A SUSTAINABLE APPROACH TO THE GOVERNANCE OF WASTE MANAGEMENT

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ABSTRACT

The European Union's revised Waste Framework Directive 2008/98/EC gives priority to waste prevention in its hierarchy of waste management measures. This paper argues that, to this end, the importance of costing and sustaining the natural resources used to demolish and/or produce any kind of infrastructure concerning the architectural, engineering and construction industries, should be factored into Environmental Impact Assessments (EIA), as part of a government's waste management strategy. In other words, this should be a preliminary aspect of the implementation of a waste management strategy. However, ideally, to fully implement a preventative waste management strategy, the range of projects for which EIA's are required should not be restricted, but should be extended to any building site. This paper further suggests that EIA's should be tailored to ensure the sustainability of our natural, used and renewable resources as far as possible. This would assist furthering the goals of the United Nations 2030 Agenda for Sustainable Development. However, to be effective, this approach requires the incorporation of a mandatory protocol involving a process similar to Natural Capital Accounting (NCA) into all associated contracts, standard or bespoke. The scope of this paper will therefore outline what NCA is, and then why it is relevant, considering how it may be used to contribute to a more sustainable EIA for the prevention of waste. It will then briefly consider the role of industry and government before concluding that its implementation should assist the reduction of overall waste of environmental and related resources arising from the said industries. This paper has used a qualitative method based on grounded theory. It involves an exploratory method initially using an inductive approach to generate data, and from this collection of data, key questions are generated to deduce results. The analysis examines, compares and contrasts relevant literature concerning what is NCA as well as how it may be implemented. Research conducted by academics from a range of disciplines, environmental, business, engineering and construction academics, organisations and case studies has been drawn on to consider the transferability of NCA methods to the management of sustainable infrastructure.

Keywords: environmental impact assessments, waste management, natural capital accounting.

1 INTRODUCTION

The European Commission has issued technical guidance on the classification of waste (2018/C 124/01) regarding the scope of the European Union's revised Waste Framework Directive 2008/98/EC. It provides a broad definition of "waste" in Article 3(1) WFD as: "any substance or object which the holder discards or intends or is required to discard" [1]. It is commonly known that a high percentage of waste generation concerns the architectural, engineering, and construction industry, especially concerning demolition and construction [2]. In 2011, for example, studies showed that of all the waste generated worldwide 35% alone was from the construction industry [3]. This paper takes the view that a sustainable approach to the governance of waste management is one that takes responsibility for the depletion of natural resources, and for the wastage of natural resources, and thereby furthers assists achieving the goal of zero waste. Environmental Impact Assessments (EIA) are a means of protecting the environment by ensuring that any likely significant effects on the environment are taken into account in the decision making process by any planning authority. In the United Kingdom, for example, the process is governed by the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. The regulations set out a

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procedure for identifying those projects which should be subject to an Environmental Impact Assessment, and for assessing, consulting and coming to a decision on those projects [4]. This paper argues that Natural Capital Accounting (NCA), or a similar process, should be used as a tool to promote a more sustainable form of EIA's in all countries.

The achievement of a sustainable EIA is one which, in this paper's view, requires incorporating a waste prevention element which both measures and monitors the natural resources to produce and maintain infrastructure for each project, as well as estimates the potential wastage. This paper therefore refers to a costing method which can be used to consider the financial impact on the whole project of the use of resources, including the wastage involved. The results can also be fed into national statistics to assess the cumulative impact on a nation's reserves of natural resources, and of the extent of waste generation on national and global economies. This should lead to a more informed sustainable waste management strategy.

This paper will therefore explain what NCA is, assess its relevance to the governance of EIA's, as well as the transferability of its methods. It will conclude that a systemic model of waste management will benefit from the incorporation of a protocol mandating the use of an NCA process into all related contracts, standard or bespoke, associated with new and renovated infrastructure projects, from demolition to completion of works, and concerning the estimated life of the structure. This is the first stage in a systemic model for the implementation of NCA methods into the before mentioned industries, concerning projects ranging from small or innovative to highly complex, or international single projects to framework or joint venture operations.

2 WHAT IS NATURAL CAPITAL ACCOUNTING?

The term "natural capital" is accepted for the purposes of this paper as referring to components of the natural environment such as the world's stocks of natural resources, which include geology, soil, air, water and all living things, and therefore minerals, fuels, animals and plants, and ecosystems [5].

The valuation of these assets in economic terms is considered the price for which it would have been exchanged if a transaction had taken place on the balance sheet [6]. In simple terms, then, the idea behind Natural Capital Accounting is that a monetary value can be placed on each natural resource, such as minerals, coal, and water. These are considered as national natural assets that should be preserved and protected. However conventional approaches to measuring and managing economic activity do not take into account that this naturally stock of resources is rapidly being depleted [7]. In the Engineering and construction arenas natural assets are generally used without taking into account whether or not there will be any left in the future; for example, we may use sand by itself, or as part of a composite such as concrete. They are "externalities" and are not shown on a company's profit and loss statement or on their balance sheet [8]. However, some UK construction companies, for example, Laing O'Rourke, and Willmot Dixon, have developed innovative measures to cut carbon, eliminate waste, and to some extent protect natural assets through environmental policies and innovations [9], which is commendable. This is also an innovative method of waste management through waste prevention.

The application of NCA methods can further assist these endeavours. It involves a type of costing method which is premised on measuring the accountability of the use of natural assets, in the sense that records should be kept of how much has been taken from the ground, as well as what the cost of this is in relation to what we can put back into nature or as a substitute.

The process of NCA has only recently been developed. In 2005, the United Nations Committee of Experts on Environmental–Economic Accounting (UNCEEA) was established under the auspices of the United National Statistical Commission. Then the System of Environmental–Economic Accounting 2012 (SEEA) Central Framework containing internationally agreed standard concepts, definitions, classifications, accounting rules and tables was adopted as the international statistical standard for environmental–economic accounting for producing internationally comparable statistics, and officially published in 2014 [10].

2.1 Why is NCA relevant to waste management?

Although the goals of commercial enterprise in the engineering and construction industry are generally considered centred around some combination of the trinity of time, cost and quality, as early as 1973 other factors have been considered just as important. It has been recognised that the maximum financial return for private investors is not the main factor which influences investment in infrastructure, because other factors, such as social and human values, private or corporate objectives and government regulation can influence private investment [11].

There is also an increasing awareness in the construction industry that product innovation in materials, such as high performance materials, should take sustainable criteria into account at an early stage of product development, and that life cycle costs should take into account the impact on the environment, because otherwise, we shall continue to see economic growth accompanied by continuing depletion of natural resources, and increased pollution [12]. For example, in 2013 Trucost undertook an investigation of Asia's economy, on behalf of The Economics of Ecosystems and Biodiversity Initiative (TEEB) established in 2007, and the Global Legislators Organization's Natural Capital Initiative established in 2012. The report showed that "the unpaid natural capital costs of business totalled $3.7 trillion in 2010, representing 50% of unpaid natural capital costs globally" [13]. The use of more sustainable EIA's, as suggested by this paper, may assist such natural capital losses.

A recent study concerning the Chinese economy and the use of Life Cycle Assessment and Data Envelopment Analysis (DEA) tools for the assessment of the environmental impacts and operational performance of various industry sectors also revealed that "the Chinese economy, in average, needs to reduce energy usage by 23.97%, water withdrawal by 27.90%, CO2 emission by 25.66%, hazardous waste generation by 23.30%, wastewater discharge by 35.06% and exhaust emission by 33.87%, to become efficient". Further it notes that "contractors should enhance the management of building construction process to improve the utilization efficiency of building materials. Greater attention should be paid to the research and application of environmentally friendly materials." [14] This is where NCA method could be used and of benefit at the EIA stage of a project.

The United Nations 2030 Agenda for Sustainable Development was adopted at the United Nations Sustainable Development Summit on 25 September 2015 [15]. Most of the goals in the publication are concerned with the sustainability of all our natural resources as well as our constructs. Goal 12.2 specifically states that the goal is "By 2030, achieve the sustainable management and efficient use of natural resources" and 12.5 states "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse" [15].

The implementation of this goal may be assisted through the use of NCA. But this requires a common framework, which is flexible enough to adapt to each country's eco-social and policy needs. This paper focuses on the application of the Natural Capital Accounting, and the Natural Capital Protocol [16] which provides a framework.

3 HOW NCA MAY BE APPLIED

The Natural Capital Protocol (NC Protocol) is currently applicable to any business sector to help businesses make more informed decisions incorporating the use of NCA. The NC Protocol has been used to assess its business impact on society in terms of its direct operations, with a value chain focus. This included assessing the impacts of the use of carbon, water consumption, waste, and air pollution on society. The various stages of the NC Protocol have been applied, starting with Frame and Scope stages which involve qualitative assessments. The stages involve nine steps which ask specific related questions. The later Stages concern the Measure and Value stages, which concern quantitative and monetary assessments, and therefore are of especial concern for costing infrastructure projects. The measure and value stages involve three steps: step 5-Measure impact drivers and/or dependencies: step 6-Measure changes in the state of natural capital; and step 7-Value impacts and/or dependencies [17].

The NC Protocol Measure and Value stage applies "impact drivers". An impact driver refers to a natural resource that is used as an input to production, e.g., the volume of sand and gravel used in the construction of concrete. Impact drivers are measured in quantitative units such as kilograms. A single impact driver may produce multiple impacts. The term impact is used to refer to a change in the quantity or quality of natural capital that occurs due to an impact driver, and could be used to assess changes in the volume, for example, of sand used for making concrete for a bridge. The NC Protocol also uses the phrase, dependency pathway, to identify how an activity which produces observed or potential changes in natural capital affects the costs and/or benefits of the business/project. The input may, for example, be water use. This impact driver will be measured in terms of the volume of groundwater consumed, or the volume of surface water consumed. The impacts can be measured according to chosen criteria such as regulatory environmental impact mitigation requirements, and access to capital, investor interest, or insurance conditions. Once all impacts have been identified and measured, an assessment of the significance of each natural capital impact and the timescale associated with each one should be made. This may require the collection of information from experts, consulting stakeholders, and reference to environment impact assessments [17], [43]–[45].

The NC Protocol Toolkit guidance then also gives examples of how the Measure and Value stages can be applied. This paper adapts the Protocol's Example 1 for the purposes of this paper.

"Example 1:

To assess the costs and benefits of using gravel (for making concrete), a project will:

- Measure the cubic meters of gravel used for the project (Step 05).
- Quantify the impact of the loss of the gravel on society, by
- understanding the changes in natural capital that results from the loss of the gravel (Step 06).
- Value the consequences for society, associated with these changes in natural capital (Step 07).

The measurement carried out in Step 05 alone does not explain the significance of the use of gravel in this project. Once the use of gravel is quantified in Step 06, the project will know if sufficient gravel is likely to remain in the system to meet the current or future needs of the project company involved and other users. Once this is valued in Step 07 the project will then be able to tell what these changes mean for the project and society" [18].

In addition, the NCA Protocol could also be used in conjunction with other tools, e.g., ecosystem life cycle tools such as Embodied Energy. It has been used for some time to measure the environmental impact of products and processes, for example, in a case study using Embodied Energy discussed by Bastianoni et al. [19]. This tool has a different purpose. It is a life cycle tool measuring the energy used during all stages of the life cycle of the construct from obtaining the natural resources to demolition of the construct. Admittedly, obtaining all relevant information requires communication with the supply chain, which may include clients, project managers, cite crews, various materials suppliers and specialist contractors and truck drivers, and more, but recent research, such as that shown by Moon S., et al., reveals that this may be assisted by "a computer-aided communication concept to bridge the many islands of communication on the supply chains". This research sets out a method "to identify the critical communication links supporting a preventive control" [20].

3.1 Proposed linkage of NCA to EIA and project accounts

The implementation of NCA and the NC Protocol or similar protocol for producing sustainable EIA's would require the integration of the resulting natural capital asset and wastage information into standard project accounts. It is proposed that the initial baseline would usually be when the site is taken control of for the project. There would also be a series of baselines, i.e., fixed points in time, the number of which would depend on the complexity or size of the project. These baselines would serve as points for a comparison for measuring the impact on natural resources and wastage prevention at various times, during the project, before and after the foundations were dug out, for example.

Projects may use any number of different accounts as part of their cost management, depending on the type of project, for example, separate accounts could be kept for Clearing and Preparing Site, Outside Utilities (water, gas, sewer, etc.), the superstructure, service works, Paving, Curbs, Walks, Installed Equipment (elevators, revolving doors, etc.) and fencing. This paper suggests that these accounts could be linked to an NCA sequence of accounts which link production, income, consumption, saving, capital formation, financial transactions and balance sheets. Records of these accounts would then be kept to provide a standard measure of a depletion-adjusted cost of the project as well as related measures of income and saving. This would mean the type of EIA this paper envisages is needed involves a process, one that starts before planning permission is given, but is not complete until the project is completed. New information gained as the project progresses would be compared with the initial EIA report, which may consequently need updating. However, EIA's should also be available to be drawn upon by future owners of the property to assess further impacts. This overall process should provide an improved measure of the economic and environmental sustainability of the project, as well as evidence of the degree of wastage of resources.

3.2 Incorporation into BIM

The accounts would also be incorporated into a Building Information Modelling (BIM) system. This model draws on information assembled collaboratively and updated at key stages of a project. Creating a digital Building Information Model enables those who interact with the building to optimize their actions, resulting in a greater whole life value for the asset, but it also defined as a "digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition" [20]. BIM is

already being used to estimate construction waste based on the work needed to rectify errors detected by BIM based design validation [21].

The challenge is to apply or modify the NC protocol in a way that ensures a profitable future for financial investment stakeholders, produces sustainable EIA's and so contributes to a resilient and sustainable economy. One way is for NCA methods to be incorporated into BIM to predict current and future natural capital costs of the project. Similarly to BIM, NCA involves a process which can also support the planning, management and delivery of a project. It is relevant to the sustainable management of the whole project lifecycle as well as the maintenance of its resulting creation during its lifetime. BIM software could incorporate the EIA usage of NCA accounts and assist the achievement of more sustainable infrastructures and construction in general, be used to prevent wastage, and so contribute to the sustainability of natural resources. But the complete integration of all this into BIM and the accounting practice of companies would require not just the initial valuations of natural assets and wastage, but also how to assess the flow between them and any benefits.

Guidance about which valuation technique to use and how is provided by the NC Protocol at the valuation stage of the application of the Protocol. These cost-based approaches involve firstly, a quantitative technique called Replacement Costs. It involves determining the cost of the market prices for "replacing natural capital (or associated ecosystem goods or services) with man-made equivalents" (e.g., replacing flow regulation of habitat with flood defence scheme). The second one is called Damages Costs Avoided and concerns determining "the costs incurred to property, infrastructure, or production as a result of decline in natural capital or the loss of associated ecosystem services". Natural assets could be treated as a cost against income in the same way as the depreciation of produced assets is seen as a cost against income [22].

A significant amount of data concerning the financial impact on the project as well as its impact in profit margins would be generated through the use of NCA. BIM could incorporate data, for example, obtained about the costs required to provide the same degree of protection from flooding as a natural wetland would provide, the degree of wastage of natural resources, and the impact on the environment. Such knowledge would feed into the ongoing updating of the EIA.

4 INDUSTRY SUPPORT

However, the level of leadership to spark and promote such innovative practices with the resulting required administration is unlikely to come from clients, as the tender price is generally known as the most important project criteria. There are also unlikely to be quick financial returns through investment in such innovative measures. Although some leadership is likely to come from the more ethical and/or affluent players in the corporate sector, government intervention is more likely to assist collaborative infrastructure projects which maximise outcomes, if it chooses to do so, since it can enable a formal governance of projects, through legislative and contractual incentives. Chen and Manley argue that these need to be "mediated by informal governance to promote mutual trust, enable cooperation, facilitate open communication, and share knowledge" [23]. They identify three mechanisms to define formal governance: (1) collective cost estimation, (2) risk and reward sharing regime and risk sharing with service providers, and (3) design integration: and four to define social-based mechanisms: (4) leadership, (5) relationship management, (6) team workshops, and (7) communication systems. Although their related research is concerned with the influence of these mechanisms on project performance, these factors are particularly transferable for the implementation of NCA in infrastructure project management where "Collaborative

activities and tools in partnering relationships are considered important in large and complex projects with high uncertainty" [24].

National governments have responsibility for the economy, and they have the authority to choose to set targets to increase the use of NCA methods and to provide incentives to meet them. Governments, for example, can provide formal governance by providing an incentive for private industry to offset the lack of short term gains through the application of NCA to assess the impact on natural resources. They can do this with tax incentives and schemes similar to that of the renewable energy tariff schemes, such as the Feed-In tariffs for electricity and the Renewable Heat Incentive for heat. These are sometimes referred to as Clean Energy Cashback schemes discussed by Finney et al. [26]. There may be an impetus, for example, for the United Kingdom government to support and creation of such schemes, because one of the European Union (EU) targets is that the United Kingdom (UK) must produce 15% of energy from renewables by 2020 (Anonymous, 2011). There may however be uncertainty about whether this goal will be met as noted by Knopf et al. [27] and it is commonly known that the United Kingdom has also decided to leave the EU.

Nevertheless, the United Nations 2030 Agenda for Sustainable Development goals, economic goals, and an increasing general educated awareness of the limitations of our environment and resources, already discussed, also provides incentive for change. If more governments set similar national targets for the uptake of NCA methods into EIA reports and the use of BIM, supported by international targets, this would contribute towards ensuring the sustainability of natural resources, and waste prevention, resulting in a more sustainable governance of waste management [27].

5 CONCLUSION

This paper considers it feasible that NCA methods and the NC Protocol or similar Protocols are transferable to the production of EIA's. They can also provide a means to predict and achieve measurable outcomes towards accompanying asset targets. Therefore they can be used to produce EIA's which also extend to providing a realistic assessment of the environmental impact of the project including its wastage over the lifetime of the asset being produced.

The paper indicates that the government and engineering/construction companies should keep records of NCA accounts to contribute to providing standard measures of the depletion-adjusted cost of various types of projects as well as of their related measures of income and saving. This would provide improved measures of a range of factors affecting the waste prevention and environmental assessments of the impacts of the project as well as promote the economic sustainability of the infrastructure, and the future sustainability of the company. The use of NCA concepts and protocols such as the NC Protocol discussed in this paper contributes to a new approach to the production of sustainable EIA reports. This will also contribute to a more comprehensive view of industry impacts on natural capital, and assist a more renewable energy future. Standard industry EIA classifications and guidelines which concern the valuation and use of each natural asset and the likely wastage can also be developed through the use of NCA methods. They can be also used to measure an infrastructure project's impact on the companies and investors involved, the natural assets of a nation, and as a supplement to the Gross Domestic Product (GDP).

Consequently, this paper argues that NCA methods should be encouraged and incorporated into a waste management strategy that forms part of every contract associated with the given project, so that all parties are bound by the same obligations, no matter where they are in the world.

5.1 Recommendation

This paper recommends that further research be conducted to examine the application of NCA methods to enable prevention of wastage and the establishment of an effective and sustainable waste management strategy. This could be achieved with the use of BIM through case studies showing its application to the range of architectural, engineering and construction projects, including international joint ventures, PPP or PPI, or national projects and large or small projects.

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