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Managerial uses of post-completion auditing of capital investments

ABSTRACT

This study examines the different managerial uses of post-completion auditing (PCA) of capital investments. The empirical data come from the 16 PCA adopters that were identified in face-to-face interviews conducted in all of the 30 largest Finnish manufacturing companies. Although PCAs are reported to be common in large companies, we still have little empirical evidence about the significance of the different managerial uses of PCA. Accordingly, drawing on the concepts of cybernetic control systems, this study assesses the significance of PCA in measuring performance and controlling current investments (assisting correction/abandonment decisions), enhancing the integrity of investment appraisals, and in evaluating personnel. The paper also elaborates and maps the beneficial effects of PCA related to organizational learning. It adds specifically to the extant literature by providing empirical support for maintaining that not only timing-related issues, but also alternate control mechanisms (e.g. quality systems, routine reporting, visits, presentations, and discussions) diminish the relevance of PCA in controlling current investments and enhancing the integrity of investment appraisals. Moreover, the findings provide support for prior studies, which suggest that enhanced organizational learning for future investments is perceived as the major benefit from PCA, whereas PCA's relevance in controlling current investments can be minor.

Key words: *Post-completion auditing, capital investments, managerial use, field study*

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1. INTRODUCTION

Post-completion auditing¹ (PCA) of capital investments can be described as a formal process that checks the outcomes of individual investment projects after the initial investment is completed and the project is operational (Chenhall and Morris, 1993). Hence, PCA can be regarded as one formal control system within a company's total management control system package, which comprises various formal and informal controls (see e.g. Otley, 1999). PCA is reported to be common in large companies.² PCA scholars (e.g. Neale, 1991a; Pierce and Tsay, 1992) suggest that the major perceived benefits from PCA are specifically related to its enhancement of organizational learning (OL), which is known to lead to improvements in future capital investment by a company. Additionally, the scholars (ibid.) suggest that PCA can be used to measure the performance of an investment, to provide feedback for controlling current investments, to enhance the integrity of investment appraisals, and to evaluate management. Nevertheless, we still have little empirical evidence about the relevance of PCA for these uses. *The purpose of this study is to assess the significance of different managerial uses of PCA.*

The basic prerequisites for functioning traditional control systems – also called cybernetic control³ or feedback systems – are the existence of ex ante targets, the ability to measure outcomes against them, and the ability to undertake necessary corrective actions (Flamholz et al., 1985; Otley, 1999). Accordingly, drawing on the concepts of a cybernetic control system, this paper will first examine PCA's appropriateness in measuring the outcomes of an investment project against its ex ante targets. The performance measurement phase constitutes a critical platform facilitating other PCA uses (Huikka, 2007). Second, PCA's relevance for controlling current investments (i.e. assisting correction/abandonment decision-making) will be addressed by investigating its ability to undertake corrective actions. Third and fourth, respectively, PCA's relevance in enhancing the integrity of investment appraisals and in evaluating personnel will be examined. Hence, how the awareness of ex-post performance measurement (here PCA) may affect the behaviour of staff involved in investment processes is studied. Finally, PCA benefits related to organizational learning will be mapped.

In addressing these research topics, this paper adds to the extant PCA literature by providing empirically supported insights about the relevance of suggested uses of PCA. The study also res-

1 Other synonymous terms used are e.g.: post-audit, post-completion review, post-appraisal (of capital investments). Post-completion audit and post-audit seem to be the two terms that have been the most often presented in the latest studies.

2 Adoption rates reported in different studies: 1) In the UK, 98% (Arnold and Hatzopoulos, 2000) and 79% (Neale, 1991b); 2) In the USA, 76% (Gordon and Myers, 1991) and 90% (Klammer and Walker, 1984); 3) In Norway, 41% (Neale, 1994); and 4) In Italy, 71% (Azzone and Maccarrone, 2001).

3 Cybernetic control systems rely on variance information to correct the progress of the process in question (see Luckett and Eggleton, 1991).

ponds to Neale's (1991b) relatively old but still unanswered call to shed light on concrete PCA effects, and to Haka's (2007, 723) call to study why PCA seems to be ineffective. In a similar vein, the paper is also motivated by Northcott and Alkaraan's (2007, 218) recent suggestion to investigate what managers actually learn from PCA. From a practical point of view, an enhanced understanding of PCA's relevance for different uses may help companies in making their PCA systems more effective.

In this study, PCA is defined as follows⁴: PCA is a *formal* review of a completed investment project fulfilling the following criteria: (1) it takes place after an investment has been completed (commissioned) and has begun to generate cash flows (or savings); (2) reporting is at least partly focused on a comparison between the pre-investment estimates of an investment project and the actual figures/achievements after completion; and (3) PCA is systematic and regular, and there are instructions for it. This definition of PCA rules out other capital investment controls such as the monitoring of capital investments⁵ and routine reporting.⁶

For the purpose of this study, the 30 largest Finnish manufacturing corporations were interviewed. The face-to-face interviews consisted of two parts: a semi-structured interview and a structured questionnaire (which was filled out in the presence of a researcher). The paper specifically addresses 16 companies that were identified in the interviews as PCA adopters. This is the most extensive study of PCA using face-to-face interviews. The focus of the paper is on tangible capital investments such as factories, production lines, machines and equipment.

The article is organized as follows: after this introductory part and the following literature part, the third section describes the research method. The fourth section presents the empirical results, and the fifth section analyzes and discusses them. Finally, conclusions follow in section 6.

4 This definition is in line with the definition of PCA suggested by Gadella (1986), Pierce and Tsay (1992), Chenhall and Morris (1993), and CIMA (2005, 60), but is more explicit with regard to criterion (3). Nevertheless, I recognize the difficulty of providing a catch-all definition of PCA including more detailed requirements such as the type of projects selected, the format, who does it, who is responsible for it, when and how frequently it is conducted, and how the results are communicated.

5 During the implementation phase, it is typical to follow up on the cost budget, scheduling, and technical specifications, to see that they are progressing according to plan. In practice, monitoring of the implementation phase and PCA are overlapping concepts, because monitoring is, to some extent, a prerequisite for PCA. However, monitoring alone cannot be considered as fulfilling the criteria for PCA. In the monitoring phase, it is typically too early to estimate whether an investment project will achieve its targets.

6 Internal and external routine reporting (monthly, trimestral, annually, etc.) usually do not fulfill all the criteria required for PCA. For example, routine reporting is typically (1) not project-focused, but profit-center or cost-center focused, and (2) does not compare the pre-investment objectives of an investment project with the actual achievements.

2. MANAGERIAL USES OF PCA

PCA scholars suggest that PCA can be beneficial in providing feedback both for current and future capital investments (Neale, 1989 and 1994; Pierce and Tsay, 1992). The benefits⁷ for current investments are project-control oriented, whereas future benefits are connected to better appraisal and planning of projects, and to improvement of the capital investment system in general (Neale, 1991a; see also Mills and Kennedy, 1993). Additionally, Neale (1991a) suggests that PCA benefits are likely to be associated with the aims specified for it. Next, with the aid of prior empirical literature, PCA's relevance to various managerial uses will be reviewed, and specific research gaps identified.

Performance measurement (evaluating the success of a completed investment) is a core function of PCA. In practice, companies do it by comparing and analyzing the ex-post outcomes of an investment project with its ex-ante objectives (Neale and Holmes, 1991). However, PCA's appropriateness in performance measurement has been much neglected in research. Consequently, I will make an attempt here to fill this research gap by specifically investigating whether and how the technical measurement difficulties⁸ encountered by companies affect PCA's measurement ability. The prior literature has reviewed PCA difficulties *per se*, but their practical impact on PCA is still ambiguous. According to Neale (1989), changes in the business environment and the presence of qualitative factors are two major difficulties in PCA. In his later research (1994), the Norwegian companies ranked separation of the incremental cash flows of investment projects as the primary difficulty. Similarly, Linder (2005) found in his review of empirical PCA studies that this was the most often mentioned and first-ranked difficulty in conducting PCA.

In some studies, performance measurement has been explicitly mentioned as a distinct PCA benefit (Neale, 1994; see also Pierce and Tsay, 1992)⁹, whereas Neale (1989) and Mills and Kennedy (1993) have not included it in their studies. Consequently, there is still ambiguity about the independent beneficial role of using PCA for performance measurement purposes. Here it will be explicitly elaborated whether performance measurement has managerial relevance *per se* or whether it is only a prerequisite function supporting other uses, as Huikku (2007) suggests.

PCA could potentially be valuable with regard to current underperforming projects by giving early warning information or helping companies to analyze different *correction/abandonment*

⁷ Prior literature (e.g. Neale, 1991a, 1994; Pierce and Tsay, 1992; Mills and Kennedy, 1993) uses the term "PCA benefits" broadly in this connection covering simultaneously the uses (functions, roles) of PCA potentially leading to achievement of the benefits. In this paper, I use the word "use (of PCA)" to cover both PCA benefits and uses.

⁸ Here the word difficulty is perceived to include other related words such as problem, shortcoming, drawback, disadvantage, and challenge.

⁹ In Neale (1994) performance measurement is called "verification of actual profitability of project" and in Pierce and Tsay (1992) "identification of past errors".

alternatives.¹⁰ The beneficial role of PCA in providing feedback for assisting decision-making for corrections is perceived within companies to be of minor, but not negligible importance (Neale, 1989; Pierce and Tsay, 1992). Based on empirical evidence, Neale (1991a) suggests that the earlier the first PCA, the greater the ability of a company to successfully modify an investment project. It is also suggested that benefits regarding modifications might arise primarily from regular monitoring of projects before commissioning rather than from PCA (Neale and Buckley, 1992). Nevertheless, we are still hesitant about whether PCA is relevant in assisting corrections of already commissioned projects at all (as an early warning system or an analysis tool), and whether the respondents in the prior surveys eventually had benefits from monitoring of the implementation phase in mind. This paper addresses these research gaps by specifically focusing on timing-related issues.

Howe and McCabe (1983) (see also Gaumnitz and Emery, 1980) suggest that a company should abandon a commissioned investment if the abandonment value exceeds the NPV for the remaining life-time of the investment. Furthermore, Statman and Caldwell (1987) maintain that formal investment control could diminish the potential of managers to hide unsuccessful investments and delay decisions to abandon.¹¹ Accordingly, Smith (1993) found a positive association between abandonment decisions and firm performance in companies with a PCA system; i.e. the existence of a PCA system in a company increases the probability of timely abandonment decisions and of avoiding unjustified ones. Nevertheless, Corr (1983) and Neale (1991a) cite the relative insignificance of PCA in assisting abandonment decisions. One reason for the low importance may be that the main focus in cases of an underperforming investment is on improving its performance, and not on terminating it (Neale, 1989). To sum, we are unsure about the role of PCA in assisting abandonment decisions because of the contradictory suggestions in the extant literature. Hence, I will examine here whether and how PCA is coupled with investment project abandonments.

Investment project appraisals can include intentional biases upwards (or less often downwards), because managers may exaggerate project cash flows in order to gain approval for their proposals (see e.g. Pruitt and Gitman, 1987; Pohlman et al., 1988). Pierce and Tsay (1992) suggest that companies consider PCA beneficial in *enhancing the integrity of investment project appraisals*.¹² Similarly, Lumijärvi (1990) argues that PCA is the only factor diminishing game

10 See e.g. Busby and Pitts (1997), Smit and Trigeorgis (2004, 108) and Shapiro (2005, 105) about the various alternatives that companies have to deal with underperforming investment projects.

11 In practice, e.g. psychological reasons, such as difficulties in confessing one's own failure decisions, may prevent or delay management's desire to abandon investments (Northcraft and Wolf, 1984). Kanodia et al. (1989) suggest that a manager's value in the labor market may weaken if he has to abandon an investment that he has advocated.

12 Similarly, Neale (1989, 1991a) and Mills and Kennedy (1990, 1993) suggest that PCA encourages greater realism in project appraisals. Both researchers use the words "realistic" and/or "realism" in this connection.

playing¹³ behavior in capital investment processes. In addition to intentional biases related to game playing, the project appraisals may include unintentional biases by managers who believe that they are acting in the best interest of shareholders (Roll, 1986). Managers may be overconfident and/or overoptimistic in connection with investment decisions and overestimate the returns of their investment projects.¹⁴ Here it will be investigated whether and in what kinds of circumstances do the companies studied perceive that PCA enhances the integrity of their investment project appraisals.

Personnel evaluation elements are typically an integral part of a cybernetic control system (Flamholz et al., 1985). Accordingly, facilitating evaluation/rewarding the personnel involved in the capital investment process has been suggested as one of the purposes for conducting PCA (Neale, 1989; 1994). However, we know little about the couplings between PCA and personnel evaluation. According to the scholars, few companies use PCA in formal evaluation of managers (Smith, 1994) or consider it beneficial in evaluation (Neale, 1994). It is plausible that timing problems may discourage companies from integrating PCA into their evaluation systems, e.g. into reward systems. One problem in trying to connect PCA and personnel evaluations can be the long time interval between the investment appraisal and PCA. This may mean that the people involved in the appraisal phase are already in other positions. Another difficulty may be that evaluation systems are often related to the financial year, whereas this frequency is not necessarily optimal for PCA purposes. The existing literature has neglected to study empirically whether the above tentatively suggested reasons or other reasons explain why the benefits related to personnel evaluation/rewarding have been perceived as marginal. As a consequence, this paper will address these questions.

The major perceived benefits from PCA within companies are related to its enhancement of *organizational learning*, which is known to lead to improvement in future capital investment (Neale, 1991a and 1994; Pierce and Tsay, 1992). OL involves the sharing of knowledge, beliefs, or assumptions among individuals, and it is influenced by a broader set of social, political, or structural elements; it is not merely a sum of individual learning within an organization (Marquardt and Reynolds, 1994). In an organizational learning process the organization responds to changes in its environment by detecting and correcting them in order to maintain its central features (Argyris, 1990). Furthermore, Argyris (1977, 1990) distinguishes between two types of

13 Because of asymmetric information distribution, managers may be in a position to play games in the capital investing process. They may use their information advantage to enhance their self-interest objectives for example by focusing on certain aspects of information, filtering information, or manipulating information.

14 Following the notions of Roll's (1986) Hubris hypothesis, Malmendier and Tate (2005) define overconfidence as overestimation of one's (a manager's) own abilities and outcomes relating to one's own personal situation, and over-optimism as a general overestimation of future life events (see also Heaton, 2002; Baker et al., 2007). Furthermore, Aktas et al. (2007) suggest that the learning process can allow managers to progressively correct overconfidence and over-optimism.

organizational learning: single-loop and double-loop learning (cf. Senge, 1990). Single-loop learning focuses on problem solving and does not address the reasons for the problems arising in the first place. This is characteristic of cybernetic control systems (Preble, 1992). In double-loop learning, organizations not only detect and correct errors, but also question underlying assumptions.

Management control systems can have a major facilitating or hindering role in organizational learning processes (Kloot, 1997; Carmona and Grönlund, 1998). According to scholars, information obtained from PCA can aid a company in identifying successful processes that can be repeated in the future capital investment projects, and help in avoiding previous mistakes (e.g. Neale, 1989, Mills and Kennedy, 1993). In a similar vein, Chenhall and Morris (1993) maintain that PCA can enhance managerial learning at the project definition stage of the capital investment process. Mills and Kennedy (1993) also suggest that PCA can be conducive to learning for capital investment processes in general – not merely for project-specific investment activities. The PCA feedback may, for example, trigger improvements in investment procedures and instructions.

According to Huikku (2007), PCA is not the only method companies use to manage their capital investment knowledge and enhance OL; companies typically use other approaches such as central expertise and experienced internal resources. He further contends that particularly the management of larger companies having major strategic, complex and repetitive capital investments perceive that PCA offers superior performance compared with “non-PCA” ways, and regard PCA as an appropriate complement to them. Nevertheless, the practical OL benefits of PCA are still ambiguous and consequently this paper maps them and additionally discusses the extent to which they are related to the single/double-loop type of learning.

Besides the above presented uses of PCA, Neale (1989) has studied whether companies use PCA for reducing management autonomy at local level. The findings indicate, however, that the companies studied consider this kind of use trivial. In addition, Neale (1991a) has examined whether companies perceive PCA to be beneficial in improving corporate performance, but in my paper this is ruled out as an ultimate, catch-all use. Consequently, in the empirical part I will study the perceived significance of the following managerial uses of PCA: 1) performance measurement, 2) assisting corrections/abandonment of current investment projects, 3) enhancing the integrity of project appraisals, 4) evaluation of personnel, and 5) enhancing organizational learning for projects and investment process development.

3. RESEARCH METHOD

The empirical evidence was gathered from all of the 30 largest Finnish manufacturing corporations. The companies were ranked according to turnover (Talouselämä 24.5.2002). This paper

addresses the 16 (out of 30)¹⁵ companies which were identified as PCA adopters according to the definition of PCA used for the paper. Additionally, four companies conduct PCA only on an ad hoc basis (lack of regularity, systematic ways, and instructions) and 10 companies do not formally compare pre-investment estimates of investment projects with actual figures after the projects have been completed and have started to generate cash flows. The 16 PCA adopters represent seven sectors of the manufacturing industry (see Table 1). In 2001, the turnover of the largest company was €13.5 billion, the largest absolute amount of tangible assets was €12.3 billion, and the largest gross investments amounted to €3.9 billion.

TABLE 1. Descriptive statistics of PCA adopters (n = 16)

In € million	Mean	Std. Dev.	Median	Min	Max
Net Sales	4199	3968	2418	585	13509
Tangible assets	2839	3869	1045	169	12335
Gross investments	609	938	242	33	3850
Industry statistics:					
	Industry	Nr			
	Paper	4			
	Metal	4			
	Food processing	3			
	Chemical/Plastics	2			
	Building material	1			
	Energy	1			
	Others	1			
	Total	16			

My original intention was to conduct a postal survey on a larger sample of companies, but during the early pilot phase it became clear that the respondents' potential for understanding the questions incorrectly would have jeopardized the reliability and validity of the findings. A major concern was the inability of the respondents to make clear distinctions between concepts such as pre-audit, monitoring, and PCA. It appeared that face-to-face interviews would be more appropriate to clarify such issues as they arose. Yet because the aim of the study was to obtain a wide and comprehensive picture of the research topic, a case analysis examining a few companies

¹⁵ In two conglomerates consisting of largely independent businesses, different policies for PCA were found. In both companies the larger divisions were PCA adopters and they were chosen to represent the whole company.

would not be sufficient. Consequently, a cross-sectional field study conducted at non-randomly selected field sites was chosen as a method, as it lay somewhere between an in-depth case study and a broad-based survey (Lillis and Mundy, 2005). Lillis and Mundy suggest that field studies can be particularly appropriate when there is doubt about the precise specification and measurement of variables, their empirical interpretation, or relationships among them. This is the case regarding specification of various PCA uses and their relevance.

The empirical evidence based on the face-to-face interviews consisted of two parts: a semi-structured interview and a structured questionnaire (which was completed in the presence of a researcher). The aim of the semi-structured interviews was to gain a general understanding of the company to be interviewed and especially the capital investment projects, policies and procedures of the company in question. The main structure of the interview was as follows: general; capital investment process; monitoring; and PCA, including informal control and OL with regard to investments. The nine-page questionnaire comprised 44 factual and attitudinal questions about PCA, covering instructions, structural properties (i.e. the type of projects selected, the format, who does it, who is responsible for it, when and how frequently it is conducted), aims, uses/benefits, difficulties, communication, and ideas for future development of PCA in a company. Likert-5 scaling was used in the attitudinal questions. The questionnaire was developed with the aid of prior normative and empirical studies, and the researcher's own experience in PCA.¹⁶ In the early phase of the interviewing process three academics and two outside experts with a great deal of capital investment experience were asked to comment on the questionnaire. The early interviewees in particular were also encouraged to comment on it. The comments gained herewith helped to formulate some questions more effectively and thus to avoid misinterpretations. During the interviews the interviewees were also asked to present examples of their PCA reports.

Specifically pertinent for this paper, the interviewees were asked to discuss and rate the perceived significance of the following seven suggested PCA uses (Likert-5 scaling)¹⁷: (1) performance measurement, (2) assistance in decision-making for corrections, (3) assistance in decision-making for abandonment, (4) evaluation of personnel involved in the capital investment project, (5) enhancing the realism/integrity of investment appraisals, (6) OL for projects, and (7) OL for process development. In a similar vein, the companies studied were asked to discuss the significance of 14 suggested potential PCA difficulties, and to rate their significance. The difficulties were compiled from prior studies (Neale, 1989; Pierce and Tsay, 1992; Mills and Kennedy, 1993; Huikku, 2001). In this paper I will specifically focus on investigating whether technical difficulties

16 The researcher had previously worked 13 years in one of the companies studied at both the divisional and profit center level, holding various controlling and general management positions.

17 1 is insignificant use, 5 is very significant use. Additionally, in the text I use the following terms to indicate other ratings: slightly significant (2), moderately significant (3), and significant (4).

such as separation of incremental cash flows, changes in business environment, and estimation of future cash flows challenge PCA's performance measurement ability. Additionally, the interviewees were asked the following questions related to PCA uses: (1) has PCA in practice assisted an investment project correction or abandonment decision, and (2) what are the concrete PCA benefits in your companies (examples asked)?

Altogether 49 interviews were conducted between December 2002 and January 2004, 25 with the 16 PCA adopters. Typical interviewees were CFOs/controllers and persons in charge of technology, investments, production or business development in corporate management or major divisions. The idea was to identify through press releases, newspapers, phone calls, hints from colleagues in other companies, and seminars the most knowledgeable person with regard to capital investment control in each of these corporations as the main interviewee. In some cases other relevant persons involved in capital investing were also included. These were typically cases where responsibility for capital investment coordination was partly the joint responsibility of the CFO and a person representing technology or production. All of the contacted persons agreed to be interviewed. The duration of one interview was on average about 2 hours, and all interviews except one were tape-recorded. In some cases, the interviewees were contacted afterwards by email or phone in order to check on some interpretations of their answers or to obtain further comments on details.

Prior studies dealing with beneficial effects of PCA uses have mainly been conducted by using postal survey methods relying on statistical methods. However, the intention of this study is to explore and shed more light on the reasons why various uses of PCA are perceived as (in)significant within the companies, rather than to find statistical support regarding, for example, whether beneficial effects are associated with the aims or design of PCA system. Even though the face-to-face approach adopted in this research had the disadvantage of restricting the number of companies studied and consequently generalization of the results, it significantly increased the reliability and validity of the study. This approach made it easier to explain the definitions in detail, to pose further questions, to return to the earlier answers, and to go through real examples of PCA reports. This study is the most extensive PCA study using face-to-face interviews. Another PCA study, which used face-to-face interviews in combination with a formal questionnaire, is Kennedy and Mill's (1993) study of 16 UK companies.

4. RESULTS

In this section the significance of different PCA uses will be empirically investigated. First, PCA's appropriateness in performance measurement is examined by drawing on the two prerequisites of cybernetic control systems, namely existence of ex ante targets and ability to measure the

outcomes. PCA's performance measurement ability will be specifically addressed by studying whether and how technical difficulties affect it. Second, drawing on the third prerequisite of cybernetic control systems (ability to make corrections) PCA's relevance in assisting correction/abandonment decision-making for current investments will be examined. Other elements closely related to cybernetic controls such as integrity of the investment appraisals and evaluation of personnel will be addressed next. Finally, the benefits related to organizational learning will be mapped.

The interviewees were asked to discuss how they perceive the significance of different PCA uses, and additionally to rate them by using Likert-5 scale. As can be seen in Table 2, performance measurement, enhancing realism/integrity of investment appraisals and enhancing OL for projects/processes were the highest rated uses (ratings per company can be seen in Appendix A). Only one company perceives PCA as significant in evaluating personnel. In a similar vein, using PCA to modify current investments has received low ratings. Furthermore, all the companies perceive PCA's role in abandonment decisions totally insignificant.

TABLE 2. Perceived significance of PCA uses (n = 16)

	1	2	3	4	5	N	Mean	Std dev.	Median	Min	Max
Performance measurement	1	1	2	7	5	16	3.9	1.15	4.0	1	5
Enhancing realism/integrity of investment appraisals	0	3	4	7	2	16	3.5	0.97	4.0	2	5
Organizational learning for future capital investments	2	2	4	6	2	16	3.3	1.24	3.5	1	5
Org. learning for capital invest. process development	4	3	5	3	1	16	2.6	1.26	3.0	1	5
Evaluation of personnel involved in investment project	6	5	4	1	0	16	2.0	0.97	2.0	1	4
Assistance in decision-making for corrections	7	5	4	0	0	16	1.8	0.83	2.0	1	3
Assistance in decision-making for abandonment	16	0	0	0	0	16	1.0	0.00	1.0	1	1

Frequencies of responses on a Likert scale are presented in columns 1 to 5
 1 = insignificant, 2 = slightly significant, 3 = moderately significant, 4 = significant, 5 = very significant

PCA's appropriateness in performance measurement

The first prerequisite for a cybernetic control system is the existence of ex ante targets. This requirement is fulfilled in the companies studied because all of them have documented their investment appraisals, and this material includes monetary and often also non-monetary targets. All the 16 companies use investment calculation techniques such as IRR, NPV, or discounted payback, and 10 companies state that they use all three techniques frequently. ROI, EVA, and ROCE were mentioned as auxiliary methods.

The second prerequisite is the ability of the control system to measure the outcomes. Here this is approached by examining whether and how the technical PCA difficulties encountered challenge PCA's functioning as a performance measurement device. According to the empirical data, the major technical difficulties encountered were separation of incremental cash flows, changes in business environment, and estimation of future cash flows. Although in 6 companies at least one of the three difficulties is perceived as significant, none of the difficulties is significant at the aggregate level.¹⁸

The separation of cash flows is perceived to be the primary difficulty in PCA. As the senior vice president of corporate strategy, investments, and business planning (company 2 in Appendix A) explained:

Many times it is a challenge to separate incremental cash flows. For example, if we expand one part within a pulp factory. The question is how to separate it.

However, usage of sophisticated cost accounting systems, such as ABC, seems to help companies in separating incremental cash flows. Furthermore, it was often pointed out that with regard to capital investments forming an integrated entity, the companies do not try to separate their cash flows but regard them as a package. The separation problem actually arises already ex ante. Hence, in the planning phase, a company can consider selecting objectives for an investment that are as measurable as possible.

Changes in business environment, such as an unexpected collapse of the market, may be considered problematic from the PCA point of view as explained by one CFO (company 16):

We invested in manufacturing pipes and pipelines for cable networks. The market collapsed and consequently we started to market these products for totally different purposes. It was not easy to make a profitability calculation afterwards.

Nevertheless, it appears that changes in business environment do not necessarily technically hamper the conduct of PCA, although they may diminish the value of PCA feedback for correcting the negative variances.

Estimation of future cash flows is among the major PCA difficulties encountered in the companies. In practice, only when the payback time of an investment is short and PCA can be conducted at the end of the life-cycle, is it possible to base the performance measurement of an investment on actual figures alone. There were two main approaches regarding how to deal with

18 Average ratings and number of companies out of the 16 that perceived the difficulties as significant or very significant: (1) Separation of incremental cash flows, 2.8 (4 companies), (2) Changes in business environment, 2.6 (4 companies), and (3) Estimation of future cash flows, 2.5 (3 companies). Likert-5 scaling: 1 = insignificant difficulty, 5 = very significant difficulty. The above mentioned difficulties were also the top three among all the 14 difficulties (technical, organizational, and economic) examined.

future cash flows in ex post calculations. Nine companies reconstruct their investment calculations, i.e. they update the original calculations with regard to future estimates according to their best knowledge as one director of technical development (company 3) commented:

Yes, we update our investment calculations in connection with PCA. The actual is actual, but we also have to make new estimations regarding the coming cash flows. This is challenging, and that is why we try to make it a team effort.

Other part of the companies do not make estimates about future cash flows, but merely focus on comparing actual and ex ante figures for key components, e.g. volume, price and profitability. The manager of corporate investment coordination (company 5) motivated their choice as follows:

We do not want to give managers the possibility to focus the discussion on unsure future cash flows; we want to stick to cold actual facts.

It appears that companies can diminish the technical drawbacks e.g. by using sophisticated cost accounting systems, considering investments as a larger package, and focusing only on actual figures. Consequently, companies do not perceive the technical difficulties to greatly challenge PCA's ability to technically measure the investment project outcomes. The senior vice president of corporate strategy, investments, and business planning (company 2) commented accordingly:

Sure, some difficulties can be somewhat challenging, but they do not affect the conduct of our PCA at all.

12 companies studied rate that using PCA for *performance measurement* is significant or very significant. Nevertheless, further discussions revealed that the companies do not perceive performance measurement to be beneficial as such, but a prerequisite function supporting other PCA uses as the vice president of finance and administration (company 14) commented:

Performance measurement facilitates achievement of other PCA benefits. That's why it is important.

The manager of a process development group (company 12) added the following about PCA's performance measurement function:

Performance measurement is not beneficial as such. It is history. If I make a long report on a capital expenditure and just state that this is it. There's no benefit. However, if it [performance measurement] leads to some actions, then it is beneficial, indeed.

To sum up, it seems that technical difficulties do not dramatically challenge PCA's appropriateness in measuring investment project performance. Additionally, empirical evidence was found to maintain that measuring performance is not considered managerially relevant (or a distinct PCA benefit) *per se*, but a prerequisite function supporting other PCA uses.

PCA in assisting correction/abandonment decisions

The third prerequisite for a cybernetic system is its ability to undertake corrective actions. Here PCA's relevance in assisting detection of underperforming investment projects and analyzing the appropriate actions required (correction/abandonment) will be addressed. Based on the findings, none of the companies studied perceives PCA to be significant in assisting decision-making for corrections and few recalls a project modification where PCA had a role. The main reason for the diminishing ability of PCA to assist corrective actions seems to be its inherently late timing (i.e. PCA is conducted after completion/commissioning of the investment). The interviewees had the following to say about late timing:

It is too late to do anything. Your pants are already wet (CFO, company 16).

Additionally, already commissioned projects seldom were abandoned in the companies. It occurred that the first alternative used by the companies with underperforming projects is to correct their progress, not to terminate them. With regard to PCA and terminations, all the companies studied perceive PCA's role in assisting decision-making with regard to abandonment as insignificant; none could remember any investment project termination where PCA had played a role.

The choice of timing for conducting PCA is evidently essential especially if a company conducts only one PCA per investment and aims to support decision-making for current investments. Among the companies studied, 12 out of 16 normally conduct only one PCA per project, whereas four companies carry out multiple PCAs. All the multiple PCA conductors and six of the others conduct the first review within one year of commissioning. However, they do not justify early PCA with a desire to obtain feedback for current investments. Instead, some companies advocate early PCA because of its potential to provide timely feedback for other similar investments under simultaneous consideration.

It appeared that PCA seldom revealed negative variances that had not been previously detected. Instead, it was found that quality systems, routine reporting, and informal ways (visits, presentations, discussions) provide information that triggers corrective actions. In one company (2), the senior vice president of corporate strategy, investments, and business planning explained:

Such indications for modifications come earlier [before PCA]. In PCA one can of course

actively discuss how to change the progress of a project, but the organization is already aware of the situation and there are plans for what to do.

A manager of process development (company 12) stated in line with this:

We pursue a continuous improvement policy in our factory. In practice this means that as soon as somebody has noticed something needs to be improved and developed, the issue is brought to the table. And the issue will be handled immediately. There would be no sense in waiting for formal meetings and [monitoring or PCA] reports to make these corrections.

As in the case of assistance for correcting decisions, the triggers for abandonment analysis seem to come from other sources (i.e. routine reporting, and informal ways) as an executive vice president of corporate strategy and business development (company 10) stated:

We have abandoned some completed capital expenditures for business reasons; the market situation has changed dramatically. However, the information has come from other sources, not from PCA.

Furthermore, it appears that the companies apply various ad hoc types of analysis to investigate whether to modify or abandon investment projects. In other words, when the companies notice an underperforming project, a separate “just-on-time” investigation can be conducted beyond regular PCA. In addition to timing issues, the ad hoc analysis may differ from PCA reports in terms of the format and communication aspects.

Nevertheless, in spite of timing-related challenges and existing alternative ways to aid detection/analysis of underperforming projects, four companies consider PCA to be moderately relevant in assisting decision-making for modifications. Typically, these companies conduct PCA relatively soon after commissioning (within one year). Particularly, in mega-investments such as paper machines where commissioning is followed by a long period (e.g. up to two years) of unstable and not yet optimal production performance, PCA may provide feedback for corrections. As one director of technical development (company 3) commented:

I always talk about developing the machinery or production line [not correcting it] because it sounds more positive. Yes, it happens. Thanks to PCA feedback we have sometimes, for instance, noticed bottlenecks in production and eliminated them.

The vice president of operations and sourcing (company 4) added the following about the special features of paper machine investments:

In this kind of an investment a period of two years after start-up is an intermediate learning phase. During that time we make several PCAs and they may lead to modifications.

PCA may also trigger further investments as the managing director of an engineering unit in one company (15) said:

Sometimes we have noticed in PCA that the investment has not achieved its production targets. This has triggered further investments to correct the situation. Nevertheless, 80% of the underperforming projects involve something else, like markets, prices, and operating costs.

In addition to trigger technical modifications, PCA may be relevant in providing feedback to assist in strategic overhauls of the project:

We may do a strategic overhaul on our paper machinery triggered by a PCA report. We call it asset restructuring (vice president of operations and sourcing, company 4).

To summarize, it appears that the inherent lateness of PCA is perceived within the companies as a major obstacle for using it in assisting corrective actions. Additionally, the possibilities of companies to detect and analyze underperforming projects by using alternative means seem to diminish PCA's relevance in assisting corrections/abandonments. Nevertheless, it seems that especially companies having major capital investments with a long running-in phase after commissioning may find PCA moderately significant in assisting corrective actions.

PCA in enhancing the integrity of investment appraisals

Five companies perceived using PCA for enhancing the integrity of investment appraisals moderately significant.¹⁹ Specifically, these companies emphasize that awareness of coming ex post performance measurement can reduce intentional over-optimism in investment appraisals:

We think that the integrity of project appraisals has been enhanced. In the planning phase you have to keep in mind that your promises will be reviewed afterwards (operations controller, company 8).

Awareness that you will be measured enhances realism in plans and diminishes over-optimism (senior vice president of corporate strategy, investments, and business planning, company 2).

The rest of the companies studied, however, do not perceive intentional exaggeration of project cash flows or other game-playing to be problematic, and consequently they do not consider using

¹⁹ Although nine of the companies rate that PCA is significant in enhancing realism/integrity of the investment appraisals (Table 2), it was revealed in the further discussions that they refer *per se* to aspects related to enhancing organizational learning, not to enhancing integrity of appraisals. The correlation analysis between the PCA uses supports this finding: there is a statistically significant positive correlation between enhancing OL and enhancing realism/integrity of the investment appraisals (see Appendix B).

PCA relevant for these purposes. Additionally, the existing alternate ways to evaluate the success of an investment appear to diminish the relevance of PCA in this sense. In other words, the managers may gain an impression of the achievement of the objectives by using alternate methods such as routine reporting. Furthermore, the major investment appraisals go before approval through many presentation forums where the main cash flow components are discussed and the over-optimistic estimations are questioned.

To conclude, the perceived status of the integrity of investment appraisals seems to affect whether companies consider PCA relevant; i.e. if the status is good, PCA is not considered relevant. Additionally, the existing alternate methods to evaluate the success of an investment and pre-approval reviews seem to diminish the relevance of PCA in enhancing the integrity of investment appraisals.

PCA in evaluating personnel

11 companies perceive PCA's role in evaluating personnel involved in the capital investment projects insignificant or slightly significant, four moderately significant, and one company significant. Only in one company is PCA and the formal incentive system occasionally connected. On the contrary, the achievement of implementation phase targets of an investment (planned schedule, cost budget, technical specifications) is often included in the companies' bonus schemas. The empirical evidence supports that appropriateness of PCA in formal staff evaluation is reduced by timing-related issues such as a long interval between an investment appraisal and PCA, and the custom of companies to tie their bonus targets with the financial year. As the CFO (company 16) said:

To have PCA results as a base for bonuses... That would make the perspective too long. We have annual bonus systems.

In a similar vein, the manager of a process development group (company 12) emphasized:

We have to settle the bonuses for the past financial year [calendar year] in the following January. However, we conduct PCAs continuously during the year. The timing simply does not fit.

Additionally, it appears that the already existing bonus measures discourage companies from launching additional measures such as those related to success of a completed investment. A senior vice president, investments (company 1) commented:

I proposed that we should have emphasized the role of investment project directors with new bonus triggers [related to PCA], but it was complicated. We would have had too many overlapping bonus targets for the same people.

Five companies perceiving PCA's role at least moderately significant in personnel evaluation refer to aspects related to informal evaluation:

It is not our aim to evaluate [staff], although they are in practice evaluated to some extent informally. We do not want to put that aim on paper. It would be interpreted negatively (executive vice president of corporate strategy and business development, company 10).

Hence, it also seems that in order to avoid reluctance to conduct PCA, companies do not want to state officially that in practice PCA is used informally to evaluate staff expertise. The informal evaluation can have some direct and indirect impacts on selection of project personnel and attitudes towards managers proposing investment plans:

PCA can send a message to the superiors. We have made organizational changes, changed personnel if the calculations are not OK. However, PCA is not directly used for evaluating people, but indirectly it is behind the evaluations (vice president of finance and administration, company 14).

PCA provides evidence about who can make appropriate plans and who can implement them (manager, investment coordination, company 5).

It is not a formal evaluation process. However, the outcomes of earlier [investment] projects affect the credibility of managers (CFO, company 16).

To sum up, the companies may perceive PCA to some extent relevant in providing (informal) information about the expertise of staff in planning and managing investments. However, timing-related aspects seem to diminish the potentiality for using PCA in formal personnel evaluation and rewarding. Existing bonus measures and avoiding staff reluctance to conduct PCA also discourage companies from integrating PCA and incentive systems.

PCA in enhancing organizational learning

Almost all the companies studied²⁰ perceive PCA to be at least moderately significant in enhancing organizational learning. Relevance of PCA's role in OL is also clearly supported by the numerous comments of the managers advocating PCA's concrete impacts. Additionally, the comments also reveal that companies often seem to consider performance measurement and enhancing realism of investment appraisals *per se* conducive to OL, making the clear distinction between the different uses ambiguous. The major OL impacts are related to obtaining valuable feedback

20 12 companies have rated PCA's role in enhancing OL for projects at least moderately significant. In addition, two (out of four) other companies perceive that learning can aid them in enhancing realism of their investment appraisals.

for the planning and implementation phases of the future capital investments as stated by a CFO (company 6):

I would say that the value added from PCA comes from transferring learning for future investments. Just to measure what happened does not give you anything. But when we learn and transfer the knowledge. That is the point.

The following quotes illustrate what kinds of specific benefits the companies have derived from PCA. The enhanced accuracy of key components in investment calculations was typically mentioned as a major benefit:

To enhance realism via organizational learning, yes. When we have more similar cases, bad or good, we are in a better position to use our experience for making more accurate investment proposals (vice president of production, company 12).

Managers have a better understanding about the potential payback of the projects (senior vice president, investments, company 1).

By obtaining concrete evidence about achievability of our targets, the realism of the future calculations is increased (vice president of operations and sourcing, company 4).

The managers refer frequently to PCA's usefulness in providing valuable feedback on managing implementation and start-up:

PCA aids our resource planning. We can better estimate how much resources [money, human resources and time] are required to reach the targets (vice president of operations and sourcing, company 4).

We can transfer experiences about technical operations and suppliers to the next projects (senior vice president, investments, company 1).

This kind of feedback helps us to run the [coming] projects more effectively (director of technical development, company 3).

Additionally, the benefits for start-up/early operational phase were emphasized:

Learning concerning the start-up period is important. We have to be able to minimize "the bad quality period". I think that this kind of learning comes with the aid of PCA (vice president of production, company 12).

In paper machinery investments the quality classification of paper changes at the outset of operational months. PCA information helps us to plan and market our product portfolio accordingly (factory controller, company 4).

Anticipation of PCA also seems to affect the behaviour of staff by directing their attention to proper documentation of planning and implementation material as the operations controller (company 8) said:

Awareness of potential PCA also improves documentation, and not only the accuracy of calculations.

On the same topic, senior vice president of corporate strategy, investments, and business planning (company 2) added:

Improved documentation enables a proper ex post performance measurement and facilitates learning for coming projects.

Furthermore, six companies refer to the concrete benefits of PCA in developing the investment process. As the group manager of manufacturing (company 8) commented:

This year we have improved our [investment] processes based on feedback obtained in PCA. We have changed forms, documentation, and processes. I think that this kind of benefits will more or less disappear when the process finds its optimal form.

It seems likely that PCA can be relevant for process development mainly during the first rounds after its adoption. Thereafter, its role will probably decline. The importance of process development is also decreased by the long intervals between capital investment process modifications as the senior vice president, investments (company 1) said:

We have not dramatically modified our capital investment processes during the last five years. Consequently, PCA's role in process development has been minor.

To sum up, the companies clearly perceive PCA's role relevant for double-loop learning. PCA appears to help them in addressing the reasons for the problems arising in the first place. Accordingly, PCA aids in revising the assumptions and goals for future capital investments. Specifically, feedback for enhancing the accuracy of key components is emphasized. Hence, the empirical evidence supports that double-loop learning benefits related to future capital investments are the major advantages of PCA, whereas PCA can be marginally beneficial in assisting problem detecting/solving (single-loop learning) for current investments.

5. DISCUSSION

PCA as a cybernetic control device

Drawing on the concepts of cybernetic control systems (see e.g. Merchant and Otley, 2007), this paper first examined PCA's appropriateness in measuring the ex post performance of an investment

project and its ability to assist correction/abandonment decision-making. In assessing PCA's performance measurement function, technical difficulties encountered in PCA were addressed as potential reasons for inappropriateness. Based on the evidence, however, it seems that companies do not perceive that technical difficulties jeopardize PCA's measurement ability to a great extent. This argument is also supported by a number of comments from managers according to which the difficulties have no effect on PCA usage. For example, the companies seem to be able to reduce the difficulties related to separation of incremental cash flows by using sophisticated cost accounting systems and by regarding integrated investments as an investment bundle, i.e. a package of investments (see also Miller and O'Leary, 1997). Additionally, it appears that performance measurement is not perceived to be beneficial *per se*, as the companies state in Pierce and Tsay's (1992) and Neale's (1994) studies, but it is instead a prerequisite function supporting other PCA uses.

Next, the ability of PCA to assist correction/abandonment decision-making for current investments was investigated. The prior survey-based studies (Neale, 1989; Pierce and Tsay, 1992) report that at aggregate level, PCA's beneficial role in providing feedback for assisting decision-making for corrections is perceived within companies to be of minor importance. Providing support for these findings it was found that only a few companies consider using PCA for these purposes moderately significant. Nevertheless, it was identified that especially companies having major capital investments with a long running-in phase after commissioning may find PCA data beneficial for assisting project modifications and even for strategic overhauls. It remains open for discussion, however, whether the running-in phase control should, in fact, be regarded as monitoring of implementation phase, and not pure PCA. Furthermore, in congruence with Corr (1983) and Neale (1991a), who suggest the limited importance of PCA in assisting abandonment decisions, my findings indicate that PCA can be perceived as totally insignificant in this context. The findings here may imply that the different suggestions of previous studies about the relevance of PCA in assisting abandonment decision-making (Smith, 1993) may be partly explained by a still unestablished definition of PCA or by the companies' perception of this definition. It appeared that late or inappropriate timing and the alternate control mechanisms of companies seem to diminish the importance of PCA in assisting companies with correction/abandonment decision-making.

According to Flamholz et al. (1985) (see also Simons, 1995, 70) formal personnel evaluation/rewarding is a fundamental element for a properly functioning cybernetic control system. However, consistent with the findings of prior studies (Smith, 1994; Neale, 1994), coupling of PCA with the formal evaluation/rewarding of personnel involved in the capital investment process seems to be rare. Specifically timing-related reasons, such as a mismatch of PCA results with bonus targets based on financial years and a long interval between an investment appraisal and PCA, seem to diminish PCA's linkages to it. As a consequence, these timing reasons reduce PCA's

effectiveness as a (cybernetic) control system for current investments (see Otley, 1999). Instead, with regard to planning of future investments, PCA may have a role in providing informal information about the expertise of staff.

Responding to the calls of Neale (1991b), Haka (2007, 723), and Northcott and Alkaraan (2007, 218) the impacts of PCA were addressed. Supporting the prior empirical literature (e.g. Neale, 1991a), this study allows to contend that the major perceived PCA benefits are related to organizational learning. Specifically, it appears that PCA can enhance double-loop learning (Argyris, 1977) by providing feedback for improving the accuracy of underlying assumptions and goals in the future planning material. On the contrary, PCA's appropriateness in enhancing single-loop learning seems to be questionable due to timing-related issues. In other words, PCA does not necessarily provide timely feedback that would facilitate corrective actions for current projects in a cybernetic control sense (Preble, 1992).

Alternate capital investment controls affecting the relevance of formal PCA

Huikka (2007) suggests that companies use various alternate control mechanisms in order to evaluate the success of an investment (performance measurement) and to achieve benefits related to OL, and that this diminishes the exclusive role of formal PCA. Contributing to this literature, it appeared here that companies use alternate mechanisms such as routine reporting and informal ways (visits, presentation, and discussions) also in detecting underperforming projects and analysing correction/abandonment options. In other words, they may obtain information about current underperforming investment projects from "non-PCA" sources and use timely ad hoc analyses to investigate the relevant actions required. The companies do not consider these analyses part of their regular (formal) PCA system due to different timing, format and communication aspects. Also, alternate mechanisms for evaluating the success of an investment seem to reduce the relevance of PCA in enhancing the integrity of investment appraisals.

Moreover, the findings support the suggestions of management control package researchers (e.g. Abernethy and Chua, 1996; Otley, 1999), who maintain that in studying management control systems it is appropriate to adopt a broad and holistic perspective rather than to study various control elements in isolation from their wider context. Here, exploring the interrelationships between PCA and other formal/informal control elements assisted in understanding and explaining the relevance of PCA for the companies.

6. CONCLUSIONS

This cross-sectional field study examined the significance of different managerial uses of post-completion auditing (PCA) of capital investments. The appropriateness of PCA in controlling

current investments was specifically addressed by drawing on the concepts of cybernetic control systems, whereas in examining its role with regard to future investments, references were made to organizational learning literature. The empirical evidence come from the 16 PCA adopters which were identified in face-to-face interviews conducted in the 30 largest Finnish manufacturing companies.

As a contribution to the extant PCA literature, this study provides empirically supported insights with regard to relevance of PCA uses. The support was found to maintain that performance measurement is PCA's core and prerequisite function; it supports other uses of PCA, but it is not beneficial *per se*. Furthermore, the paper investigated the potential difficulties of PCA to find out whether these challenge its measurement function. The evidence suggests that technical difficulties do not jeopardize measurement ability to a great extent. Most importantly, it is argued here that in addition to inherently inappropriate timing, the alternate ("non-PCA") control mechanisms available to companies diminish the relevance of PCA in controlling current investments, and in enhancing the integrity of investment appraisals. The alternate control mechanisms may include e.g. quality systems, routine reporting, visits, presentations, and discussions. Moreover, the findings provide clear support for the contention that the major benefits of PCA are related to better planning of future investments, whereas its relevance in controlling current investments can be minor. As an additional contribution, PCA's practical benefits for organizational learning were mapped.

This study adds specifically to the extant literature by providing empirical support for maintaining that companies use alternate control mechanisms in controlling current investments. Because the role of alternate controls appeared to be essential, the focus in future studies could be on investigating in more detail how the triggers for correction/abandonment decisions actually arise, and how analysis of correction/abandonment options takes place in practice. Furthermore, it would be fruitful to investigate how the feedback obtained from various alternate control mechanisms (formal and informal) is communicated within the companies, and how it is eventually converted into action.

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APPENDIX A. Perceived significance of PCA uses per company (n = 16)

Companies (ind.)	Performance measurement	Enhancing realism/integr. of inv. appr.	OL, future capital investments	OL, inv. process development	Evaluation of personnel	Assistance in DM for corrections	Assistance in DM for abandonment
1 (metal)	5	4	4	4	3	3	1
2 (paper)	4	4	4	4	2	2	1
3 (paper)	5	3	3	1	3	3	1
4 (paper)	4	4	3	2	1	2	1
5 (paper)	1	5	5	3	4	1	1
6 (food)	3	3	3	3	1	1	1
7 (food)	4	4	1	1	2	1	1
8 (others)	4	5	5	5	1	1	1
9 (food)	5	2	1	1	1	1	1
10 (metal)	4	4	4	3	3	2	1
11 (metal)	5	2	2	2	2	3	1
12 (metal)	3	4	4	3	1	3	1
13 (build. mat.)	4	3	4	2	2	2	1
14 (energy)	4	4	4	4	2	1	1
15 (chem./plastics)	2	2	3	3	1	2	1
16 (chem./plastics)	5	3	2	1	3	1	1

Likert-5 is used to measure the significance: 1 = insignificant, 5 = very significant.

APPENDIX B. Correlation coefficients (Pearson): perceived significance of PCA uses (n = 16)

	PM	Real./integr.	OL, proj.	OL, proc.	Pers. eval.
Performance measurement (PM)	1				
Enhancing realism/integrity of investm. appraisals (Real./integr.)	-0.301	1			
Organizational learning for future capital investments (OL, proj.)	-0.446	0.669**	1		
Org. learning for capital investment process development (OL, proc.)	-0.312	0.548*	0.792***	1	
Evaluation of personnel involved in investment project (Pers. eval.)	0.000	0.286	0.223	-0.110	1
Assistance in decision-making for corrections	0.252	-0.207	0.113	-0.008	0.083

Assistance in decision-making for abandonment has been ruled out in this analysis (all observations 1 on a Likert-5 scale).

Similar results were obtained by using Spearman correlation coefficients.

*, **, *** Statistically significant at 5 percent, 1 percent, and 0.1 percent, respectively.