The “fuzzy front end” of product development: an exploratory study of German and Japanese innovation projects

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THE "FUZZY FRONT END" OF PRODUCT DEVELOPMENT: AN EXPLORATORY STUDY OF GERMAN AND JAPANESE[1] INNOVATION PROJECTS

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ABSTRACT

In this paper, we report the complete and unabridged results of an exploratory study of typical front-end activities in 28 innovation projects in German and Japanese companies. We further reveal differences in the practice of innovation management in both countries. Based on these, we develop first evidence for effects of front end management practices on project execution and project outcomes.

For this purpose, we interviewed managers of 13 Japanese and 14 German enterprises concerning 14 Japanese and 14 German new product development projects. The focus of the interviews was the so-called "fuzzy front end" and activities or deliverables later in the process which might be affected by front end management practice.

Overall, most projects achieved their objectives with varying efficiency, which is therefore the focus of our analysis. Our study reveals similarities as well as distinctive differences between the projects studied in Japan and Germany. In sum, the 14 Japanese projects relied on a thorough planning and strict controlling to minimize deviations from front end specifications and enhance efficiency. The majority of the 14 German projects did not have a formal planning and controlling process supported by methods and tools like the Japanese projects. Instead, they integrated all relevant functions early in the process, partly already during idea generation, to ensure that all information and points of view were taken into consideration right from the start to reduce later deviations and enhance efficiency. Responsibilities were assigned during the front end and rarely changed during project execution. In addition, during the front end of the German and Japanese projects, market and technical uncertainty were strongly reduced prior to development to avoid later deviations and secure efficiency targets.

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CONTENTS

1 INTRODUCTION

Recently, increased attention has been paid to the so-called "fuzzy front end" of product development. Managers indicate the front end as the greatest weakness in product innovation[2]. It strongly determines which projects will be executed, and quality, costs, and timings are defined to a large extent during the front end. At this early stage, the effort to optimize is low, but effects on the whole innovation process are high[3].

Consistently, an extensive empirical study by Cooper and Kleinschmidt showed that "the greatest differences between winners and losers were found in the quality of execution of pre-development activities"[4]. Two factors were identified to play a major role in product success: the quality of executing the pre-development activities, and a well defined product and project prior to the development phase[5]. A study of 788 new product introductions in Japan confirms that Japanese new product professionals view the importance of pre-development proficiency much the same way as their American and European counterparts[6].

Most of large-scale empirical studies of the fuzzy front end as well as large-scale cross-national comparative studies are part of research on success factors for new product development, where most of the activities during the fuzzy front end were combined in one factor like "pre-development activities"[7]. In addition, the majority of studies focused on direct contributions of the fuzzy front end to project success. However, the literature indicates that activities during product development are interrelated and besides a direct effect they might have an indirect effect on project outcome as well[8]. Furthermore, the contingency approach suggests an influence of contextual factors on the product development process and project outcomes. Depending on the situation, different factors become more or less important[9]. Besides company- or project-specific contextual factors like company size or degree of newness of a project, cultural differences are assumed to exert an influence on innovation-related activities including the front end[10].

Overall, there are many research questions in this area which have not been addressed yet. Therefore, we decided on an exploratory study as a basis for further in-depth research. The aims of our study are threefold: Firstly, we describe and compare front end activities in the context of two different countries, Germany and Japan, and

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2 see Khurana, Rosenthal (1997), p. 103

3 see Moore, Pessemier (1993), p. 100

4 see Cooper, Kleinschmidt (1994), p. 26

5 see Cooper, Kleinschmidt (1990), p. 27

6 see Song, Parry (1996), pp. 422, 433

7 see, e.g., Cooper, Kleinschmidt (1994), p. 26; Song, Parry (1996), p. 433; Song, Parry (1997-1), p. 3

8 see Calantone, di Benedetto (1988), p. 202; Homburg (1989), pp. 29–31; Karle-Komes (1997), pp. 100–102; Kohlbecher (1997), pp. 192–193

9 see, e.g., Balachandra, Friar (1997), p. 285; Veryzer (1998), p. 318; Song, Montoya-Weiss (1998), p. 132; Souder, Song (1998), p. 209

10 see, e.g., Jürgens (2000), pp. 2–3; Mishra, Kim Lee (1996), p. 530; Song, Parry (1996), p. 432; Song, Xie (1996), p. 5; Souder, Song (1998), p. 222

explore differences in the management of 14 projects in each country. The countries were chosen, because literature indicates differences in innovation management practices[11]. Secondly, we identify hints for direct and indirect effects of the fuzzy front end on project execution and project outcomes and contextual factors influencing the fuzzy front end. Thirdly, we discuss the appropriateness of the framework and measures utilized in our study for a large-scale cross-national study of the fuzzy front end.

The framework and methodology of our study and a description of the samples are presented in the following section. The proceeding section summarizes findings about the fuzzy front end. Descriptive results about project execution and project outcomes are presented in section four and five. In chapter six, we try to find interrelations between the fuzzy front end and latter phases of the product development process and influences of contextual factors. Finally, we summarize key findings, highlight managerial implications and give suggestions for future research.

2 STUDY

2.1 Study design

Figure 1 shows the framework of our exploratory research as a basis for further large-scale studies. Typical front end activities and parameters include idea generation, idea assessment, remaining market and technological uncertainty, and project planning. Cooper, too, divides the fuzzy front end into four phases from idea generation, initial screening, and preliminary evaluation to concept evaluation and stresses the importance of both market-related and technical activities[12]. Khurana and Rosenthal define the front end "to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews"[13]. In contrast to them, we focus on project-related activities and exclude strategic aspects from our study.

During the product development process, information is gathered to reduce uncertainty[14], whereby uncertainty is defined as "the difference between the amount of information required to perform a particular task, and the amount of information already possessed by the organization"[15]. We assume that the more uncertainty about the market and technology is reduced during the front end, the lower deviations from front end specifications during the following project execution phase and the higher the product development success.

Contextual factors which might have an impact on the new product development process are manifold. To reduce the complexity of our study, we focus on companies in similar industrial sectors in Germany as well as Japan and assume sector-related contextual factors to be constant.

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11 see, e.g., Jürgens (2000), p. 5; Park (1996), pp. 164–166

12 see Cooper (1988), p. 243

13 see Khurana, Rosenthal (1998), p. 59

14 see Moenaert, De Meyer et al. (1995), pp. 252–253; Mullins, Sutherland (1998), p. 228

15 see Galbraith (1973), p. 5

Further, we consider the size of a company and the degree of newness of a product development project to a company as critical contextual factors. The importance of the degree of newness has been highlighted by a substantial amount of studies[16].

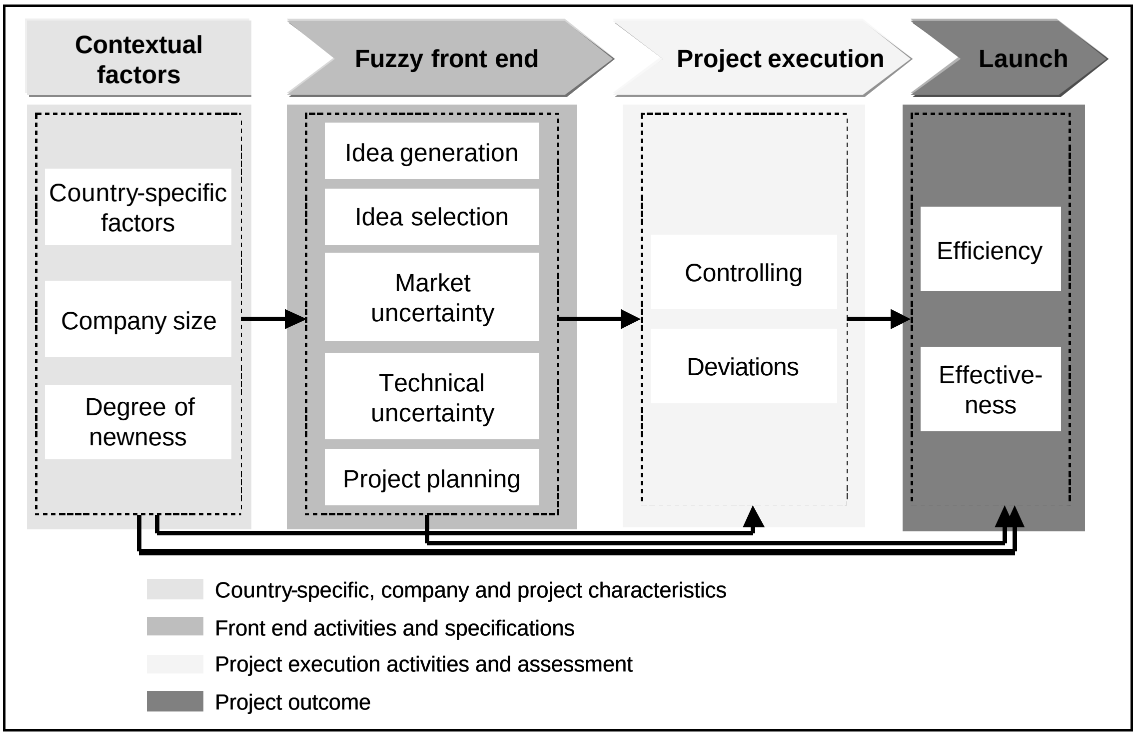

Figure 1: Framework of our study[17]

2.2 Methodology

In Germany, we identified a total of 102 mechanical and electrical engineering companies located in the state of Hamburg by using the Hoppenstedt database[18]. All companies were contacted by telephone. Seven mechanical engineering companies and seven electrical engineering companies agreed to participate in our study. In-depth interviews were conducted with managers responsible for the development of new products during 2001.

In Japan, MOST (Management of Science and Technology Department) at the Tohoku University in Sendai contacted 28 mechanical and electrical engineering companies. 13 companies agreed to participate. In one large electrical engineering company, two projects were studied. In sum, 14 in-depth interviews were conducted in 2002 with three mechanical and nine electrical engineering companies. For pragmatic reasons, as it is difficult to convince Japanese companies to participate in studies from outside Japan, the sampling procedure in Japan differed from the procedure in Germany. Although the Japanese companies of our sample belong to the

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16 see, e.g., Kohlbecher (1997), pp. 192–193; Balachandra, Friar (1997), p. 285; Mishra, Kim, Lee (1996), pp. 536–539; Song, Montoya-Weiss (1998), p. 132; Moenaert, De Meyer et al. (1995), p. 253; Schlaak (1999), p. 304; Veryzer (1998), p. 318

17 source: own depiction

18 www.firmendatenbank.de

same branch as the German companies and products and markets are comparable, this somewhat limits the force of expression of our comparative results.

Interviews lasted between two and three hours and were conducted by two interviewers in each country. The majority of the interviewees were directors of Research and Development department (R&D) or General Managers. In six companies, both, the R&D Director and Marketing Director were interviewed. In one of the Japanese companies, we had the opportunity to interview the complete product development team. Interviews consisted of two parts: Firstly, interviewees were asked to briefly describe the development process and outcome of the last product launched (last-incident-method) with focus on front end activities. The second part of the interview was completely based on a standardized questionnaire which was translated from German into Japanese for the interviews in Japan. The majority of the items were measured on a 7-point Likert-scale, as the questionnaire is supposed to be used in a large-scale cross-national comparison. This two-stage approach should allow to guarantee the comparability of different interviews and to ensure that all aspects considered important by the interviewees were covered by our standardized questions.

2.3 Sample

Size of the companies

Figure 2 shows the number of employees and the annual sales of all companies in the year 2000.

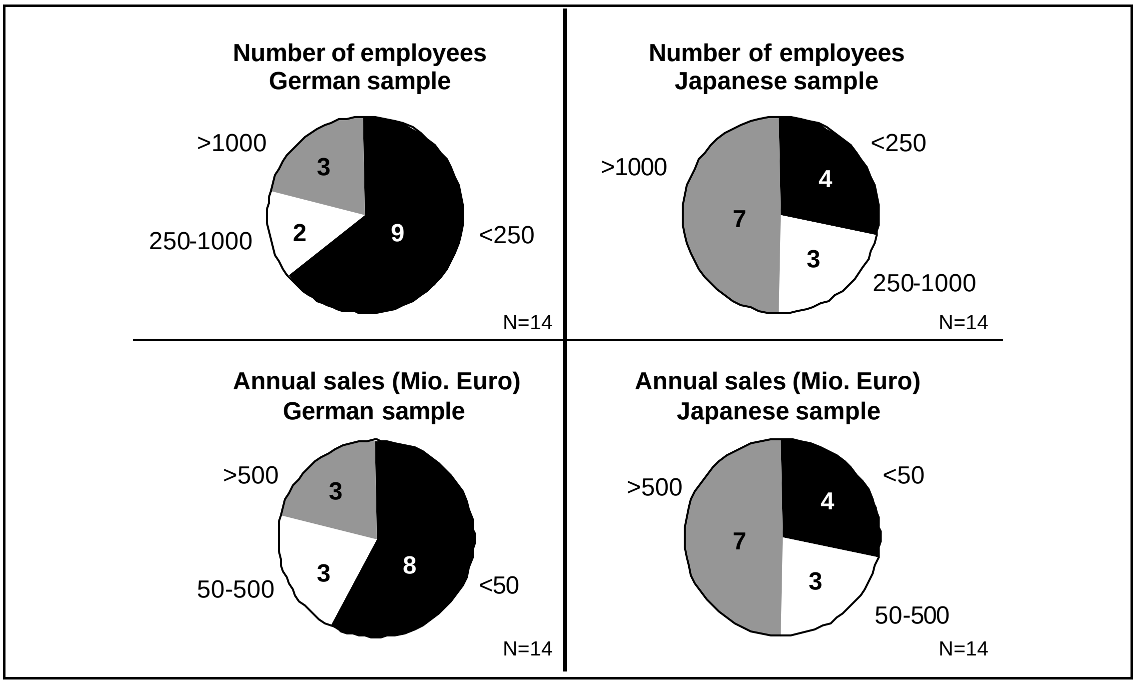

Figure 2: Size of the companies19

The German sample contains three large companies with 11000, 200000, and 420000 employees and annual sales above one billion Euros. However, the majority of the

19 source: own depiction

German sample consists of small and medium-sized enterprises (SMEs) with 25 to 360 employees and annual sales from 2 to 77 million Euros.

The Japanese sample is split half between large companies with 2500 to 10000 employees and annual sales mostly above one billion Euro and SMEs with 66 to 930 employees and annual sales from 7 to 708 million Euros. On average, the Japanese companies are larger than the German companies. Therefore, it has to be considered in the following analysis, that differences in innovation management could besides cross-national differences also be partly explained by company size.

<u>Scope of the projects</u>

The average development time for new products developed was 20 month in Germany and 24 month in Japan.

<u>Degree of newness of the projects</u>

Interviewees in both countries classified the newness of their product concepts and assessed the overall degree of newness of the product concept to their company *(see figure 3)*.

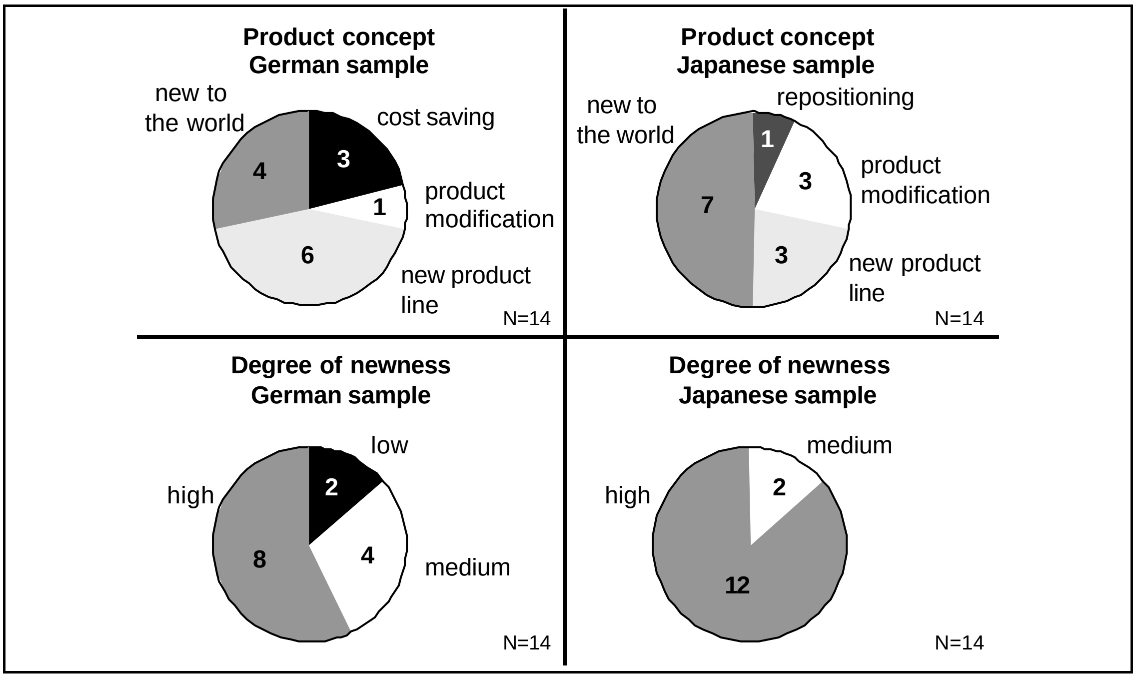

Figure 3: Degree of newness[20]

Firstly, ten of 14 projects were classified as new product lines in Germany as well as in Japan. Secondly, whether regarding the classification of the product concept or the subjective overall rating, the newness of the Japanese product development projects was rated higher than the degree of newness of the German projects. Thirdly, in both countries, the overall subjective assessment of the degree of newness to the company does not correspond to the rather objective classification in categories. Surprisingly,

[20] source: own depiction

two cost saving projects were rated as highly new to the company. There seems to be a general tendency to overestimate the degree of newness in an overall assessment. The impression has been confirmed by a German large-scale study[21]. Therefore, we additionally present data on single aspects of the degree of newness. Interviewees were asked to what extent new skills had to be developed that were not yet available in their company *(see figure 4).*

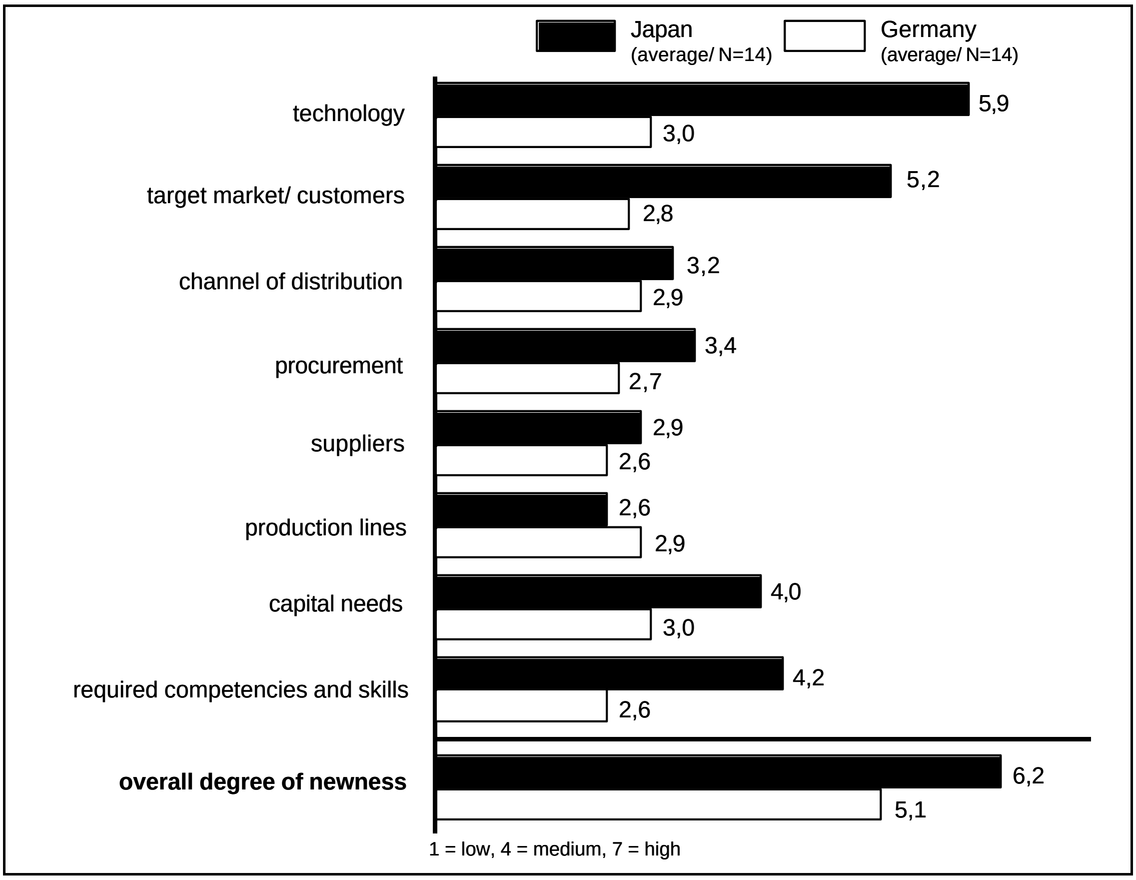

Figure 4: Single aspects of the degree of newness[22]

Corresponding to overall ratings, the degree of newness of the Japanese development projects was rated higher, especially with regard to technology, target market and customers, capital needs, and required competencies and skills.

Measurement of the degree of newness with a single overall assessment delivered even higher values than the assessment of several aspects[23]. In fact, in both countries, the overall degree of newness was rated higher than every single aspect. Experience in innovation and attitudes towards innovation presumably influence the assessment. Companies or individuals, for example, which or who are only seldom personally involved in the development of new products may regard small deviations from existing products or procedures as a high degree of newness to the company. Or the

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21 see Schlaak (1999), p. 210

22 source: own depiction

23 This is in line with the results of a large-scale study by Schlaak (1999), p. 210.

level of personal involvement in innovation projects might influence the personal judgement of the innovative ness of products.

3 THE FUZZY FRONT END OF THE PRODUCT DEVELOPMENT PROCESS

This section summarizes our key findings about the fuzzy front end and tries to identify first hints for country-specific differences. Firstly, we answer the question if ideas were initiated by the market and/or technical area. Secondly, we describe how ideas were generated, assessed, and selected. Thirdly, we summarize to what extent market and technological uncertainty were reduced prior to project execution. Finally, we describe the intensity of project planning activities as a basis of controlling during the following product development process steps.

As already mentioned in the previous section, our study suffers from several limitations, e.g., different sampling procedures in Germany and Japan and a small sample size of 14 projects in each country. Therefore, we will only interpret differences between Japanese and German projects only if we have a strong impression from the interviews that a difference exists and can be explained and the difference between average values is relatively high to confirm our impressio n.

3.1 Initiation

In the past, products were differentiated as either consumer or market driven (“market pull”), or initiated by technological development (“technology push”). The recent literature drops this polarizing view and clearly favours the importance of market and technical strength, i.e., “dual-driven” product development [24].

Whilst the Japanese sample predominantly mirrors such “dual-driven” product development projects, the German sample includes five “market pull” projects and one “technology push” project *(see table 1)*. The other eight German projects were “dual-driven”. The German technology-push project was a new-to-the-world product with a high degree of newness to the company. Four of the five market-pull projects in Germany were initiated by direct contact to customers.

[24] see Johne, Snelson (1988), p. 119; Rubinstein (1994), p. 658

Germany		Technology push			
		no	neutral	yes	sum
Market pull	no	1	1	1	**3**
	neutral	2	1	-	**3**
	yes	5	1	2	**8**
	sum	**8**	**3**	**3**	**14**

Japan		Technology push			
		no	neutral	yes	sum
Market pull	no	-	1	-	**1**
	neutral	-	3	3	**6**
	yes	-	3	4	**7**
	sum	**-**	**7**	**7**	**14**

Table 1: Market pull vs. technology push[25]

Figure 5 shows, which department of the company initiated the project. In both countries, the majority of the projects were initiated by either Marketing or R&D. In Germany, as expected, the origin of the technology-push project was R&D, whereas the origin of three of the five market-pull projects was Marketing. The other two market-pull projects were initiated by a Product Development Department and, in a small company, by the General Manager himself.

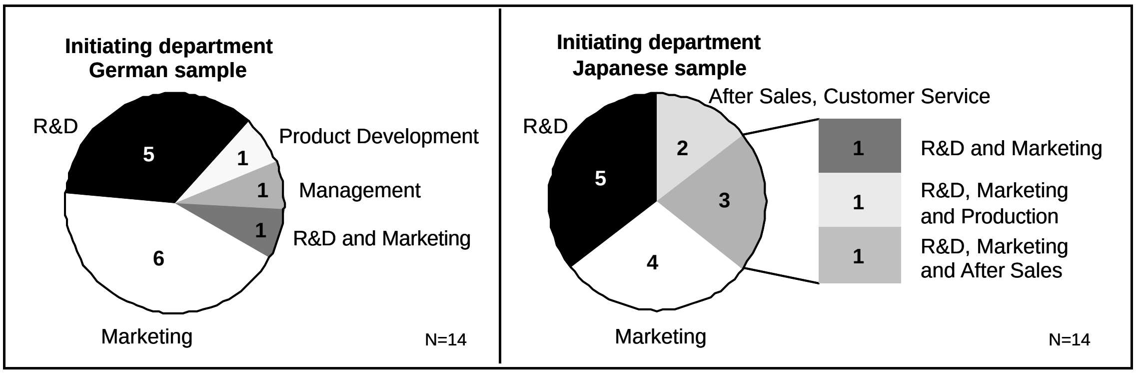

Figure 5: Initiating department[26]

In opposition to the German sample, where Production and After Sales/Customer Service did not participate in the initiation of new development projects, two Japanese projects were initiated together with Production or After Sales/Customer Service and in two projects After Sales/Customer Service was the sole initiator. Nevertheless, although After Sales/Customer Service did not take the initiative in the German projects, the level of amount of information from After Sales/Customer Service used is similar to Japan in average on a medium level *(see figure 6)*. Direct contact to customers was more important for the initiation of German as well as Japanese projects of our study.

[25] source: own depiction

[26] source: own depiction

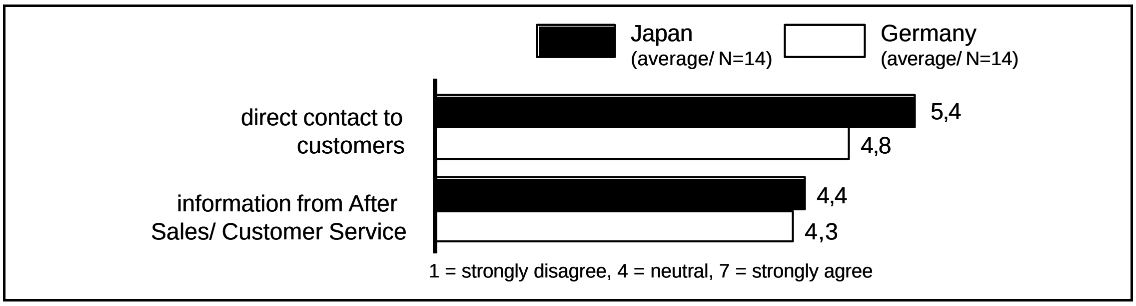

Figure 6: Initiation[27]

Overall, our findings with regard to initiation resemble the results of a large-scale cross-national comparison between Germany, Japan, and the United States[28].

3.2 Idea generation

The idea generation process is a combination of an organizational need, problem, or opportunity with a means for satisfying this need, problem, or capitalizing on the opportunity. Management can support the process for example by assigning a person responsible for the systematic gathering, storing, and transfer of idea-related information. Furthermore, ideas can be fostered by using creativity techniques.[29]

Some authors claim that individual idea generation produces more creative solutions than groups[30]. However, most authors favour an interdisciplinary group for idea generation[31]. R&D and Marketing as well as other function (e.g., Production, Customer Service) should cooperate early in the process to ensure that customer needs and technology means can be combined to satisfy those needs[32]. A joint understanding and shared goals early in the process can foster information transfer between departments[33].

Furthermore, there exists a widely held view that companies should set sufficient time aside for idea generation[34].

Our results presented in *figure 7* indicate differences between the various approaches and procedures to generate ideas in the German and the Japanese sample. Whereas the 14 Japanese projects were stronger supported by systematic approaches and the use of methods or tools, like systematic information processing and creativity techniques, the

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27 source: own depiction

28 see Albach et al. (1991), pp. 311–312

29 Geschka (1992) gives an overview of creativity techniques.

30 see, e.g., Rochford (1991), p. 289

31 see, e.g., Baker, Green, Bean (1985), p. 40; Geschka (1992), pp. 284, 294–295; Rubinstein (1994), p. 656; Rochford (1991), p. 289; Song, Parry (1997-1), p. 9

32 see Rubinstein (1994), p. 656

33 Although Japanese management practice emphasizes internal harmony, large-scale studies identified Sociocultural differences between R&D and Marketing, so that teamwork barriers between departments are not restricted to Western culture (Song, Parry (1997-2), pp. 364–366).

34 see Baker, Green, Bean (1985), p. 41; Rochford (1991), p. 291

14 German projects placed emphasise on interdisciplinary teams and scope for the employees to generate new ideas.

Whilst only three of the 14 ideas in Germany, which suffered from limited resources in small enterprises, were not generated by an interdisciplinary team, six of the Japanese ideas were generated by only one function. These six ideas occurred in medium or large enterprises so that restriction to one function cannot be ascribed to limited resources. Further, the Japanese companies for research favoured a clear allocation of responsibility to a single competent person within one of these functions, whilst the German companies preferred a team approach to generate new ideas.

Our present study corresponds with former findings about the rare use of tools and methods to support generation of new ideas in Western culture[35] in contrast to frequent use of brainstorming in Japan[36]. In 11 of 14 German projects, creativity techniques were not used at all, whereas in 12 Japanese projects, brainstorming was applied. In contrast, a comparative study in the chemical industry showed that creativity techniques were more often used in Germany than in Japan. Corresponding to our study, brainstorming was the most common creativity technique[37].

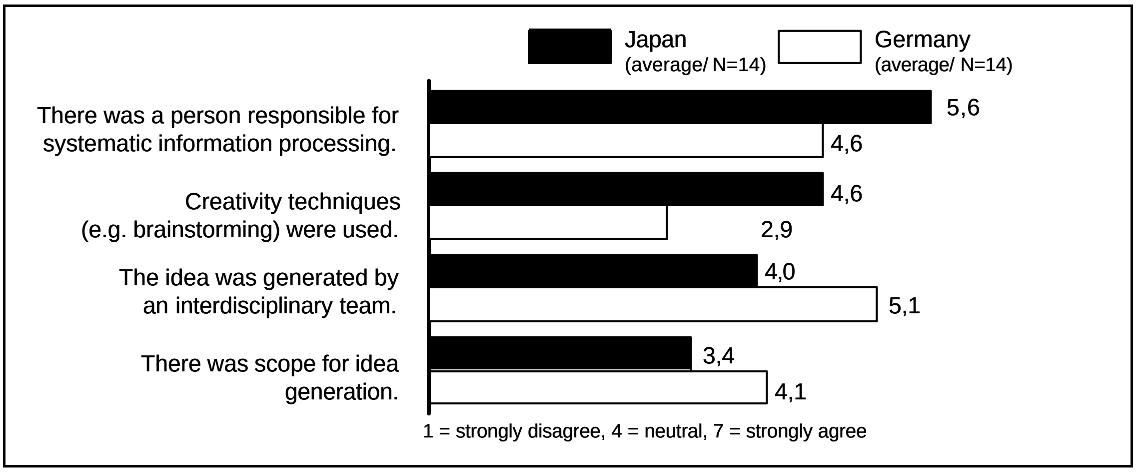

Figure 7: Idea generation[38]

Overall, our study indicates differences in the way, Japanese and German companies organize their idea generation processes.

3.3 Idea assessment

Idea assessment is necessary to decide on execution of an idea or to select the most promising idea from alternatives. The importance of this step within the product development process is empirically supported by studies in Western countries as well as in Japan and other countries[39]. As for idea generation, some authors suggest an

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35 see, e.g., Förderer, Kry, Palme (1998), p. 13 (German study); Smith (1998), p. 114; Sowrey (1987), pp. 11–12

36 see, e.g., Harryson (1996), p. 26

37 see Park (1996), p. 129

38 source: own depiction

39 see, e.g., Cooper, Kleinschmidt (1986), p. 82; Cooper, Kleinschmidt (1994), p. 25; Johne, Snelson (1988), p. 119; Mishra, Kim, Lee (1996), p. 540; Song, Parry (1996), p. 431

interdisciplinary idea assessment to ensure that all facets and points of views are taken into consideration[40]. Criteria have to be developed jointly in order to properly evaluate the ideas. Such criteria could be either technical and/ or economic. Furthermore, studies identified a proficient financial analysis as success factor[41].

Six of the 14 companies in Germany (five of the 14 companies in Japan) had to realize their ideas anyway for various reasons. One of the companies, e.g., had to adopt to a technical change in the target market. These six (five) companies assessed the idea but did not have to select between alternatives. Hence, in the following analysis, only the remaining eight (nine) companies which built in a project selection step in their product development process are considered.

With regard to interdisciplinary idea assessment in the German projects, this approach misleads, as all three projects dominated by one function are reflected in the mean value of 14 projects for idea generation and eight projects for idea assessment. The decrease of mean values in *figure 8* compared to *figure 7* is therefore only caused by the smaller sample size. In Germany, all ideas that were selected by an interdisciplinary team were already generated by multiple functions. In Japan, similar to our results with regard to idea generation, the level of multidisciplinarity for idea assessment was lower than in Germany.

In general, idea selection took place in meetings, where the various functions of the company were represented. In Germany, one company hold a meeting with participants from one department only. Contrary, in Japan, five of the nine ideas were assessed during meeting with participants from one function only. This early assessment included discussions concerning the technical as well as economical attractiveness of the projects.

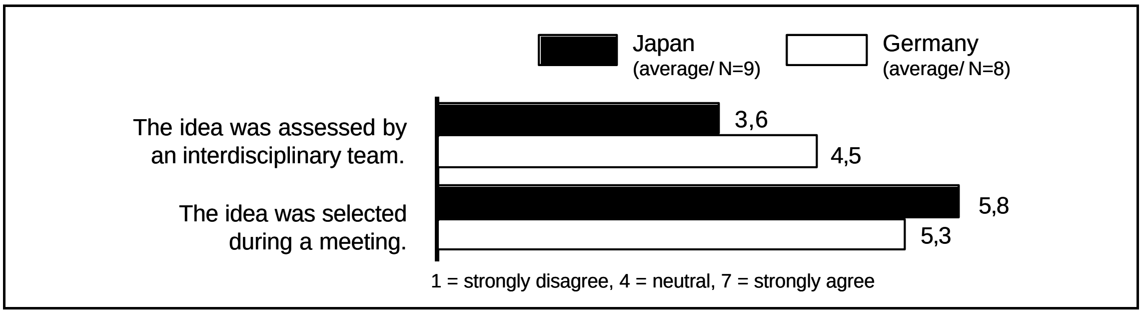

Figure 8: Idea assessment[42]

Table 2 shows the importance of technical and economic criteria for the assessment of an idea in Germany and Japan. Most of the companies considered technical as well as economic criteria (16 of 17)[43].

40 see, e.g., Aggteleky, Bajina (1992), pp. 154–155; Song, Parry (1997-1), p. 9

41 see, e.g., Dwyor, Mellor (1991),p. 42; Mansfield, Wagner (1975), pp. 187–188; Mishra, Kim, Lee (1996), p. 540

42 source: own depiction

43 Song and Parry (1996) provide more detailed data on project evaluation criteria and their correlation with product advantage and project success in 788 Japanese projects.

Germany		Technical criteria			
		not impor-tant	neu-tral	very impor-tant	sum
Eco-nomic criteria	not impor-tant	-	-	-	**-**
	neutral	-	-	3	**3**
	very impor-tant	-	2	3	**5**
	sum	**-**	**2**	**6**	**8**

Japan		Technical criteria			
		not impor-tant	neu-tral	very impor-tant	sum
Eco-nomic criteria	not impor-tant	-	-	1	**1**
	neutral	-	-	1	**1**
	very impor-tant	-	-	7	**7**
	sum	**-**	**-**	**9**	**9**

Table 2: Importance of technical and economic selection criteria[44]

Concerning the methodological support of idea assessment, in about half of the German as well as the Japanese projects selection criteria used were weighted *(see figure 9)*. A cost effective analysis seems standard for Japanese projects independent on company size. In Germany, only one medium-sized and two larger companies carried out a cost effective analysis. A comparative study in the chemical industry showed different results. Whilst weighting of criteria was more common in Japan than in Germany, no significant difference was found with regard to cost effective analysis[45]. Nevertheless, a stronger methodological support of idea assessment in Japan is a similarity between the studies of different branches.

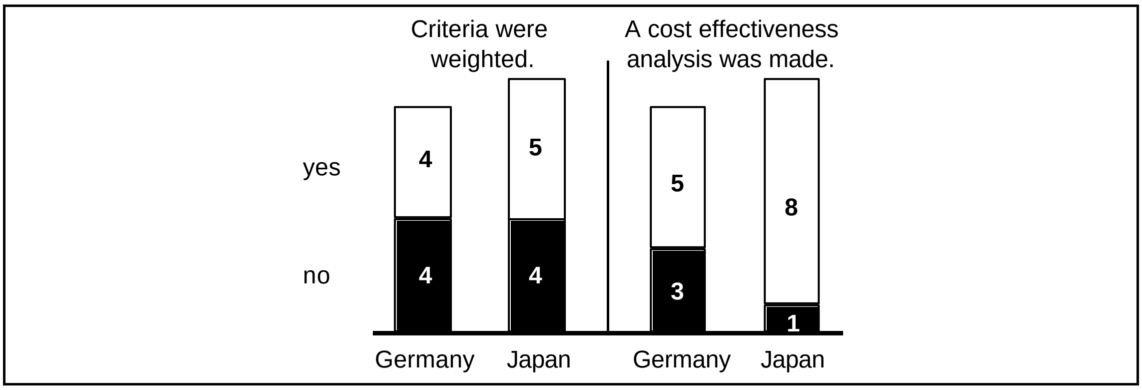

Figure 9: Methodological support of idea assessment[46]

To summarize, whereas, in the German projects, ideas were often assessed during meetings with participants from several functions, in Japanese projects, meetings were held with participants from one function only. In both countries, idea assessment relied on technical and economical criteria which were weighted in about half of the cases. Whilst a cost effective analysis seems standard in Japan, only a few larger enterprises in Germany elaborately calculated costs.

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44 source: own depiction

45 see Park (1996), pp. 140–141

46 source: own depiction

3.4 Reduction of market uncertainty prior to development

The new product development process is a process of uncertainty reduction. Independent on the country, the more market and technological uncertainty are reduced during the fuzzy front end, the less deviations occur during project execution and the higher the probability of success[47]. The target market should be defined and customer requirements integrated into the product concept prior to development[48]. In new markets, it is more difficult to reduce market uncertainty as potential customers are often unable to articulate their needs or are even not aware of them[49].

Figure 10 reflects the results of our study. For the Japanese as well as for the German projects, the remaining market uncertainty prior to development was relatively low. The target market and customer needs were well understood before start of development. We have the impression, that in the Japanese projects the determined customer requirements were integrated even more consequently into the product definition than in Germany.

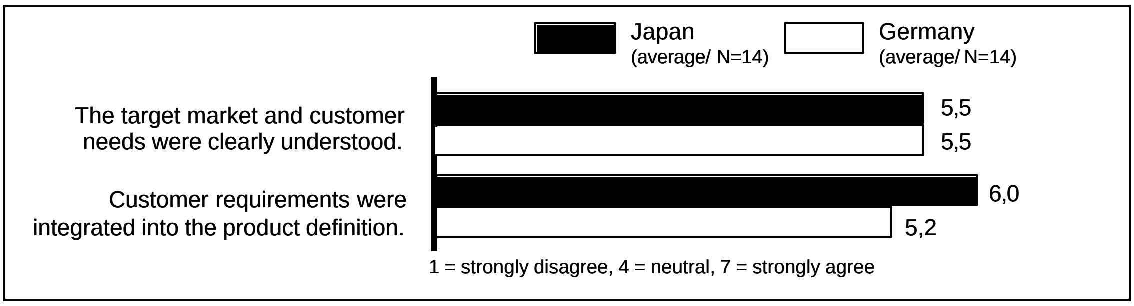

Figure 10: Reduction of market uncertainty prior to development[50]

To summarize, reduction of market uncertainty prior to development was achieved in the majority of projects studied in Japan as well as Germany.

3.5 Reduction of technical uncertainty prior to development

According to Moenaert et al., successful and unsuccessful projects differ by a wider gap on the information acquired on the technology[51]. The NewProd studies of Cooper and Kleinschmidt indicate a strong relation of preliminary technical assessment to project outcomes[52]. In Cooper and Kleinschmidt's measurement, preliminary technical assessment includes, among other things, feasibility analysis and definition of product specifications. In NewProd, preliminary technical assessment was undertaken in 85 % of projects and rated as proficiently undertaken. Song and Parry

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47 see, e.g., Mishra, Kim, Lee (1996), p. 540; Moenaert, De Meyer et al. (1995), p. 253; Song, Parry (1996), p. 431

48 see Balbontin, Yazdani et al. (1999), p. 274; Cooper, Kleinschmidt (1990), p. 26; Cooper, Kleinschmidt (1994), p. 26; Khurana, Rosenthal (1997), p. 113; Maidique, Zirger (1984), p. 198; Song, Parry (1996), p. 427

49 see Mullins, Sutherland (1998), p. 228

50 source: own depiction

51 Moenaert, De Meyer et al. (1995), p. 249

52 Cooper, Kleinschmidt (1986), p. 82

likewise report a highly significant correlation between technological information prior to development (measured with six items) and project success in Japan[53].

Our results draw a similar picture. Technical uncertainty prior to development was relatively low in the German and Japanese projects *(see figure 11)*. Technical requirements were not defined in two, and technical feasibility not verified in one of fourteen German projects. In all Japanese projects requirements were defined and technical feasibility checked at least to some extent.

To summarize, reduction of technical uncertainty prior to development was achieved in the majority of the projects studied.

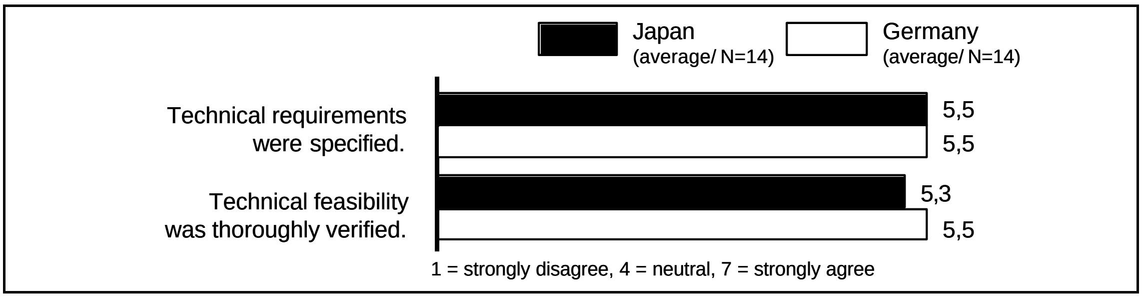

Figure 11: Reduction of technical uncertainty prior to development[54]

Since market and technical uncertainty were relatively low in the Japanese as well as German projects one might conclude that the nature of all innovation projects are more of an incremental than breakthrough kind right from the beginning. Looking back to the various innovation projects discussed, we would support this impression. But this view is not reflected by the judgement on the level of innovativeness by the companies (see section 2.3). This supports the assumption of a tendency to overestimate the newness of an innovation in the view of a person or team responsible for development.

3.6 Front end project planning

The first step of front end project planning is to break a product development project down into various work packages. Thereafter, timings, resources and overall responsibilities are allocated to the work packages. In addition, costs projections should be made and responsibilities assigned individually. The task of project planning can be supported by several tools and methods like bar charts, network plans, or project management software[55]. Several large-scale studies suggest a positive impact of a proficient planning on project outcomes in Western countries[56]. Song and Parry determine similar results for Japan[57]. Khurana and Rosenthal's exploratory study of incremental innovation projects in the U.S., Europe, and Japan

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53 Song, Parry (1996), p. 431; Mishra et al. report a significant correlation for Korean projects, see Mishra , Kim, Lee (1996), p. 540

54 source: own depiction

55 see Pinto, Slevin (1988), p. 73

56 see, e.g., Balachandra, Friar (1997), p. 279; Pinto, Slevin (1988), p. 67; Maidique, Zirger (1984), p. 198

57 Song, Parry (1996), p. 432

observed deficiencies like confusion about priorities and incomplete resource planning which led to delays and product-strategy mismatches[58].

In our study, project planning is a front end activity that reveals clear differences in the management of Japanese and German projects. In every aspect of project planning, average values are higher for the 14 Japanese projects *(see figure 12)*. Two of the German projects did not have a front end project planning step at all. As expected, this was the case for product development projects in small firms (25/ 140 employees) and resulted in low project efficiency. The three large enterprises of our German sample carried out a detailed planning in every aspect. Nevertheless, differences between German and Japanese projects cannot be explained by company size. In Japan, smaller enterprises had the same front end planning standard than larger enterprises. This country-specific difference is abundantly clear for cost projections and flow charts, which were routinely utilized in all of the Japanese projects and an exception in Germany. This is consistent with our finding about the routine use of cost effective analysis in the Japanese sample compared to the German sample. Commonness between Japanese and German projects already indicated by former studies is the rare support of front end planning by project management software[59]. In Germany, four companies used project management software, whereas, to our surprise, such software was not used at all in Japanese companies, where partially the existence of such tools was even unknown.

In addition to the assessment of single aspects of front end planning, interviewees were asked to assess the overall proficiency of their front end planning. The average value for the German sample is surprisingly high compared to the assessment of single planning aspects as well as compared to the overall assessment of the Japanese projects. A more critical self-assessment might help at least German managers of our sample to identify deficiencies in the planning stage.

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58 Khurana, Rosenthal (1997), p. 111

59 see, e.g., Herstatt, Lüthje, Verworn (2001), pp. 155–156

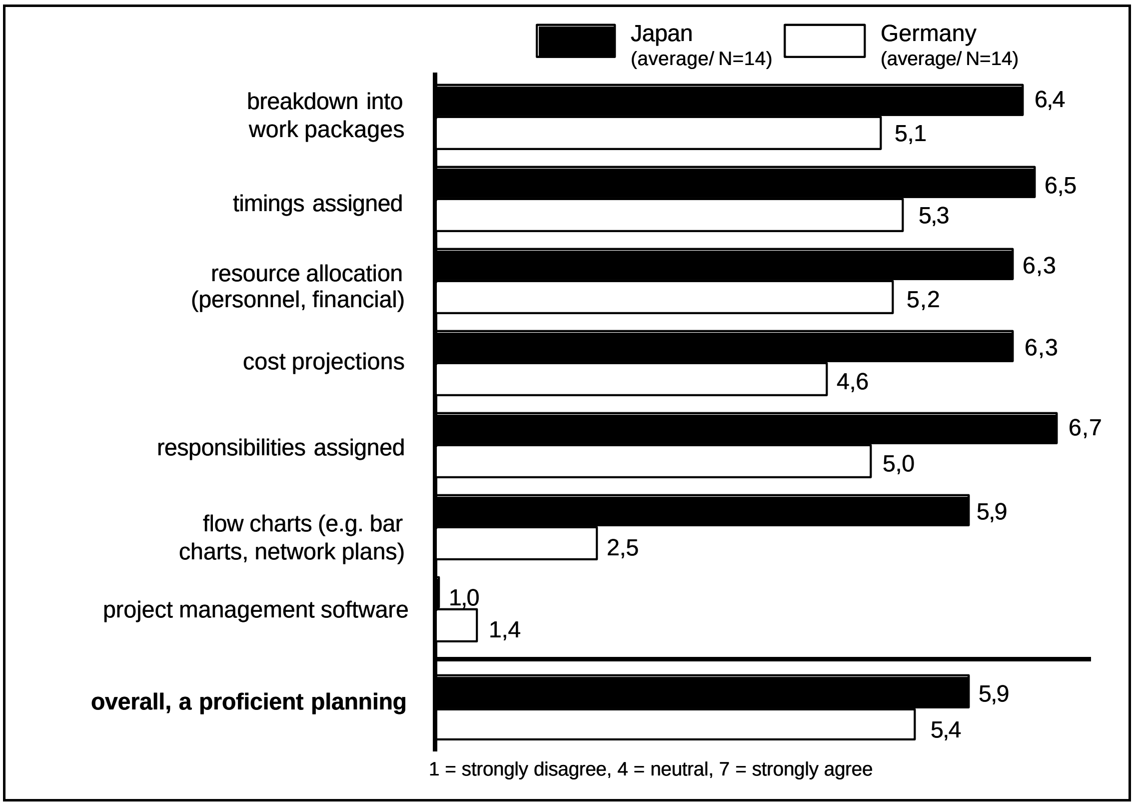

Figure 12: Front end project planning[60]

Overall, in our study, front end planning reveals the clearest differences between our Japanese and German sample. Whilst a proficient planning including cost projections and flow charts seems standard for Japanese projects independent on firm size, the proficiency of front end planning is lower and divergent between the projects studied in Germany.

4 PROJECT EXECUTION

This section presents descriptive results about properties of project execution which are probably influenced by the proficiency of the proceeding fuzzy front end, namely controlling and deviations from front end specifications. Controlling builds on deliverables defined during the proceeding front end. Well-defined objectives communicated to all members of the project team during the front end are a precondition to measure progress against. Furthermore, the more objectives and deliverables are clarified during the fuzzy front end, the less deviation should occur during project execution.

4.1 Controlling

A principal task of controlling is to detect deviations from plans as early as possible. Furthermore, reasons for deviations should be ascertained, the impact assessed and a corrective action plan developed[61].

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[60] source: own depiction

[61] see Webb (2000), p. 216

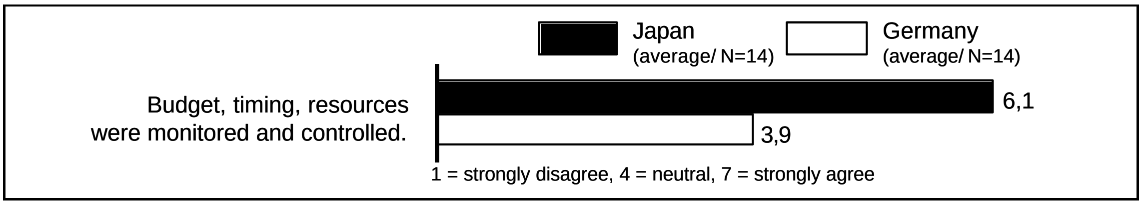

Figure 13: Controlling[62]

Consistent with our findings about project planning, the proficiency of controlling is significantly higher in our Japanese than our German sample *(see figure 13)*. Independent from company size, the Japanese firms spent substantially more effort on plans and controlling of these plans.

4.2 Deviations from front end specifications during project execution

Several studies show that well-defined deliverables and procedures during the fuzzy front end reduce deviations from specifications during project execution and therefore foster project success[63]. Deviations may stem from changes in the environment internal to the company or from outside. External changes are for example changes in the customer's view, market circumstances, unforeseen technical developments or movements of a competitor. Internal changes are, e.g., changes in priorities, objectives, scope or funding of a project[64]. *Figure 14* shows deviations from front end specifications during the 14 Japanese and 14 German projects of our study. Overall, deviations are rare for the Japanese as well as for the German projects.

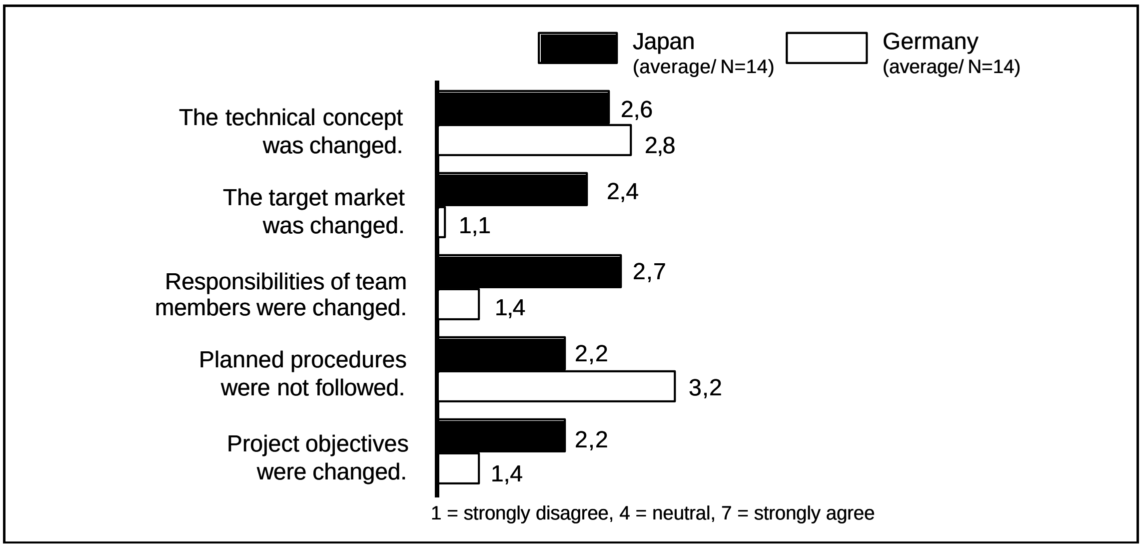

Figure 14: Deviations from front end specifications[65]

From the kinds of deviations we assessed, changes in the technical concept and changes in the target market may be caused by changes in the internal or external

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62 source: own depiction

63 see, e.g., Cooper, Kleinschmidt (1994), p. 26; Gupta, Wilemon (1990), p. 29; Khurana, Rosenthal (1997), p. 110; Pinto, Slevin (1988), p. 72

64 see Webb (2000), p. 214

65 source: own depiction

circumstances. On the one hand, it might be necessary changes to adapt to changing customer requirements or technical developments. On the other hand, changes might become necessary because not all relevant information was assessed and included into front end specifications. Changes in the technical concept were on a similar level for the Japanese and the German projects. In contrast, the target market remained the same for all German projects but significantly changed during the execution of four of the 14 Japanese projects. In the case of our Japanese companies changes were mostly caused because of a poor cooperation between central Marketing and the R&D department at departmental level. Like it is still the case with many large Japanese Companies, the Marketing function often is a head quarter-based function and responsible for all of the market research for all company-groups (which in this case do not have a separate marketing group). This centralized function sometimes delivers incomplete or only rough customer-related information, which lacks adequate relevance or depth. But since they do market research for all of the group-companies, they are often just over-demanded. Understood too late in the process on the group-company level, changes become inevitable.

> One company developed an innovative device to sterilize various surfaces hygienicly for various consumer markets. This company was active for industrial markets only before. Belonging to a large Japanese group, this group-company did not have a separate market research department. The information to develop an innovative device for consumer markets was elaborated by the marketing department at the Tokyo headquarter. Very late in the development process it turned out that consumers were not willing to pay such an high price for this product. Central marketing had neglected this point (willingness to pay for) and the group company had no first hand information or experience with consumer markets at all. This caused a major change in the target markets for this new device.

Another difference can be observed with regard to changing responsibilities of team members. Whilst in the German projects of our sample, all relevant functions were integrated early into the team responsibilities were clarified and not changed during project execution, during the course of five of the Japanese projects project teams had to be enlarged to integrate necessary capacity or know-how.

Consistent with a more detailed planning and controlling of the Japanese projects, deviations from planned procedures were lower compared to the German projects, where six projects did not follow planned procedures.

Overall, the Japanese and the German projects of our sample managed to keep deviations from front end specifications small. Nevertheless, the approach seems different. Whilst in the German projects emphasize seemed on integrating all relevant information and functions early in the process and keep responsibilities unchanged, the Japanese projects rather relied on a thorough planning and stringent controlling.

5 PROJECT OUTCOMES

Generally, project outcomes can be divided into effectiveness (achievement of objectives) and efficiency (by what means). We additionally asked for the subjective satisfaction of each interviewee.

5.1 Effectiveness

To assess the effectiveness of the projects, interviewees were asked, if objectives existed and if yes, were achieved *(see figure 16).* The five objectives we enquired were relevant the majority of the German projects (between 12 and 14) and all Japanese projects.

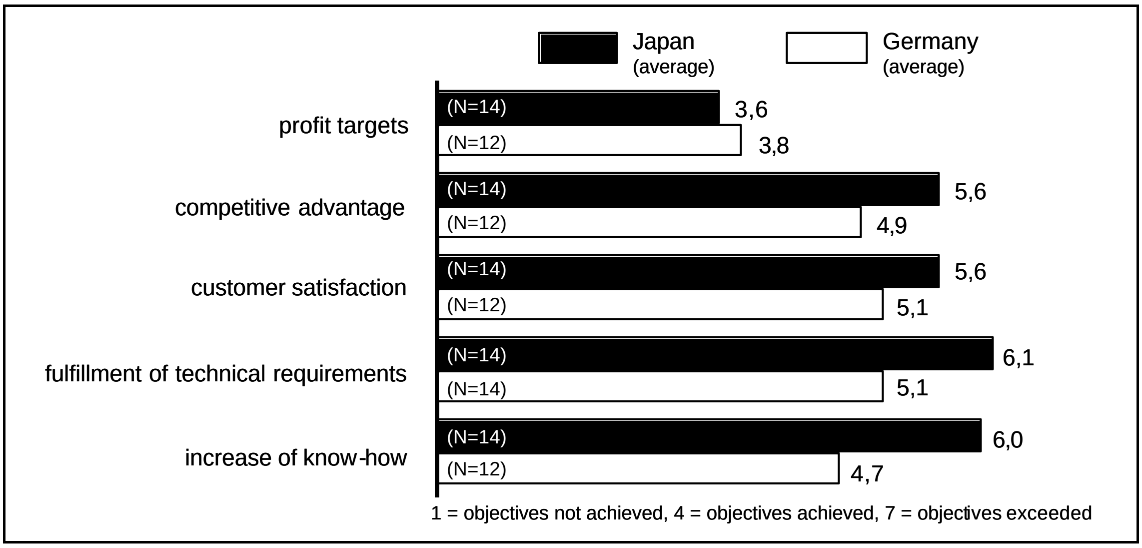

Figure 16: Achievement of objectives[66]

Overall, the effectiveness of the projects was fairly high regarding competitive advantage, customer satisfaction, fulfilment of technical requirements, and increase of know-how. For these objectives, all Japanese and German projects were on target or even better. The Japanese projects were rated slightly higher, particularly with regard to acquiring know-how. Deficiencies were observed in the financial area, where target profits were not reached in two German and six Japanese projects. The Japanese sample contains two flops with regard to financial objectives.

Due to the high effectiveness of the majority of the projects, it is not promising to further analyse effects of the product development process on project effectiveness in the following chapter. An alternative way would have been to ask every company to describe a successful and a non-successful project. We did not choose this alternative because our interview time was restricted and it was not possible to examine two product development processes in detail.

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66 source: own depiction

5.2 Efficiency

All interviewees were asked, to what extent they agreed to statements concerning the compliance with time, financial, and personnel resources planned during the fuzzy front end *(see figure 17).*

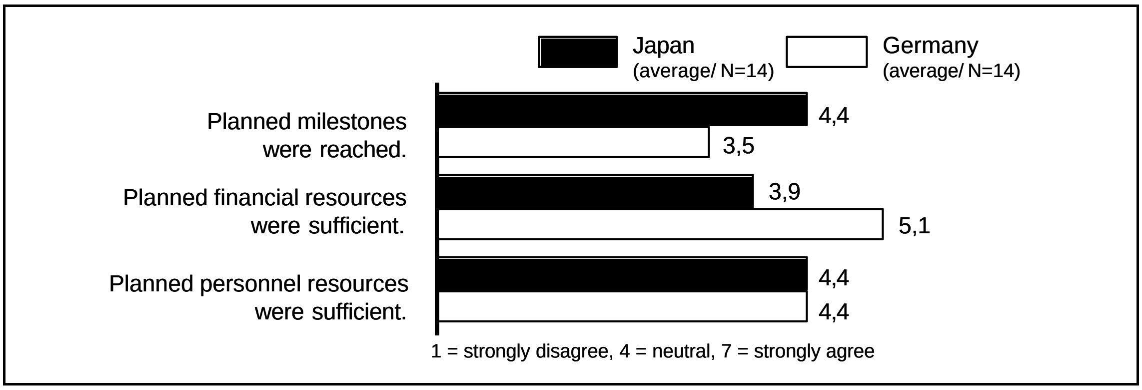

Figure 17: Compliance with planned resources[67]

Milestones were fully reached in only two German and four Japanese projects. In this connection, the more detailed planning and controlling in most of the Japanese projects seems to pay out. This is not true for the compliance with resources. Planned financial resources were fully sufficient in seven of 14 German and five of 14 Japanese projects and planned personnel resources in five German and six Japanese projects, therefore equal or even slightly better in Germany.

Concerning efficiency, contrary to effectiveness, it seems to be promising to have a deeper look at influences from the fuzzy front end of project execution on efficiency in the following chapter.

5.3 Overall assessment

Interviewees were asked, if they were satisfied with the development process and overall with the project they described.

As most objectives were reached, consequentially, only two Japanese interviewees and no German interviewee were altogether dissatisfied with the project *(see figure 18)*. In contrast, corresponding to deficiencies with regard to efficiency in both countries, satisfaction with the development process is in average on a medium level. We have the impression that the satisfaction lecel with the development process enhances with increasing compliance with financial and personnel resources.

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[67] source: own depiction

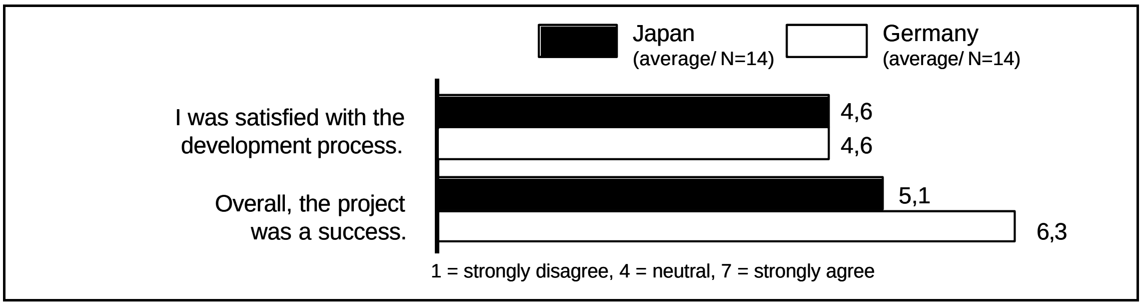

Figure 18: Overall assessment of project success[68]

6 INTERRELATIONSHIPS

Due to the small sample sizes of our study, it is not possible to test hypothesis about interrelationships pictured in our framework *(see figure 1)*. Instead, in this chapter, we try to present descriptive findings of the former chapters in a larger context to summarize our impression of implications of the management of the fuzzy front end of the 14 German and 14 Japanese projects we studied. With regard to project outcomes, we focus on efficiency, as the projects studied did not show much difference in effectiveness.

The 14 Japanese projects relied on a thorough planning and strict controlling to minimize deviations from front end specifications and enhance efficiency. Projects were broken into work packages and timings, resources and responsibilities were allocated. In addition, project planning was supported by costs projections and graphical methods like bar charts or network diagrams. In addition, market and technical uncertainty were strongly reduced prior to development to avoid deviations later in the process and secure efficiency targets. During project execution, budget, timings, and resources were monitored and controlled.

The majority of the 14 German projects did not have a formal planning and controlling process supported by methods and tools like the Japanese projects. Instead, they integrated all relevant functions early in the process, partly already during idea generation, to ensure that all information and points of view were taken into consideration right from the start to reduce later deviations and enhance efficiency. Responsibilities were assigned during the front end and rarely changed during project execution. In addition, similar to the Japanese projects, market and technical uncertainty were strongly reduced prior to development to avoid later deviations and secure efficiency targets.

Overall, our study revealed many similarities but also some differences between the management of the fuzzy front end of the 14 Japanese and 14 German product development projects we studied.

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68 source: own depiction

7 SUMMARY AND CONCLUSIONS

7.1 Summary of key findings

Despite the small sample size and different sampling methods in Germany and Japan, our study reveals some interesting results. Contrary to former studies, the fuzzy front end of 14 projects studied in Japan and 14 projects studied in Germany was predominantly managed proficiently. Market uncertainty and technical uncertainty were strongly reduced prior to development. All projects reached the majority of objectives. Yet, with regard to efficiency, a different approach was identified in the Japanese compared to the German projects. Whilst Japanese projects relied on a thorough planning and strict controlling to minimize deviations from front end specifications and enhance efficiency, in German projects all relevant functions were integrated early in the process, partly already during idea generation, to ensure that all information and points of view were taken into consideration right from the start. Responsibilities were assigned during the front end and rarely changed during project execution to reduce deviations and enhance efficiency.

7.2 Managerial implications

We looked at 28 innovation projects in two different industries and two different environments (countries), 26 projects being described as successful. Our framework for observing the way companies organize and manage their „Fuzzy Front Ends" turned out to be useful. But we could not explore one single best way leading to innovation success, since all companies observed in our research somehow differed concerning their front end innovation management. A message for the management could be, to develop a concept or framework and to give the front end of innovation a minimum structure, but not to rigidly instruct innovation teams how to walk through this process.

Besides, we could observe country-culture specific management styles which have implications on the way companies allocate tasks to single people versus teams, firstly screen ideas for innovation projects in functional versus interdisciplinary management teams, apply creativity enhancing techniques, planning procedures and process-supporting tools – or not vice versa. This observation supports our impression that a certain freedom to organize front end activities in detail should have no dramatic impact on the project success (effectiveness). More important seems that management understands the importance of the fuzzy front end and will give team sufficient support to organize, staff, and manage front end activities sufficiently.

7.3 Limitations and directions for future research

Due to the small sample size of our study and sampling different sampling procedures, our findings cannot be generalized. Nevertheless, first hints for country-specific approaches to the fuzzy front end and effects of the fuzzy front end on project execution and project outcomes were found. These findings suggest a contingency approach to similar research questions. The framework of our study could be beneficial for large-scale studies based on hypotheses, considering interrelationships, direct and indirect effects. In addition, the influence of further contextual factors on the fuzzy front end should be considered. Furthermore, studies of the fuzzy front end could be extended to other countries and industries.

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APPENDIX (questionnaire)

TUHH

Technical University of Hamburg-Harburg

Technology and Innovation Management

Study

Successful management of the fuzzy front end of product development

(idea generation, idea assessment, project planning)

⇒ Please describe the development of the last product introduced to the market.

⇒ Please mark the answers as shown in the following example:

To what extent do you agree to the following statement?	strongly disagree	neutral	strongly agree
Planned financial resources were sufficient.	①—②—③—④—⑤—⑥(X)—∅		

⇒ **All information will be treated as** highly confidential**.**

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A) Initiation of the product development project

1. Which **function** initiated the product development project? *(Please mark only one function)*
   - Marketing/Sales ☐
   - R&D ☐
   - Production ☐
   - After Sales/Customer Service ☐
   - Management ☐
   - Other (please specify): ....

B) Idea generation

	strongly disagree — neutral — strongly agree
1. There was a person responsible for the systematic gathering, evaluation and communication of idea-related **information.**	①—②—③—④—⑤—⊕—∅
2. **Creativity techniques** like brainstorming were used to generate the idea for the new product.	①—②—③—④—⑤—⊕—∅
3. The idea was generated by an **interdisciplinary team**.	①—②—③—④—⑤—⊕—∅
4. There was **enough time** besides current business to search for the new product idea.	①—②—③—④—⑤—⊕—∅

C) Idea assessment

1. There were **no alternatives** to evaluate. The idea had to be realized.	disagree ☐ agree ☐
2. A **cost effectiveness analysis** was made.	disagree ☐ agree ☐
	strongly disagree — neutral — strongly agree
3. The idea was assessed by an **interdisciplinary team**.	①—②—③—④—⑤—⊕—∅
4. The idea was assessed during **discussions or meetings**.	①—②—③—④—⑤—⊕—∅
5. **Economic criteria** were used to assess the idea (e.g. annual sales, development costs, production costs).	①—②—③—④—⑤—⊕—∅
6. **Technical criteria** were used to assess the idea.	①—②—③—④—⑤—⊕—∅
7. The **criteria** were **weighted**.	disagree ☐ agree ☐

D) Marketing activities during the fuzzy front end

		strongly disagree — neutral — strongly agree
1.	The project was initiated by **direct contact to customers**.	①—②—③—④—⑤—⊕—∅
2.	**Information from Sales or Customer Service** were used to generate the idea for the new product.	①—②—③—④—⑤—⊕—∅
3.	**Customer requirements** were integrated into the definition of the new product concept.	①—②—③—④—⑤—⊕—∅
4.	**Target market** and consumer needs were clearly understood before the start of the development.	①—②—③—④—⑤—⊕—∅
5.	It was a **market pull** project.	①—②—③—④—⑤—⊕—∅

E) Technical activities during the fuzzy front end

		strongly disagree — neutral — strongly agree
1.	The idea was enabled by **extensive technical predevelopment activities**.	①—②—③—④—⑤—⊕—∅
2.	**Technical requirements** with regard to the product were clearly specified before the start of development.	①—②—③—④—⑤—⊕—∅
3.	**Technical feasibility** of the product concept was thoroughly verified before the start of development.	①—②—③—④—⑤—⊕—∅

F) Project planning

		strongly disagree — neutral — strongly agree
1.	The project was broken into **work packages**.	①—②—③—④—⑤—⊕—∅
2.	**Timings** were assigned to the work packages.	①—②—③—④—⑤—⊕—∅
3.	**Resources** (personell, financial) were assigned to the work packages.	①—②—③—④—⑤—⊕—∅
4.	There was a **detailed cost plan** for the project.	①—②—③—④—⑤—⊕—∅
5.	**Responsibilities of team members** were assigned at the beginning of the project.	①—②—③—④—⑤—⊕—∅
6.	**Flow charts** (e.g. bar charts, network plans) were made at the beginning of the project.	①—②—③—④—⑤—⊕—∅
7.	Project planning was supported by a **project management software**.	①—②—③—④—⑤—⊕—∅
8.	Overall, the project was **thoroughly planned**.	①—②—③—④—⑤—⊕—∅

G) Degree of newness

	strongly disagree		neutral		strongly agree
1. The **technical knowledge** required was new to our company.	①—②—③—④—⑤—⊕—∅				
2. The **target market/ customers** differed from our current markets our customers.	①—②—③—④—⑤—⊕—∅				
3. Our company did not have much experience with the required **distribution channels**.	①—②—③—④—⑤—⊕—∅				
4. The required **buying activities** differed from our current practice.	①—②—③—④—⑤—⊕—∅				
5. It was difficult to predict the behavior from **potential suppliers**.	①—②—③—④—⑤—⊕—∅				
6. The required **production lines** were not yet existing in our company.	①—②—③—④—⑤—⊕—∅				
7. **Need for capital** was higher than in former projects.	①—②—③—④—⑤—⊕—∅				
8. The required **competencies and skills** to realize the product concept differed strongly from available competencies/ skills for most of the employees.	①—②—③—④—⑤—⊕—∅				

	low	medium	high
9. Please assess the **overall degree of newness** of the new product concept to your company.	①—②—③—④—⑤—⊕—∅		

H) General information

1. How many **employees** does your company have? ....
2. **Development** time for the new product: .... month
3. Which **function** do you have in your **company**? ....
4. Which **function** did you have with regard to the **new product development project**? ....
5. Please assess the **product concept**:

Cost reduction	Repositioning	Product modification	New product line	New to the world
☐	☐	☐	☐	☐

I) Project execution

		strongly disagree — neutral — strongly agree
1.	The **technical concept** was changed during project execution.	①—②—③—④—⑤—⊕—∅
2.	The **target market** was changed during project execution.	①—②—③—④—⑤—⊕—∅
3.	**Responsibilities of team members** were changed during project execution.	①—②—③—④—⑤—⊕—∅
4.	During project execution we diverged from **planned procedures**.	①—②—③—④—⑤—⊕—∅
5.	**Project objectives** were changed during project execution.	①—②—③—④—⑤—⊕—∅
6.	Several **conflicts** occurred during project execution.	①—②—③—④—⑤—⊕—∅
7.	All relevant aspects of the project (budget, timing, resources) were **monitored and controlled**.	①—②—③—④—⑤—⊕—∅
8.	**Communication** and collaboration between **project team members** were good.	①—②—③—④—⑤—⊕—∅
9.	**Communication** and collaboration between **Marketing and R&D** were good.	①—②—③—④—⑤—⊕—∅

J) Project success

		objectives not achieved — objectives achieved — objectives exceeded
1.	To what extent did the new product fulfill **your company's objectives** with regard to the following aspects?	
	• **profit**?	①—②—③—④—⑤—⊕—∅
	• **competitive advantage**?	①—②—③—④—⑤—⊕—∅
	• **customer satisfaction** with the product?	①—②—③—④—⑤—⊕—∅
	• fulfillment of **technical requirements**?	①—②—③—④—⑤—⊕—∅
	• increase of **know-how**?	①—②—③—④—⑤—⊕—∅

		strongly disagree — neutral — strongly agree
2.	**Planned milestones** were reached.	①—②—③—④—⑤—⊕—∅
3.	**Planned financial resources** were sufficient.	①—②—③—④—⑤—⊕—∅
4.	**Planned personell resources** were sufficient.	①—②—③—④—⑤—⊕—∅
5.	I was satisfied with the **development process**.	①—②—③—④—⑤—⊕—∅
6.	Overall, considering all aspects, the project was a **success**.	①—②—③—④—⑤—⊕—∅