Measuring Sustainable Development Goal Targets on Infrastructure Projects

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Abstract: Achievement of the United Nations' Sustainable Development Goals (SDGs) is of paramount importance. Infrastructure projects are critical to facilitate this change at local and global levels, but a gap exists in understanding how to measure their SDG impact. It is therefore important that research is conducted on how project management systems and processes can be further developed to enable SDG performance measurement on projects. This paper builds on a comprehensive literature review and supporting analysis in order to develop a conceptual framework to guide future research on measuring SDG impact on infrastructure projects. The findings suggest using the 'Triple Bottom Line' during the lifecycle of projects, which provides a golden thread linking SDGs with project success criteria. This approach thereby balances economic business success with wider benefits to society and the environment and helps improve infrastructure project investment decisions.

Keywords: United Nations' Sustainable Development Goals (SDGs); Sustainability; Project Success; Measurement; Outcomes

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Introduction

It is now over two years since Morris (2017) published the defining research into what the project management profession should be doing about climate change and other grand challenges. Indeed, many others (Seinfeld & Pandis, 2016; Sachs, 2016; United Nations, 2018) have suggested that the planet is in a crisis and we now need radical change. Morris and Sachs have shown that never before have we had such confidence in the evidence that demonstrates so many species are threatened and our ecosystem 'faces massive change and collapse unless action is taken immediately' (Morris, 2017). The urgency of finding solutions to these challenges is highlighted by the United Nations (UN) Intergovernmental Panel on Climate Change, which released their latest and most damning Report on 8th October 2018 (IPCC, 2018). The Report drew on the findings from *ca*. 6,000 research papers. The evidence of global warming exceeding 2^{o}C above pre-industrial levels by the end of the century is overwhelming and indicates 'impending catastrophe' – climate change is an existential threat to the human race. Whilst there have been some significant advances since the Rio Summit (1992 and +20 in 2012) and the Kyoto Protocol (2005), such as the transformational technologies for battery-powered cars and renewable energy, even a rise of 1.5^{o}C now appears to be inevitable. This temperature rise would potentially wipe out almost all of the world's coral with hundreds of millions killed from the effects of drought and coastal flooding, while the threat of starvation will likely trigger unprecedented mass migration (United Nations, 2019; Sachs, 2016).

The response of the international community to the grand challenge of sustainable development was codified in the '2030 Agenda for Sustainable Development' that was adopted by the 193 Member States of the United Nations at the UN Sustainable Development Summit in September 2015 (United Nations, 2015). The UN General Assembly agreed the seventeen Sustainable Development Goals (SDGs), also known as the 'Global Goals', as shown in Figure 1 below. The SDGs are intended to provide a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

Figure 1*:* The Global Goals for Sustainable Development (United Nations permission to use).

Five years into the global commitment to deliver meaningful SDG action, it is evident that we are falling behind on our local and global ambitions (OECD, 2019; United Nations, 2019). This is relevant for project managers because much of tomorrow's resilience and development will be delivered by the project management profession, across all sectors, but especially infrastructure. For example, the IPCC's October 2018 Report identifies that "*directing finance*

towards investment in infrastructure for mitigation and adaptation" is key to meeting SDG targets. Another indication of the importance of infrastructure projects is shown by the estimated USD $94 trillion (Global Infrastructure Hub, 2019) of investment in infrastructure projects that is required globally between 2018 and 2040. This represents a significant opportunity to stimulate economic prosperity, reduce poverty and raise standards in health, education and gender equality. Equally, done badly, the evidence suggests (Silvius et al., 2012; Thacker and Hall, 2018; Thacker et al., 2019) that economic benefits from projects' impacts could be outweighed by the negative impact on the environment and society.

Although previous studies (Martens and Carvalho, 2017; Okland, 2015; Silvius et al., 2012) have provided valuable insights into the relationship between the lifecycle of projects and the concept of sustainability, there has been less research into sustainable development and the relationship between projects' success and success of the UN Global Goals. Some studies have made useful inroads by considering the project risk management disciplines and its relationship with project sustainability success (Silvius & Schipper, 2014), which indicates the need for better tools, methods, and approaches. In particular, the evolving knowledge on project management benefits realization (Keeys & Huemann 2017; Marnewick, 2016) suggests that project benefits management, especially when reporting on the more elusive sustainable development impacts, has not reached maturity amongst organisations and that this is an area for further research. This represents a knowledge gap that recent research highlights as worthy of further study (Økland, 2015) since the existence of a gap between what literature suggests and what is carried out in practice, leads to weaker investment decisions because SDG lessons are not being learned from project delivery success and failures. This knowledge gap is framed by three iterative questions that provide the focus for this paper:

1. Are the existing UN SDG targets and indicators adequate for defining success at the infrastructure project level?
2. What framework would support further research?
3. How could the proposed framework be used to further our understanding and, ultimately, provide a contribution to both theory and practice?

Therefore, this paper seeks to help close the gap by sharing emerging research into the linkage from project-level benefit realization to local, national, regional and global SDG targets. It concludes with a new conceptual framework for establishing a 'golden thread' that can be used for further research to support the project level implementation of the 2030 SDG targets. The benefit to practitioners of this work is that it supports ongoing development of a practical method to measure SDG impacts at project level which will likely improve their ability to define and measure a broader Triple Bottom Line (TBL) (Elkington, 1994) value creation across the three-legs of economic, environmental and social impacts, which some argue (Elkington, 2013 and 2018), is a necessary broadening of success definition if the most value from infrastructure project investments are to be realised. It should also enable broader lessons to be learned for future investments that better balance projects' TBL impacts.

The concept of grand challenges in relation to SDGs

Grand Challenges is a term used, predominantly by the academic community, to qualify and structure responses to so-called 'wicked problems' (Head & Alford, 2015) of immense magnitude and impact. 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 also achievable ("*solve ... problems*"). Additionally, the definition identifies the need for measurement and impact to demonstrate meaningful progress. The definition of Grand Challenges has evolved since Mertz's (2005) focus on the engineering communities, to a broader group of stakeholders that includes policy shapers, funders, and delivery-to-

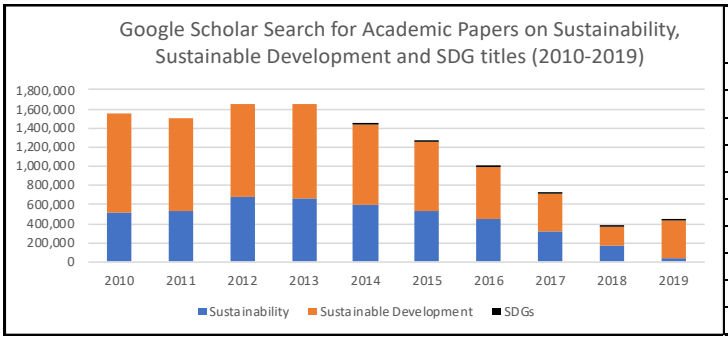
operations project teams (Omenn, 2006). Consequently, project management professionals have the opportunity to take a leading role in this, especially in providing tangible action that can be implemented by practitioners to affect improved performance against the SDG targets.

More recent research into Grand Challenges (Sakhrani et al., 2017) has identified five characteristics that are helpful in this paper's analysis: Grand Challenges are (a) articulated by stakeholders, (b) specific, (c) ambitious yet feasible, (d) framed in a manner that suggests the use of specific methods or disciplines, and (e) have the potential for broad impact. These characteristics provide a useful reference point for developing a conceptual framework to deepen the research into how the project management community can measure projects' SDG impacts.

The concept of sustainability and sustainable development in relation to SDGs

Sustainability can be a problematic word. Fifteen years ago, there were up to sixty definitions of sustainability (Hartshorn, et al., 2005) with little convergence of how the theory of sustainability could be given meaning in practice. There are those (Zuofa, & Ochieng, 2016; Sverdrup & Rosen, 1998) who suggest that sustainability is essentially the long-term harnessing of an ecosystem to maximise the outcomes whilst ensuring the extraction of the input of resources from the ecosystem do not negatively impact its long-term viability. Alternatively, there are others (Costanza & Patten, 1995) who define sustainability simply as a measure of whether a system can ultimately continue or is self-consuming. It can thus be shown that 'sustainability' 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; Moore, et al., 2017). These examples explain why the definition remains nebulous and why a practical definition has greater utility (Glavic and Lukman, 2007) for project managers.

Interestingly and somewhat counter-intuitively, the number of publications on sustainability and sustainable development has been rapidly decreasing, albeit along with an increase in research on SDGs. In this regard, a bibliometric search on the Google Scholar platform for articles on sustainability, sustainable development and SDGs 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 Figure 2). 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.



Year	Sustainability	Sustainable Development	SDGs
2010	509,000	1,040,000	
2011	532,000	976,000	
2012	687,000	966,000	
2013	661,000	987,000	
2014	603,000	834,000	1,590
2015	535,000	718,000	4,500
2016	452,000	540,000	9,560
2017	326,000	388,000	14,600
2018	170,000	195,000	18,800
2019	41,700	399,000	3,060

Figure 2: Analysis of Google Scholar – submissions of papers and journal articles over the past 10 years, 2010-2019, across titles of Sustainability, Sustainable Development and SDG.

For the purposes of this paper, the definition of sustainability builds on the broader definition of sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987). Over the past 50 years, the phraseology and understanding of 'sustainable development' (Sachs, 2016) has become an increasingly central theme of nation states and their citizens. Today, the Planetary Boundaries (Rockström, 2009) provide a global litmus test for how we are doing. The concept of nine planetary boundaries within which humanity can continue to develop and thrive for generations to come was developed in 2009 by environmental scientists from the Stockholm Resilience Centre. The most significant global response to the Planetary Boundary challenge was in 2015, when all governments ratified the UN's seventeen Sustainable Development Goals (United Nations, 2015) to be achieved by 2030 (with 169 targets and 244 indicators agreed in 2017). This represented a major step-change in the implementation of the sustainability agenda and effective responses to the Planetary Boundary challenge. Although the SDGs build on the earlier Millennium Development Goals (MDGs) (United Nations, 2000) by focusing on similar issues, the SDGs differ from the MDGs because they are for all countries in the world to implement – developed and developing alike (Sustainable Development Network, 2014). Also, unlike the MDGs, the SDGs are focused on monitoring, evaluation and accountability – across society, not just at national level, which is why it is critical that the link is made from the 'bottom-to-top', meaning from delivery of project-level impacts that can then be assessed against the national and global targets and indicators. The research presented later shows this cannot currently be achieved, and the evidence (Martens, & Carvalho 2016a and 2016b) illustrates that the golden thread from project measurement to national/global level, is missing. There is a gap between theory and practice (Okland, 2015).

The concept of sustainable infrastructure projects that impact society in relation to SDGs

The ongoing development of society relies on multiple sectors' evolution of their social and economic systems (Heravi, Fathi, and Faeghi, 2015). This development consumes large quantities of capital resources, as defined by Bebbington (1999) in the five capitals evaluation model, which often results in negative outcomes. This was informed by the work of sociologist Anthony Giddens, when he defined a 'Risk Society' as 'a society increasingly preoccupied with the future (and also with safety), which generates the notion of risk,' (Giddens & Pierson, 1998) whilst the German sociologist Ulrich Beck defined it as 'a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself' (Beck et al., 1992). The risk to society and its relationship to the SDGs, is that society's economic development has been fuelled by the unprecedented growth of industrialization and population (Betts, et al., 2011).

Most of society's developments can be connected to infrastructure projects (Thacker and Hall, 2018; Thacker et al., 2019) and the UN recognize that this represents a massive opportunity to stimulate economic prosperity, reduce poverty and raise standards in health, education and gender equality (UNOPS, 2018).

Further evidence of the growing literature on the measurement of infrastructure project sustainability is provided by Shen, Tam, Tam and Ji (2010), who focus on the balance needed between benefits to society whilst protecting the environment and still achieving the economic benefits envisaged in the projects' business case. The linkage across the three areas in the construction industry is further defined by Kibert (2013), who suggests the interrelationship between a project's outputs and the society that is impacted is a central component of defining sustainability success of an infrastructure project. This introduces the concept that project success definition needs to consider success against the Triple Bottom Line (TBL) (Elkington,

1994) 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).

It is apparent that ameliorating many of the risks associated with climate change can only be achieved through investment in appropriate, and resilient, infrastructure and engineering (OECD, 2019). Greenhouse gas emissions cannot be sufficiently reduced without new forms of energy infrastructure or less polluting transport networks, to name but two; water security requires investment in new and more resilient forms of water infrastructure (OECD, 2019; United Nations, 2019). A formal recognition of the ability of engineering and infrastructure to reduce strategic business risk would benefit everyone – business, engineering and society.

The concept of project success in relation to SDGs

SDGs, are by definition, global goals. Their success is defined by specific targets and indicators across the selected 17 SDGs that need to be delivered by 2030. At a local level, the definition of projects' success is also an important area of analysis if a link is to be made between project success and SDG success. Recent studies (Joslin and Müller, 2016) have shown that forty years of research into project success factors and criteria have indicated that project success is the achievement of a particular combination of objective and subjective measures assessed at the project's end. This perspective links to the previously referenced five characteristics of Grand Challenges (Sakhrani et al., 2017), which are:(a) articulated by stakeholders, (b) specific, (c) ambitious yet feasible, (d) framed in a manner that suggests the use of specific methods or disciplines, and (e) have the potential for broad impact. This correlation is used later to test a unified approach to addressing the measurement of global SDGs at the local project level.

Methodology

The methodology is based on a comprehensive literature review to support the development of a conceptual framework for the measurement of SDGs on infrastructure projects (see Figure 3). The introductory analysis and context for the research study (stage 1) involved identification of the urgent need to mitigate the impact of climate change and the importance of adopting the UN SDGs along with the formulation of supporting concepts in the areas sustainable development and infrastructure projects. This is followed by the literature review and hypothesis development (stage 2), which focuses on four main areas: (a) project sustainability; (b) evolution from corporate social responsibility to creating shared value; (c) limitations of SDG targets and indicators as measurement of projects' success; and (d) project success criteria and output-outcome success criteria. Finally, the methodology involves a synthesis of the conceptual framework for measuring SDGs on infrastructure projects along with the formulation of the research agenda and future research questions to be addressed.

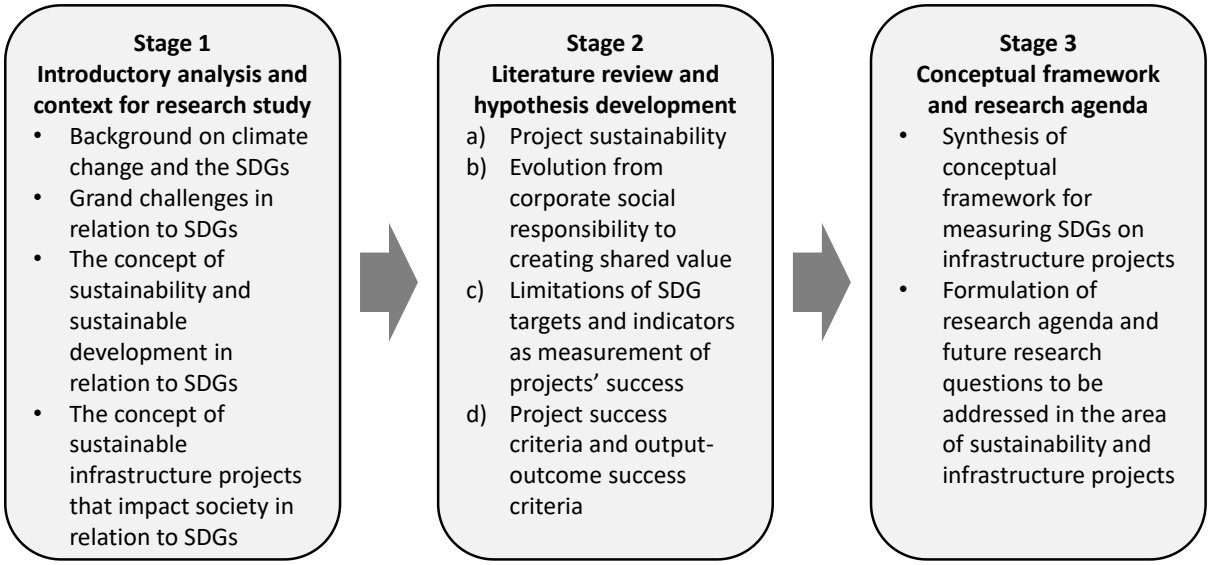


Figure 3: Methodology to support an exploratory investigation of measuring SDG targets on infrastructure projects.

The conceptual framework is based on two linked strands, firstly analyzing the theoretical evolution from Corporate Social Responsibility (CSR) to the theory of Creating Shared Value (CSV) proposed by Porter and Kramer (2006 & 2011), and secondly, the analysis of the limitations of SDG targets and indicators as measurement of project success. The primary focus of the analysis is to better understand the difference between 'output-outcomes-impact' that lies at the heart of CSV theory. Moreover, this study integrates the previously reviewed literature and achieves what Venkatesh (2016) proposes as the "*meta-inferences*" which gives an integrative summary of the earlier analysis. The resultant framework is devolved from the earlier analysis built on cause-effect deductive reasoning. Cummins (1991) was an advocate of the conditional reasoning and causation approach and proposed that each stage is part of an exploratory research process to narrow the scope while establishing priorities for the final research design, which in this case, provides the basis for future research areas of interest.

(a). Project sustainability

The Association of Project Management's Body of Knowledge (APM BoK, 2012) defines the boundaries of project, programme and portfolio management, and the functions undertaken as part of these endeavours. Helpfully for project managers seeking ways to measure SDG impact, it provides useful insights into how this 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 modern concept of sustainable development as derived from the Brundtland Report (1987), which suggests that efforts to create improvements in the short-term should be without a negative impact in the longer-term. The Report also recognizes that project strategies need to consider success against the triple bottom line (or otherwise noted as TBL or 3BL) of social, environmental (or ecological) and financial effects. However, the over-emphasis on the last of the TBL criteria, namely finance, brings us to the root of the problem of measuring projects' SDG impact (Martens, et al., 2016). 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 introduces these three core areas into the business investments decisions that measure 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). 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 current research study is that the proliferation of sustainability measurement theories, tools and concepts, that are mostly finance-driven causes confusion and often leads to sub-optimal action (Silvius and Schipper, 2014).

As a result of the increased knowledge and tempo of the uptake of sustainability language, it has become mainstream with many academics (Tilt, 2007) and practitioners (Perrini and Tencati, 2006) seeking to further develop from an accounting-centric method towards a broader approach, such as the Balanced Scorecard (Kaplan and Norton, 1996). Whilst there has been a proliferation of sustainability accounting terminology (sustainability accounting is also known as: social accounting, corporate social reporting, corporate social responsibility reporting, social and environmental accounting, and non-financial reporting), the project world is still mired in confusion; this is because although the APM's definition of sustainability is aligned to the TBL in general, it is rare that a project's outcomes are defined comprehensively along with all TBL thematic areas, despite a growing recognition that this approach provides a genuine competitive advantage (Mansell et al., 2019a). Indeed, the previous analysis of the definition of project success (Müller et al., 2016) highlights the excessive reliance on the project outputs of time, cost and scope/quality, with less importance placed on the broader (or more holistic) TBL outcomes.

Considering the aforementioned literature, it is possible to derive the first hypothesis related to the measurement of SDGs on infrastructure projects, as follows:

H1: Measurement of SDG performance should accommodate the perspective of the Triple Bottom Line (i.e., social, environmental and economic performance).

(b). Evolution from Corporate Social Responsibility (CSR) to Creating Shared Value (CSV)

'Creating Shared Value' (CSV) (Porter and Kramer, 2006, 2011), is a unifying theory that can help us to rethink the definition of project success by demonstrating impact across the triple bottom line (Elkington, 1994) of all SDGs, at all levels and stages of a project. Using CSV as the strategic framework, the SDGs cease to be an additional external cost on business but instead become the key input for transformational business strategies that enable both business and society to flourish, even in uncertain or challenging times. The project management profession has a unique role to play in this transformation process by ensuring that projects' success is defined in the right way from the start.

CSV is based on three key insights: (i) the interdependence of business and society (Porter and Kramer 2006); (ii) that businesses must act in specific ways to achieve their performance rather than on generalized CSR aims; and (iii) that CSR – the traditional mechanism for delivering the sustainability activities of the business – is both inefficient and ineffective (Porter and Kramer 2006). Since business and society are interdependent, the best outcomes for each will be obtained when businesses develop strategies that integrate social needs with real commercial opportunities and *vice versa*. However, most sustainability efforts to-date have focused on the identification of harm to society in general and the creation of corporate responses to meet those harms as described in general. As a result, many sustainability efforts have been largely divorced from the specific business model of each organization. In reality, sustainability activities have often functioned as additional actions for the purposes of deflecting stakeholder criticism, conducted regardless of their actual relevance to the business' capabilities, suppliers or customers. The net effect is to leave core business activities and project risks unchanged. The nub of Porter's argument is that CSR is both inefficient and ineffective: inefficient because it creates irrelevant 'add-on' activities that add to the costs of doing business without adding to the real value created for any of the business' stakeholders, or removing real business risks; ineffective, because it continues to pit society and business as opposing forces rather than recognising the opportunities of their real interdependence.

CSV also enables a new understanding of the SDGs. Under shared value strategies, the SDGs become a framework for each business to discover its unique shared value proposition, rather than being an additional external cost on business. Studies (Mansell et al, 2019b) have also shown that CSV strategies can also be cascaded to the project level since they provide a mechanism to more accurately define project success, including time, cost, scope (and quality) but crucially broadened to consider the societal and environmental aspects. The core proposition of this paper is that CSV is not just at organizational level theory, but also relevant at the portfolio, program and project levels; and that project managers are critical to CSV delivery but lack appropriate tools (Mansell et al., 2019a).

The further analysis of literature allows the derivation of a second hypothesis related to the measurement of SDGs on infrastructure projects, as follows:

H2: Measurement of SDG performance should accommodate the perspective of Creating Shared Value (i.e., seeking solutions that are good for business in the short and long term through balancing profit-planet-people objectives).

(c). Limitations of SDG targets and indicators as measurement of projects' success

This stage includes analysis of how the UN SDGs are currently defined by internationally agreed targets and indicators and whether this measurement framework can be used at project level. The research seeks to explore why there is an apparent missing link between project delivery and SDG targets/indicators and what this gap means for projects' success.

As described earlier, the 17 SDG are defined by 169 targets. This was further delineated by UN Statistical Commission's Interagency and Expert Group on SDG Indicators (IAEG-SDGs) in 2016, when they agreed to include 232 (or 244 if 12 additional overlapping indicators are included) individual indicators to monitor the 169 targets of the SDGs. This increased granularity of definition is both good and bad. There are many (Klopp and Petretta, 2017; Donohue at al., 2016) that criticize the SDGs for being too broad and deep – ultimately being

impenetrable except for the deep-specialist. Conversely, the advocates (Nerini et al., 2018; Allen et al., 2016) suggest that the 17 SDG icons provide the communications medium for ensuring simplification, thereby enabling the simplest messages to be kept to 17 powerful, interlinked, themes. They also contend that the targets and indicators are needed to add viability for evidence-based measurement to ensure meaningful tracking of progress against a pre-determined baseline, such as for climate change (IPCC, 2018), where the pre-industrial age temperature levels and related gas emission pathways as a proxy for its objective to reduce global warming below the 1.5^0C levels by 2030). The naysayers (Klopp and Petretta, 2017; Donohue at al., 2016) challenge the assertion that the targets and indicators are fit for purpose by suggesting that they are inconsistent, difficult to quantify, implement, monitor, Report and learn lessons from. They also challenge the governance of the SDG oversight mechanism because the goals are non-binding, with each nation creating their own national or regional plans. Moreover, the source(s) and the extent of the financial resources and investments for the SDGs are ambiguous.

In Swain's 'A Critical Analysis of the Sustainable Development Goals' (2018), he identifies tactical and operational issues contended by strategic managers of projects. These include: (a) what are the interdependent relationships between SDGs to prevent them from being assessed in silos?; (b) how can the targets and indicators that were designed for national and global level reporting be cascaded down to the project level?; and (c) how do the SDG targets and indicators compare with existing targets provided by other industry standards' sustainability reporting mechanisms, such as by the Global Reporting Initiative (GRI) (see www.globalreporting.org), or project-specific sustainability tools such as UK's Buildings Research Establishment's CEEQUAL (see https://bregroup.com)?

To assess the usability and applicability of an SDG measurement framework at the organizational or project levels it needs to be considered by its relevance on a sector-by-sector basis, which was a key finding of the UN Compact Group that aligns private sector businesses with SDG delivery (UN, 2018). For example, in the infrastructure sector, recent analysis (Hall et al., 2018) has provided some confidence that the higher-level targets do have influence at the project level. The analysis indicates that 81% of the SDG targets are influenced by infrastructure investment projects. However, despite the positive conclusion from the ITRC's analysis (2018), there is conflicting evidence that the measurement is achievable at the Interagency and Expert Group on SDG's (IAEG-SDG) Indicators level, where a further 244 measurement metrics reside. For example, the UK's Office for National Statistics (ONS), responsible for reporting UK's progress against global SDG indicator measurement, shows that in October 2018 they only had data for 64% of the IAEG-SDG's indicators, with 9% of statistics 'in progress' and 27% with no data available.

It is possible to map the three areas of analysis by the ITRC and the ONS, which is shown in Figure 4. The analysis illustrates that although the work conducted by UNOPS and ITRC at the SDG targets level, suggests that infrastructure can influence 81% of the targets, measurement is significantly more challenging at the Indicator level. The final row in Figure 4 shows the researchers' analysis of the UN Global Compact's data (a collaborative venture between the GIR and the World Business Council) of sustainability reporting indices. This suggests that only 39 of their 1,554 indicators can be measured at the project level. Overall there is a very large gap between global definitions of SDG objectives and project-level definitions of action.

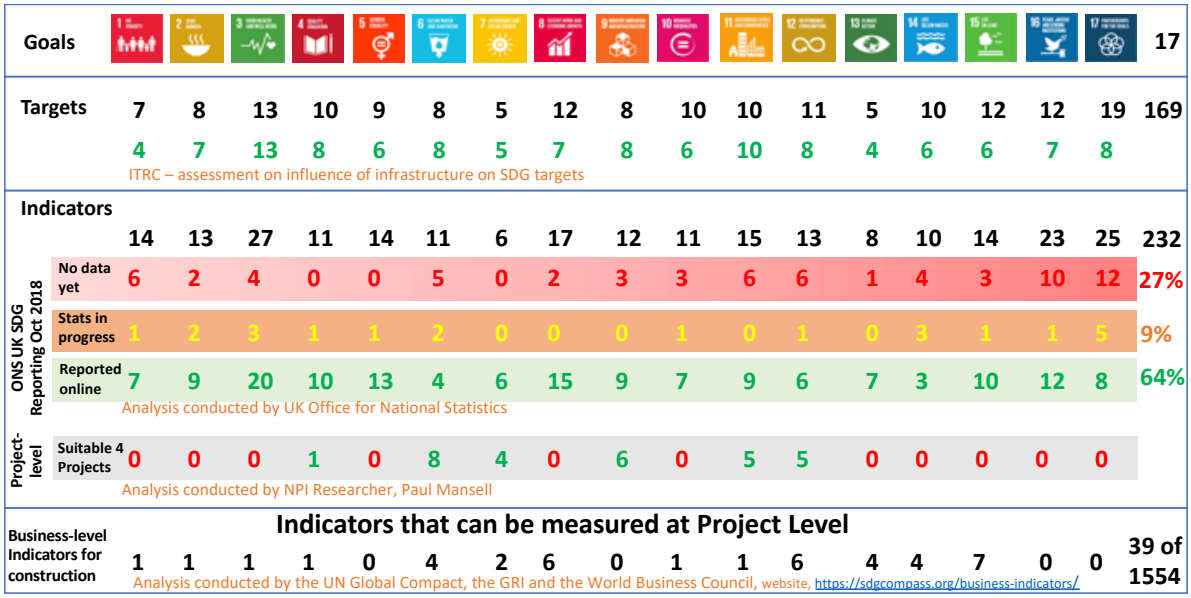


Figure 4: Analysis of the SDG targets and indicators' measurability.

Selective use of the 'traceable' indicators from the four studies might provide a manageable 'entry point' to assess projects' SDG impact measurement, but the gap is too large to be credible. Therefore, there is a need to look at other ways of achieving the golden thread linkage from projects' outcome measurement to the globally agreed SDG targets and indicators. This may potentially be through adapting other TBL measurement mechanisms that are already in use, such as the GRI reporting framework, or the BRE's CEEQUAL sustainability reporting method.

Consideration of the analysis provided on sustainability reporting systems allows the third and fourth hypotheses to be generated:

H3: Only a small proportion of the 1,554 SDG indicators are currently being measured at the project level and consequently there is a large gap between global definitions of SDG objectives and project-level definitions of action.

H4: Measurement of SDG performance should accommodate the required different organizational levels, namely organizational, portfolio, program, and project levels.

(d). Project success criteria and output-outcome success criteria

This section of the research developed the study of project success further through the analysis of output-outcome success criteria. While project success is a heavily researched field of study within the field of project management [see for example the work of Thiry, 2004; Sward, 2006; Jenner, 2010; Müller and Judgev, 2012; Joslin and Müller, 2016)], the quantitative analysis of success criteria and their alignment to outputs or outcomes, is less evident. Therefore, the aim of this step was to collate studies that identified the causal output-outcome factors that influence projects' success and failure. The reason for compiling a list of success and failure criteria was because they indicate what factors are managed by project leaders to drive delivery success. This in turn, when analyzed against output or outcome definitions, provides an insight into whether the projects' success is aligned to criteria of the management of the project (outputs), or more importantly, to the wider stakeholder perception of the change (outcomes) enabled by the projects' completion. Simply put, project managers are overly focussed on the

iron triangle of time, cost, scope (and quality) instead of the longer-term benefits that a project enables.

Research into 'project success' indicates that it is one of the most frequently reported subjects of project management study in recent decades. For example, in Themistocleous and Wearne's study (2000) of project management topic coverage in journals, they identified 'success criteria' as the ninth most popular subject area of the forty-four topics from the International Journal of Project Management. More recent research into project success definition (Thiry, 2004; Sward, 2006; Jenner, 2010; Bradley, 2010a and 2010b; Lavagnon, 2009) has consistently identified benefits and outcomes as being a critical determinant for the assessment of project success. For example, Michael Thiry (2004) highlights that '*too many critical success factors are related to inputs and management processes and not enough on outcomes*'. This is further supported by those (Morris, 2013; Terry Cooke-Davies, 2002, 2007) who identify three levels of success criteria: project management success – was the project done right?; project success – was the right project done?; and consistent project success – were the projects done right, time after time?

In order to understand the limitations of defining project success in the narrower method, it is necessary to understand the profession of project management that at its core, is a discipline that focuses on the initiation, delivery and completion that often transitions into operations with the initiation, development and delivery of projects (Morris, 2017). Projects are also temporary organizations that have a well-recognized development process, referred to as the project life cycle (Morris, 2017). There is, however, a fundamental problem that, as a discipline, project management too often defines success by the best use of these practices, instead of what its impact is on producing outcomes of real value (Morris, 2017). This is important to resolve because of the huge investment across all projects to effect successful change. For example, the UK's National Audit Office indicates that about 20% of GDP (gross domestic product) is committed to projects (see NAO Report Projects, 2017), and the pace and scale of this change are increasing. As a result, there is a growing need for the project management sector and profession to focus more on 'ends' rather than just the 'means'. In the case of impacting SDGs, this requires it to ensure that its contribution is the most valuable for the economy, society and the environment, meeting TBL needs in the competitive business context of CSV.

Although research into Critical Success Factors has become increasingly prevalent in recent years, most of the studies actually indicate a divergence of understanding. For example, Miller and Lessard (2000) suggest there is an excessive focus on the success of managing projects, and less on the benefits or outcomes of projects. Their study analyzed sixty large engineering projects of costs in excess of USD $1Bn that performed poorly: '*close to 40% of them performed very badly; by any account, many are failures*'. This was despite 82% achieving their cost targets and 72% achieving schedule targets. These different views of results were characterized by Miller as having a focus on '*efficiency measures*' but he suggests that in fact, there needs to be an even more important characterization using '*effectiveness measures*' that assessed whether they delivered against their original vision and objectives? Using these latter effectiveness measures, only 45% achieved their investor's objectives, 18% without crisis, 17% needed restructuring, with 20% being abandoned or taken over. The relevance for this research into projects' SDG impact measurement is that the study (one of the 35 reviewed in this paper's research) identified the difference between tracking the *project management success*, as different from the actual *project's success*.

The selection of which studies to use for this phase of research was based on harnessing the existing research studies that had been compiled by leading academics in this field. The use of 35 separate studies was selected from the list of 88 studies compiled by Morris (2013). The choice of study samples from Morris' list was based on seeking a spread of *ca*. 10% across the Middle East, Africa and Asia, but with the majority (*ca*. 60%) being from Europe and North America. The reason for this geographical spread was to seek a core of similar cultural and professional frameworks that would provide greater consistency to the analysis, whilst also having some examples of different global project environments that might indicate cultural or value-based differences. The selection of which studies to include was also influenced by identifying studies that came from four primary categories: construction (N = 8), IT (N = 7), R&D/new product development (N = 6), and defence (N = 4). In particular, the construction sector projects are important because they are the sample set that is carried further in subsequent research beyond this paper, and as such, could provide a useful insight into any stand-out characteristics that might be of value to deepen subsequent research.

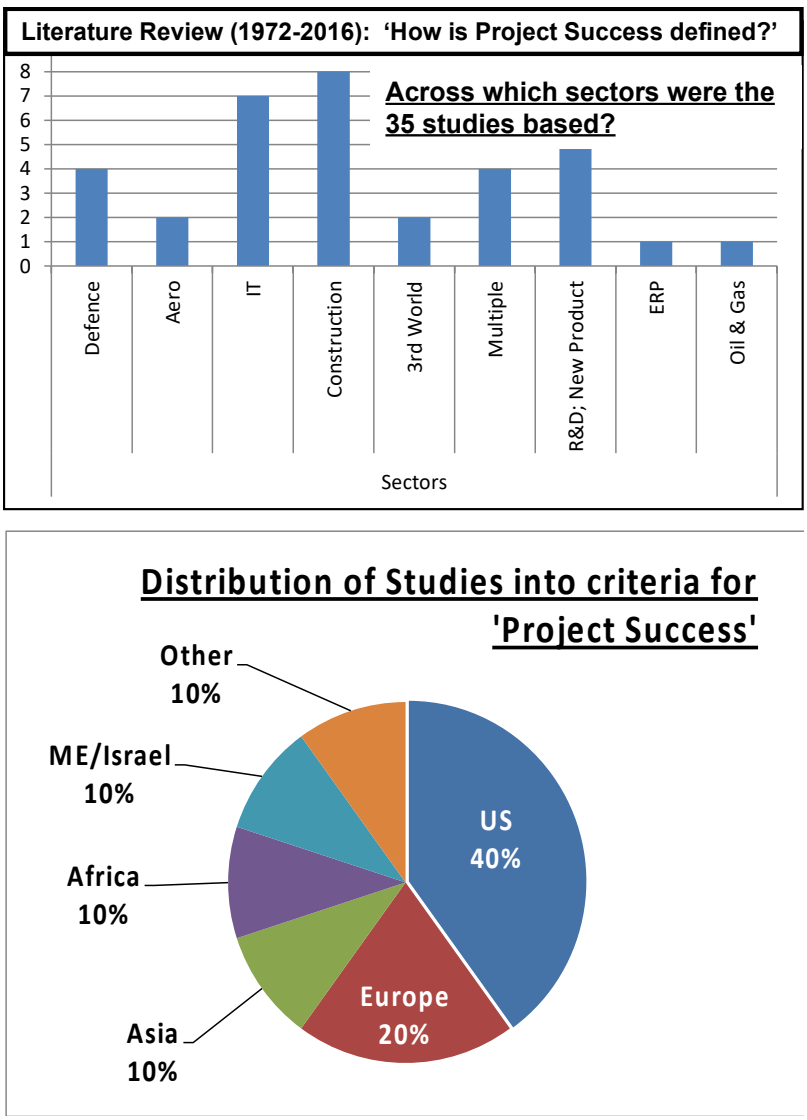


Figure 5: Distribution of project success studies by sector and geography.

The method chosen to structure the data analysis was to build a MS Excel grid that plotted the 154 success criteria from the 35 separate studies. The 154 success criteria were grouped under sixteen dimensions derived from the APM's PM BOK (also captured in the OGC's 2006 P3M3 Maturity Model, that focused on seven process perspectives), the PMI's PM Book of Knowledge (as well as its OPM3 Maturity Model), and the IPMA's standards that define projects. The 16 dimensions were: leadership, governance, strategy/goals/objectives, risk, cost estimation, benefits/value, control & change management, quality management, client & user involvement, suppliers, stakeholder engagement and communications, funding, planning, HR/resources, procurement, monitoring & evaluation, technical, and innovation. The grid then placed each study into a column and allocated the identified success criteria against each of the normative dimensions. A copy of the matrix and underpinning analytical data is available from the data support documentation supporting this paper.

Considering the review that has been conducted on the literature relating to project success, it is possible to establish the fifth and final hypothesis:

H5: Measurement of SDG performance should be viewed from a systemic perspective and thereby move beyond the traditional 'iron triangle' view of projects in the short term (i.e. according to schedule, budget, scope, and quality performance) and additionally take account of longer-term project outcomes and impacts.

Development of a conceptual framework for measuring the SDG performance of infrastructure projects

As a deduction it is posited that the shared value approach aligns individual business priorities of specific firms with sustainable development imperatives. Consequently, CSV is capable of releasing the energies of business to pursue competitive advantage and the SDGs through integrated business strategies. As such, CSV is also a valuable part of the context for projects, and we, therefore, propose a conceptual framework to support further research in this area.

It is useful to summarise the conceptual development of the literature presented in this study, including the hypotheses, supporting literature and corresponding concepts that have been derived (see Table 1).

Area of literature	Hypotheses	Supporting literature	Key Concepts (KC) derived to inform model design
Project sustainability	H1: Measurement of SDG performance should accommodate the perspective of the Triple Bottom Line (i.e., social, environmental and economic performance).	Silvius et al., 2012; Martens and Carvalho, 2017; Økland, 2015; Silvius & Schipper, 2014; Ainger and Fenner, 2014; APM BoK, 2012; Brundtland Report (1987); Martens, et al., 2016; Yamey, 1949; Emerson et al., 2000; Millar and Hall, 2013; Forum for the Future, 2018; Rainey et al., 2015; Sawaf and Gabrielle, 2014; Schaltegger and Burritt, 2000; Eccles and Krzus, 2010; Bonini and Emerson, 2005); Bugg-	KC1: The model should include the TBL 'golden thread' to establish a pathway through the project SDG measurement. This will drive a broader definition of project sustainability that includes the three pillars (i.e. social, environmental and economic performance). It provides simplicity and structure for the analysis in regard to selecting and measuring SDGs.

		Levine and Emerson, 2011; Preston, 2012; Malhi et al., 2009; Suess, 1980; Tilt, 2007; Perrini and Tencati, 2006; Kaplan and Norton, 1996 Triple Bottom Line: Elkington, 1994, 2013, 2018; Griggs et al., 2013	
Evolution from CSR to CSV and the understanding of the different requirements at global and national levels, as well as organisational, portfolio, program and project levels	H2: Measurement of SDG performance should accommodate the perspective of Creating Shared Value (CSV) (i.e., seeking solutions that are good for business in the short and longer-term through balance of profit-planet-people objectives).	Creating Shared Value: Porter, 1985; Porter and Kramer, 2006 2011and 2019; Elkington, 1994; OECD, 2019; United Nations, 2019; Crane, Palazzo, Spence, and Matten, 2014; Michelini and Fiorentino, 2012; Beschorner, 2014; Joslin, Müller, 2016).	KC2: The model should utilize the broader definition of CSV to improve the current perspective of CSR being a 'add-on' as part of charitable work. The mindset of adopting CSV changes and the analysis to view measurement of SDG impacts commences with a business positive view on their role driven more by stakeholders than shareholders.
Limitations of SDG targets and indicators as measurement of projects' success.	**H3:** Only a small proportion of the 1,554 SDG indicators are currently being measured at the project level and consequently there is a large gap between global definitions of SDG objectives and project-level definitions of action. H4: Measurement of SDG performance should accommodate the required different organizational levels, namely organizational, portfolio, programme, and project levels.	Klopp and Petretta, 2017; Donohue at al., 2016; Nerini et al., 2018; Allen et al., 2016; IPCC, 2018; Swain, 2018; UN, 2018; Hall et al., 2018; ITRC, 2018; Martens, & Carvalho 2016a and 2016b	KC3: The evidence of the difficulty to use the existing 169 targets and 232 indicators suggests that the derived model should recognize that a contextual perspective needs to be adopted to distinguish the different requirements (i.e. the organisational level will have different SDG imperatives and reporting requirements, such as using the GRI, than the project level, which might have limited capability and capacity to track too many targets and indicators.) KC4: Establish a MREL (monitoring, reporting,

			evaluation and learning) learning loop.
Project success criteria and output-outcome success criteria	**H5:** Measurement of SDG performance should be viewed from a systemic perspective and thereby move beyond the traditional 'iron triangle' view of projects in the short term (i.e. according to schedule, budget, scope, and quality performance) and additionally take account of longer-term project outcomes and impacts.	Project Success: Joslin and Müller, 2016; Müller and Judgev, 2012; Thiry, 2004; Sward, 2006; Jenner, 2010; Themistocleous and Wearne, 2000; Bradley, 2010a and 2010b; Lavagnon, 2009; Morris, 2013; Terry Cooke-Davies, 2002 and 2007; Morris, 2017; NAO Report Projects (2017); Miller and Lessard, 2000; Theory of Change and Logic Model: Stein and Valters, 2012; Weiss, 1995; Renger, 2002; Frechtling, 2015; Anderson et al, 2011;	KC5: The model should harness the core concepts of the Theory of Change and the Logic Model, with their focus on outcomes measurement, including the analysis of causal linkages, engagement of stakeholders and strategic design with the 'ends' being the starting point for a right to left causal mapping. This should define the causal value chain from project inputs through activities, outputs, outcomes and impacts to build a commonly understood view of what future success looks like.

Table 1: Summary of the conceptual development of the literature presented in this study, including hypotheses, supporting literature and corresponding concepts.

According to the literature review, accompanying analysis and hypothesis development, it is possible to synthesize a conceptual framework that supports the measurement of SDGs on infrastructure projects, which is provided in Figure 6.

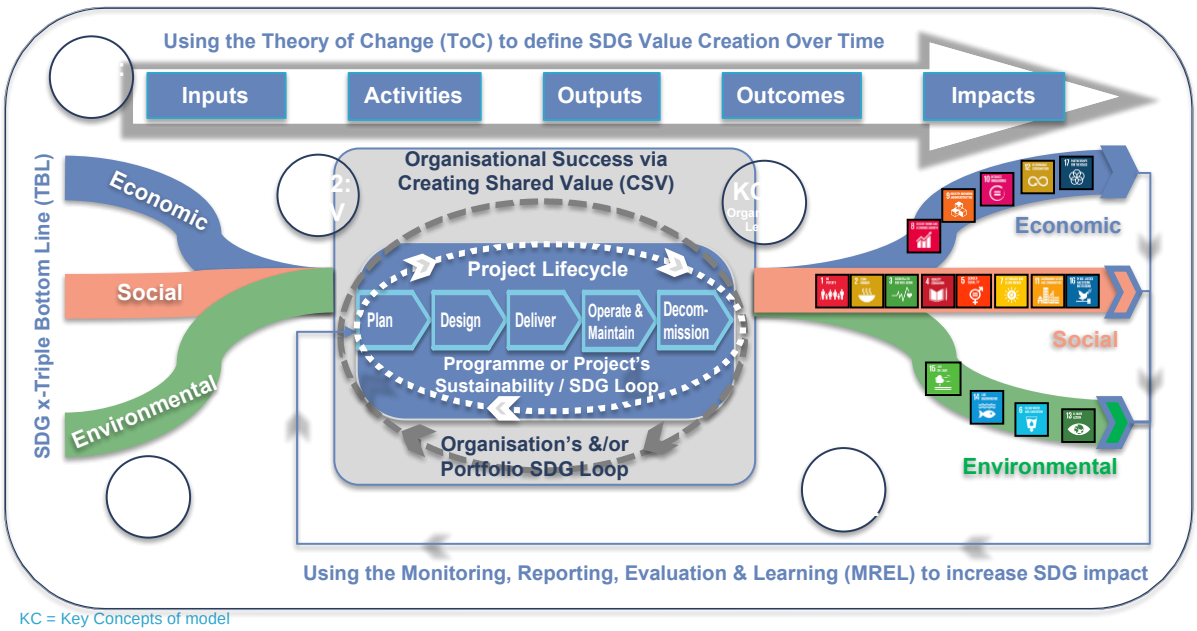


Figure 6: Conceptual framework for measuring SDG targets on infrastructure projects.

The key components of the framework are shown to be derived from the concepts in Table 1 thereby linking the framework back to the hypotheses generated from the literature review.

Conclusions and future work

The paper has sought to answer whether the existing UN SDG targets and indicators are adequate for defining success at project level in the infrastructure sector. The conceptual development was based on literature research across both the broader definition of sustainability and the evolution of CSR to CSV as well as the analysis of the limitations of the existing SDG targets and indicators as measurement of project success. The first question, '*Are the existing UN SDG targets and indicators adequate for defining success at infrastructure project level?*', was examined through analysis of available data and emerging (since SDGs only came into existence in 2015) literature on the shortcomings of the SDG target framework at global, regional, national and organizational levels. The analysis of the meta-data showed that the further down the hierarchy the analysis was focused, the greater the gap appeared to be. The analysis showed that at the lowest, project level, the gap was significant and therefore this gave a negative response to the posed question. Having confirmed that the UN SDG targets and indicators were not 'adequate' for defining success at infrastructure project level, the second question was addressed: *What framework would support further research?* The findings and resultant model provides five hypothesis and five corresponding key concepts that have informed the design of the conceptual model. This framework is proposed as the foundation for future research. The analysis described above, answers the third of the paper's questions: *How could the proposed framework be used to further understanding and ultimately, provide a contribution to both theory and practice?* Consequently, this research study has identified a number of questions that inform further research, which are provided in Table 2.

No.	Theme	Research questions
1	Governance	• How do the OECD definition of governance and the underlying principles of governance affect the measurement of projects' SDG impact? • Who are the major governance stakeholders and shareholders that influence the measurement of SDGs at project level? • If there is insufficient effective action in measuring SDGs, how is the governance model strengthened to drive greater success at project level?
2	International context	• What are the international contextual issues (political, cultural, environmental and social) that affect the measurement of SDG impacts at infrastructure project level?
3	Engineering organizational and project context	• How does the theory of a temporary organization affect the measurement of SDGs at project level as compared to the organizational level?

		• What understanding had been derived from the research into projects' benefits management and how might this effect the successful measurement of SDGs on projects?
4	Monitoring, reporting, evaluation and learning	• What are the core characteristics of monitoring, reporting, evaluation and learning (MREL) as defined by leading global organizations such as the OECD (Organisation for Economic Co-operation and Development) and the World Bank and how might these be applied for MREL of SDGs at project level?

Table 2: Proposed questions for further research.

The paper contends that achievement of the SDGs is dependent on business' aligning with society through CSV, and that tools at project management level are critical for this. While the endorsement of the SDGs by all the world's governments is a major step forward, current progress on achieving the SDGs has been limited by a fundamental misunderstanding of the interdependent relationship between business and society. CSV corrects this misunderstanding, and is being increasingly adopted by firms, but the golden thread from projects to SDG targets is still missing. The end result of this gap in knowledge is potentially the wrong choice of projects' success definition, based on outputs, not on TBL outcomes.

The limitations of this exploratory research phase are that it has not provided definitive findings. Whilst it has helped to narrow the scope of future research by establishing priorities for the final research design, the comparative analysis of literature is too narrow to make final conclusions. It should thus be viewed only as a sign-post for further research, potentially through the use of a case study to build more detailed qualitative and quantitative data that the findings of the exploratory research can be tested against. In this way, the research will likely provide more meaningful insights into how infrastructure investment can be better focused and lessons that increase impact across SDGs will be applied more effectively. This is important because infrastructure projects have always been an essential underpinning for society, but today's global business context gives new weight to infrastructure's importance, and this approach of measuring SDG impact at the project level provides a golden thread to link the projects' delivery outcomes with national and global SDG targets. However, if projects do not widen the definition of success to incorporate SDG impacts, they will fail to accommodate the unique enabling role of engineering and infrastructure, inadvertently weakening the resilience and wellbeing of both business and society.

It is proposed that further research uses the model to develop an improved understanding of the organizational context within which the definition and measurement of infrastructure project success is made. It could be used to examine the leadership and governance theories and relationships that underpin the overall analysis of project success definition and measurement. For example, recent studies (Müller, 2017) have provided clarity on how project governance, that shapes the reporting, directing and management of projects, is best understood by scrutinizing the overlapping influences of corporate governance at the organisational level and the separate, but related, governance at project level that has its own customs, rules and approaches for reporting project success.

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