ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 11, Issue 3, pp: (17-21), Month: July 2023 - September 2023, Available at: www.researchpublish.com

Mitigation of Behavioral Biases by Utilizing Artificial Neural Network in Project Management

Khalid H. Alsufyani

DOI: https://doi.org/10.5281/zenodo.8224508
Published Date: 08-August-2023

Abstract: **An accurate estimation of project cost, and time is one of the most vital information for project management team, especially in mega-project involved brownfield scope of work. It is argued that behavioral biases are the root cause of projects underperform which lead to sunk cost fallacy and schedule overrun. Starting from the uniqueness bias which is considered the real feed of behavioral biases. The paper explains the two most popular behavioral biases which are optimistic, and escalation of commitment biases and how mentioned behavioral biases lead to inaccurate estimation of project cost and duration. Then, A solution was proposed to overcome behavioral biases in project management field by utilizing Artificial Neural Network which is a fast and accurate technique for estimating project cost, time, and risk in comparison with traditional methods.**

Keywords: **behavioral biases, optimistic biases, escalation of commitment biases, Artificial Neural Network, Cost and Time Estimation, Project Management.**

1. INTRODUCTION

A new tolling system for the German Federal government was expected to begin tolling heavy truck on motorways and proven the possibility for public-private partnership in infrastructure management. However, the project developers were excessive optimistic about the capability of the created software to run the system which was acknowledged a year later. As a result, the government lost toll revenues of approximately $244M per month and total estimated of $96 billion before the issue could be fixed. The huge lost caused scarcity of funds in which Germany put on hold all new infrastructure projects which negatively impacted around 70,000 construction jobs (Flyvbjerg, Garbuio, and Lovallo., 2009).

Similarly, London's Savoy Hotel renovation project was completed with 100 percent cost overruns and approximately twice the estimated period (Biltz., 2010). 300 percent over project budget was spent to complete the Welsh Assembly Building, and ten times more than estimated project cost was the total cost of the Scottish Parliament Building. In 2004, a project to build an ERP system by car rental firm was canceled due to design and implementation issue after spending $ 54.5 million. The company's CEO said: "We are very disappointed that major IT parts of the project have incurred significant exceptional costs and will not deliver the anticipated benefits. We felt it was right to take decisive action on the results of the review."

In 2005, virtual case file (VCF) project by FBI was canceled with a total spent cost of $170 million. The project duration was three years. However, the software vendor and project's scope were not managed properly resulted the cancellation. In 2008, An airline company canceled a project intended to build a system called Jetsmart parts management after spending $40 million. The issues of the project were identified as early as 2004. However, the decision to cancel the project was taken four years later.

Research found that project completion with a total cost exceeding 100 percent of estimated cost are not uncommon (Flyvbjerg, Garbuio, and Lavallo., 2009; Keil and Mahring ., 2010). For example, study conducted in 20 countries stated that only one out of ten major projects did not experience cost overruns (Flyvbjerg et al., 2002). In addition, 77% of highway projects in the USA suffered from cost overruns based on studies (in kaliba et al., 2008). Furthermore, a study indicates that

an average of 28% is the cost escalation of 86 percent of projects reported a cost overrun (Flyvbjerg et al. 2003a). Acknowledging the gap between project performances and expectations is the first step toward resolving the issue as projects do not become black holes overnight.

Poor decisions are usually a result of insufficient motivation and cognitive biases. In this paper, insufficient motivation will not be addressed. Cognitive biases are defined as a systematic thought process of simplifying received information caused by tendency of human brain through a filter of personal experience and preferences. In project management field, decision maker usually tends to simplify the project performance indications to avoid making a difficult decision such us cancel or put a project on hold even if the project performance is clear that project is benefit shortfalls. Other examples, project team tends to justify project cost overrun or delays as a result of project complexity, changes in project scope, and unexpected site conditions which are considered as cognitive biases. Cognitive biases are only half of the issues associated with project cost overrun and delays. The other half of the issue is the behavioral biase which the author considers it as the main cause of project issues. The behavioral biases may be cognitive biases or emotional biases. One of the most behavioral biases in project management filed which lead to the main two behavioral biases optimistic and escalation of commitment biases is uniqueness bias.

uniqueness is directly emphasized as one of two defining features for project. As per Project Management Institute (PMI, 2017, p. 4) "A project is temporary endeavor undertaken to create unique product, service, or result". In reality, projects are not completely unique as many projects considered unique do not utilize non-standard designs and technologies. Therefore, managers and planners must trace all accurate estimation in comparison to actual project cost and execution duration opportunities of other similarly and non-similarly projects in which minimize the contribution of uniqueness biases in project management field. The risk of uniqueness biases contribution in project cycles is that project planners and managers will not utilize the knowledge gained during similar or semi-similar projects including how these project events were addressed or should be addressed in future. As a result, non-accurate cost and duration estimation will drive the project to cost overrun and extension of project duration resulted by uniqueness biases where previous risk events were underestimated and not consider from similar projects.

A Research conducted by Budzier and Flybgjerg (2013) and Budzier (2014) found that project team performance significantly improves when they do not consider their project as a unique. The research emphasizes the importance of learning from other projects by taken all lesson learned into consideration for estimating project cost and duration. Kahneman (2011, p. 247) explains the "inside view" as when project planners concentrate on certain events and components of the project and seeking evidence to prove this perspective. For the explanation, it is obvious that the main root cause of "inside view" is uniqueness bias. Avoiding uniqueness bias is extremely difficult, when planners estimate project budget and schedule based on the inside view or bottom-up technique as in conventional cost engineering. Therefore, the concept of "outside view" is an alternative method where planners view new projects from the perspective of similar, and completed project. The outside view will assist planners to build the estimation of project budget and schedule based on actual outcomes of these projects taken into consideration all associated risk events occurred in previous completed project.

The fact that project might be unique in term of geography and time should not be overheard, even if it is self-evidently true. In addition, Scope changes, project complexity, price changes, unexpected projects site conditions, bad weather, and so on are not the root cause of projects cost overruns, delays. This paper emphasizes the main root cause of behavioral biases which are optimism, and escalation of commitment biases. In addition, the author proposed a solution to mitigate the mentioned behavioral biases by utilizing Artificial Neural Network (ANN).

Optimism Bias:

Optimism bias is a cognitive bias in which individuals are non-deliberately optimistic about the consequences of taken or planned actions (Kahneman, 2011, p. 255). "one of the greatest deceptions of which the human mind is capable" Sharot (2011, p. xv). Individuals, and groups make decisions based on optimistic vision of the future including overestimate gains and underestimate losses instead of a rational and realistic view of a project duration, cost, and risk. Optimism bias is non-deliberate scenarios of success and neglect the potential for miscalculation of project time, cost, and risk. Therefore, project will not be delivered as per schedule, and cost due to low estimation influenced by optimistic bias by project management.

Optimism bias is ubiquitous and directly link with the way the mind processes information which is a systematic deviation from the rationality (O'Sullivan, 2015; Sharot et al., 2007; Shepperd et al., 2002). Delays or cost overrun in project are usually justified by forecasters as a result of scope changes, complexity, unexpected conditions, price changes, and so on

where optimism bias might be the main cause. Optimism bias is a cognitive bias which can be proven by psychologists since it has not been recognized as a main cause of project delays and overrun. Moreover, the impact of optimism bias has not been studied in real-project planning and management situations instead most of the studies are performed in laboratory experiments with students (Buehler et al., 1994; Newby-Clark et al., 2000) which is a dilemma and open question.

In project management filed, team must be optimistic to complete project activities as stated by Kahneman (2011, p.255) optimism is "the engine of capitalism". However, optimism can lead project team to take on risks that would have been avoided if the real situation, non-optimistic, is well defined and recognized. If the real situation was known, many projects cost overrun and delays can be avoided such as transportation projects (Van Wee, 2007). (Flyvbjerg & Gardner, 2022) found that project team shall have a combination of hyperrealism and optimism attitudes which called "realistic optimists" to be make rational decisions and succeed in project management field.

Planning for the worst-case scenario is vital to succeed in projects and businesses in which "the more paranoid we are, the harder we will continue to labor to shift the probability curve in our favor and the more optimistic we can afford to be" (Siilasmaa, 2018, p. xvi). Simplify, Plane passengers will leave the plane if the pilot states he is optimistic about the fuel level same as project team cannot be trusted if project schedule and budget were optimistically estimated since schedule and budget are the project fuel. Doubtless, projects with cost underestimate and benefit overestimates are more likely to be approved and funded by top management. At the same time, these projects are more likely to end-up with a great cost overrun. It can be concluded that project selection criteria must be changed to more rationally approach.

Escalation of Commitment:

"Throwing good money after bad" and "In for a penny, in for a pound" are popular proverbs of escalation of commitment. Escalation of commitment, also known as commitment bias, is a behavior of neglecting all indications of wrong investment decisions associated with time, cost, and risk investment which leads to falsely decide to invest more which is highly influenced by previous investment that has been done. It is a non-accurate justification of further investment. For example, two friends invested more time, cost, and risk attempting to drive to attend a proficiently basketball game in a major winter storm day due the high-ticket prices paid (Thaler, 2015, p.20). That is escalation of commitment. Therefore, it is clear that the potential of escalation of commitment occurs increased with high investment. Individuals, groups, and whole organizations shall not decide to continue investing based on what was invested before which will be a rational approach.

The difficulty to identify behavioral biases is the main challenge which are not like other cognitive biases. However, Understanding the mechanism of escalation of commitment would help a decision maker to realize it, especially if it is used deliberately. Once project started where significant amount of money and duration had been spent, any suspension of the project would cause an irretrievable loss, not only money but of 'face'. Misrepresentation of the real cost of a project and spending a sufficient cost to create a point of no return are an example of strategic misrepresentation. After a while, project manager and planner will most likely fall to cognitive bias where more money and time will be invested claiming that the project complexity was not accurately addressed, labor and material prices have increased, and so forth. in fact, it is escalation of commitment in form of complex interaction result of cognitive and political bias.

Expo 86 (Ross & Staw, 1986), the Shoreham nuclear power plant (Ross & Staw, 1993), and Denver International Airport (Monteagre & Keil, 2000), are excellent studies illustrated the influence of escalation of commitment in project management field. Monteagre & Keil, 2000 created a process model of de-escalation that would help to avoid 16 months behind schedule and around $2 billion over budget occurred at Denver International Airport for automated baggage system project. Usually, the escalation of commitment influence starts when a project team realized that the earlier forecasted cost, time, risk is not valid as giving up the project is not an option.

Flyvbjery (2009b) argued that organizations are drawn to invest in a project based on earlier underestimation of time, cost and risk as a result of preferential attachment which ends up with largest additional required funding and duration to complete the project. Due to lock-in and a point of no return which will be followed by escalation of commitment where more fund and resources will be allocated to minimize the gap between earlier underestimation of time, cost and risk and actual project progress.

Solution:

The above two mentioned behavioral biases are not the only biases that caused schedule delays, cost overrun, and accepted risks that should never been accepted (Flyvbjerg, 2021). These behavioral biases can be mitigated by utilizing Artificial Neural Network (ANN). ANNs are a machine learning technique based upon mathematical models used to accurately

estimate actual cost of work performed ACWP), and Estimate at Completion (EAC) which are a non-linear function in real project execution field with the ability to utilize "piece-wise" approximations of functions which make ANNs an interesting feature. ANNs consists of three different layers named input, hidden, and output layers with a certain neuron of each layer. ANN designer carefully decides the layer number as it is the most vital factor for achieving accurate schedule, and cost estimation. Then, the built ANN must be trained by feeding the network of input collected from historical data in which the actual cost of a completed project is compared with the network outcome. ANN shall be trained until the desired outcome is achieved. Therefore, the number and quality of historical data are the second important factor for building an accurate neural network.

Once the network is trained, the learning process of neural network will be commenced. In the learning process, several iterations are conducted to adjust any behavioral biases which will lead to minimize any measured error by comparing the network output with the actual cost of completed project. The error correction is repeated until reaching an accurate convergence of the actual data from completed project. The fact that project management team usually needs to estimates project cost and duration at earlier stage such as pre-design stage with a short time which make applying ANN a promising tool to accurately estimate cost and time of a project. The accuracy of estimated cost and time by utilizing ANN over conventional methods are obtained from the fact that ANN is built based on knowledge and experience from previous completed projects. As a result, behavioral biases can be mitigated.

There are number of decision-marking and estimating studies applied ANN approach such as (Chua et al., 1997, Tabtabai et al., 1997, Adeli & Wu, 1998, Hegazy & Ayed, 1998). However, there is a notable gap that no studies are concerned with cost and time estimation for brownfield projects in oil and gas project. The authors suggest that building an ANN model based on current data base of the previously completed projects taken into consideration construction activities that have high weight weighable activities such piping work would significantly improve the cost and time estimation of the project during pre-design, design, and construction phases. The first step to control behavioral biases in project management field starts by measuring and categorizing these behavioral biases to eliminate associated impacts which are the root cause of project cost overrun, and delays.

Training Artificial Neural Network models requires collecting numerous of high-quality data for several completed projects to reach an accurate estimation of project cost and time. This limitation can be resolved, if organization can provide high-quality data of executed projects to be used as input data to train ANN model. In addition. ANN designer can utilize project simulator to generate the basic data that can be used as input data.

2. CONCLUSION

The risk of behavioral biases considered to be the main root cause of project cost overrun and delay schedule which are significantly increased in mega-projects, especially in brownfield projects where the level of uncertainty is high. One of the most promising techniques to overcome the behavioral biases is utilizing Artificial Neural Network to estimate cost and time for projects. The well-known limitation of the availability of high-quality data to train ANN model can be dominated by utilizing the project simulator techniques which will improve the estimation of project cost and duration, especially at earlier stage. The project simulator techniques will facilitate the required training process to improve the ability of ANN model to estimate the cost, and schedule of a project.

REFERENCES

[1] Adeli, H. & Wu, M. (1998) Regularization neural network for construction cost estimation. *Journal of construction Engineering and management, 124*(1), 18-24.

[2] Al-Tabtabai, H., Kartam, N., Flood, I. & Alex, A.P. (1997). Expert judgment in forcasting construction project completion. *Engineering Construction and Architectural Management, 4*(4), 271-293.

[3] Biltz, R. (2010). "Savoy reopens after 220m revamp," *Financial Times*, 8 October, http://www.ft.com.

[4] Budzier, A., & Flyvbjerg, B. (2013). Making sense of the impact and importance of outliers in project management through the use of power laws. Proceedings of IRNOP (International Research Network on Organizing by Projects), Volume 11, June, PP.1-28

[5] Budzier, A. (2014). *Theorizing outliers: Explaining variation in IT project* performance (Dphil thesis). Green-templeton College.

[6] Buehler, R., Griffin, D., & Ross, M. (1994). Explroing the 'plannig fallacy': Why people underestimate their task completion times. *Journal of personality and Social Psychology, 67,* 366-381.

[7] Chua, D.K.H., Kog, Y.C., Loh, P.K. & Jaselskis, E.J. (1997). Model for construction budget performance: Neural network approach. *Journal of construction Engineering and management, 123*(3), 214-222.

[8] Flyvbjerg, B., & Gardner, D. (2022). *Big Plans: Why most fail, how some succeed.* Penguin Random House.

[9] Flyvbjerg, B., M.S. Holm, and S. Buhl. (2002) "Underestimating Costs in Public Works Projects: Error or Lie?," *Journal of the American Planning Association,* 68/3, 279-295.

[10] Flyvbjerg, B., N. Bruzelius and W. Rothengatter. (2003a). Megaprojects and Risk: An Anatomy of Ambition. Cambridge University Press, Cambridge.

[11] Flyvbjery, B. (2009b). Survival of the unfittest: why the worst infrastructure gets built, and what we do about it. *Oxford Review of Economic Policy, 25*(3), 344-367.

[12] Flyvbjery, B. (2021). Top ten behavioral biases in project management: An overview. *Project Management Journal, 52*(6), 531-546.

[13] Flyvbjery, B., Garbuio, M., and Lavallo, D. (2009). "Delusion and deception in large infra-structure projects: Two models for explaining and preventing executive disaster," *California Management Review*, 51: 93-170.

[14] Hegazy, T. & Ayed, A. (1998) Neural network model for parametric cost estimation of highway projects. *Journal of construction Engineering and management, 124*(3), 210-218.

[15] Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Stratus and Giroux.

[16] Kaliba, C., M. Muya, and K. Mumba. (2008). "Cost escalation and schedule delays in road construction projects in Zambia." *International Journal of Project Management:* doi:10.1016/j.ijproman.2008.07.003

[17] Keil, M. and Mahring, M. (2010). "is your project turning into a black hole?" *California Management Review*, 53: 6-28.

[18] Monteagre, R., & Keil, M. (2000). De-escalating information technology projects: Lessons from the Denver International Airport. *MIS Quarterly, 24,* 417-447.

[19] Newby-clark, I. R., Ross, M., Buehler, R., Koehler, D. J., & Griffin, D. (2000). People focus on optimistic scenarios and disregard pessimistic scenarios while predicting task completion times. *Journal of Experimental psychology: Applied, 6*(3), 171-182.

[20] O'Sullivan, P. (2015). The neural basis of always looking on the bright side. *Dialogues of Philosophy, Mental and Neuro Science*, 8(1), 11-15.

[21] Project Management Institute (PMI). (2017). *A guide to the project management body of knowledge (PMBOK guide)* – Sixth edition. Author.

[22] Ross, J., & Staw, B. M. (1986). Expo 86: An escalation prototype. *Administrative Science Quarterly, 31* (2), 274-297

[23] Ross, J., & Staw, B. M. (1993). Organizational escalation and exit: The case of the Shoreham Nuclear Power Plant. *Academy of Management Journal, 36*(4), 701-732.

[24] Sharot, T. (2011). *The optimism bias: A tour of the irrationally positive brain.* Pantheon.

[25] Sharot, T., Riccardi, A. M., Raio, C. M., & Phelps, E. A. (2007). Neural mechanisms mediation optimism bias. *Nature, 450*, 102-105.

[26] Shepperd, J. A., Carroll, P., Grance, J., & Terry, M. (2002). Exploring the causes of comparative optimism. *psychologica Belgica, 42,* 65-98.

[27] Siilasmaa, R. (2018). *Transforming Nokia: The power of paranoid optimism to lead through colossal change*. McGraw Hill.

[28] Thaler, R. H. (2015). *Misbehaving: How economics became behavioural.* Allen Lane.

[29] Van Wee, B. (2007). Large infrastructure projects: a review of the quality of demand forecasts and cost estimations. *Environment and Planning B: Planning and Design,* Vol. 34, pp. 611-652.