**Measuring Infrastructure Projects’ Impact on UN SDG Global Goals: Development of an SDG Impact-Value Chain for the Infrastructure Sector based on the Triple Bottom Line**

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**Abstract**

Global grand challenges of climate change, pandemics and other sustainable development risks are threatening international societies. Five years ago, the need for urgent action was grasped by the international community in their report, ‘Transforming Our World: The 2030 agenda for sustainable development’ (United Nations, 2015), where the 17 Sustainable Development Goals (SDG) were adopted by 193 states at the UN General Assembly. This research study develops a theory-led value-chain impact model that enables project success to be measured against economic, social and environmental aspects, i.e. ‘Triple Bottom Line’ (TBL). This integrated approach provides the infrastructure sector a way to increase the benefits realised across the TBL according to SDG language that accords with global imperatives. The study informs investment decisions and offers academics and practitioners a viable model for future development. For example, it has recently completed pilot trials and been agreed for further development to enable full-scale roll-out across the UK’s Environment Agency’s portfolio of projects.

1. **Introduction**

The construction industry has a major role in achieving measurable impact against the SDG 2030 targets (Goubran, 2019). The estimated USD $94 trillion (Global Infrastructure Hub, 2018) of investment in infrastructure projects that is required globally by 2040, represents a massive opportunity to stimulate economic prosperity, reduce poverty and raise standards in health, education and gender equality. However, the linking of infrastructure project success to SDG targets is problematic as a recent Institution of Civil Engineers’ survey (Mansell, 2018) demonstrated: whilst the appetite for SDG reporting at project level is very strong (87%), especially by millennials, only a third of the 325 respondents to that survey assessed current tools as ‘fit for purpose’. They identified four primary challenges to closing the gap: inherent difficulty in measuring project success using poorly understood output/outcome definitions (1); competing business priorities (2); leadership (3); and, the lack of suitable tools, methods and frameworks to carry out meaningful measurement of SDG success at the project level (4). This represents a knowledge gap that results in weaker investment decisions since SDG lessons are not being learned from project delivery successes and failures. Indeed, Silvius (2017) identified that there is an emerging challenge associated with adopting sustainability in project management and there is a need for an improved understanding of the relationship between projects and sustainability. The problem is complex and multi-faceted in nature, at both the project and organisational levels. At the organisational level, there is a plethora of financial and non-financial reporting artefacts (including rules, regulations and advisory guidance) that compete for adherence and conformity, which is exacerbated at project level, where there is largely an absence of guidance and legal framework for consistent reporting. This results in somewhat *ad hoc* reporting, where it is done well, provides transformative capability to the users and stakeholders, whilst done badly, it erodes stakeholder’s confidence that we are maximising the investment benefits from our finite levels of investment.

The research study was framed by leading theory [for instance see the work of Elkington (1994); Baccarini (1999); Weiss (1995); Porter (1985); Morris (2013); Hall et al. (2016)] that informed the development of this new transformation process model, which is proposed in this article as the ‘*Infrastructure SDG Impact-Value Chain*’ (IVC). This IVC model is the primary output of this study and has been underpinned by the empirical analysis undertaken previously (Mansell et al., 2019). The IVC harnesses a holistic ‘systems approach’ to address infrastructure sustainability in the SDG context. It also builds on evolving knowledge on impact definition, which when applied to the concepts of ‘Value Chain’ and ‘Creating Shared Value’ (Porter, 1985 and 2011), allows a clearer understanding of the so called ‘ends, ways, means’ process of investments, from input of capital, through to the delivery of activities and outputs. These produce outcomes, which in turn, can be mapped to SDG impacts. The IVC provides a new holistic method to improve the sustainability of projects and programmes by guiding decision-makers in their investment choices through confidence that they link to specific SDG targets.

The research study summarizes knowledge that underpinned the development of the IVC theoretical model. The SDG IVC transformation process model was subsequently used to examine one of the UK’s leading project-level sustainability reporting methodologies (Mansell et al., 2019), branded as ‘CEEQUAL’ (Building Research Establishment, 2019) and the organisational-level’s Global Reporting Initiative’s (GRI) sustainability tool, which is used by over 6,500 firms in 2017 (GRI database, 2019), including 73% of the 729 largest global companies analysed by PwC (2018). Using these two frameworks, the detailed research tested whether CEEQUAL (an infrastructure project tool) could map to GRI (an all sector organisational tool) across the IVC thematics; and also, whether they could be mapped to SDGs at project and company level.

The article is structured as follows. After the introduction section is the preliminary literature review section (including formulation of the research question), which is followed by the method section. This is followed by the section on building the infrastructure SDG transformation model and finally the conclusions and next steps section.

1. **Literature review**

**2.1 Sustainable project management**

In order to ground this research study in the wider context, it is useful to consider a broader perspective on sustainable project management. Indeed, in addition to research on project management in the construction sector (Hwang and Ng, 2013; Banihashemi et al., 2017), other industrial sectors have also been grappling with the need to adopt sustainable practices. In the case of the manufacturing sector, Labuschagne and Brent (2005) adopted a project lifecycle approach in order to develop a multi-level framework to assess the sustainability of operational activities including measurable indicators for the sustainability evaluation criteria. In other work (Carvalho and Rabechini Jr, 2017), empirical research through use of a survey instrument across eight different industries was carried out in order to propose and validate a research model on project sustainability management. This study identified that there is a positive relationship between project sustainability management and project success in the context of reducing the level of social and environmental negative impact.

Other researchers have adopted different research methods in order to explore sustainable project management. For instance, Sánchez (2015) explored integrating sustainability issues into project management through use of data envelopment analysis for selection and monitoring of projects. This research was based on the premise that social and environmental dimensions of sustainability are difficult to incorporate in both projects and programmes. The study focused on developing a framework to ensure that an organization is working on the right projects to achieve both its business strategy and meet the demands of stakeholders, where there is an improved portfolio selection of projects based on the simultaneous analysis of eco-level impacts as well as the contribution to organizational focused goals.Aarseth et al. (2017) carried out a [systematic literature review](https://www.sciencedirect.com/topics/engineering/systematic-literature-review) on project sustainability strategies. This work identified 68 articles, where two distinct streams of research were synthesized, which are the perspective of the project organization and of the host organization. The study also identified and described eight strategies that are adopted by either the project level organization or the host organization in order to support high-level sustainability goals. Furthermore, Silvius and Schipper (2014) investigated sustainability in project management through a literature review and impact analysis. They identified the areas of impact of sustainability on project management according to different levels and a key finding was an apparent shift of scope in the management of projects from the triple constraint to managing social, environmental, and economic impact. More recent research (Sabini et al, 2019; Sabini et al, 2017) has identified that there is a lack of a shared analytical framework for understanding what ‘sustainable project management’ involves. The later research used a systematic literature review to identify three main narratives: the reasons for adopting sustainability on traditional project management; the impact of sustainability on traditional project management practices; and finally, how is sustainability embedded in projects. This work underscores the trend in the academic research on project management in regard to embracing the need for sustainability and thereby adopting appropriate objectives that ensure sustainable practices are effectively ‘hard-wired’ into projects. These research studies from across the project management literature also highlight that this is a highly dynamic area that is being pursued by researchers across different industrial sectors and through the use of different research methods.

**2.2** **Sustainable development and sustainability reporting**

It is useful to ground this literature review with a common definition of sustainable development. Indeed, sustainability can be a problematic word. It lacks value perception by many senior business managers, which results in them not ‘walking the talk’ and only giving lip service to the fundamental changes that a full adoption of sustainability thinking requires across the private sector. Interestingly, the number of publications on sustainability and sustainable development has been rapidly decreasing, albeit there is an increase in research on SDGs. In this regard a bibliometric search on the Google Scholar platform for articles on the terms sustainability, sustainable development and SDG indicates that the frequency of submissions on sustainability related subjects has been dropping significantly since 2013, when it peaked at over 1.6 million (see ***Error! Reference source not found.***). There are a number of potential reasons for this, including the possibility of terminology creep (i.e. the subject being covered under many other headings) and ‘sustainability fatigue’. The latter is perhaps a symptom of perceived evangelising by a core of well-meaning champions of the people-planet dimensions at the cost of the bottom-line business reality of profit. Indeed, securing the optimal balance between the people-planet-profit of the Triple Bottom Line (Elkington, 1994) lies at the heart of this conceptual study.

***Figure 1 about here***

Figure 1: Analysis of Google Scholar – submissions of papers and journal articles over the past 10 years, 2009-2018, across titles of Sustainability, Sustainable Development and SDG.

Despite the apparent reduction in the number of publications, the core subject areas of sustainable development and sustainability have had an abundance of academic attention in recent years. In this regard, a search on Google Scholar over the previous 10 years identifies 2,490,000 results for academic papers on ‘sustainability practices’ and this increases to over 4,160,000 papers if reduced to a single word search of ‘sustainability’. Notwithstanding the recent reduction, this highlights the broad expanse of literature on sustainability themes, which is one reason why it has become mired in value-laden language and often vague in concept (Mebratu, 1998; Ciegis et al, 2009; Emas, 2015) that can cause diffusion of interpretation and confusion in practice (Fenner et al, 2006; Ainger and Fenner, 2014). Helpfully for project managers seeking ways to measure SDG impact, the Association of Project Management’s Body of Knowledge (APM, 6th Edition, 2012) provides useful insights into how clarity can be achieved through its definition of sustainability as "*an environmental, social and economically integrated approach to development that meets present needs without compromising the environment for future generations*". The APM’s definition has been based on the concept of sustainable development as derived from the highly influential Brundtland Report (Brundtland et al, 1987), which suggests that efforts to create improvements in the short-term should be without a negative impact in the longer-term. It also recognises that project strategies need to consider success against the TBL of social, environmental (or ecological) and economic (or financial) effects or otherwise noted as the ‘Three Pillars’ concept of ‘people, profit and the planet’ (Elkington, 1994, 2013, 2018; Griggs et al, 2013). The understanding that sustainable development is only achieved when there is balance or a trade-off between these three aspects is critical to TBL, as shown in ***Error! Reference source not found.***. This also highlights the development of the concept by Rockström (2016) who proposed a new way of viewing the economic, social and ecological aspects of the SDGs, which implies that economies and societies are seen as embedded parts of the biosphere. The greater number of SDGs aligned with the social layer should not necessarily imply that this is more important; instead, the diagram suggests that we should transition toward a logic where the economy (or profit) serves society (or people) so that it evolves within the safe operating space of the environment (or planet).

***Figure 2 about here***

Figure 2: The TBL view of Economy, Environment and Social translated into the donut view of SDG alignment by Johan Rockström (2016)

However, the historical over-emphasis on the last of the TBL criteria, namely finance, brings us to the root of the problem of measuring projects’ SDG impact. This is because the crux of the sustainability reporting problem lies with the dominance of accounting tools, which has been the pre-eminent business method of reporting business success for over 500 years since Luca Paccioli first published his papers on double entry bookkeeping (Yamey, 1949). It has largely remained unchanged. As evidence of this, there has been a proliferation of mechanisms and economic models to track different elements of TBL, including: ESG (environmental, social and governance) (Elkington, 1994) that includes the three core areas used in the business investments measurement of ethical and sustainability impacts of a company; Social Return on Investment (SROI) (Emerson et al, 2000; Millar and Hall, 2013); Net Positive (Forum for the Future, 2018; Rainey et al, 2015); Double and Quadruple Bottom Lines (Sawaf and Gabrielle, 2014); a myriad of capital (human, social, manufactured, financial, natural) analysis models; Environmental Full Cost Accounting (Schaltegger and Burritt, 2000); Boston Consulting Group’s Total Societal Impact framework; Integrated Reporting (Eccles and Krzus, 2010); Blended and Shared Value (Bonini and Emerson, 2005); and, Impact Investment (Bugg-Levine and Emerson, 2011). Recently this has been extended to new frameworks that focus on specific issues such as Sharing and Circular Economies (Preston, 2012); Carbon Productivity (Malhi et al, 2009; Suess, 1980); and Biomimicry (Elkington, 2018).

The contention of this study is that the proliferation of sustainability measurement theories, tools and concepts, that are often finance-driven, causes confusion and often leads to sub-optimal investments. As a result, and relevant to the assessment of how project managers can measure projects’ SDG impacts, there has been a growing demand (PWC, 2018; KPMG, 2017; Corporate Reporting Dialogue, 2019; PIMCO, 2019; OECD, 2007) for knowledge on how sustainability reporting can be aligned with SDGs and organisational reporting frameworks, in effect, finding what links investment decisions on capital (namely financial, manufactured, human, natural and social) usage with impact measurement. But to do this effectively, a new value creation model is required that commences from understanding the ‘ends’ or impacts, then traces back through the ‘ways’ and ‘means’ to understand the causal value chain that sequentially depicts inputs, activities, outputs and outcomes. The established Logframe model (or Logical Framework Approach), aligned to Porter’s model on Value Chains and Creating Shared Value (Porter, 1985, 2011) helps us to integrate this paradigm as a way to seek competitive business advantage for organisations.

**2.3 Formulating the research question**

The aforementioned challenges in regard to realising sustainability for infrastructure projects can be regarded in terms of a ‘Grand Challenge’, which a term which gained widespread usage when the United States White House Office of Science and Technology Policy (OSTP) formalised its definition as “*ambitious but achievable goals that harness science, technology, and innovation to solve important national or global problems*” (OSTP, 2013). The US government’s definition implies that practical action-based solutions are needed to impact the national and global policy context. Therefore, Grand Challenges capture ideas that are equally relevant to academics as well as practitioners. They are also, by definition, both ambitious (“*capture the peoples’ imagination*”) and achievable (“*solve … problems*”). Additionally, the definition identifies the need for measurement and impact to demonstrate meaningful progress. Consequently, this study adopts the ‘Grand Challenge’ metaphor as part of the context for the research question, which can be defined as follows: ‘*In order to realise the infrastructure solutions to the SDG Grand Challenge, how can the Triple Bottom Line paradigm (i.e. Economic, Social, and the Environment) provide a way to link existing sustainability frameworks at the project and organizational levels with SDG impacts?*’

1. **Method**

The research study is based on a conceptual research method that was inductive in nature, where the focus was on the synthesis of a new conceptual model that could be thereafter further validated and tested through the use of appropriate empirical studies. Conceptual analysis is a useful technique that has been used across a range of different applications. For example, analysis of the role of intellectual capital in creating and adding value to organizational performance (Bhatti and Zaheer, 2014), analysis of strategic capability development within product innovation projects (Kashan and Mohannak, 2014), analysis of distance, proximity and types of cross-border innovation systems (Lundquist and Trippl, 2013), and analysis of sustainability and ethics in the process of price determination in financial markets (Bosch-Badia et al., 2018).

The conceptual research method was adopted in this research study because an initial literature review of this area identified that sustainable project management is an emerging field of research enquiry and consequently there was a need for an exploratory study that would analyse the extant literature in order to derive a new conceptual view on how sustainability (and specifically the SDGs) can be measured on infrastructure projects. Moreover, there are also areas of underpinning theory, such as the triple bottom line (Elkington, 2013), the theory of change(Weiss, 1995) and value chain analysis (Porter, 1985). Figure 1 provides a schematic view of the method employed in the research study, which is based on four main stages that enable the conceptual analysis to be undertaken as part of building the infrastructure SDG transformation model.

**Insert Figure 3**

Figure 3: Schematic view of method employed in the research study.

1. **Conceptual analysis through building the infrastructure SDG transformation model**

In the search for a way to link ‘bottom-up’ project delivery and the ‘top-down’ Global Goals, four related theoretical models have been applied in this research study and they are described as follows.

**4.1 Concept 1 - The Theory of Change’s Impact-Value Chain (IVC)**

The overarching IVC model has its roots in the development of the Logical Framework Approach (Baccarini, 1999), also known as the ‘LogFrame’ or Goal Oriented Project Planning (GOPP) and Objectives Oriented Project Planning (OOPP) methods, in the development sector. Leading authorities such as the World Bank (2004), OECD (2007) and UNDP (2009) have combined with academic research institutions, such as Oxford University’s School of Geography and Environment (2014) to develop the temporal logic model to help investors, and wider stakeholders to design, monitor and evaluate development projects (International Fund for Agricultural Development, 2002). These Value Chain methods all stem from the ‘Theories of Change’ (Weiss, 1995; Stein and Valters, 2012) that have a number of principles, which are core to the proposed Infrastructure SDG model: they define long-term goals and then map backward to identify necessary preconditions; it explains the process of change by outlining causal linkages in an initiative, i.e., its shorter-term, intermediate, and longer-term outcomes; and the identified changes are mapped – as the ‘outcomes pathway’ – showing each outcome in logical relationship to all the others, as well as chronological flow. Finally, the ultimate success of any Theory of Change lies in its ability to demonstrate progress on the achievement of outcomes. Evidence of success confirms the theory and indicates that the initiative is effective. *Figure*  depicts these causal chain relationships.

***Figure 4 about here***

Figure 4: Concept 1 - The Theory of Change’s fundamentals for delivering impact (the number ‘1’ in the diagram refers to the Concept number, this is sequentially repeated in Figures, 4, 6, 7 and 8).

A core part of this research is understanding the SDG measurement at project level. This stems from an understanding of the project lifecycle and how sustainability reporting is critical to starting the project ‘right’ with alignment across stakeholders on what impacts define their success and how the Value Chain will be measured. The authors have used the following supporting definitions for the value chain:

* **Theory of change** (Weiss, 1995): A basis for planning intervention in a given policy or project arena that helps to identify processes and preconditions whereby actions can best attain their intended consequences.
* **Value** (Porter, 1985): The worth of a good or service as determined by the customer’s preferences and the trade-offs they choose to make given their scarce resources, or the value the marketplaces on an item.
* **Value chain** (Porter, 1985; Bloom and Hinrichs, 2011): The full range of processes and activities that characterize the lifecycle of a product from production, to manufacturing and processing, to distribution, marketing and retail, and finally to consumption (including waste and disposal across all stages).
* **Impact** (World Bank, 2004): Adapted by the authors to include a positive or negative contribution to one or more SDG targets across the TBL of environmental, economic, or social thematic areas.
* **Outcome** (APM, 2012): Adapted by the authors to be based on a change in the extent or condition of the stocks of capital (namely natural, produced, social and human) from the use of an output, due to value-chain activities that deliver SDG impacts.
* **Output** (APM, 2012): The tangible or intangible product typically delivered by a project.
* **Activity** (APM, 2012):A task, job, operation or process consuming time and other resources in a project to produce specific outputs.
* **Input** (APM, 2012): Adapted by the authors to include all those items required to undertake work utilising the stocks of capital including financial, natural, produced, social and human resources.

**4.2 Concept 2 - Delivery of projects within an organisational structure**

Infrastructure project management in the built environment is a discipline that focuses on phased delivery, within the parameters of time, cost and scope (and quality), to deliver a defined output (i.e. the iron triangle of project management), or if a programme, an outcome (APM, 2012). Project management has a well-recognised development process, referred to as the project life cycle (Morris, 2013), which is typically based on a number of iterative and normative stages, such as: plan, design, deliver, operate/maintain, and decommission. Therefore, understanding the sustainability reporting requirements within the project lifecycle enables the right stakeholders to be engaged at the right time to design the right approach to the definition, measurement, monitoring and reporting of sustainability outputs and outcomes, as shown in *Figure* .

***Figure 5 about here***

Figure 5: Concept 2 - Delivery of projects within an organisational structure; both with sustainability reporting loops embedded.

The project context is important, especially in its relationship with stakeholders, such as clients, designers, and contractors, because alignment of what success means to different stakeholders is a critical success factor in itself. However, these relationships indicate that the project sits at both inter and intra organisational boundaries, where each organisation has its own sustainability reporting requirements as part of an annual reporting cycle. This is highlighted in *Figure* , which shows the proliferation of sustainability reporting instruments; currently in excess of 400, including 170 government and stock exchange / financial market regulations, 129 Codes of Conduct or Guidance, 8 Standards, as well as a myriad of other industry frameworks (KPMG, 2017).

***Figure 6 about here***

Figure 6: Global Sustainability Reporting. Source data from GRI (2016).

**4.3 Concept 3 – Infrastructure investments as ‘system-of-systems’**

The layered description of the proposed conceptual model, IVC, is iterated below in *Figure* , with a third concept that relates to infrastructure projects that are based on a ‘system-of-systems’ approach (Hall et al., 2016; Thacker and Hall, 2018).

***Figure 7 about here***

Figure 7: Concept 3 – Infrastructure investments as a ‘system of systems’ – Source: The Future of National Infrastructure: A System of Systems Approach (Hall et al, 2016; UNOPS, 2017).

The concept of a system-of-systems recognises that infrastructure projects in the built environment are more than the sum of their parts, albeit that the strength of their synergy also has an inherent risk of resilience weakness through both complexities and boundary management issues if they are not fully understood and managed. The concept challenges the traditional understanding of infrastructure as stand-alone physical assets. The systems approach recognises a number of linear value chain connections that fit with concepts 1 and 2 described earlier. These are illustrated in *Figure* , which highlights the way that investment of resources on specified infrastructure projects deliver assets that can be transformed through programme change initiatives to provide a service to society, which if successful, has strategic impacts that could be aligned to SDGs. Thus, infrastructure operates as a set of both interrelated and interdependent systems, which enable service systems within a certain context to function. The key definitions for the infrastructure systems are (UNOPS, 2017) as follows:

* **Systems thinking**: An approach that focuses on the identification of interrelationships between components (i.e. sub-systems) of a system.
* **Infrastructure system** (UNOPS, 2017; ITRC’s Hall et al, 2016). A system comprised of assets, institutions and knowledge that provides a society its services. Examples of National Economic Infrastructure systems include water, energy, transport, waste, and telecommunications.
* **Assets** (UNOPS, 2017; ITRC’s Hall et al, 2016). The physical components of the system. This also extends to the links that exist between the assets in the system. Note that there are man-made assets but also ‘Natural Assets’, which provide a service. Examples of man-made assets include roads, bridges, power lines, and pipes. Example of natural assets include wetland systems, and mangrove forests.
* **Services** (UNOPS, 2017; ITRC’s Hall et al, 2016). The functions which the infrastructure system enables. Examples include healthcare services, transport services, and education services.

***Figure 8 about here***

Figure 8: Infrastructure System of systems Map showing ‘Ends, Ways, Means’. Adapted from papers by UNOPS (2017) and ITRC’s (Hall et al, 2016).

Infrastructure projects’ SDG impact is best understood through the relationship, shown in Figure , between the infrastructure systems’ service to society. This provides the causal link to the SDG impacts and a coherent way to assess sustainability across the TBL of economic, social and environmental impact areas.

The applicability of understanding infrastructure projects within a system that delivers outcomes, is becoming more clearly understood (ICE, 2018; National Infrastructure Commission, 2018; IPA TIP Report, 2017) as a value-based proposition, as evidenced in the Institution of Civil Engineers (ICE) transformative research on Project 13 (ICE, 2018). It focuses more on wider stakeholder social and environmental impacts as well as the business-leading economic requirements of time, cost and scope.

**4.4 Concept 4 – Delivering impact measured against the TBL/SDGs**

The connection between the SDG impacts and the five main national economic infrastructure systems of power (i.e. energy), water (including collection, treatment, distribution, and disposal), transport, waste, and information and communications technology (ICT), is described in the fourth concept (see Figure 9), which illustrates the TBL link that connects the entire SDG Infrastructure Value-Impact Chain (IVC).

***Figure 9 about here***

Figure 9: Concept 4 – Delivering impact measured against the TBL/SDGs, and completing the learning-loop for smarter investments, adapted from ICAS/IIRC’s ‘The Sustainable Development Goals, integrated thinking and the integrated report’ (Adams, 2017).

In practice, the TBL can be mapped against the five stages of the IVC as shown in *Table 1*. This table was developed as part of a parallel research initiative with the Institution of Civil Engineers and a water utilities company (Mansell, Philbin, Boyd, 2020b). The exercise represented in Table 1 was undertaken with a focus group of 15 academics/professionals from a variety of engineering sectors, hosted by the Knowledge Directorate at ICE. The simple representation of the analysis, shown in Table 1, was subsequently developed further as part of in-depth case study with the UK’s Environment Agency and the Thames Tideway mega-project. These results are currently being analysed. Therefore, the Focus Group’s work illustrated in Table 1 represents early indications, but helpfully provides increased confidence in the stability of the underpinning assumptions of the IVC model. The simple representation of linkages across the IVC, comparing Theory of Change to TBL thematic areas, indicate that there are clear ‘Theory of Change’ patterns that build through the iterative stages and this can be linked directly to project and organisational level understanding of sustainability reporting (Mansell, Philbin, Boyd, Nicholson, 2020a).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Input | Activity | Output | Outcome | Impact |
| Economy | Finance / investment; insurance; risk contingency allocations; whole life costs (WLC) analysis; stable government; non-corrupt financial context; | Job creation; income; wages; source, move & assemble materials; build iteratively through defined activities such as early earthworks; local & wider supply chain activity  | Project completion to time/cost/scope – bridge, building, road etc.; income; profit; taxes; Net Present Value provides strong return on investment against WLC; | Economic growth enabled by completed assets as a system; more resilience; wealth creation; ownership; increased future investment and additional job creation | SDGs 8, 9, 10, 12 |
| Social | People; social networks; cultural and technical knowledge; listening & working with stakeholders; | Collaborative innovation; health & wellbeing; stakeholder engagement; skills and learning; working conditions; production activity; user engagement;  | Asset’s social utility; meeting stakeholders’ objectives; individual and group learning and post project knowledge sharing;  | Infrastructure enabled change across health, education etc., e.g. reduced mortality; gender equality; social equity; justice;  | SDGs 1,2,3,4,5,7,11 |
| Environment | Raw materials; land take; water; light; clean air; energy; planned land use; ecology ecosystem valuation assessment; | GHG emissions; pollution; noise and air quality; works’ affects pre and during production e.g. waste management, nitrogen, carbon dioxide, acidification levels | Managed effects on completion of asset; replanted trees etc.; improved local area; no net loss on eco system footprint; short term environmental targets met;  | Restored/ improved biodiversity and natural balance and increased long term positive affect on environment through improved sustainability | SDGs 6,13,14,15 |

Table 1: IVC Grid illustrating mapping of the TBL against the 5 stages of the IVC.

Based on the conceptual IVC mapping in the table, the research study developed a series of tests to assess whether leading national and global sustainability reporting frameworks could provide a means to define SDG targets’ impacts at project level that also had coherence at organisational level. Secondly, the tests also assessed whether there was a prioritised list that the infrastructure sector could use to develop this approach further, since the full list of 17 SDGs with their 169 targets is not appropriate at project or organisational levels.

1. **Conclusions and next steps**

This article summarizes theory-driven research into the existence of a link between sustainability reporting at the ground-level of project delivery and the strategic level of the Global Goals – the UN’s 17 Sustainable Development Goals. The research study enabled an innovative conceptual model to be assembled, based on four underpinning theoretical models including: The Theory of Change; Creating Shared Value; Infrastructure Systems approach; and, the Triple Bottom Line. The last of these, the TBL, provided the link to SDGs. The evidence of this linkage offers an opportunity to develop industrial case studies across large construction projects in their design phase to develop knowledge in this important area. The research therefore concluded by proposing the Infrastructure SDG Impact-Value Chain as a basis for testing on ‘live’ infrastructure projects. The IVC model has subsequently been evaluated further through demonstration of the linkages to the recognised CEEQUAL and GRI (global reporting initiative) frameworks (Mansell et al, 2020a) and as part of a case study investigation of a water utility company (Mansell et al, 2020b).

The benefits of the conceptual research described herein are as follows:

1) The study aligns the infrastructure sector’s thinking and action around the global goals, providing a meaningful commitment to support delivery of the 2030 targets.

2) The research allows an improved understanding of the characteristics of sustainable infrastructure, which will help stakeholders clarify what defines success, both at the tactical delivery phase of the project (inputs, activities, outputs) as well as the strategic post-project benefits delivered by the system/services (outcomes and SDG impacts) thereby strengthening the business case.

3) This leads to development of improved projects because of a clearer and unified understanding of sustainable infrastructure that will ensure we are maximising use of our finite capitals (namely finance, human, manufactured, social, and environmental).

4) This study supports governance and institutional strengthening because the IVC framework can help identify opportunities for institutional (i.e. pertaining to policy, regulation, legislation, organisational and project level) capacity building to ensure systemic-driven changes that build stronger infrastructure project pipelines and improved delivery of infrastructure-related services.

5) The research has the capacity to enable sustainable infrastructure investors to align financial systems with the broader TBL objectives and both incentivise and mobilise finance to drive sector transformation to increase the impact of investments across the USD $94 trillion infrastructure portfolio (Global Infrastructure Hub, 2018).

6) Lastly, the study can potentially help support the standardisation of methods and tools through a common process for prioritisation of impacted SDGs on infrastructure projects, with conformance on an agreed set of targets and indicators that the sector can use to help accelerate adoption. This enables improved measurement of progress through cross-sector learning and will result in better-quality infrastructure investments that are scalable.

Based on this research, an IVC implementation handbook was developed to support the testing phase of research (from November 2019 to March 2020), which trialled the use of the IVC methodology across the sector. The research team partnered with the national UK Environment Agency to test the IVC approach across their portfolio of 1,400 flood mitigation projects, which total £5.2bn for FY2021-22, including 15 major projects in excess of £50million. This concluded in March 2020 and as a result, the Environment Agency’s has agreed that it will now enter formal trials to embed the IVC approach across the Environment Agency. The UK Government is also partnering in this programme to assess whether the success at the Environment Agency can be replicated across the full UK major projects’ portfolio (in 2019, this represents 130 projects, at a total lifetime cost of £450bn) (IPA, 2020). Whilst these trials have been UK-centric, there is optimism that it has relevance internationally and the authors have been collaborating closely with the United Nations Office for Project Services to trial the IVC methodology more widely.

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**Figures**

All diagrams can be supplied in higher definition and as black-white with clear definition of indices.



Figure 1: Analysis of Google Scholar – submissions of papers and journal articles over the past 10 years, 2009-2018, across titles of Sustainability, Sustainable Development and SDG.



Figure 2: The TBL view of Economy, Environment and Social translated into the donut view of SDG alignment by Johan Rockström (2016)



Figure 3: Schematic view of method employed in the research study.



Figure 4: Concept 1 - The Theory of Change’s fundamentals for delivering impact (the number ‘1’ in the diagram refers to the Concept number, this is sequentially repeated in Figures, 4, 6, 7 and 8).



Figure 5: Concept 2 - Delivery of projects within an organisational structure; both with sustainability reporting loops embedded.



Figure 6: Global Sustainability Reporting. Source data from GRI (2016).



Figure 7: Concept 3 – Infrastructure investments as a ‘system of systems’ – Source: The Future of National Infrastructure: A System of Systems Approach (Hall et al, 2016; UNOPS, 2017).



Figure 8: Infrastructure System of systems Map showing ‘Ends, Ways, Means’. Adapted from papers by UNOPS (2017) and ITRC’s (Hall et al, 2016).



Figure 9: Concept 4 – Delivering impact measured against the TBL/SDGs, and completing the learning-loop for smarter investments, adapted from ICAS/IIRC’s ‘The Sustainable Development Goals, integrated thinking and the integrated report’ (Adams, 2017).