Strojniški vestnik - Journal of Mechanical Engineering 53(2007)9, 569-581
UDK - UDC 330.322:621
Strokovni članek - Speciality paper (1.04)

Analiza poznavanja in uporabe metod presoje investicijskih projektov v strojništvu

Analysis of the Knowledge and the Use of Investment Project Evaluation Methods in the Field of Mechanical Engineering

Igor Pšunder - Nadja Ferlan
(Fakulteta za gradbeništvo, Maribor)

Raziskave, ki so jih opravili v ZDA in Veliki Britaniji, nakazujejo, da se je z razmahom osebnih računalnikov in elektronskih preglednic razširila tudi uporaba metod presoje investicijskih projektov, ki temeljijo na razobrestovanju (diskontiranju) denarnih tokov. Vendar teoretična spoznanja o teh metodah razlagajo, da metode vsebujejo veliko omejitev, katerih nepoznavanje lahko vodi do napačnih rezultatov ter tudi do napačnih sklepov presoj investicij in investicijskih projektov.

V pričujočem prispevku prikazujemo rezultate raziskave, ki smo jo opravili med projektnimi vodji v slovenskih podjetjih. V raziskavi smo preučevali lastna mnenja anketirancev o uporabi metod presoje investicijskih projektov in poznavanju njihovih pomanjkljivosti, pri čemer smo v raziskavo vključili tako metode, ki temeljijo na razobrestovanju denarnih tokov, kakor tudi enoobdobne metode presoje investicij in investicijskih projektov. V analizi rezultatov smo ločeno obravnavali stanje na področju strojništva ter ga primerjali s preostalimi tehničnimi ter drugimi (netehničnimi) vedami.

Z raziskavo smo ugotovili, da strokovnjaki, ki se ukvarjajo s presojo investicijskih projektov in imajo izobrazbo s področja strojništva, pogosteje uporabljajo metode presoje investicijskih projektov, ki temeljijo na razobrestovanju denarnih tokov, kakor strokovnjaki drugih tehničnih smeri, vendar približno enako pogosto kakor strokovnjaki ekonomskih in sorodnih smeri. Ugotoviti je tudi mogoče, da strokovnjaki strojniške smeri izobrazbe nadpovprečno dobro poznajo pomanjkljivosti metod presoje investicijskih projektov, vendar jih kljub temu le polovica pozna večkratno notranjo (interno) donosnost, ki je v teoriji najpogosteje opisovana pomanjkljivost metode notranje donosnosti in le slabi dve tretjini popačenost rezultata zaradi neupoštevanja časovne zapadlosti plačil pri metodi časa vračila sredstev.

(Ključne besede: strojništvo, investicijski projekti, evalvacije, pretok denarja)

Research done in the USA and the UK has shown that, with the increased use of computers and electronic spreadsheets, the use of these investment project evaluation methods that are based on discounted cash flow has increased. However, theoretical findings about these methods show that they have numerous limitations, and ignorance of these limitations can lead to false results as well as false conclusions about investments and investment projects.

This paper shows the research results acquired from project managers of Slovene companies. Their personal opinions about investment project evaluation methods and knowledge of the methods' faults were studied in the research. Methods based on discounted cash flow as well as single-period methods of investment evaluation and investment projects were used. During the analysis of the results the situation in the field of mechanical engineering was treated separately and compared with other technical and non-technical sciences.

Research has shown that experts dealing with investment project evaluation who have a degree in the field of mechanical engineering more often use discounted cash-flow methods for investment project evaluation than do experts of other technical sciences, but approximately as often as experts in economics and similar sciences. We were able to conclude that experts with education in mechanical engineering are more than usually familiar with the flaws in investment project evaluation methods, but at the same time, only half of them know the multiple internal rate of return, which is the most commonly mentioned fault of

the internal rate of return method. Only one-third of experts are familiar with result deformation due to a disregard for the time component of payments in the payback period method.

(Keywords: mechanical engineering, investment projects, evaluation, cash flow)

0 UVOD

Raziskave, ki so jih opravili konec preteklega stoletja, nakazujejo, da se je z razmahom osebnih računalnikov razširila uporaba metod presoje investicij in projektov, ki temeljijo na razobrestovanju (diskontiranju) denarnih tokov, med katerimi velja izpostaviti predvsem metodo notranje donosnosti (IRR) in metodo čiste sedanje vrednosti (NPV). Klammer in Walker [1] navajata, da se je v ZDA "uporaba razobrestovanja povečala z 19 odstotkov leta 1960 do 57 odstotkov leta 1970", v raziskavi pa nadalje ugotavljata, da se je uporaba razobrestovanja v letu 1980 zvišala do 75 odstotkov pri projektih, ki zadevajo razširjanje sedanjih zmogljivosti. Podobno piše Pike [2] za Veliko Britanijo, in ugotavlja, da se je uporaba metod notranje donosnosti ali čiste sedanje vrednosti v velikih podjetjih v Veliki Britaniji med leti 1975 in 1986 zvišala z 58 na 84 odstotkov, uporaba izključno metode notranje donosnosti s 44 na 75 odstotkov, uporaba izključno metode čiste sedanje vrednosti pa z 32 na 68 odstotkov. Zanimivo je, da Ho in Pike [3] v raziskavi iz leta 1996, v kateri preučujeta informacijski sistem presoje investicij (ISPI - CABIS), ugotavljata precej podobne deleže in pišeta, da "odgovori kažejo, da so podjetja najbolje seznanjena z metodami razobrestovanja, na primer čisto sedanjo vrednostjo in notranjo donosnostjo: 74,8 % uporabnikov CABIS-a jih redno uporablja". Na podlagi rezultatov pričujočih raziskav lahko povzamemo, da ni mogoče sklepati o bistvenih spremembah v pogostosti uporabe sodobnih metod presojanja investicij in investicijskih projektov po osemdesetih letih prejšnjega stoletja, obenem pa Puxty in Dodds [4], na podlagi rezultatov raziskave McIntyrea in Coulthursta [5], opozarjata na velike razlike v uporabi metod razobrestovanja denarnih tokov med velikimi in srednje velikimi podjetji.

Omenjene raziskave so odprle vprašanje o uporabi metod evalvacije projektov v Sloveniji, kamor – zaradi relativne majhnosti podjetij – rezultati navedenih raziskav, ki so jih opravili med velikimi podjetji, niso neposredno prenosljivi. Pri raziskavi smo poseben poudarek namenili strokovnjakom s področja strojništva ter podjetjem, katerih pretežna dejavnost je strojništvo, saj so

0 INTRODUCTION

Research done at the end of last century shows that with the increased use of computers, the use of discounted cash-flow methods for investments and projects' evaluation has increased. Among these methods, the internal rate of return method (IRR) and the net present value method (NPV) were the most common. Klammer and Walker [1] state that in the USA, "the use of discounting grew from 19 % in 1960 to 57 % in 1970", and their research establishes that the use of discounting in 1980 grew to 75 % in projects dealing with the expansion of existing capacities. Similar conclusions for the UK are drawn by Pike [2], who established that the use of the internal rate of return method or net present value method in large UK companies grew from 58 % to 84 % between 1975 and 1986; the exclusive use of the internal rate of return method grew from 44 % to 75 % and the exclusive use of net present value grew from 32 % to 68 %. It is interesting that Ho and Pike [3] in their 1996 analyses of CABIS (capital budgeting information systems) established very similar percentages, so they concluded that "the summary of responses shows that firms are most familiar with discounting methods such as net present value/internal rate of return: 74.8 % of CABIS users always use it". Based on the results of these research projects we can establish that it is not possible to conclude that there have been any essential changes in the frequency of use of investment evaluation methods and investment project evaluation methods since the 1980s. At the same time Puxty and Dodds [4], based on the research results of McIntyre and Coulthurst [5], stress the major differences in the use of discounting cash flow methods between large and medium-sized companies.

The above-mentioned research has raised questions about the use of project evaluation methods in Slovenia, where – owing to the relatively small size of Slovene companies – the results of such research conducted on large companies are not directly transferable. Throughout our research, special stress was placed on experts with education in mechanical engineering and companies who deal mostly with mechanical

projekti na področju strojništva pogosto investicijske narave, njihov obseg razmeroma velik, narava denarnih tokov pa zaradi občasnih večjih vzdrževalnih del spremenljiva, tako da lahko metode razobrestovanja denarnih tokov, predvsem metoda notranje donosnosti, izražajo neverodostojne rezultate.

V raziskavi smo obravnavali enoobdobne in večobdobne metode oziroma metode razobrestovanja denarnih tokov. Med enoobdobnimi smo zajeli metodo časa vračila sredstev in metodo tekoče donosnosti, pri metodah dikontiranja denarnih tokov pa smo se omejili na metodo čiste sedanje vrednosti, indeks čiste sedanje vrednosti, metodo notranje donosnosti in metodo prilagojene (modificirane) notranje donosnosti. Pri analizi poznavanja pomanjkljivosti smo se osredotočili na metodo časa vračila sredstev med enoobdobnimi metodami in na metodo notranje donosnosti med metodami razobrestovanja denarnih tokov, saj tema dvema avtorji pripisujejo največ pomanjkljivosti.

Na pasti navidezne preprostosti uporabe in pomanjkljivosti razumevanja metod presoje investicijskih projektov opozarjajo številni avtorji; Lumby in Jones [6] se osredotočata predvsem na pomanjkljivosti metode notranje donosnosti, ki izvirajo iz njene polinomske zasnove:

- na večkratno notranjo donosnost,
- na neobstoječo notranjo donosnost in
- v povezavi z metodo čiste sedanje vrednosti tudi neobstoječo pozitivno čisto sedanjo vrednost ob hkratni enolični notranji donosnosti.

Vse naštete pomanjkljivosti se, če se pojavijo, izrazijo v napačnih ali vsaj v neenoličnih rezultatih (napovedih), Holmes [7] pa še dodatno opozarja na problem možnosti nasprotnih rezultatov (napovedi) metod notranje donosnosti in čiste sedanje vrednosti, kadar metode uporabljamo pri primerjanju dveh vzajemno izključujočih se projektov. Mauboussin [8] izpostavlja še napake, ki izvirajo iz neustreznih vstopnih podatkov, ki jih analitiki uporabljajo pri presoji investicij, kakor na primer prekratko predvideno investicijsko obzorje ali neustrezni stroški kapitala, vendar te napake presegajo področje raziskave, ki smo jo opravljali, zato jih posebej ne bomo obravnavali.

Iz prej omenjenih raziskav je mogoče razbrati, da metoda časa vračila sredstev sodi med najbolj uporabljane. Tudi pri tej metodi pa se lahko porajajo napačne razlage rezultatov, ki izvirajo iz njene matematične zasnove. V prvi vrsti gre med pomanjkljivostmi poudariti značilnost vseh

engineering, because projects in the field of mechanical engineering are often investment-based, their scope is relatively wide, and the nature of cash flow changes owing to occasional maintenance work. Therefore, discounting cash-flow methods, especially the internal rate of return method, could produce non-credible results.

We covered single-period as well as multi-period or discounted cash-flow methods in the study. Among single-period methods, we dealt with the payback-period method and the accounting rate of return method, and among discounted cash-flow methods we dealt with the net present value method, the net present value index, the internal rate of return method and the modified internal rate of return method. When analyzing the deficiencies of the methods, we focused on the payback period method among single-period methods and on the internal rate of return method among discounted cash-flow methods, since authors ascribe the most deficiencies to these methods.

Numerous authors point out the misleading simplicity in the use of investment project evaluation methods and lack of understanding of their use; Lumby and Jones [6] focus mainly on flaws in the internal rate of return method that result from its polynomial foundation:

- on multiple internal rate of return,
- on non-existent internal rate of return,
- in connection with the net present value method, also a non-existent positive net present value along with an existent internal rate of return.

All these faults are, if they appear, expressed in false or at least inexact results (indications). Holmes [7] discusses the additional problem of the potential for conflicting results (indications) when using methods of internal rate of return and net present value when these methods are used when comparing two mutually exclusive projects. Mauboussin [8] stresses the faults that result from inadequate incoming data used by analysts in investment evaluations, such as the forecast horizon being anticipated too short or inadequate capital costs. Since these faults exceed the scope of our research, we have not dealt with them in detail.

From the aforementioned research we can conclude that the payback period method belongs among the most commonly used methods. The false interpretations of results that appear with this method arise form its mathematical structure. In the first place we should point out a characteristic

enoobdobnih metod, da ne upoštevajo različnega časovnega dospevanja plačil ter da temeljijo na izmišljenem povprečnem donosu reprezentativnega obdobja. Vir [9] piše, da je mogoče zanesljivo uporabljati metodo časa vračila sredstev šele ob upoštevanju modela tržnega ravnovesja.

Zaradi pomanjkljivosti metod presoje investicijskih projektov, katerih posledica je lahko tudi napačna presoja in odločanje, smo v raziskavi posebno poglavje namenili poznavanju teh pomanjkljivosti.

1 PODROČJE RAZISKAVE IN METODOLOGIJA

Raziskovalni okvir

Namen raziskave, izvedli smo jo med strokovnjaki, ki se ukvarjajo z investicijami v slovenskih podjetjih, je bil ugotoviti raven poznavanja in uporabe metod presoje investicij, pri čemer se pri razlagi rezultatov osredotočamo na tiste, ki zadevajo strokovnjake s področja strojništva oziroma na podjetja, katerih pretežna dejavnost je strojništvo. Poznavanje in uporabo metod presoje investicij med strokovnjaki s področja strojništva oziroma med podjetji, katerih pretežna dejavnost je strojništvo, smo primerjali s poznavanjem in uporabo istih metod med strokovnjaki preostalih tehniških, naravoslovno-matematičnih ter drugih ved. Poleg poznavanja in (pogostosti) uporabe metod evalvacije projektov so nas zanimale tudi odvisnosti med smerjo izobrazbe in poznavanjem metod presoje investicijskih projektov ter med stopnjo izobrazbe in poznavanjem ter uporabo obravnavanih metod. Na podlagi primerjave ravni znanja med strokovnjaki s področja strojništva in drugih sorodnih ved ter širše smo sklepali o izdatnosti izobraževanja na posameznih strokovnih področjih.

Vzorec in zbiranje podatkov

Podatke smo zbirali z anketiranjem. Vzorec je obsegal 44 podjetij, ki so pokrajinsko pokrivala vso Slovenijo. Strojniško izobrazbo je imelo 18,2 % vprašanih in 11,4 % jih je bilo zaposlenih v podjetjih, katerih pretežna dejavnost je strojništvo. Izmed anketirancev s strojniško izobrazbo jih je bila večina (37,5 %) zaposlenih v podjetjih, katerih pretežna dejavnost je strojništvo, ostali pa v gradbeništvu – okrog 25 % – energetiki in

of all single-period methods: that they do not consider differences in payment maturities and that they are based on the fictive average income for a representative period. Source [9] says that the payback period method can be reliable only when we consider the market equilibrium model.

Owing to the flaws in the project investment evaluation methods, which can also lead to false judgements and decisions, one part of our research concentrates on the knowledge about those flaws.

1 RESEARCH AREA AND METHODOLOGY

Research frame

The goal of the research conducted among experts dealing with investments in Slovene companies was to establish the level of knowledge and the use of investment evaluation methods while, during the interpretation of results, focusing on those results which concern experts from the field of mechanical engineering and companies whose main activity is mechanical engineering. We compared the knowledge and use of investment evaluation methods among experts in the field of mechanical engineering and among companies whose main activity is mechanical engineering with the knowledge and use of the same methods among experts in technical, natural, mathematical and other sciences. Besides the knowledge and (frequency of) use of the project evaluation methods, we were also interested in any relation between the field of education and knowledge of investment project evaluation methods, and between the level of education and the use of the methods in question. Based on a comparison between the level of knowledge of experts in the field of mechanical engineering and other related and also non-related sciences, we reached conclusions about the effectiveness of the education in a particular field.

Sample and data gathering

We gathered data using questionnaires. The sample included 44 companies, representing all the Slovene regions. A total of 18.2 % of people involved in the research have education in the field of mechanical engineering and 11.4 % work in companies whose main activity is mechanical engineering. Among people with an education in mechanical engineering, most (37.5 %) work in companies whose main activity is mechanical engineering; the rest (around 25 %) work in construction, while the percentage of engineers working

komunali ter metalurgiji, kjer so bili deleži okrog desetinski.

Dobri dve tretjini (34,1 %) preostalih anketiranih je imelo izobrazbo drugih tehničnih smeri (gradbeniška, elektrotehniška), še dobri dve odstotni točki več (36,4 %) pa je bilo strokovnjakov ekonomske ali družboslovne izobrazbe. Okrog desetina je bilo anketirancev z drugih področij (matematika, kemija in geodezija).

Anketni vprašalnik je bil sestavljen v obliki uporabe spleta. Udeleženci so bili povabljeni k odgovarjanju po elektronski pošti. Odziv je bil 11,7 odstoten.

Vprašalnik je bil sestavljen iz treh sklopov. V prvem smo poizvedovali po dejstvih o izpolnjevalcu (starost, spol, stopnja in smer izobrazbe, delovno mesto, dejavnost in velikost podjetja ipd.). V drugem delu smo poizvedovali o mnenjih anketirancev o lastnem poznavanju in pogostosti uporabe enoobdobnih metod presoje investicijskih projektov, h katerim smo uvrstili dve, ki ne upoštevata časovne vrednosti denarja (čas vračila sredstev, tekoča donosnost), ter o poznavanju in pogostosti uporabe metod razobrestovanja denarnih tokov, torej tistih, ki časovno razsežnost denarja upoštevajo, med katerimi smo se omejili na metodo čiste sedanje vrednosti, metodo notranje donosnosti, indeks čiste sedanje vrednosti in metodo prirejene notranje donosnosti. V zadnjem sklopu smo povpraševali o mnenjih anketirancev o lastnem poznavanju pomanjkljivosti metod presoje investicijskih projektov. Pri tem smo se med enoobdobnimi metodami omejili na pomanjkljivosti metode časa vračila sredstev, med metodami razobrestovanja denarnih tokov pa na metodo notranje donosnosti.

Analiza podatkov

Z anketo pridobljene podatke smo sistematizirali in statistično analizirali. Izračunali smo odvisnosti poznavanja metod in pomanjkljivosti le-teh od posameznih spremenljivk. Za analizo povezanosti smo uporabljali kazalce negotovosti (osnovni kazalnik χ^2, Pearsonov koeficient negotovosti in popravek negotovosti).

2 REZULTATI

Analiza uporabe metod presoje investicij je v skladu s pričakovanji pokazala, da večina podjetij pri svojem delu uporablja tako metode razobrestovanja denarnih tokov kakor enoobdobne

in the field of energetics, environmental engineering and metallurgy is around 10 %.

Among the respondents to the questionnaire, over two-thirds (34.1 %) had an education in other technical sciences (construction, electrical engineering), and 36.4 % were experts with an economics or social science education. Around one-tenth the questionnaire respondents had an education in other fields (mathematics, chemistry, and geodesy).

The questionnaire was in the form of an internet application. The people answering the questionnaire were asked to submit it by e-mail. A total of 11.7 % of the questionnaires were returned.

The questionnaire had three parts. The questions in the first part dealt with the personal data of the person answering the questionnaire (age, sex, education degree level, position, field of activity and size of the company, etc.). The second part was composed of questions about their opinion of their knowledge and frequency of use of single-period investment project evaluation methods, among which we selected two that do not consider the time value of money (payback period, accounting rate of return). With the questions about the knowledge and the frequency of use of discounting cash-flow methods, which means the methods that do consider the time value of money, we focused on the net present value method, the internal rate of return method, the net present value index, and the modified internal rate of return method. The last part of the questionnaire consisted of questions about the respondents' opinions of their own knowledge of the flaws in investment project evaluation methods. Among the single-period methods, we focused on the faults of the payback period method; among the discounting cash flow methods, we focused on the internal rate of return method.

Data analysis

The data acquired from the questionnaires were systematised and analysed statistically. We calculated the dependence of method and faults knowledge from individual variables. For the analysis of dependence, we used contingency indicators (elementary indicator χ^2, Pearson's contingency coefficient and the correction of contingency).

2 RESULTS

The analysis of investment evaluation method use showed, as anticipated, that most companies use discounting cash-flow methods as well as single-period methods. Most companies,

metode. Največ podjetij za presojanje investicij uporablja metodo časa vračila vloženih sredstev – več ko tri četrtine (77,3 %), med metodami razobrestovanja denarnih tokov pa se največkrat uporablja metoda čiste sedanje vrednosti (70,45 %), ki ji sledi metoda notranje donosnosti z manj ko 70-odstotnim deležem. Razmeroma skromna pa je uporaba metode prirejene notranje donosnosti (manj kot 30 %), kar gre pripisati zamudnemu izračunavanju, predvsem pa manjši splošni prepoznavnosti te metode, saj je po navedbah ne pozna polovica strokovnjakov s strojniško izobrazbo.

Uporaba enoobdobnih metod presoje investicijskih projektov in poznavanje njihovih pomanjkljivosti

Rezultati raziskave potrjujejo domnevo, da so enoobdobne metode v podjetjih v Sloveniji še vedno zelo priljubljene. Iz izsledkov raziskave uporabe enoobdobnih metod presoje investicijskih projektov glede na strokovno smer izobrazbe pokažejo, da je več ko 80 odstotkov anketirancev s strojniško izobrazbo odgovorilo, da v podjetjih, v katerih so zaposleni, za ugotavljanje upravičenosti in uspešnosti investicij uporabljajo enoobdobne metode, približno enako pa so te metode razširjene med anketiranci z ekonomsko ali družboslovno izobrazbo, ki tvorita pretežni del razreda "preostale smeri". Med strokovnjaki drugih tehničnih smeri in matematično-naravoslovnih smeri so te metode manj razširjene, kar podrobneje prikazujemo v preglednici 1.

Med enoobdobnimi metodami se največkrat uporablja metoda časa vračila sredstev, še posebej med strojniki in med ankenitranci "preostalih smeri" izobrazbe, saj jo kot analitsko orodje uporablja kar 87,5 % strokovnjakov navedenih smeri, s čimer bistveno presegajo povprečje, ki

more than three-quarters (77.3 %), use the payback period method for investment evaluation. Among the discounting cash flow methods, the net present value method is most commonly used (70.45 %), followed by the internal rate of return method, with a percentage of less than 70 %. There is relatively little use of the modified internal rate of return method (less than 30 %), most probably due to the time-consuming calculations and especially due to low general recognition of this method, since only half the experts with mechanical engineering educations are familiar with it.

Use of single-period investment project evaluation methods and knowledge of their faults

Research results confirm the hypothesis that single-period methods are still very popular in Slovene companies. The results of the research on the use of single-period investment project evaluation methods according to the field of education show that more than 80 % of people with a mechanical engineering education answered that the companies for which they work use single-period methods to determine the justification and success of investments. The answers of people with an education in economics or social science (forming the majority of the "other sciences") were approximately the same. Among experts in other technical sciences and mathematical-natural sciences, these methods are less common. Table 1 shows detailed results on the use of the single-period investment project evaluation methods.

Among the single-period methods, the most commonly used is the payback period method, especially among mechanical engineers and people with education in other sciences – 87.5 % of experts in these other sciences use this method as an analysis tool, and in this way exceed the average frequency

Preglednica 1. *Uporaba in poznavanje enoobdobnih metod glede na strokovno smer izobrazbe*
Table 1. *Use and knowledge of single-period methods according to the field of education degree*

Strokovna smer izobrazbe Field of education degree	uporabljajo use of methods	poznajo knowledge of methods	ne poznajo unfamiliar with the methods
strojniška smer mechanical engineering	81,3 %	12,5 %	6,3 %
druge tehnične smeri other technical sciences	65,6 %	15,6 %	18,8 %
matematična in naravoslovna smer mathematical and natural science	50,0 %	10,0 %	40,0 %
preostale smeri other sciences	81,8 %	18,2 %	0,0 %

znaša nekoliko več ko tri četrtine.

Iz rezultatov je mogoče razbrati, da kombinacijo enoobdobnih metod najpogosteje uporabljajo strokovnjaki z matematično in naravoslovno izobrazbo ter vprašani z ekonomsko ali družboslovno izobrazbo, obakrat okrog tri četrtine. Analiza je tudi pokazala, da slabih 7 % anketirancev z ekonomsko, elektrotehniško in gradbeniško izobrazbo v svojih organizacijah presoja upravičenost in uspešnost investicij tudi z drugimi metodami (kot npr. študijo izvedljivosti ali z analizo dobička/izgub), medtem ko anketirani strojniki drugih metod ne uporabljajo.

Ključno raziskovalno vprašanje je zadevalo poznavanje pomanjkljivosti metod evalvacije projektov. Pri enoobdobnih metodah največ pomanjkljivosti vsebuje metoda časa vračila sredstev, za katere lahko ugotovimo, da so vendarle premalo poznane, da bi smeli sklepati o brezhibno izpeljanih presojah investicijskih projektov.

Z ugotavljanjem poznavanja pomanjkljivosti metode časa vračila vloženih sredstev v odvisnosti od smeri izobrazbe smo ugotovili, da anketiranci s strojniško izobrazbo nadpovprečno dobro poznajo vse pomanjkljivosti omenjene metode (62,5 % jih pozna popačenost rezultata zaradi

of use, which is a little over three-quarters.

These results lead to the conclusion that the combination of single-period methods is most commonly used by experts with a mathematical or natural science education and by those with an education in economics or social science; in both cases the percentage of use is around 75 %. The analysis also showed that less than 7 % of experts with an education in economics, electrotechnics or construction also evaluate the justification and success of investments in their organisations by other methods (such as a feasibility study or a profit/loss analysis). On the other hand, experts with an education in other sciences use no other methods.

A key research question concerns the knowledge of flaws in these project evaluation methods' faults. Among single-period methods, the payback period method has the most faults with which experts are not sufficiently familiar to be absolutely confident in producing faultlessly executed investment project evaluations.

In establishing how much the experts know about the faults of the payback period method, depending on their field of education, we concluded that experts with an education in mechanical engineering have an above-average knowledge of all the flaws in this method. 62.5 % of them are familiar with result deformation due to a disregard for payment maturity; 37.5 % are familiar with result deformation due to a disregard of payments after

Preglednica 2. *Poznavanje pomanjkljivosti metode časa vračila vloženih sredstev v odvisnosti od strokovne smeri izobrazbe*

Table 2. *Knowledge of faults in the payback period method by field of education*

Popačenje ali omejitev Deformation or restriction	strojniška smer mechanical engineering	druge tehniške smeri other technical sciences	matematična in naravoslovna smer mathematical and natural sciences	preostale smeri other sciences
zaradi neupoštevanja časovnega prihajanja plačil due to disregard of payment expiration	62,5 %	46,7 %	20,0 %	62,5 %
zaradi neupoštevanja plačil po preteku časa vračila investicije due to disregard of payments after expiration of investment payback time	37,5 %	33,3 %	20,0 %	50,0 %
zaradi nezmožnosti prilagajanju tveganja due to incapacity for risk adjustment	50,0 %	46,7 %	40,0 %	56,3 %
zaradi upoštevanja stabiliziranih plačil v evalvacijskem obdobju due to consideration of fixed (stabilized) payment during evaluation period	12,5 %	20,0 %	0,0 %	18,8 %
drugo other	0,0 %	6,7 %	0,0 %	0,0 %

neupoštevanja časovnega prihajanja plačil, 37,5 % jih pozna popačenje zaradi neupoštevanja plačil po preteku časa vračila investicije in 50 % jih pozna omejitev zaradi nezmožnosti prilagajanju tveganja), z izjemo popačenja zaradi upoštevanja stalnih (stabiliziranih) plačil v obdobju evalvacije, ki jo pozna le 12,5 % strojnikov, kar je primerjalno z drugimi strokami prikazano v preglednici 2.

Izpostaviti velja, da 6,7 % anketiranih z drugo tehniško smerjo izobrazbe po lastnem mnenju pozna tudi druge pomanjkljivosti enoobdobnih metod presoje investicijskih projektov.

Uporaba metod razobrestovanja denarnih tokov in poznavanje njihovih pomanjkljivosti

Izmed metod razobrestovanja denarnih tokov se v slovenskih podjetjih največkrat uporablja metoda čiste sedanje vrednosti (v povprečju 70,5 %), najbolj skromna pa je uporaba prirejene notranje donosnosti (v povprečju manj ko 30 %). Izpostaviti pa velja, da strojniki najpogosteje uporabljajo metodo notranje donosnosti (kar 87,5 %), medtem ko jih metodo prirejene notranje donosnosti uporablja polovica. Primerjavo med pogostostjo uporabe posamezne metode med strokovnjaki različnih smeri prikazujemo v preglednici 3.

the expiration of the payback period, and 50 % know about result deformation due to the incapacity for risk adjustment. The only exception is knowledge about result deformation due to a consideration of fixed (stabilized) payments during the evaluation period: only 12.5 % of respondents with a mechanical engineering education are familiar with this. The results showing the knowledge of various deficiencies in the payback period method are shown in Table 2.

We need to stress the fact that according to their opinion, 6.7 % of experts with an education in other sciences are also familiar with additional faults of single-period investment project evaluation methods.

Use of discounting cash-flow methods and knowledge of their flaws

Among the discounting cash flow methods, the most commonly used method in Slovene companies is the net present value method (average use is 70.5 %), while the least popular is the use of the modified internal rate of return method (on average less than 30 %). We need to stress the fact that employees with an education in mechanical engineering most often use the internal rate of return method (87.5 %), while the modified internal rate of return method is used only by half of these. A comparison of the use of individual methods among experts from different sciences is shown in Table 3.

Preglednica 3. *Uporaba metod razobrestovanja denarnih tokov glede na strokovno smer izobrazbe*
Table 3. *Use of discounting cash-flow methods by field of education*

Metoda Method	strojniška smer mechanical engineering	druge tehniške smeri other technical sciences	matematična in naravoslovna smer mathematical and natural science	ostale smeri other sciences
metoda čiste sedanje vrednosti net present value method	62,5 %	66,7 %	40,0 %	87,5 %
metoda notranje donosnosti internal rate of return method	87,5 %	46,7 %	60,0 %	81,3 %
indeks čiste sedanje vrednosti net present value index method	50,0 %	26,7 %	20,0 %	56,3 %
metoda prirejene notranje donosnosti modified internal rate of return method	50,0 %	13,3 %	0,00 %	43,8 %

Pogostost uporabe metode notranje donosnosti med strokovnjaki s strojniško izobrazbo je mogoče pojasniti z njeno lahko razumljivostjo, saj je rezultat izražen v odstotkih (donosnosti) in hkrati s preprosto primerljivostjo med različnimi projekti ter tudi z različnimi oblikami drugih naložb. Izračunavanje sicer zahteva iteracijski postopek ali interpolacijo, vendar finančna računala in elektronske preglednice vsebujejo standardne podlage za izračun notranje donosnosti. Pogostost uporabe metode čiste sedanje vrednosti lahko razložimo s preprostostjo njenega izračunavanja ter s splošno razširjenostjo (običajno delovanje računal in elektronskih preglednic).

Metoda prirejene notranje donosnosti je najmanj uporabljana med preučevanimi navkljub dejstvu, da se z njo izognemo pomanjkljivostim, ki jih vsebuje metoda notranje donosnosti (na primer izločimo predpostavko, da so vsa plačila reinvestirana po isti donosnosti, kakor je notranja, kar je tudi ključna prednost metode prirejene notranje donosnosti). Delno lahko manjšo "priljubljenost" omenjene metode pojasnimo z nižjo ravnijo poznavanja (metoda sodi v razširjena znanja metod razobrestovanja denarnih tokov), bržkone pa gre del pripisati tudi dolgotrajnejšemu postopku izračunavanja.

Omeniti velja, da večina strokovnjakov uporablja več metod razobrestovanja denarnih tokov hkrati, kar zmanjša možnost napačnega sklepanja. Strojniki, ki presojajo investicije z metodami razobrestovanja denarnih tokov, največkrat uporabljajo kombinacijo dveh izmed njih (57,1 %), strokovnjaki preostalih smeri pa dve metodi uporabljajo v povprečju 35,7 odstotno.

Pri ugotavljanju poznavanja pomanjkljivosti smo se osredotočili na metodo notranje donosnosti, saj avtorji, ki jih navajamo v uvodu, tej pripisujejo največ pomanjkljivosti. Ugotovili smo, da le slaba polovica (43,2 %) anketirancev (vseh smeri) v slovenskih podjetjih pozna večkratno notranjo donosnost, le okrog 16 % pa problem navzkrižnega rezultata (indikacije) med metodo notranje donosnosti in metodo čiste sedanje vrednosti. Velike razlike pa se pojavljajo med strokovnjaki različnih profilov, kar je natančneje razvidno iz preglednice 4.

Iz raziskave je mogoče ugotoviti, da 12,5 % anketirancev z ekonomsko ali družboslovno smerjo

The use of the internal rate of return method among experts with an education in mechanical engineering is explicable in terms of the method's ease of understanding, since the result is expressed as a percentage (of rate of return). At the same time, the results can easily be compared between different projects and between different forms of other investments. Although the calculation demands on iteration procedure or interpolation, financial calculators and electronic spreadsheets contain standard procedures for an internal rate of return calculation. The frequency of use of the net present value method can be explained by the simplicity of its calculation and by the generally widespread use of this method (a standard function on calculators and electronic spreadsheets).

The modified internal rate of return method is the least used among the methods studied in our research, despite the fact that this method avoids the deficiencies that occur with the internal rate of return method (e.g., one avoids the presumption that all payments are reinvested at the same rate of return as the internal one – which is the key advantage of the modified internal rate of return method). The lower "popularity" of this method can be explained by its lower level of recognition (the method forms part of the extended knowledge of discounting cash flow) and partly by the lengthy calculation procedure involved.

It is also interesting that most experts simultaneously use a number of discounting cash-flow methods, a technique which diminishes the possibility of false conclusions. A total of 57.1 % of experts with an education in mechanical engineering who evaluate investments by means of discounting cash-flow methods most often use a combination of two methods, but only 35.7 % of experts in other sciences use a combination two methods.

In establishing the level of knowledge about faults, we focused on the internal rate of return method, because the authors quoted at the beginning of this article ascribe most faults to this method. We established that in Slovene companies less than half (43.2 %) of experts (in all sciences) are familiar with multiple internal rate of return, and only 16 % know the problem of results (conflicting indications) between the internal rate of return method and the net present value method. Major differences occur between experts of different profiles; Table 4 shows these differences in detail.

Research results show that, according to their opinion, 12.5 % of experts with a degree in

Preglednica 4. *Poznavanje pomanjkljivosti metode notranje donosnosti v odvisnosti od strokovne smeri izobrazbe*

Table 4. *Knowledge of flaws in the internal rate of return method by field of education degree*

Popačenje ali omejitev Deformation or restriction	strojniška smer mechanical engineering	druge tehniške smeri other technical sciences	matematična in naravoslovna smer mathematical and natural sciences	preostale smeri other
navzkrižna indikacija čiste sedanje vrednosti in notranje donosnosti cross indication of net present value and internal rate of return	37,5 %	33,3 %	0,0 %	43,8 %
večkratna notranja donosnost multiple internal rate of return	37,5 %	6,7 %	0,0 %	18,8 %
popačenje zaradi predpostavke, da se vsa plačila reinvestirajo po donosnosti, ki je enaka interni deformation due to a presumption that all payments are reinvested according to the rate of return identical to the internal one	37,5 %	40,0 %	20,0 %	56,3 %
drugo other	0,0 %	0,0 %	0,0 %	12,5 %

izobrazbe po lastnem mnenju pozna druge pomanjkljivosti metode notranje donosnosti.

Odvisnost poznavanja metod presoje investicijskih projektov ter poznavanja njihovih pomanjkljivosti od smeri in stopnje izobrazbe

Povezanost poznavanja metod presoje investicijskih projektov s smerjo in stopnjo izobrazbe smo ugotavljali z izračunavanjem koeficienta negotovosti. Pri ugotavljanju jakosti povezanosti enoobdobnih metod od strokovne smeri izobrazbe je popravek koeficienta negotovosti znašal 0,447, pri ugotavljanju jakosti povezanosti razobrestovalnih metod s smerjo izobrazbe pa 0,4, iz česar je mogoče sklepati, da ni močne povezanosti med poznavanjem metod evalvacije in strokovno smerjo izobrazbe.

Pri ugotavljanju povezanosti poznavanja enoobdobnih metod in metod razobrestovanja denarnih tokov s stopnjo izobrazbe, smo ugotovili, da ne glede na stopnjo izobrazbe, ki jo imajo ankentiranci (magisterij oz. doktorat dobrih 34 %, univerzitetno izobrazbo skoraj 39 %, visokošolsko več kot 20 % in srednješolsko izobrazbo slabih 3 %), med poznavanjem metod presoje investicij in stopnjo izobrazbe obstaja dokaj šibka povezanost, saj sta vrednosti izračunanih popravkov koeficienta negotovosti znašali le 0,377 in 0,355.

Izračunani popravek koeficienta negotovosti, s katerimi smo določili odvisnost

economics or social science do know about other faults of the internal rate of return method.

Dependence of knowledge about investment project evaluation methods and familiarity with their faults by field and level of education degree

The connection between the knowledge of investment project evaluation methods and the field and level of education degree was established by calculating the contingency coefficient. In establishing the level of connection between single-period methods and the field of education the correction of contingency was 0.447, and in establishing the level of connection between discounting cash-flow methods and the field of education, the contingency coefficient was 0.4. These results show that there is no strong connection between knowledge about evaluation methods and the field of education.

In establishing a connection between knowledge of single-period methods and discounting cash-flow methods and level of education, we found that, regardless of their level of education (over 34 % had a PhD or an MSc degree, almost 39 % a university degree, more than 20 % a college degree and less than 3 % had a secondary-school degree), there is a relatively weak interdependence between the knowledge of investment evaluation methods and the level of education. The values of the calculated correction of contingency were only 0.377 and 0.355.

The calculated correction of contingency through which we established the dependence between

poznavanja pomanjkljivosti metode časa vračila vloženih sredstev od strokovne smeri izobrazbe, je znašal 0,634, torej med poznavanjem pomanjkljivosti časa vračila vloženih sredstev in izobrazbo zaposlenih v slovenskih podjetjih obstaja zmerna povezanost. Ugotovili pa smo močno povezanost med poznavanjem pomanjkljivosti metode notranje donosnosti in smerjo izobrazbe, saj je vrednost izračunanega popravka koeficienta 0,91.

Rezultati so tudi pokazali, da je poznavanje pomanjkljivosti metode časa vračila vloženih sredstev močno odvisno od tega, kako visoko izobrazbo so dosegli ankentiranci (popravek koeficienta negotovosti je znašal 0,866), med poznavanjem pomanjkljivosti notranje donosnosti in stopnjo izobrazbe pa obstaja šibka povezanost (popravek koeficienta negotovosti je 0,256).

3 RAZPRAVA IN SKLEP

Rezultati preteklih raziskav, ki smo jih navedli na začetku, so pokazali povečano uporabo metod presoje investicijskih projektov do osemdesetih let preteklega stoletja, kasneje pa večanja ni mogoče potrditi. S pričujočo raziskavo smo raziskali stanje na področju uporabe metod presoje investicijskih projektov v Sloveniji s posebnim poudarkom na področju strojništva. Raziskava je pokazala, da je uporaba metod presoje investicijskih projektov v Sloveniji povsem primerljiva s stanjem v drugih državah, zaradi pomanjkanja primerljivih raziskav pa nismo mogli izvesti primerjave poznavanja pomanjkljivosti obravnavanih metod.

Dobljeni rezultati raziskave uporabe in poznavanja pomanjkljivosti metod presoje investicijskih projektov nakazujejo, da večina strokovnjakov strojniške smeri, podobno pa tudi tistih z ekonomsko in družboslovno izobrazbo, za ugotavljanje upravičenosti in uspešnosti investicij uporablja tako enoobdobne metode kakor tudi metode razobrestovanja denarnih tokov. Ne glede na strokovno smer izobrazbe pa so enoobdobne metode še vedno bolj priljubljene od metod razobrestovanja denarnih tokov; izmed obeh preučevanih enoobdobnih metod je bolj priljubljena metoda časa vračila vloženih sredstev.

V raziskavi se je pokazalo, da strokovnjaki, ki se ukvarjajo s presojo investicijskih projektov in imajo strojniško izobrazbo, nadpovprečno veliko uporabljajo metode evalvacije investicijskih

the knowledge about the faults of the payback period method and the field of education was 0.634. This shows that there is a moderate level of connection between knowledge about deficiencies in the payback period method and the field of education of the people working in Slovene companies. But we established that there is a strong connection between knowledge about flaws in the internal rate of return method and the field of education, since the calculated correction of contingency coefficient is 0.91.

Results have shown that knowledge about the faults of the net present value method is highly dependent on the level of education of the respondents (the correction of contingency was 0.866), but according to our results there is only a weak connection between knowledge of the deficiencies in the internal rate of return and the level of education (the correction of contingency is 0.256).

3 DISCUSSION AND CONCLUSION

The results of past research, cited at the beginning of this article, have shown an increase in the use of investment project evaluation methods until the 1980s; after that, there was no proof of a continuing increase. Our research project investigated the situation in the field of use of investment project evaluation methods in Slovenia, with special stress on the field of mechanical engineering. Our results show that the use of investment project evaluation methods in Slovenia is fully comparable with the situation in other countries. However, due to a lack of comparable research we could not compare knowledge about the deficiencies of the subject methods.

The results obtained through research into the use and knowledge of faults in investment project evaluation methods show that most experts in the field of mechanical engineering as well as experts with a degree in economics or social sciences use single-period methods and discounting cash-flow methods to establish the justification and success of investments. Regardless of the field of education, single-period methods are still more popular than discounting cash-flow methods; the more popular of the two single-period methods studied in our research was the asset payback period method.

The research also shows that experts who have an education in mechanical engineering and are involved in investment project evaluation practice are more likely than average to use discounting cash-

projektov, ki temeljijo na razobrestovanju denarnih tokov. Pri tem se uvrščajo ob bok strokovnjakom ekonomskih in sorodnih smeri (druge smeri), hkrati pa bistveno presegajo druge tehniške smeri. Prav tako tudi nadpovprečno dobro poznajo pomanjkljivosti metod evalvacije investicijskih projektov, kljub temu pa se postavlja vprašanje, ali je poznavanje pomanjkljivosti metod zadostno. Navkljub nadpovprečnemu poznavanju pomanjkljivosti namreč le slabi dve tretjini strojnikov pozna popačenost rezultata zaradi neupoštevanja časovnega prihajanja plačil, kar je ne le ključna pomanjkljivost, temveč tudi ključna razlikovalna značilnost med enoobdobnimi metodami in metodami razobrestovanja denarnih tokov.

Pri metodi notranje donosnosti izstopa poznavanje večkratne notranje donosnosti, ki je v teoriji najpogosteje opisovana pomanjkljivost omenjene metode, bržkone zaradi tega, ker so veliki projekti v strojništvu zaradi spremenljivih denarnih tokov tipični predstavniki projektov, katerih presoja je izpostavljena večkratni notranji donosnosti.

Ugotovimo lahko, da se z višanjem izobrazbene stopnje poznavanje izboljšuje le delno in velja le za statične metode. Iz tega je mogoče sklepati, da je veliko znanj pridobljenih ali vsaj temeljito poglobljenih na podlagi praktičnega dela v podjetjih. Glede na to ugotovitev lahko sklepamo, da potrebe v podjetjih v splošnem presegajo raven znanja, ki ga ponujajo šole na vseh ravneh. Hkrati je mogoče ugotoviti, da obravnavana tematika pridobiva pomen tudi v slovenskih izobraževalnih ustanovah v okviru aktualnih družbenih in gospodarskih sprememb. S tem se odpira potreba po primerjanju stanja v različnih časovnih obdobjih, kar pomeni smernico za nadaljnje raziskovalno delo.

flow methods. In this way they stand side by side with experts in economics and similar sciences (other sciences) and at the same time greatly exceed experts from other technical sciences. They also possess above-average knowledge about the deficiencies in investment project evaluation methods, but this raises a question at the same time: Is their knowledge of such flaws sufficient? Despite their above-average familiarity with the drawbacks, only two-thirds of respondents with an education in mechanical engineering are familiar with result deformation due to a disregard for payment maturity. This is not only the key fault but also a key distinguishing characteristic between single-period methods and discounting cash-flow methods.

When using the internal rate of return method, experts with a mechanical engineering education are most familiar with multiple internal rate of return, which is, in theory, the most commonly presented fault of this method. Familiarity with the multiple internal rate of return is above average, most probably because big projects in the field of mechanical engineering are, owing to variable cash flow, typically subject to a multiple internal rate of return.

We can establish that, with an increased level of education, knowledge about methods increases partially and only with single-period methods. This leads to the conclusion that much of this knowledge has been acquired or thoroughly revised through practical work in companies. With regard to this conclusion, we can establish that the needs of companies generally exceed the levels of knowledge that schools transfer to their students at all levels. At the same time experience leads us to the conclusion that, in the light of actual social and economic changes, these topics will gain in significance in Slovenian educational institutions. Consequently we can identify a need to compare the conditions at different time periods, which represents a guideline for further research work.

4 LITERATURA
4 REFERENCES

[1] Klammer T. P., M. C. Walker (1984) The continuing increase in the use of sophisticated capital budgeting techniques. *California Management Review*, 27 (1), pp. 137-48.

[2] Pike R. H. (1988) An empirical study of the adoption of sophisticated capital budgeting practices and decision making effectiveness, *Accounting and Business Research*, 18 (72), pp. 341 – 51.

[3] Ho S., R. Pike (1996) Computer decision support for capital budgeting: some empirical findings of practice. *Journal of Information Technology*, 11, pp. 119-28.

[4] Puxty A. G., J. C. Dodds (1991) Financial management: method and meaning, 2nd edition, Ed. Wilson, R. M. S., *Chapman & Hall*, London.

[5] McIntyre A. D., N. J. Coulthurst (1985) Theory and practice in capital budgeting. *British Accounting Review*, Autumn, pp 24 – 70.
[6] Lumby S., C. Jones (1999) Investment appraisal & finacial decisions, 6th edition, *International Thomson Business Press*, London.
[7] Holmes P. (1998) Investment appraisal, *International Thomson Business Press*, London.
[8] Mauboussin M. J. (2006) Common errors in DCF models, Legg Mason capital management [online]. Available: http://www.leggmason.com/funds/knowledge/mauboussin/CommonDCFErrors.pdf, 8.6.2006.
[9] Pšunder I. (2003) Metoda množiteljev (multiplikatorjev) kot investicijsko sodilo. V: Poslovanje z nepremičninami (ur. Kožar A.), *Gospodarska zbornica Slovenije*, Ljubljana.

Naslov avtorjev: doc. dr. Igor Pšunder
Nadja Ferlan
Univerza v Mariboru
Fakulteta za gradbeništvo
Smetanova 17
2000 Maribor
igor.psunder@uni-mb.si
nadja_ferlan@yahoo.com

Authors' address: Doc. Dr. Igor Pšunder
Nadja Ferlan
University of Maribor
Faculty of Civil Engineering
Smetanova 17
2000 Maribor, Slovenia
igor.psunder@uni-mb.si
nadja_ferlan@yahoo.com

Prejeto: 13.10.2006
Received:
Sprejeto: 25.4.2007
Accepted:
Odprto za diskusijo: 1 leto
Open for discussion: 1 year