers, researchers or other people who may have an input to the future of their company.[221] A follow up question is "internal innovation participation" where the participation by employees or departments is investigated, therefore the question specify the circle of involved personas. In a study by Schiele 53% out of 121 informants from D/A/CH country companies stated, that the not involvement of the purchasing function end up in not involvement of the suppliers in the NPD project.[222] Furthermore according to Gemünden et al. the innovation process is driven by more than one person, which form a cross-functional team in order to work together and come up with more ideas to handle obstacles during a project.[223] The "innovation activities responsibility" covers the aspect of who is in charge for the managing activities within the supplier's organization. The indicator is an outcome of Gemünden et al. study, which investigates the influence of innovator roles in highly

[215] See Cooper et al. (2004b), p. 40.
[216] See Cooper et al. (2004b), p. 40.
[217] See Cooper et al. (2004b), p. 32, p. 40.
[218] See Cooper (1999), p. 117.
[219] Cooper (1999), p. 117.
[220] Laursen/Salter (2006), p. 146.
[221] Policy Brief OECD Observer, p. 2.
[222] See Schiele (2010), p. 15.
[223] See Gemünden et al. (2007), p. 408.

innovative ventures and taking into account the degree of innovativeness of these projects.[224] Gemünden et al. use for this its promoter concept, where he and other co-authors of the paper opts for more than one person in the innovation process, which helps to overcome barriers namely: the power promoter, expert promoter, process promoter and relationship promoter (technology-related and market-related).[225] By using a sample of 146 highly innovative new product developments projects and the promoter concept Gemünden et al. shows in his study, that in times of open innovation firms perform better in highly innovative projects, if beside the support from a power promoter, if a technology-related promoter (e.g. innovation scout etc.) and market-related promoter (product management employee etc.) are on the innovation team.[226] "Furthermore, in the area of professionalized project and innovation management, formally assigned project leaders, and professionalization of innovator roles, professionalization of cross-functional teamwork, and a good innovation system also play a very important role."[227] The next aspect prototyping, therefore "producing quickly built, purposely incomplete systems"[228], is one of the basic soils of the world class manufacturing concept (WCM).[229] The flexibility in incorporating rapid changes in a running project is an integral part of the innovation and enables a fast new product development process in compliance with a "try-and-error" approach.[230] The higher the speed of implementation of the supplier's know-how, the more satisfying outcome for the customer firm e.g. being first to market, greater market share, monopoly profits etc.[231] Furthermore ■■■■■■■■■■■■■■■■■■■■■■■■■■■■ a supplier with own prototyping capabilities is in most cases much closer to the particular technology and its potential developments and additionally usually the technical specifications are much accurate than from a supplier, which outsources this task.[232]

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[224] See Gemünden et al. (2007), p. 408.
[225] See Gemünden (2007), p. 409.
[226] See Gemünden (2007), p. 417.
[227] Gemünden et al. (2007), p. 417.
[228] Längle et al. (1984), p. 274.
[229] See Rosochowski/Matuszak (2000), p. 191.
[230] See Rothwell (1994), p. 21.
[231] See Rothwell (1994), p. 13.
[232] Interview with ■■■■■■■■■■- director of electro-technical laboratory, ■■■■■■■■■■- director of Construction Department

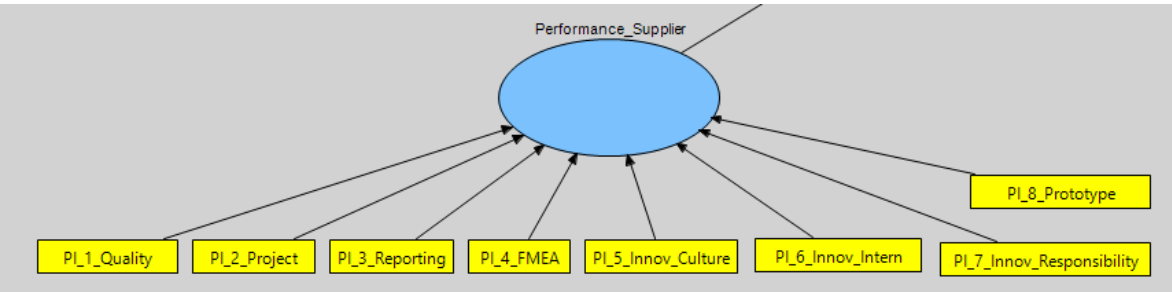

Fig. 5: Visualisation of the theme block performance

Source: author's own

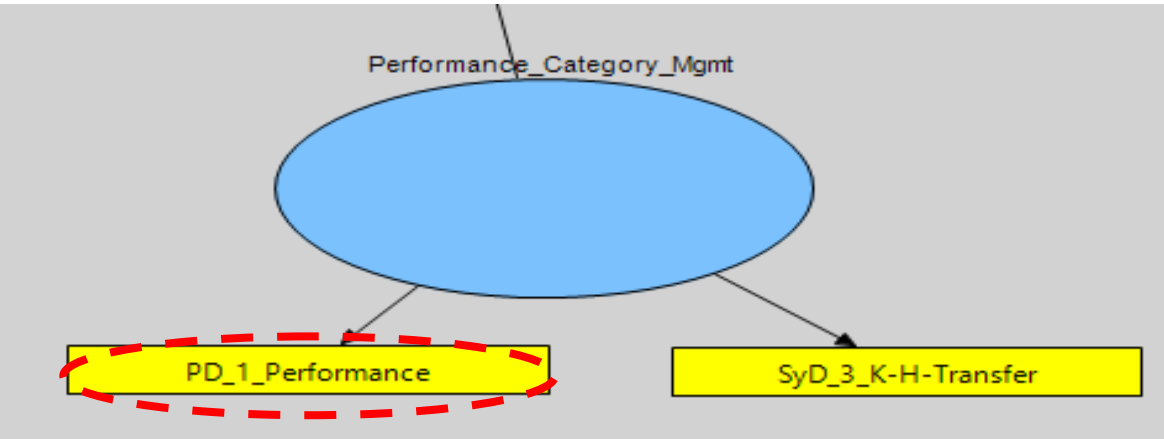

Fig. 6: Visualisation of theme block element "overall performance" within model construct "performance category management"

Source: author's own

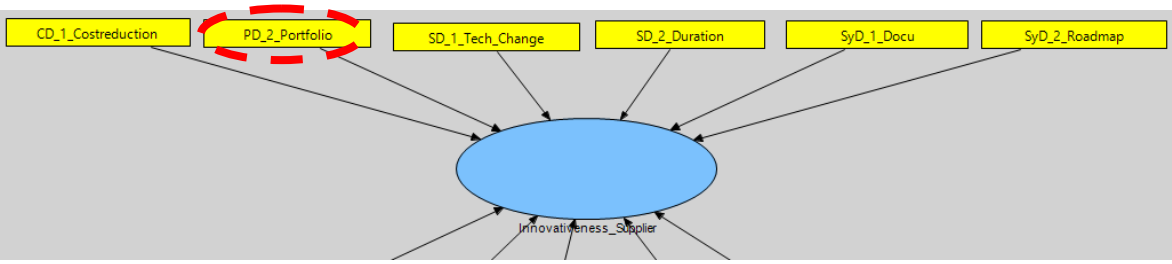

Fig. 7: Visualisation of theme block element "portfolio" within model construct "supplier innovativeness"

Source: author's own

3.5.3 Cost and Finance

This theme block is very problematic in several ankles. On the one side there are usually hard numbers, which can be used for the evaluation, but as known from the literature by judging only the facts (numbers) the soft part (the process) in between is fast to be

missed.[233] Additionally suppliers although non-disclosure agreements (NDA) are signed are not willing to share hard numbers about their operations. Therefore this theme block is very short and consist only 2 questions namely: "cost reduction and behaviour willingness" and "R&D spend". The first one is a category management question in order estimate suppliers attitude regarding cost reduction according to the "lean thinking", where employees of both organisations jointly analyse the current product in order identify the cost reduction potential of the particular product line.[234] Proactive suppliers support its customer with improvements (not only innovations), which allow a cost reduction for both parties. e.g. technology transfer between the supplier and customer, design to cost or improvement workshops, where products of the customer are analysed regarding obsolete parts due to technology changeless e.g. LED The second one is a supplier question, where the supplier states it share of expenditures spend on R&D activities, where it is one of the most popular innovation indicator since 1950.[235] The rule behind it is, that the more the supplier is spending on R&D, usually it means a big size firm, the higher the chance of the development of an innovative product.[236] The weakness of R&D spend is that not all budget spend on development activities in order to develop a new product, process or discover new knowledge in particular field end up in feasible commercial product, which can be offered to the customer.[237] Furthermore ■■■■■■■■■■■■■■■■■■■■ different commodities have a different innovation grade in terms of spending on R&D.[238] e.g. metals suppliers in overall do not spend so much as ECG or LED suppliers It also not to forget that additional shortcoming of this indicator is, that small and medium size enterprises and their informal R&D activities are underestimated.[239] Last but not least there is also an non-disclosure issue with the R&D spend, which can lead to a biased result within the research.[240]

[233] See Rothwell (1994), p. 22.
[234] See McIvor (2001), p. 228.
[235] See Kleinknecht et al. (2002), p. 110.
[236] See Kleinknecht et al. (2002), p. 111.
[237] See Kleinknecht et al. (2002), p. 110.
[238] Interview with category manager ■■■■■■■■■■■■■■■■■■■■■■
[239] See Kleinknecht et al. (2002), p. 111.
[240] See Kleinknecht et al. (2002), p. 111.

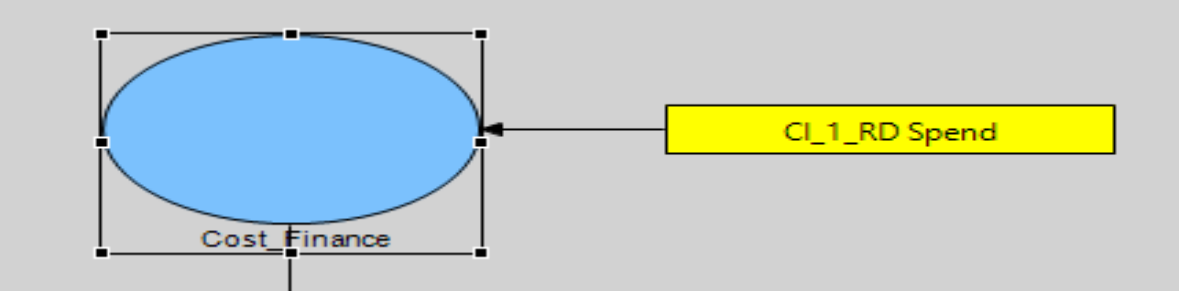

Fig. 8: Visualisation of the theme block cost and finance

Source: author's own

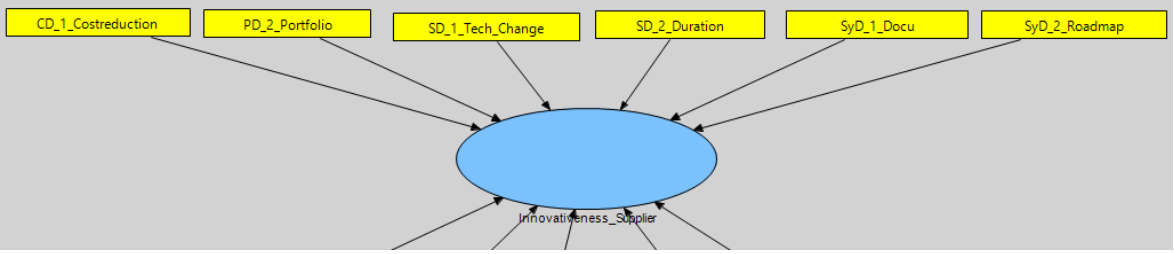

Fig. 9: Visualisation of theme block element "portfolio" within model construct "supplier innovativeness"

Source: author's own

3.5.4 Service and soft facts

The "flexibility in case of technical change" as mention already above is one the basic soil of the WCM concept.[241] Furthermore a fast reaction time and copying with the changes in uncomplicated manner is one of few signs for a PCS and technical competence as already mentioned in the literature review.[242] On the opposite scale, if a supplier responds inflexibly or not all and cannot handle the changes, so either the customer firm has not a PCS or the supplier choice regarding technical competence was bad in the first step ergo the selection does not work out in favour for the customer firm. The "laboratory service" question investigate the ratio between in-house testing at the supplier facility and outsourced testing procedures. The answers range is from "no own testing and no testing protocol" to "100% own testing facility available and testing done by the supplier itself". The idea behind the question is, that suppliers with own testing facilities are much closer to the technology than a supplier without in-house testing possibilities.[243] Additionally there is a pattern in accordance of delivered specification of supplier's product. Suppliers with an

[241] See Rosochowski/Matuszak (2000), p. 191.
[242] See Steinle/Schiele (2008), p.11.
[243] according to interview with ■■■■■■■■- director of electro-technical laboratory

own testing facility usually deliver much accurate specifications of their products in comparison with suppliers, which outsourced the testing of their products.[244] As mentioned in the literature review according to Schiele a customer firm starts a new development project with already known suppliers.[245] The average time period of collaboration is 10 years and the total number of innovative suppliers among its own supplier base is in average not more than 12 suppliers.[246] Therefore "cooperation duration" is a risk assessment question, where the longer years a relationship is established the less risk in a collaborative new product development project is involved.[247] On the other hand new suppliers with less than 3 years experience can deliver disruptive and innovative solutions for the customer firm, but there is more risk involved in such collaboration due to uncertainty with the technology or/and with the supplier itself.[248] According to Kotabe et al the "cooperation duration" is tightly connected with the knowledge transfer between the supplier and the buyer firm, because the knowledge transfer secure the collaboration gains for the supplier.[249] If there is a "change management" process implemented at a supplier, there is indicator for operational competence and transparency regarding the project, which results in less risk during an NPD project. The risk during an NPD project is quality problems, excessive costs, extended product design lead times, legal problems concerning intellectual property rights (IPR).[250] The answers range is from "no change management process in place" to "all changes are documented and the customer is informed about it". Next aspect "co-design strategy" investigates the range of assistance of a supplier during a NPD project. It is a multiple choice question, where several answers can be choice in order to reach full points. The answers range from "ideation phase" till "prototyping and pilot phase". The idea behind is, that the earlier the supplier is involved, therefore there can be a PCS of the customer firm be associated with the supplier.[251] Furthermore an early supplier involvement (ESI) is an important coordination mechanism for decisions regarding the product design, process design and last but not least the supply chain design.[252] Another issue which arise with the design activities is the responsibility for the particular aspects on

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[244] according to interview with ■■■■■■■■- director of electro-technical laboratory
[245] See Schiele (2010), p.45.
[246] See Schiele (2010), p.45.
[247] See Schiele (2010), p. 7.
[248] See Hoetker (2005, p. 77.
[249] See Kotabe et al. (2003), p. 294.
[250] See Zsidisin/Smith (2005), p. 45.
[251] See Schumacher et al. (2008), p. 193, p. 195.
[252] See Petersen et al. (2005), p. 372.

the project and the whole project itself.[253] Therefore "cooperation culture" investigates the amount of involvement of supplier in a NPD project on resource level and project responsibility level. The answers range from "no resource involvement and no responsibility" to "resource involvement and full responsibility". The idea behind this indicator is, the bigger the involvement, the bigger the interest of the supplier, that the outcome of a NPD project satisfy the customer firm. Furthermore it can be also an indicator of the PCS, because as previous mention in the literature chapter by Schiele resources are limited. A decision about the limited resource is a statement about which customer is preferred regarding NPD projects.

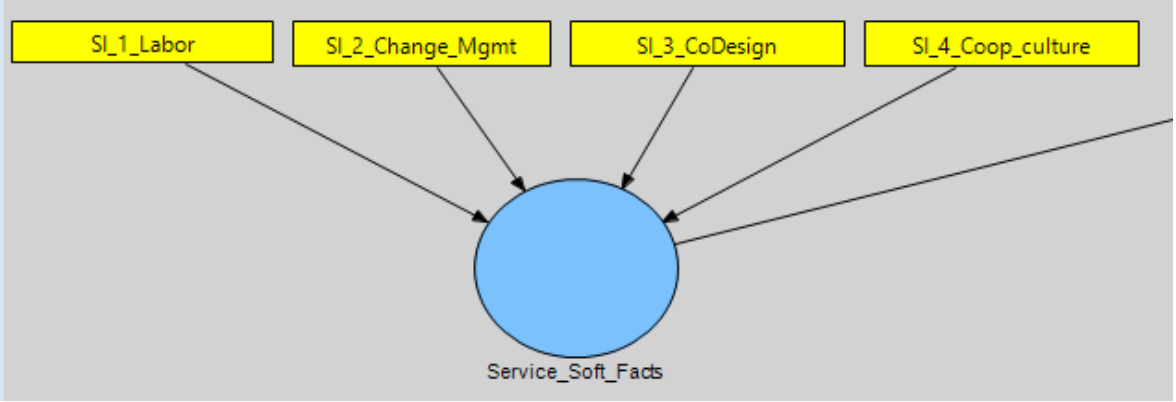

Fig. 10: Visualisation of theme block service and soft facts

Source: author's own

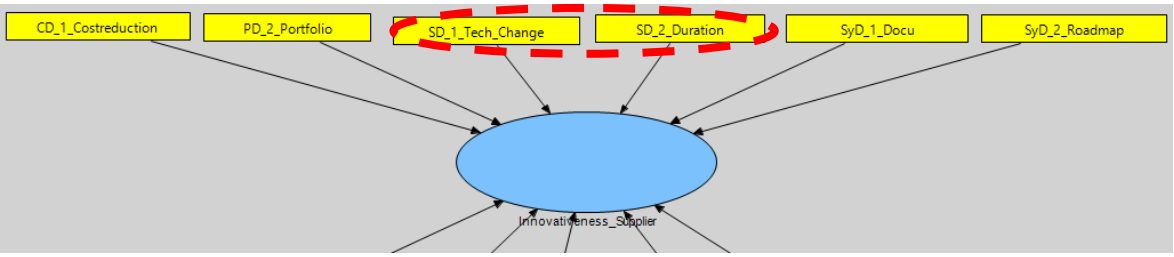

Fig. 11: Visualisation of theme block elements "technical change" and "cooperation duration" within the model construct "supplier innovativeness"

Source: author's own

3.5.5 Systems and Strategy

"Technical and R&D documentation" question implies the following rule: the bigger the fulfilment in this category the less problems during the cooperation. If there is something more to add, which is additional to the regular documentation, it can be an indicator for

[253] See Petersen et al. (2005), p. 372.

special treatment and in consequence a sign for having a PCS by the customer firm. The answers range from "the supplier does not fulfil the requirements" to "full documentation is on time and if need additional 2D/3D documentation is handed over". An extra point regarding the commitment of supplier is a documentation provided in the customer firm's native language.[254] A strategic issue is a "technology or innovation roadmap" and it availability to the customer firm. "New product development decisions that do not take into consideration the dynamics of technology evolution may result in investments that are unsustainable."[255] A special remark at this point is, that technology or innovation roadmap must be handed over in written form. By this is meant that there is a document, which is written. Mails, memos or other ways of communication like phone calls, meetings are not taken into account as written form. The answers range from "no technology or innovation roadmap at all" to "technology or innovation roadmap in written form available and with the product map of the supplier synchronised". A technology roadmap and innovation road map implies a future oriented supplier, which watch over the technology development in its field. A technology roadmap and innovation roadmap means the same due to the fact that a technology invention is requisition for innovation, namely commercialised invention. The next aspect "know-how transfer" implies one more time the PCS, which requires a trusted relationship between the customer and supplier in order to share information, which in most cases is non-disclosure kind of information. In scope of the interest, is the information, which was on purpose not patented and therefore it is hard accessible, here in the lighting industry e.g. epiwafer production process As in the literature review stated a cluster supports a fruitful cooperation regarding NPD project between the supplier and customer firm due to the geographical proximity. The smaller the distance, the higher the chance of cooperation between the companies.[256] This question is estimated according to the information input from the registration form input. The distance is estimated according to the postal number of the headquarter. This question is not a standalone question and has supportive character for questions, which covers the cluster and preferred customer status. The "export strategy" is measured by the ratio export sales and total sales ratio. The answers range between below 30% for non-innovative supplier and above 70% for highly innovative supplier. The idea behind this question is that highly innovative suppliers can sell their product anywhere, because the products are so highly demanded due to high

[254] See Ford (1984), p. 103.
[255] See Petrick/Echols (2004), p. 83.
[256] See Schumacher et al. (2008), p.195, p.215, p. 230, p. 272; See Schiele (2010), p. 7, p. 30.

quality or extraordinary specifications, which give him a unique selling proposition. e.g. new material, new function etc.[257] Therefore an exporter is usually innovative supplier, which choose the customer firm with which it cooperates.[258] In such a situation it is not only a price question, but additional reasons like NPD projects, know-transfer, trust etc. As already the previous question it is only a supportive indicator. Furthermore it has to be taken into account, that there are also producer of products like kashmir on the market, which do not have an innovative product, but demand is so high, that the total production volume is sold in advance to foreign suppliers. There are also producers in markets like the USA, which are very large, and although the suppliers are very innovative, they are not exporting at all, because the produced amount is sold totally to the customers in the USA. "Small innovative firms appear to be more orientated towards the domestic market."[259] Therefore export occurs at multinational big size firms much often.[260] The "NPD experience" question ask the supplier about the number of projects started and project finished in the last 3 years. According to the given numbers a "success rate" is calculated, namely the ratio between projects started and finished in the 3 year time period. This ratio can be an indicator of efficiency of R&D spending. Of course it is not a hard fact indicator although it is number. There are mainly two reasons for this: first not all R&D spending goes on NPD activity, second there is no right number of this indicator. As mentioned above different commodity suppliers have a different innovation pattern and a R&D spend policy. Furthermore there is here a non-disclosure issue and not all supplier will be willing to share their information with the customer about their current innovation activities. On the other hand suppliers, which share the number are treating TRILUX as preferred customer or shooting the numbers out of the hips, caused by the fact that sales people are mostly answering the questionnaire. The "innovation type" is a multiple choice question, where the supplier can choose the following answers "process innovation, product innovation, marketing innovation, organisation innovation". Each of the term is defined and to read by interviewee before marking. The question aims to estimated the potential fields of collaboration between the customer and supplier and categorize the field of specialisation of the supplier. The "NPD strategy" is an indicator for cooperation manner of the supplier. The answers range from "no partnerships at all" till "a network of proven

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[257] See Schumacher et al. (2008), p. 271; See Schiele (2010), p. 33.
[258] See Wakelin (1998), p. 836.
[259] Wakelin (1998), p. 836.
[260] See Wakelin (1998), p. 837.

partners established or no partnerships needed". The more different partnerships are established the more potential "spill over" effects can take place and therefore a know-how transfer. Furthermore more diverse partnerships bring into project different ankles of expertise and therefore there is chance of new approach which end up in a new solution, which happen to be innovative one.[261] The "intellectual property rights" management estimated the handling of the issue within supplier-customer firm collaboration. It range from "no participation by customer firm" till "no restrictions or IPR is bounded at the tool contract". It is a very important issue for commercialisation of the outcome of NPD activities. The more clarity in this field, the less problems with commercialisation. Furthermore it also helps to estimate the aims of the supplier in NPD project and therefore it is beneficial for decision making of resources allocation. e.g. ■■■■■■■■■■■■■■■■■■■■■, where the supplier at front made a clear line about the roles in the project due to IPR arrangements between the supplier and the customer firm.

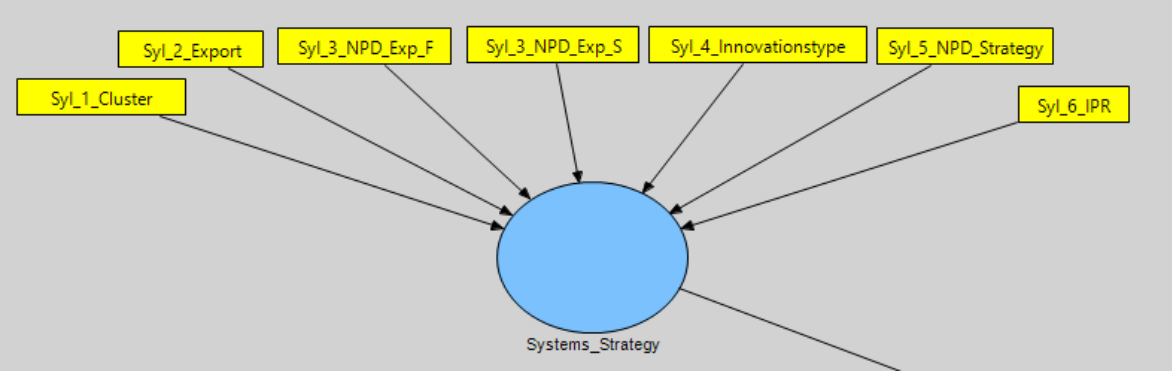
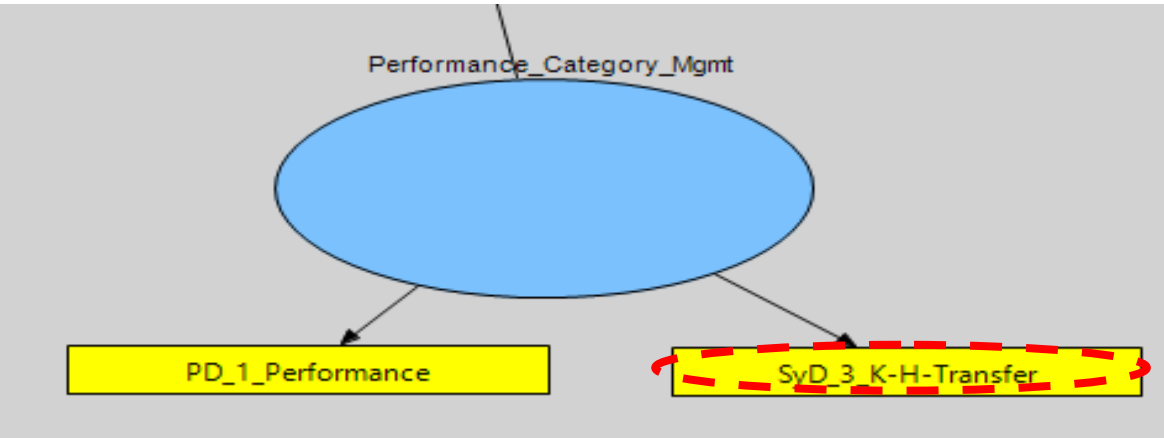


Fig. 12: Visualisation of theme block systems and strategy

Source: author's own



[261] See Schiele (2010), p. 2.

Fig. 13: Visualisation of a theme block element "know-how-transfer" within construct "performance category management"

Source: author's own

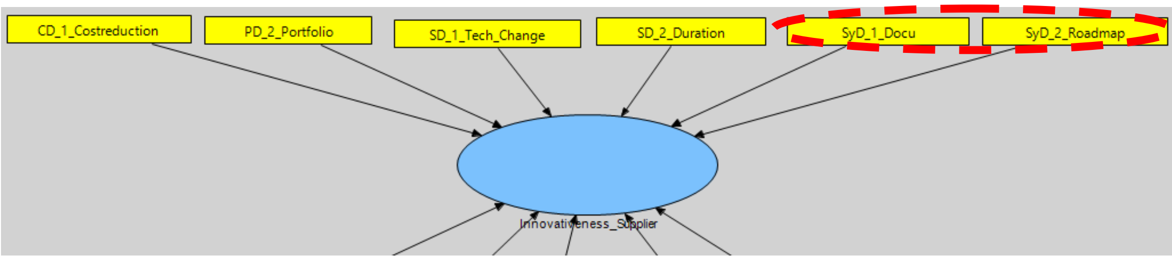


Fig. 14: Visualisation of theme block elements "documentation" and "roadmap" within model construct "supplier innovativeness"

Source: author's own

3.6 Data collection method: internet survey among suppliers

The questionnaire was put together and programmed into an online survey tool. The supplier representatives, where approached via an introduction mail and a link to the survey. The survey was divided by language into German speaking suppliers and English speaking suppliers. After 5 days without reaction the suppliers representative were approach by a second mail with a reminder notification. After another 5 days without reaction the supplier representative were approach by a telephone interview. Most of the answers were collected by internet survey. 2 suppliers printed the survey and fill it out and send it back by fax. 1 supplier due to time constraints filled the survey by a telephone interview. Some suppliers do not filled the survey due to non-disclosure issues and stated the reason openly. Some suppliers do not filled the survey due to management decision without additional reasoning.

4 Analysis of collected data with partial least squares structural equation modelling (PLS-SEM)

4.1 The used data set and its characteristics: Pareto principle in action

[redacted].[262]

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[262] statement by purchasing director [redacted]

[redacted] Therefore the questionnaire was answered only once by a representative from the holding responsible for the particular business operations for the holding combining the different divisions. Additionally although some of the suppliers get a huge spend, they are only cost-suppliers within non-innovative operation fields e.g. metals commodity or do not invest any resources into innovation e.g. very small firms namely below 10 employees in average[263]. As consequence the sample number ended up in the first round at 14 answered questionnaires due to the reasons mentioned above. Therefore in the next step the category managers selected a group of 5-6 suppliers from its supplier panels, which were important for the particular commodity group [redacted], for a second survey round. In the end the final sample for this project is 36 out of 45 suppliers big. A next aspect, which is also crucial for the quality of the collected data, is the person which delivered the answers. In most cases it was a sales representative namely a key account manager or head of sales for the particular supplied product group. Very often the CEO answered the questions, mostly in very small firms. Few times a technology responsible person answered the questionnaire, usually it was the head of R&D, which were in charge of technology management within the innovation responsibilities. Taking the analysis of the sample on the question level it is noticeable, that only holdings or very large organisation has controlling process regarding the amount of new product development projects. Some supplier were excluded from the sample due to the fact, that the supplier were not a manufacturer, but a reseller of a particular product group.

4.2 The use of partial least squares structural equation modelling (PLS-SEM) in strategic management research with SmartPLS

"Since the introduction of covariance-based structural equation modelling (SEM) by Jöreskog in 1973, this technique has been received with considerable interest among empirical researchers."[264] "PLS-SEM is particularly appealing when the research objective focuses on prediction and explaining the variance of key target constructs (e.g., strategic success of firms) by different explanatory constructs (e.g., sources of competitive

[263] statement by category manager [redacted]
[264] Haenlein/Kaplan (2004), p. 283.

advantage); the sample size is relatively small and/or the available data is non-normal."[265] "The PLS-SEM is a prediction-oriented variance-based approach that focuses on endogenous target constructs in the model and aims at maximizing their explained variance (i.e., their R^2 value)."[266] Furthermore PLS-SEM was used in 37 recent studies published by 8 leading management journals for dozens of different criteria.[267] PLS-SEM address in strategic management research issues described by different authors like long term survival of firms, performance of global firms, knowledge sourcing and collaborations and last but not least cooperation of firms.[268] PLS-SEM is a second generation SEM method which combines components such as principal component and linear regression analysis and can bring a lot benefit to the researcher, if the principles underlying the method are understood correctly, the method itself is applied properly and the research results are correctly reported.[269] Additional due to the fact, that PLS-SEM is a user-friendly method and overcomes the rigors of the covariance-bases SEM (CB-SEM) it as widely applied in the research world as also in practice and enables both world to presented more nuanced analysis.[270] According to Hair et al. the four important reasons for applying PLS-SEM in order of importance are: non-normal data, small sample size, formative measures and focus on prediction, where the primary advantage is the small sample size with which the researchers in the field of strategic management research has to deal.[271] Another argument for applying this analysis method is the fact, that SEM-PLS can process different types of variables, namely: nominal, ordinal, interval, and ratio scaled variables.[272] An important characteristic is that SEM-PLS is able is to use both formative and reflective measures for the latent variable.[273] However, there is also criticism upon the method ranging from concerns about the application type till usefulness of the method at all for research activities, which is wondering due to fact that in social science including economics researchers has to deal with small sample size, which often does not make it possible to meet the rigor of the CB-SEM method.[274] Moreover, there is an interest in diverse scientific areas like marketing, management information systems research, strategy, but

[265] Hair et al. (2012), p. 312.
[266] Hair et al. (2012), p. 312.
[267] See Hair et al. (2012), p. 320.
[268] See Hair et al. (2012), p. 321.
[269] See Hair (2012) p. 312, p. 321.
[270] See Hair et al. (2012), p. 312-313.
[271] See Hair et al. (2012), p. 321.
[272] See Hair et al. (2012), p. 326.
[273] See Hair et al. (2012), p. 326.
[274] See Hair et al. (2012), p. 313.

theoretical considerations in these fields do not meet the CB-SEM method requirements, even after available modifications in the method itself.[275] Concluding: due to the characteristics of the data input, there PLS-SEM is the best choice in order undertake an analysis within this particular project. In order to proceed the analysis within this master thesis project a software called SmartPLS was used for this purpose. This software is used for the illustration of the model and the calculus of the input data in accordance with the model. It is released in the version 2 (release 3). Algorithm settings were by default. Resuming the PLS-SEM method were chosen due to characteristics of the given sample, research aim and the formative model of the latent variables itself, because this method makes it possible to investigate not directly observables variables (performance, service and soft facts, cost and finance, system and strategy) within a small sample size (here: 36 samples) in order to analyse the best indicators regarding innovativeness investigation among the supplier base of TRILUX.[276]

4.3 Description of the model and its characteristics

The aim is to build the model as much as close to the question logic behind the survey (see annexure 2). The model consists 6 latent variables: supplier performance, service and soft facts, systems and strategy, cost and finance, category management performance and innovativeness, where the last one is a 2nd factor order and the rest a 1st factor order. Latent variables are not directly observable and called in the model factors. The following 4 factors systems and strategy, service and soft facts, cost and finance, supplier performance are measured by indicators covering the questions out of 4 theme blocks from the survey and are the 1st order factors. The factor innovativeness is measured by the 4 factors named above and additional fifth factor category management and therefore innovativeness is a 2nd order factor. The factor category management performance was extracted out of the innovativeness indicators due to the fact, that some questions in the theme blocks are answered by the category management managers and have a subjective character ergo personal estimation or opinion of the involved person regarding the particular supplier. In consequence the category management performance factor has a reflective connection with the both indicators, which are building it. The rest of the connections between the indicator and the factor including innovativeness has a formative

[275] See Hair et al (2012), p. 313.
[276] See Chin (2010), p. 668-669.

character due to the fact, that the indicators are based on survey answers and a change in one answer do not imply a change in another answer within the survey, which suggest a multidimensionality of the indicators.[277] There are two relation types in the model: the outer relations are formed between the factor: systems and strategy, service and soft facts, cost and finance, supplier performance and category management performance, innovativeness and its indicators. The second type the inner relations are formed between the factors namely systems and strategy, service and soft facts, cost and finance, category management performance, supplier performance and innovativeness. All supplier answers including the registration answers are placed behind the particular factor in the model and are called indicators. All category management answered indicators are placed behind the factor innovativeness and as mention above two category management answered indicators form the factor called performance category management due to the fact that the statement in this particular indicator is an overall opinion about the performance and know-how transfer in contrast to the rest, where the category manager estimates according to available data the supplier in the specific questions. Below in the table 5 are presented all factors with given characteristics regarding the number of indicators and number of questions from the survey.

Latent variable / Factor	Type	Number of indicators (all)	Number of indicators (reduced)	Number of questions covered
Supplier Performance	Formative	8	2	8
Cost and Finance	Formative	1	1	1
Service and Soft Facts	Formative	4	2	4
Systems and	Formative	4	2	3

[277] See Chin (2010), p. 664.

strategy				
Category Management Performance	Reflective	2	2	2
Innovativeness	Formative	6	2	6

Tab. 5: Overview of factors and number of indicators and questions from the survey

Source: author's own work

Furthermore the indicators can be divide into external and internal related, where the external ones are the one indicators answered according to the information provided by the supplier itself and the internal ones are the estimations of the category managers about the supplier. In this particular case the ratio is as following out of 27 questions 19 are external and 8 are internal. The internal one are marked on the figure no. 15 with a blue circle. The bundle of internal questions is called also "category management score" (CaMa score) and the bundle of the external questions is called "supplier score", therefore it is a correlation between the purchasing managers assessment about the given supplier and self assessment of the particular supplier. The smaller the difference between the CaMa score and the supplier score, the better the assessment of the tool and therefore the validity of the tool is higher. An issue to clear rise, when the CaMa score and the supplier score show a bigger difference. Such situation implies either a not recognized by the purchasing manager innovative supplier or a supplier has an overestimated self assessment about its own competence and capabilities. In both cases action has to be taken in order to check the reason for the difference.

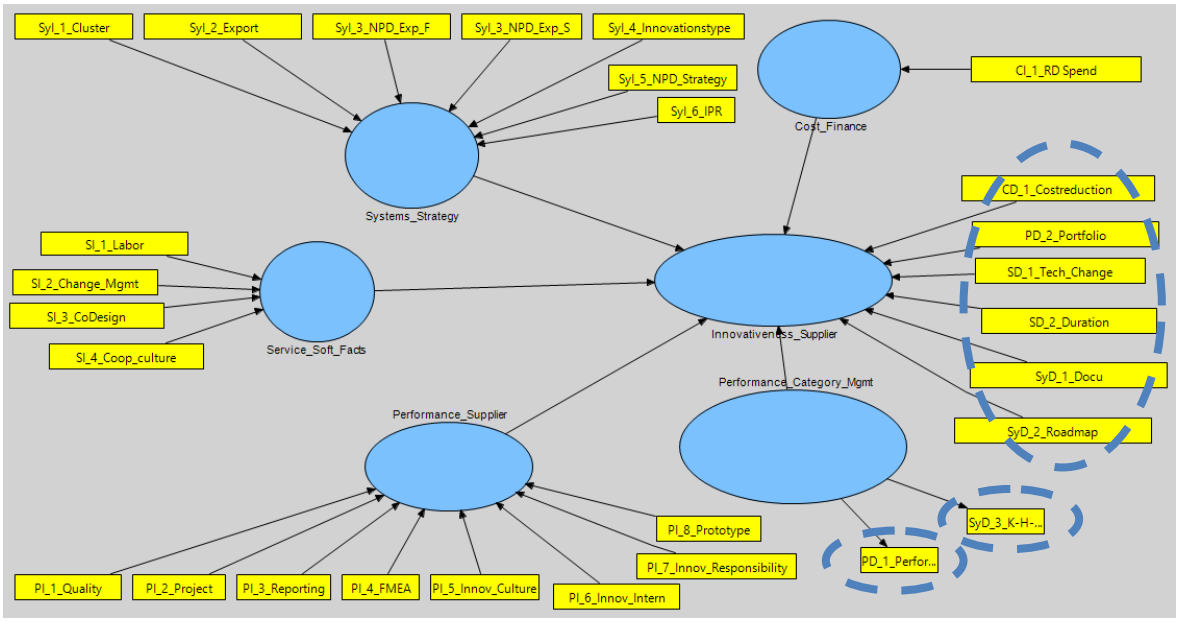

Fig. 15: Visualisation of all indicators within the model

Source: author's own

4.4 Analytical proceedings: reporting

4.4.1 General reporting framework: criteria to met for a valid and reliable report

"A fundamental issue in the use of any statistical technique relates to the reporting of the choice of computational options as these can have a significant bearing on the analysis results."[278] The rule of thumb in SEM analysis states that the sample size has to be at least 10 times greater than either the number of the indicators in a formative factor (here: 8) or the number of total factors in the model (here: 6) depending, which is greater.[279] Therefore the minimal sample number should be at least 80. There is also a weaker version of the rule of thumb, where the sample size is only 5 times greater than the largest number ergo the minimal number of sample size should be at least 40.[280] In the case here the sample number is 36 out of 45 send surveys due to the fact that the sample size was given by TRILUX according to criteria mentioned above in the description of the sample, namely [redacted] Therefore although the analytical methodology is applicable especially for small sample sizes, there is still a limitation of the method regarding the minimal needed sample size in

[278] Hair et al. (2012), p. 332.
[279] See Henseler et al. (2009), p. 292; See Sosik (2009), p. 15.
[280] See Sosik et al. (2009), p. 15.

order to secure reliable and valid research results. As mentioned above in the description of the given model there are 2 types of sub-models, namely the outer model (direct connection between indicators and factors) and inner model (direct connection between the factors itself), which build the given model. According to Henseler et al. there is a 2 step approach in order to evaluate such a model, which starts with the step number 1: the outer model evaluation and its assessment of reliability and validity of reflective factors and validity of the formative factors and is followed by step number 2: the inner model evaluation and variance explanation of endogenous factors, effect size, predictive relevance.[281]

4.4.2 Inner model analysis: indicator impact on the given factor

Therefore the analysis starts with the outer model, where as mention in section above there are 2 types of indicators in the model (reflective and formative) and both has to be treat different during the analysis.[282] A traditional criterion for internal consistency is Cronbach's Alpha (value here: 0.638), which helps to estimate reliability based on the intercorrelation between the indicators.[283] Taking this into account that Cronbach's Alpha has some flaws regarding underestimation of the internal consistency in PLS path models therefore Henseler et al. recommends to check the composite reliability (CR) (value here: 0.847), which takes into account the fact that indicators have different loadings and can also be interpreted as Cronbach's Alpha.[284] A value above 0.700 in an explanatory research is satisfying and indicates enough reliability of the model. As the reliability of each indicator varies, each of them should be also evaluate.[285] All loadings for the given factor category management performance meet the hurdle rate of 0.750 for a sample size of at least of 50 items in the sample. Taking as given that the hurdle rate rise or fall by 0.05 with 10 less or 10 more items in the sample the loadings for performance (0.851) and know-how transfer (0.862) are sufficient and significant supporting a good indicator reliability. Even taking into account the small sample size (value here: below 40 samples) and a hurdle rate of 0.850 for such sample size.

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[281] See Henseler et al. (2009), p. 298.
[282] See Gil-Garcia (2008), p. 244.
[283] See Henseler et al. (2009), p. 298.
[284] See Henseler et al. (2009), p. 298.
[285] See Henseler et al. (2009), p. 299.

In the outer measurement model in order to assess the validity of the reflective indicators 2 validity sub-types are investigated: convergent validity and discriminant validity.[286] As criterion for convergent validity the average variance extracted (AVE) (value here: 0.734) is used, which means that a set of indicators represent the same factor.[287] An AVE value of at least 0.500 indicates sufficient convergent reliability implying that the factor can explain more than the half of variance of its indicators on average.[288] Furthermore discriminant validity means that the indicators correlate with the given factor more than with other factors in the model. Also the indicator level cross-loadings offer a way to investigate the discriminant validity and therefore it is enough to investigate, if the indicators have or not have a higher correlation with another factor.[289] There is also the final remark to make, that there is only one reflective factor in the whole model. Formative factors are supposed not to correlate with each other therefore traditional measurements of validity do not apply to them. [290] Therefore the concepts of reliability (internal consistency) and validity (convergent and discriminant validity) are not meaningful for formative factors. [291] However, Bollen argues that "validity is the strength of the direct structural relation between measure and the latent variable"[292] and therefore the size and significance of the weight between the indicator and the factor itself validates the factor.[293]

Factor	Indicator	Weight
Supplier Performance	Quality	0,790 (0,977)
	Innovation Responsibility	0,521 (0,545)
Service and Soft Facts	Laboratory	0,668 (0,668)
	Co-Design	0,634 (0,575)
System and Strategy	Export	0,774 (0,620)

[286] See Henseler et al. (2009), p. 299.
[287] See Henseler et al. (2009), p. 299.
[288] See Henseler et al. (2009), p. 299.
[289] See Henseler et al. (2009), p. 300.
[290] See Gil-Garcia (2008), p. 244.
[291] See Henseler et al. (2009), p. 301.
[292] Bollen (1983), p. 222.
[293] See Gil-Garcia (2008), p. 244.

	Cluster	0,399 (0,342)
Cost and Finance	R&D Spend	1,000 (1,000)
Innovativeness	Cost reduction	0,726 (0,601)
	Documentation	0,459 (0,318)

Tab. 6: Weight of formative indicators (reduced version and)

Source: author's own work

Table 6 shows the weight after the model were reduced of indicators with weights below 0.400 as not significant. In the brackets are the weights of the given indicators in the model, when all indicators were in the model included, namely before the reduction of the indicators below 0.400. The weights of all indicators are in the annexure number 5. The procedure of the indicator reduction were introduced to narrow the model to the most relevant indicators, which contribute the most to the given factor. On the factor level the question arise, if the given indicator have a meaningful contribution to the particular factor, either by the impact of the indicator on the factor or the lack of multicollinearity with other formative factors in the model.[294] This issue can be examined by the researcher with the application of the bootstrapping.[295] Furthermore in the process of the assessment of the validity of a formative factor is the usage of rationale and expert opinion (nomological validity) necessary, which was the case here, taking into account that the factors were developed according to the input from the research in action approach from the practitioners (employees).[296] Therefore the aspect, if the given indicator should enter the particular factor were investigated on a previous step in the research project on a face and content level and consulted with experts from academic field and business world with additional backup from the literature review.[297] However, although the formative indicator is backed up by an expert opinion, the researcher has still to watch after the indicator weight as a tool for interpretation about the formative indicator importance.[298]

[294] See Henseler et al. (2009), p. 302.
[295] See Henseler et al. (2009), p. 302.
[296] See Henseler et al. (2009), p. 302.
[297] See Henseler et al. (2009), p. 301.
[298] See Henseler et al. (2009), p. 303.

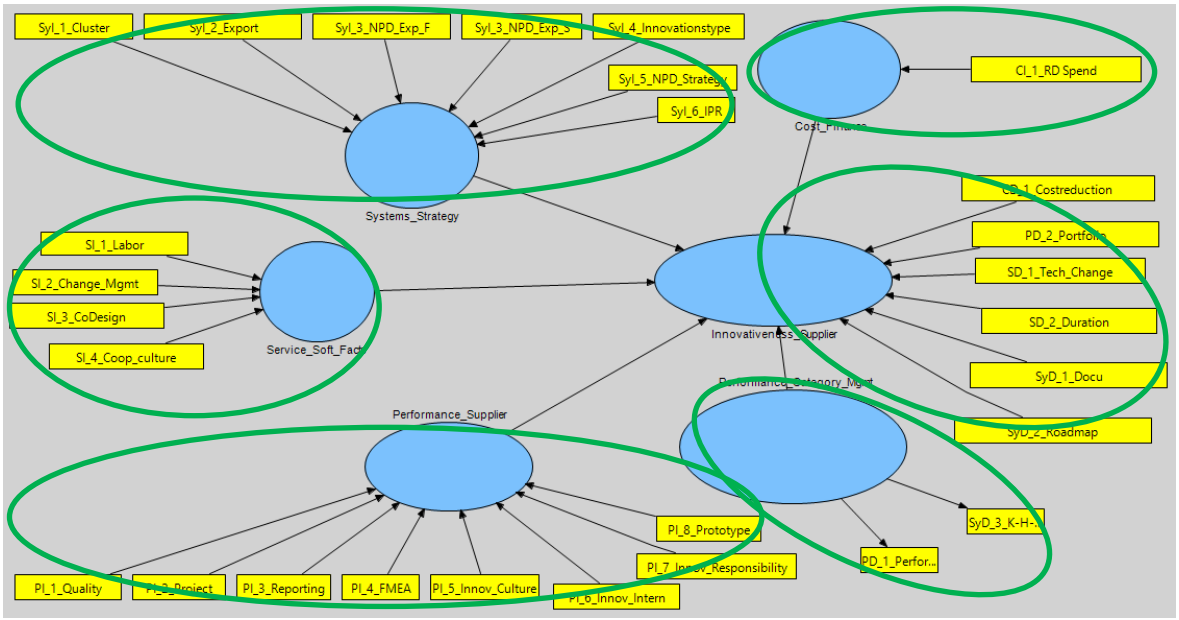

Fig. 16: Outer model - relations between the given construct and the indicators

Source: author's own

4.4.3 The outer model analysis: path correlations between the factors

A reliable and valid outer model enables the investigation of the inner model, therefore the direct connections between the factor innovativeness (2nd order factor) and the rest of the factors (1st order factor), also called the structural model.[299] A typical criterion for inner model evaluation is the coefficient of determination (R^2) of the endogenous latent variable here the factor innovativeness.[300] There is the following classification regarding R^2 values in a PLS path model: 0.67 strong, 0.33 moderate, 0.19 weak.[301] R^2 in the given model is 0.758 (all indicators included version) and 0.620 in the reduced indicators version. Taking into account that the factor innovativeness as an endogenous factor is described by 5 other factors the value is strong and therefore the given model is capable to explain the factor innovativeness.[302] In the next step the weight of the 5 factors and the endogenous factor innovativeness are going to be investigated. "The individual path coefficients of the PLS structural model can be interpreted as standardized beta coefficients of ordinary least squares regressions."[303] "Paths (statistical and practical significance) and coefficients of

[299] See Gil-Garcia (2008), p. 244.
[300] See Henseler et al. (2009), p. 303.
[301] See Henseler et al. (2009), p. 303.
[302] See Henseler et al. (2009), p. 303.
[303] See Henseler et al. (2009), p. 303.

determination (R-squares) together indicate overall model goodness of fit."[304] Therefore the given standard regression weights here called paths as shown in table 7 suggest a significance. Additional a bootstrap analysis performed with the SmartPLS software resulted in a path outcome above 1.960 for all factors beside cost and finance (value here: 1.141). Therefore the non-significance of the indicator in the expected case of the cost and finance factor is also with the bootstrap method confirmed.

Factors	Innovativeness Regression weight (all)	Innovativeness t-Test (bootstrapping)	Significance (95% level)
Supplier Performance	0,440 (0,392)	4,821	Yes
Cost and Finance	-0,066 (-0,040)	1,141	No
Service and Soft Facts	0,177 (0,181)	2,618	Yes
System and strategy	0,219 (0,343)	2,018	Yes
Category Management Performance	0,331 (0,309)	4,386	Yes

Tab. 7: Model path significance according to regression weight and t-test value.

Source: author's own work

Taking this into account a statistical power calculation for the model in the reduce version was conducted and the results was 0.99993032, which means that observed power for the multiple regression study, given the observed probability level, the number of predictors, the observed R^2, and the sample size is significant, because it is above the 0.800 value.[305] In practical matters the statistical power is the "number or percentage that indicates the probability that a study will obtain statistically significant effect in a repetitive manner".[306] In simple words, if a statistical power is 0.800, then it means, that if the study or survey is

[304] See Gil-Garcia (2008, p. 244.
[305] Calculator retrieved from http://www.danielsoper.com/statcalc3/calc.aspx?id=9 (access 16.01.2014)
[306] retrieved from http://www.businessdictionary.com/definition/statistical-power.html (acess 05.02.2014)

going to be repeat over a given a time period it is likely that 8 times out of 10 the study produce statistical significant results. Statistical power is especially important in studies or surveys, where the sample size is very small and therefore the statistical power were checked in this study with a result, that the produced results are statistical significant with security of 99,993%.

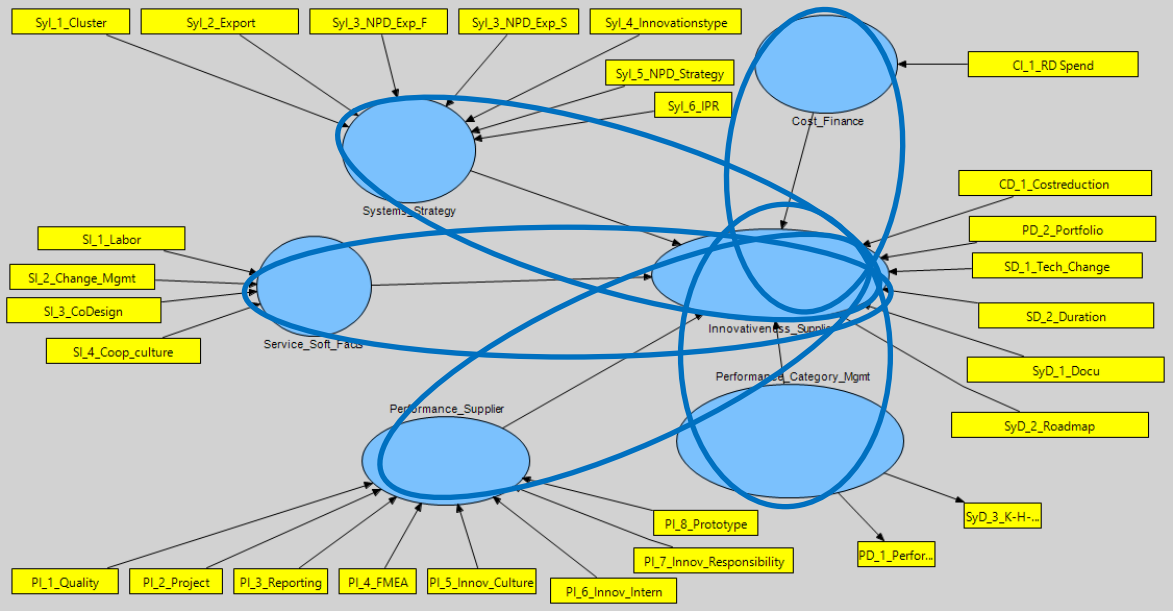

Fig. 17: Outer model - relations between the constructs

Source: author's own

5 Conclusion: main factors for innovation assessment within the own supplier base

5.1 Quality issues of the analytical outcome of the investigated data with SEM-PLS

Although the SEM-PLS is primary applied for the reason of a small sample size it is important, that the method itself cannot cover the following shortcomings connected with a small sample size. First "relying on small sample sizes tends to capitalize on the idiosyncrasies of the sample at hand"[307] and researchers have to be aware that smaller sample size goes hand in hand with a bigger chance for a sample error in consequence false research results.[308] Second "the biasing effects of small sample sizes are likely to be

[307] See Hair et al. (2012), p. 325.
[308] See Hair et al. (2012), p. 325.

accentuated when data are extremely non-normal."[309] Although SEM-PLS is well known for being robust on not normal data, such has a tendency to score bigger bootstrapping errors and therefore reducing the statistical power of the method itself.[310] However, the most important aspect about SEM-PLS method is, that it enables the researcher to investigate a formative indicator model in an explanatory research, which is not the case with other SEM methods and therefore for the particular study within this master thesis project it is the best fit method. Furthermore misspecification is common treat in SEM-PLS studies. By misspecifications is meant, that reflective factors are functioning in the model as formative factors and of course the other way around, where formative are functioning as reflective one. According to Jarvis et al. it is the case in 4% (46) of 1192 studies.[311] Considering what a huge impact a misspecified study with falsifying research results can have it either can misguide results of future research of the field or even does not make it possible to build a model according to the given study with flaws within it.[312] This scenario can occur under the assumption, that the given study is highly cited.[313] Furthermore another aspect arising is the misconceptualization of each factor or the whole model and in consequences misguiding or bad measures in order to catch the right indicators to describe the given factor. Such a situation can lead to measurement of indicators, which do not describe properly the factor or wrong choosing of type of indicators (formative or reflective) for the given aspect in the research context. As consequence the results of wrong specified model deliver low validity of the whole model, low statistical validity of the conclusion and low internal validity.[314] At the end of the research is unreliable, not valid and therefore useless piece of research. Another aspect is a one-item described latent variable, in this case it is the cost and finance factor, which is described only be one indicator namely the R&D spend. A researcher has to be aware that a single-item measures in terms of predictive validity perform as well as multi-item scales only under very specific conditions.[315] Therefore the cost and finance latent variable has a major flow due to the fact, that it is a single-item measure and therefore its predictive validity lags in comparison

[309] See Hair et al. (2012), p. 325.
[310] See Hair et al. (2012), p. 325.
[311] See Jarvis (2003), p. 206.
[312] Dr. James Gasikin on SEM-PLS method retrieved from http://www.youtube.com/watch?v=-9Cty2Mzlxk (access 15.01.2014)
[313] Dr. James Gaskin on SEM-PLS method retrieved from http://www.youtube.com/watch?v=-9Cty2Mzlxk (access 15.01.2014)
[314] Dr. James Gaskin on SEM-PLS method http://www.youtube.com/watch?v=-9Cty2Mzlxk (access 15.01.2014)
[315] See Hair et al. (2012), p. 327.

to other latent variables, which are multi-item measured.[316] Although it is not preferred, it has still be included on the survey, because the financial aspects are so low in amount in the survey at all.

5.2 Verifying questions for construct validity of the questionnaire

Constructs are higher level concepts, which are not directly observable or measurable (nature), where variables (also measures or indicators) try to measure the underlying construct with a particular research method (nature exposed to a research method).[317] "Construct validity refers to the degree to which inferences can legitimately be made from the operationalisations in a study to the theoretical constructs on which those operationalisations were based." [318] Verifying construct validity is very important especially, when survey items are self-developed and there is a lack of previous applications of the questionnaire itself.[319] Therefore any conclusion about the construct validity concerns the research method, therefore the questionnaire as final outcome of the chosen research method. Construct validity involves the support of the theory itself and the gathered empirical data in order to interpret the investigated phenomena. Taking the theoretical input and the achieved survey results and necessary modifications in order to increase the validity of the achieved results. therefore construct validity (here selection of the questions for the final questionnaire version) ergo the extent to which the operationalisations (questions) of the construct (innovativeness) are measured, what the literature review describes.

5.3 Conclusion: most valuable predictors of supplier innovation potential

Overall 36 suppliers out of 45 answered the survey. During the analysis of the collected data the strongest correlation between the particular indicator (question) and the factor (theme block) were investigated. Due to the researched the following results presented in the table 8 were achieved. The table 8 summarize the questions with the most impact on innovation outcome according to achieved weights or loadings within the research model

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[316] See Hair et al. (2012), p. 334.
[317] See Agarwal (2011), p.1.
[318] See Trochim (2006), retreived from http://www.socialresearchmethods.net/kb/constval.php (access 18.12.2013)
[319] See Agarwal (2011), p.1.

and gives a recommendation regarding the change of the particular questions weight within the innovation survey prepared for TRILUX.

Theme Block	Question	Weight/Loading	Question Weight Change
Supplier Performance | 0.428	Overall Performance	0.852 (0.559)	■■■■■■■
	Quality Management	0.791	■■■■■■■
	Innovation Responsibility	0.520	■■■■■■■
Cost and Finance	Cost reduction behaviour	0.714	■■■■■■■
Service and Soft Facts | 0.162	Laboratory Service	0.664	■■■■■■■
	Co-Design Strategy	0.638	■■■■■■■
Systems and Strategy | 0.264	Technical Documentation	0.473	■■■■■■■
	Know-How Transfer	0.861 (0.608)	■■■■■■■
	Innovation Cluster Potential	0.365	■■■■■■■
	Export Strategy	0.638	■■■■■■■
	NPD Strategy	0.531	■■■■■■■

Tab. 8: Comparison of old and new weights for the supplier innovation survey in accordance with weights or loadings from the SEM-PLS analysis

Source: author's own work

Each question in the innovation survey prepared for TRILUX has question weight estimated according to input of the employees of TRILUX and the extensive literature review. In order to investigate the question without question weight bias, the answers of the suppliers were analyzed without the question weight. In accordance with the research results some questions within the survey scored better during the analysis of the collected data and therefore its importance in the survey rise ergo the question weight is going to be higher and the recommendation for question weight change is therefore also in the table 8

included. In consequence an adaptation of the scoring model has to take place and therefore the aspects above listed covered by a particular question within the survey gain more impact on the overall innovativeness score. In the table 8 are two aspects above 0.800 due to the fact that these are loadings of reflective connections within a factor, which tend to score a higher values in comparison to the rest of the values, which were weights of formative connections within other factors. In brackets of the reflective indicators are the values of formative connection included for comparison purpose. Furthermore due to the lack of sensitive data regarding financial and NPD activities, which were not disclosed by the supplier some questions either lost impact on the final score like R&D spend or will be removed from questionnaire due to the fact that the delivered that were inconsistent with other questions in the survey and cause an irrational outcome during the analysis like NPD experience (here: the number of NPD projects started and finished). The main aim of the research was to explore the strongest correlations between particular aspects of innovative suppliers stated by the literature and innovativeness of supplier as such within the sample size in order to rank the suppliers regarding its innovativeness. Surprisingly the cluster (0.365) effect was not such strong as expected according to literature. One explanation for this can be, that there is no innovative lighting industry cluster in North Rhine-Westphalia anymore and is already surpassed by lighting industry clusters from other world regions like Asia due to the disruptive character of the LED technology. Another aspect which have an impact on the outcome of this is the technical documentation measurement, where a more innovative supplier is willing to make the extra mile and deliver something more than agreed upon in the contract. It also support the statement of the PCS of the customer firm gained among the particular supplier. Innovation responsibility support the literature review statement that more innovative suppliers have a higher degree of innovation process sophistication and innovation structures in form of special departments or special designated and prepared people for innovation management. Therefore in comparison to non-innovative suppliers it secure more fruitful outcome for the customer firm (TRILUX). NPD strategy is not a surprise due the fact, that its supports the statement that innovative supplier collaborate within networks, therefore involve also the 2nd tier suppliers in its own new product development process. This result is also backed up in the literature and confirms, that innovation is getting much more a team effort of different suppliers than single firm result. Laboratory service support the statement, that an innovative supplier has own capacity for testing purpose and therefore the specification are much more exact. Furthermore it is also supports the statement from the director of electro-technical

laboratory department, that a supplier with own laboratory capacities is much closer the technology and might also come up with new and innovative ideas. Co-design strategy support the fact that a more innovative supplier is able to support the customer firm beginning with the idea generation for a given product until the design and technical product planning with all the aspects non-technical aspects. This indicator can also be biased due the fact, that it was multiple choice question, where the interviewee are able to mark all answers. Cost reduction behaviour implies that a constant delivery of applicable solutions for cost reduction is a characteristic for innovative supplier. It goes hand in hand with know-how transfer, which can be implied, if a supplier work together with customer firm on cost reduction solutions. These all indicators lead to the fact, that an innovative supplier scores on the overall performance question high, because the customer firm is satisfied with the collaboration characteristics covered by other indicators in the survey. In the annexure 5 is the table with all indicators and its weights. Resuming traditional purchasing measurements are not meaningful as they were due to the fact of movement from industrial economy into intellectual capital economy, where only counting the number of successful deliveries is not sufficient anymore in order to achieve competitive advantage in a knowledge-based economy. Therefore the focus is not in counting bottles of wine, but more about the analysis of the process of making the wine itself. Furthermore in a more and more complex world, where information overload is daily-business, it is very difficult and challenging task to filter the key information areas in order to secure the best available suppliers.

5.4 Implications for further research: current restrictions and chances for the next innovation surveys

Unfortunately it was not possible at the end of the project period due to time constraints to compare all data received from the suppliers with the data collected by the controlling department of TRILUX. A comparison of the highly sensitive data due to confidential issues and the non-disclosure policy of TRILUX outside of the company was not an option. Therefore it is highly interesting to investigate the survey results for the particular supplier with the prepared purchasing controlling data in order to look for additional relationship characteristics between TRILUX and the particular supplier from the sample backed up by hard numeric controlling data. There is a potential to discover a pattern for the more innovative suppliers according to delivered controlling data. Secondly future

research can be performed in the same manner, but extended on a selected group of only new suppliers for the particular customer firm (here: TRILUX). Therefore it would be interesting how completely new suppliers score on the innovation survey in comparison to suppliers already known by TRILUX. Due to a such comparison of the collected data it is possible to discover potential similarities or differences between innovative supplier from the own supplier base and completely new suppliers. On this way it is possible to close the research gap and get the insight about the completely new suppliers, where the input about the supplier can be only collected through a market research or other on the market available information sources. Additional such research activity can be connected with the firms exhibition activities or fair visits. Moreover, it is highly recommended for future research to expand the sample size in order to meet the criteria of SEM-PLS research method. In this case the sample size of at least 80 suppliers. Such a move can increase the reliability and validity of the results achieved within this research and check, if the developed survey delivers consistent results with bigger samples. An aspect which limits a research like that is the fact, that especially well know organisations do not want to share sensitive data regarding its operations, especially they do not want answer questions regarding financial or NPD aspects. Therefore it is highly recommended to handle the issue either with non-disclosure agreements or with other method to gain the trust and support for such a research and get access to financial information regarding its operations. On the analytical level there is still work to do regarding the indicator configuration in order to avoid or minimize cross loadings and therefore achieve a better fit between an indicator and the particular factor. Especially factor with financial data like cost and finance has to be better operationalise, because as an one-item factor is not reliable. On the survey level it is important to extend the industry sectors, where such surveys are conducted in order to validate the results within other branches than the lighting sector. Therefore the results achieved here are applicable only on an interfirm level within one organisation and in one industry sector. The research should also be conducted in different countries in order to unified the achieved results on country level. On the firm level future research can be conducted with suppliers of firms, where a higher degree of sophistication of supplier evaluation process within the category management unit exists and innovation policies are more developed and already established within the particular firm. At TRILUX it was a first approach to foster such activity like innovation assessment, therefore a high error rate is not unusual in this kind of research. A restriction for such a research is the innovativeness level of different commodities, where it is hard to compare different

suppliers among each other due to the fact, that different commodities have different innovation results regarding its dynamic. Due to the lack of commensurability among different commodities, it was very hard to find a common denominator to catch to the maximum each commodity and its dynamics, which made a comparison among commodities hard. This was likely to see in the collected data, where in overall some suppliers of a particular commodity like metals scored lower values on average, although there was still a big amount of spend behind such a commodity. Therefore a more detailed specification regarding the particular firm from the commodity group could provide more insight about the proper innovativeness level for the particular commodity supplier. In overall it needs more research to validate the proposed solution and test the theoretical assumptions behind the questionnaire and increase relevance and re-check the scientific rigor.

5.5 Recommendations for TRILUX

5.5.1 Executive summary

The aim of this master project was to develop method in order to evaluate the current and future supplier regarding its innovation potential within the purchasing department, exactly within the category management department, which handles the selection process of the suppliers for the whole TRILUX Group. Furthermore the proposed solution has to be in form of an automated system and has to be proceed within the supplier relationship management system (SRMS) provided by the outside contractor ■■■■■■■ During the extensive literature review and interviews with the employees of TRILUX responsible for the process of innovation development and implementation of suppliers into the current new product development process a list of aspects were chosen for operationlisation in order to build indicators (questions with given answers). The final outcome of the literature review and interviews with employees was an innovation survey with 27 questions including answers prepared to be answered by the suppliers. The questions were divided into 4 theme blocks: performance, cost and finance, service and soft facts, systems and strategy. Most of the questions are multiple-choice type questions or evaluation questions in order to estimate the particular level of the indicator. The weight of the 4 theme blocks and the scoring for each question were setup according to importance of covered aspects after interviewing the employees and backed up with the extensive literature review. During the project several employees from different departments (category management,

construction) and the unit innovation and technology centre evaluate the questions and theme block to choose different weights for them in order to focus on aspect important for the particular department regarding innovativeness recognition. Different departments and also different employees within a department have a specific focus on its daily operations regarding supplier assessment in the context of the innovativeness. This aspect was taken into account for the final version of the survey and the weights were chosen as average of the weights from different employees. The data collection was proceed via an online survey according to given sample by TRILUX by contacting the suppliers on the phone and sending them the survey after the call. The outcome of the survey was an overall ranking of suppliers, which filled the questionnaire. In order to classified the suppliers regarding the innovativeness the following levels were proposed to the purchasing management: innovative supplier 75% and above (green), between 74% and 50 % (orange) a potential innovative supplier, 49% and below (red) a non-innovative supplier. According to results achieved through the statistical analysis the collected data from the survey the following recommendations can be formulated. Highly positive significant was the performance block. A moderate significance had the theme block systems and strategy and service and strategy. No significance had the theme block cost and finance due to the fact, that this theme block had only 2 items, where one item R&D spend was a hard fact item and was due to disclosure issues not very often filled in by the supplier, therefore the results for this particular theme block has to be watch with caution and there is need of future evaluation of this theme block again with a bigger sample size. Therefore the new weights for the theme blocks are recommended to be set up as follows: performance ■■% (■■%), cost and finance ■■% (■■%), service and soft facts ■■% (■■%) systems and strategy ■■% (■■%). On the questions level within each theme block most significant indicators according to the conducted research were the grey marked questions within the table 8 and therefore the weights for the question were raised. In consequence the less significant or not significant indicators either its weights declines or in one extreme case the indicator fall out of the survey like in the case of NPD experience. Therefore in each theme block only few questions stand for at least 60% of the total theme block value.

Theme Block	Question	Weight (old)	Weight (new)
Supplier Performance	Overall Performance	■■%	■■%

■■% → ■■% (new)	Product Portfolio	■■%	■■%
	Quality Management	■■%	■■%
	Project Management	■■%	■■%
	Project Reporting	■■%	■■%
	FMEA & APQP	■■%	■■%
	Innovation Culture	■■%	■■%
	Internal Innovation Participation Culture	■■%	■■%
	Innovation Responsibility	■■%	■■%
	Prototyping	■■%	■■%
Cost and Finance ■■% → ■■% (new)	Cost reduction behaviour	■■%	■■%
	R&D Spend	■■%	■■%
Service and Soft Facts ■■% → ■■% (new)	Technical Change	■■%	■■%
	Laboratory Service	■■%	■■%
	Cooperation duration	■■%	■■%
	Change Management	■■%	■■%
	Co-Design Strategy	■■%	■■%
	Cooperation Culture	■■%	■■%
Systems and Strategy ■■% → ■■% (new)	Technical Documentation	■■%	■■%
	Technology and Innovation Roadmap	■■%	■■%
	Know-How Transfer	■■%	■■%
	Innovation Cluster Potential	■■%	■■%

	Export Strategy	■■%	■■%
	NPD Experience	■■%	■■
	Innovation Type	■■%	■■%
	NPD Strategy	■■%	■■%
	IPR Strategy	■■%	■■%

Tab. 9: Comparison of old and new weights for the supplier innovation survey

Source: author's own work

The presented here results are valid and reliable for the own supplier base and not for new supplier, where the pattern can have commonalities, but can also be different. Especially very interesting are start-ups or innovative supplier (e.g. ■■■■) from foreign markets, which do not patent its innovation and do not export, because the domestic market like the US is very big. Furthermore suppliers with own laboratory are much near at their technology than supplier with outsourced laboratory service. The cost and finance construct can be on this sample neglected, because it is only one single item construct and therefore it is not representative for the particular construct. The reduced version of the innovation survey explains on a 62% level and the full version of the innovation survey on 75% level. Therefore there is the question between the invested time and the effort of the employees for the difference of 13%, which is on the stake. Furthermore the innovation assessment should be done once a year and therefore not often, because it is on the one side more efficient for a customer firm regarding its capabilities and on the other side it gives the supplier enough time to make possible changes or developed something new for its customer. Furthermore the innovation actions are an outcome of the innovation strategy, overall TRILUX strategy and the product strategy, which make it dependent, if a cooperation with a supplier takes place.

Supplier	Category	Innovations-Score	CAMA-Score	Supplier-Score	Cluster [km]	Time [min.]
■■■■■■■	ECG	80,06%	79,5%	80,5%	■■	■■
■■■■■■■	ECG	78,69%	78,5%	78,9%	■■	■■
■■■■■■■	OEM	74,89%	76,8%	73,5%	■■	■■

■■■■■■■■	Plastics	74,81%	54,8%	89,3%	■■	■■
■■■■■■■■	ECG	73,66%	83,9%	66,2%	■■	■■
■■■■■■■■	ECG	72,48%	64,0%	78,6%	■■	■■
■■■■■■■■	ECG	65,35%	46,0%	79,4%	■■	■■
■■■■■■■■	Metals	62,54%	61,9%	63,0%	■■	■■
■■■■■■■■	Metals	62,45%	81,8%	48,4%	■■	■■
■■■■■■■■	LED	61,14%	44,8%	73,0%	■■	■■
■■■■■■■■	Metals	61,09%	43,6%	73,7%	■■	■■
■■■■■■■■	Metals	60,95%	78,0%	48,6%	■■	■■
■■■■■■■■	Metals	59,71%	53,2%	64,4%	■■	■■
■■■■■■■■	ECG	59,09%	51,2%	64,8%	■■	■■
■■■■■■■■	Metals	58,45%	43,1%	69,6%	■■	■■
■■■■■■■■	OEM	58,01%	53,3%	61,4%	■■	■■
■■■■■■■■	Metals	55,45%	51,0%	58,7%	■■	■■
■■■■■■■■	Metals	55,29%	44,0%	63,5%	■■	■■
■■■■■■■■	OEM	54,78%	45,7%	61,3%	■■	■■
■■■■■■■■	OEM	54,61%	47,6%	59,7%	■■	■■
■■■■■■■■	ECG	53,09%	69,5%	41,2%	■■	■■
■■■■■■■■	OEM	51,64%	55,2%	49,1%	■■	■■
■■■■■■■■	LED	47,46%	26,5%	62,6%	■■	■■
■■■■■■■■	OEM	44,59%	45,7%	43,8%	■■	■■
■■■■■■■■	Metals	43,05%	61,4%	29,7%	■■	■■
■■■■■■■■	Metals	40,14%	46,2%	35,8%	■■	■■
■■■■■■■■	Plastics	39,76%	4,8%	65,1%	■■	■■
■■■■■■■■	Plastics	38,65%	46,0%	33,4%	■■	■■

■■■■■■■■	Plastics	37,54%	4,8%	61,3%	■■	■■
■■■■■■■■	Metals	35,66%	37,0%	34,7%	■■	■■
■■■■■■■■	Metals	32,11%	41,9%	25,0%	■■	■■
■■■■■■■■	Plastics	32,01%	9,5%	48,3%	■■	■■
■■■■■■■■	Plastics	28,78%	4,8%	46,2%	■■	■■
■■■■■■■■	ECG	22,80%	54,3%	0,0%	■■	■■
■■■■■■■■	Plastics	21,28%	4,8%	33,2%	■■	■■

Tab. 10: Innovation supplier ranking based on the innovation survey results

Source: authors own's

In the table 10 is the innovation supplier ranking based on the outcome of the innovation survey results presented. The innovation mark is a green line at the level of 75%. The non-innovation line is red and starts at a level of 50%, therefore every supplier below 50% is to be seen as a non-innovative one. The biggest part of the suppliers are between 75% - 50%. In some cases like ■■■■■■■■ the supplier missed the innovative supplier group by less than 2 %. On other part some suppliers were only 2-3% above the non-innovative supplier hurdle rate. The orange group is the most interesting one due to the fact, that among the suppliers are the future innovation suppliers of TRILUX. The data used for the supplier is one more time used in order to visualize the results on matrix in order to bundle the suppliers according to it group on 2 scale matrix to observe the variation of the CaMa score and the supplier score for the particular supplier. The violet lines marked the 50% hurdle rate for the scores. The grey line in the middle of the matrix is the trend line.

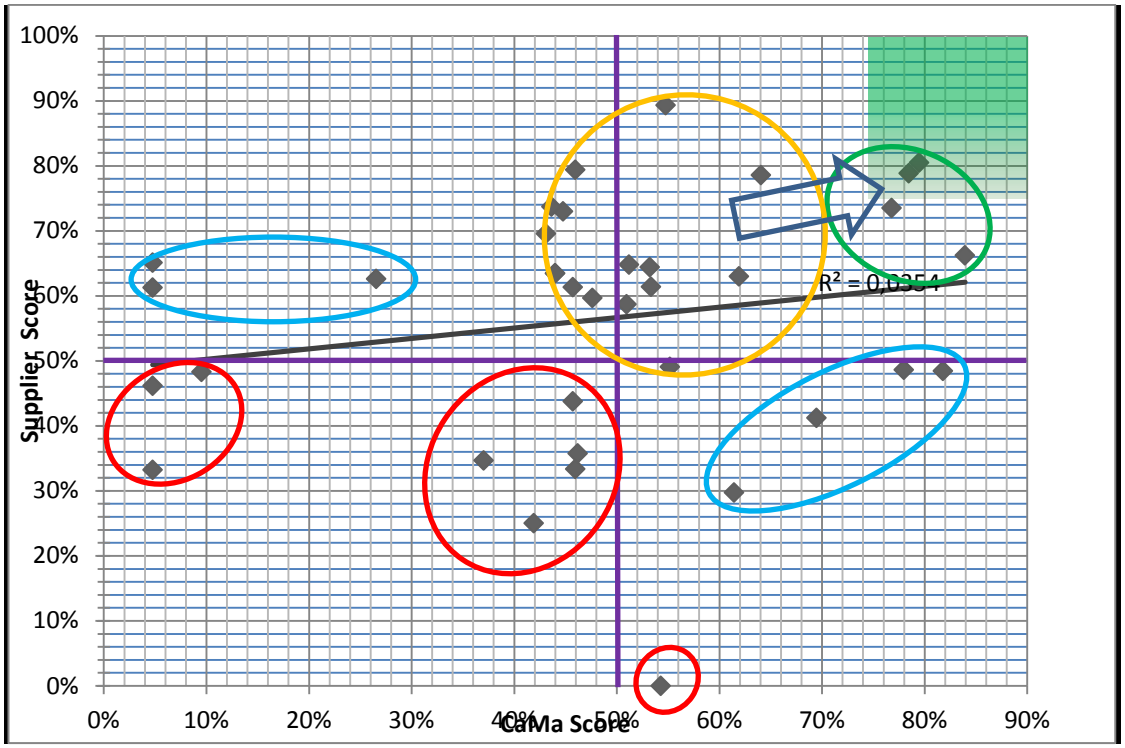
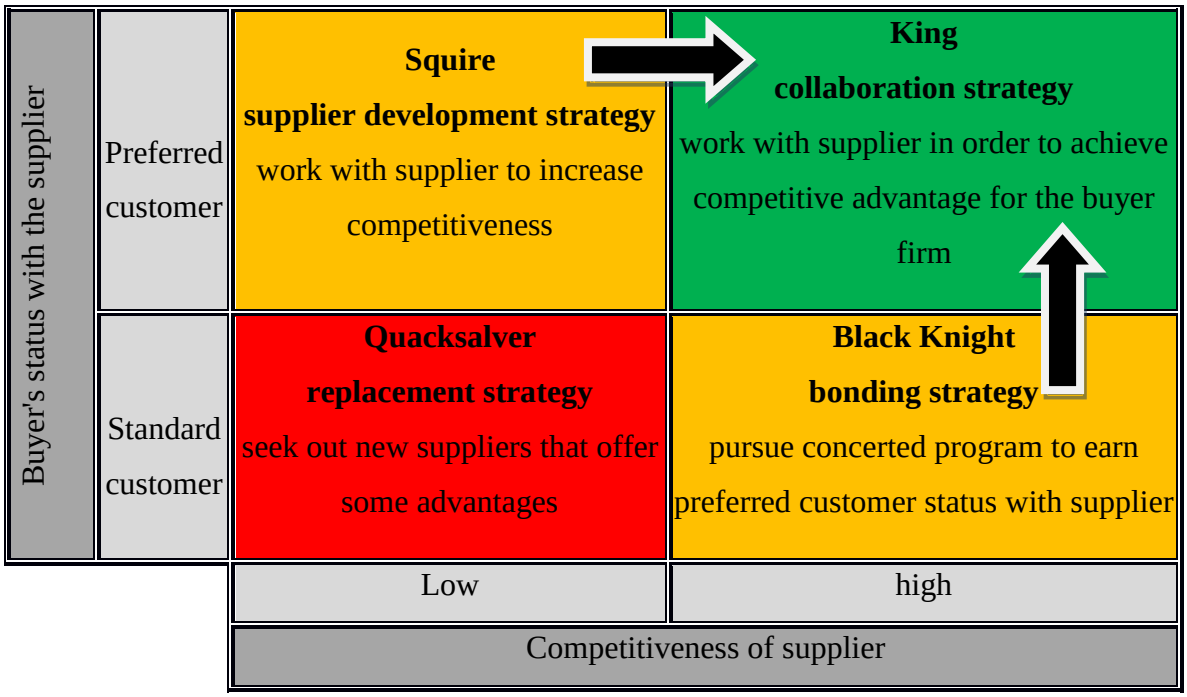


Fig. 18: Innovation matrix according to supplier ranking bases on the innovation survey

Source: authors own's

Suppliers in red circles are either cost suppliers, therefore they do not score high on the CaMa score regarding innovation and the self assessment of the supplier confirms the assessment of the purchasing managers. This is the case for ■■■■■■■■, ■■■■■■■■, ■■■■■■■■ and others in this group. In some cases the supplier is only a reseller and therefore the supplier score was not possible, because the product range is too broad and covers several manufacturers. In some cases the like ■■■■■■■■, ■■■■■■■■ and ■■■■■■■■ the suppliers have a mismatch between the category management assessment and the supplier self assessment and therefore there is a need to investigate the difference in the view, but it is highly not possible to find in this particular group a new innovative supplier due to a score below 50% on the supplier score. In terms of Schiele's classification the red circle suppliers are Quacksalvers. The green circle supplier are the innovative suppliers and most of them reached the 75% hurdle rate. In most cases these are the big names in the industry like ■■■■■■■■, ■■■■■■■■, ■■■■■■■■. In terms of Schiele's classification this are the Kings, which can choose with which customer they will cooperate together. The most interesting group is the orange circle, which are suppliers in the middle of the matrix, which have high supplier score, but

are not yet recognised by the category management at least on the same level and therefore they are not identified as innovative suppliers. In dependence of the earned or not earned PCS this are either Squires or Black Knights according to Schiele and therefore it is important to establish with these suppliers a PCS by applying a satisfaction survey to identify the shortcomings of the current customer-supplier relationship or work together with this suppliers during innovation workshops in order to identify more and better opportunities for increased competitiveness for both transaction sides. The aim is to shift the suppliers into a King position in the particular commodity, component segment and in the same time secure special treatment for TRILUX due to the achievement of a PCS with the given supplier. Furthermore there are also 2 blue circles, with a high probability these suppliers are outliers in terms of overestimated self assessment, which applies to the group with ■■■■■■■■, ■■■■■■■■ with a bad self assessment. On the other hand the second blue circle are suppliers with underestimated self assessment, which applies to the group with ■■■■■■■■ and ■■■■■■■■, but in contrast to the first blue circle group this suppliers score very high on the CaMa-Score. Therefore further investigation can result in identification of the cause of the difference in the assessment lead through development of combined innovation projects or innovation workshops to a status change into innovative supplier. Below in the table 11 one more time is the classification of suppliers according to Schiele presented, but this time with colour underline in order to sort the achieved results into the introduce theoretical framework.



Tab. 11: Classification of the suppliers according to the preferred customer matrix and generic strategy buying firm (based on Schiele (2012) p. 48)

5.5.2 Survey SWOT: What can be improve?

A strong side of the survey as the research showed is the fact that the achieved result are valid and reliable, therefore for the given sample size the recommendations are applicable. The downside is the fact, that the sample size was only 36 supplier big and therefore is recommended to reassess the results of the innovation survey, when more suppliers fill out the survey. The next appropriate level would be a sample size of 80 suppliers and the future a duplication of the sample can be used as rule of thumb for a reassessment milestone regarding the size of the sample. A thread and in the same time an opportunity for the innovation survey is definitely the interviewee self, especially the position which is held by the person. It's noticeable that the quality of the answers is dependent on the person, which were asked in the organisation. Sales and marketing employees tend to overestimate often the technical issues. Furthermore sales representative aim for a high result within the survey instead of honest answer about their technical capabilities. Additional to this they often answered the questions without consulting them within their organisation with an expert employee e.g. construction or R&D employee. Therefore one solution is to randomize the answers in order to make it harder to aim for a high score by following a particular pattern. e.g. low point item in the beginning and high point item at the end of the given question. The solution of the second issue is that the interviewee,

whom filled in the questionnaire has to leave his name and position in order to get deeper on the given aspect covered by the question in later stages of supplier qualification. Furthermore it can be in the introduction text make very explicit clear, that it is highly important, that the specific questions are answered by the most qualified and knowledgeable employee within an organisation or at least after consultation with it in order to make the assessment as valid and reliable for TRILUX and fair for the supplier itself. The best bad example for such a question is the NPD experience question, where the question is removed from the survey due to fact that interviewees delivered numbers in most cases randomly. Furthermore the question is not sharp enough and therefore an error rate was very high or the achieved result were very doubtful e.g. small entities had a very high project number and high finish score although their R&D spend do not facilitate this. Another bad example are the estimation questions like for example R&D spend or export ratio. As already mention above either the value are overestimated by the interviewee or do not disclose at all. Therefore an additional thread for the survey is the non-disclosure policy regarding the delivered information. A potential solution for this situation is non-disclosure agreement or legal information regarding the provided data. Furthermore a logical next step based on the achieved results is to start a supplier satisfaction analysis with current suppliers in order to discover the potential within the relationship between TRILUX and the innovation suppliers (Kings) or the potential innovation suppliers (Black Knights) with the aim to discover issues, which may be an obstacle to achieve the PCS among innovation suppliers. The aim of a such survey is to help to identify the shortcomings of supplier-customer firm relationship and operationalise them in order proactive remove them in agreement with the supplier.

5.5.3 Lessons learned: additional outcome of the project

[redacted]

Another aspect which came up during the data analysis is, that some suppliers state a longer collaboration period than the responsible category manager. This issue has probably a reason within the personal either on the supplier or TRILUX side within the department, that current people either are a shorter period within the organisation than the actual collaboration period.

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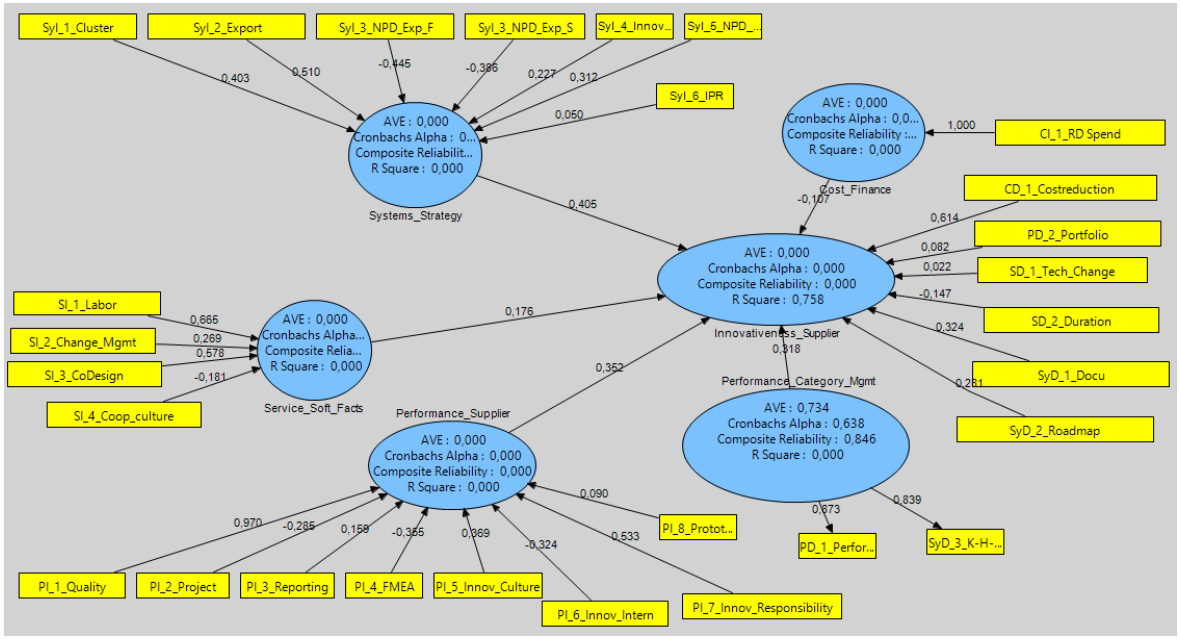
Index of annexures

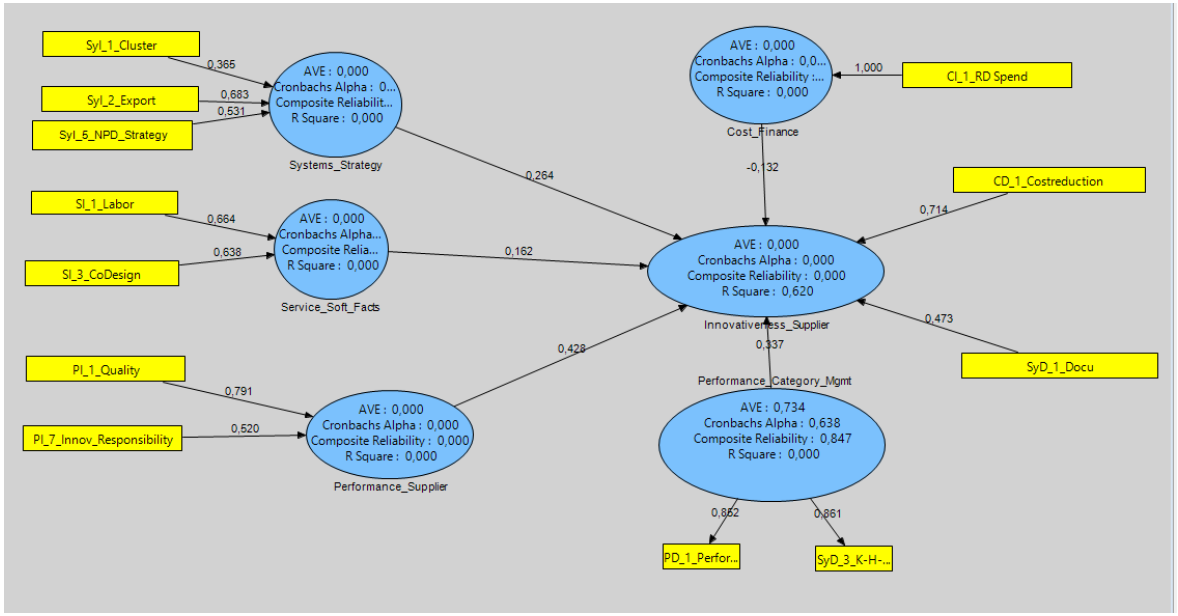
Annexure 1: List of suppliers provided by TRILUX for the survey (including distance and travel time to supplier's HQ)

Company	ZIP	City	Adress	Distance [km]	Time [min.]
■■■■■■■■■■■■■	■■■■■■■■■	■■■■■■■■■■■■■	■■■■■■■■■■■■■■	■■■■	■■■■
■■■■■■■■■■■■■	■■■■■■■■■	■■■■■■■■■■■■■	■■■■■■■■■■■■■■	■■■■	■■■■
■■■■■■■■■■■■■	■■■■■■■■■	■■■■■■■■■■■■■	■■■■■■■■■■■■■■	■■■■	■■■■

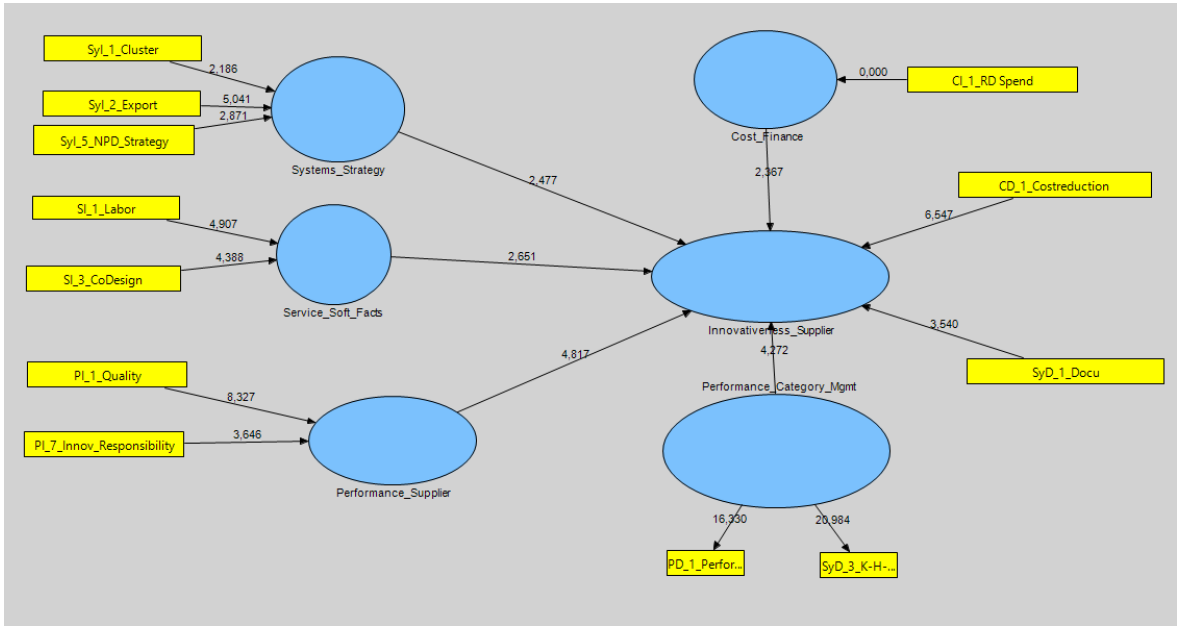
Annexure 2: SmartPLS graph with all indicators including loadings and weights



Annexure 3: SmartPLS graph with only chosen indicator including loadings and weights



Annexure 4: Bootstrapping with the reduce model version (100 cases, 300 samples)



Annexure 5: List of factors and indicators with the weight according to SmartPLS graph

Factor	Indicator	Weight
Supplier Performance	Quality Management	0,977
	Innovation Responsibility	0,545
	Innovation Culture	0,368
	Reporting	0,159
	Prototyping	0,096
	Project Management	-0,271
	Innovation Intern	-0,342
	FMEA	-0,370
Service and Soft Facts	Labor	0,668
	Co-Design	0,575
	Change Management	0,278
	Cooperation Culture	-0,197

System and Strategy	Export	0,620
	Cluster	0,342
	NPD Exp F	-0,372
	NPD Exp S	-0,452
Cost and Finance	R&D Spend	1,000
Innovativeness	Costreduction	0,601
	Documentation	0,318
	Roadmap	0,285
	Portfolio	0,105
	Technical Change	0,013
	Duration	-0,165

Annexure 6: List of employees interviewed during the project

Mrs. ■■■■■■■■■ - Category Manager Plastics

Mr. ■■■■■■■■■ - Category Manager Metals

Mr. ■■■■■■■■■ - Category Manager LED

Mr. ■■■■■■■■■ - Category Manager ECG

Mr. ■■■■■■■■■ - Category Manager OEM

Mr. ■■■■■■■■■ - Supervisor Category Management

Mr. ■■■■■■■■■ - Head of Purchasing Department and Member of Directors Board

Mr. ■■■■■■■■■ - Supervisor Purchasing Operations

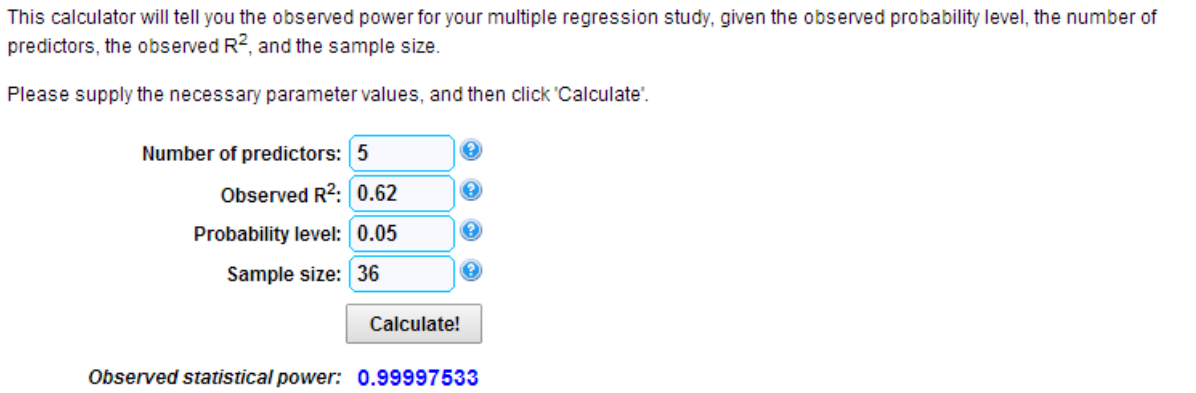
Mr. ■■■■■■■■■ - Director of electro-technical laboratory

Mr. ■■■■■■■■■ - Director of construction department

Mr. ■■■■■■■■■ - ITC scout

Mr. ■■■■■■■■■ - ITC

Annexure 7 : Calculations of statistical power



Source: http://www.danielsoper.com/statcalc3/calc.aspx?id=9 (access 17.01.2014)

Annexure 8: Supplier questionnaire for the survey (English version)

theme block	source type of the answer: internal - TX - or external - Supplier - or available questionnaire	potential contact internal/external	title of the criterion (question)	weight for the single question in the particular theme block	**the wording of the question**	**the wording of the answers for the question**	**weight for the particular answer**
		[1] Technology - Performance [■■%]					
[1] Technology - Performance	**Internal**	**Cateogory Management**	**Overall Consulting Performance**	**■■%**	Is the supplier‘s production process innovative and efficient? Is the supplier capable to provide the engineering and consulting services required by TRILUX?	The supplier cannot provide the requisite services; there is no properly qualified support	■■%
		R&D				The supplier meets the requirements with some exceptions	■■%
		Construction				The supplier can provide the required services; qualified and very readily accessible contacts are available	■■%

						The supplier provides all the services; qualified and very readily accessible contacts proactively contribute with innovative approaches	■■%
						N/A	N/A
	Internal	**Cateogory Management**	**Product Portfolio**	**■■%**	Are the products and services of the supplier technologically superior? Does the breadth and depth of the supplied product range meet the requirements of TRILUX?	Technologically obsolete; the product range is not adequate	■■%
		Construction				Technologically below average; the product range largely corresponds to requirements	■■%
						Technologically up to standard; the product range very largely corresponds to the requirements.	■■%

						Technologically superior; the product range supplied fits completely	■■%
	Registration	**Quality Management**	**Quality Management (QM) | Environmental Management (EM) (Certificates)**	■■%	Do you have a quality management system (QMS) or environmental management system (EMS)? (Multiple answers possible) [Answer should be collected from register form]	not avaiable	■■%
						ISO 9001	■■%
						ISO 16949	■■%
						ISO 14001 (EMS)	■■%
	External	**R&D**	**Project Management**	■■%	Is a dedicated project management (employee or team) in development projects at your company established?	No project manager in development projects established	■■%
		Construction				One team member has additional project management tasks, but no project management education or certificate	■■%

						One team member has additional project tasks and has project management education or certificate	■■%
						Dedicated and educated project manager in every product or technology development project in place	■■%
	External	**Construction**	**Project Reporting**	■■%	How do you report about the project development to your customer?	No reporting out of development teams, no project documentation available	■■%
		R&D				Cyclic reporting to team leader, partly project documentation	■■%
						Cross-departmental group established including top management, project documentation available	■■%
						Steering group established, project specific customer integrated, project documentation available and harmonised	■■%

	External	**Construction**	**FMEA & APQP**	**■■%**	Is FMEA (Failure Mode and Effects Analysis) or APQP (Advanced Product Quality Planning) or other method (e.g. Fishbone, Moldflow, 5-Why etc.) during the development process established?	No process or no tool established	■■%
		R&D				FMEA or APQP or other method vestigial established (e.g. excel tool, changing responsibility)	■■%
						FMEA or APQP internal or External established with professional tool and trained	■■%
						FMEA or APQP internal or External established with professional tool and special responsible department	■■%
	External	**Technology Management**	**Overall Innovation Culture**	**■■%**	What is your working style/culture in a new product development (NPD) project? (Multiple answers possible)	Employees work across network, borders, sectors; convergence of different technologies with innovative partners available	■■%

		Construction				Employees work in internal cross-departmental comitees	■■%
		R&D					
						An organigramm of the innovation responsible persons established	■■%
	External	**Project Management** **Management**	**Internal Innovation Participation Culture**	**■■%**	Which employees (function or department) from your company are taking part in innovation activities e.g. workshops? (Multiple answers possible)	Marketing	■■%
						Production	■■%
						R&D (Reseach & Development)	■■%
						Sales / Customer service	■■%
						Purchasing	■■%
	External	**Project Management**	**Innovation Activities Responsibility**	**■■%**	Which employees are responsible for managing new product development (NPD)	No structure established	■■%

		Management			projects?	Senior managers e.g. product manager, CEO etc. are responsible	■■%
						Senior managers and R&D managers are responsible	■■%
						Responsible person or a special department is defined	■■%
	External	**R&D**	**Prototyping**	**■■%**	Is the prototype manufacturing available?	No possibility and / or no experience with prototyping available	■■%
						Prototyping with External partners available	■■%
						Prototyping partwise through External partners, partwise internally available; a responsible person defined	■■%

						Own 100% prototyping capability with clear responsibilities	■■%
number of inquiries	**Registration form**	**Internal-Question**	**External-Question**				
	1	**2**	**7**	**■■%**			
		[2] Technology - Cost & Finance [■■%]					
[2] Technology - Cost & Finance	**Internal**	**Cateogory Management**	**Cost Reduction Behaviour & Willigness**	**■■%**	Please estimate the supplier‘s degree of willingness and effort in order to reduce costs.	No cost reduction efforts; no proactive suggestions from supplier	■■%
						Cost reduction efforts only partially existing; rare and sometimes unrealisable suggestions	■■%
						Frequent cost reduction efforts; frequent advancement of realisable suggestions with a generally favourable cost-benefit relationship	■■%

						Continuous cost reduction efforts; supplier proactively advances realisable suggestions with favourable cost-benefit relationship	■■%
	Registration		**R&D Expenditure**	■■%	What is your share of R&D expenditure in comparision to your total turnover in %? (R&D/Turnover-ratio) [Answer should be collected from Registration form]	[Answer as number, in the normal case input from the Registration form]	■■%
							■■%
							■■%
							■■%
number of inquiries	**Registration form**	**Internal-Question**	**External-Question**				
	1	**1**		■■%			
		[3] Technology - Service & Soft Facts [■■%]					
ology - Servi ce &	**Internal**	**Category Management**	**Flexibility in case of technical changes**	■■%	Does the supplier respond flexibly and	The supplier responds too inflexibly or not at	■■%

		Construction			promptly to technical changes made by TRILUX (e.g. changes to specifications, product modifications, etc.) and does he implement them?	all	
						The supplier mostly copes with changes, sometimes with delay	■■%
						The supplier copes with most changes in a rapid and uncomplicated manner	■■%
						The supplier copes with all changes in a rapid and uncomplicated	■■%
	External	**R&D** **Construction**	**Laboratory Service**	**■■%**	Do you have your own laboratories or testing facilities?	No own laboratory, no own testing available	■■%
						No own laboratory and complete outsourced testing available	■■%
						Own laboratory, but partly outsourced testing available	■■%
						Own laboratory and own testing available	■■%
	External	**Category Management**	**Cooperation Duration**	**■■%**	How many years do you cooperate with TRILUX?	<3	■■%
						>3	■■%
						>6	■■%

						>9	■■%
						N/A	N/A
	External	**R&D** **Production**	**Change Management**	**■■%**	Is a Change Request Process during the development process established?	No process for change management established	■■%
						Changes are documented	■■%
						Changes are documented and released team internally	■■%
						Changes in specification or way of working are documented, released and the customer is informed	■■%
	External	**Product Management** **R&D**	**Co-Design Activity Strategy**	**■■%**	In which areas of specialization do you usually collaborate in new product development (NPD) projects with a customer? (Multiple answers possible)	Product engineering and design	■■%
						Prototype build, test and pilot	■■%
						Business and technical assessment	■■%
						Idea generation	■■%

	External	**Project Management** **Management**	**Cooperation Culture**	**■■%**	What is your usual input in new product development (NPD) projects with your customer?	No support at all	■■%
						Only ressources	■■%
						Ressources, task and shared project responsibility with customer	■■%
						Ressources, task and full project responsibility	■■%
number of inquiries	**Registration form**	**Internal-Question**	**External-Question**				
		1	**5**	**■■%**			
		[4] Technology - Systems & Strategy [20%]					
[4] Technology - Systems & Strategy	**Internal**	**R&D**	**Technical and R&D documentation**	**■■%**	Is the technical and R&D documentation (process description, design engineering drawings, test and acceptance certificates etc.) provided complete, comprehensible? Is it handed over in	The supplier responds too inflexibly or not at all	■■%
		Labatory				The supplier does not meet the requirements; missing documentation continuously results in complaints	■■%

					comprehensive form on time according to NDA and development property agreement?	The supplier meets the requirements properly and provides complete documentation	■■%
						Complete and timely documentation, if necessary supplied with drawings made by the supplier	■■%
	Internal	**Technology Management**	**Technology/Innovation Roadmap**	■■%	Is a technology/innovation roadmap in written form available? ("written form" a written document; an email or phone memo is not "written form")	No technology/innovation roadmap available	■■%
						Technology/Innovation roadmap available, but not in written form	■■%
						Technology/Innovation roadmap available in written form	■■%
						Technology/Innovation roadmap available, synchronized with your product roadmap	■■%

	Internal	**Technology Management** **R&D**	**Know-how transfer**	**■■%**	Does the supplier voluntarily provides open and comprehensive knowledge about products and processes, over and above what is contractually agreed? Is the supplier suitable as a development partner? Can the relationship to the supplier be characterized as creating a mutual obligation and based on trust?	Supplier holds back knowledge or does not possess the requisite expertise	■■%
						Little transfer of know-how takes place. The relationship does not extend beyond operational processing	■■%
						Supplier exchanges knowledge. He has developed a constructive working relationship	■■%
						A relationship that serves as a mutual obligation and is based on trust. Supplier passes on knowledge and contributes innovations	■■%
	Registration		**Innovation Cluster Potential**	**■■%**	Where is the headquater of the supplier?	> 800 km	■■%
						< 800 km	■■%
						< 400 km	■■%
						< 200 km	■■%

	Registration		**Export Strategy**	**■■%**	What amount in % of your production do you export? (export sales/total sales-ratio)	[Answes as number. Input out of the Registration form.]	<■■%
							>■■%
							>■■%
							>■■%
	External	**Construction** **R&D**	**NPD Experience**	**■■%**	What is the number of new product development projects (NPD) projects, which you did start and the number of finished NPD projects in the last 3 years with your buyer companies?	[Answer is number of started and finished NPD projects in the specific time period]	
						Project started:	#
						Project finished:	#
						N/A	
	External	**Technology Management** **R&D**	**Innovation Type**	**■■%**	What kind of innovation type do you usually offer to your customers? (Multiple answers possible)	Process innovation	■■%
						Product innovation	■■%
						Marketing innovation	■■%
						Organizational innovation	■■%

	External	**Construction** **Product Management**	**NPD Partnership Strategy**	**■■%**	What is your partnership strategy in new product development (NPD) projects?	No partnerships available	■■%
						Partnerships with different Externals partners	■■%
						Partnerships with only approved partners	■■%
						Network of established partners available or at no time partners are needed	■■%
	External	**Technology Management** **Legal**	**IP Strategy**	**■■%**	What is your intelectual property rights (IPR) policy regarding TRILUX?	No intelectual property participation by TRILUX	■■%
						Lincense with time and region limitation	■■%
						Lincense with no time limitation, but region limitation	■■%
						No intelectual property restrictions regarding time and region	■■%
						Intelectual property rights regulated through the tool contract	■■%

number of inquiries	Registration form	Internal-Question	External-Question				
	2	3	4	■■%			
	4	**7**	**16**	**27**			

Annexure 9: Supplier questionnaire for the survey (German version)

Themenblock, der abgefragt wird	Quelle der Antwort (Intern -TX - oder Extern - Supplier oder bereits vorhandene Fragebögen)	potenzielle Ansprechpartner Intern/Extern	Titel (Beschreibung) des bewerteten Kriteriums (Frage)	Gewichtung der einzelnen Frage	**Wortlaut der Frage**	**Vorformulierte Antworten auf die gestellte Frage**	**Gewichtung der einzelnen Antworten**	
		[1] Technology - Performance [■■%]						
[1] Technology - Performance	**Intern**	**Einkauf** **Konstruktion**	**Allgemeine Bewertung der Leistungsfähigkeit hinsichtlich Entwicklung, Beratung und Produkten**	**■■%**	Ist der Produktionsprozess des Lieferanten innovativ und effizient? Ist der Lieferant fähig die von TRILUX angeforderten Entwicklungs- und Beratungsdienstleistungen zu erbringen?	Der Lieferant kann die angeforderten Dienstleistungen nicht erbringen; Es gibt keinen qualifizierten Support vom Lieferanten	■■%	
						Der Lieferant erfüllt die Anforderungen bezüglich Entwicklungs- und Beratungsdienstleistungen mit einigen Ausnahmen	■■%	

		Forschung und Entwicklung				Der Lieferant kann die angeforderten Dienstleistungen erbringen; Ein qualifizierter und zugänglicher Support ist vorhanden	■■%	
						Der Lieferant erbringt die angeforderten Dienstleistungen; Ein qualifiziertes und sehr zugängliches Personal trägt pro aktiv mit innovativer Herangehensweise zur Innovation bei	■■%	
						o. A.	o. A.	
	Intern	**Einkauf**	**Produktportfolio**	**■■%**	Sind die Produkte und Dienstleistungen vom Lieferanten technologisch überlegen? Erfüllen die	Die Produkte sind technologisch überholt; Die Produktpalette wird den Anforderungen nicht gerecht	■■%	

		Konstruktion			angebotenen Produkte die Anforderungen von TRILUX?	Die Produkte sind technologisch unterdurchschnittlich; Die Produktpalette erfüllt größtenteils die Anforderungen	■■%
						Die Produkte sind technologisch auf dem aktuellen Technologiestand. Die Produktpalette erfüllt weitgehend die Anforderungen	■■%
						Die Produkte sind technologisch überlegen; Der Umfang und die Tiefe der Produktpalette erfüllt vollständig die Anforderungen	■■%

	Registrierungs-prozess	**Quality Management / Registrierungs-fragebogen**	**Qualitätsmanagement | Umweltmanagement-system (Zertifikate)**	**■■%**	Besitzen Sie ein Qualitätsmanagementsystem (QMS) oder ein Umweltmanagementsystem (UMS)? (Mehrfachnennungen möglich) [Antwort wird von den Registrierungsfragebogen übernommen.]	ein QMS ist nicht vorhanden	■■%	
						ISO 9001 vorhanden	■■%	
						ISO 16949 vorhanden	■■%	
						ISO 14001 (UMS) vorhanden	■■%	
	Extern	**Forschung und Entwicklung** **Konstruktion**	**Projektmanagement**	**■■%**	Ist ein Projektmanagementprozess (Team oder Mitarbeiter) in den Neuproduktentwicklungsprojekten in Ihrem Unternehmen vorhanden?	Kein Projektmanager während des Neuproduktentwicklungsprojekts vorhanden	■■%	
						Ein Entwicklungsteammitglied hat zusätzliche Projektmanagementaufgaben, verfügt jedoch über keine Projektmanagement-Ausbildung oder Zertifikat	■■%	

						Ein Entwicklungsteammitglied hat zusätzliche Projektmanagementaufgaben und eine Projektmanagement-Ausbildung oder Zertifikat	■■%	
						Ein ausgebildeter Projektmanager ist in jedem Produkt- und Technologieentwicklungsprojekt vorhanden	■■%	
	Extern	**Konstruktion** **Forschung und Entwicklung**	**Projekt Reporting**	■■%	Wie berichten Sie Ihrem Kunden über die Projektentwicklung?	Kein Reporting aus dem Entwicklungsteam vorhanden; Keine Dokumentation zum Projekt vorhanden	■■%	
						Zyklisches Reporting zum Team Leader vorhanden; Eine Dokumentation zum Projekt ist teilweise vorhanden	■■%	

						Ein Reporting im Rahmen einer abteilungsübergreifenden Gruppe inklusive der Führungsebene vorhanden; Eine Dokumentation zum Projekt ist vorhanden	■■%	
						Ein Lenkungsgremium ist vorhanden, der projektspezifische Kunde ist ins Reporting integriert; Eine abgestimmte Dokumentation zum Projekt ist vorhanden	■■%	
	Extern	**Lieferant** **Konstruktion**	**FMEA & APQP**	**■■%**	Ist eine FMEA (Failure Mode and Effects Analysis) oder APQP (Advanced Product Quality Planning) oder eine andere Methode (z.B. Fishbone, Moldflow, 5-Why etc.) während des Entwicklungsprozesses	Kein Prozess / Tool eingerichtet	■■%	
						FMEA, APQP oder eine andere Methode stellenweise eingerichtet (z.B. Excel Tool, wechselnde Verantwortlichkeiten)	■■%	

		Forschung und Entwicklung			eingerichtet?	FMEA oder APQP mit professionellem Tool und ausgebildetem Personal intern oder extern sind eingerichtet	■■%	
						FMEA oder APQP mit professionellem Tool und einer verantwortlichen, spezialisierten, internen oder externen Abteilung sind eingerichtet	■■%	
	Extern	**Technologie Management**	**Allgemeine Innovationskultur des Unternehmens**	■■%	Wie gehen Sie bei Neuproduktentwicklungsprojekten (New Produkt Development) vor? (Mehrfachnennungen möglich)	Mitarbeiter arbeiten über Netzwerke, Grenzen, Branchen hinaus; Zusammenführung von unterschiedlichen Technologien mit innovativen Partnern ist gegeben	■■%	
		Konstruktion				Mitarbeiter arbeiten intern in abteilungsübergreifenden Ausschüssen	■■%	

		Forschung und Entwicklung						
						Ein Organigramm von den Innovationsverantwortlichen ist vorhanden	■■%	
	Extern	**Projektmanagement** **Management**	**Interne Innovationsteilnahme Kultur**	■■%	Aus welchen Abteilungen nehmen Mitarbeiter Ihres Unternehmens an Innovationsaktivitäten teil? z.B. Innovationsworkshops (Mehrfachnennungen möglich)	Marketing	■■%	
						Produktion	■■%	
						F&E (Forschung und Entwicklung)	■■%	
						Vertrieb/Kundenservice	■■%	
						Einkauf	■■%	
	Extern	**Projektmanagement** **Management**	**Innovationsaktivitäten Verantwortlichkeit**	■■%	Welche Mitarbeiter Ihres Unternehmens sind für die Koordination von Neuproduktentwicklungsprojekten (New Produkt Development) verantwortlich?	keine Struktur der Verantwortlichkeiten vorhanden	■■%	
						leitender Angestellter z.B. Produktmanager, Geschäftsführer ist verantwortlich etc.	■■%	

						leitender Angestellter und F&E- Leiter sind verantwortlich	■■%	
						eine zuständige Person oder eine zuständige und spezialisierte Abteilung ist vorhanden	■■%	
	Extern	**Forschung und Entwicklung**	**Prototypenbau**	**■■%**	Bieten Sie Ihrem Kunden Prototypenbau (Engineering Samples oder Vorabmuster) an?	keine Möglichkeit oder Erfahrung mit Prototypenbau vorhanden	■■%	
						Prototypenbau mit externen Partnern vorhanden	■■%	
						Prototypenbau teils mit externen Partnern und teils intern vorhanden, ein zuständige Person ist genannt	■■%	
						100% interne Prototypenbaumöglichkeiten mit klaren Zuständigkeiten sind vorhanden	■■%	

Anzahl Fragen	Registrierung	Intern	Extern				
	1	**2**	**7**	**■■%**			
		[2] Technology - Cost & Finance [■■%]					
[2] Technology - Cost & Finance	**Intern**	**Einkauf**	**Kostenreduzierungsverhalten und -bereitschaft des Lieferanten**	**■■%**	Wie ist der Grad der Bereitschaft seitens des Lieferanten bezüglich Bemühungen zur Kostenreduzierung einzuschätzen?	Keine Bemühungen zur Kostenreduzierung vorhanden; Keine proaktiven Vorschläge zwecks Kostenreduzierung vom Lieferant vorhanden	■■%
						Kostenreduzierungsbemühungen teilweise vorhanden; Seltene und manchmal nicht umsetzbare Kostenreduzierungsvorschläge vorhanden	■■%
						Häufige Kostenreduzierungsbemühungen vorhanden; Häufige Entwicklung von umsetzbaren Vorschlägen mit generellen Kostenvorteil vorhanden	■■%

						Kontinuierliche Kostenreduzierungsbemühungen vorhanden; Lieferant setzt pro aktiv Vorschläge mit Kostenvorteil um	■■%	
	Registrierungs-prozess		**F&E Ausgaben**	■■%	Wie hoch ist der Anteil (in %) der F&E-Ausgaben am Gesamtumsatz? (F&E/Gesamtumsatz-Anteil)	■■%	■■%	
						■■%	■■%	
						■■%	■■%	
						■■%	■■%	
Anzahl Fragen	**Registrierung**	**Intern**	**Extern**					
	1	**1**		**■■%**				
		[3] Technology - Service & Soft Facts [■■%]						
Technology - Service & Soft	**Intern**	**Einkauf**	**Umsetzung von technischen Änderungen**	■■%	Wie reagiert der Lieferant im Falle von technischen Änderungen	Der Lieferant ist unflexibel oder reagiert gar nicht	■■%	

		Konstruktion			von TRILUX (z.B. Änderungen in der Spezifikation, Produktmodifikationen etc.) und wie implementiert er die Änderungen?	Der Lieferant implementiert die Änderungen in den meisten Fällen, nicht immer termingerecht	■■%	
						Der Lieferant implementiert fast alle Änderungen schnell und zuverlässig	■■%	
						Der Lieferant implementiert alle Änderungen schnell und zuverlässig	■■%	
	Extern	**Supplier**				Kein eigenes Labor vorhanden, es wird keine Prüfung durchgeführt	■■%	
		[R&D/Construction]	**Labor Service | Qualitätsprüfung**	**■■%**	Haben Sie eigene Labore oder Testeinrichtungen?	Kein eigenes Labor vorhanden, die Prüfung wird über externe Partner abgewickelt	■■%	
						Eigenes Labor vorhanden, die Prüfung wird teilweise über externe Partner abgewickelt	■■%	

						Eigenes Labor vorhanden; Prüfungen werden intern durchgeführt	■■%	
	Extern	**Einkauf**	**Kooperationsdauer**	■■%	Wie viele Jahre arbeiten Sie mit TRILUX zusammen?	<3	■■%	
						>3	■■%	
						>6	■■%	
						>9	■■%	
						o. A.	o. A.	
	Extern	**Forschung und Entwicklung**	**Änderungsmanagement**	■■%	Ist ein Änderungsmanagementprozess während des Neuproduktentwicklungsprojekts (New Produkt Development) eingerichtet?	kein Änderungsmanagement prozess vorhanden	■■%	
		Produktion				alle Änderungen werde dokumentiert	■■%	
						alle Änderungen werden dokumentiert und intern im Entwicklungsteam veröffentlicht	■■%	
						alle Änderungen in der Spezifikation oder der Arbeitsweise sind dokumentiert, veröffentlicht und der Kunde wird darüber informiert	■■%	

	Extern	**Produktmanagement** **Forschung und Entwicklung**	**Co-Design Strategie**	**■■%**	In welchen Bereichen arbeiten Sie im Rahmen von Neuproduktentwicklungsprojekten mit den Kunden zusammen? (Mehrfachnennungen möglich)	technische Produktplanung und Design	■■%	
						Prototypenbau, Test- & Pilotphase	■■%	
						kaufmännische und technische Bewertung der Produktidee	■■%	
						Ideengenerierung	■■%	
	Extern	**Projektmanagement** **Management**	**Kooperationskultur**	**■■%**	Was tragen Sie üblicherweise zu Neuproduktentwicklungsprojekten mit dem Kunden bei?	Keine Unterstützung in jeglicher Art oder Form	■■%	
						Nur Ressourcen werden zur Verfügung gestellt	■■%	
						Ressourcen werden zur Verfügung gestellt und Aufgaben werden in Teilverantwortung übernommen	■■%	
						Ressourcen werden zur Verfügung gestellt und Aufgaben werden mit vollständiger Verantwortung übernommen	■■%	
Anzahl Fragen	**Registrierung**	**Intern**	**Extern**					

	1	**5**	**■■%**				
		[4] Technology - Systems & Strategy [■■%]					
[4] Technology - Systems & Strategy	**Intern**	**Einkauf**	**Technische und F&E Dokumentation**	**■■%**	Ist die technische und F&E-Dokumentation (z.B. Prozessbeschreibung, Konstruktionszeichnungen, Prüfungs- und Machbarkeitsbestätigung etc.) vollständig, verständlich und fristgerecht entsprechend der TRILUX-Verträge und -Vereinbarung vorhanden?	Der Lieferant erfüllt die Anforderungen nicht	■■%
		Konstruktion				Der Lieferant erfüllt die Anforderungen; Die Dokumentation ist nicht immer vollständig	■■%
		Forschung und Entwicklung				Der Lieferant erfüllt die Anforderungen ordnungsgemäß und stellt eine vollständige Dokumentation zur Verfügung.	■%
		Labor				Eine vollständige und fristgerecht beigestellte Dokumentation ist vorhanden; Bei Bedarf werden interne 2D/3D Zeichnungen vom Lieferanten zur Verfügung gestellt	■■%

	Intern	**Einkauf** **Technology Management**	**Technology/Innovation Roadmap**	**■■%**	Ist eine Technologie- und/oder Innovationsroadmap des Lieferanten in schriftlicher Form für TRILUX vorhanden? ("schriftliche Form" = ein Dokument, welches alle nötigen Informationen zum Thema Innovation und Technologie beinhaltet. Eine Information über Mail oder Telefon wird nicht als "schriftliche Form" angesehen.)	Keine Technologie oder Innovationsroadmap vorhanden	■■%	
						Eine Technologie oder Innovationsroadmap ist vorhanden, aber nicht in schriftlicher Form	■■%	
						Eine Technologie oder Innovationsroadmap ist in schriftlicher Form vorhanden	■■%	
						Eine Technologie oder Innovationsroadmap ist in schriftlicher Form vorhanden und mit der Produktroadmap des Lieferanten abgestimmt	■■%	
	Intern	**Einkauf** **Technology Management**	**Know-how Transfer**	**■■%**	Kommuniziert der Lieferant freiwillig ein offenes und umfassendes Wissen zu Produkten, Prozessen und Entwicklungen? Eignet sich der Lieferant als Entwicklungspartner? Kann die Beziehung	Der Lieferant hält das Wissen zurück oder besitzt die nötige Expertise nicht	■■%	
						Ein geringer Wissenstransfer findet statt; Die Beziehung erweitert sich nicht über operative Tätigkeiten	■■%	

		Forschung und Entwicklung			zum Lieferant als vertrauensvoll bezeichnet werden?	Der Lieferant tauscht Wissen aus; Er hat eine konstruktive Arbeitsbeziehung mit dem Kunden entwickelt	■■%	
						Die Lieferantenbeziehung basiert auf gegenseitigen Vertrauen; Der Lieferant gibt sein Wissen weiter und trägt zu Innovation bei TRILUX bei	■■%	
	Registrierungs-prozess		**Innovation Cluster Potential**	■■%	Wo befindet sich der Firmensitz des Ansprechpartners?	[Antwort als Zahl. Sie Kommentar rechts.]	> 800 km	■■ %
							< 800 km	■■ %
							< 400 km	■■ %
							< 200 km	■■ %
	Registrierungs-prozess		**Export Strategy**	■■%	Wie hoch ist der Anteil (in %) Ihrer Produktion den Sie exportieren? (export sales/total sales-ratio)	[Antwort wird aus dem Angaben in den Registrierungsfragebogen übertragen.]	<30%	■■ %

							>30%	■■ %
							>50%	■■ %
							>70%	■■ %
	Extern	**Konstruktion** **Forschung und Entwicklung**	**Neuprodukt-entwicklungsprojekt Erfahrung**	**■■%**	Wie viele Neuproduktentwicklungsprojekte haben Sie zusammen mit Ihren Kunden in den letzten 3 Jahren gestartet (beendet)? (Nennen Sie eine Zahl) (angefangene/beendete Projekte - Verhältnis)	[Antwort ist die Anzahl der angefangenen und beendeten Projekten in den abgefragten Zeitraum]		<■■ %
						Projekte angefangen:	#	>■■ %
						Projekte beendet:	#	>■■ %
								>■■ %
								N/A
	Extern	**Technology Management** **R&D**	**Innovationstyp**	**■■%**	Welche Innovationen bieten Sie Ihren Kunden an? (Mehrfachnennungen möglich)	Prozessinnovation	■■%	
						Produktinnovation	■■%	
						Marketinginnovation	■■%	
						Organisationsinnovation	■■%	
						o.A.	o.A.	

	Extern	**Konstruktion** **Produktmanagement**	**Neuprodukt-entwicklungsstrategie**	**■■%**	Arbeiten Sie mit Partnern bei Neuproduktentwicklungsprojekten zusammen?	Keine Partnerschaften vorhanden	■■%	
						Projektabhängige Partnerschaften mit unterschiedlichen Partnern	■■%	
						Neuproduktentwicklungsprojekt nur mit zugelassenen Partnern	■■%	
						Netzwerk von etablierten Partnern vorhanden oder kein Bedarf an Partnern notwendig	■■%	
	Extern	**Technology Management** **Rechtsabteilung**	**Schutzrechte Strategie**	**■■%**	Wie gehen Sie bei immateriellen Schutzrechten (intelectual property rights) bezüglich TRILUX vor?	keine Teilhabe von TRILUX an den Schutzrechten	■■%	
						Lizenz (Exklusitivität) mit zeitlicher und geographischer Einschränkung	■■%	

						Lizenz (Exklusitivität) mit keiner zeitlicher, aber geographischer Einschränkung	■■%
						keine zeitliche oder geographische Schutzrechteeinschränkugen	■■%
						Die Schutzrechte sind an den Werkzeugsvertrag gebunden	■■%
Anzahl Fragen	**Registrierung**	**Intern**	**Extern**				
	2	3	4	**■■%**			
	4	**7**	**16**	**27**	**Total # Frage**		

Annexure 10: Ranking of survey questions with most significance including the questions from the innovation survey

Question	Weight/Loading
Overall Performance Is the supplier‘s production process innovative and efficient? Is the supplier capable to provide the engineering and consulting services required by TRILUX?	0.852 (0.559)
Quality Management Do you have a quality management system (QMS) or environmental management system (EMS)? (Multiple answers possible)	0.791
Innovation Responsibility Which employees are responsible for managing new product development (NPD) projects?	0.520
Cost reduction behaviour Please estimate the supplier‘s degree of willingness and effort in order to reduce costs.	0.714
Laboratory Service	0.664

Do you have your own laboratories or testing facilities?	
Co-Design Strategy In which areas of specialization do you usually collaborate in new product development (NPD) projects with a customer? (Multiple answers possible)	0.638
Technical Documentation Is the technical and R&D documentation (process description, design engineering drawings, test and acceptance certificates etc.) provided complete, comprehensible? Is it handed over in comprehensive form on time according to NDA and development property agreement?	0.473
Know-How Transfer Does the supplier voluntarily provides open and comprehensive knowledge about products and processes, over and above what is contractually agreed? Is the supplier suitable as a development partner? Can the relationship to the supplier be characterized as creating a mutual obligation and based on trust?	0.861 (0.608)
Innovation Cluster Potential Where is the headquater of the supplier?	0.365

Export Strategy What amount in % of your production do you export? (export sales/total sales-ratio)	0.638
NPD Strategy What is your partnership strategy in new product development (NPD) projects?	0.531