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Resilient Design with Triple Bottom Line-Enhanced BIM

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Learning Objectives

- Understand how BIM can be extended with value metrics
- See how cities have prioritized infrastructure projects based on best value
- Avoid the ten common traps in the Triple Bottom Line Cost Benefit Analysis (TBL-CBA) process

Description

By standardizing the data, methodologies, and output, the Triple Bottom Line (TBL) can augment BIM (6D = 3D + cost + schedule + TBL). Automation of Triple Bottom Line Cost Benefit Analysis (TBL-CBA) means that TBL augmented BIM can bring high-performance building design, resiliency, and sustainability to smaller and smaller design decisions. Computational design needs a guiding algorithm that aligns with owners, infrastructure users, community, and environmental values. Civil engineers must understand stakeholders' expectations to keep projects on schedule. Examples will be provided of how cities have used TBL-CBA to prioritize infrastructure projects.

Speakers

John C. Parker
Chief Product Officer & Cofounder
With over 30 years of experience as an economist, John led the Canadian economics business for an international architecture and engineering company where, with John Williams and Stéphane Larocque, he pioneered the development of the Sustainable Return on Investment (SROI) framework. John has worked across every infrastructure area as well as in risk management software and financial services sectors.

Stéphane Larocque
Chief Operating Officer & Cofounder
Stéphane brings a background as an internationally recognized professional in the field of triple-bottom line economic analysis. Over his 20-year career, he has established himself as a thought leader in this space leading that practice at an international architecture and engineering company. Along with his co-founders he has help propel Autocase into being the undisputed leader in the economic analysis software space.

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Understanding how BIM can be extended with value metrics

Value that Serves the Public Good

Jeffrey D. Sachs ("Sustainable infrastructure after the Automobile Age" The Boston Globe September 26, 2016) notes that public infrastructure must be renewed "in line with new needs, especially climate, safety, and new opportunities … We should seek an infrastructure that abides by the triple bottom line of sustainable development." Triple bottom line (financial, social and environmental) thinking encourages ethical design while updating public infrastructure to the current needs of society. Triple bottom line thinking allows investors, designers, architects and engineers to incorporate a higher standard by pushing a project beyond what is required.

Incorporating the triple bottom line into infrastructure planning and design is thinking about whether to build larger pipes to handle stormwater or green infrastructure that, like grey infrastructure reduces flooding but also reduces the urban heat island, cleans the water and the air, and increases community property values. And taking the big picture into account will mean that we recognize the health, productivity, and reduced absenteeism benefit that sustainable design can bring to the buildings we work in.

Optimal infrastructure design must quantify and put a dollar value on the externalities – the positive and negative spill over effects – that are not captured by market prices. Keeping a project on budget and schedule is no longer enough. Project stakeholders care about the environmental footprint of a project and the quality of life it brings. We need to know who or what is harmed and who benefits so we can make the right decisions. Taking a broad perspective on costs and benefits in a triple bottom line framework means we are being considerate of others and future generations in our decisions.

Infrastructure serves the public good. It is built and maintained for the well-being of all of us. While the case for infrastructure is often made in terms of economic benefits like jobs, GDP growth and international competitiveness, infrastructure's raison d'être should always be to improve the well-being of citizens. Wise infrastructure investments will make us safer, give us back time, improve our finances, provide opportunity, protect the environment, and help reconnect us to each other.

Triple Bottom Line Cost Benefit Analysis (TBL-CBA) is a systematic evidence-based economic business case framework that uses best Cost Benefit Analysis (CBA) techniques to quantify and attribute monetary values to the Triple Bottom Line (TBL) impacts resulting from an investment. These TBL outcomes are typically represented as People, Planet, Profits or Social, Environmental and Financial. The framework quantifies all of these impacts in dollars over the life of the project and discounts them to the present in order to calculate the Net Present Value of an investment from the financial viewpoint of an organization, as well as from society's perspective.

We have come to understand that people's quality of life is determined not just by profits but also by how we treat the planet. TBL, or people, profit, and planet thinking helps to ensure we are not compromising one area of our lives as we try to improve it overall.

Infrastructure is long-lived while its costs are more immediate. Future generations often benefit more than us from the infrastructure we plan and build today. Methods for monetizing the costs and benefits that may contribute to the public good over long periods are codified in Cost Benefit Analysis (CBA). Sustainable infrastructure will give us benefits for the public good without compromising the planet or future generations. Too much emphasis is on the current cost of infrastructure and not on the future public benefit it generates. CBA decision criteria in a TBL framework ensures that infrastructure is sustainable and contributes to the public good now and over its life.

From Standardization to Automation

By standardizing the data, methodologies, and output, the Triple Bottom Line (TBL) can augment BIM. Practitioners have been adding cost and schedule estimates to 3 dimensional models to go from 3D to 5D. Adding the TBL value models adds another dimension (6D = 3D + cost + schedule + TBL).

It is a myth that TBL-CBA is new, untested, and non-standard. Cost Benefit Analysis has been around for over a hundred years. It was standardized over 70 years ago, and has been formalized by governments around the world since. Non-cash goods to be included are ecosystem goods and services (for example clean air, fresh water, habitat protection) but even those have been researched for over 20 years (see the compilation of data in the Ecosystem Services Value Database under "Trap #9. Ignoring the Vast Collection of Ecosystem Services Research"). The most recent research is concerning the value of building design (daylighting, thermal comfort, biophilic design, etc.) on the health and productivity of the occupants.

CBA is the primary valuation analysis methodology behind TBL-CBA, and there are many ways of summarizing the results. The best criterion for deciding whether a project can be justified using CBA is a positive Net Present Value (NPV). The NPV is the discounted monetized value of expected net benefits (i.e., benefits minus costs). Other metrics (such as the return on investment, internal rate of return, benefit cost ratio, simple payback period, or discounted payback period) can also be used to summarize the CBA results. Cost Benefit Analysis has long incorporated soft dollar measures like the value of reduced air pollution or enhanced transit accessibility, but practitioners have differed on which metrics they chose to quantify.
Enter the "triple bottom line", first coined in 1994 by John Elkington, whose consultancy led the charge in helping Fortune1000 companies expand their definition of bottom line, thereby launching the private sector sustainability movement.

By adding the TBL qualifier to CBA, it becomes absolutely clear that all of the relevant social and environmental factors must be rigorously quantified in dollars and included in the analysis. The social (or people) impacts are the effects of a project on the broader community, quality of life, or society. The environmental (or planet) impacts are the effects of a project on the surrounding environment, habitat or climate. Combined with the financial impacts (the investment costs and returns for the project owner), these three values form the TBL valuation. When CBA is married with TBL in Triple Bottom Line-Cost Benefit Analysis, it becomes a systematic, evidence-based economic business case framework that uses best practice Life

Cycle Cost Analysis (LCCA) and Cost Benefit Analysis techniques to quantify and attribute monetary values to the Triple Bottom Line impacts resulting from an investment.

Like the myth that every CBA is unique, it is also a myth that the time and cost of legions of economists needed to run TBL-CBA make cost-prohibitive. The truth is that with the standardization of inputs, methodology, and outputs, automation of TBL-CBA is possible. While there will be people who will feel better paying $50,000-250,000 for a bespoke TBL-CBA study, don't let anyone talk you into a custom study until they have told you what they will be adding to a well-established, transparent process that is the productized result of years of consulting engagements.

Can you afford the time and money to hire economists to help with a TBL-CBA? If not, can you DIY? As an engineer, architect, or designer, you probably don't have the time to sift through arcane CBA manuals to find the right value for property value uplift, recreational value, or the social cost of using an acre-foot of water. A more productive approach would be to find a team that does this for a living and has developed a standardized methodology that reduces the cost to everyone. The future sustainability of the built environment depends on removing barriers. Making TBL-CBA as ubiquitous as other tools, like computer-aided design, will go a long way toward that goal.

Automation of Triple Bottom Line Cost Benefit Analysis (TBL-CBA) means that TBL augmented BIM can bring high-performance building design, resiliency, and sustainability to smaller and smaller design decisions.

Architects and civil engineers must understand stakeholders' expectations to keep projects on schedule. They need to consider the triple bottom line to make sure that the public and environmental benefits that are the required in public projects are realized.

If that is not enough most engineers and architects have codes of conduct that require them to act to support the public good. For example, APWA has a Standards of Professional Conduct that include "I will put public interest above individual, group or societal interest and consider my chosen occupation as an opportunity to serve society. I will encourage sustainability through wise use of resources; whether they are natural resources, financial resources or human resources." ASCE's Code of Ethics says "Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties" as Canon 1. The Canadian Engineering Qualifications Board code of ethics is to "Hold paramount the safety, health and welfare of the public and the protection of the environment". Architects have similar ethical obligations to serve not just their clients, but to respect the public, the natural, and cultural environments.

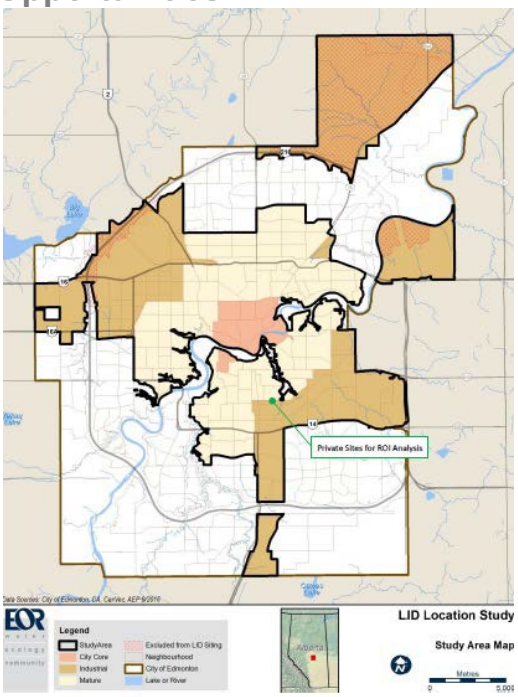
Just as pprofessional codes of conduct require engineers and architects to act to support the public good, investors have Environmental, Social and Governance (ESG) and Principles of Responsible Investment (PRI). Everyone involved in infrastructure from planners, owners, funders, and users are demanding infrastructure that contributes to the public good.

Because TBL-CBA Value is in demand by the public, those with the purse strings, and by our ethical responsibility to future generations, all aspects of building and infrastructure projects need to be tested against a TBL metric.

How major construction projects and cities have prioritized infrastructure projects based on best value

Some examples of how cities and major projects have used TBL-CBA to prioritize infrastructure projects.

Edmonton - Prioritizing Tens of Thousands of Low Impact Development Opportunities



Computational design is revolutionizing the design world. Allowing algorithms to suggest designs, or having a computer run through all feasible designs is an exciting development. Algorithm that use TBL-CBA can align owners, infrastructure users, community, and environmental values.

The City of Edmonton has identified Low Impact Development (LID) as a strategy to achieve their water quality target of no net increase in pollutants discharged to the North Saskatchewan River. Flood reduction is also a top priority for the City to limit flooding and to build long term resiliency into the drainage system.

The City of Edmonton had lots of combinations of potential sites and green stormwater features - over 33,000 stormwater management opportunities exist on public lands. In the past it has taken months to ascertain the size of green infrastructure co-benefits such as flood risk mitigation, avoided grey infrastructure costs, property value uplift, and cleaner air, and it is only cost effective to do the analysis once a project is approved and is in the later stages of design. In this case, the automated software provided default local data for the early-stage designs and each site only took seconds to run in a batch TBL-CBA analysis to determine that there were $420 million net benefits over project life.

While some of the more capital and O&M intensive LID practices are not as attractive for pay back, the lower cost options, such as rain barrels and land cover conversion to native prairie, offer roughly the same triple bottom line. Public LID retrofits offer significant cumulative holistic value with half of sites having benefits greater than costs. The results also show the ability to exceed the City's short & medium-term pollution targets for the North Saskatchewan River. Autocase results provided the City with the ability to prioritize LID implementation based on: TBL value, runoff and pollutant reductions, flooding area, or locations that are prime for redevelopment.

For more information, email us and we'll send you the case study.

LaGuardia Airport Terminal B

Skanska, is using TBL-CBA to test business case assumptions for their Design-Build Offering at LaGuardia Airport Terminal B. This constructor-led project is using Autocase to rethink decision making from a low bid to a best value mind-set – one that puts economic data at the center of BIM – providing a common platform for investors, owners, architects, engineers and the entire constructor led consortia.

Dewberry HQ

Dewberry's 7-story, 87,400 square foot headquarters in Fairfax, VA was first built in 1981. Dewberry knew it was time to carve out resources to design and implement a renovation for their own building that would meet LEED standards and deliver a higher performing building. While the LEED Credits guided sustainable strategies, the designers at Dewberry were equally interested in how those workplace and energy efficiency improvements would translate into dollars of return over the 30-year lifespan of the project. However, the project's design staff was

already extremely busy. How would they find the additional time to collect the data and perform the economic analysis that would accurately account for all the hard and soft dollar benefits of the renovation in present terms?

Dewberry used Autocase to conduct a TBL- CBA on seven LEED credit categories to compare against a baseline building. Autocase simplified and automated the delivery of full lifecycle costs, the social and environmental impacts, and the dollar value of those impacts for each LEED renovation area: Energy Performance; Indoor Water Use Reduction; Daylighting; Quality Views; Interior Lighting Controls; Low Emitting Materials; Outdoor Air Delivery Monitoring; Construction Indoor Air Quality Management Plan; and Construction Waste Management.

The net financial benefit alone for Dewberry was $19.98/square foot, far outweighing the incremental sustainable investment of $6.81/square foot. Adding in the societal and environmental benefits delivered a total benefit of $30.66/square foot, such that for every $1 invested in LEED-compliant upgrades, $5.50 of value was generated for all stakeholders.

For more information see the case study here.

Terminal 1 at SFO

During construction of the new Terminal 1 at SFO the design/build team were able to quickly compare the financial, social, and environmental implications of installing options considered in design development. For example TBL-CBA was used to reinforce the data-driven decision to install a building envelope with electrochromic glazing. SFO now requires TBL-CBA business cases for their entire design/build program and recommends using Autocase.

For more information, email us and we'll send you the case study.

Prologis

Prologis, the world's largest logistics REIT, used Autocase to create a comprehensive triple bottom line business case for their Stapleton Business Center in North Denver. Their builder integrated broader triple bottom line decision making in real-time, minimizing change orders and maximize profits. Prologis communicated the economic value of their construction to multiple stakeholders during meetings with communities, local governments and tenants for permitting, entitlement and leases.

For more information, email us and we'll send you the case study.

More Examples

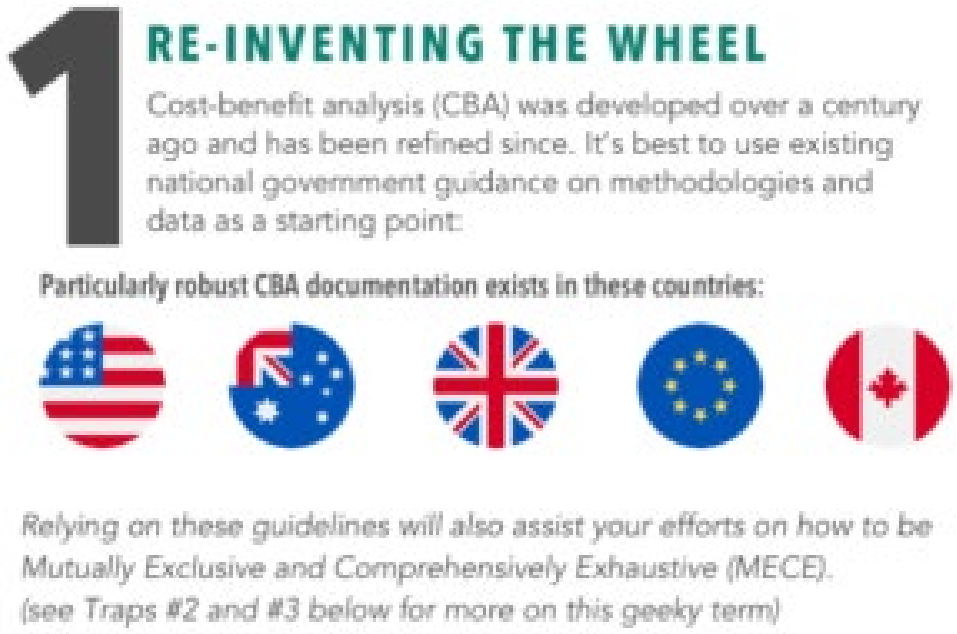
Other large-scale building and infrastructure decisions and prioritizations using TBL-CBA:

- Leveraging TBL-CBA for a Utility Infrastructure Master Plan Leading engineering firm, HNTB prioritized utility infrastructure designs for Los Angeles International Airport (LAX).
- Airports are small cities. They face complex problems. To be competitive they need to choose the least cost option that meets their objectives. To be sustainable and resilient airports need to choose the most effective and cost-efficient investments. In order to accomplish this, Atlanta's Hartsfield-Jackson airport (ATL) used TBL-CBA.
- Green Infrastructure for Watershed Planning – Quantifying the Benefit Autocase assists the City of Pittsburgh in conducting Triple Bottom Line Cost Benefit Analysis (TBL-CBA) as part of its "Green First Plan".
- Reaping the Greatest Benefit from Engineering Design Barr Engineering optimizes the value of a Ford plant redevelopment site in the City of Saint Paul.

The Top 10 Traps: Common Mistakes to Avoid When Running Triple Bottom Line – Cost Benefit Analysis (TBL-CBA)

Before we created the Autocase family of TBL-CBA software, our team of economists, along with engineers and architects conducted numerous custom assessments as consultants. Our collective knowledge is now reflected in Autocase, but, we have to admit, there were some moments along the way when we were caught off-guard and ran into some tricky traps: practices, policies and thinking that might have derailed us. We hope the following 10 will guide those interested in TBL-CBA but we also suspect that they will resonate with our fellow practitioners.

1. Re-Inventing the Wheel



Cost-benefit analysis is a time-tested methodology. It was invented over a century ago, was standardized after World War II, and has been refined since. So, there's no excuse not to use, as a starting point, existing national government guidance on methodologies and data (the US, Canadian, UK, Australia, and European Commission's documents are particularly robust). These guidelines will also assist your efforts on how to be "MECE" – Mutually Exclusive and Comprehensively Exhaustive (see Traps #2 and #3).

2. Forgetting Certain (Increasingly Vocal) Stakeholders

When conducting a Triple Bottom Line – Cost Benefit Analysis (TBL-CBA), a common trap is thinking too narrowly about the project. By definition, a triple bottom line approach avoids thinking only in financial terms – the narrowest thinking of all. Assigning a dollar value to environmental or social metrics that lack a simple market price is the big step that helps to broaden the view.

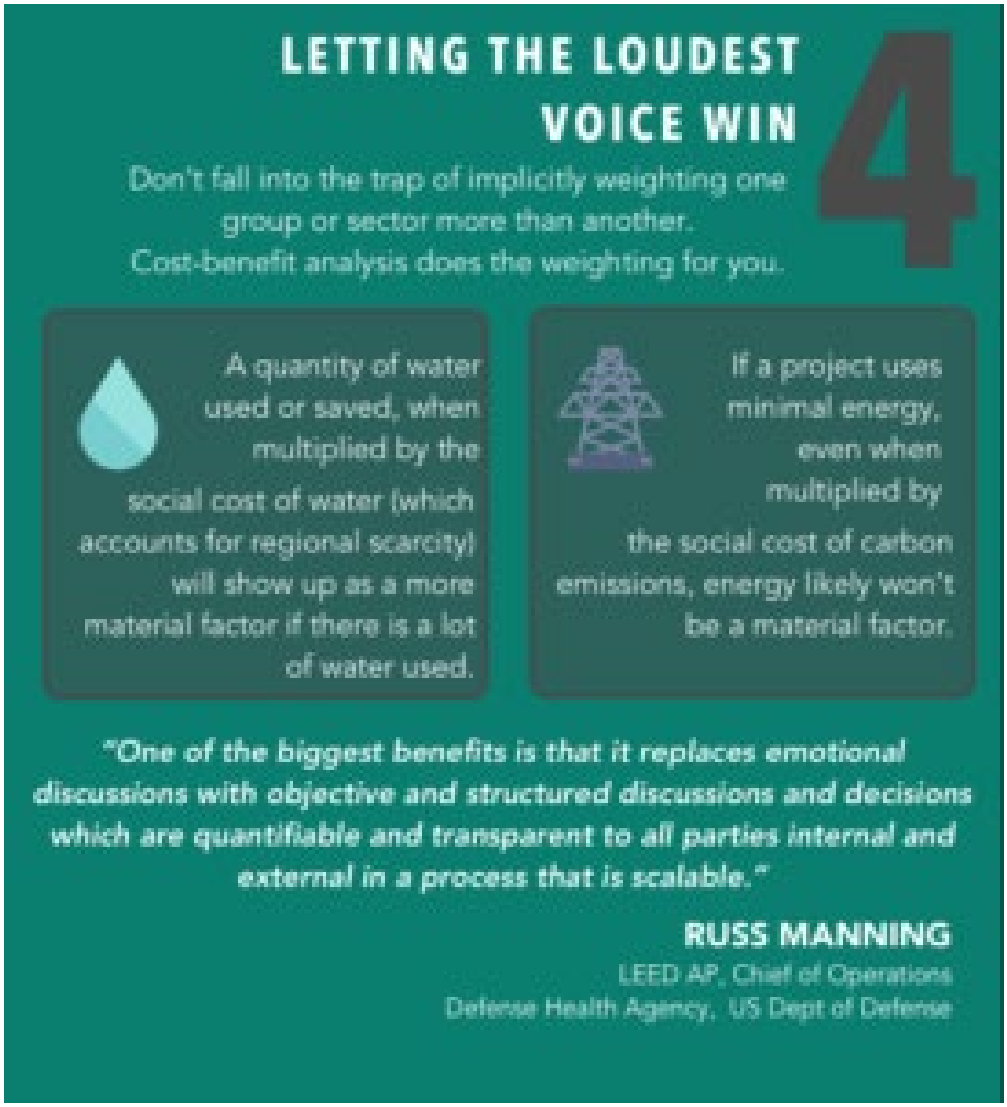
Broadening the view, however, does not mean losing the perspective of each project stakeholder. Infrastructure and building projects have always been complex to manage, but now project managers are being asked to manage an even wider scope of concerns because project footprints have grown and project stakeholders have become more sensitive and sophisticated about the direct and spill-over effects for them. This is where Multiple Account CBA comes to the rescue – it breaks out negative and positive impacts by stakeholder group, from neighbors to local governments to those downstream. It goes a long way towards countering NIMBYism and avoiding project delays.

3. Double Counting

By avoiding the trap of being too narrow, people often fall into this trap. In particular, benefits are more likely to be double counted than costs. Take, for example an infrastructure or building project that lowers the cost of a product for consumers. There will also be a rise in the profits of producers and other middle men involved in delivering the product to consumers because it costs less to deliver. The cost savings is passed on from producer to consumer, so it is one and the same. Similarly, if, out of the net benefit of a project, tax is paid to the government, this should be counted as a transfer not as a loss. Another frequently double-counted benefit is "property price increase" resulting from a project. Many cost-benefit analyses of property price increases from better transit access, for example, will often erroneously include both the capitalized future transportation benefits and the non-transportation use benefits of liveability.

So, be inclusive and avoid thinking narrowly about stakeholders, but not so inclusive that you double count. By side-stepping both traps, you'll have lived up to one of the founding principles of cost-benefit analysis: be "MECE" – Mutually Exclusive and Comprehensively Exhaustive. (See trap # 1)

4. Letting the Loudest Voice Win



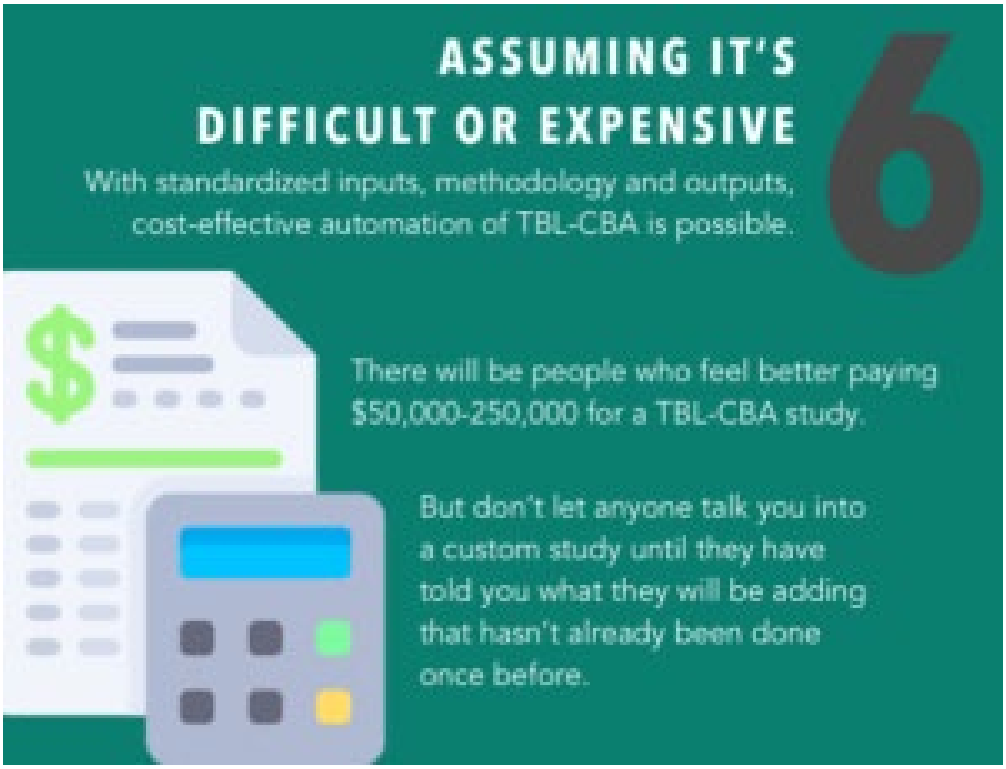
While the TBL-CBA analysis often points out trade-offs between people, planet and profits and highlights distributional effects across affected stakeholder groups, don't fall into the trap of implicitly weighting one group or sector more than another. Cost-benefit analysis does the weighting for you. For example, a quantity of water used or saved, when multiplied by the social cost of water (which accounts for regional scarcity) will show up as more material if there is a lot of water used. Likewise, if a project uses minimal energy, even when multiplied by the social cost of carbon emissions, energy likely won't be a material factor.

One of the most compelling attributes of TBL-CBA is its objectivity.

5. Asking "Are We Doing the Right Project?" but Forgetting "Are We Doing the Project Right?"

Once the project has been greenlighted, a million and one design decisions remain to be made by engineers, architects, sustainability professionals, planners, project manager, and designers that determine what exactly gets built and how. TBL-CBA should be used for these small decisions, not just the make or break choices, to keep the evolving design in line with the investment thesis. TBL-CBA should be used early and often throughout the planning, design, procurement, and construction phases as the project changes. For example. after a decision has been made to build a bus rapid transit line – where it will stop, what the stations will look like, and how it will be integrated with other transportation networks – TBL-CBA can be used to decide whether to collect water at the bus depot with a green roof or a cistern, and whether it makes economic sense to reuse the water for washing the buses.

6. Assuming it is Difficult and Expensive

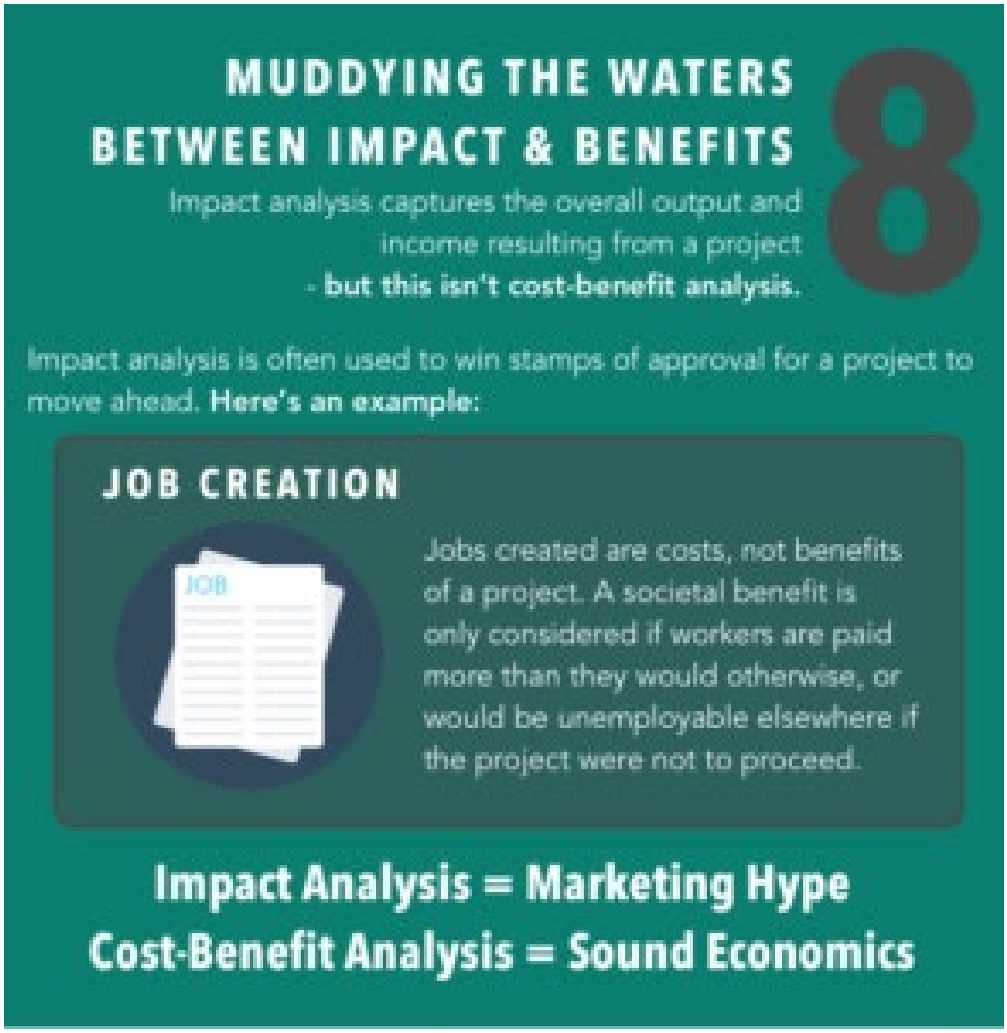


With standardized inputs, methodology and outputs, cost-effective automation of TBL-CBA is possible. While there will be people who will feel better paying $50,000-250,000 for a bespoke TBL-CBA study, don't let anyone talk you into a custom study until they have told you what they will be adding that hasn't already been done once before.

7. Tolerating False Precision

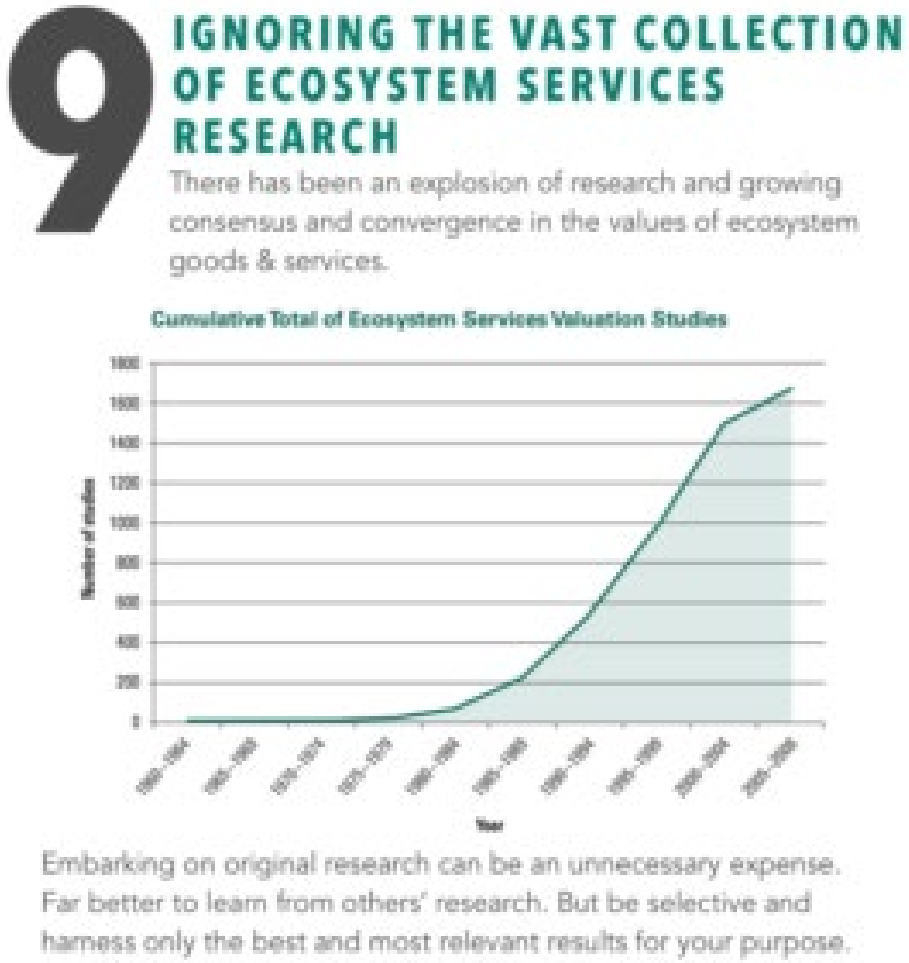
The results are in – the Net Present Value is $101.234567 million (exactly) – let's go! But wait…what if the risk associated with that number is +/- $200 million? How do you feel now? Is the project still a go? Robust TBL-CBA methodologies employ risk analysis so that all inputs are described by a probability curve derived from the low-expected-high values across the economics literature for a given input. Doing so means that you can offer confidence intervals (think, levels of certainty) attached to all the results. So, everything, including uncertainty, is on the table for the client.

8. Muddying the Waters between Impacts and Benefits



Impact analysis captures the overall output and income resulting from a project i.e. “400 local jobs created” or “an increase of $3M in GDP”. But this is not cost-benefit analysis. Impact analysis is often *a marketing exercise* intended to curry favor with those whose stamp of approval is needed for the project to move ahead. One particularly egregious example is job creation. Jobs created *as part of a project* are costs to the project, not benefits in a societal cost-benefit framework. To count as a societal benefit, these workers would have to be paid more than they would otherwise or be unable to be employed elsewhere were the project not to go ahead. In this case, there is no net benefit unless there is a labor shortage so a project attracts new entrants to the profession. When trades are induced to work on a project because of *higher* wages, it is only this *incremental* wage that is a benefit. If a project hires from a pool of unemployed workers, their wages over what they would have received from any unemployment insurance scheme could be considered a benefit. But in general, the job itself is not a benefit. Impact analysis = marketing hype. Cost-benefit analysis = sound economics.

9. Ignoring the Vast Collection of Ecosystem Services Research

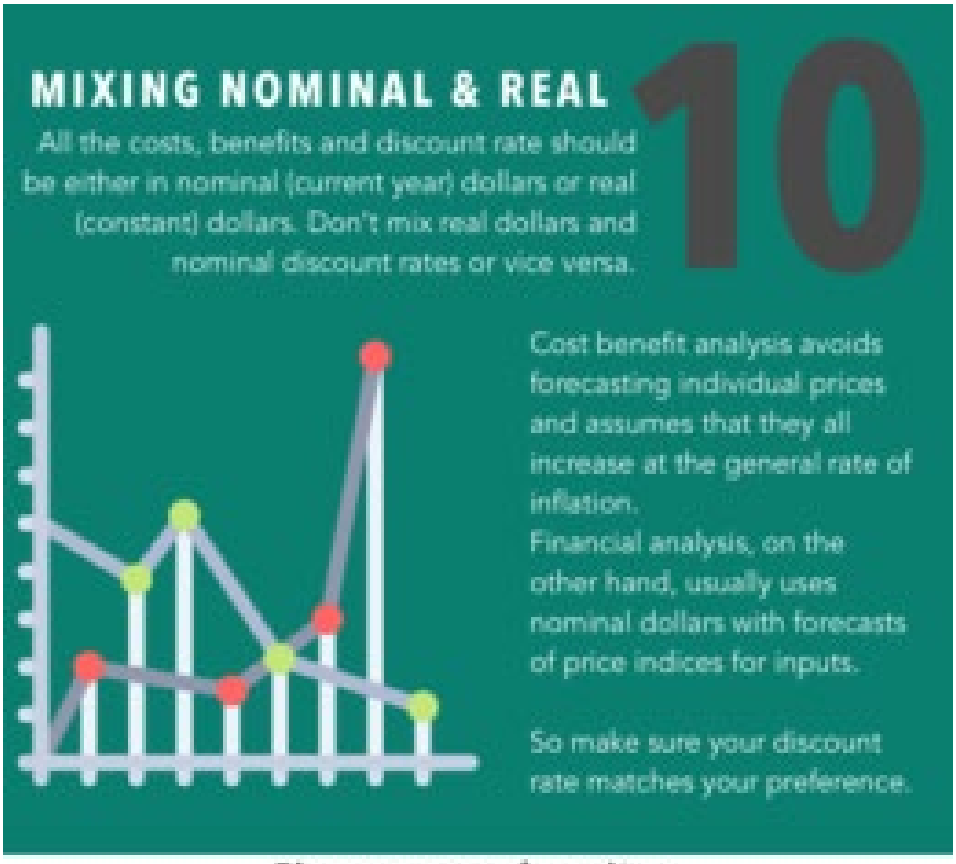


Source[1]

A lot of smart people have spent a lot of time over the last two decades putting values on ecosystem goods and services (e.g. clean air, fresh water, habitat protection). There has been an explosion of research and growing consensus and convergence in these values. Embarking on original research is always a good thing but it can be an unnecessary expense. Far better, we think, to stand on the shoulders of giants, learn from their research, scour all the research, but be selective and harness only the best and most relevant results for your purpose. Even this is very laborious if you do it correctly and do it frequently, but it's certainly more attainable than sending your staff out to the field for years at a time.

[1] Graph Source: Cumulative total of ecosystem services valuation studies sourced from EVRI from 1960 to 2008. Rudolf de Groot et. Al., Global estimates of the value of ecosystems and their services in monetary units, Ecosystem Services, Volume 1, Issue 1, July 2012, Pages 50-61, ISSN 2212-0416, http://dx.doi.org/10.1016/j.ecoser.2012.07.005 from M. Christie, et. al., "An Evaluation of Economic and Non-economic Techniques for Assessing the Importance of Biodiversity to People in Developing Countries" Defra, London (2008)

10. Mixing Nominal and Real



These are our favorites.
Which ones resonated with you?

FOR MORE INFO ON TBL-CBA,
go to WWW.AUTOCASE.COM

All the costs, benefits and discount rate should be either in nominal (current year) dollars or real (constant) dollars. Don't mix real dollars and nominal discount rates or vice versa. Most economists recommend being real and staying real (man). That said, the preference for real/constant dollars is more convention than recommendation. In financial analysis, when cash flow is the primary concern, costs and benefits are usually estimated in nominal dollars with forecasts of specific price indices used for the inputs. Cost benefit analysis, on the other hand, usually shies away from forecasting individual prices and assumes that they all increase at the general rate of inflation. So, while CBA uses real and financial analysis nominal, make sure your discount rate matches your preference.

These are our favorites. Which ones resonated the most? What did we miss?