

Impact Evaluation of Engineering Project on Sustainability using Engineering Economic Analysis

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Abstract

Sustainable Development has recently become an essential issue of interest in all countries. It also has become an essential subject of research for different specialities of researchers. The multi dimensions of sustainability make it multidisciplinary subject.

Engineers form the interface between society needs and scientific discoveries, they transfer natural and environmental resources into useful products that increase people welfare, and this is done by engineering projects.

In Syrian and international universities, engineering students learn engineering economic analysis, which covers the basic principles and concepts of engineering economic analysis of projects and alternatives.

This paper presents a proposed methodology to use engineering economic analysis to evaluate the effect of engineering project on sustainability. The proposed methodology develops Benefit/Cost Analysis (BCA) to include the multiple dimensions of sustainability, that are: environmental, social, and economic dimensions. Then, it integrates the proposed developed BCA with Multi-Criteria Decision Making (MCDM) to get the integrated proposed methodology. The paper presents practical examples to show how to implement the proposed methodology.

Keywords: Sustainability evaluation, engineering economic analysis, sustainable development, engineering project evaluation.

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References:

1. اللجنة العالمية للبيئة والتنمية (1989). مستقبلنا المشترك، ترجمة: محمد كامل عارف، مراجعة علي حسين حجاج، سلسلة عالم المعرفة 142، المجلس الوطني للثقافة والفنون والآداب، الكويت.
2. بولت، كاترين؛ روتا، جوفاني؛ صراف، ماريما (2005). تقدير كلفة التدهور البيئي، قسم البيئة في البنك الدولي، واشنطن.
3. جرانت، إيجين ل.؛ أريسون، و. جرانت؛ وليفثورث، ريتشارد س. (1982). المبادئ الأساسية للاقتصاد الهندسي، ترجمة: جمال محمد نوار و عمرو مصطفى الشهابي، دار جون وإيلي وأبنائه.
4. حرفوش، سهام؛ صحراوي، إيمان؛ وبوباية ذهبية، ريم (2008). "الإطار النظري للتنمية الشاملة المستدامة ومؤشرات قياسها." من أوراق المؤتمر العلمي الدولي الأول: التنمية المستدامة والكفاءة الاستخدامية للموارد المتاحة، تنظيم كلية العلوم الاقتصادية وعلوم التسيير في جامعة فرحات عباس - سطيف في الجزائر، في الفترة 7-8 إبريل (نيسان).
5. داسكوبتا، بارثا (2008). علم الاقتصاد مقدمة مختصرة جداً، ترجمة: خضر الأحمد، مكتبة العبيكان، الرياض.
6. سوليفان، ويليام ج.؛ ويكس، إين م.؛ ولوكسهوج، جيمس ت. (2004). الاقتصاد الهندسي، ترجمة: محمد نايفة؛ محمد الجالي؛ لبانة مشوح؛ ومحمد نوار العوا، المركز العربي للتعبير والترجمة والتأليف والنشر، دمشق.
7. Blank, Leland; and Tarquin, Anthony (2005). *Engineering Economy*, McGraw-Hill, 5th edition.
8. Boyle, Carol and Coates, Gerry Te Kapa (2005). "Sustainability principles and practice for engineers." *IEEE Technology and Society Magazine*, FALL 2005, pp. 32-39.
9. Collier, Courtland A.; and Glagola, Charles R. (1998). *Engineering Economic and Cost Analysis*, 3rd edition, Addison-Weseley, USA.
10. Dasgupta, Partha; Sen, Amartya; and Marglin, Stephen (1972). *Guidelines for Project Evaluation*, United Nations.
11. Engineering Council UK (2009). *Guidance on Sustainability for the Engineering Profession*. EC UK.
12. Fenner, R. A., Ainger, C. M., Cruickshank, H. J., and Guthrie, P. M. (2006). "Widening engineering horizons: addressing the complexity of sustainable development." *Engineering Sustainability, Proceedings of the Institution of Civil Engineers*, Vol. 159, Issue ES4, pp. 145-154.
13. Friedrich, Rainer; and Bickel, Peter (2001). *Environmental External Costs of Transport*, Springe-Verlag Berlin.
14. Goodman, Alvin S.; and Hastak, Makarand (2006). *Infrastructure Planning Handbook, Planning, Engineering, and Economics*, American Society of Civil Engineers ASCE, McGraw-Hill, USA.
15. Huntzinger, Deborah N., Hutchins, Margot J., Gierke, John S., and Sutherland, John W. (2007). "Enabling Sustainable Thinking in Undergraduate Engineering Education." *International Journal of Engineering Education*, Great Britain, Vol. 23, No. 2, pp. 218-230.
16. Kates, Robert W.; Parris, Thomas M.; and Leiserowitz, Anthony A. (2005). "What is sustainable development, goals, indicators, values, and practice." *Environment: Science and Policy for Sustainable Development*, Vol. 47, No. 3, April, pp. 8-21.
17. Matheson, Sam; Lence, Barbara; and Fürst, Josef (1997). Distributive fairness considerations in sustainable project selection, hydrological Sciences-Journal 42(4) August.
18. Martin, Mike W., and Schinzinger, Ronald (2005). *Ethics in Engineering*, Fourth Edition, McGraw-Hill, Inc.
19. Park, Kwangho; Hwang, Yongwoo; Seo, Seongwon; and Seo, Hyungjoon (2003). "Quantitative Assessment of Environmental Impacts on Life Cycle of Highways." *Journal*

- of Construction Engineering and Management*, ASCE, vol. 129, No. 1, January/February, pp. 25-31.
20. Pearce, David; Barbier, Edward; and Markandya, Anil (1990). *Sustainable Development: Economics and Environment in the Third World*, Earthscan Publications Ltd., London, UK.
 21. Pearce, David; Groom, Ben; Hepburn, Cameron; and Koundouri, Phoebe (2003). "Valuing the Future – Recent advances in social discounting." in *World Economics*, Vol. 4, No. 2, April-June, pp. 121-141.
 22. Riggs, James L.; and West, Thomas M. (1986). *Engineering Economics*, McGraw-Hill, Inc. 3rd edition, USA.
 23. Rogers, Peter P.; Jalal, Kazi F.; and Boyd, John A. (2008). *An Introduction to Sustainable Development*, Prentice-Hall of India, New Delhi, India.
 24. Ruth, Matthias (2006). "A quest for the economics of sustainability and the sustainability of economics." *Ecological Economics*, Elsevier, Vol. 56, pp. 332-342.
 25. Sahely, Halla R., Kennedy, Christopher A., and Adams, Barry J. (2005). "Developing sustainability criteria for urban infrastructure systems." *Canadian Journal of Civil Engineering*, Vol. 32, pp. 72-85.
 26. Siller, Thomas J. (2001). "Sustainability and Critical Thinking in Civil Engineering Curriculum." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, Vol. 127, No. 3, July, pp. 104-108.
 27. Squire, Lyn; and Tak, Herman G. van der (1981). *Economic Analysis of Projects*, The World Bank, Washington D.C., USA.
 28. Sullivan, William G.; Wicks, Elin M.; and Luxhoj, James T. (2006). *Engineering Economy*, 13th edition, Pearson Education, Inc., USA.
 29. Tam, Edwin K.L. (2002). "Challenging in using environmental indicators for measuring sustainability practices." *Journal of Environmental Engineering and Science*, National Research Council Canada NRC, Volume 1, No.6, pp. 417-425.
 30. The Institution of Civil Engineers (2002). *Society, Sustainability, and Civil Engineering*. ICE, UK.
 31. The Royal Academy of Engineering (2005). *Engineering for Sustainable Development: Guiding Principles*, The Royal Academy of Engineering, London, UK.
 32. Thuesen, Gerald J. and Fabrycky W. J. (2009).
 33. UNIDO United Nations Industrial Development Organization (1978). *Guide to Practical Appraisal – Social Benefit-Cost Analysis in Developing Countries*, United Nations.
 34. Vezzoli, Carlo; and Manzini, Ezio (2008). *Design for Environmental Sustainability*, Springer-Verlag London Limited.
 35. Vos, Robert O. (2007). "Perspective Defining sustainability: a conceptual orientation." *Journal of Chemical Technology and Biotechnology*, Vol 82, pp. 334-339.
 36. Weston, Joe (2000). "EIA and public inquiries." in *Planning and Environmental Impact Assessment in practice*, edited by: Joe Weston, Longman, UK, pp. 120-140.
 37. White, John A.; Agee Marvin H.; and Case, Kenneth E. (1989). *Principles of Engineering Economic Analysis*, 3rd edition, John Wiley & Sons, USA.
 38. Woodruff, Paul H. (2006). "Educating Engineers to Create a Sustainable Future." *Journal of Environmental Engineering*, ASCE, vol. 132, No. 4, April, pp. 434-444.