

# Role of Strategic Investment Planning Towards Sustainable Manufacturing and Industrial Pollution Prevention

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**Abstract :** *Sustainable manufacturing is a crucial aspect of manufacturing and sustainable innovation and pollution prevention. Manufacturing organizations always take or focus on preventive measures for pollution prevention and control, while for sustainable manufacturing a proactive strategic investment planning initiatives in the resources is essential. This paper discusses the various strategic investment planning criteria viz., sustainable renewable resources, 6R's, Life cycle cost, workstation design etc. with capital budgeting decision viz., internal rate of return, net present value, benefits cost ratio analysis, and various appraisal criteria viz, social, technical, financial, environmental and economical appraisal of the investment for the project proposal.*

*This will give organizations market, social, economical and environmental performance benefits.*

**Keywords:** Strategic investment planning, Sustainable manufacturing, Firm performance

## **I. Introduction**

Due to global warming, climate changes, environmental imbalance, rising energy prices and ecological environmental degradation, social awareness and lack of resources, organizations are now giving the emphasis to

manufacture the products and services in more sustainable manner. Organizations are responding to these issues by identifying the social, environmental, ecological impacts of the product, process, system and supply chain along with control and preventive measures to assure the sustainability of their activities and outcomes. Organizations now also voluntarily assess the risk for their unsustainable activities as it cause long term impact on business success.

Strategic investment planning for sustainable manufacturing calls for the sustainable investment in sustainable resources which do not damage the environment and ecology. It must also reduce the emissions along with consumption of resources throughout its life cycle. The process, supply chain and output produced must be sustainable. Sustainability includes 6R's reduce, reuse, recycle, recover, remanufacture, redesign during the life cycle of the resource (Jawahir and Bradley, 2016). Strategic investment planning for sustainable manufacturing and resources, leads to considerations of sustainable inflows and sustainable outflows in the capital budgeting decisions.

Strategic sustainable investment planning must consider the sustainable appraisal of the investment which includes (i) environmental

appraisal, i.e., energy efficiency, resource consumption (e.g., material, energy, water) and outputs (e.g., emissions, effluents, waste), impact of investment on the human and physical environment, biodiversity, environmental compliance (Global Reporting Initiative, 2011), (ii) technical appraisal, i.e. architectural design, appropriate technology (iii) economic appraisal, i.e., social cost-benefit analysis, contribution to increase in the economic wealth of a region or country, enhanced services, employment, standard of living, income distribution etc (iv) financial appraisal (revenue producing or not, investment cost v/s operating cost, risk and sensitivity analysis) (v) managerial appraisal (Kerzner, 2017; Rory Burke, 2003).

Traditionally, environmental issues are considered in product design, process design, and in location selection and not at the time of capital budgeting decision (Vesty G, 2011). Also conventionally capital budgeting methods viz., Net Present Value (NPV), Pay Back Period, Discounted Cash Flow (DCF) or Internal Rate of Return (IRR) – do not consider sustainability in the investment planning (Hopwood, 2009). These methods give unfair results while going for investment selection of sustainable alternatives as sustainable projects might require high initial investments and takes long payback period to generate the profit and cash inflows.

This study discuss strategic sustainable capital budgeting approaches through incorporating environmental degradation forces to the given investment proposal's inflows and outflows. It is observed that higher degree of environmental degradation forces are involved in the investment proposal, lower priority should be given to budget that proposal. Sustainable capital budgeting, also try to quantifying the abstract characterization of sustainable and non-sustainable variables or forces.

Organizations has to focus on positive qualitative benefits of sustainable alternatives,

viz. future biodiversity preservation, natural capital conservation and the risk associated with the less-sustainable alternative while making the investment decision as these benefits goes on increasing as the time passes. Future and long term tangible and intangible benefits of a sustainable venture are difficult to measure before time but it will be more value added to the organization than its present short term benefits. For unsustainable proposal, organizations have to acquire resources to mitigate the unsustainability issues at the later stage during the whole life cycle of the project which will be the hidden costs associated with the unsustainable proposal.

### Capital Budgeting Methods

Capital budgeting is a organization's formal process for evaluating potential investments proposals. It involves the decision to invest the current funds for addition, disposition, modification or replacement of fixed assets. Various capital budgeting methodologies used are (Prasanna Chandra, 2011)

*Payback period method* calculates the time required for the initial capital outlay to be recovered by the investor.

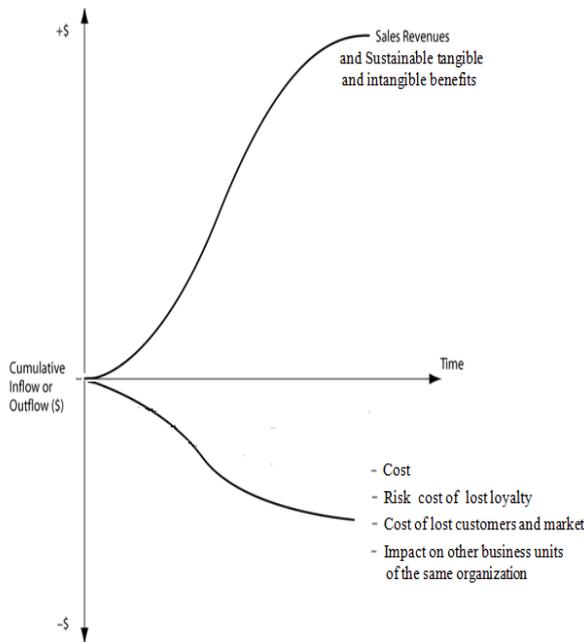
*Discounted payback period method* calculates the time required for the initial capital outlay to be recovered with discounting cash inflows at the cost of capital decided by the organization.

*Net Present Value (NPV) method* compares the discounted cash inflows with the cash outflows for the investment proposal for the sustainable resources. Cost of capital is used to discount the cash inflows and outflows. An investment in sustainable resource proposal is considered favourable if the discounted cash inflows exceed the cash outflow, i.e., NPV is positive.

*Internal Rate of Return (IRR)* is the discount rate at which the NPV was rendered to be zero. An investment in sustainable resource proposal is favourable if the IRR exceeds the required rate of return set by the organization.

*Benefit Cost Ratio or Profitability Index* is the ratio of PV of a project's cash inflows to PV of outflows. Accept all projects with a BCR greater than 1, when costs and benefits are discounted at the opportunity cost of capital.

*Risk-Adjusted Discount Rate*, for risky projects, the discount rate or the cost of capital is a function of the weighted average cost of capital and project's sustainability perceived risk rate. Organization has to build a base case financial model including sustainability in account as shown in Fig 1.



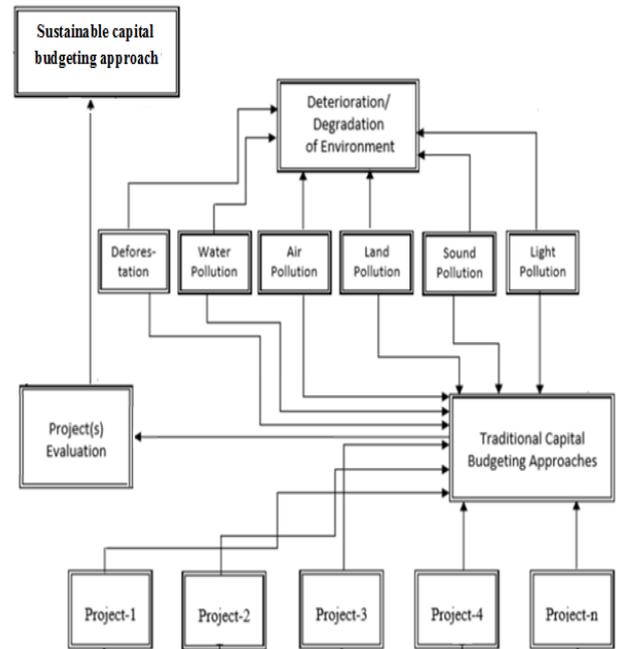
**Fig. 1 Cash inflow and outflow for an investment proposal**

Fig. 1 shows the cash inflow and outflow analysis along with benefits, loss and impact of an investment during its full life cycle for an investment proposal. It may be called total cost-benefits-loss-impact accounting in the capital budgeting.

Fig. 2 shows a structural model for sustainable capital budgeting evaluation for various projects considering ecological dimension into account (Siddikee, 2018).

For incorporating sustainability into capital budgeting, organization has to identify and

measure all tangible and intangible costs and associated benefits for the life cycle of the project as shown in Table 1 and this should be taken into account in capital budgeting formula (Kimbrow, 2013).



**Fig. 2. Structural model of sustainable capital budgeting evaluation for various projects**

Various formula used for capital budgeting methods are same as that of traditional formula. The only difference is here sustainability benefits and life cycle cost is taken into account.

Multidimensional capital investment selection process may be used for selection among various sustainable proposals (Epstein and Roy, 2000). It covers may covers various appraisal dimensions as discussed earlier. For example in Fig. 3, three dimensions with various weights are integrated into a comparison matrix to evaluate and compare alternative investment projects.

**Table 1** Initial inventory of costs and benefits

Costs	Yes or no. If yes, explain and quantify	Savings
Initial, operating, remediation, externalities and other costs		
Purchase price		Increase production, revenues and sales
Taxes		Tax rebates
Transportation costs		Tax savings
Interest/financing costs		Energy savings
Installation costs		Water conservation savings
Energy use (assume increasing costs in cash flows)		Revenues from recycled externalities
Emissions and impacts		Reduced costs of inputs
Costs of monitoring emissions		Waste disposal costs savings
License and permit costs		Remediation/clean up costs savings
Calibration costs		Calibration costs
Plant or land space		Space savings
Maintenance costs		Maintenance costs savings
Training costs		Training costs savings
Repair costs		Repair costs savings
Material inputs (ink, detergents, fuel, etc.)		Material inputs savings
Insurance costs		Insurance costs savings
Insurance fees to cover handling of hazardous substances		Reduced fees to cover handling of hazardous materials
Waste disposal costs		Waste disposal savings
Landfill costs and taxes		Landfill costs and taxes savings
Remediation/clean up costs		Shut-down costs savings
Shut-down costs		Fines and prosecutions savings
Fines and prosecutions		Increase in useful life
Capital asset disposal costs		Disposal costs savings
Useful life		

## Conclusion

It is observed through literature that organizations must take proactive measures for sustainability than measuring and assessing the life cycle costing of unsustainable system. Organizations should take sustainability benefits into account from “cradle to grave” while using DCF, NPV and IRR as there are many hidden cost for unsustainable resource selection. This new way of incorporating environmental impact assessments (EIAs), life cycle assessments (LCAs), full cost accounting and environmental cost/benefit analysis, and triple bottom line (TBL) accounting would maximize the all stakeholders’ value along with preserving ecology and environment. Thus strategic investment planning towards sustainable manufacturing and industrial pollution prevention is the only solution for sustainability movement.

## References

1. Epstein, M.J., Roy, M., 2000. Strategic evaluation of environmental projects in SMEs. *Environ. Qual. Manag.* 9, 37–47. [https://doi.org/10.1002/1520-6483\(200021\)9:3<37::aid-tqem4>3.3.co;2-k](https://doi.org/10.1002/1520-6483(200021)9:3<37::aid-tqem4>3.3.co;2-k)
2. Global Reporting Initiative, 2011. *Sustainability reporting Guidelines, version 3.1.* Amsterdam, Netherlands.
3. Hopwood, A.G., 2009. Exploring the interface between accounting and finance. *Accounting, Organ. Soc.* 34, 549–550.
4. Jawahir, I.S., Bradley, R., 2016. *Technological Elements of Circular Economy and the Principles of 6R-Based Closed-loop Material Flow in Sustainable Manufacturing.* *Procedia CIRP* 40, 103–108. <https://doi.org/10.1016/j.procir.2016.01.067>
5. Kerzner, H., 2017. *Project Management – A Systems Approach to Planning, Scheduling, and Controlling, 12th ed.* Wiley.
6. Kimbro, M., 2013. Integrating Sustainability in Capital Budgeting Decisions, in: *Corporate Sustainability.* Springer, London, pp. 103–114.
7. Prasanna Chandra, 2011. *Financial Management.* Tata McGraw-Hill Education.
8. Rory Burke, 2003. *Project Management: Planning and Control Techniques, 4th ed.* Wiley.
9. Siddiquee, M.J.A., 2018. The Development of the Green Capital Budgeting Approaches Based on Traditional Capital Budgeting Approaches. *Int. J. Innov. Appl. Stud.* 25, 253–262.
10. Vesty G, 2011. The influence and impact of sustainability issues on capital investment decisions, CPA Australia.

		Project 1	Project 2
Dimension	Weight	Score	Score
<b>Strategic</b>			
• Improve environmental image	.07		
• Improve relations with community	.05		
• Support identified market requirements			
• Customers' requirements	.06		
• Competitors	.06		
• Support anticipated regulatory requirements	.05		
• Opportunity to introduce new "green" product	.06		
<b>Technical</b>			
• Capacity	.06		
• Vendor reputation	.08		
• Cycle time	.06		
• Waste generation	.06		
• Energy consumption	.05		
• Input consumption	.04		
• Health hazards to employees	.05		
<b>Financial</b>			
• Payback period	.25		
<b>Total weighted score</b>	1.00		

**Fig.3** Multidimensional evaluation – comparison matrix