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The capital budgeting evaluation practices (2004) of building contractors in Hong Kong

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Abstract

This paper reports the investigation results of capital budgeting evaluation practices of Hong Kong building contractors. The survey aims to identify the popularity of various techniques for capital budgeting evaluation and to measure the changes of the practices longitudinally by comparing the results of the current study (2004) with those of the similar surveys conducted in 1994 and 1999. The current survey results revealed that the ‘‘formal financial evaluation’’ was the most popular technique for capital budget evaluation. The ‘‘payback period’’ was the mostly used investment appraisal technique. For risk appraisal techniques, ‘‘shortening payback period’’ occupied the first position. The ‘‘planning programming’’ remained as the most popular management science technique. Moreover, a comparison of the practices of large contracting firms was carried out to view the changes over the last 10 years. The results showed that the practice of capital budget evaluation was emphasized. The popularity of employing investment appraisal and risk analysis techniques was dropping. In addition, the capital budgeting evaluation techniques examined were fitted into a discriminant function analysis (DFA), which allowed contracting firms to be classified in accordance with their predominant characteristics in the practices. The classification result was 89.1% of all cases were correctly classified.

Keywords: Capital budgeting evaluation; Investment appraisal; Risk analysis; Discriminant function analysis

1. Introduction

This paper aims to highlight the capital budgeting evaluation practices (behaviour) used by the contractors in the construction industry of Hong Kong SAR, China (hereafter we call Hong Kong), such that the information could provide a reference for the building contractors of their behaviour. Most of the healthy firms continuously invest funds in assets, and expect these assets to produce profit and cash flows so that the firms can then either reinvest in more assets or pay to the shareholders. These assets, both tangible and intangible, represent the firms' capital. The term capital also means the fund being used to finance the firms' assets [1]. Capital budgeting can be defined as the process of choosing a firm's intermediate (more than two years) and long-term (10 years or more) capital investments (outlays) and capital budget is the firm's set of planned capital expenditures [2]. Capital budgeting is an important management process that certainly influences the long-run survival and value of a firm, because of the amounts involved are so large that managers need to carefully plan and evaluate expenditures for capital assets. Capital budgets are based on sales forecasts and on the anticipated plants and equipments needed to meet those expected sales [3]. Most firms prepare at least a short-run budget that indicates planned capital outlays for the current and immediate forthcoming periods. Many firms also prepare intermediate and long-term capital budgets.

There were many capital budgeting practices surveys [4–8] drawn on the samples of the largest firms in the UK; Scotland's top 500 and Sweden's top 500. However, little survey has been attributed to building firms in different

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countries/cities. Therefore, this kind of survey shall contribute to the understanding of the capital budgeting practices of project-based firms. Moreover, previous research studies on capital budgeting have been mainly focusing on the application and improvement of modelling techniques [9–12]. Other researchers proposed to use mathematical and optimisation methods for capital budgeting [13–15]. While these operations research and modelling techniques are significant for the improvement of capital budgeting decision-making, relatively little research has been attributed to the practices (behaviour) of capital budgeting evaluation used by contractors in different countries longitudinally.

This paper examines the capital budgeting evaluation practices used by the Hong Kong building contractors in 2004 (current study) and the results are also compared with those data collected in the two similar surveys (the same questionnaires and survey methods) done in 1994 [16] and 1999 [17]. The paper consists of three sections: (i) the methodology, (ii) the analysis of capital budgeting evaluation practices employed by Hong Kong building contractors and (iii) the findings of a discriminant function analysis (DFA). The purposes of the DFA were to classify the financial management practices in accordance with the peculiar characteristics of firms, and to establish the variables which had the greatest impacts on the capital budgeting evaluation practices.

2. Methodology

Modified from the questionnaire set by Pike [5] for the study of capital budgeting practices, 157 questionnaires were sent to all the approved building contractors under the category of building out of about 1000 approved contractors from the list of Approved Contractors from the Architectural Services Department of Hong Kong SAR Government and the Hong Kong Construction Association. Contractors were classified as Group A (allowed tender value was up to HK$20 million), Group B (allowed tender value was up to HK$50 million) and Group C (unlimited) in accordance with their sizes (maximum capacities) as defined by the Architectural Services Department of Hong Kong SAR Government. During the survey period, 7 contractors of the selected sample had either moved out or closed down. The remaining 150 contractors were then divided into three groups (A, B, C) accordingly. Forty-eight contractors came from Group A list, 41 contractors came from Group B list and 61 contractors came from Group C list. Fifty-one questionnaires were received and only 46 questionnaires were qualified. Within those qualified questionnaires, 12 responses came from Group A contractors (response rate of 25% within this group), 13 came from Group B contractors (31.7%) and 21 came from Group C contractors (34.4%). The total response rate was 30.7%. The response rates of the three groups were close, which indicated that the results were not overly biased towards any one of the groups.

Respondents were asked to rate the usage of the capital budget evaluation techniques, investment appraisal methods, risk analysis approaches, management science techniques, methods for anticipating inflation and financial modelling systems. The rating was based on a five-point scale (i.e., 0 = *no*, 1 = *rare*, 2 = *often*, 3 = *mostly* and 4 = *always*). To examine the popularity of these methods, the positive attitude (PA) was devised to represent the combined number of responses of *rare*, *often*, *mostly* and *always*. Since the usage of a particular technique depends on the nature of decision being undertaken, some techniques might have been *rarely* or *always* used by a contractor. The PA will therefore help us to distinguish the contractors from those who did not use a particular technique instead. Besides the PA, the median (Me), mode (Mo) and one-way ANOVA testing of null hypothesis: "there is no significant differences between the groups' capital budgeting evaluation practice" were also used to establish the extent of usage and the pattern of usage between the groups. A 95% confidence level is adopted in the one-way ANOVA testing.

3. The analysis of capital budgeting evaluation techniques

3.1. Capital budget evaluation techniques

According to Riggs [18], the most commonly used capital budget evaluation techniques in construction are "formal financial evaluation", "formal risk analysis" "searching and screening of alternatives before accepting projects", and "best/worst estimate". The results from Table 1 showed that the four practices in capital budget evaluation techniques gained large percentages in PA. The findings of the current study showed that the "formal financial evaluation" had the highest observed frequency of usage (PA = 95.7%) and followed by the "formal risk analysis", "searching and screening of alternatives", and "best/worst estimates" where PA were 91.3%, 89.1%, 87%, respectively.

Formal Financial evaluation: It was often used by small to large contractors (Me = 2 for Group A and B, and Me = 3 for Group C). In the large firms (see Appendix I), a high proportion (PA = 95.2%) of respondents *always* adopted "formal financial evaluation" technique (Mo = 4), indicating that it is a very popular capital budget evaluation technique for contractors of that size (see Table 1). Group B firms (PA was 100%) indicated that they had all exercised this practice (see Appendix I). Most (PA was 91.7%) of the Group A contractors often (Me = 2 and Mo = 2) used this practice. We rejected the null hypothesis with the one-way ANOVA value of significance being 0.008 at 95% level of confidence. There was a real difference between the groups in using this technique.

Risk analysis: In all the three groups (see Appendix I), there was a high proportion (overall PA = 91.3%) of contractors having formal analysis of risk (PA of 83.3%, 92.3% and 95.2% for Group A, Group B and Group C,

Table 1
Comparisons of the usage of capital budget evaluation techniques

Firms have	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Searching and screening of alternatives before accepting projects	1.50 $n = 12$	2.00	2.00 $n = 13$	2.00	3.00 $n = 21$	4.00	2.00 $n = 46$	2.00	89.1
One-way ANOVA significance value = 0.004									
Formal financial evaluation	2.00 $n = 12$	2.00	2.00 $n = 13$	3.00	3.00 $n = 21$	4.00	2.00 $n = 46$	2.00	95.7
One-way ANOVA significance value = 0.008									
Formal analysis of risk	1.00 $n = 12$	1.00	2.00 $n = 13$	3.00	3.00 $n = 21$	4.00	2.00 $n = 46$	3.00	91.3
One-way ANOVA significance value = 0.016									
Analysis under different assumptions (best/worst estimates)	1.00 $n = 12$	1/2[a]	1.00 $n = 13$	1.00	3.00 $n = 21$	3.00	1.00 $n = 46$	1.00	87.0
One-way ANOVA significance value = 0.013									

Number of cases = 46.
[a] Multiple modes exist, the smallest value is shown. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

respectively). But the usage frequency differed among the three groups. Group A contractors indicated that they *rarely* used this practice (Me = 1 and Mo = 1), Group B contractors *mostly* used this practice (with Me = 2 and Mo = 3) and Group C contractors *always* used this practice (Me = 3 and Mo = 4). The one-way ANOVA significance value (0.016) suggested rejecting the null hypothesis. There was a real difference between the groups in using the risk analysis system.

Searching and screening of alternatives before accepting projects: The results showed that this practice was quite common within the construction industry. Most of the Group A and Group B firms *often* searched and screened of alternatives (Mode = 2). Group C firms *always* exercised this practice (Mode = 4). The median values also reflected the same trend (the median were 1.5, 2 and 3 for Group A, Group B and Group C firms, respectively). The one-way ANOVA result was 0.004 which meant that the null hypothesis was rejected and there was a real difference between the groups in engaging this practice. The larger the size of a firm, the more frequent it would have interest in searching and screening of alternative projects.

Best/worst estimates: From Appendix I, it is seen that this practice was also gained reasonable acceptance by the building contractors with PA for Group A, Group B and Group C was 75%, 92.3% and 90.5%, respectively and Group C (see Table 1) firms had emphasized more on the implementation of this practice (Me = 3 and Mo = 3) than Group A and Group B did (both Me = 1 and Mo = 1). This meant that Group C contractors *mostly* did analyse under different assumptions while Group A and Group B firms *rarely* did it. The one-way ANOVA significance value was 0.013, showing that the null hypothesis test was rejected and there was a difference in the application of this technique between the three groups. The larger firms tended to be more interested in this practice than smaller firms did.

Despite the high PA values, it should be noted that the mode and median regarding the usage of the capital budget evaluation techniques discussed above were not particularly high in the current study. The larger sized contractors had a higher percentage in adopting the capital budgeting evaluation techniques. It might be due to the fact that more sophisticated evaluation procedures required a large amount of human resources which sometimes might not be affordable by smaller firms. Hence, it deterred the use of these practices by smaller firms. Some of these techniques involve sophisticated evaluation procedures and require a large amount of human resources. Contractors need to undergo a series of thorough investigations, discussions and evaluations prior to each investment, which may discourage some contractors in HK from adopting a proper capital budget evaluation technique.

3.2. Investment appraisal techniques

Generally, after the cash flows have been estimated, firms evaluate their finance position to determine whether the investment should continue. Several techniques are available to evaluate investment proposals. The popular investment appraisal methods namely "payback period" (PBP), "average accounting rate of return" (AARR), "internal rate of return" (IRR), and "net present value" (NPV) were used [19]. Respondents were asked to rate their usage of the methods. As shown in Table 2, PBP was the most predominant investment appraisal technique used by practitioners (PA = 84.8%), and this is in line with many previous similar studies [20–22]. The AARR technique ranked second (PA = 82.6%). Despite NPV being argued as a popular technique for normative capital budgeting [8,22]), the overall PA of NPV and IRR were 71.7% and 65.2%, respectively.

The within group analysis reveals that there was not much differences for PBP and AARR. Large and medium

Table 2
Comparisons of usage of investment appraisal techniques

Appraisal techniques in use	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Payback period (PBP)	2.00 $n = 12$	2.00	2.00 $n = 13$	2.00	2.00 $n = 21$	1.00	2.00 $n = 46$	2.00	84.8
One-way ANOVA significance value = 0.470									
Average accounting rate of return (AARR)	1.00 $n = 12$	0.00	2.00 $n = 13$	2.00	2.00 $n = 21$	2.00	2.00 $n = 46$	2.00	82.6
One-way ANOVA significance value = 0.127									
Internal rate of return (IRR)	1.00 $n = 12$	0.00	1.00 $n = 13$	1.00	1.00 $n = 21$	0.00	1.00 $n = 46$	0.00	65.2
One-way ANOVA significance value = 0.712									
Net present value (NPV)	1.00 $n = 12$	2.00	1.00 $n = 13$	1.00	1.00 $n = 21$	0.00	1.00 $n = 46$	1.00	71.7
One-way ANOVA significance value = 0.771									

Number of cases = 46. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

contractors *often* used PBP and AARR for investment appraisal (Me = 2, Mo = 2), while usage by small firms for PB was also *often* (Me = 2, Mo = 2), but for AARR was *rare* (Me = 1, Mo = 0). Notwithstanding with the academic endorsement, data showed that both Group C and Group A firms *rarely* used (Me = 1, Mo = 0) the IRR method and Group B *rarely* to *often* used (Me = 1, Mo = 1) it as well. For NPV method, Group A and Group B firms *rarely* to *often* used (Me = 1, Mo = 2) it and Group C firms *rarely and not practised at all* (Me = 1, Mo = 0). The surveyed results of IRR and NPV usage by large firms are alarming. The puzzle is why the practitioners do not use these discounted cash flow (DCF) methods while academics are still pushing them? The one-way ANOVA significance values (0.470, 0.127, 0.771, 0.712 for PBP, AARR, NPV and IRR, respectively) had accepted the null hypothesis and indicate that there was no real difference between groups in the use of the surveyed investment appraisal techniques.

3.3. Risk appraisal and management science techniques

The techniques that managers might use for the evaluation of projects include risk analysis and management science techniques. There are several methods for analysing the riskiness of capital projects, and various management science techniques for evaluating or controlling projects. This section examines the usage of these methods by Hong Kong contractors.

3.4. Risk appraisal techniques

Every construction project is unique and each has different risk allocation, capital requirements, management teams, construction methods etc. All these factors could affect project cost, and thus it is necessary to identify and analyse the risks associated with capital budget. Horngren and Foster [23] advocate that the evaluation of projects should account for different risk characteristics through various risk analysis techniques, such as "shortening payback period", "raising required rate of return or discount rate", "probability analysis", "sensitivity analysis", and "beta analysis". The respondents were asked to rate their usage of these techniques.

Table 3 and Appendix I show the PA of various risk appraisal techniques. Their popularity, in descending order, is "shortening payback period" (PA = 80.4%), "raising required rate of return" (PA = 78.3%), "probability analysis" (PA = 71.7%), "sensitivity analysis" (PA = 69.6%), and "beta analysis" (PA = 43.5%). More than half of the respondents did not use "beta analysis" for risk analysis, which indicating the unpopularity of this technique in Hong Kong.

The median and mode of "raising required rate of return" was the highest (overall Me = 2; Mo = 2) indicating that this technique was *often* used by contractors in analysing risks. The usage of "shortening payback period" (Me = 2 for large; Me = 1 for medium; Me = 1 for small), "probability analysis" (Me = 1 for all groups), and "sensitivity analysis" (Me = 1 for all groups) was *rare*. "Beta analysis" had the lowest median and mode (Me = 0; Mo = 0 for all groups). The results exhibited the low utilization percentage of this technique in all the three groups. The pattern of usage frequency coincidently showed that most of them did not try this analysis technique.

According to the results of null hypothesis testing, all the one-way ANOVA significance values had accepted the hypothesis, which showed that there was no real difference between the groups in employing all these risk appraisal techniques.

3.5. Management science techniques

The results of Table 4 show that "Planning programming" (e.g., critical path method, PERT, etc.) was the most commonly used management science technique amongst the Hong Kong constructors (PA = 87%). A corporate

Table 3
Comparisons of usage of risk appraisal techniques

Method in use for analysis risk	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Shortening payback period	1.00 $n = 12$	1.00	1.00 $n = 13$	2.00	2.00 $n = 21$	2.00	1.50 $n = 46$	2.00	80.4
One-way ANOVA significance value = 0.545									
Raising required rate of return or discount rate	1.50 $n = 12$	2.00	2.00 $n = 13$	2.00	2.00 $n = 21$	2.00	2.00 $n = 46$	2.00	78.3
One-way ANOVA significance value = 0.428									
Probability analysis	1.00 $n = 12$	1.00	1.00 $n = 13$	0/2[a]	1.00 $n = 21$	2.00	1.00 $n = 46$	1.00	71.7
One-way ANOVA significance value = 0.243									
Sensitivity analysis	1.00 $n = 12$	1.00	1.00 $n = 13$	1.00	1.00 $n = 21$	0.00	1.00 $n = 46$	0/1[a]	69.6
One-way ANOVA significance value = 0.704									
Beta analysis	0.00 $n = 12$	0.00	0.00 $n = 13$	0.00	0.00 $n = 21$	0.00	0.00 $n = 46$	0.00	43.5
One-way ANOVA significance value = 0.419									

Number of cases = 46.
[a] Multiple modes exist, the smallest value is shown. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

Table 4
Comparisons of the usage of management science techniques

Management science techniques	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Mathematical programming	0.00 $n = 12$	0.00	1.00 $n = 13$	1.00	0.00 $n = 21$	0.00	1.00 $n = 46$	0.00	52.2
One-way ANOVA significance value = 0.314									
Computer simulation	0.00 $n = 12$	0.00	1.00 $n = 13$	1.00	1.00 $n = 21$	2.00	1.00 $n = 46$	0.00	58.7
One-way ANOVA significance value = 0.092									
Decision theory	1.00 $n = 12$	0/1[a]	1.00 $n = 13$	1.00	2.00 $n = 21$	0/2[a]	1.00 $n = 46$	2.00	73.9
One-way ANOVA significance value = 0.589									
Planning programming	2.00 $n = 12$	2.00	2.00 $n = 13$	2.00	3.00 $n = 21$	4.00	2.00 $n = 46$	2/4[a]	87.0
One-way ANOVA significance value = 0.008									

Number of cases = 46.
[a] Multiple modes exist, the smallest value is shown. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

cash flow can be obtained from the contract programme in the form of a critical path method, in which the early and late progress can be shown in conjunction with the resources. With the logic and sequence of construction being determined, a cumulative early-and-late progress envelope can be derived and converted into an early-and-late contract cash flow [24]. The above-mentioned procedures are the commonly used corporate cash flow forecasting methods. Many construction projects are very complex, and the cash flows of these projects are likely to be affected by the sequence of operations. The technique which ranked second was "decision theory" (PA = 73.9%), followed by "computer simulation" (PA = 58.7%) and "mathematical programming" (PA = 52.2%).

Regarding the extent of usage (see Table 4), a higher proportion of respondents in Group C *always* used "planning programming" as a management science technique (Mo = 4; Me = 3). On the contrary, Group A and Group B firms only *often* used "planning programming" (Me = 2; Mo = 2). The usage for decision theory is *often* for Group C (Me = 2; Mo = 2) and other two groups are *rare* (Me = 1; Mo = 1). For computer simulation and mathematical programming, Group B *rarely* used them (Me = 1; Mo = 1 in virtually all cases) and Group A did not try to use them (Me = 0; Mo = 0 in virtually all cases).

In view of the null hypothesis testing, only "planning programming" was statistically significant with the one-way ANOVA significance value of 0.008. The usage of the four management science techniques was influenced by the sizes of the firms.

3.6. Computer packages or financial modelling systems

Nowadays, computer software can assist many management techniques like sensitivity analysis and improve the efficiency of the analyzing process. Computer simulation packages are thought to be more realistic than theoretical calculations. The survey's results (see Appendix I) indicate that the use of computer packages is gaining popularity in Hong Kong contracting firms (PA = 61.5% for both Group B and Group C and PA = 41.7% for small), and over half of the contractors (PA = 56.5%) are using computer packages in their capital budgeting evaluation. It seemed that Group B and Group C contractors were more popular in employing computer packages than Group A contractors. This might be due to the fact that larger firms having a greater financial capability to afford expensive computer packages. Having said that, the data as per Table 5 show that a low proportion of firms applied computer modelling for capital budget evaluation (overall Me = 1 and Mo = 0).

The test of null hypothesis has a significance of 0.173 at 95% significance level, and thus the null hypothesis is accepted. There is no difference between groups in applying computer packages or financial modelling systems to investment analysis.

3.7. Anticipating inflation

It is necessary to consider and anticipate the inflation rate in capital budget planning. The four methods put forward in this survey were "consider inflation at risk analysis stage", "specify cash flows in constant processes and apply a real rate of return", "adjust for estimated changes in general inflation" and "specify different rates of inflation for all costs and revenues". From Table 6, we can see the most commonly used inflation anticipation methods were "consider inflation at risk analysis stage" (PA = 78.3%) and followed by "specify cash flows in constant processes and apply a real rate of return", "adjust for estimated changes in general inflation" (both PA = 76.1%) and "specify different rates of inflation for all costs and revenues" (PA = 65.2%). For Group C firms *always* used "consider inflation at risk analysis stage" (Me = 3 and Mo = 4). For Group A firms *rarely* used these four techniques for

Table 5
Comparisons of the usage of computer packages or financial modelling systems

	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Firms use of computer package/financial modelling	0.00 *n* = 12	0.00	1.00 *n* = 13	0.00	1.00 *n* = 21	0.00	1.00 *n* = 46	0.00	56.5
One-way ANOVA significance value = 0.173									

Number of cases = 46. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

Table 6
Comparisons of the usage of methods for anticipating inflation

Firms which	Size of firm								
	Group A		Group B		Group C		Overall		
	Me	Mo	Me	Mo	Me	Mo	Me	Mo	PA (%)
Consider inflation at risk analysis/sensitivity stage	1.00 *n* = 12	0/1[a]	1.00 *n* = 13	1.00	3.00 *n* = 21	4.00	2.00 *n* = 46	1.00	78.3
One-way ANOVA significance value = 0.000									
Specify cash flows in constant process and apply a real rate of return	1.00 *n* = 12	0/1[a]	1.00 *n* = 13	2.00	2.00 *n* = 21	2.00	1.50 *n* = 46	2.00	76.1
One-way ANOVA significance value = 0.098									
Adjust for estimated changes in general inflation	1.00 *n* = 12	1.00	1.00 *n* = 13	2.00	2.00 *n* = 21	2.00	2.00 *n* = 46	2.00	76.1
One-way ANOVA significance value = 0.098									
Specify different rates of inflation for all costs and revenues	1.00 *n* = 12	1.00	1.00 *n* = 13	0/1[a]	2.00 *n* = 21	2.00	1.00 *n* = 46	0.00	65.2
One-way ANOVA significance value = 0.381									

Number of cases = 46.
[a] Multiple modes exist, the smallest value is shown. A five-point scale has been adopted. 0 = no, 1 = rare, 2 = often, 3 = mostly and 4 = always.

the forecast of inflation (Me = 1 and Mo = 1). The null hypothesis was rejected for the method of "consider inflation at risk analysis stage" (the one-way ANOVA significance value was 0). There was a difference between the groups in applying this method.

4. Discussion–comparison of 1994, 1999 and 2004 surveys (Group C)

The results of the current study was compared with similar surveys conducted in 1994 [15,16] to determine if the capital budgeting evaluation practices as adopted by the Hong Kong contractors (Group C) had been consistent over the past 10 years.

4.1. Capital budget evaluation

A comparison of the PA's reveals that there was a general increase in the popularity of various capital budget evaluation techniques from 1994 to 2004 (see Table 7), except for "searching and screening of alternatives before accepting projects" (PA dropped from 96.6% in 1994 to 90.5% in 2004). The most remarkable increase was the "formal financial evaluation" (from 86.7% in 1994 to 95.2% in 2004). When examining the mode and median, rising trends are noted in the extent of usages in all techniques. There was a significant drop in the use of "formal risk analysis" (from Mo = 4 in 1994 to Mo = 1 in 1999), which bounced back in 2004.

4.2. Investment appraisal techniques

The scores of PA for the four investment appraisal techniques in the 2004 study were dropped compared with those of the 1994 and 1999 studies. The drop of IRR was significant from PA = 89.7% (1999) to PA = 57.1% (2004). In terms of the extent of usage, there was a decrease in usage of all four investment appraisal techniques between 1999 and 2004 and even for PBP (from Mo = 2 in 1999 to Mo = 1 in 2004). This implies that lesser contracting firms in Hong Kong prefer to use sophisticated techniques such as IRR and NPV, albeit the concept of DCF is overwhelmingly accepted by the academic circles. Despite the general drop of the usage, PBP technique and AARR are still employed by the Hong Kong contractors. In fact, PBP does have some disadvantages such as cash flows outside the PBP are ignored when appraising an individual project [25].

4.3. Risk analysis

When comparing the results of the 1994, 1999 and 2004 surveys, the popularity of "shortening payback period" was still the highest, albeit the PA dropped from 86.2% (1999) to 76.2% (2004). The "probability analysis" also dropped slightly from 81.5% (1999) to 76.2% (2004). The popularity (PA) of "raising required rate of return" was slightly raised from 74.2% (1999) to 76.2% (2004). However, the PA of the "sensitivity analysis" was significantly dropped from 81.5% (1999) to PV = 61.9% (2004). The "beta analysis" was unpopular.

4.4. Management science techniques

The only technique which had a slight increase in its popularity was "decision theory" (from PA = 51.9% in 1999 to PA = 66.7% in 2004). The popularity of the other three techniques remained more or less the same. The high PA of "planning programming" indicated that the Hong Kong contractors were embracing the values of management science techniques. In terms of the extent of usage, apart from decision theory, there was no particular improvement or decline in the use of different management science techniques between 1994, 1999 and 2004.

4.5. Anticipation inflation

From Table 7, the popularities of the four methods put forward in this survey were dropped. The PA of "adjust for estimated changes in general inflation" dropped from 100% (1999) to 76.2% (2004) and the PA of "specify different rates of inflation for all costs and revenues" also dropped from 88.9% (1999) to 66.7% (2004). The PA of "specify cash flows in constant processes and apply a real rate of return" was also dropped but the median and mode remained the same. However, the mode and median of "consider inflation at risk analysis stage" increased significantly from Mo = 1 and Me = 2 in 1999 to Mo = 4 and Me = 3 in 2004 despite the fact that PA dropped from 92.9% to 85.7% correspondingly. It is the most commonly used inflation anticipation method amongst the Hong Kong building contractors.

4.6. Computer packages

The comparison's result (see Table 7) indicates that the use of computer packages is gaining popularity in Hong Kong contracting firms (Overall PA = 41.4% in 1994, PA = 34.5% in 1999 to PA = 61.9% in 2004). The fact that over half of the contractors are using computer packages in their capital budgeting evaluation indicates that Hong Kong contractors are also relying on information technology.

5. Discriminant function analysis

To further investigate the practices of capital budget evaluation, a discriminant function analysis (DFA) was employed to classify the firms in accordance with a set of variables that best represent their characteristics. DFA is a technique for deciding as to which category a case (a contractor in this case) is most likely to fall. The "size of firm"

Table 7
Comparisons of 1994, 1999 and 2004 surveys (Group C)

Firms have	Year of study								
	1994		1999		2004		PA (%)		
	Mo	Me	Mo	Me	Mo	Me	1994	1999	2004
Capital budget evaluation									
Searching and screening of alternatives before accepting projects	1.00 $n = 29$	2.00	1.00 $n = 27$	2.00	4.00 $n = 21$	3.00	96.6	92.6	90.5
Formal financial evaluation	4.00 $n = 30$	3.00	3.00 $n = 27$	2.00	4.00 $n = 21$	3.00	86.7	88.9	95.2
Formal analysis of risk	4.00 $n = 29$	2.00	1.00 $n = 27$	2.00	4.00 $n = 21$	3.00	96.6	92.6	95.2
Analysis under different assumptions (best/worst estimates)	2.00 $n = 27$	2.00	2.00 $n = 27$	2.00	3.00 $n = 21$	3.00	75.9	88.5	90.5
Investment appraisal									
Payback period (PBP)	3.00 $n = 30$	3.00	2.00 $n = 28$	2.00	1.00 $n = 21$	2.00	86.7	89.3	81
Average accounting rate of return (AARR)	2.00 $n = 29$	2.00	2.00 $n = 29$	2.00	2.00 $n = 21$	2.00	86.2	93.1	81
Internal rate of return (IRR)	2.00 $n = 29$	2.00	1.00 $n = 27$	1.00	0.00 $n = 21$	1.00	82.8	89.7	57.1
Net present value (NPV)	2.00 $n = 29$	2.00	1.00 $n = 27$	1.00	0.00 $n = 21$	1.00	75.9	74.1	66.7
Risk analysis									
Shortening payback period	2.00 $n = 28$	2.00	2.00 $n = 29$	2.00	2.00 $n = 21$	2.00	82.1	86.2	76.2
Raising required rate of return or discount rate	3.00 $n = 29$	2.00	1.00 $n = 29$	1.00	2.00 $n = 21$	2.00	86.2	74.1	76.2
Probability analysis	1.00 $n = 27$	1.00	1.00 $n = 29$	1.00	2.00 $n = 21$	1.00	74.1	81.5	76.2
Sensitivity analysis	1.00 $n = 27$	1.00	1.00 $n = 29$	1.00	0.00 $n = 21$	1.00	77.8	81.5	61.9
Beta analysis	0.00 $n = 26$	1.00	0.00 $n = 29$	0.00	0.00 $n = 21$	0.00	57.7	48.1	47.6
Management science									
Mathematical programming	0.00 $n = 29$	1.00	1.00 $n = 29$	1.00	0.00 $n = 21$	0.00	72.4	66.7	66.7
Computer simulation	0.00 $n = 29$	1.00	0.00 $n = 29$	1.00	2.00 $n = 21$	1.00	65.5	60.7	61.9
Decision theory	0.00 $n = 30$	2.00	0.00 $n = 29$	1.00	0.00/2.00 $n = 21$	2.00	66.7	51.9	66.7
Planning programming	3.00 $n = 27$	3.00	4.00 $n = 29$	3.00	4.00 $n = 21$	3.00	92.6	96.3	90.5
Anticipation of inflation									
Consider inflation at risk analysis/sensitivity stage	3.00 $n = 28$	2.00	1.00 $n = 29$	2.00	4.00 $n = 21$	3.00	82.1	92.9	85.7
Specify cash flows in constant process and apply a real rate of return	3.00 $n = 29$	3.00	2.00 $n = 29$	2.00	2.00 $n = 21$	2.00	96.6	89.3	85.7
Adjust for estimated changes in general inflation	3.00 $n = 30$	3.00	2.00 $n = 29$	2.00	2.00 $n = 21$	2.00	96.7	100	76.2
Specify different rates of inflation for all costs and revenues	1.00 $n = 29$	1.00	1.00 $n = 29$	2.00	2.00 $n = 21$	2.00	79.3	88.9	66.7
Computer packages									
Firms use of computer package/financial modelling	0.00 $n = 29$	0.00	0.00 $n = 29$	0.00	0.00 $n = 21$	1.00	41.4	34.5	61.9

was used as a variable for initial grouping, and Groups A, B and C were represented as Groups 1, 2 and 3, respectively, in this analysis. The variables on capital budgeting evaluation as examined in the above analyses were used for the DFA.

The DFA generated two sets of standardized discriminant function coefficients (λ; function 1 and function 2) (Table 8). Based on these two functions, it is possible to compute the discriminant scores for each case. As shown in Table 8, for function 1, the variable having the greatest

Table 8
Standardized canonical discriminant function coefficients

Variable criteria (θ)	Discriminant function coefficients (λ)	
	Function 1	Function 2
Searching and screening of alternatives before accepting projects	−1.034	0.695
Formal financial evaluation	0.394	0.119
Formal analysis of risk	−0.585	0.517
Analysis under different assumptions (best/worst estimate)	1.138	−0.815
Payback period	−0.212	−0.872
Average accounting rate of return	−0.754	1.009
Internal rate of return	0.068	0.197
Net present value	−0.530	−0.198
Shortening payback period	0.002	0.100
Raising required rate of return or discount rate	0.355	−0.322
Probability analysis	−0.683	0.294
Sensitivity analysis	−1.039	0.294
Beta analysis	0.829	−0.106
Mathematical programming	−1.464	0.341
Computer simulation	0.650	−0.198
Decision theory	−0.818	0.123
Planning programme	1.203	−0.579
Consider inflation at risk analysis/sensitivity stage	1.010	0.177
Specify cash flows in constant process and apply a real rate of return	0.907	−0.286
Adjust for estimated changes in general inflation	0.719	0.230
Specify different rates of inflation for all costs and revenues	−0.232	−0.059
Computer package or financial modelling system used for investment analysis	0.981	−0.161

positive impact on capital budget evaluation was "planning programming" (with an absolute of 1.203). This was followed by "best/worst estimates" (1.138), and "consider inflation at risk analysis" (1.010).

The group centroids (i.e., group means) of the three groups are summarised in Table 9. For function 1, Groups 1 and 2 had means of −1.358 and −1.969, respectively, while the mean for Group 3 was +1.995, indicating that the characteristics of Group 3 were opposite to Groups 1 and 2. The attitudes of Group 3 contractors on the usage of "planning programming", "best/worst estimates", "consider inflation at risk analysis", etc. were distinctive to Groups 1 and 2 contractors. For function 2, the mean for Group 1 was in a negative territory (−1.137), while the means for Groups 2 and 3 were positive (+0.888 and +0.100, respectively). A territorial map showing the centroid and borders of each Group within Functions 1 and 2 is shown as per Fig. 1.

The DFA also generated the classification results. This includes a predicted group membership, which represents an expected classification of the different cases. The measure is evaluated by comparing the observed misclassification rate to that expected by chance alone. The percentage of cases correctly classified can be regarded as a measure of effectiveness to the discriminant function. In this study, 89.1% of all cases were correctly classified, i.e., only 10.9% of the cases (overall) were misclassified (see Table 10). The group breakdowns indicated that 83.3% of cases in Group 1; 92.3% of cases in Group 2; and 90.5% of cases in Group 3 were correctly classified and predicted.

Since the performance of a building contractor's financial management may not be easily represented by its size, the purpose of DFA is to identify a set of variables (Table 8) which could help scrutinizing the performance of firm in

Table 9
Canonical discriminant functions evaluated at group centroids (group means)

Group	Discriminant score	
	Function 1	Function 2
1	−1.358	−1.137
2	−1.969	0.888
3	1.995	0.100

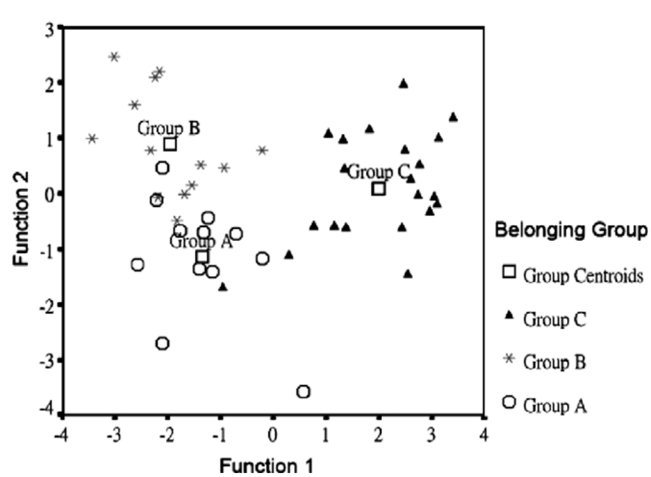

Fig. 1. Scatter plot of canonical discriminant functions for all groups.

Table 10
Table of classification results from the discriminant function analysis

Actual group (classified by size of firm)		No. of cases	Predicted group membership		
			1	2	3
Group A (<20 M)	1	12	10	2	0
			83.3%	16.7%	0.0%
Group B (<50 M)	2	13	1	12	0
			7.7%	92.3%	0.0%
Group C (>50 M)	3	21	2	0	19
			9.5%	0.0%	90.5%

Percentage of "grouped" cases correctly classified: 89.1%.

capital budgeting. The variables used in this study are the primary factors involved in managing capital budgets, and these variables are highly correlated with the firms' competence in managing their finance. Based on this analysis, contracting firms can be classified in accordance with their level of performance in managing the capital budgeting process.

6. Conclusion

This paper reports a study on the capital budgeting evaluation techniques used by building contractors in Hong Kong. The majority of firms studied use some forms of evaluation techniques for projects' finance. The most popular capital budget evaluation techniques were "formal financial evaluation" and "formal risk analysis". Despite the drop in PA, the result was consistent with the finding in 1999 as the PBP and AARR remained as the most popular investment appraisal techniques over the years. The findings showed that NPV and IRR were not the predominant techniques for capital budgeting as claimed by literatures.

Risk analysis is very important to decision-making as risks may exist in any prospective investments. The most commonly used techniques were still the "shortening payback period" and "raising required rate of return" longitudinally.

Owing to the rapid development of information technology, many management science techniques in capital budgeting have been computerised. The technique of "planning programming" was overwhelmingly practised by the Hong Kong building contractors. Although computerisation was not particularly popular in Hong Kong, contractors started to use computer packages in financial modelling in making sound investment decisions. The technique of anticipating inflation i.e., "consider inflation at risk analysis" was *always* used.

A comparison of the 1994, 1999 and current studies reveals that there is a general increase in popularity in the usage of capital budget evaluation techniques over the years. The most remarkable increase in popularity included the "formal financial evaluation". PBP and AARR remained as the popular investment appraisal techniques. Despite the conservative nature of the Hong Kong construction industry, construction companies started to use computer packages in capital budgeting evaluation process. The longitudinal survey inhibits any generalisation of findings other than those of the construction finance practices in Hong Kong contractors. However, the longitudinal survey helps to see the changes of the practices over the years and ensure that the results can accurately reflect the perceptions of respondents in Hong Kong. This makes the work valuable in terms of adding to the knowledge of contemporary practice and identifying some issues which may shape and direct its future. For example, why less and less contractors use IRR?

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Appendix I. Positive attitudes of respondents for variables (2004)

Variable	Group A, % (<20 M)	Group B, % (<50 M)	Group C, % (>50 M)	Overall, %
Searching and screening of alternatives before accepting projects	75.0	100.0	90.5	89.1
Formal financial evaluation	91.7	100.0	95.2	95.7
Formal analysis of risk	83.3	92.3	95.2	91.3
Analysis under different assumptions (best/worst estimate)	75.0	92.3	90.5	87.0
Payback period	83.3	92.3	81.0	84.8
Average accounting rate of return	66.7	100.0	81.0	82.6
Internal rate of return	58.3	84.6	57.1	65.2
Net present value	66.7	84.6	66.7	71.7
Shortening payback period	83.3	84.6	76.2	80.4
Raising required rate of return or discount rate	75.0	84.6	76.2	78.3

Appendix I (*continued*)

Variable	Group A, % (<20 M)	Group B, % (<50 M)	Group C, % (>50 M)	Overall, %
Probability analysis	66.7	69.2	76.2	71.7
Sensitivity analysis	75	76.9	61.9	69.6
Beta analysis	33.3	46.2	47.6	43.5
Mathematical programming	41.7	76.9	66.7	52.2
Computer simulation	41.7	69.2	61.9	58.7
Decision theory	66.7	92.3	66.7	73.9
Planning programme	83.3	84.6	90.5	87.0
Consider inflation at risk analysis/ sensitivity stage	58.3	84.6	85.7	78.3
Specify cash flows in constant process and apply a real rate of return	66.7	69.2	85.7	76.1
Adjust for estimated changes in general inflation	75.0	76.9	76.2	76.1
Specify different rates of inflation for all costs and revenues	66.7	61.5	66.7	65.2
Computer package or financial modelling system used for investment analysis	41.7	61.5	61.5	56.50

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