

## The effect of visualization and complexity tasks in investment decision making

Luciana S., ALMILIA,  
STIE PERBANAS SURABAYA, Wonorejo Utara 16, Surabaya, Indonesia  
lucy@perbanas.ac.id  
Nurul H. U., DEWI,  
STIE PERBANASSURABAYA, Wonorejo Utara 16, Surabaya, Indonesia  
nurul@perbanas.ac.id  
Putri, WULANDITYA,  
STIE PERBANAS SURABAYA, Wonorejo Utara 16, Surabaya, Indonesia  
putri@perbanas.ac.id

### Abstract

*This study examines the effect of visualization level and level of assignment complexity on investment decision making as measured by level of accuracy, level of confidence and calibration level. This research uses experimental method. The experimental method in this research is 2x2 (mixed design) include: (1) Level of visualization (high and low) and (2) Complexity of task (high and low). The dependent variable in this research is the level of accuracy, level of confidence and calibration level. Data analysis technique used in this research is independent sample t-test.*

*Participants in this study are students of Accounting Undergraduate Program in one Private University in East Java. The total participants in this study were 103 people, but only 77 participants who passed the check manipulation and can be analyzed further. The results of this study indicate that the visualization effect in decision-making has an effect only when decision makers receive assignment with low complexity of assignment. The results of this study indicate that the effect of the complexity of the assignment influences both decision-making as measured by the level of accuracy, level of confidence and calibration level.*

*Keywords: visualization effects, effects of task complexity, level of accuracy, level of confidence, calibration level.*

JEL Classification: M40, G11.

## 1. Introduction

The development of behavioral accounting research currently is growing rapidly. This development is due to the many important factors that influence the behavior of individuals, especially in decision making. This study specifically examines the factors that influence investment decision making. This research focuses on investment decision making, since the development of capital market in Indonesia in the last 5 years shows an increase. The increase in capital market development in Indonesia is shown by: First, the growth of Composite Stock Price Index in 2015 by 29%. Secondly, there is a growth of companies listed on the Indonesia Stock Exchange of 23% in 2015, from 420 companies in 2010 to 516 companies in 2015. Third, there is a 52% market share capitalization growth in 2015, market capitalization value of Rp3,247.10 trillion in 2010 to Rp4,932.29 trillion in 2015.

Improving market conditions also more people interested in investing in the capital market. Data from the Indonesian Central Securities Depository (KSEI) shows that in 2014 registered investors were 364,465 people. This number continues to increase until finally until the end of September 2017 the total investors in Indonesia amounted to 1.06 million people, increase 191.57% for almost three years. Based on the phenomenon, it shows that investment in capital market is still in demand by investors. This is what motivates researchers related to the factors that can affect investment decision making in the capital market.

Preliminary studies that have been done and the results already achieved by researchers are as follows: Almilia, et al. (2013) examined the model of belief adjustment in research decision making. The results of Almilia, et al. (2013) suggests that "judgment bias", especially the present effect will be higher when the pattern of information presentation is sequential. Research conducted by Almilia (2013) shows that the belief revision model of Hogarth Einhorn (1992) is partially hold in investment decision making. The results of Almilia and Supriyadi (2013) also provide evidence of no effect of recency effect if the disclosure pattern of end of sequence (EoS).

The research related to belief adjustment model has also been done by Pravitasari and Almilia (2015). The results of Pravitasari and Almilia (2015) show the pattern of end-sequence presentation and short information series occurs recency effect. Kusumawardhani and Almilia (2015), Astania and Almilia (2017) and Nisa (2017) show that no difference between participants that were informed a good news followed by bad news with participant who informed good news followed by bad news in step by step presentatiom and complex

information. Almilia and Wulanditya (2016) examined the influence of belief adjustment model and investor confidence in investment decision making. The results of Almilia and Wulanditya (2016) show that individuals with high self-esteem tend to ignore the available information; this has the effect that individuals with high confidence levels avoid sequence effects.

Research-related investment decision-making also focuses on task complexity, use of information technology (interactive and visualization) types of information (pro forma earnings and profit information), and information forms (graphs and texts) show mixed results. Dilla et al. (2013) shows nonprofessional investors in investment decision making influenced by information in the form of graphs, while professional investors in the current investment decision is not affected by the information in the form of graphs. Tang et al. (2014) provide evidence that by presenting a set of information that has only high levels of visualization or high level of interaction alone can reduce the performance of investment decision making. Ang and Trotman's research (2015) also provides evidence that when investment decisions are conducted in groups, groups tend to use quantitative information in comparison with qualitative research.

This study examines the visualization factor and task complexity in investment decision making. Tang et al. (2014) provide evidence that by presenting a set of information that has only high levels of visualization or high level of interaction alone can reduce the performance of investment decision making. Tang et al. (2014) also provides evidence that a comprehensive set of multimedia tools, visualization and interactive, can improve the performance of investment decision making. This study examines the effect of visualization level and level of assignment complexity on investment decision making as measured by level of accuracy, level of confidence and calibration level.

## **2. Literature Review and Hypotheses Development**

### *2.1. The Decision Support Systems Design Theory and Dual Coding Theory*

The potential influence of visualization and interactivity on decision making is known as the Decision Support Systems (DSS) design theory by Kasper (1996). This theory states that decision-making is determined by the symbolic representation descriptions (including visibility) and actions of inquiry. Visibility is the ability of a system to help users visualize the data it receives. Inquirability includes the interaction between information users with the information system available.

Dual Coding Theory developed by Paivio (1986) shows two types of information processing systems namely verbal systems and imagery. Verbal and imagery effects have independent functions but partially have interconnection. If the verbal and imagery systems are activated on the same object, both systems can have additional effects on individual memory and understanding, improving individual performance in decision making (Paivio 1991).

This research incorporates a visualization component in investment decision making. Users of information receiving information with a high level of visualization are expected to perform well in investment decision-making levels.

### *1.2. Effect of Visualization in Investment Decision Making*

Visualization is the selection, transformation and presentation of data in visual form that helps the exploration and understanding of individuals in decision making (Lurie dahn Mason, 2007: 161). This research incorporates visualization effects in the form of visual pointers, ie graphics or images that can facilitate information processing by users of information.

Several studies have shown that the presentation of information in graphical form substantially improves decision making as individuals assess the financial performance of firms (Desanctis and Jarvenpaa, 1989). In contrast to Kaplan's (1988) study that examined the effect of graphical representation and tables when an auditor predicted future account balances and showed no evidence of the effect of information presented in graphical form with information presented in tabular form in predicting future account balances.

In this study, the information presented with high visualization is the information presented in the form of graphs or pictures and tables, while the information presented with low visualization is the information presented in the form of text such as tables. With high visualization is expected to improve the accuracy and performance in decision-making based on dual coding theory.

High visualization in investment decision making is the user can obtain information items in the financial statements in the form of tables and graphs, so that decision makers can use the same data source in the form of images or graphics and text in the form of tables. The information presented in graphical form represents the presentation of information in the processing of imagery systems, while the presentation of information presented in tabular form represents the processing of verbal system information. The results show that the presentation of information in the form of verbal and imagery will improve the accuracy and performance in decision making information (Mayer and Anderson, 1991, Mayer and Sims, 1994).

Visualization can also increase the level of confidence in decision making. Koriat et al. (1980) states that belief is determined by the amount and strength (quality) of information used in decision making. Based on dual coding theory, visualization can provide more information to users in verbal and non verbal information processing systems.

***H1: Decision-makers that obtain information with a high visualization format have high Calibration (Accuracy and Confidence) levels compared to informed decision-makers with low visualization format.***

### *1.3. The Influence of Complexity of Duties in Investment Decision Making*

The complexity of the task is a critical factor in decision making (Chung and Monroe, 2001) and provides evidence that task complexity affects the level of accuracy, degree of confidence and calibration level. The complexity of duties is negatively related to the degree of accuracy. The high level of complexity, the individual processing more information that impacted the processing of information will be overloaded. Conversely, when assignments are simple, decision makers have enough cognitive resources to solve problems and they tend to make accurate decisions (Kosslyn, 1989; and Lohse, 1993).

The task complexity also affects the level of individual beliefs. Efklides (2008) states that the level of confidence in the decision is influenced by two main types of information, namely: estimation of correct answers and difficulty assignment level. If the individual feels that a given task has a high level of complexity, then it affects the decreased level of belief in the answer given.

***H2a: Decision-makers who complete the complexity of high assignments have a low degree of decision-making accuracy compared to decision-makers who resolve the complexity of low assignment.***

***H2b: Decision-makers who complete the complexity of high assignments have a lower level of decision confidence than decision-makers who resolve the complexity of low assignment.***

***H2c: Decision-makers that resolve the complexity of high assignments have low decision calibration rates compared to decision makers that solve low assignment complexity.***

## **3. Research Methods**

This study is an experimental research that is a method to examine the causality relationship with several variables that are manipulated to answer the research problem. Criteria of the subject in this study are: having knowledge in

the field of investment and capital market and financial statement analysis. Participants in this study are accounting students who have knowledge in the field of investment and capital markets and analysis of financial statements shown by having followed the courses of Investment Management and Capital Markets and courses Financial Statement Analysis. This research uses experiment.

Experiment method in this research is 2 x 2 (mixed design). The 2 x 2 experimental methods in this study include: (1) Level of visualization (high and low) and (2) Task complexity (high and low). The dependent variables in this study are the level of accuracy (as measured by the number of correct answers versus the whole question), the level of confidence (average belief rate for all questions given) and calibration level (difference between degree of accuracy and level of confidence). Data analysis technique used in this research is independent sample t-test.

The experimental assignment is that participants are asked to answer the questions provided, i.e. 11 questions with low level of task complexity and 7 questions with high complexity level. Each participant question was asked to fill in the participants' confidence level.

#### 4. Research Results

Participants in this study are students of Accounting Undergraduate Program in one Private University in East Java. Participants in this study are students who already have knowledge in the field of Investment Management and Capital Market and Financial Statement Analysis. The total participants in this study were 103 people, but only 77 participants who passed the check manipulation and can be analyzed further.

Table 1 shows the difference test results of visualization effects at the calibration level. The results of research that examines the effect of visualization effects are grouped into 2 assignments, namely when decision makers receive assignments with high complexity and low complexity.

**Table 1**  
**The Effect of Visualization on Decision Making (Calibration Level)**

Decision Making	Visualization Effect	Average	t-score	Sig
Calibration level on Low Task complexity	Low Visualization	-0,0547	-2,113	0,038
	High Visualization	-0,0121		
Calibration level on High Task complexity	Low Visualization	-0,3855	-0,044	0,965
	High Visualization	-0,3831		

Hypothesis 1 in this research is decision makers who obtain information with high visualization format has a high level of Calibration (Accuracy and Faith) compared to decision makers who obtain information with low visualization format. The results in Table 1 show that when the decision maker completes the assignment with a low task kompleksitas, the average calibration rate on decision makers who receive information with a high level of visualization is higher than the average calibration rate on decision makers who receive information with low visualization level. The results in Table 1 also show that when decision makers complete assignments with high task complexity, there is no difference in average calibration rates for decision makers who receive information with a high level of visualization compared to the average calibration rate on decision makers who receive information with low visualization rate.

The first hypothesis of this research is partially hold when decision makers receive assignment with low complexity so that decision makers who obtain information with high visualization format have high level of Calibration (Accuracy and Belief) compared to decision makers who obtain information with low visualization format.

Table 2 shows the results of different test effects of task complexity on decision making. Decision making in this study is measured by the level of accuracy, level of confidence and calibration level.

**Table 2**  
**The Effect of Complexity on Decision Making (Accuracy, Confidence and Calibration)**

Decision Making	Complexity Effect	Average	t-score	Sig
Accuracy Level	Low Complexity	0,9386	14,318	0,000
	High Complexity	0,5417		
Confidence Level	Low Complexity	0,9728	3,239	0,001
	High Complexity	0,9261		
Calibration Level	Low Complexity	-0,0342	12,298	0,000
	High Complexity	-0,3843		

Hypothesis 2a in this study is the decision makers who solve the complexity of the high assignment have a low level of decision accuracy compared to decision makers who solve the complexity of low assignment. The results in Table 2 show the average level of greater accuracy in decision makers who receive low complexity assignments than decision makers who receive high complexity assignments. The results also show that there is a significant difference in the average level of accuracy in decision-makers who accept assignment with lower complexity than decision makers who accept assignment with high complexity. The results of this study showed hypothesis 2a supported.

Hypothesis 2b in this study is the decision makers who solve the complexity of high assignment have a low level of decision-making compared to decision makers who solve the complexity of low assignment. The results in Table 2 show a higher average confidence level for decision makers who receive low complexity assignments than decision makers who receive high complexity assignments. The results also show that there is a significant difference in the average level of confidence in decision-makers who accept assignment with lower complexity than decision makers who accept assignment with high complexity. The results of this study showed hypothesis 2b is supported.

Hypothesis 2c in this study is the decision makers who solve the complexity of high assignment have a low decision calibration rate compared to decision makers who solve the complexity of low assignment. The results in Table 2 show higher mean calibration rates for decision makers who receive low complexity assignments than decision makers who accept high complexity assignments. The results also show that there is a significant difference in average calibration rates on decision makers who receive assignments with lower complexity than decision makers who receive high complexity assignments. The results of this study showed hypothesis 2c is supported.

The results suggest that the effect of task difficulty on decision accuracy, confidence, and user calibration. The result of this research support Tang et al. (2014) that the effect of task difficulty on user calibration is relatively robust across different tasks and areas. Specifically, when the tasks are easy, providing visualization features to users has a little effect on confidence. Instead, visualization increases users' confidence only if the tasks are difficult.

## **5. Conclusions, Limitations of Research, and Recommendations of Further Research**

This study examines the effect of visualization level and level of assignment complexity on investment decision making as measured by level of accuracy, level of confidence and calibration level. Participants in this study are students of Accounting Undergraduate Program in one Private University in East Java. Participants in this study are students who already have knowledge in the field of Investment Management and Capital Market and Financial Statement Analysis. The total participants in this study were 103 people, but only 77 participants who passed the check manipulation and can be analyzed further.

The results show that when decision makers complete assignments with high task compensation, there is no difference in average calibration rates on



decision makers who receive information with a high level of visualization compared with calibration rate average on decision makers who receive information with low visualization level. However, when the decision maker completes the assignment with low task compensation, the average calibration rate on decision makers receiving information with a high level of visualization is higher than the average calibration rate on decision makers receiving information with low visualization rates. The results also show that there are significant differences in the average level of accuracy, level of confidence, and calibration levels in decision makers who receive assignments with lower complexity than decision makers who receive high complexity assignments.

The results of this study indicate that the visualization effect in decision-making has an effect only when decision makers receive assignment with low complexity of assignment. The results of this study indicate that the effect of the complexity of the assignment influences both decision-making as measured by the level of accuracy, level of confidence and calibration level.

Limitations in this study are still many participants who do not pass the check manipulation; and experiments using paper based. Subsequent research is better to modify the experimental material so that the experimental material can be more easily understood by the participants. In addition, further research can use internet based. The use of internet in experiments can improve internal validity; construct validity and external validity of research results (Nahartyo, 2012). Increased internal validity in experimental research.

## **References**

- [1] Almilia, Luciana Spica, J. Hartono, E. Nahartyo and Supriyadi. (2013). Belief Adjustment Model in Investment Decision Making. *Gadjah Mada International Journal of Business*, 15(2), pp. 171 - 182
- [2] Almilia, Luciana Spica. (2013). Belief Adjustment Model in Investment Decision Making. *Doctoral Program Dissertation Faculty of Economics Gadjah Mada University of Yogyakarta*.
- [3] Almilia, Luciana Spica and Supriyadi. (2013). Examining Belief Adjustment Model on Investment Decision Making. *International Journal of Economics and Accounting*, 4(2), pp. 169 – 183
- [4] Almilia, Luciana Spica and P. Wulanditya. (2016). The Effect of Overconfidence and Experience on Belief Adjustment Model in Investment Judgement. *International Research Journal of Business Studies*, 9(1), pp. 39 – 47
- [5] Astania, A. and L. S. Almilia. (2017). Mitigation of Order Effects on Investment Decision Making. *The Indonesian Accounting Review*, 6(2), pp. 136 – 143.
- [6] Chung, J, and G. S. Monroe. (2001). A Research Note on the Effect of Gender and Task Complexity on an Audit Judgment. *Behavioral Research in Accounting*, 13, pp. 111 – 125.

- [7] Desanctis, G, and S. L. Jarvenpaa. (1989). Graphical Presentation of Accounting Data for Financial Forecasting. *Accounting, Organization and Society*, 14(5 – 6), pp. 509 – 525.
- [8] Dilla, W. N., D. J. Janvrin and C. Jeffrey. (2013). the Impact of Graphical Displays of Pro Forma Earnings Information on Professional and Nonprofessional Investors' Earnings Judgments. *Behavioral Research in Accounting*, 25(1), pp. 37 – 60.
- [9] Efklides, A. (2008). Metacognition: Defining its Facets and Levels of Functioning in Relation to Self-Regulation and Co-Regulation. *European Psychologist*, 13(4), pp. 277 – 287.
- [10] Hogarth, R. M. and H. J. Einhorn. (1992). Order Effect in Belief Updating: The Belief – Adjustment Model. *Cognitive Psychology*, 24, pp. 1 – 55.
- [11] Kaplan, S. E. (1988). An Examination of the Effect of Presentation Format on Auditors' Expected Value Judgments. *Accounting Horizons*, 2(3), pp. 90 – 95.
- [12] Kasper, G. M. (1996). A Theory of Decision Support Systems Design for User Calibration. *Information Systems Research*, 7(2), pp. 215 – 232.
- [13] Koriat, A., S. Lichtenstein and B. Fischhoff. (1980). Reasons for Confidence. *Journal of Experimental Psychology*, 6(2), pp. 107 – 118.
- [14] Kosslyn, S. M. (1989). Understanding Charts and Graphs. *Applied Cognitive Psychology*, 3, pp. 185 – 225.
- [15] Kusumawardhani, H. and L. S. Almilia. (2015). Information Presentation Pattern and Irrational Investor Decision. *Journal of Business and Economics*, 22(2), pp. 140 – 153.
- [16] Lohse, G. L. (1993). A Cognitive Model for Understanding Graphical Perception. *Human Computer Interaction*, 8, pp. 353 – 388.
- [17] Lurie, N. H. and C. H. Mason. (2007). Visual Representation: Implications for Decision Making. *Journal of Marketing*, 71(1), pp. 160 – 177.
- [18] Mayer, R. E, and R. B. Anderson. (1991). Animations Need Narrations: An Experimental Test of Dual-Coding Hypothesis. *Journal of Educational Psychology*, 83(4), pp. 484 – 490.
- [19] Mayer, R. E. and V. K. Sims. (1994). For whom is a Picture worth a Thousand Words? Extensions of A Dual Coding Theory of Multimedia Learning. *Journal of Educational Psychology*, 86(3), pp 389 – 401.
- [20] Nahartyo, Ertambang. 2012. *Design and Implementation of Experimental Research*. PublisherUPP STIM YKPN Yogyakarta.
- [21] Nisa, A. K. (2017). Belief Adjustment Model Test in Investment Decision Making: Experimentation of Short Information Series. *The Indonesian Accounting Review*, 7(1), 15 – 30.
- [22] Pavio, A. (1986). *Mental Representation: A Dual Coding Approach*, New York, NY: Oxford University Press.
- [23] Pavio, A. (1991). Dual Coding Theory: Retrospect and Current Status. *Canadian Journal of Psychology*, 45(3), pp. 255 – 287.
- [24] Pravitasari, N. P. and L. S. Almilia. (2015). The Effect of End of Sequence Presentation Patterns and Short Information Series in Investment Decision Making. *Journal of Business and Economics*, 22(2), pp. 129 – 139.
- [25] Tang, F., T. J. Hess, J. S. Valacich, and J. T. Sweeney. (2014). The Effect of Visualization and Interactivity on Calibration in Financial Decision-Making. *Behavioral Research in Accounting*, 26(1), pp. 25 – 58.