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## Capital budgeting for electrical engineering projects: A practical methodology

Pravin Sankhwar\*

*Independent Researcher, Electrical Engineering, Gujarat, India.*

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### Abstract

The paper presents the capital budgeting process and identifies key elements in the process. A standardized approach in capital budgeting by application of information technology resources for both proposal submission and documentation becomes key to success in handling large volumes. An electrical engineering distribution system design project involves the application of engineering codes and standards to stay compliant and provide safe design and construction. A model starting with proposals acceptance to evaluation and approval of capital projects was presented. The proposal stage was decoded further into assessments of the existing electrical infrastructure based on aging and engineering standards. Upon review of the standards, the proposals were accepted for evaluation and approval. For business professionals, there is a gap when working in an electrical engineering construction industry when it comes to knowing applicable engineering standards and their application. This research filled that gap by enlisting the intent of the standards review process. Although the focus was on understanding a holistic approach to electrical engineering projects, a detailed analysis of specific tasks may be designed based on the model presented in this paper. Additionally, the transmission side of projects will have a similar application of capital budgeting.

**Keywords:** Capital Budgeting; Electrical Engineering; Engineering Standards; Engineering Assessments; Electrical Power Distribution System

### 1. Introduction

Capital budgeting is a way to determine the funds required to accomplish a mid to a large size project for any firm (Mukherjee & Scott Jr, 1987; Schönbohm & Zahn, 2016). The objective is to be able to determine the budget so that the company is able to allocate resources and keep the company value within the expectations. For example, a capital project for improvement of the processes of the manufacturing in an industry required to compete with other firms because of improving technology is something a firm must start planning ahead otherwise they might fall behind other organizations (Choi & Yoo, 2022; Yao & Li, 2023). The cash flow implications are considered during the capital budgeting process wherein the exact estimates of the cash flows are determined. There are key terms to learn here namely cash inflow and the outflow. When these terms are understood in terms of the opportunity cost and the time of the value then there are more insights developed in the capital budgeting.

Let us consider an example of capital budgeting a project for development of a dam project there are several aspects the company must have to consider around the allocation of the money. It can start with high level estimation of the project design and construction costs. Then it follows with the development of plans to get the permitting from various agencies. It factors in the costs due to waiting for approval or acquiring land or other resources. So, the concept of opportunity costs comes into play as it is something that relates to the value.

For example, the funds are limited so there is a need to use them to its most value so that there is no loss of interest. Many times the money comes from tax payers share (US Department of the Treasury, 2023) and it can be daunting if the results were not satisfactory from the capital project due to improper utilization of the funds. Next is the term that

\* Corresponding author: Pravin Sankhwar

tosses around the opportunity cost is the time of the value of the money. The cash flows must ensure the time of the value of the money is taken care of in the accounting as they are the ones that would lead to optimal utilization of the funds. Just in simple terms the value of the money grows with time and thus considerations around keeping the money's worth accounted is a great tool when capital budgeting is concerned.

There are several steps in the capital budgeting process wherein a limited staff from the firms starts to engage in the decision-making processes. A group of accounting staff prepares the historic utilization and records for the capital budget and expenditures and allows the decision-making group to ensure they have the resources to develop a capital budget plan for the upcoming years. Although the expertise lies within the top management professionals, the role of the line managers and their subordinates is key to learning the needs of the organization for the upcoming years for both manpower, training, and technology requirements (Kuroki, 2022).

Firstly, the identification as mentioned earlier is performed by engaging discussions with the people within the organization or even external stakeholders may provide some ideas (Schoenmaker & Schramade, 2023). There may be flooding of proposals coming in from varied departments, and the top management would be overwhelmed with the same. But the key to identifying or approving a project lies with the fact that some of them may either be relevant and some may not. Many may require immediate attention and fewer may not. So, filtering the required proposal and prioritizing them becomes a viable option when capital budgeting for large number of proposals is concerned.

Secondly, a group effort is required to start gauging the projects that are resultant of the proposals. When the group, constituted of the line managers and top management staff members, decides to pursue a project the discussion is around scoping and finding optimal resources and funds. It may be likely that with discussions some estimates may result in cheaper ways to deliver the project. Many critical paths would have risks that may be within tolerable limits and some may not.

Thirdly, just like any other project management processes, implementation of the project may be done by capital allocation. Approved projects are allocated with the funds for execution, they might sometimes have inadequate budget left towards the end of the project. Thus, accurate determination of the scope of the work plays a key role there. And, finally, it ends with the evaluation and review. Lessons learnt are documented by the staff members and used for improving the processes going forward.

When it comes to seeing ideal practices at the budgeting there are some lessons learnt from industry practices such as focussing on the cash flows, estimating with accuracy, proper timing, establish a plan or framework, and utilize feedback. As the capital budget are something that lapse during end of the period of allocation, there is a need to accurately allocate the same based on the projects planned (Ermasova N. , 2020). In accuracies in the cash flow estimation and timing issues are detrimental for the company when spendings and capital budgeting is seen.

A simple example is where infrastructure project was planned under a capital budgeting for three fiscals' years for design and construction completion. However, many issues with lack of materials availability due to supply chain issues and lack of labor to support the project due to undue weather conditions may result in losses. The risks must be documented and the costs associated must be accounted for during the capital budgeting.

When complains within the project teams starts to accumulate for the delayed schedule of the work and associated cost increase, the liability of the capital budget allocating teams comes into picture. The questions are certainly raised for mis calculations and oversights in the budget allocation. There are ways to allocate additional funds due to contingencies such as weather conditions restricting constructions or supply chain issues with materials purchase such as using the unallocated reserves or savings from other capital projects during the same review period. However, these decisions are to ensure the flow of funds but doesn't allow the budgeting teams to inaccurately determine the capital budgets of the planned capital project for the given period.

Electrical engineering projects for large infrastructure development include power distribution for a large township or large commercial buildings (Gort, *The Planning of Investment: A Study of Capital Budgeting in the Electric- Power Industry. I*, 1951; Gort, *The Planning of Investment: A Study of Capital Budgeting in the Electric- Power Industry. II*, 1951). There are projects related to routine maintenance and operations to large-scale upgrades to the system from aging, and deficiencies from gaps between engineering standards and existing infrastructure. Capital budgeting in these cases is similar to a typical capital project budgeting but will engage detailed engineering assessments of the infrastructure by professionally certified and experienced professionals to provide recommendations on needed repairs and upgrades to existing systems. This paper is organized into sections: introduction, literature review, research methodology, practical application, and conclusion.

The purpose of this research is to establish how important capital budgeting is for an organization. A simple pathway to allocation of the capital budget for a given fiscal year was presented wherein the top management along with other support staff starts to entertain proposal and then approves of the capital project. Resources and funds are allocated using the estimation and lesson learnt from the past projects along with risks associated were factored into for the practical application of the concepts in the capital budgeting. The review of the literature is focussed on the capital budgeting concepts and ideas presented by the researchers in the past of a successful delivery of capital projects for mid to large size firms.

There may be gaps seen between the communication of the teams submitting the proposal to the top management and the accounting staff. The top management may sometimes be less aware of the costs and practical risks associated with the work. Sometimes the costs may inaccurately determine by accounting staff and many times some proposals may not come to the management's attention because of lack of documentation. The criticality of the documentation, estimation, coordination, and risk management is very important when the purpose of this research comes into picture for a capital budgeting. The focus may not be limited to determination of the budget but also to filter off the right project at right periodization.

Some keys here to highlight include presenting a practical application of a firm that is working on a large infrastructure development project, seeking proposals, and thus budgeting them. The development of a process for proposal acceptance and review was modeled. The use of information technology resources and easy-to-use interactive applications on the company portal with closed-loop communication between the teams is a key aspect from a capital budgeting standpoint and was presented in the practical application of this work.

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## 2. Material and methods

The capital budgeting process involves fears that the budget officers may have when large amounts of cash flows will trigger negative thought processes due to failures (Kuroki, 2022). Depreciation information is a key indicator of a lack of interest by government officials in capital budgeting. Internal decision-making is highly dependent on the accuracy of the costs. Any uncertainty around the costs and allocation of resources (Kuroki, 2022) is seen as a driving factor for its rejection. Lack of information and knowledge becomes a limitation to the officers when evaluating the worth of capital assets. The decision-making process often involves acceptance or rejection of the proposal, methods to obtain the cost of capital and equity, and risk analysis methods (Brinks, Haddad, Lotfaliei, & Trombley, 2020). So, this explains why there is a rejection by the government officers with the limited information.

The methods for the capital budget include Net Present Value (NPV), Internal Rate of Return (IRR), Performance Index (PI), Average Accounting Return (AAR), and Payback Period (PV). It was found by the authors that the best method used were PB and NPV methods (Brinks, Haddad, Lotfaliei, & Trombley, 2020). NPV is often utilizing the cash inflows and outflows and accounts the discounted rate. The positive value of NPV is indicator of positive sign for proceeding. On the other hand, PB is the factoring in the time to get the investment back and there is no monetary value given so it ignores the profitability. The next aspect is to know the risk and thus risk analysis for the cash flows serves as an excellent tool for the capital budgeting. However, NPV factors in the profitability of the firm and thus ensure the stakeholders are happy with the outcomes when returns on investment are a key indicator.

Public capital budgeting is complicated and at times does more stringent review processes to ensure there is less chances of failure as there were evidences seen in the researches (Brunner & Ostermaier, 2019) and (Brinks, Haddad, Lotfaliei, & Trombley, 2020) for public officials encouraging information and knowledge to proceed with large capital budget allocation. The model for capital budget and the project management works in a integrating manner wherein the long range needs are first forecasted or obtained by proposal from the various teams. The planning and project management are closely coordinated before the capital budgeting is pursued. All the options for how to obtain funds by financing is determined during the project management phase.

Describing the capital budgeting after planning starts with budget request generated and passed along the way to the top managers for approval. Then there is a coordination with the capital and operating budgeting allocation and teams. When there are many external stakeholders involved in the financing or funding there are several meetings with them to ensure that the federal, state, and city officials are aware of the project budget allocation. Upon approval the key is to track the budget expenditures as the project moves along. There is a mechanism required to ensure that the budget is maintained and fundings are re designated as required on a rolling basis.

External stakeholders are players that may show up at any point as they may be silent for some reasons. Thus, the risk management must factor in the entry of stakeholders (phantom) at any point of the project processes. Some

stakeholders may be very strong in terms of power and influence so they must not be ignored at all. A project management team must focus on them when capital budget allocation for the given project. For example, say a manufacturing process improvement may be approved by the engineering teams at design but the operations being a major stakeholders would have a strong opinion on not proceeding with certain processes due to practical challenges that engineering design team may lack knowledge and awareness.

Some other frameworks for capital budgeting decision making includes capital asset pricing model (CAPM) and betting (Johnstone, 2023). Some aspects of the decision making for funds allocation is seen as a betting process. The managers are often determined at their educated bets to achieve success with the way they allocated resources and funds to gain a positive return or at least the returns they anticipated. For example, a subjective probability of events happening, and risk taken by investing money become a betting factor for the manager (Johnstone, 2023).

The states have a varying spending depending on the politics and debt limits (Srithongrung, 2018). The failure to report the actual information also called sabotage is detrimental to the profitability on the capital budgeting (Brunner & Ostermaier, 2019). Both small business and large firms use the capital budgeting to allocate funds for improvements (Purnamasari & Adriza, 2024), however, as realized the spendings are influenced so is the information. The role of ethical behavior when the managers are collecting the information and documenting for further processing.

For example, lets say a manager got a proposal from their subordinates on a critical system that required repair. However, the manager ignored the same because if presented to the top management it may be seen as a negligence as it should have been presented years before. The manager choses to hide it and thus there is a lack of reporting of the project. Similarly, a manager may lack to report the right processes to be used for a capital project from ignorance. They may not be interested in learning and getting trained on new technologies that may possibly improve the processes leading to lack of interest and allocation of more money due to the same.

Engineering standards assessment for existing infrastructure begins with documenting applicable local codes and standards enforced. For example, the National Electrical Safety Code and the National Electrical Code are major design engineering standards applicable for electrical distribution system design (Woodgate, 2022; Georgia Southern University, 2021). Additionally, energy conservation for commercial buildings is governed by International Energy Conservation Code, and ASHRAE 90.1. Some specific National Fire Protection Association (NFPA) standards govern the life safety, and emergency operations of a commercial building. However, local government agencies enforce specific standards applicable to their operations. These standards are applicable for both new construction and renovations to existing electrical systems. There are many international organizations such as American National Standards Institute (ANSI), Code of Federal Regulations (CFR), European Telecommunications Standards Institute (ETSI), International Electrotechnical Commission (IEC), Institute of Electrical Engineers (IEEE), International Telecommunications Union (ITU), International Organization for Standardization (ISO), National Institute of Standards and Technology (NIST), Society of Automotive Engineers (SAE), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA) and so on that provide engineering standards for electrical engineering projects.

Let us consider a firm that operates on infrastructure development projects for wastewater treatment plants and other water pumping stations for a major county in a given State. The application of capital budgeting begins with the stage wherein the company develops an application in the intranet for the employees and other stakeholders from public to submit proposal at given time frame. For example, January of each calendar year becomes beginning the acceptance of new proposals and June becomes end of the acceptance period. After that the company managers starts to review them based on supporting documentation. During the review meetings there is balloting by the committee members on which ones are the critical ones and are required to be prioritized and then a list is prepared for further discussions. A closed loop documentation wherein all the members can see the process of acceptance or reject of the proposals is developed.

Projects approved then starts with rigorous processes of risk determination and costs estimation with closed loop communication with experts within the company and consulting supports. The lessons learnt from past for other capital projects are factored in to improve the budget allocation process. A web portal to ensure there is a budget submitted and passed to the appropriate channel for timely approval is ensured by use of information technology experts. The key indices are calculated such as payback period and analysis of net present value, profitability, and returns on investment are performed. Some uncertainties are there, which may restrict the allocation with accuracy, and thus, real options analysis plays a key role.

For example, there were proposals accepted for repairing aging infrastructure, application of new technology in the water filtering process, and launching new applications for customer complaints. The top management, during the balloting process, may review all the given proposals and determine which ones are a priority. Say aging infrastructure

will get priority of the repairs of the elements that are at criticality of failure in next year than the ones that may have at later years. Thus, the budget may allocate based on the prioritization of the repairs. Similarly, new technology application will depend on industry shift the same and whether it is required at given year or not. Customer complaints may be addressed by launching a new application and this might get the priority. Fig. 1 shows a simple process flow for capital budgeting decision making a monitoring process.

Utilization of the known indices for the budget allocation serves as a key tool upon learning from the literature review. For example, PB and NPV were they major indicators of the firm’s success for pursuit of a given project. Although PB was indicator of years or timelines to get project completed but was lacking the monetary profits from the same, the NPV become an indicator of the profits as it accounted the net present value of the projects. Without knowing the monetary benefits of a project there are less chances of approval for a firm that is focused on profit optimization and increasing the revenue. Many capital projects may not have a direct implication on the profits, but they may have a long-term benefit. For example, Tesla invested in R&D for long term projects, and upon success, they become market pioneer in the electric vehicles market. Thus, the concept learned in the literature review of betting in the capital budgeting by the managers is available for the practical application here in this paper.

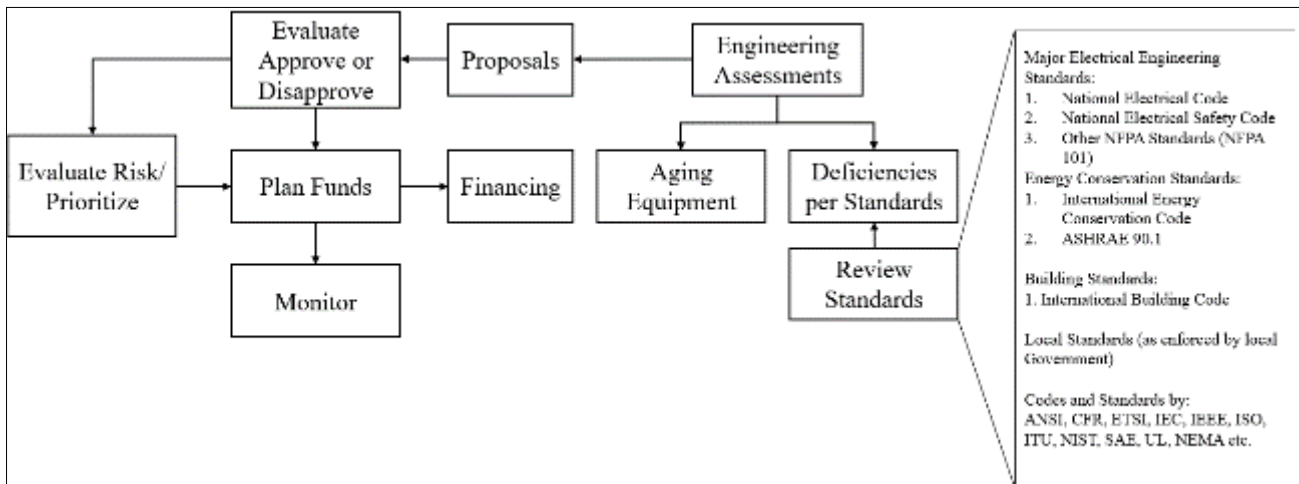


Figure 1 Simple Process Flow for Capital Budgeting

### 3. Conclusion

The holistic model of how the coordinated manner of operation of a firm for the budget allocation of the capital projects was understood. Electrical engineering standards’ role in capital budget planning was incorporated in the model. The need of engagement of the top management, accountants, external stakeholders and the line managers by a closed loop communication channel by deployment of IT infrastructure and resources was highlighted. Although the capital projects have a certain timeline and the funds may lapse at the end of the cycle, the savings may help for another capital project when in need. The key to the documentation of the work is essential as they serve as goby for the next cycle of the capital budget allocation process. PB and NPV were the key elements learned for the capital budgeting and decision-making process. The elements of capital project planning, project management, and execution with respect to the capital budgeting process were presented. Capital budgeting is heavily dependent on the project planning process that was touched upon here in this paper.

Although engineering standards are subject to amendments during the regular review cycle, a firm must be prepared for compliance with the latest standards upon enforcement of the latest versions. Additionally, the scale of the project impacts the budgetary allocation as larger projects tend to have more costs and risks. Small projects may sometimes are not part of capital projects and are accomplished within regular operating budgets. Business professional tends to have a gap in their understanding of engineering principles. A business professional, in collaboration with electrical engineering experts, can streamline the processes related to capital budgeting. For example, some safety-critical repair items based on an assessment of standards may be subject to immediate attention, whereas regularly operating systems within permissible limits may be prioritized in the next cycle of budgeting. New construction projects get priority based on many other factors. When planning such projects electrical distribution systems go hand in hand with trades involved in architectural, landscape, structural, civil, mechanical, plumbing, and fire protection. This paper focused on the distribution side of the electrical system; a similar approach may be followed for transmission systems.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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## References

- [1] Brinks, S., Haddad, K. M., Lotfaliei, B., & Trombley, T. E. (2020). A Synthesis of Capital Budgeting Techniques Around the World: 1990-2018. *JSTOR*, 58(4), 105-130. Retrieved from <https://www.jstor.org/stable/10.2307/27159073>
- [2] Brunner, M., & Ostermaier, A. (2019). Sabotage in Capital Budgeting: The Effects of Control and Honesty on Investment Decisions. *The European Accounting Review*, 28(1), 71-100. Retrieved from <https://doi.org/10.1080/09638180.2017.1412338>
- [3] Choi, S., & Yoo, J. (2022). The Impact of Technological Innovation and Strategic CSR on Firm Value: Implication for Social Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(188), 1-20. Retrieved from <https://doi.org/10.3390/joitmc8040188>
- [4] Ermasova, N. (2020). 35 Years of Public Capital Budgeting: A Review and Future Research Agenda. *Public Finance and Management*, 19(4), 297-326. Retrieved from <https://www.proquest.com/scholarly-journals/35-years-public-capital-budgeting-review-future/docview/2568313371/se-2>
- [5] Ermasova, N., & Mikesell, J. L. (2019). Public Capital Budgeting and Management: The Concept and Its Application in Three Important Federations. *Public Finance and Management*, 19(3), 175-199. Retrieved from <https://doi.org/10.1177/152397211901900301>
- [6] Georgia Southern University. (2021, October 25). Engineering Standards. Retrieved October 20, 2024, from Electrical and Computer Engineering: <https://www.georgiasouthern.edu/cec/ece/engineering-standards/>
- [7] Gort, M. (1951). The Planning of Investment: A Study of Capital Budgeting in the Electric- Power Industry. I. *The Journal of Business of the University of Chicago*, 24(2), 79-95. Retrieved from <https://www.jstor.org/stable/2349908>
- [8] Gort, M. (1951). The Planning of Investment: A Study of Capital Budgeting in the Electric- Power Industry. II. *The Journal of Business of the University of Chicago*, 24(3), 181-202. Retrieved from <https://www.jstor.org/stable/2349853>
- [9] Johnstone, D. J. (2023). Capital budgeting and Kelly betting. *Australian Journal of Management*, 48(3), 625-651. Retrieved from <https://doi.org/10.1177/03128962221118837>
- [10] Kuroki, M. (2022). Impact of Depreciation Information on Capital Budgeting among Local Governments: A Survey Experiment. *Australian Accounting Review*, 32(101), 201-213. doi:10.1111/auar.12355
- [11] Mukherjee, T. K., & Scott Jr, D. F. (1987). The Capital Budgeting Process of large Firms: An Analysis of Capital Budgeting Manuals. *The Financial Review*, 22(3), 92-92. Retrieved from <https://doi.org/10.1111/j.1540-6288.1987.tb01226.x>
- [12] Purnamasari, P., & Adriza. (2024). Capital budgeting techniques and financial performance: a comparison between SMEs and large listed firms. *Cogent Economics*, 12(1), 2404707. doi:10.1080/23322039.2024.2404707
- [13] Schoenmaker, D., & Schramade, W. (2023). Capital Budgeting. In: *Corporate Finance for Long-Term Value*. Springer Texts in Business and Economics. Corp, 173-204. Retrieved from [https://doi.org/10.1007/978-3-031-35009-2\\_7](https://doi.org/10.1007/978-3-031-35009-2_7)
- [14] Schönbohm, A., & Zahn, A. (2016). Reflective and cognitive perspectives on international capital budgeting. *Critical Perspectives on International Business*, 12(2), 167-188. Retrieved from <https://doi.org/10.1108/cpoib-02-2013-0006>
- [15] Srithongrung, A. (2018). Capital Budgeting and Management Practices: Smoothing Out Rough Spots in Government Outlays. *Public Financial Publications*, 38(1), 47-71. Retrieved from <https://doi.org/10.1111/pbaf.12167>

- [16] US Department of the Treasury. (2023, June 7). Capital Projects Fund. Retrieved October 20, 2024, from US Department of the Treasury: <https://home.treasury.gov/policy-issues/coronavirus/assistance-for-state-local-and-tribal-governments/capital-projects-fund>
- [17] Woodgate, J. (2022, June 24). The Basics of Electrical Engineering Standards. Retrieved October 20, 2024, from All About Circuits: <https://www.allaboutcircuits.com/technical-articles/the-basics-of-ee-standards/>
- [18] Yao, W., & Li, L. (2023). Information technology capability, open technological innovation and firm growth. Plos One, 18(10), 1-19. doi:10.1371/journal.pone.0291227

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### Author's short biography

**Pravin Sankhwar** is an independent researcher and a renowned electrical engineer. His research and practical experiences are directly applied to improving the engineering standards and users of his designed works. He is a licensed professional engineer and has passion and commitment towards a sustainable future.

