IJAAF; Vol. 8, No. 1, Winter 2024, Serial 26

Ferdowsi University of Mashhad

Iranian Journal of
Accounting, Auditing & Finance

Quarterly

RESEARCH ARTICLE

Mitigating the Mental Accounting Cognitive Bias through Instruction

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How to cite this article:
Parsaei, M., Molanazari, M., Mashayekhi, B., & Jalalialiabadi, F. (2024). Mitigating the Mental Accounting Cognitive Bias through Instruction. Iranian Journal of Accounting, Auditing and Finance, 8(1), 89-109. doi: 10.22067/ijaaf.2024.43891.1319
https://ijaaf.um.ac.ir/article_43891.html

ARTICLE INFO

Article History
Received: 2023-09-30
Accepted: 2023-12-05
Published online: 2024-01-01

Keywords:
Cognitive Bias, Instruction, Mental Accounting, Investment Decision Behavior, Judgment and Decision Making

Abstract

This study explores the influence of instructional interventions in mitigating mental accounting bias during capital investment decisions. Initially, we investigate the potential costly errors resulting from mental accounting. Subsequently, we employ instructional strategies to reduce this cognitive bias. Employing an experimental methodology, we employ an 8x2 mixed factorial design to examine the impact of financing sources on mental accounting and the effectiveness of instructional interventions. The findings reveal that managers prone to mental accounting tend to retain debt-financed assets over equity-financed assets. Importantly, instruction proves effective in alleviating this cognitive bias. This research holds significance for both academic scholars and practitioners. It sheds light on the deficiency of instructional resources in accounting education for fostering essential professional judgment skills among students. It is recommended that Finance, Business, and Accounting faculties incorporate modules on mental accounting and related cognitive biases in postgraduate programs. Furthermore, manufacturing industries can benefit from employee training programs to reduce cognitive biases associated with mental accounting in capital budgeting.

https://doi.org/10.22067/ijaaf.2024.43891.1319

CC BY

NUMBER OF REFERENCES
49

NUMBER OF FIGURES
-

NUMBER OF TABLES
12

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Neoclassical economics assumes that individuals are rational and use thorough information processing when making decisions (Serfas, 2011). However, behavioral economics has unveiled that human decisions are not always rational (Mnif, Salhi, and Jarboui, 2019; Bonner, 2008). The shortcomings of traditional economic theories in elucidating human behavior have spurred the development of practical models that incorporate psychological insights (Shefrin and Thaler, 1988). These models take into account the influence of "heuristics" techniques, which are grounded in cognitive psychology and serve to elucidate and predict biases in judgment and decision-making (JDM) (Tversky and Kahneman, 1981). Heuristics are mental shortcuts individuals employ to simplify information processing due to their inherent limitations in rationality. While these shortcuts may offer certain advantages, they can also lead to systematic biases in decision outcomes (Serfas, 2011; Beasley et al., 2014).

Mental accounting functions as a problem-solving heuristic in financial decision-making, yet it can result in deviations from rational choices. Substantial evidence supports the idea that heuristics can adversely affect judgments related to accounting (Fay and Montague, 2015; Cloyd and Spilker, 1999). Previous literature in the field of accounting has explored the impact of cognitive biases on financial decisions, with studies by Bhattacharjee, Moreno, and Salbador (2015), Bonner, Clor-Proell, and Koonce (2014), Falsetta, Rupert, and Wright (2013), Jackson, Keune, and Salzsieder (2013), Jackson, Rodgers, and Tuttle (2010), and Lipe (1993) providing insights into this subject. As researchers explore cognitive biases in judgment and decision-making, they have not only criticized these biases but also identified debiasing techniques (Bonner, 2008). Publications by KPMG (Ranzilla et al., 2011) and the Committee of Sponsoring Organizations of Treadway Commission (Glover and Prawitt, 2012) offer guidance for accounting professionals to mitigate prevalent judgment biases and improve accounting decisions.

Studies have shown that debiasing techniques yield varying results, and their effectiveness depends on the specific type of cognitive bias (Bonner, 2008; Serfas, 2011). Furthermore, certain behaviors are deeply ingrained and resistant to permanent change because they are rooted in unconscious mental activities or established behavioral patterns (Serfas, 2011). Capital budgeting decisions shape a corporation's long-term strategies (Du Toit and Pienaar, 2005). Consequently, managerial judgment and decision-making biases can impose significant costs on an organization (Bylinski and Chow, 1985). Bonner (2008) asserts that improving the quality of judgment and decision-making, as well as fostering economic growth within corporations, can be achieved by (1) gaining a comprehensive understanding of managers' decision-making processes and (2) identifying and mitigating cognitive biases through the use of debiasing techniques. Lack of training is a key factor contributing to biases in judgment and decision-making (Bonner, 2008). By alerting managers to the potential pitfalls stemming from heuristics, this source of bias can be effectively controlled (Bylinski and Chow, 1985).

The primary objective of this study is to investigate the possibility of reducing cognitive bias arising from mental accounting by applying the instruction technique. To achieve this goal, we first examine the impact of mental accounting on capital investment decisions and subsequently assess the effectiveness of the instruction technique in mitigating potential cognitive biases. Our research questions are as follows:

How does mental accounting influence the decision-making process in capital investment decisions?

Can the instruction technique effectively reduce the impact of mental accounting on capital investment decisions?

This research is categorized as a Judgment and Decision-Making (JDM) study, utilizing

experimental data at the individual level. In the initial phase of this study, we build upon the work of Jackson et al. (2013) by demonstrating the influence of psychological factors on managerial decisions. The results further indicate that individuals' use of mental accounting may result in irrational investment decisions. In the second phase, we investigate the effectiveness of instruction as a debiasing technique and provide insights into the decision-making process of individuals. Numerous studies have delved into heuristics and cognitive biases to gain insights into investors' decision-making in stock exchanges (Cherono, 2020; Bakar and Yi, 2016; Kengatharan and Kengatharan, 2014; Nofsingera and Varmab, 2013). However, prior research has paid limited attention to the influence of mental accounting on capital budgeting decisions and the potential impact of instructional debiasing techniques on mental accounting. Our research aims to address this gap by investigating the specific impact of mental accounting on capital investment decisions, contributing to the literature where empirical evidence is scarce regarding this relationship. We emphasize mental accounting biases in the context of capital investment, thus enhancing our understanding of the cognitive processes and biases that affect decision-making quality. This study offers several noteworthy contributions to the literature. Firstly, from the standpoint of accounting education, it is the first study to explore the impact of instruction on the cognitive bias of mental accounting in the context of capital budgeting decisions, providing practical insights to improve managerial decision-making. Secondly, we present empirical evidence concerning the presence and influence of economically irrelevant psychological factors on managers' investment decisions, shedding light on previously unexplored facets of decision-making processes in capital investments.

The remainder of the paper is structured as follows: Section 2 provides an overview of existing research related to mental accounting and debiasing techniques, laying the groundwork for developing our hypotheses. Section 3 elaborates on the research methodology, encompassing aspects of research design, participant demographics, and experimental materials. In Section 4, we delve into the intricacies of the results obtained, along with rigorous checks to ensure their robustness. Finally, Section 5 offers a conclusion and outlines potential avenues for future research.

2. Prior Literature and Hypotheses Development

2.1 Mental accounting

Kahneman and Tversky (1979) and Thaler (1980) introduced a pioneering fusion of traditional economics and psychology, culminating in a novel framework for economic theories. One of the significant outcomes of this paradigm shift is the inception of "mental accounting." Mental accounting is the cognitive process employed by individuals to categorize, assess, and evaluate economic outcomes (Thaler, 1985) or as a set of mental operations used to organize, evaluate, and track financial activities (Thaler, 1999). According to Thaler's concepts (Chatterjee et al., 2009), the mental accounting process unfolds in three distinct phases.

The first phase involves identifying and assigning economic elements, such as costs and benefits, to a specific mental account associated with a particular transaction. This phase can be selective, as individuals may choose to transfer only certain costs and benefits to the mental account (Cheema and Soman, 2006; Chatterjee et al., 2009). The second phase entails framing or coding these costs and benefits within the mental account in a manner that aligns with the decision-maker's preferences. The third and final phase occurs when a decision is made to close the mental account. This closure can happen either after all the relevant benefits have been realized and transferred into the corresponding mental account or without identifying all the pertinent benefits (Prelec and Loewenstein, 1998; Chatterjee et al., 2009). Throughout each phase, cognitive biases can significantly impact the quality of judgment and decision-making (Thaler, 1980, 1985).

Prospect theory introduced the concept of framing mental accounts and aligning costs and benefits (Kahneman and Tversky, 1979). Thaler (1985) further expanded on this concept by considering multiple outcomes to determine whether individuals value costs and benefits jointly or separately (Hearst et al., 1994). Lipe (1993) was the first to apply the theory of mental accounting to analyze variance investigation decisions, and since then, it has been extensively studied in accounting research. For example, studies have examined the impact of multiple tax returns on tax compliance behavior (Bhattacharjee, Moreno, and Salbador, 2015), the effect of depreciation method choice on asset selling prices (Jackson et al., 2010), and the influence of timing and direction of capital gain tax changes on investment in risky assets (Falsetta et al., 2013). Mental accounting theory has also been utilized to examine the disaggregation of managers based on the sign and relative magnitude of income statement items (Bonner et al., 2014).

Using mental accounting in investment decisions can potentially decrease the quality of individuals' judgment and decision-making (JDM). Prelec and Loewenstein (1998) discuss how individuals align costs and benefits to enhance the pleasure of consuming an asset, and they also highlight the effect of timing on individuals' perceptions of alignment. Mental accounting suggests that initial instalment payments are more psychologically painful, leading to a noticeable reduction in the utility level, but consumption utility gradually recovers as debt is settled (Prelec and Loewenstein, 1998). In general, upfront payments accelerate the perception of receiving sufficient consumption-related benefits from an asset, which may lead individuals to rational decision-making regarding asset replacement more quickly (Jackson et al., 2013). However, the literature on mental accounting has yet to determine effective debiasing techniques to mitigate these cognitive biases.

2.2 Debiasing techniques

Debiasing techniques can be categorized into three main categories (Serfas, 2011; Bonner, 2008; Koehler and Harvey, 2004). The first category is "knowledge, experience, and expertise," where proponents argue that awareness of biases and domain expertise can help eliminate biases. The other two categories are "incentive and accountability" and "personnel screening practices and promotions based on appraisal." Instruction plays a critical role in mitigating cognitive biases within these techniques. Instruction serves a dual role: as a separate debiasing technique and a prerequisite for implementing other strategies. However, it is important to note that certain biases, such as hindsight biases and anchors, may persist even when individuals know their bias effects (Serfas, 2011).

Instruction is the most commonly used method by psychologists to counteract cognitive biases. It is a "set of events deliberately designed to support learning" (Gredler, 2005). Instruction can take various forms, ranging from simple techniques like "considering the opposite," "seeking input from an outsider with a different perspective," and "analyzing competing hypotheses" to more advanced procedures such as "analogical reasoning" (Serfas, 2011). Learning, as defined in psychology literature, encompasses knowledge acquisition and a change in performance. Formal classroom activities and preparation activities, which can be conducted in universities or training courses supported by corporations and professional institutes, are part of the learning process. These activities include reading texts, listening to lectures, solving worked-out example problems, asking and answering questions, and engaging in problem-solving and case studies (Bonner, 2008).

The existing literature on cognitive biases can be categorized into two main groups. The first category encompasses studies that delve into the psychological aspects of investment decisions. These studies provide compelling evidence for behavioral biases arising from mental accounting in decision-making (Okada, 2001; Jackson et al., 2013; Yalcin et al., 2016). The second category includes studies examining instructional techniques' impact in mitigating cognitive biases in judgment and decision-making (JDM). Research findings suggest that implementing instructional

interventions can positively reduce belief bias and the framing effect (Evans et al., 1994; Cheng and Wu, 2010; Cheng et al., 2014). In contrast, research focusing on hindsight bias and anchoring effects indicates that these biases persist even when participants are exposed to interventions to reduce them and are taught strategies to avoid them (Bazerman and Moore, 2008). The diverse nature of these biases may be a potential factor contributing to the contradictory findings in this area.

2.3 Hypothesis development

The theory of separation, initially proposed by Ferrara in 1966, posits that irrational investments may arise when investment and financial decisions are amalgamated. This theory suggests that the unpaid principal balance of debt is considered irrelevant in accounting. In contrast, as outlined by Jackson et al. in 2013, the mental accounting theory argues that the unpaid principal balance of debt, as a psychological factor, diminishes managers' inclination to replace or dispose of an asset. This reduced willingness is attributed to individuals' cognitive processing, which seeks to align costs and benefits. Equity financing is recommended to address the cognitive discomfort stemming from the misalignment between costs and benefits during asset replacement or disposal. Employing the full payment method associated with equity financing can help mitigate cognitive discomfort, a view supported by Prelec and Loewenstein (1998). In the context of contemplated capital investment, where a new capital investment could serve as a source of financing to replace a prior one, the misalignment between future costs and benefits is resolved. Consequently, the "separation principle," "relevant costing," and mental accounting all advocate that the source of financing should not influence managers' capital investment decisions in the context of contemplated capital investment. These concepts and theories, including the separation principle, relevant costing, and mental accounting, have been explored in various studies, such as those by Jackson et al. (2013), Okada (2001), and Heath and Fennema (1996). Based on these ideas, we can formulate two testable hypotheses:

H1: Individuals engaging in mental accounting will be reluctant to replace debt-financed assets compared to equity-financed assets.

H2: Individuals engaging in mental accounting have an identical tendency to invest in assets financed by debt and equity.

Researchers have devised debiasing techniques to mitigate cognitive biases in investment decisions, and their efficacy varies depending on the specific technique and the cognitive bias in question. One relatively recent approach centers on "instruction," as proposed by Bazerman and Moore in 2008. Studies, including the one conducted by Serfas in 2011, have demonstrated the effectiveness of instruction in reducing cognitive biases. Evans et al. (1994) further classified instruction into feedback learning and verbal instruction. For this study, we will be employing the verbal instruction technique. Expanding on this, our next hypothesis explores the impact of instruction on investment decisions:

H3: Instruction significantly influences the investment decisions made by individuals.

3. Research Methodology

3.1 Research design

Empirical studies in judgment and decision-making (JDM) often employ experimental methods to uncover the behavioral determinants of individuals' choices (Bonner, 2008; Christensen, 2007). Experimental research in accounting is highly regarded within the discipline (Turner and Coote, 2017; Libby et al., 2002). In our experiment, we aim to assess the influence of the source of finance on the decisions made by the subjects. Contingent upon the presence of such an effect, we will investigate

whether the instructional technique has the potential to enhance decision-making.

We employ a pretest-posttest control group design to examine the impact of instruction on reducing cognitive bias. This design is known for its strong internal validity (Christensen, 2007; Sekaran, 2016). Participants are divided into eight groups based on their "retrospective and prospective source of finance." Each of these groups comprises four experimental and four control groups. A pretest is administered to all participants, ensuring that the relevant conditions (i.e., retrospective and prospective source of finance) are the same for both experimental and control groups. Following the pretest, participants in the experimental groups receive a dedicated instructional program. This instruction program covers the influence of the source of finance on decision-making and addresses cognitive biases stemming from the application of mental accounting. The details of the instruction program are outlined in the "Instruction" section.

Following the instructions, the experimental groups are asked to complete the posttest. The pretest and posttest are administered to the control groups consecutively. We employ an 8x2 mixed factorial design, with participants being randomly assigned to the eight groups, representing a between-subjects design. In our pretest-posttest design, group members make decisions twice, reflecting a within-subjects design.

The initial manipulated variable (retrospective and prospective source of finance) comprises eight levels, with four pairs assigned to the experimental groups (debt-debt, debt-equity, equity-debt, equity-equity) and four pairs allocated to the control groups (debt-debt, debt-equity, equity-debt, equity-equity). The second variable (instruction) is presented at two levels (pretest-posttest). The dependent variable under consideration is the participants' capital investment decision.

The experimental design is orthogonal, characterized by the random selection and assignment of participants and an equal sample size for all groups. Both the experimental and control groups undergo pretest and posttest procedures to control for testing effects and instrumentation. Furthermore, the experiment's maximum duration of one hour serves to mitigate the potential effects of history and maturation.

3.2 Participants

Our research participants encompass postgraduate students and professionals. Data collection occurred in two distinct stages: In the first stage, we randomly selected postgraduate students from top-ranked universities, including Tehran University, Allameh Tabataba'i University, Shahid Beheshti University, Tarbiat Modares University, Islamic Azad University-Science and Research Branch, Qom University, Farabi Campus, and Alzahra University. Those students with no work experience or less than 4 years of work experience were categorized as student participants. In contrast, individuals with 4 or more years of work experience in the manufacturing industry and expertise in capital budgeting were classified as professional participants for our analysis. In the second stage, we selected other professional participants who held managerial positions, such as CEOs, deputy CEOs, financial managers, management accounting unit managers or supervisors, and internal audit managers. These selections were made based on their substantial work experience in capital budgeting. This combined representation of university students and experienced professionals enhances the external validity of our research.

We excluded 16 experiments from the sample due to incorrect responses in the designated comprehension test. The final sample comprises 160 participants, randomly assigned to 8 groups. To ensure an equivalent level of experience across all groups, we homogenized participants with respect to their level of expertise. In each group, 12 participants are university students, some of whom have limited experience, and 8 participants are professionals in the manufacturing industry holding positions relevant to management accounting decisions. To mitigate the potential influence of age

and gender variables, randomization was employed. We upheld the principles of informed consent, emphasizing to the subjects that their participation is voluntary and that all information obtained during the investigation will remain confidential. Given the research's focus on expertise in project evaluation for capital investment, more than 87% of the participants hold postgraduate degrees in accounting, while the remaining 13% have backgrounds in financial management. The participants are approximately 29 years old, with an average of around 5 years of work experience in the manufacturing industry. Each participant has previously completed courses in capital budgeting. To provide further insight into descriptive statistics, we have organized and presented the data for professional and university participants in Tables 1 and 2.

In Table 1, concerning the professional participants, 70% were male, and over 60% of these professionals occupied managerial or supervisory roles within financial, management accounting, internal auditing, and other related units. The average age of professional participants was 34 years, with the age range spanning from the youngest individual at 23 years old to the oldest at 58 years old. Furthermore, the average work experience among these professionals was 10.5 years, with the minimum work experience being 4 years and the maximum experience reaching 30 years.

Table 1. The descriptive statistics of participants-professionals

Variable	Category	Frequency	Relative Frequency	Variable	Category	Frequency	Relative Frequency
Gender	Male	45	70.300	**University**	Specialist	4	6.200
	Female	19	29.700		Senior Specialist	14	21.900
	Total	64	100.000		Supervisor	19	29.700
Degree	Master	44	68.800		Manager	21	32.800
	PhD	20	31.200		Deputy CEO	1	1.500
	Total	64	100.000		CEO	5	7.900
Variable	Mean	min	Max		Total	64	100.000
Age	34.22	23	58				
Experience (year)	10.5	4	30				

In Table 2, we provide descriptive statistics for the group of university students. This group comprises a total of 96 participants, with approximately 33% of them being male and 67% female. Given the substantial sample size in this research, the researcher included master's and Ph.D. students from 8 universities. The average work experience of the students is 9 months, and the average age is 25 years. The age range of participants varies, with the oldest being 36 years old and the youngest 21 years old.

3.3 Experimental materials

The rational decision in our experiment involves replacing the existing asset with a new one. However, existing literature indicates that managers often hesitate to invest in a new asset when their current one is financed with debt (Prelec and Loewenstein, 1998; Jackson et al., 2013). In the pretest phase, we assess this potential bias. Participants are instructed to step into the role of a manager at a manufacturing corporation facing a situation where the efficiency of a key machine (Machine M) has declined, resulting in negative material and labor variances. Their task is to decide whether to continue using Machine M or to replace it. To ensure informed decision-making, we provide

participants with comprehensive information about the asset, including the purchase time, remaining useful life, salvage value, and current value.

Table 2. The descriptive statistics of participants post graduate students

Variable	Category	Frequency	Relative Frequency	Variable	Category	Frequency	Relative Frequency
Gender	Male	32	33.300	**University**	Tehran	12	12.500
	Female	64	66.700		Allameh Tabata'i	19	19.800
	Total	96	100.000		Shahid Beheshti	9	9.400
Degree	Master	90	93.800		Tarbiat Modares	9	9.400
	PhD	6	6.300		Alzahra	27	28.100
	Total	96	100.000		Qom,.Farabi	16	16.700
Variable	Mean	Min	Max		Islamic Azad	4	4.100
Age	25.26	21	36.000		Total	96	100.000
Experience (year)	0.76	0	3.000				

Participants' capital investment decisions, our dependent variable, are recorded on a ten-point scale. The scale's left endpoint is marked as "strong inclination to continue using Machine M," while the right endpoint is designated as "strong inclination to purchase the new machine." A vertical line indicates the midpoint of the scale. We aim to examine how the source of finance influences managers' investment decisions. Additional specifics about the experiment can be found in Appendix 1.

3.4 Instruction

Bonner (2008) posits that the spectrum of available instructional techniques encompasses a wide array of theoretical foundations, ranging from simple warnings to comprehensive instructions. In our study, we employ the verbal full instruction method to investigate its potential to reduce cognitive biases resulting from mental accounting. One of the researchers conducted the instruction process for all participants in the experimental condition. Our instructional content delves into the intricacies of mental accounting and elucidates how cognitive biases manifest within individuals' thought processes when aligning costs and benefits. The instruction content is meticulously structured with specific headings crafted by the researchers and is delivered to the participants through a PowerPoint presentation.

We train the participants within each of the four experimental groups, followed by their responses to the subsequent test questions. The second test maintains similar content, with minor numerical adjustments to mitigate learning effects. Control group subjects, on the other hand, answer the second test questions without prior instruction. Here is an outline of the instruction content:

1- The importance of JDM quality in capital budgeting decisions and the factors affecting it. These factors include person, task and environmental variables and introduce individuals' cognitive processes as person variables.

2- The usage of heuristics by individuals, the possibility of low-quality JDM caused by the usage, and the introduction of mental accounting as a heuristic.

3- Introducing the prospect theory, explaining mental accounting, and elaborating individuals' cognitive processes in diagnostic tests (four examples are given, including the Theater Ticket problem in Tversky and Kahneman (1981), the Basketball Game problem in Thaler (1980), investments in stock exchange, and sunk costs in making decisions).

4- Investigating the cause of individuals' attention to sunk costs as per "costs and benefits alignment" and "mental depreciation" and the necessity of ignoring sunk costs and irrelevant costs in capital budgeting decisions (by simulating unpaid principal of debt-financed asset to book value of an asset).

5- Notifying participants about the effects of mental accounting usage in this study (i.e. viewing unpaid principal of debt-financed asset as a cost and misaligning costs and benefits in decision making).

4. Results

We apply a mixed two-factorial analysis of variances to compare capital investment decisions in pretest and measure the impact of instruction on decision-making. The results are discussed below. All assumptions before performing mixed ANOVAs have been satisfied including "the existence of at least two independent variables, at least one of which is between-group and the other is within-group", "the existence of at least two groups or conditions for all independent variables", "the parametricity of dependent variable", "the reasonable normal distribution for the dependent variable across the independent groups and over the within-group conditions", "the sphericity of within-group variance", "the homogeneity of variance-covariance matrices" and "the homogeneity of the between-group variances"(Myers, 2013).

4.1 Interpretation of repeated-measures ANOVA

Table 3 presents the results of the ANOVA tests for the main effects of instruction and groups, along with the interaction effects on capital investment decisions. Given the significance of the interaction effect, we should interpret the main effects cautiously. We conducted two additional one-way ANOVA tests and eight t-tests to delve into this interaction's source.

Table 3. Repeated-measures ANOVA results for capital investment decisions

Tests of within-subjects Effects					
Source	**SS**	**DF**	**MS**	**F**	**Sig**
Instruction	121.278	1	121.278	97.730	0.000
Instruction × group	276,597	7	39.514	31.842	0.000
Error (Instruction)	188.625	152	1.241	-	-
Tests of Between-Subjects Effects					
Source	SS	DF	MS	F	Sig
Group	1209.597	7	172.8	60.308	0.000
Error	435.525	152	2.865	-	-

4.2 Descriptive statistics

Table 4 displays the means and standard deviations of investment decision scores for each group in both the pretest and posttest conditions. Participants in Groups 1 and 2 exhibit significant shifts in their investment decisions after receiving instruction. The initial estimates of investment decisions suggest a preference for retaining the current asset, but this changes to an inclination toward investing in a new asset after instruction. A comparative analysis with the control groups yields precise insights. The mean values of investment decisions in Groups 5 and 6, which serve as the control groups for Groups 1 and 2, remain relatively consistent between pretest and posttest conditions (3.6 vs 3.75 and 3.7 vs 3.75), indicating a tendency to maintain the existing asset. Furthermore, the pretest conditions for Groups 1 and 5 (3.7 vs 3.6) and Groups 2 and 6 (3.1 vs 3.7) show similarity. Therefore, it becomes

evident that instruction significantly influences decisions regarding the maintenance or acquisition of a new asset.

Specifically, we have observed a significant disparity in individuals' inclination to replace a debt-financed asset as opposed to an equity-financed one. As evident in Table 4, the proclivity to replace the machine is notably lower in cases of debt financing (Groups 1 and 2, where the retrospective source of finance is debt) compared to situations with equity financing (Groups 3 and 4, where the retrospective source of finance is equity).

The decisions of Groups 3 and 4 do not exhibit significant differences between pretest and posttest conditions (8.25 vs 8.35 and 7.5 vs 8.35). The mean values of investment decisions for these groups imply a consistent intention to acquire a new asset in both the pretest and posttest phases. A comparison of Groups 3 and 4 with their respective control groups (Groups 7 and 8) reveals that the mean values of investment decisions remain relatively consistent. Furthermore, the mean values for Groups 3 and 7 (8.25 vs 8.55) and Groups 4 and 8 (7.5 vs 8.4) show minimal disparity before the instructional intervention. Overall, instruction has not significantly altered the investment decisions of Groups 3 and 4. Nevertheless, we conducted one-way ANOVA tests and paired sample t-tests for a more precise analysis.

Table 4. Descriptive statistics of Mixed design for Capital Investment Decision

Group	Pretest			Posttest		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
(Experimental) Group 1 - (Debt-Debt)	20	3.700	1.129	20	7.850	1.387
(Experimental) Group 2 - (Debt-Equity)	20	3.100	1.483	20	7.850	1.552
(Experimental) Group 3 - (Equity-Debt)	20	8.250	1.251	20	8.350	1.268
(Experimental) Group 4 - (Equity-Equity)	20	7.500	1.192	20	8.350	1.226
(Control) Group 5 - (Debt-Debt)	20	3.600	1.759	20	3.750	1.773
(Control) Group 6 - (Debt-Equity)	20	3.700	1.525	20	3.750	1.888
(Control) Group 7- (Equity-Debt)	20	8.550	1.099	20	8.200	1.508
(Control) Group 8 - (Equity-Equity)	20	8.400	1.429	20	8.650	1.137
Total	160	5.850	2.713	160	7.080	2.431

4.3 Independent one-way ANOVA

First, we conducted one-way ANOVA to examine the disparities in means between the experimental groups and their respective control groups prior to the instructional intervention. As shown in Table 5, the results indicate at least two groups with means that differ significantly. To pinpoint the sources of these differences, we employed post hoc tests. Given the equitability of group sizes and the homogeneity of variances, we utilized the Tukey option (as detailed in Table 6). Consistent with the methodology suggested by Myers (2013), we divided the significance cutoff point by 2 and conducted one-way ANOVA twice. A significant outcome is only deemed valid when $p<0.025$.

Table 5. one-way ANOVA Results

Source	SS	df	F	Sig
Between-groups	882.900	7	66.684	0.000
Error	287.500	152	-	-

Tukey post hoc analyses in Table 6 reveal no significant difference in the means of investment decisions between the experimental groups and their respective control groups (as depicted in Part 1). In Part 2, we present the results of mean comparisons between groups with differing retrospective and prospective sources of finance (1 vs 3 and 2 vs 4) and different prospective sources of finance (1 vs 2 and 3 vs 4). Our findings show that the decisions of participants in Groups 1 and 2 are notably distinct from those in Groups 3 and 4. Consequently, the first hypothesis is not rejected, indicating that the retrospective source of finance indeed impacts participants' decisions. However, there is no noteworthy difference between the means of Groups 1 and 2 and Groups 3 and 4. This suggests that the prospective source of finance does not influence participants' decisions; thus, the second hypothesis is not rejected. These results align with the findings of Jackson et al. (2013). Furthermore, our results support Okada's (2001) observations regarding using mental accounting in asset replacement decisions and Heath and Fennema's (1996) insights concerning the depreciation process and the alignment of costs and benefits. Mental accounting is a cognitive bias that can generally influence individuals' decision-making processes, particularly within asset replacement decisions (Jackson et al., 2013). By delving into the impact of mental accounting biases, we aim to enhance the understanding of how individuals' decision-making can be influenced in capital investment scenarios. Our findings suggest that individuals display reluctance to replace the current machine financed through debt, thereby highlighting the presence of a cognitive bias. We infer that individuals tend to favor retaining the current asset for two main reasons: (1) the discomfort experienced by participants when facing a lump-sum payment to the lender during replacement and (2) the absence of current or acquired benefits to offset the payment during this process. The net present value of the increased benefits of acquiring the new machine in the experiment is positive. This should serve as a guiding factor for individuals to consider replacing the current asset. In conjunction with participants' expertise in capital budgeting techniques, this observation leads us to conclude that individuals' cognitive inclination to retain the existing machine tends to override their capacity for sound decision-making.

Table 6. Tukey Outcomes for Capital Investment Decisions in Pretest

Tukey Outcome			
Part 1:Comparison of each experimental group with the corresponding control group	**Mean Difference**	**Standard Error**	**Sig.**
Group 1(Debt-Debt) and Group 5 (Debt-Debt)	0.100	0.435	1.000
Group 2(Debt-Equity) and Group 6 (Debt-Equity)	-0.600	0.435	0.865
Group 3(Equity- Debt) and Group 7 (Equity- Debt)	-0.300	0.435	0.997
Group 4(Equity-Equity) and Group 8 (Equity-Equity)	-0.900	0.435	0.439
Part 2:Comparison of groups for the effect of retrospective source of finance and prospective source of finance	**Mean difference**	**standard error**	**Sig.**
Group 1 (Debt-Debt) and Group 3 (Equity-Debt)	-4.550	0.435	0.000
Group 2 (Debt- Equity) and Group 4 (Equity - Equity)	-4.400	0.435	0.000
Group 1 (Debt - Debt) and Group 2 (Debt-Equity)	0.600	0.435	0.865
Group 3 (Equity-Debt) and Group 4 (Equity - Equity)	0.750	0.435	0.671

4.4 Paired Sample t-tests

Table 7 presents the results regarding the impact of instructions on individuals' investment decisions. The first column is divided into four panels, each consisting of two rows. These panels compare pretest and posttest conditions within the groups and across the experimental and control groups. With eight pairs of groups, significance is reached if $p < 0.00625$. In Group 1, the pretest means exhibit significant differences from the posttest means. In the corresponding control Group 5, investment decisions (which align with pretest decisions in Group 1 according to Table 6) do not significantly change after receiving instruction (p-value = 0.643). Thus, we find compelling evidence that instruction changes biased investment decisions. Group 2 demonstrates similar results, supporting further the notion that instruction significantly alters participants' investment decisions. We base this inference on two key findings: Groups 2 and 6 do not exhibit significant differences in the pretest (as shown in Table 6), and the means of Group 6 do not significantly differ between the pretest and posttest conditions. Consequently, Hypothesis 3 is not rejected.

Panels 3 and 4 present the results of t-tests for groups that relied on equity as their retrospective source of finance. The average investment decision pretest scores in Groups 3 and 7 exhibit no significant differences from their posttest scores. Given that the pretest scores in these groups show no significant variance (as seen in Table 6), we infer that instruction does not significantly impact individuals' investment decisions in Group 3. This is because the participants' decisions in Group 3 are already rational before receiving instruction. Likewise, Groups 4 and 8 also demonstrate no significant differences between their pretest and posttest scores. Since their pretest means are similar (as indicated in Table 6), we can conclude that instruction does not significantly affect the investment decisions in Group 4. This outcome aligns with expectations, as the primary goal of instruction is to mitigate cognitive biases in individuals' investment decisions. Given that participants in Groups 3 and 4 made rational pretest decisions, it is likely that they were unaffected by the instruction, as anticipated.

Table 7. Paired Sample T-test results for capital investment decision scores across Instruction by group

Paired Comparison	Mean	T	Sig.
Experimental Group 1 (Debt - Debt)	-4.150	-9.631	0.000
Control Group 5 (Debt - Debt)	-0.150	-0.471	0.643
Experimental Group 2 (Debt - Equity)	-4.650	-8.700	0.000
Control Group 6 (Debt - Equity)	-0.050	-0.188	0.853
Experimental Group 3 (Equity - Debt)	-0.100	-0.370	0.716
Control Group 7 (Equity - Debt)	0.350	1.377	0.185
Experimental Group 4 (Equity - Equity)	-0.850	-2.203	0.040
Control Group 8 (Equity - Equity)	-0.250	-1.000	0.330

4.5 Manipulation checks

A comprehension test has been employed to determine whether the participants in each group paid proper attention to the manipulated variable when responding to the key question. To clarify this point, participants were required to answer two additional questions related to the retrospective and prospective sources of finance before addressing the main question. To mitigate the influence of other potential factors that could impact participants' decisions, individuals were also asked to respond to questions concerning liquidity problems and personal responsibility. Subjects were excluded from the sample if they answered any of these questions incorrectly. A total of 16 experiments were omitted from the sample due to incorrect responses. In the following sections, we will elaborate on the potential factors that may exist and explain how these experiments controlled for each.

Liquidity Problems: Participants may be concerned that the repayment of the loan associated with

Machine M could lead to liquidity problems for the company, making them hesitant to invest in a new machine. To address this potential concern, participants were provided with information about the sufficiency of cash resources to maintain/replace the current machine, and it was emphasized that their decisions would not significantly impact the company's financial ratios. Additionally, they were asked questions regarding the company's financial situation. These questions were designed to help us gauge whether the participants processed the provided information.

Personal Responsibility: Participants' sense of personal responsibility for the poor performance of the machine may lead them (especially if the retrospective source of finance is debt) to believe that their reputation within the corporation might be at risk if they opt to replace the asset. Consequently, they may lean towards retaining the machine. This potential factor is examined by analyzing participants' responses to a question inquiring about their level of personal responsibility for the inefficient performance of the current machine.

4.6 Additional analysis

4.6.1 Additional Tests: Individuals' Perceptions about the Obtained Benefits

Another 2×8 mixed factorial design is employed to gauge participants' perceptions regarding past benefits derived from the asset. The manipulated variables remain consistent with the previous design, while the dependent variable centers on individual perceptions of past benefits. To this end, a set of questions is designed to probe participants' opinions on the realized benefits of Machine M, rated on a seven-point scale. The left endpoint of the scale is denoted as 'completely agree,' indicating that past benefits from Machine M have not yet been fully realized. The right endpoint, labeled 'completely disagree,' signifies that past usage of Machine M has realized most, if not all, of the desired benefits. We calculate the average responses of the participants to the five questions to evaluate their perspectives on the obtained benefits. To ensure that these questions represent a single underlying construct, we compute Cronbach's alpha (1951). The resulting alpha value is 0.76, surpassing the threshold of 0.7, which affirms that the questions measure a one-dimensional construct (Myers, 2013). For more comprehensive details regarding the experiment, please refer to Appendix 1.

Table 8. Repeated-measures ANOVA results for past benefit perceptions

Tests of within-subjects Effects					
Source	**SS**	**DF**	**MS**	**F**	**Sig**
Instruction	0.006	1	0.006	0.009	0.923
Instruction × group	279.147	7	39.878	61.384	0.000
Error (Instruction)	98.747	152	0.650	-	-
Tests of Between-Subjects effects					
Source	**SS**	**DF**	**MS**	**F**	**Sig**
Group	150.115	7	21.445	18.475	0.000
Error	176.435	152	1.161	-	-

4.6.2 Interpretation of repeated-measures ANOVA

Table 8 presents the main effects of instruction and group and their interaction effect on individuals' perceptions of past benefits derived from the asset. Given the statistical significance of the interaction term, we conducted additional tests, including one-way ANOVA tests and t-tests, to delve into the source of this difference.

4.6.3 Descriptive statistics

Table 9 presents the means and standard deviations of participants' perception scores for each group in both the pretest and posttest conditions. Notably, the mean values of Groups 1 and 2 (where

the retrospective source of finance is debt) exhibit substantial changes after instruction (2.93 to 5.45 and 3.09 to 5.65). Specifically, the perspective that benefits have not been adequately realized may shift to the point where the retrospective source of finance becomes irrelevant. Conversely, the perception scores for the corresponding control groups remain consistent between pretest and posttest conditions (3.02 vs. 3.11 and 3.26 vs. 3.32), indicating that participants do not consider the past benefits to be sufficient. Furthermore, the mean values of all four groups are similar prior to instruction, suggesting that the instruction has prompted subjects to alter their perceptions regarding the influence of the source of finance on realized benefits. The results for Groups 3 and 4 support this finding in the context of equity-financed assets. In particular, the perception that the asset has provided sufficient benefits may transform, leaning towards the viewpoint that the source of finance is not a relevant factor.

Table 9. The descriptive statistics of mixed design for past benefit perceptions

Group	Pretest			Posttest		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
(Experimental) Group 1 - (Debt-Debt)	20	2.930	0.734	20	5.450	1.070
(Experimental) Group 2 - (Debt-Equity)	20	3.090	0.832	20	5.650	0.851
(Experimental) Group 3 - (Equity-Debt)	20	4.940	0.818	20	1.750	0.765
(Experimental) Group 4 - (Equity-Equity)	20	4.70	0.709	20	2.510	1.057
(Control) Group 5 - (Debt-Debt)	20	3.020	1.030	20	3.110	0.914
(Control) Group 6 - (Debt-Equity)	20	3.260	1.293	20	3.320	1.083
(Control) Group 7- (Equity-Debt)	20	4.660	1.040	20	4.810	1.162
(Control) Group 8 - (Equity-Equity)	20	5.080	0.680	20	5.010	0.939
Total	160	3.960	1.270	160	3.950	1.680

4.6.4 Independent one-way ANOVA

Table 10 reveals a notable variance in the mean perception scores among the groups. Table 11 presents the results of Tukey tests to pinpoint this disparity's origin. The findings in Part 1 suggest that there is no statistically significant difference in the mean perception scores of the experimental groups and their corresponding control groups.

Table 10. one-way ANOVA results

Source	SS	df	F	Sig
Between-groups	128.876	7	22.072	0.000
Error	126.788	152	-	-

Part 2 in Table 11 compares the means of groups in which the retrospective source of finance is debt (Groups 1 and 2) with groups in which the retrospective source of finance is equity (Groups 3 and 4). This suggests that individuals' perceptions in Groups 1 and 2 significantly differ from those in Groups 3 and 4. As suggested by the descriptive statistics in Table 9, the results from Table 9 imply that the perception of participants in Groups 1 and 2 is the opposite of those in Groups 3.

Table 11. Tukey outcomes for past benefit perceptions in pretest

Tukey Outcome			
part 2: Comparison of each experimental group with the corresponding control group	**Mean Difference**	**Standard Error**	**Sig.**
Group 1(Debt-Debt) and Group 5 (Debt-Debt)	-0.090	0.289	1.000
Group 2(Debt-Equity) and Group 6 (Debt-Equity)	-0.170	0.289	0.990
Group 3(Equity- Debt) and Group 7 (Equity- Debt)	0.280	0.289	0.970
Group 4(Equity-Equity) and Group 8 (Equity-Equity)	-0.380	0.289	0.890
part 2:Comparison of groups for the effect of retrospective source of finance and prospective source of finance	**Mean Difference**	**Standard Error**	**Sig.**
Group 1 (Debt-Debt) and Group 3 (Equity-Debt)	-2.010	0.289	0.000
Group 2 (Debt- Equity) and Group 4 (Equity - Equity)	-1.610	0.289	0.000
Group 1 (Debt - Debt) and Group 2 (Debt-Equity)	-0.160	0.289	0.999
Group 3 (Equity-Debt) and Group 4 (Equity - Equity)	0.240	0.289	0.991

4.6.5 Paired Sample t-tests

Table 12 presents the results concerning the impact of instruction on the subjects' perceptions, following the format of Table 7. The paired sample t-test results in Panel 1 indicate a statistically significant difference in the average perception scores of participants in Group 1 between the pretest and posttest conditions. Conversely, the mean for Group 5 (which, as shown in Table 9, is approximately the same as the Group 1 mean in the pretest) does not change significantly following instruction. Therefore, we can conclude that instruction changes individuals' perceptions. Similarly, in Panel 2, the results in Table 11 suggest that instruction influences participants' perceptions in Group 2. The instruction prompts individuals in Groups 1 and 2 to view financing an asset as irrelevant in capital investment decisions.

Table 12. Paired Sample T-test results for past benefit perception scores across instruction by group

Paired comparison	**Mean**	**T**	**Sig**
Experimental Group 1 (Debt - Debt)	-2.520	-6.847	0.000
Control Group 5 (Debt - Debt)	-0.090	-0.619	0.543
Experimental Group 2 (Debt - Equity)	-2.560	-10.786	0.000
Control Group 6 (Debt - Equity)	-0.060	-0.302	0.766
Experimental Group 3 (Equity - Debt)	3.190	13.368	0.000
Control Group 7 (Equity - Debt)	-0.150	-0.546	0.591
Experimental Group 4 (Equity - Equity)	2.190	6.767	0.000
Control Group 8 (Equity - Equity)	0.070	0.402	0.692

Panel 3 reveals a notable distinction in the means of Group 3 between pretest and posttest conditions, while Panel 4 presents a similar outcome for Group 4. In contrast, control Groups 7 and 8 show no significant variation in means between pretest and posttest conditions. Since the means of Groups 3 and 4 match those of their respective control groups in the pretest (as seen in Table 11), we can deduce that instruction impacts individuals' perceptions in Groups 3 and 4. Therefore, the instruction alters the perspective of these two groups, although it does not affect their investment decisions.

The rationale behind this is that individuals believe that covering an asset's cost (whether through loan repayments or a lump-sum payment) or unpaid debt should not influence their investment

decisions. In our experiment, participants in Groups 1 and 2, where the retrospective source of finance is debt, initially believe that the machine's obtained benefits are insufficient, thus justifying the retention of the machine. Conversely, participants in Groups 3 and 4, where the retrospective source of finance is equity, start with the perspective that a significant portion of the required benefits from the machine has already been realized, justifying its replacement. Through the instructional intervention, participants' perceptions of realized benefits' influence on their investment decisions are recalibrated. In the case of Groups 3 and 4, the decision to replace the asset remains unchanged after instruction, as it aligns with rationality. However, the underlying rationale behind this decision undergoes a shift from considering an irrelevant factor associated with mental accounting (balancing costs and benefits) to the relevant factor of Net Present Value (NPV).

5. Conclusion and Discussion

One of the primary challenges within the decision-making process in the accounting field is the frequent reliance on heuristics by decision-makers, often without their awareness (Fay and Montague, 2015). Consequently, educating professionals on the specific biases that commonly impact accounting Judgment and Decision Making (JDM) becomes essential. Mental accounting, as a cognitive bias, has been recognized for diminishing the quality of JDM during the decision-making process (Jackson et al., 2013). In addition to mental accounting, our study incorporates various related theories and concepts, such as prospect theory (Kahneman and Tversky, 1979), which elucidates how individuals' decisions are shaped by the framing of choices and the reference points used in their evaluations.

Comprehensive evidence regarding the effectiveness of instructional techniques in mitigating the mental accounting bias within capital investment decisions is limited (Evans et al., 1994; Cheng and Wu, 2010; Chang et al., 2014; Bazerman and Moore, 2008). This study investigates how individuals engage in mental accounting during their capital investment decisions and evaluate instructional techniques' impact on optimizing decision outcomes. Our findings contribute to the body of knowledge concerning the effects of instruction, one of the most commonly employed debiasing techniques (Bonner, 2008), on capital investment decisions. The results indicate that instruction aids participants in transitioning from irrational decisions to economically efficient ones. Furthermore, participants' initial perceptions, which suggest that the benefits derived from assets are insufficient when there is a high unpaid principal balance, are subject to modification through instruction.

Past research on decision biases has predominantly emphasized factors that contribute to these biases (Banerjee et al., 2019; Chandra and Kumar, 2012; Boylan, 2008). Furthermore, studies on debiasing techniques have focused on the framing effect (Cheng et al., 2014) and anchors (Kaustia and Perttula, 2012), with limited attention given to mental accounting.

Furthermore, our research unveils the presence of an irrelevant psychological factor that influences managers' decision-making processes, leading to suboptimal choices. The results indicate that participants' reluctance to part with debt-financed assets may result in missed opportunities to enhance firm value through investments. The relationship between the source of finance and individuals' choices to replace assets is partly mediated by their perceptions of past benefits. These findings resonate with previous studies conducted by Heath and Fennema (1996), Prelec and Loewenstein (1998), Okada (2001), and Jackson et al. (2013). This study provides substantial evidence supporting the effectiveness of instructional techniques in mitigating cognitive biases stemming from mental accounting. The insights into the efficacy of instruction have the potential to aid management in improving investment decisions and facilitating more rational choices.

The findings of this research hold significance for both practitioners and academic researchers. Academic institutions offering Finance, Business, and Accounting programs can enhance their

postgraduate curriculum by incorporating modules on mental accounting and related cognitive biases. This study underscores the importance of managers and investors being cognizant of the biases influencing their decision-making processes. By recognizing the presence and impact of these biases, decision-makers can equip themselves to make more well-informed and rational choices. Our study suggests that instruction can facilitate a transition from irrational decisions to economically efficient ones. This discovery implies that managers and investors have the potential to enhance their decision-making processes by implementing strategies that counteract biases and promote more effective choices. Furthermore, manufacturing industries may consider introducing employee training programs designed to reduce cognitive biases arising from mental accounting within capital budgeting environments.

Future research endeavors could explore the impacts of succinct instructional interventions, such as warnings, the presentation of multiple perspectives, the articulation of the reasons that underpin Judgment and Decision Making (JDM), and the provision of counter-explanations. Additionally, studies may delve into how factors related to individuals' cognitive abilities (such as verbal, reasoning, and spatial skills), intrinsic motivation, and a range of personality characteristics may enhance the quality of JDM. Lastly, as our experiments are grounded in manipulating independent variables and controlling extraneous factors, prospective research could focus on the cognitive processes within the human brain and the identification of mental patterns. This could be accomplished through collaboration with cognitive neuroscience laboratories.

Experimental scenarios, by their nature, do not perfectly replicate real-world decision-making settings due to certain simplifications and limitations imposed on participants' behavior. For instance, in our experiment, participants were prohibited from using educational resources or engaging in collaborative discussions. Additionally, participants operated under implicit time constraints. Another generalizability limitation stems from inherent disparities between the participants and real-life populations. We included professionals in our sample to bolster external validity, making it somewhat more representative of real-world conditions. The final limitation of our experimental studies pertains to methodological constraints arising from the influence of environmental and participant variables. The logistical challenges included the difficulty of assembling academic and professional participants within a laboratory setting, given their time constraints. Moreover, instructional sessions typically require around an hour to administer, making it more challenging to recreate real-life conditions. Nevertheless, we made efforts to minimize the impact of environmental variables by maintaining consistency. All participants were subject to the same experimental conditions, received identical background information and instructions, and were allotted the same amount of time to answer questions. They were also closely supervised to prevent the use of any additional tools. Consequently, the influence of environmental variables was kept to a minimum, minimizing the potential distortion of our results.

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Appendix 1

Further information about the experiment provided to participants is as follows:
Experimental materials

Machine M has been used from three years ago and engineering reports suggest that the Machine M can be used for the next five years before becoming worn out. The current value of Machine M is $ 42,000, but the salvage value would be zero after five years. The new machine has a useful life of five years with no residual value.

The two levels of the retrospective source of finance are defined as follows:

The condition that the retrospective source of finance is debt - Machine M was purchased 3 years ago with an 8-year secured loan of $ 210,000 at an 8% interest rate. The corporation should make equal annual payments of $ 36,500 at the end of each year (each installment includes principal plus interest). The third installment has been made and the firm will continue to make payments for up to 5 years. However, if you decide to sell Machine M, the unpaid principal balance of $ 146,000 should instantly be paid to the lender for loan settlement.

The condition that the retrospective source of finance is equity - Machine M is purchased with $ 210,000 of cash flows created by the firm's operations.

The two levels of prospective sources of finance are defined similarly as follows:

The condition that the prospective source of finance is debt- A new machine can be purchased with a 5-year secured loan of $ 231,000 at an 8% interest rate. The corporation should make equal annual payments of $ 57,900 at the end of each year over the next 5 years.

The condition that the prospective source of finance is equity – A new machine can be purchased with $ 231,000 of cash flows created by the firm's operations.

In all conditions, the present value amounts are given to the subjects. The present value of the increased benefits obtained from the new machine is $ 273,000 due to eliminating negative variances in production and improving operational efficiency.

Benefit perceptions

Content of questions related to obtained benefits of the asset are listed below:

- Sense of wasting resources (Machine M) when deciding to maintain or replace it.
- Failure to obtain sufficient past benefits from Machine M up to now when deciding to maintain or replace it.
- Consumption pleasure attained from past usage of Machine M when making a decision to maintain or replace it.
- Adequate benefits obtained from Machine M in the alignment of the initial cost.
- Participants' picture about obtained benefits of Machine M, in the way of comparing the cost of purchased asset (Machine M) financed by debt and repaid through instalments rather than fully paid at the time of purchase.