Making the Business Case for Sustainable Infrastructure

LITERATURE REVIEW

October 2017

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1. Executive Summary

The current literature review on the "Business Case for Sustainable Infrastructure" (BC) is part of the Zofnass program's research on the subject. The scope of the research is to address the business context of developing sustainable infrastructure and especially the finances of sustainable infrastructure.

Currently, the financial return on sustainable investments is vague to stakeholders. Sustainable projects avoid impacts, negative externalities and the associated costs, which, nevertheless are rarely measured and shared with public officials and taxpayers. By providing a comprehensive methodology that uses reliable and concrete data to illuminate the costs and the avoided risks through sustainable projects is the necessary first step for decision-makers to identify and understand the economic benefits of sustainability and appreciate it as a value proposition, rather than a value imposition.

However, equally important is the rigorous quantification of the direct costs of sustainable infrastructure to the project owner, both upfront cost and life cycle cost. This is critical information for both the owner and the financiers and often determines the viability of the available choices.

Our hypothesis is that sustainable infrastructure, under certain conditions, saves money. This is the result of:

- Selecting the right project to address the problem at hand
- Regulations
- Portfolio/system-level cost savings
- Project-level cost savings (O&M costs, while providing additional economic benefits)
- External market forces
- Broader societal benefits and societal acceptance

In order to support this hypothesis and fill the knowledge gap, it is necessary to establish an understanding of (a) what constitutes sustainable infrastructure, (b) how the cost is measured, and (c) what are the financial benefits of specific sustainability features.

Due to the complexity of the research, we start with a wider scope of investigation to explore the determinants and implications of the business case, across industries.

Then, we will define the issues for the research on sustainable infrastructure. So, we will progress from the wide to the narrow. In order to narrow the research, the Zofnass Program for Sustainable Infrastructure has restated the question as:

Do we save by adopting sustainability in infrastructure and how much do we save?

The literature review aims to summarize prior research and provide the background information to the discussion of the costs and benefits of sustainable infrastructure projects. This background information provides a context for economic frame-of-reference and will help answer the research question and support the BC argument. It will identify the body of knowledge existing in the field of quantifying the Business Case for infrastructure sustainability and therefore identify the knowledge gap.

The insight of John Mogge, Global Environmental Market Executive, CH2M, and member of the Sustainability Industry Advisory Board of the Zofnass Program, is indicative: "Specifically in the area of capital cost outlays, any time one immediately assumes that sustainability costs more; it is usually because there is a lack of understanding in the means and methods used to create sustainable solutions and because the project requirement has been defined in normative terms without the benefit of newer and innovative sustainable means and methods." He adds, "breaking through the first cost barriers of sustainable planning, design and construction is all about defining the requirements in performance terms. Typical infrastructure engineering requirements are defined in terms of what is required not the performance that is needed. Creating a performance specification allows truly creative planners and designers to innovate to solve bounded problems. This is what unleashes the true sustainable solutions."

Considering the wide diversity of scenarios that can be defined under the research question as we have stated it, the scope of the literature review, as well as of this research, will include the direct costs associated with the lifecycle of the project, but not necessary the indirect costs. Understanding that the indirect costs are project-based, this research will explore these externalities on a project by project basis. Field research based on case studies of infrastructure projects will follow the literature review.

2. Literature Review -Objectives

As already mentioned, the literature review under the general research theme of the Business Case for sustainable infrastructure aims to provide the context for the research. The review's objectives are:

(1) To identify which are the main themes in the area of the BC of sustainable infrastructure. Study of their evolution, identification of emerging themes and novel concepts.

(2) To document available information regarding the factors affecting the final cost of sustainable infrastructure

(3) To examine available information directly related to the research question, such as:

- Which are the different approaches to the BC for sustainable infrastructure?
- Are the attempts to detect a systematic relationship between sustainable and economic performance successful?
- Is there an overall established method?
- Are there concrete statements by researchers in favor or against the research question? Which are the key arguments in both cases? Which are the open-ended issues that emerge for further research?
- Explore if there is sector-specific evidence, and if there is potential to extend this evidence to sustainable infrastructure in general.
- Which are the gaps and shortcomings of existing research?

Overall the literature review will summarize and organize the available literature that identifies and measures the economic costs and benefits of sustainable projects and compares costs or benefits between sustainable and conventional practices. The review will present the information in a way that non-economist municipal officials, managers, ratepayer stakeholders and others can use.

3. Literature Review- Methodology

The literature review used the Harvard library database and recommendations of the Sustainable Infrastructure's Advisory Board of the Zofnass Program and the participants to the Zofnass Program workshop "The Business Case for sustainable infrastructure", held on April 3- 4, 2017.

The literature review was based on academic papers, conference proceedings and reports of government agencies, multilateral financial institutions and consulting firms and organizations addressing business and sustainable development for the

period 2001-2017. It covers available publications from institutions such as: the American Society of Civil Engineers (ASCE); the World Business Council For Sustainable Development (WBCSD); the U.S. Environmental Protection Agency (EPA); the International Finance Corporation (IFC); the Infrastructure Sustainability Council of Australia (ISCA); consulting firms such as, the Boston Consulting Group (BCG) and McKinsey Institute; the Institute of Civil Engineers' (ICE) Virtual Library, the Organisation for Economic Co-operation and Development (OECD); the International Institute for Sustainable Development (IISD) and others.

3.1. Searching Mechanism

The initial search was based on the following keywords:

"BC for sustainable infrastructure"

"BC for sustainability"

"Sustainable infrastructure economics"

"Sustainable infrastructure investment"

"Sustainable investment long-term performance"

"Cost of sustainable infrastructure"

"Sustainable infrastructure cost assessment"

"Cost-benefit analysis for sustainable infrastructure"

"Cost-Effectiveness of Sustainable infrastructure"

"Monetizing benefits of sustainable infrastructure"

The initial keywords were expanded to include terms related to "sustainable" such as:

"Business case for green infrastructure;

"Business case for natural infrastructure";

"Business case for resilient infrastructure";

"Economics of climate change"

The searching mechanism was enriched by terms that emerged as the research progressed:

More specific economics-related terms: *"monetized benefits"; "Avoided costs"; "cost of delay; "risk analysis and evaluation"; "Multiple Objective Determination Analysis (MODA)"; "pricing externalities"; financial models," "sustainable business models"; "public-private partnerships"; "value management"; "investment decision-making support methods"; "return on investment"; "stakeholder value"; "alternative financing of sustainable infrastructure"; "innovative financial instruments"*[1]*; "circular economy"; "shared value"*

We summarized all articles, reports and books and we have identified keywords for a more comprehensive classification of information, as well as for new potential search keywords to enable further targeted research.

3.2. Classification of Resources

Two main streams of research are identified in the available literature resources: (a) theoretical studies and (b) empirical/descriptive studies.

The theoretical studies are based on frameworks that aim to explain the nature of the relationship between financial performance and sustainability and the empirical/descriptive studies examine approaches in practice based on case studies.

Within these two broad categories, the reviewed resources were classified and grouped into additional categories, in an effort to extract instructive conclusions:

Classification per source type

First, they were classified per source type in an effort to understand the economic aspects of sustainable infrastructure from the perspective of the relevant sectors involved in infrastructure from research to decision making and planning.

The relevant categories per source type are:

Academic sector, development banks, investors, insurers, infrastructure operators, contractors, consultants, commercial banks, non-profit organizations, government agencies, and engineers/designers.

Second, there was an attempt to classify the resources by the stakeholders of the sustainable infrastructure process that each document refers such as municipal decision-makers, investors, private developers, constructors, owners or operators,

[1] Resilience bonds, climate bonds, green bonds etc.

etc. This classification is more complex as most documents relate to and concern multiple stakeholders.

Finally, they were classified according to the main theme they discuss. The result is the following most predominant thematic groups:

- CORPORATE SUSTAINABILITY
- INFRASTRUCTURE INVESTMENT
- COST-BENEFIT MEASURING METHODS
- SYSTEMIC APPROACH
- INFRASTRUCTURE TYPE SPECIFIC
- ALTERNATIVE/ INNOVATIVE APPROACHES
- DETERMINANTS OF DIRECT COST

4. Literature Review – Outcome

The outcome, main takeaways of the Literature Review are organized and presented as three main categories of observations:

- Observations (1) according to search keywords
- Observations (2) of theoretical- empirical studies
- Observations (3) of thematic groups

4.1. Observations according to search terms used

When searching for "*BC for Sustainable infrastructure"* or "*BC of Infrastructure Sustainability"* most of the findings direct to "*corporate sustainability*" (see list of bibliography) and "*assessment*" of sustainable infrastructure in terms of social/ environmental performance but not financial. Economic performance is evaluated in the long-term but not always through quantified data.

The positive impacts of Corporate Sustainability and Corporate Social Responsibility are well-documented. The overlaps with the "BC for Sustainable Infrastructure" topic under study are explored. Stapledon (2012) reports "why infrastructure sustainability is good for your business", published by the Cooperative Research

Centre for Infrastructure and Engineering Asset Management (CIEAM) and reaffirms the strong link between the two:

"*[…] views on corporate responsibilities meet where management can show how voluntary social and environmental management contributes to the competitiveness and economic success of the company. This approach is fundamental to the business case for infrastructure sustainability. It suggests that beyond-compliance activities undertaken by companies are commercially justified if they can be shown to contribute to profitability and shareholder value"*.

Searching for "*cost-benefit analysis of sustainable infrastructure*" and/or "*cost effectiveness*", "*cost assessment*" the result is various infrastructure type- specific articles, mostly based on case studies that present outcomes of analyses. They are mostly related to green infrastructure projects, water and wastewater projects, as well as transportation (transit) projects.

When searching for "*investment cost of sustainable infrastructure*", the focus of the relevant studies is the "*investment gap*" and the barriers to investment such as regulations, policy etc., as well as recommendations on how to address them.

When searching for "*sustainable infrastructure cost assessment*" many papers refer to assessment tools and international standards for sustainable infrastructure. These studies present interactive tools for assessment and evaluation of sustainability, but not always of cost.

4.2. General observations per main stream: theoretical/descriptive studies

Theoretical studies provide insight on the benefits and risks of sustainable infrastructure projects and suggest frameworks of approach. They list benefits and risks, but do not quantify them. Some of the identified common places are on (a) the barriers to the acceptance of the Business Case for infrastructure sustainability, (b) the prevailing industry culture, (c) the lack of appreciation of how stakeholder value is created and (d) the accounting practices of costs and benefits. Most of the theoretical studies address corporate sustainability and the related main findings will be presented in the respective thematic group.

As observed in literature, the documents that provide specific value-based arguments are supported by case studies; as well as the ones that end up proposing alternative methods/ alternative financing or project management vehicles; the latter are suggested variations of newly- tested methodologies, however not yet generally accepted. The wide use of variables and methodologies reveals a work-in-

progress status and the absence until now of a consistent approach for the business case for sustainable infrastructure.

The most metric-specific studies address Green Infrastructure (GI), or Low-Impact Development (LID). These studies explicitly state that sustainable designs cost less than conventional ones based on project-specific case studies. The large majority of studies either focuses exclusively on the costs of installation of Green Infrastructure or compares the costs of installing sustainable features with the costs of installing conventional ones. Some studies look beyond installation costs to include operations and maintenance costs proving that the natural low-maintenance practices save costs.

4.3. Observations per thematic group of reviewed resources as identified

The principal tasks of the present literature review were to identify the main themes that relate to the "business case for sustainable infrastructure" and the prior research. They are presented in thematic groups as explained in the methodology.

4.3.1. CORPORATE SUSTAINABILITY

Corporate Sustainability or sustainable practice at the corporate level includes themes such as: risk perception, value creation, competitiveness, operation efficiency, good leadership, market value. We have already mentioned the research intention to explore the overlaps of corporate sustainability with infrastructure sector sustainability to extract useful conclusions on benefits and see if and how they can be translated to financial benefits. The sustainable objectives adopted at a corporate level by an organization that delivers infrastructure services should be aligned with and are expected to translate to project delivery. A common observation is that although theoretical and empirical research often points to a positive relation between corporate sustainability and company competitiveness, a consistent approach to document it is missing in the current literature (Weber, 2008).

Risk perception and management

Several papers and reports highlight the "unknown nature", the "lack of understanding" of what sustainability means for decision-makers, managers or other agents involved in the infrastructure project lifecycle. As a result the integration of sustainable practices on a project could be perceived as a "risk", an "imposition", that might "incur costs and delays and damage to a project. This is contradictory to the "*abundant evidence that corporate social responsibility and*

sustainability are valuable to business and drivers of market value." (Stapledon, 2012).

However, companies or other institutions with a deeper understanding of sustainability, or the different procedures to integrate sustainability practices at the corporate level benefit from an early adoption. In these cases sustainability, it is understood as a tool to reduce risk and open possibilities to explore different market niches.

"A key competitive advantage provided by sustainability is that it extends risk management beyond compliance activities outside the typical infrastructure considerations of time, cost and quality. This allows systematic, early identification and addressing of risks in the operating environment" (IFC, SustainAbility, Ethos Institute, 2002).

Leisinger (2015) refers to the integrity that sustainable practices provide to a company as "*smart risk management",* explaining that *"acting against global societal interests results in reputational damage, law cases, penalties and more regulation*."

Value creation

It is relevant to identify that most of the information available regarding the "Business Case for sustainable infrastructure" highlights value creation for customers, shareholders, and other stakeholders, as one of the top benefits of the integration of sustainable practices at the business level. This value creation can refer to various aspects from more competitive advantage, reputational or image improvement to higher level of engagement at the workplace. However, literature points out the need for adapting a different approach for measuring shareholder value, encompassing both operational and investment perspectives, in order to quantify this value creation benefit (Stapledon, 2012).

"A McKinsey survey of 1560 CFOs, investment professionals, and finance executives found they agreed, by a large margin, that improved corporate reputation and image is the most important way sustainability programs create value" (Jenkinson, 2010). The link with the infrastructure sector is implicit in the value creation merit of sustainability and more explicit in some cases:*"[…]embedding a culture of sustainability throughout the infrastructure delivery and management process will not only achieve public good outcomes, but will add bottom line value to your project, your organisation, and to society"* (Stapledon, 2012).

Competitiveness

Numerous surveys conducted to decision-makers and executives conclude that a solid sustainability strategy is important: "*A clear business case is the* crux of a sustainability strategy" for future competitiveness, nevertheless a low percentage declares to have such a strategy in place. "[…] only 60% have a strategy, and one-quarter have managed to develop a positive business case" (BCG, 2016). A general comment is that current methods to track the project sustainability impacts are incomplete with imprecise data that cannot support the decision-making process for companies.

Lubin et al. (2010) provides numerous examples of companies that have emerged as leaders within the shifting sustainability landscape developing and executing sustainability strategies. According to the same article, these companies gained competitive advantage matching both innovative green services and new and differentiated business models with strategic execution. More specifically regarding strategies, the authors state: *"pioneering companies in sustainability often start by focusing on risk and cost reduction and over time develop strategies for increasing value creation, ultimately including intangibles such as brand and culture."*

Efficiency- related cost savings at the corporate level

Sustainability provides the framework to achieve efficiency at the corporate level.

As identified in the paper published by the Harvard Business School, *"It has been proven that increasing operation efficiency can minimize the cost of the project reducing the cost of resources*". Eccles et al. (2012) provide examples of firms reporting significant internal savings from individual and systematic efforts of energy and water reduction across their portfolio; e.g. as much as $150 million of returns per year.

Weber (2008) registers corporate social responsibility (CSR) induced cost decreases: *"triggered by CSR-specific collaborations with e.g. NGOs that provide knowledge or contacts to critical stakeholders such as public authorities reducing the costs for product or market development" or "from tax concessions or reductions of certain duties granted by governments to promote e.g. environmentally friendly technologies"*.

Leadership

Sustainability requires an integrated, multidisciplinary approach calling for coordination among professionals from different disciplines or departments to achieve a common target. Leadership and strategic management enable companies to transition from siloed to integrated approaches. As a result sustainability is a synonym for committed and good leadership, given that it is required to balance

not only economic performance, but also strong social and environmental commitments. This will not just integrate the efforts at the company level, but will also bring together other stakeholders such as communities, customers, suppliers and clients. "*Corporate transformation for sustainability is a leadership task. […]New, integral thinking is crucial. […]Sustainability thinking must penetrate the entire corporate value chain"* (Leisinger, 2015).

Market value

A common view reflected in literature is that sustainability increases the market value of the company, because it does the "right thing". The reputation it provides "*is not an end in itself. It matters because it enhances the ability to attract capital — both human and financial — to mitigate risk and to build a company's license to operate*" (IFC, SustainAbility, Ethos Institute, 2002). Improved access to capital can be due to a higher sensitivity of investors to sustainability issues, but also external market forces magnified by escalating public and governmental concern about climate change, industrial pollution, food safety, natural resource depletion, etc. Sustainability emerges as a megatrend, and as such presents inescapable strategic imperatives for corporate leaders. "*Managers can no longer afford to ignore sustainability as a central factor in their companies' long-term competitiveness"* (Lubin et al. 2010). *"In five years, there will be no access to international markets for companies that do not show respect for the environment. It is becoming fundamental to international trade." (Rafael Wong, executive vice president of Reybancorp in Ecuador)* (IFC, SustainAbility, Ethos Institute, 2002).

The above mentioned benefits in the majority of studies are mostly qualitative and not quantitative, considered a company's intangible assets. Efforts to quantify business benefits and demonstrate an increase in revenues and profits after integrating sustainability has led to developing frameworks and company-specific measurement models. However, approaches are not consistent. In the case of the study of Ballow's et al. (2004) the proposed framework identifies and lists tangible and intangible assets, but is limited to only quantify the traditional accounting assets. According to Stapledon (2012) *"traditional accounting assets explain only about one quarter of market value"* and some intangible assets typically overlooked by managers, are actually valued by the market. Willard (2012) makes a statement about profit increase and presents a tool for calculating profits. However, the assumptions made have raised skepticism regarding their validity and thus it cannot be considered an established method or evidence. An important issue is that sustainability initiatives have additional intangible benefits that may offer additional value (and profits) to a business, which often are not included in business case assessments.

According to Lubin et al. (2010) "*Recognizing that if they can't measure it, they can't manage it, companies are developing better means of gauging corporate-sustainability-related costs and benefits and of benchmarking performance.*" The authors express certainty that this process will be eventually streamlined: "*Once firms have a solid base of analytical data, they will be positioned to develop distinctive sustainability strategies. Many aspects of strategy development will remain internal, but companies will increasingly adopt open-source approaches."*

4.3.2. INFRASTRUCTURE INVESTMENT

Sustainable infrastructure investment is related to investment gap, challenges and barriers to overcome, the need of decision-making frameworks, value management as a methodology to enable stakeholders to collectively balance competing interests and also as investments mechanisms' reviews or suggestions. Sustainable infrastructure is recognized as an investment and business driver.

Regarding the decision-making process, the necessity of suitable evaluation tools to address the complexity of decisions is emphasized. *"To date, however, there has been no widely accepted methodology that enables stakeholders collectively to balance competing interests"* (Jenkinson, 2010). Tools and methods for measuring cost-benefit will be presented later in their respective thematic group: cost-benefit tools and methods.

Key business driver

Sustainability as a business driver for buildings is well documented and the property industry has been transformed. However, at the infrastructure scale the industry has not yet evaluated the full value from investments on sustainable infrastructure projects. According to the literature, the infrastructure sector provides a solid area of investment and its sustainable development is considered to be a key business driver for shared public and business value. "*Public infrastructure, if properly managed and maintained, offers a stable and visible long term asset with a steady user base and well known, potentially growing, inflation protectable revenue streams".* To achieve a widespread adoption of sustainable investments it is imperative to analyze the ways that sustainability creates shared stakeholder value and compare and evaluate relative triple bottom line performance and return on investment (Janowitz, 2014).

Investment gap

According to ASCE's analysis (2017) of the state and performance of America's infrastructure given the current infrastructure investment trends, a gap is reported

between needs and investments, the so called "investment gap". The findings of this study indicate that investment needs will continue to escalate. At the same time, governments, the main funding sources and operators of infrastructure, are preoccupied by *"a strain of staunch fiscal conservatism that sees every investment as an expense and every initiative as an inappropriate imposition"* (Janowitz, 2014). However, *"the scale of infrastructure spending required over the next 15 years, coupled with widespread public-sector fiscal constraints, means that private finance will be increasingly important"* (McKinsey, 2016).

"The financing gap for sustainable infrastructure is in large part the result of poor policies, institutional failures, and lack of investor familiarity with greener technologies and projects" (McKinsey, 2016). Literature shows that over the past decades infrastructure owners were choosing where to invest based on *"priorities, borrowing capacity and tax-paid revenues [...] hoping that the private sector, and especially so called impact investors, will step in to fill the investment gap"* (Janowitz, 2014). They were also moving forward with what could get funded or part of what was needed for lowest front-end cost.

Challenges and barriers

In the process of credibly linking and forecasting the relation between specific infrastructure investments and performance outcomes, great challenges arise. To proceed with sustainable infrastructure investment, like in any investment, the resources must be found and the paybacks must be assessed. A challenge, commonly presented in the available literature, is the establishment of the right method to evaluate financial returns from sustainability factors and identify key performance indicators against which a project's sustainable performance can be measured. Investors are seeking to quantify the value and risk and large constructor-operators are looking for opportunities that can meet their risk profiles.

"Large up-front costs with returns flowing only much later, and constraints on long-term financing, make the funding of infrastructure particularly challenging" (Brookings Institute, 2016). The overemphasis on short-term results (profits & losses) and on front end costs instead of lifecycle costs is a common barrier of investment. The McKinsey Center for Business and Environment (2014) also points out five major barriers of private-sector investment in sustainable infrastructure.

- The lack of transparent and “bankable” pipelines,
- High development and transaction costs,
- Lack of viable funding models,
- Inadequate risk-adjusted returns and
- Unfavorable and uncertain regulations and policies.

The Brookings Institute reaffirms public policy as barrier to investment, as it sets the regulatory and institutional framework that influences the actions of private investors and consumers. The government has the responsibility to create and maintain a framework of conditions that can offer maximum stability and create the right incentives. Regulations may constrain the operation of infrastructure projects and may have a negative effect on profitability. On the other hand, regulatory certainty and an appropriate mix of policy tools can play a key role in promoting sustainable infrastructure investments.

The literature refers also to challenges related to the lack of a common language for sustainability within individual infrastructure industry sectors, as well as the conflicting agendas of infrastructure stakeholders and short-term confrontational contractual relationships (financiers, developers, consultants, contractors, owners, and operators), (Stapledon, 2012). In addition, studies confirm that investment on sustainable infrastructure projects is a field with extremely high potential but with a mixed risk scenario. The risks can be asset-specific, related to all the phases of the project (design, construction, operation) or asset-class related, such as interest rates fluctuations or political factors.

Opportunities

Given the dynamic nature of the infrastructure sector, where risks and opportunities evolve rapidly, ASCE's 2017 Infrastructure report presents the prioritization of investments as an opportunity pathway. More specifically, it proposes as main guidelines:

- *the life cycle planning and cost analysis for high cost projects that receive federal funding,*
- *the creation of incentives to invest in maintenance,*
- *the streamline of projects' permitting process across infrastructure sectors and*
- *the identification of a pipeline of infrastructure projects attractive to private sector investment and public-private partnerships.*

"Policy frameworks and financing mechanisms for public-private partnerships (PPPs) must improve in order to increase investment in sustainable infrastructure. PPPs are considered to be increasingly important investment modality" (Brookings Institute, 2016). At the same time, innovative financing, which makes sustainable infrastructure pay for itself, is also considered as an opportunity. Mobilizing concessional resources, catalyzing private sector investments and maximizing the use of market-based mechanisms (carbon, insurance markets) can create the right access and incentives for financing and investment.

4.3.3. COST-BENEFIT MEASURING METHODS

Research has provided significant contributions toward sustainability-related tools and best practices, allowing sustainability to be integrated even further across business operations. "*In order for infrastructure businesses to embrace sustainability, the initiatives they adopt must be seen to be valuable within the context of usual industry practice.*" A common trend of existing accounting practices is that "*what cannot be empirically measured is typically viewed as unimportant or even non-existent to business performance." To overcome this trend, management should start using non-traditional cash flow methods"* (Stapledon, 2012). Complex project evaluations involving multiple objectives and multiple stakeholder groups, such as related to infrastructure, have to aim~~ed~~ to satisfying simultaneously private economic goals, broader social objectives and environmental targets.

The present literature review focused on analytical tools and methods of measuring the cost of integrating sustainability. The "sustainable return-on-investment" analytical tools and *"the emergence of synchronized holistic 'triple bottom line"* provide a basis to assess risk, cost-benefit and investment parameters of various alternatives and thus support the decision-making process, defending choices. *"Such analysis […] highlights a host of other ways in which these sustainability-oriented projects have added or could add genuine value to their stakeholders"* (Janowitz, 2014), thus recognizing superior outcomes and establishing new benchmarks.

This type of input for the BC is important given that sustainable outcomes more often than not, cost less depending on how one measures the cost.[2]

There are many (not one) decision support tools that project planners need to be equipped with to develop a sustainable requirement be it manifested in a concept design, desired performance based outcome statement, or the basis document for a plan or design.[3] The effectiveness of these available tools has been under examination by various papers. The literature provides an insight to the available tools and the factors they propose to be considered. Additionally, efforts are made to respond to the question if these tools that have emerged through the prism of economic analysis rather than sustainability, are effective in assessing the wider sustainability costs and benefits of infrastructure projects – with long life spans and significant impacts across institutional boundaries.

A key tool in the assessment of project options and selection of a delivery strategy is Cost Benefit Analysis (CBA). "*A literature review reveals the limitations of CBA*

[2] ~~Feedback from~~
[3] As Robert Beinstein comments

alone to effectively evaluate economic, environmental and social externalities or impacts that apply over a long time frame, and that are ultimately irreversible" (Reidy et al. 2014). According to Grimes's analysis (2010) it is especially useful for making comparisons between alternative specifications that are designed to produce similar benefits. He concentrates on circumstances that may render a standard CBA inappropriate, to highlight the critical role of parameter assumptions and the range of issues to be taken into account. Through use of specific examples of how the choice of the appropriate discount rate, the use of option values and network complementarities can materially alter the perceived worth of an individual project and alter the ranking of alternative projects. He explains how the reasoning that lies behind the parameters can significantly alter the outcomes (Grimes, 2010).

Life Cycle Cost Analysis, for example, is a tool based on simple engineering economics, suitable for infrastructure owners who are also operators. "*In Traditional contracting methods where operation is not included the Life-cycle costing principles are not relevant"* (Stapledon, 2012).

Another more sophisticated tool Multiple Objective Determination Analysis (MODA), or Multi-criteria Analysis (MCA), takes one back to what are the objectives of the investment and how each one will be measured, so it could prove more suitable for other applications. MODAs use dashboards with algorithmic formulas that weight and interrelate the objectives to allow for holistic understanding. It is the preferred approach for problems with conflicting objectives. It uses both qualitative and quantitative parameters, and enables assessment of non-monetized values (Tudela et al. 2006).

Cross-comparisons of the available tools realized point out the shortcomings of individual tools and suggest that combination, for example, of Cost Benefit Analysis and Multi-Criteria Analysis could lead to improved guidelines for Business Case development (Reidy et al. 2014). In general, there is an emerging trend across researchers to propose and promote hybrid methodologies for the evaluation of projects rather than one specific method to respond to the shortcomings they identify. Consistency in the evaluation of benefits is critical to avoid overestimation or overestimation of benefits. An example of such hybrid evaluation tools is the so called Triple Bottom Line Valuation or TBL-CBA, study of elevated complexity that accounts for a sustainable project's total value, and not only financial feasibility at the point of procurement. Autocase®, created in 2012 by Impact Infrastructure, is an example of such tool with the additional value of streamlining the complex analysis process of a TBL-CBA. Autocase® through a cloud-based automated technology "*synthesizes hundreds of industry- and government- recognized research*

studies to provide smart default values" and after combining these values with basic project-specific data input, it computes and reports the project's full range of costs and benefits.

Another example of total value assessment tool is the International Institute for Sustainable Development (IISD)'s *Sustainable Asset Valuation (SAVi) Tool*, a simulation tool, customized for four sectors/ asset categories: energy, buildings, roads and water infrastructure, to inform decision-making for both governments and investors. SAVi through a System Dynamics Methodology integrates and processes data in a non-linear fashion and generates a conventional cost-benefit analysis with the added value of the quantification of broader co-benefits, avoided costs and project risks. According to IISD, SAVi is a tool capable of "*demonstrating the business case for sustainable infrastructure and how improved sustainability performance can affect future cash flows and contribute to more attractive financial returns."* The tool's outcome is sustainable project finance modeling presented through reports and illustration of results under various customized scenarios.

Finally, it is worth mentioning that the use of evaluation tools is not only important when weighing conventional vs. sustainable options, but also choosing the degree of sustainable performance that can prove valuable. There is evidence that there is a point beyond which higher performance demonstrates lower returns: *"there is evidence of diminishing returns for higher performance beyond a certain point"* (Stapledon, 2012).

4.3.4. SYSTEMIC APPROACH

This thematic group refers to infrastructure system- level sustainable approaches as opposed to isolated project-level ones. These two scale- approaches are probably the most influential in terms of cost-benefits according most recent studies. The present literature review will cite the benefits of the systemic approach in infrastructure financing as referenced and how it can alter perceptions of cost. However, as the integrated system approach is inherent in green and resilient infrastructure projects it will be also commented in the respective thematic group.

Conventional approaches' notion of infrastructure value is about delivering a specific, discrete service at the lowest upfront capital cost. This has resulted in projects relatively isolated from an inclusive view of their place and impact within the wider infrastructure system. The opposite of this approach is growingly merited in literature: *"There is considerable value to society in raising the standard of integrative, systemic design and planning"* (Janowitz, 2014). This could apply to either a series of linked projects of the same type, or complementary investments of different types made in a specific areas. E.g. master-planning for large-scale

urban extensions exemplifies the latter case. *"A new settlement requires multiple types of infrastructure – roads, public transport networks, telecommunications, electricity supplies, water supply, sewerage, schools, health services, community facilities, etc. If any one of these infrastructures is lacking, the entire project may be rendered infeasible or lose significant value, but each investment project can only be evaluated in the context of all others also taking place"* (Grimes, 2010).

A coordinated approach to infrastructure investment, the network effects or complementarities with other infrastructure investments, according to Grimes (2010) is a potential source of increasing returns to scale. "*A suite of complementary investments can produce greater returns than the sum of returns to each individual investment*". He also underlines the potential that lies in a sequence of interrelated projects that the initial steps have information value about the benefits of further stages in the development. This is the case of new information that becomes available after the completion of earlier projects in the sequence, which according to the author may act against disinvestment decisions and opportunities of benefits lost.

On a basis of value for money and definition of the opportunities that deliver reasonable returns at reasonable risk, these investments can provide long-term predictable returns, inflation protection and positive social and environmental impact.

4.3.5. INFRASTRUCTURE TYPE-SPECIFIC

As already mentioned the studies that fall into this thematic group are based on case studies mostly related to green infrastructure projects, water and wastewater projects, transportation (transit) projects, as well as resilient/ climate change mitigation projects. It refers to project-level sustainable approaches to provide more detailed and sector-specific information and will focus on transportation, as a representative example of infrastructure project, as well as on green infrastructure and resilient projects as singular, yet instructive examples of infrastructure projects cost-effective potential.

Green infrastructure projects

Among all the other related categories the Business Case for green infrastructure is the most fully developed and analyzed through the existing literature. There are several reports, papers and case studies showcasing that green infrastructure and low impact development projects (LID) cost less than projects designed with conventional methods. The United States Environmental Protection Agency (EPA) has an extensive database of resources proving the cost-effectiveness on this

category. The database includes several reports and case studies for the economic benefits of green infrastructure for urban developments, subdivisions, municipalities or cities. At some cases also provides analysis for the cost-effectiveness of individual green infrastructure features, such as green roofs. There are also references to guides and tools that stakeholders can use to calculate the benefits green infrastructure features might have on their projects.

There are several reports showcasing the substantial economic benefits of green infrastructure for residential or commercial urban developments. Shaver (2009) compares the construction costs of conventional and low impact development (LID) approaches for nine subdivisions in the United States and Auckland, New Zealand. The data from the report contradict any notion that LID is always more expensive than conventional development. In fact, the case studies indicate a significant reduction in construction costs may result when compared to conventional techniques. The report moves a step further and examines besides the upfront costs, the investment return benefits for three of the cases based in New Zealand. He concludes that in two out of three cases investment return increases with LID. In general, benefits to developers may include increased number of buildable lots due to smaller lot sizes and reduction in lot area devoted to conventional stormwater treatment, less spent on infrastructure by replacing kerb and channel drainage with roadside swales and increased property values. Clar (2004) reinforces the cost saving benefits achieved by adopting a green infrastructure approach and uses as a case study the Pembroke Woods residential subdivision in Frederick County Maryland. Without available calculations for all cost-savings attributes, the project's construction cost savings for the 43-acre development are expected to be at least 510.000$. Since Pembroke Woods was one of the first LID developments in the area (early 00') two important factors for the development of similar projects have been raised by this case study. The need for changes in the permitting process that would make easier the adoption of LID practices and secondly the need for public acceptance and education of property owners on the right maintenance of LID features. Similarly, the Illinois Conservation Foundation (2005) supports the same notion by analyzing case studies for housing schemes, corporate campuses and streets. "[…] *these results contradict the notion that conservation design is always more expensive than conventional practices. Not only do the three analyses show conservation is cost-competitive, but they also raise many situations where conservation methods can save the developer significant expense that translates directly to their bottom lines. In terms of overall approaches then, a gentle footprint on the land will reduce construction costs. Clustering and minimal site disturbance go a long way to cut infrastructure costs significantly, especially for stormwater management*". Besides cost-effectiveness the report points out two other

important reasons to support green infrastructure "*Even where conservation costs are competitive, municipalities and other governments should offer incentives to encourage conservation development for two reasons: 1) to help communities and developers overcome market inertia, which often exists even when they have information that supports change; and 2) to enable financing mechanisms for tools or combinations of tools to be piloted or implemented, especially as part of larger municipal stormwater management programs*." ECONorthwest (2009) describes experiences that developers have had with LID and also concludes that "*developments with LID can cost less than comparable developments with conventional stormwater controls, can sell for more, or both*." However, they also point out risks that LID developments might have for developers. Risks has to do with legislation, "*these risks include uncertain construction delays as developers apply for variances to local zoning codes because the codes do not explicitly recognize LID as an accepted stormwater control*" but also with the fact that potential buyers not always understand what is LID and the benefits of it, sometimes considering it less effective than conventional stormwater management, thus making developers more reluctant to use it. Finally, proposes incentives for developers to adopt a LID approach that can work in one of the following ways:

"*Reduce developers' costs, for example by lowering permitting fees. Reduce developers' risks, for example by expediting permitting. Increase developers' revenues, for example by allowing development densities greater than that permitted by code*."

Several other reports showcase the economic benefits municipalities might have by adopting green infrastructure strategies on city scale. The report by EPA (2014) refers to the case study of Lancaster, PA, a city that like hundreds of other cities across the country has both a combined sewer system (CSS) and a municipal separate storm sewer system. Besides the construction savings for installed infrastructure the report points out addition savings of "*$4.2 million in energy, air quality, and climate related benefits annually.*" It concludes though that green infrastructure installation is much cheaper if it is integrated into planned improvement projects compared to be implemented as stand-alone projects. New York City Green Infrastructure Plan also shows that green infrastructure strategies can reduce more CSO volumes at significantly less cost to New Yorkers than an all-grey strategy while providing more community benefits. It also points the immediate and gradually increasing positive effect of green infrastructure compared to usually decades-long design and construction period of grey infrastructure "*The significant sustainability benefits of the Green Strategy – which are not available through the Grey Strategy – would begin to accrue immediately and build over time, in contrast to tanks, tunnels, and expansions, which provide*

only water quality benefits at the end of a decades-long design and construction period." The report concludes that the Green Infrastructure Plan for NYC would cost approximately $1.5 billion less than the required cost for the Grey Strategy. It also estimates over a 20-years period "*between $139 million and $418 million in additional benefits through reduced energy bills, increased property values, and improved health.*"

Few of the reports on green infrastructure attempt to quantify the benefits of individual features. For example, the article by McPherson and others (2005) describes the structure, function, and value of street and park tree populations in five municipalities across the USA and monetize the benefits. Strategies each city can take to increase net benefits are also presented. The article calculates that "*Although these cities spent $13– 65 annually per tree, benefits ranged from $31 to $89 per tree. For every dollar invested in management, benefits returned annually ranged from $1.37 to $3.09."* The Evans et al. (2008) report attempts to quantify the cost of benefits of 'ecoroofs' program in Portland, Oregon. In 2001 the Portland City Council passed an ordinance that changed the zoning code to allow ecoroofs as a Floor Area Ratio (FAR) Bonus. Since 2008 more than 260,000 SF of ecoroof has earned the FAR. The report monetizes and offers a detailed analysis of each benefit for both private and public stakeholders. It quantifies cost benefits for several topic areas including, stormwater management, energy, climate, habitat, amenity value and building development. The report describes the costs and benefits for a new five-story commercial building with a 40,000 square-foot roof in downtown Portland and concludes that for the public there is an immediate and long term benefit (At year five, the benefit is $101,660, and at year 40 the benefit is $191,421) while for the developers and owner (private) in the near term, the costs for initial ecoroof installation outweigh the benefits. This shift at the 20 year mark and over the 40 year life of the ecoroof, the net benefit to the private property owner is $404,000 (in 2008 dollars). These calculations though do not include ecoroof FAR bonus that could increase developer's revenue for the building by several millions.

Guides and tools are also included on the available resources quantifying the cost benefits of green infrastructure. The 'Value of Green Infrastructure' guide by Center for Neighborhood Technology describes the steps to quantifying and valuing many of the environmental, social, and public health benefits of green infrastructure. The guide aims to inform decision-makers and planners about the multiple benefits green infrastructure delivers to communities and guide communities in valuing the benefits of potential green infrastructure investments. It describes five green infrastructure practices (green roofs, tree planting, bioretention, permeable paving and water harvesting) and examines the breadth of benefits this type of infrastructure can offer. The guide provides for the five practices calculation types

that at a first step quantify the benefits and at a second step evaluate the quantified benefits. The National Green Values™ Calculator by Center for Neighborhood Technology is an online tool for quickly comparing the performance, costs, and benefits of Green Infrastructure, or Low Impact Development (LID), to conventional stormwater practices. It provides estimations for construction, annual maintenance and life cycle costs.

It is clear from the preceding analysis that the Business Case for green infrastructure is well documented, despite the fact that quantifying and evaluating the exact cost benefits is a site-specific issue and the fact that many environmental and social benefits are almost impossible to calculate without using some basic assumptions. Still though, the available case studies, guides and tools provide a useful toolkit for monetizing the benefits of green infrastructure.

Transportation infrastructure projects

Transportation projects are large-scale and long lifespan projects and a representative type of projects of several goals with inevitable trade-off between them. Funding cannot be obtained by a single source and multiple sources imply the need to bring together different interests with different objectives and thus different weights in any appraisal process (Vickerman, 2007). They consist of system expansion and maintenance projects to address safety risks, unmet transit needs, urban congestion, urban capacity deficiencies and future growing demand due to demographic shifts. As studies point out transportation investments according to the current trends have the added cost of repairing as opposed to preserving entities in a good condition. "*Short-term "band-aid" solutions result in less than minimum tolerable conditions of function with greater operational cost and elevated user cost*" (ASCE, 2011).

The studies consulted for the present literature review mostly refer to methods of evaluation in terms of complexity of process; they explore the limitations of available methods and suggest alternatives. Within this survey the criteria for economic evaluation are put under consideration and testing, providing in the same time important insight on those attributes of transportation projects' that influence the Business Case.

The literature highlights that investment decisions for transportation projects are made under uncertainty (lack of accuracy of cost forecasts and uncertain demand during the long timescale for large projects to be planned, approved and constructed) and have to be guided by analytical tools to determine their feasibility. Especially if incorporating a sustainable development viewpoint into the evaluation then social and environmental aspects have to be considered through selected

criteria, as well as wider economic impacts, that aim to capture the project's broader benefits and costs. Vickerman (2007) described CBA as the most common method for evaluation and identified a number of types of CBA which incorporate varying degrees of realism.

The economic costs of transportation projects are investment- and maintenance-related, while the environmental and social are related to noise, visual intrusion and local air pollution or global climate effects. However, a degraded road pavement obligates vehicles to move slower, thus exhaust more pollutants, produce more dust, and create low-frequency noise. Noise and dust reduction with a new road are thus calculated within potential benefits of a new road, along with accident prevention (Tudela et al. 2006).

Among the criteria used for economic evaluation there are certain items quite straightforward, such as user-related benefits, travel time savings and vehicle operating cost savings (including fuel savings and savings on spare parts due to better ride quality of pavement). These can be incorporated as values and calculated within specific economic indicators.

To determine the feasibility of a transportation project Cygas et al. (2006) propose the use of the following economic indicators that are calculated by using cash flow and cost-benefit analysis method: the Net Present Value (NPV), the Internal Rate of Return (IRR), Payback Period (PP) and Profitability Index (PI).

Resilient infrastructure projects

The studies that refer to projects of this type, related to climate change mitigation, highlight the importance of risk analysis & evaluation. Numerous sources of uncertainties associated with the lifecycle performance of infrastructure systems require the use of a risk-informed decision-making approach to properly account for uncertainties and to identify cost-effective strategies to manage risk.

"Often the most cost-effective solutions to disaster risk are the ones available prior to a disaster to protect against a loss occurring in the first place. The capital cost of large-scale resilient infrastructure is often too high to be absorbed by local governments or utilities and the benefits are long-term, and non-monetary, making the same types of infrastructure investments unattractive to private investors. Project developers need to be able to quantify the savings from improvements before designing a financing mechanism to capture this value" (Re.bound, 2015).

Though resilient projects are highly site-specific, an issue outlined is the global scale of the phenomenon of climate change that makes their assessment even more

complex. The related studies highlight the interrelation of economics, risk analysis & evaluation with policy making and price-oriented mechanisms on a global scale. They suggest that economics have to be more strongly involved in order to broaden and deepen analytical investigation and reach to an agreement for a shared global framework of policy. Uncertainty over future climate policy decisions makes investors reluctant to undertake large-scale investment without upfront government support. On the other hand, in many developing countries, climate policies can be viewed as a constraint on their ambitions for development (Stern, 2008).

They also highlight the role of technological advances on climate change mitigation costs given that assumptions about efficiency improvements in the baseline and mitigation scenarios depend on innovation and market penetration rates for these technologies. Still, a clear statement made is that *"the costs of strong and timely action are much less than the costs of weak and delayed action"* (Stern, 2008).

Stern in his 2008 study revisits and updates a prior study of his, while referring to other studies' assumptions demonstrating underestimation or overestimation of risks. What is apparent regarding climate change economics is that it is still an uncertain field, due to the uncertainty of the phenomenon itself, which has not yet established a common reference framework with widely accepted assumptions.

4.3.6. ALTERNATIVE/ INNOVATIVE APPROACHES

Among the studies, revisions of prior studies etc. that constitute the literature reviewed there are the ones that using an either theoretical, or descriptive background, develop and propose new alternative approaches to the BC for sustainable infrastructure and whose insight is worth mentioning. In a field of open-ended issues these efforts reaffirm that the BC for sustainable infrastructure still holds potential of additional research and shift of paradigm from traditional practices to innovative ones.

The RE.invest program report based on specific case studies, states that "*design and financing are fundamentally parallel and complementary activities*" and explores the ways so that *"up-front design-thinking can identify specific and pragmatic value-capture opportunities*." *"Starting with design decisions that create savings can help align incentives to maximize resilience benefits over time and open up pragmatic pathways to implementation."* A recommendation the program directs to project designers and implementers is to "*Design based on cash flows, not only costs*", which can be of use for the BC research.

Through specific cases of resilience planning proposes a shift of focus to large-scale resilience projects that generate multiple benefits and has the potential to bring more funding and financing to infrastructure. *"Focus on systems finance, not project finance."* This approach can respond to investors' preference to large-scale problems and captures multiple cross-sector revenue streams through shared problem solving. Via engineering & design, legal & policy and finance assigned core teams the program aimed to: "*(1) catalyze large-scale systems solutions, (2) build pragmatic public-private partnerships, and (3) monetize and capture multiple benefits and revenue streams created by resilient infrastructure projects"* and attract large-scale private investors for comprehensive city-wide resilient infrastructure development. Through the cases of the eight participating US cities with identified common problems, the initiative demonstrated six innovative, investable and implementable resilient solutions that were mixed-and-matched to each city's specific needs. Apart from early cost estimates and feasibility studies, the analysis of broader benefits was realized to identify direct financial value, e.g. water rates, energy efficiency savings, or parking fees and indirect benefits, such as physical risk reductions and potential insurance savings, based on site-specific project designs. According to the program this broader economic evaluation "*is the missing link in current pre development processes".* This evaluation is *"essential for producing viable investments instead of proposals that are subsequently "value-engineered" to reduce costs at a loss of overall system resilience"* (RE.invest, 2015).

4.3.7. DETERMINANTS OF DIRECT COST

One purpose of the literature review and previously mentioned outcomes was to document through thematic groups, in large part, the determinants of cost, the factors that affect cost and how sustainability determines or differentiates these factors. The present thematic group, therefore, in some degree recapitulates prior findings focusing on direct costs. Factors that affect direct cost can be both external to an infrastructure project, e.g. regulations, as well as internal to its development process.

Project Development process-related factors

- A robust project management approach involves the development of a business case to guide investment decision-making and selection of the most cost-effective project option.

- Early integration of financing: Design and financing are fundamentally parallel and complementary activities.

"Starting with design decisions that create savings can help align incentives to maximize resilience benefits over time and open up pragmatic pathways to implementation" (Re.invest, 2015). Therefore early integration of financing in the project development process will determine the final cost.

- Financing structure-specific costs: Having to create unique financing structures for each project and jurisdiction increases transaction time and costs. For sustainable-infrastructure projects, transaction and development costs may be even higher because limited data on financial and risk performance makes deal evaluation more complicated (McKinsey, 2016).

- The procurement process is key to enabling responding companies to bid projects featuring sustainability as a core guiding principle. Perhaps the most important part of this is how the client defines the project team selection criteria that will determine financial proposals[4].

- Project Delivery Mechanisms: *"Meeting the demand for infrastructure using sustainable and resilient solutions requires new approaches to realign incentives and design new delivery mechanisms at the right scales to systematically aggregate, monetize, and capture benefits that are usually left off project balance sheets entirely or simply described as "co-benefits" (Re.invest, 2015)*

- Project objectives and performance-based criteria setting: How not setting the typical infrastructure engineering requirements (defined in terms of what is required) but rather setting the performance that is needed, can redefine projects' development. Creating a performance specification allows truly creative planners and designers to innovate to solve bounded problems. This is what unleashes the true sustainable solutions.

- Innovative Technology- specific costs: Incorporating new technologies, can introduce delays and increase costs related to finding the right products at the right price, convincing lenders and insurance providers of their value of etc.; however, can reduce operating costs.

- Time horizon for delivering financial results: cost-benefit evaluation of a project depends on the time horizon in scope, lifecycle costs versus upfront costs, long-term vs. short-term focus etc.

"Seeking to honor sustainability principles provide an incentive to design towards full lifecycle project value. An over-emphasis on front-end cost does not incentivize

[4] Feedback from Robert Beinstein

operational efficiency, longevity or resilience, all of which contributes to greater overall resource, energy and cost efficiency" (Janowitz, 2014).

The studies reaffirm that current tendency, or rather pressure, is to focus on delivering short-term financial results rather than long-term. That there is a misalignment of the timelines of budgets and projects. *"Infrastructure sustainability will invariably involve trade-offs. These may include operational versus capital costs, short-term versus long-term planning, and the frequent need for individual pieces of infrastructure to function as an integrated part of a system. The challenge for business is to maintain profitability and continuously build value for shareholders while best balancing the economic, environmental and social needs of, and impacts on, its other key stakeholders"* (Stapledon, 2012).

The above citation apart from commenting on the time horizon of an investment, also refers to the system vs. project approach: system management can prove to be more cost-effective than individual project management. Reference to the cost-effectiveness of the systemic approach is a recurrent theme, inherent to resilient and green infrastructure projects, that has been further explained previously in this review.

Public Policy/ Regulations

"Governments have always played a central role. [...] A poor enabling environment—one characterized by distorting subsidies, unreliable counterparties, and flawed procurement processes— can raise the cost of private finance to the point where infrastructure projects are no longer economically viable" (McKinsey, 2016). Brookings Institute (2016) states that public policy, at both national and international levels, has a crucial role to play in scaling up sustainable infrastructure development. *"There is a range of policy, institutional, and market failures that undermine the adequacy, efficiency, affordability, and sustainability of infrastructure. These failures raise costs and lower returns, increase risks, limit institutional capabilities, and drive a wedge between social and private costs and returns"* (Brookings Institute, 2016).

In many cases regulation barriers, or outdated regulations requirements increase a contractor's design and regulatory costs, which delays construction and can increase a contractor's financing costs. To surpass these barriers reforms are required e.g. tax and expenditure reforms, better use of balance sheets, new innovative ways, such as carbon pricing and improved property taxation, to leverage more private finance and lower its cost, risk mitigation and the promotion of infrastructure as an asset class.

Finally, it is worth mentioning that the context of a project is determining of costs. Project across different sectors, the location of projects, as well as the time and the funding institutions explain much of the variability of outcomes.

5. Further Research

The present review is considered a working document that will continue to expand and provide input to the research program along with the project-specific contributions of real-world case studies. It reaffirms the need to update traditional business tools—business case analysis, scenario planning, risk modeling, and cost accounting—to encompass the specialized requirements of sustainability and tracking its results.

The outcomes so far point out to some open-ended issues regarding the BC for sustainable infrastructure that can help direct the BC research to areas that may increase our understanding of the economics of sustainable infrastructure. The most evident open-ended issue is the evaluation tools' efficiency and consistency that has repeatedly been subjected under examination. The accounting practices regarding the sustainability outcomes have been recognized as one of the main barriers the acceptance of the business case for infrastructure sustainability (Stapledon, 2012).

The question that the BC Research seeks to answer to prove the cost-effectiveness of sustainable infrastructure is supported in by sector-specific evidence, which however is not generalized for sustainable infrastructure. The barrier set by the lack of understanding of value creation for stakeholders through sustainability, for example, reaffirms a non-generalized perception. The question is yet to be answered through the development of case studies-based research.

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