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IS THERE A REAL BENEFIT IN INVESTING IN SMART CITIES?

Measuring Smart Return on Investment: A Conceptual Framework

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Internship Report

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Abstract

This internship report examines the role of smart cities as a vehicle for improving the quality of life, as per so the Sustainable Development Goals established by the United Nations in 2015. The climate crisis has resulted in a global trend towards addressing Environmental, Social and Governance concerns. Numerous reporting initiatives and regulatory changes have emerged, including methods of measuring non-financial impact.

Incorporating evidence from a comprehensive review of the literature, interviews with experts, and authentic case studies, this research investigates how policymakers currently evaluate the return on investment of smart city initiatives. The findings emphasize the need to establish a robust framework that can provide a clear business case and demonstrate the extra-economic benefits in a transparent and unambiguous manner. Such an approach is crucial to ensure that the advantages resulting from the adoption of technological advancements in cities are shared equitably and inclusively, thereby accelerating economic growth across developed and developing countries.

The research highlights the importance of political commitment towards smart city planning and implementation. It underscores the potential of smart city technologies and strategies to address social, economic, and environmental benefits. By leveraging data-driven solutions, cities can optimize resource allocation, enhancing public services, and fostering citizen engagement.

This report contributes to the existing body of knowledge by providing insights into the current practices and challenges associated with evaluating the impact of smart cities. It calls for a more holistic and standardized approach to measuring the success of initiatives, encompassing not only economic metrics but also social and environmental indicators. Ultimately, the findings support the argument that smart cities, when designed and implemented with a comprehensive understanding of their potential impact, can advance sustainable development, and improve the quality of life for citizens worldwide.

Keywords: SDGs; ESG Framework; Impact Assessment; Return on Investment; Smart Cities

Resumo

O presente relatório de estágio examina o papel das cidades inteligentes como um veículo para melhorar a qualidade de vida, de acordo com os Objetivos de Desenvolvimento Sustentável estabelecidos pelas Nações Unidas em 2015. A crise climática resultou numa tendência global para abordar questões ambientais, sociais e de governança. Neste âmbito, surgiram múltiplas iniciativas de reporte e regulação, incluindo métodos de medição de impacto não financeiro.

Incorporando evidências da literatura, entrevistas e estudos de caso reais, esta investigação demonstra como os criadores de políticas públicas avaliam atualmente o retorno do investimento das cidades inteligentes. As conclusões sublinham a necessidade de se definir uma abordagem capaz de oferecer um *business case* claro e provar a existência de resultados extraeconómicos de forma transparente e inequívoca. Essa abordagem garantirá que os benefícios da tecnologia sejam usufruídos de forma equitativa e inclusiva, acelerando o crescimento económico nos países desenvolvidos e em desenvolvimento.

O estudo salienta a importância do compromisso político para com o planeamento e a implementação de cidades inteligentes. Sublinha o potencial das tecnologias e estratégias das cidades inteligentes para obter benefícios sociais, económicos e ambientais. Ao tirar partido de soluções suportadas por dados, as cidades podem otimizar a atribuição de recursos, melhorando os serviços públicos e promovendo a participação dos cidadãos.

Este relatório contribui para a comunidade científica, informando sobre as práticas atuais e desafios associados à avaliação do impacto das cidades inteligentes. Apela a uma abordagem mais holística e padronizada para medir o sucesso de iniciativas, englobando não só métricas económicas, mas também indicadores sociais e ambientais. Em última análise, as conclusões apoiam o argumento de que as cidades inteligentes, quando projetadas e implementadas com uma compreensão abrangente do seu potencial impacto, podem contribuir para o desenvolvimento sustentável e melhoria da qualidade de vida dos cidadãos em todo o mundo.

Palavras-Chave: ODSs; ESG Framework; Avaliação de Impacto; Retorno de Investimento; Cidades Inteligentes

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Index of Acronyms

aaS – as a Service

BCR – Benefit Cost Ratio

CAPEX – Capital Expenditures

CBA – Cost-Benefit Analysis

CSR - Corporate Social Responsibility

ESG - Environmental, Social and Governance

ETF - Exchange Traded Fund

GDP – Gross Domestic Product

GHG – Greenhouse Gas

IDC - International Data Corporation

IFRS - International Financial Reporting Standards

IMM - Impact Money Multiple

IoT - Internet of Things

IRR - Internal Rate of Return

ISO – International Standards Organisation

KPI – Key Performance Indicators

MDB - Multilateral Development Bank

MFD - Maximizing Finance for Development

NGO – Non-Governmental Organisation

NPV - Net Present Value

NPS – Net Promoter Score

OASC – Open and Agile Smart Cities

OECD - Organisation for Economic Cooperation and Development

OPEX – Operational Expenditures

PE - Private Equity

PPP - Public and Private Partnerships

ROA - Return on Assets

ROE - Return on Equity

ROI – Return on Investment

SDG - Sustainable Development Goals

SEE – Social, Economic and Environmental Benefits

SME – Subject Matter Expert

SMROI – Smart Return on Investment

SRI - Socially Responsible Investment

SROI - Social Return on Investment

TOC – Total Ownership Costs

TI – Total Investment Required

VC - Venture Capital

1. Introduction

Introduced at the beginning of the twenty-first century, the "smart city" concept places technology at the service of citizens to improve their quality of life. Since then, the term has evolved to "cognitive cities" which can anticipate and proactively address urban issues due to the evolution of technologies such as artificial intelligence or machine learning.

There has been constant debate regarding the ability of technology to create value for society. Nevertheless, the undeniable technological advances from the Fourth Industrial Revolution, paired with the urgency of the climate crisis, have acted as a catalyst for the development of this industry. Over the next few years, expenditure and investment in smart innovation will rise as prototype testing gives place to deploying and integrating modern technologies (Vuppuluri, 2020). But will society benefit from this equitably?

The cartoon in Annex 1 – **Cartoon Inspiration** by Zamchick (2018) refers to Tel Aviv, one of the smartest cities in the world, to identify the industry as "the trojan horses for technology companies". It is congruent with the decade-old view exposed by Greenfield (2013) that technological powerhouses shaped the smart city concept exclusively with the intention of maximizing their own financial gains.

Measuring the return on this type of investment and accurately identifying the beneficiaries will provide incentives to deliver real impact. The present research analyses the ability of smart city projects to generate non-financial results as an incentive for accomplishing the Sustainable Development Goals (SDGs) established by the United Nations (2015).

Despite the existence of multiple reporting initiatives, there remains a lack of consistency and maturity in the standards and regulations established in this field. Additionally, conventional financial theory has faced challenges in incorporating dynamic and non-financial aspects in analytical frameworks. The classification of intangible investments, such as goodwill, cannot represent a viable solution for this quantification (Aich et al., 2021).

By leveraging the importance of Environmental, Social and Governance (ESG) factors, which play a crucial role in evaluating the progress of the private sector towards SDGs (Institutional Shareholders Service, 2023), this study aims to develop a standardized framework for evaluating the impact of smart city initiatives. The primary objective is to equip policymakers with the necessary tools to make well-informed decisions when assessing investment projects in smart cities.

2. Internship Framework

2.1. Deloitte Portugal

Deloitte is a multinational firm with more than 175 years of experience, positioned amongst the main global leaders in auditing and consulting services. The firm operates in more than 150 countries around the world in the business of auditing, consulting, and risk advisory.

The Smart Cities Solution Centre, located in Lisbon, Portugal, focuses on offering technological solutions for urban centres. It provides tailor-made urban planning solutions to public and private clients, contributing to the sustainable development of resilient cities.

The team's main asset, the Synergy solution, designed to support city operations, combines the definition of processes with the capacity to integrate solutions and perform data correlation and visualisation. It promotes city management through predictive analysis to inform decision-making.

2.2. Role Description and Activities

The role of the analyst integrating the Global Smart City and Urban Transformation team provided a practical perspective on smart city use cases and research reports, which focus on researching the main tendencies of technology application to urban centres.

The main goal of the internship was to design a framework for evaluating return on investment of smart cities projects, from the social, economic and environmental perspectives. The activities conducted during the internship include:

- Analysing financial analysis metrics, which allow to perform cost-benefit analysis.
- Setting a context for the financial evaluation measures in a more holistic perspective that focuses on social, economic and environmental dimensions.
- Contributing to the design of a framework to assess social, economic and environmental impact from smart technologies applied to urban centres.

The collaboration with the Financial Advisory Department allowed the participation in activities such as creating business plans or applying firm valuation methodologies, including the calculation of discount rates and terminal values.

3. Literature Review

3.1. Environmental, Social and Governance

3.1.1. Will The Trend Last?

Across firm sizes, sectors, industries and geographies, organisations have been increasing their resource allocation towards improving ESG aspects (Arvidsson and Dumay, 2021). This "triple-bottom-line approach" (Elkington, 1994), initially coined to describe the dimensions of sustainability, has since been applied to measure the overall impact of an organisation's investments (Li et al., 2021) as follows:

- Environmental: considers the impact of an organisation's operations on the natural environment. It can include measuring carbon emissions, the percentage use of renewable energy or listing waste management practices.
- Social: analyses how an organisation acts towards its stakeholders, namely its employees, customers, and the communities in which it operates. It can include assessing labour practices, diversity and inclusion strategies or social activism.
- Governance: appraises an organisation's leadership, auditing controls, ethical behaviour, decision-making processes, mechanisms for controlling conflicts of interest and excess power. It can include evaluating the board of directors' composition, the executive compensation, or the risk management systems in place.

More than 90 per cent of S&P 500 and 70 per cent of Russel 1000 firms have become regular in publishing ESG reports (Government and Accountability Institute, 2021). The competition between rating agencies and score providers for standardized measures of ESG performance has incentivised information disclosure and improved reporting frameworks (Escrig-Olmedo et al., 2019). Regulators have been meticulous in their benchmark requirements for ESG (Singhania and Saini, 2021). Organisations have become increasingly aware of their corporate governance control mechanisms (Farinha, 2003).

As ESG pillars strengthen amongst stakeholder groups, it seems inevitable to question the longevity of this trend. Just as accounting principles and norms have evolved to International Financial Reporting Standards (IFRS) mostly due to "stakeholder pull, rather than regulatory push" (Brown, 2020), these are a result of extensive progress and thorough debate, as a reflection of how important these matters are to stakeholders.

3.1.2. Investing in Sustainability - Socially Responsible Investing

ESG considerations have become increasingly relevant to investors, as they impact firm financial sustainability in the long-term and its reputation. Investors are currently appraising ESG when performing investment decisions since these factors can reflect on company management and global risk profile (Statman and Glushkov, 2009; Gillan et al., 2021).

Socially Responsible Investing (SRI) is an investment perspective which seeks financial returns and social and environmental impact (Renneboog et al., 2008). Thus, SRI includes performing investments, exclusively, in securities which align with an investor's values and beliefs. It applies to a variety of asset classes, including stocks, bonds, mutual funds, and exchange-traded funds (ETFs), by conducting:

- Negative screening: avoiding investments in firms which engage in activities considered to be socially or environmentally harmful, such as alcohol or gambling.
- Positive screening: investing in firms that claim to be pro-ESG by evaluating their environmental performance, labour practices, or community involvement.
- Best-in-class method: investing in the best-performing securities in each sector, according to their ESG performance.
- Impact investing: investing in firms focused on creating positive social and environmental value in addition to financial return.

Evidence from over two thousand academic studies points to a non-negative relationship between ESG scores and financial returns (Friede et al., 2015; Hvidkjær, 2017; Huang, 2021), whether measured by equity returns, profitability, or valuation multiples. Moreover, a better ESG disclosure translates into a higher return on assets (ROA) and return on equity (ROE) (Alareeni and Hamdan, 2020) and a lower cost of capital by decreasing firm risk (Sassen et al., 2016). However, there is also evidence that these impacts no longer produce abnormal returns for investors (Halbritter and Dorfleitner, 2015).

Although there have been increasing incentives for SRI in recent years, barriers have been undermining its full potential. Examples include greenwashing, rating shopping or the misalignment between SDGs and ESG criteria (Stern, 2018).

There is a need to "recall" the concept of the "triple-bottom-line" approach, rethinking capitalist foundational principles (Elkington, 2018). It is equally urgent to apply a broader stakeholder framework to ESG investing, adequately appreciating its benefits (Cornell, 2020).

3.1.3. Funding Sustainability - Public and Private Partnerships

In the mid-2000s, initiatives aimed at financing SDGs emerged to restructure cash flows, build on innovations in private markets and improve risk management strategies (United Nations Task Force on Financing for Development, 2022). Pooled funds, SDG-linked bonds or solidarity taxes are examples of instruments aspiring to attract the private financing of sustainable development.

Most recently, this trend has been shifting towards securitisation. The current World Bank's Maximising Finance for Development (MFD) strategy draws on its basic premise of de-risking SDG assets to attract institutional investors with long-term horizons and deep pools of capital. According to the World Bank's president, it is imperial to "start asking whether private capital rather than government funding or philanthropy can finance sustainable development projects. If these conditions are not available for private investment, we need to collaborate with our partners to de-risk projects, sectors, and entire countries" (Kim, 2017).

The current MFD strategy goes beyond direct public funding vehicles. Through Public-Private-Partnerships (PPPs), public services such as education, infrastructure, or health become tradable asset classes. This implies a structural transformation of local financial systems, changing from bank-based to engineering market-based finance to create investible SDG assets and blended finance. Through Multilateral Development Banks (MDBs), securitisation will align private finance with SDGs, distributing demand, political, climate and liquidity risk into PPPs where institutional investors can channel their capital into local SDG assets (World Bank, 2017).

Nevertheless, relying solely on market-based finance exposes the system to increased vulnerability during global financial cycles and fluctuations in domestic currency financing conditions (Rey, 2015). Furthermore, increased intermediation reduces accountability, making the enforcement of ESG compliance incentives less effective and thereby weakening the overall approach.

The alternative for this lies in implementing green development through financing "just transition" to low-carbon economies (Gabor, 2019). It aims at ensuring that the benefits of investing in the green transition are equally shared while further supporting the ones who stand to lose economically, namely countries, regions, industries, communities, workers, or consumers. Estimates from the Organisation for Economic Cooperation and Development (OECD), in 2016, signal an increasing trend in public and private flows mobilised for climate action.

3.2. The Green and Digital Transition

3.2.1. Enabling Innovation in Public Policy

The new digital era has transformed the universal innovation process, both in the public, private and non-profit sectors, with a notorious impact on organisations and, foremost, on policymaking (European Investment Bank, 2021).

Cities are working towards becoming smart, adopting digital solutions to improve urban mobility, energy efficiency, sustainable housing, digital public services or civic-led governance. An extensive upscale of these solutions throughout cities is vital to meet climate pledges and reduce ecological impacts while promoting citizen engagement and economic prosperity (European Commission, 2023).

The OECD (2021) recognises the value of smart cities' performance as essential to the execution of public policies with greater efficiency and effectiveness. Identifying cost-effective solutions to deliver public services, improving accountability between governors and citizens, and keeping track of progress and impact will bring relevant economic and social changes. Roundtables and conferences have highlighted the importance of discussing the development of these performance frameworks (Buallay et al., 2021).

3.2.2. Unlocking Global Smart Cities Market Potential

According to Research and Markets (2022), the global smart cities market, accelerated by Internet of Things (IoT) growth and regulatory changes, estimated to 1024 billion dollars, performing a compounded annual growth rate of 14.9 per cent in the period of 2020 to 2027.

Moreover, 64 per cent of the SDG policies are established at the city level, which can translate into relevant market opportunities for smart technology development. For example, building management systems are key to achieving net-zero emissions as these infrastructures are responsible for 30 to 40 per cent of the total energy consumption in cities (Sharif, 2020).

Technology is capable of supporting SDG-guided growth (Goudlson et al., 2018; Blasi et al., 2022). Nevertheless, there is a need for a clear business case (Loonam et al., 2018). Both public and private sources demand to realise market opportunities and broader economic, social, and environmental benefits. Identifying direct, tangible financial returns from market investments and non-monetised benefits will provide adequate stimulus for this transformation.

3.2.3. Overcoming Barriers for Developing Countries

Despite the efforts to finance sustainable development, several developing countries still face relevant barriers, and some have fallen further behind (Banga, 2018). The fourth Industrial Revolution can comprehend a trial for developing countries, leading to the increase of the digital divide and social inequalities if not managed correctly (Manda and Dhaou, 2019; Tewathia et al., 2020; Aly, 2022).

It may appear reasonable to assume that smart city market growth concentrates within developed cities. However, according to the International Data Corporation (IDC), in 2019, the top one hundred smart cities in the world represent less than 30 per cent of the total investment in the industry, led by cities such as Singapore, Tokyo, New York and London. Remarkably, investment opportunities are broadening for developing cities, with 70 per cent of growth potential lying in cities which invest less than one million dollars per year in smart innovation. Latin America registered the fastest growth in investment in regional terms.

Furthermore, the recent pandemic crisis has brought fragilities at the municipal level. Cities have been at the forefront of containing the spread of the coronavirus disease, exposing social inequalities or inefficient healthcare systems (Wahba, 2020). Nevertheless, it has created a unique moment where all urban ecosystems across the world, in distinct stages of development, shared an experience of imminent crisis. This allowed cities to be in an "equal" position, where uncertainty requires agility and responsiveness, forcing most cities to adapt rapidly, leading to a global acceleration of innovation and digitalisation. By building on this opportunity, data-driven cities can lead to world economic growth (Merritt, 2020).

Therefore, a new globalisation approach which prioritises collective investment in public services and includes technological and ethical growth to benefit all population has become imperative (Khagram, 2020).

3.3. Theoretical Foundations of Finance

3.3.1. Measuring Return on Impact Investing

Since the rise of Corporate Social Responsibility (CSR) in the 1980s to the Creating Shared-Value approach (Porter and Kramer, 2011), organisations have included non-market dimensions in their strategic planning. Managing between proactive and reactive actions towards ESG considerations has become decisive for their reputation and, consequently, their performance.

The most recent attempt of relevant stakeholders to quantify their extra-financial performance value reinforces the actuality and relevance of the "doing well by doing good" proposition (Falck and Heblich, 2007). It is important to note that, by definition, impact investing differs from SRI or ESG investing, even if used in concomitance. The former aims at achieving transformational change, while the latter does not necessarily produce impact-generating investments (Busch et al., 2021).

Addressing the lack of an established metric for evaluating return beyond financial benefits when performing investment decisions (Capelle-Blancard and Monjon, 2012; Hoͤchstaͤdter & Scheck, 2015), impact measures have emerged in the past two decades. These aim to evaluate the economic value of environmental and social benefits, with the ultimate practical goal of helping reduce social imbalances and environmental deterioration by assessing the impact of investments which improve the quality of life.

Nevertheless, the trend is forming towards fulfilling sustainability requirements rather than achieving transformational change (Agrawal and Hockerts, 2021). Nowadays, fund managers prefer businesses focused on solving simple societal challenges, generating a residual impact. This happens because this impact is easy to quantify and generates a predictable financial return for investors (Roundy et al., 2017). Without a purpose-driven seek for change, this approach will not deliver actual impact, turning into a broader version of SRI or ESG investing by targeting profitable investments which barely connect to environmental or societal challenges.

According to Casalini and Vecchi (2022), without adequate standards and regulation, accompanied by de-risking mechanisms to attract private capital inflows, impact investing will keep evolving further away from its fundamental values. Moreover, a new generation of entrepreneurs and investors, formally supported by academia, is relevant for accomplishing SDGs and addressing real-world challenges.

3.3.1.1. Cost-Benefit Analysis (CBA)

Investors, either individual or institutional, perform their decisions based on diverse model implications. Financial theory states that these should include: (1) estimating expected future cash flows from an investment and (2) discounting cash flows at a rate derived from an explicit asset pricing model (Sharpe, 1964). Table 1 aggregates the main financial analysis indicators, namely the net present value (NPV), the internal rate of return (IRR), and the benefit-cost ratio (BCR) which allow to compare the cash inflows against the cash outflows of a project and can reflect the time value of money.

Table 1 - Financial Analysis Indicators. Source: Own Elaboration.

Indicator	Description	Formula
Net Present Value (NPV)	Calculates the current value of a future stream of payments form an investment, considering the time value of money by discounting future cash flows at a required rate of return or cost of capital. An NPV>0 indicates value creation.	$NPV = -Investment + \frac{CF_1}{(1+r)^1} + \cdots + \frac{CF_t}{(1+r)^t}$
Internal Rate of Return (IRR)	Measures the discount rate that equals the NPV of the investment to zero. An IRR>required rate of return means that the investment is profitable.	$0 = NPV = \sum \frac{CF_t}{(1 + IRR)^t} - Investment$
Benefit-Cost Ratio (BCR)	Evaluates the profitability of an investment, comparing the total present value of benefits to the total present value of costs. If BCR >1, the benefits exceed the costs of the investment.	$BCR = \frac{Present\ Value\ of\ Benefits}{Present\ Value\ of\ Costs}$

The European Commission (2014) supports Cost-Benefit Analysis (CBA) as a useful analytical tool for assessing public investment decisions. The main purpose of CBA is to improve resource allocation efficiency, demonstrating the return of an investment in terms of how it benefits society, in comparison to other mutually exclusive investments. The underlying rationale

implies that investment decisions, driven by profit and market incentives, can sometimes result in undesirable outcomes, particularly when market failures such as information asymmetry, externalities, or public goods come into play. Conversely, if the costs and benefits of an investment project, including intangible factors and external impacts, are evaluated based on their societal opportunity costs, the calculated return becomes a valid measure of the project's contribution to social well-being.

CBA requires a discount rate to compare the benefits and costs that are distributed over the life of the investment (Harberger et al., 2007). If the NPV of a project is greater than zero, this is an indication that the project might create value. Put simply, the project has the potential to generate greater benefits compared to alternative uses of the same resources within the economy. Alternatively, if the NPV is negative, it is advisable to reject the project since the resources invested would have yielded a higher return if allocated to other purposes.

Furthermore, as public investments envision the fair distribution of wealth, it is necessary to determine a "social" discount rate, based on the principle of intergenerational justice (Turečková and Nevima, 2020). Thus, the rate of return should be the same as the economic growth which equals the population growth and may be adjusted according to macroeconomic variables, investment characteristics and the industry sector in question.

In summary, CBA can provide a plausible performance framework for clarifying the benefits of investing in technological solutions applied to urban centres to increase the overall quality of life. Comparing the benefits and costs, these solutions can demonstrate their efficiency, provided that the results are satisfactory to all parties involved. When paired with the smart region concept, these solutions can provide a viable tool for wealth redistribution, ensuring accountability and transparency between municipalities and its citizens.

Thus, the next chapter will focus on analysing impact indicators which draw on CBA measures of return to guarantee that non-financial value is captured to inform political decision-making and public resource allocation, ensuring good governance.

3.3.1.2. Social Return on Investment (SROI)

Social Return on Investment (SROI) comprises a ratio of monetised social value, first introduced by Emerson and Twersky in 1996. The concept has evolved to the return on social, environmental, and economic value for every dollar invested and can be obtained as given in equation (3.1). In other words, a ratio of 2:1 reveals that an investment of 1 dollar returns 2 dollars of social value (Nicholls et al., 2012). Therefore, a ratio SROI>1 indicates that the investment can create social value. The firm assessing the investment should define the minimum threshold required.

$$SROI = \frac{Net\ Present\ Value\ of\ Benefits}{Value\ of\ Investment} \tag{3.1}$$

This indicator is based on the principles of Cost-Benefit Analysis (CBA) (Rotheroe and Richards, 2007), measuring the relative costs of achieving the designated benefits. Public and private organisations, investors and policymakers can use SROI to understand and communicate impact and to decide on resource allocation (Nicholls et al., 2012). It pairs with other measurement tools such as benefit-cost ratio (BCR) in the public sector and ESG analysis of private companies (Nicholls, 2017).

3.3.1.3. Impact Money Multiple (IMM)

The Impact Money Multiple (IMM) is another financial metric introduced by Addy et al. (2019). It measures the multiple of the social and environmental impact return generated by an investment relative to its financial return, as provided in equation (3.2). It assesses the trade-off between financial investment and impact return. For instance, an IMM of 8, means that for every 1 dollar, the investment provides 8 dollars of social or environmental return.

$$IMM = \frac{Impact\ Cash\ Inflows}{Cash\ Outflows} \tag{3.2}$$

Investors and organisations can use IMM to assess the sustainability of an investment. If it meets the required benchmark, they should realise the investment. Just as SROI, this measure adjusts for risks, discounting the probability of achieving the estimated social or environmental value and its ability to perpetuate, at least in the foreseeable future.

3.3.2. Limitations of Impact Assessment

The proposed measures described above have shortcomings. The most common subjective metric is social and environmental benefits monetisation, which is difficult to express in financial terms. In any valuation, performing this type of analysis requires assumptions and historical data to forecast cashflows. The main issue is that the information available is often present in ESG reports, which lay out intentions, rather than actions (Miller and Hall, 2013).

Moreover, Pathak and Dattani (2014) have exposed technical issues as the utilisation of discount values, which fail to select adequate time horizons for forecasting the perpetual economic value of the social benefits. Moreover, the miscalculation of operational costs, namely overhead, can lead to the overestimation of impact measures. Finally, there is a difficulty in laying out the counterhypothesis when counting on the knowledge of direct beneficiaries and when identifying attribution risk in the case of complementary projects. Nevertheless, these challenges can be overcome by engaging more stakeholders in the process.

Most recently, Yates and Marra (2017) have highlighted the difficulty in accurately estimating societal costs and benefits. This could lead to poorly informed or biased decision-making when selecting and funding programs. For this reason, it might be relevant to involve stakeholders in planning, conducting, reporting, and using findings, encouraging feedback and knowledge sharing between parties. However, it further exacerbates discrimination if the stakeholder group does not include advocates for minorities or groups which are not representative when estimating social benefits. Lastly, it is also important to note that these ratios alone do not justify a decision to invest, or to divest. This analysis should always include evaluation criteria which reflect project capacity and clearly defines causal attribution of the benefits in question.

4. Methodology

Smart cities aim to be more liveable, efficient and sustainable by using digital technologies to improve urban systems management and services. The goal of smart cities is to increase the quality of life for their citizens, attract businesses and investment, and reduce the environmental impact of urbanisation. However, despite the vast literature on SRI, ESG and Impact Investing, there is no consensual approach to evaluating the extra-financial return of this type of investment.

This study focuses on learning how practitioners currently assess the impact of smart city projects by applying interview-based research methodology. The argument draws on semi-structured interviews with experts to learn their views on the process of evaluating extra-financial return in the context of these projects. The interviews, conducted and recorded through Microsoft Teams, took place between the period of the 17th of April and the 15th of May 2023. The interviewees, in Table 2, were selected according to their former experience in the field of technological experimentation and urban transformation. Their professional backgrounds include managing roles in project coordination, sustainability studies development, innovation strategic leadership, operations management and data analytics, in different entities.

Table 2 - Interviews Conducted. Source: Own Elaboration.

	Date	Role	Entity
A.	17.04.2023	Head of Project Management	Porto Digital – Project Management
B.	21.04.2023	Head of Information and Economic Strategy	Municipality of Porto – Information and Strategic Studies
C.	24.04.2023	Head of Innovation Management	Porto Business School - Centre for Business Innovation
D.	8.05.2023	Chief Operations Officer	NOSHUT – Digital Transformation Consultancy
E.	11.05.2023	Project Director	Open and Agile Smart Cities (OASC) Network
F.	15.05.2023	Data Analyst	Porto Digital – Systems Architecture & Data Analytics

Interviewee A is the head of project management at Porto Digital, a conciliator entity responsible for implementing the smart city strategy of Porto. For that, the specialist has managed innovation projects of distinct size and complexity while also focusing on prospection, analysis and development of applications for national and international funding. One key example includes piloting to integrate and empower marginalized communities to develop sustainable projects and solutions for their specific urban and social-related issues such as isolation of the elderly or low-level of education in socially vulnerable neighbourhoods.

Interviewee B is currently leading the unit of Information and Strategic Studies of the Municipality of Porto, which aims to deliver relevant city insights through data analytics and business intelligence. The expert has overseen the monitoring of sustainable outcomes within the Municipality and the economic development strategy for long-term investment projects among local stakeholders. The platform for socio-economic data dashboards constitutes a meaningful example, aggregating more than 300 indicators from reliable and complementary sources to compare Porto with other peer-cities and provide internal departments within the Municipality with useful information to support decision-making.

Interviewee C has served as director of the Centre of Business Innovation of Porto Business School. This professional has been involved in the design and implementation of academic programs aimed at activating the community around innovation and entrepreneurship topics. An impactful project in the expert's portfolio includes the creation of the first renewable energy community in Porto, interacting with the entire social spectrum to encourage the consumption of clean energy, promoting electric mobility sustainable development and the possibility of storing part of the energy produced.

Interviewee D is the chief operations officer at NOSHUT, a private consultancy company specialized in digital transformation. The most relevant project the expert was involved in focuses on maintaining and upgrading the core infrastructure that supports public Wi-Fi in cities as well as other subsystems essential to coordinate daily smart city operations.

Interviewee E is the project director for the international network of Open and Agile Smart Cities (OASC), which partners with local administrations worldwide to support their journey towards digital transformation. This expert's role includes managing global partnerships and alliances with more than one hundred and fifty cities and coordinating the network's project management. A relevant project entails the mapping of digital innovation in cities, assessing the

maturity level of technology adoption in governance and public service provision to discuss the state of digital transformation across Europe.

Finally, Interviewee F is a data analyst at Porto Digital, who specializes in applying machine learning and data mining in the implementation of smart technologies in cities. One key project in this portfolio includes the analysis of transaction data systems to identify patterns of consumption in the local commerce, providing an accurate diagnosis of sector dynamism and highlighting critical opportunities for digitalization.

The set of questions posed and answered during the one-hour interviews are presented in Annex 2 – Interview Guidelines. Addressing themes such as the measurement of non-financial impact or the contribution of smart city investment towards reducing social imbalances, the professionals expressed their perspectives and shared their experiences.

Combining the output of these interviews with research from the literature, a framework was developed for impact assessment of an individual smart city project, including the analysis of resources, activities, and outcomes. The main objective is to promote structured thinking when considering the diversity of impacts of a project and its beneficiaries, helping to weight them against the total investment required. An illustrative example of a Smart Energy Management System applied to public buildings is provided in Appendix 1– Measuring Smart Return on Investment of an Energy Management System explaining in further detail how to assess social, economic and environmental benefits in monetary terms and discounting these to the present value.

Furthermore, a matrix for the comparison of similar projects was also created to support policymakers, addressing the trade-offs of impact and investment. It can be useful to promote debate around inclusivity and innovation, helping to quantify impact in relative terms.

The key contribution of this research lies in providing a broader definition of the return on smart city investment, to better understand its potential to generate social, economic and environmental value. This was equally relevant to perceive their role in driving the implementation of the United Nations' SDGs.

5. Interview Analysis and Discussion

5.1. How do practitioners currently select which smart city projects to implement?

The experts interviewed have between 4 and 10 years of experience in assessing, managing, or implementing smart city projects. When expressing their views, the interviewees always referred to a "smart city" as a concept which cannot be alienated from its social, economic, and environmental dimensions, as presented in Table 3. Adding to this, the term "efficiency" is widely mentioned to describe the city's operations and services.

Table 3 - The Interviewees Smart City Definitions. Source: Own Elaboration.

A	"A city where citizens can live a safe, prosperous, and happy life. For reaching this apparently simple but utmost complex goal, all dimensions must be considered, like human life, environmental and economic, among others."
B	"A city which measures its performance, monitoring a series of indicators provided by the private sector – not just economic, but also environmental and social - and ensuring accountability and transparency to better inform decision-making."
C	"An urban ecosystem supported by a decision-making process which incorporates feedback and suggestions from stakeholders and considering the needs of all citizens. A place where technology is tested within diverse groups of people to create equitable and sustainable solutions."
D.	"A city which maximizes the efficiency and effectiveness of its infrastructure and services, using technologies that can serve its citizens to improve their quality of life."
E.	"Globally interconnected cities which use their human, technological, financial and environmental resources efficiently, to address the needs of their citizens and visitors."
F.	"A city which draws on technology and connectivity to optimize the efficiency of public services, improving the quality of life of its citizens and promoting environmental sustainability."

Although all the experts identified impact assessment as a frequent practice in their organisations, when deciding to invest in a new project this evaluation exercise often relied on the theoretical and empirical knowledge of the managers rather than on the application of a specific formula. According to Interviewee A, "cities are living organisms where the connections and the flow of the impacts are not subject to an exact science methodology. There are too many variations to consider for obtaining a model."

Moreover, Interviewee B referred to the difficulty in assessing extra-economic impact, especially regarding the measurement of social considerations. On one hand, it is easy to quantify environmental indicators, as sensors and other technologies in place can provide real-time structured data on air quality and water consumption, for example. On the other hand, the spill over effect that a specific project implementation can cause on people's lives constitutes a more challenging task. From the expert's point of view, "there is a lack of expertise in the public sector. A standardized framework could provide support when performing this type of analysis".

Furthermore, Interviewee E pointed out that impact analysis should also be carried out after the project has finished. "In the post-implementation phase, this analysis is usually subject to confirmation bias, since it focuses on achieving the metrics established a priori to meet the requirements for funding, in the case of regionally financed projects." In the experts' opinion, it is critical that funding agencies become more flexible, allowing errors and failure to be recognized and made useful to inform future projects.

When inquired about the main challenges of impact evaluation, Interviewee C reinforced that time and budget constraints, data quality and reliability and the lack of qualified personnel as the most relevant. In the interviewee's opinion, evaluations of projects can be "time-consuming and costly," especially if they involve collecting data from multiple sources, conducting surveys, and engaging with stakeholders.

Additionally, this type of evaluation requires a range of skills and expertise, which can be difficult to access, especially in the municipalities' technical human resources. Some foundational concepts, such as open data or open source, are not fully understood by the teams which implement the projects in the field, working under pressure to deliver on specific Key Performance Indicators (KPIs) and deadlines. According to Interviewee E, "the time required for human resources training should also be accounted for in the overall timeline of regionally funded projects."

Moreover, most practitioners lack a good understanding of the citizens' problems, given their distance from the real environment where the projects are implemented. In Interviewee E's perspective, this issue undermines the overall potential of initiatives. Nevertheless, when discussing the involvement of citizens in the process of evaluation, it was consensual that this practice can ensure the project is aligned with the needs and priorities of the community and build legitimacy and acceptance for the project, providing greater knowledge of the local environment. Interviewee E added that "ecosystem engagement has become a trend and

practitioners are performing it without realizing the principles behind it and without applying the tools adequately." One key example can include participatory budget initiatives, which directly ask the citizen about the funding allocation of public policies. This has "led to the implementation of projects without effective impact on their daily lives, such as the statue of a famous football player." Thus, the role of each stakeholder in the co-creation process should be defined clearly, always counting on academia and the private sector to provide practical solutions and on the citizens to share their real problems and needs.

5.2. Does this type of projects contribute towards achieving the SDGs?

Overall, the interviewees agree that smart cities can play a key role in achieving the United Nations' Sustainable Development Goals. Interviewee E believes that "cities are at the right level to implement this type of projects. They are close enough to the citizens to understand their needs, but also have influence on the national panorama to define public policies."

Interviewee D points out that, the main return on investment in this type of technologies lies in the improvement of the city's operations management in terms of public lighting, water and waste management, among others. As an example, the expert pointed that implementing a smart system for waste containers can improve the efficiency of cleaning routes, saving time and resources. In the professional's opinion, "the consequences of a more efficient usage of resources can result in social and environmental benefits, contributing towards the fulfilment of the United Nations' SDGs".

Furthermore, when discussing the sustainable objectives to be achieved by 2030, experts consistently highlighted SDG 11 as a prominent focus for fostering the advancement of sustainable cities and communities. This goal targets equality of access to adequate and affordable housing, safe and sustainable transport systems, protection and preservation of cultural and natural heritage, reduction of the environmental impact of cities and the enhancement of urban-rural linkages.

Adding to this, the experts have also referred SDG 9, which aims to build resilient infrastructure, promote sustainable industrialization, and foster innovation, SDG 3 which focuses on good health and well-being and SDG 16 which promotes peace, justice and strong

institutions. Nonetheless, the interviewees recognized the importance of technological investment to transform cities' operations in the achievement of all 17 SDGs.

Moreover, technological experimentation was described as a fundamental practice in this context. Deploying innovative solutions and services in small and controlled environments narrows the scope of the impact and allows to test and validate assumptions, which can be replicated to more citizens or in different areas of the city. Quoting Interviewee A, "while considering the importance of evaluation, we should not keep refrained by the obsessive quantification of every project before proceeding to implementation." According to the expert, acknowledging that failure is an inevitable part of innovation and learning from previous errors can be essential to stimulate investment which cannot offer an objective measure of return.

However, Interviewee F pointed out cases of cities which have paused or abandoned their smart city strategies due to the lack of foundational governance principles. According to the expert, "testing an excessive number of pilots simultaneously, can eventually lead to high technical complexity and, ultimately, to lack of financing, which results in the unsustainability of projects." There is a need for establishing clear governance structures to ensure that policy frameworks safeguard data privacy and security, ethical considerations and long-term planning and sustainability.

Nevertheless, governance mechanisms should also allow for flexibility and innovation to accommodate emerging technologies and evolving needs, allowing smart city projects to embrace innovative solutions and adapt to changing circumstances effectively. According to Interviewee B, "most projects follow political programs which have already been disclosed and approved by electors. Delivering on what has been promised will increase public support, rather than engaging in new investments." In the expert's opinion, this approach focuses on meeting the expectations set during the political campaign, assuming that by fulfilling these promises, the public's confidence and satisfaction will increase, potentially bolstering the legitimacy of the governing body. However, this might overlook the potential benefits of technological experimentation in smart city projects. Balancing the delivery of political programs with a willingness to explore and invest in new technological experimentation is essential to meet immediate expectations of the population but also to adapt to the evolving challenges and opportunities in the dynamic urban development landscape.

5.3. Are there social, economic or environmental benefits in investing in smart cities?

Overall, the experts agree on the potential of smart city projects to generate social, economic and environmental benefits. However, this is subject to the fulfilment of some key conditions, as described in Table 4.

Table 4 – The Interviewees Key Conditions to Guarantee Smart City Return on Investment. Source: Own Elaboration.

Long-term vision and strategy definition	Political commitment to a strategic long-term vision and definition of priorities at the city level
	Alignment between the regional funding vehicles and actual project implementation to ensure that the financed research meets long-term goals and that the most adequate players have access to public tenders
	Guarantee that public services reach the highest number of users and that these always account for inclusivity
Fully capacitated operational teams	Guarantee of effectiveness and efficacy of operations through a resilient conciliator entity which implements projects in the city
	Knowledge transfer on use cases and good practices and training and development of teams to leverage technological scalability
	Responsible project management, keeping a record of technology testing and ensuring meaningful impact, to learn from failures and continuously improve
Effective ecosystem engagement	User-centred design of technological solutions to meet the users' needs
	Meaningful stakeholder engagement throughout design and implementation phases
	Defining very clearly what can be asked from each participant in the co-creation processes

While political strategy and vision are determinant, the interviewees have highlighted various aspects of designing a smart city, which should be carefully analysed. The impact assessment exercise has been identified as a complex, although especially important task whose potential can be maximized with the involvement of important stakeholders in the process.

Moreover, it is essential to perform training and development of human resources to provide them with the necessary tools for knowledge transfer. Providing a standardized framework for impact assessment will allow to leverage on industry best practices and real use-cases. Following a bottom-up approach, practitioners can inform decision-making and capitalize on scalability to attain social, economic, and environmental benefits.

Lastly, it is crucial to carefully manage each project individually, guaranteeing the fulfilment of well-defined long-term objectives to address city-specific needs. Impact must be consistently monitored, at the cost of no return from investing in the digital transformation to fight climate change and improve the quality of life.

5.4. Are these benefits equally distributed in societies?

Finally, regarding the topic of exacerbation of social inequalities, the answers converged towards smart cities having the potential to simultaneously reduce social imbalances and aggravate the existence of marginalized communities, depending on how they are designed and implemented.

According to the example provided by Interviewee C, "smart cities can improve citizen participation in decision-making processes, which can empower marginalized communities to have a greater say in the development of their neighbourhoods and cities. However, if these participation mechanisms are not designed inclusively, they can further marginalize communities that have limited access to technology or face language barriers." To ensure that smart cities are inclusive and equitable, it is important to involve diverse stakeholders in the planning and implementation process, prioritize accessibility and inclusivity in technology design, and consider the social impacts of smart city technologies on marginalized communities. According to Interviewee F, smart cities can work as catalysers for reducing social imbalances, if there are pre-established public policies to address these challenges in the long-term. "Technological implementation without political guidance has no real social impact."

Interviewee A pointed that cities have acknowledged their responsibility in mishandling marginalized community's needs. For this reason, it has become a top priority in the cities' political agenda to address these communities' complex problems, moving towards becoming more inclusive and fairer. It was also noted that addressing minorities needs can create a broaden

impact in society, both in terms of number of citizens benefiting from it, directly and indirectly, as well as in duration scope impact.

However, it is also recognized that the current efforts will not be enough to accomplish this. There is a need for training municipalities teams and citizens, promoting broader sensibilization campaigns to increase digital literacy levels. According to Interviewee E, "the effective implementation of technological innovation depends largely on the correct understanding of its concepts by both practitioners and citizens. If not learned, the digital divide will keep further increasing". Global networks have already started to address this issue, working alongside medium and small-sized cities to promote technical but also social interoperability mechanisms, to ensure a common language is adopted and good practices are followed.

Additionally, Interviewee B pointed that "smart cities provide practitioners with the tools to measure equality or the lack of it". According to the expert, data-driven solutions can help identify poverty zones and build strategies to tackle their main challenges. However, it is important to guarantee ethical considerations towards efficient public resource allocation. "The impact of these solutions must be a priority. Designing solutions without real applicability for users translate into investments with zero return".

Moreover, all experts agreed that addressing the same usual stakeholders with the benefits provided by technology and innovation has not revealed beneficial to the overall population. It was further discussed that no "one-size-fits-all" solution can apply to developed and developing cities, given their distinctive characteristics. While scaling technology from developed countries to developing countries and regions can be a useful strategy for reducing the development gap, it is important to recognize the contextual factors that can affect the applicability and impact of these technologies. City-tailored policies were identified as being part of a more effective and efficient approach to urban transformation: "technology transfer must be accompanied by efforts to build local capacity."

6. Developing a Framework for Impact Assessment

A study by McKinsey (2018) found that 60 per cent of the initial investment required to implement technological applications in cities could come from private entities. Additionally, more than half of the initial investment made by the public sector could generate a positive return, whether from cost savings or new revenue opportunities.

However, more recent research indicates that central government funding for municipalities has been decreasing over the past years. At the same time, growing populations have increased cost structures for the cities, shifting the focus towards financial sustainability, incentivising revenue maximisation and cost optimisation (McKinsey, 2019). Measuring financial return on investment (ROI) has become a priority for cities.

As it was mentioned in the previous section, decision-making on the implementation of projects often relies on the knowledge and experience of the managers. The process of selection relies both on financial viability and capability to absorb risks, but mostly on the solution's ability to generate social, economic, and environmental impacts (ESI ThoughtLab, 2019). Return on investment as a pure financial metric no longer applies.

Furthermore, impact assessment frameworks should be designed to provide specific, comparable, and clear results. The literature on non-financial return metrics highlights the difficulty in quantifying social, economic, and environmental benefits. Therefore, determining the extent to which a given project has the potential to generate these benefits and to assess their value to society can often be described as challenging. For that reason, ROI calculations often conduce to lower-bound estimates, and it should be taken into consideration in the analysis.

6.1. The SEE/TI Ratio

In the context of smart cities, technology is the main ingredient for attaining the improvement of the quality of life of citizens, accelerating economic growth, and guaranteeing environmental sustainability. This recipe can be summarized into the SEE/TI ratio, represented in equation (6.1), which measures the proportion of Social, Economic and Environmental (SEE) benefits over the Total Investment (TI) required.

$$\frac{SEE}{TI} = \frac{(\Delta Quality\ Life + \Delta Economic\ Value + \Delta Sustainability) \times Scalability}{Total\ Investment} \quad (6.1)$$

To compute the SEE/TI ratio, the cash flows associated with the benefits and the investment are discounted to the present value, using an appropriate discount rate. This discount rate reflects the risk and uncertainty of an expected impact, as a higher uncertainty may warrant a higher discount rate to account for the perceived risks. It can also reflect the time preference, given that a lower discount rate may be appropriate to account for long-term impacts and intergenerational equity. Lastly, it can consider the opportunity cost, in terms of the value of investments with similar risk profiles that have the same potential impacts. By discounting the cash flows, the SEE/TI calculation allows for a more accurate assessment.

Moreover, assigning a monetary value to social or environmental benefits can represent a difficult task. When cash flows are measured in scores or ratings, one approach can be to convert these values into a monetary equivalent. This can be achieved by establishing a correlation between the scores or ratings to actual monetary values built on historical data or market research.

Another approach can include relative weighting or qualitative adjustment, to reflect the relevance of the cash flows measured in scores or ratings. This can be done by directly assigning a weight to the discount rate, according to the relative impact of the cash flows. It is important to carefully consider the underlying assumptions and limitations of any chosen approach to ensure the accuracy and reliability of the analysis.

6.1.1. Social - Enhancing the Overall Quality of Life

The quality of life is enhanced through happier people. According to the Liveability Index, the highest quality of life can be found in cities such as Vienna, Copenhagen, Zurich, Calgary and Vancouver (Economist Intelligence Unit, 2022). Moreover, the Social Progress Index (World Bank, 2022) and the World Happiness Report (Helliwell et al., 2022) indicate Finland, Denmark, Iceland, Switzerland and the Netherlands as the top-ranked countries.

Singapore, Zurich, Oslo, Taipei and Lausanne rank at the top of the Smart City Index, which measures human, economic and technological development (Institute for Management Development and the World Competitiveness Centre, 2021). The Digital City Index highlights Copenhagen, Amsterdam, Beijing, London and Seoul, when assessing the degree of digital connectivity, service accessibility, culture and sustainability (Economist Impact, 2022).

The commonalities found in the results of these rankings point that smart cities could be a synonym of happier cities, where the quality of life of citizens is a priority. Some evidence can include the increased citizen and community well-being, enhanced accessibility and efficiency of public services and guaranteed accessibility to technology.

6.1.2. Economic - Creating Economic Value

According to a study from ESI Thought Lab (2018), cities are allocating about 15 per cent of their operating budgets and 17 per cent of their capital budget to smart technology programs. By generating capital for further innovation, attracting businesses and talented individuals and fostering technological advancements, smart city investments have the potential to fuel cycles of economic growth.

On average, smart technologies can potentially increase Gross Domestic Product (GDP) per capita by 21 per cent and population growth by 13 per cent, in five years, in beginner cities. The ones with higher maturity levels can also achieve potential growth, although at a slower rate.

Furthermore, another research found evidence that the new urban economy positively impacts GDP, varying across different sectors (ABI Research, 2018). According to this study, economic development can be achieved through several vectors:

1. Open data platforms, which facilitate access to real-time data from relevant ecosystem stakeholders. These can translate into an incremental GDP close to 1 trillion dollars until 2026.

2. IoT investments, which materializes policy objectives such as economic welfare, employment and prosperity through technology adoption. These can provide a multiplier effect adding up to 10 trillion dollars in incremental GDP until 2026.
3. Structural Smart Urban Economy Growth, enabling disruptive economic paradigms, leading to GDP sustainable growth of 2.8 per cent, by 2026.

When considering the impact of smart technology investment from the perspective of cost savings, research metrics can include total savings for businesses, governments and the average cost savings per citizen (ABI Research, 2017). According to the study, increased cost savings are achieved through reducing the total ownership costs (TOC) by preferring as-a-service (aaS) solutions. This decreases capital expenditures (CAPEX) or setup costs such as infrastructure, in favour of operating expenditures (OPEX) or running costs such as employees or utilities. Moreover, monetizing existing assets, such as buildings or microgrids, can also represent an important cost-saving opportunity. These benefits can apply to efficiency in government operations, supply chain management for businesses and to family budget items.

6.1.3. Environmental - Contributing for Sustainability

The investment in scalable technological solutions can lead cities towards decarbonization and energy efficiency. According to the Stockholm Environmental Institute for the Coalition for Urban Transitions (2019), carbon emissions can be reduced by 90 per cent with the help of smart technologies applied to urban centres. Residential and commercial buildings have the most important role to play, being capable of cutting 60 per cent of total emissions, with transportation and waste management systems following on this ranking.

Moreover, smart and sustainable practices applied to city infrastructure provide relevant benefits. Smart buildings are large information providers, with the average commercial office building producing about 150 gigabytes of data each day (Deloitte, 2021). This represents an opportunity for policymakers to perform better in terms of city planning, also impacting the social and economic dimensions.

Furthermore, smart technologies are also capable of improving natural resources allocation, by increasing the efficiency of water and waste management systems. One example can include the monitorization of urban residues collection to improve cleaning routes and frequencies, increasing the amount of recycled waste.

Lastly, natural landscapes and species can be preserved through the usage of technology. By applying sensors and cameras which provide real-time data on the status of a natural ecosystem, field service teams can intervene immediately in cases of emergency such as fires or floods.

6.1.4. Scalability Potential – Becoming a Hyperconnected City

According to the study by ESI Thought Lab (2019), as cities become more hyperconnected, their ROI grows. The more interlinked their solutions, the greater scalability potential towards the national and regional contexts. The estimates provided by the cities in the study, average a global ROI of 5 per cent for hyperconnected cities, while beginners realize returns between 1.8 and 2.6 per cent.

One reason that hyperconnected cities report a higher ROI is that they incorporate social, economic and environmental benefits when assessing their investments. By contrast, less advanced cities tend to only consider economic benefits in their calculations.

Based on average ROI, the 141 billion dollars investment made by the 100 cities in the study sample can yield a return of 4.5 billion dollars. Globally, the 1.2 trillion dollars investment in smart technologies could generate a gain of 40 billion dollars, with this impact increasing to 60 billion dollars if all cities become hyperconnected.

6.1.5. Ensuring Governance – Building Trusting Relationships

Digital technologies are facing a crisis of citizen confidence. In 2020, trust in technology declined, reaching all-time lows, according to the Edelman Trust Barometer (2021). Trust in technology decreased an average of 14 per cent in countries such as China, Canada, the United States and the United Kingdom. As a result, several projects have been cancelled after concerns regarding the security and usage of personal data.

The benefits of the digital transformation will only be perceived correctly by stakeholders if a trusting relationship is built, valuing transparency and open communication channels. Ensuring good governance by setting up the right technical support structures, improving accessibility and avoiding widening the digital divide between cities will lead to better ecosystem engagement.

6.2. The Smart Return on Investment Framework

The Smart Return on Investment (SMROI) framework, represented in Table 5, was developed to promote structured thinking about the social, economic and environmental impacts of various initiatives and projects aimed at improving the liveability, competitiveness and sustainability of a city. There are 5 steps involved in measuring SMROI:

1. Collecting data on the expected inputs, activities and outputs of the project. This can include information on (1) resources and funding required, (2) the plan of action to be tested, implemented, or improved and (3) the desired outcomes and impacts of the project.
2. Determining the value of the outputs and impacts of the project in the three dimensions: social, economic, and environmental. This involves assigning a monetary value to the outputs and then discounting the values to account for the time-value of money.
3. Calculating the SEE/TI ratio. This indicator can be computed by dividing the value of (3) the expected outputs by (1) the total investment required to implement the project.
4. Making the business case. This requires interpreting the SEE/TI ratio and using it to inform investment decisions. Determining the expected overall effectiveness of the project can support resource allocation by policymakers.
5. Managing expectations of all stakeholders. It is important to guarantee they are included in the process of evaluation and that they understand that innovation requires iteration. Pivoting through solutions requires investment and might lead to failure, which should also be considered when evaluating SEE/TI results.

Notwithstanding the limitations of this type of analysis, this framework can provide useful insights into the social, economic and environmental impacts of a project and can be a useful tool for evaluating the effectiveness of smart city initiatives. It is extremely relevant to make this information clearly available to stakeholders when justifying investment decisions. The example on Appendix 1– Measuring Smart Return on Investment of an Energy Management System can provide an illustrative case of smart city project assessment.

It is also important to note that, despite the enormous potential of smart city projects, implementation remains a challenge, due to a lack of an integrated perspective which respects interoperability standards (OECD, 2022). Research points that one-third of deployments fail and nearly 80 per cent of prototypes have not been further developed.

Table 5 - Smart Return on Investment Framework. Source: Own Elaboration.

Inputs (1)	Activities (2)	Outputs (3)
1. Project Timeline The definition of measurable indicators and attainable objectives for the project. a. Goals and KPIs b. Milestones c. Change management **2. Resources** The assets needed for the project which should be defined in advance. a. CAPEX i. Infrastructure ii. Technology i. Software ii.Hardware b. OPEX i. Human Capital ii. Rent and utilities iii. Supplies and materials iv. Other running costs **3. Funding** The financing options which should be considered for the project, if available.	**1. Ecosystem Engagement** The stakeholders who influence/are influenced by the technological adoption. a. Users i. Citizens ii. Visitors b. Private Sector i. Service providers ii. Technology vendors c. Government d. Non-Governmental Organisations (NGOs) e. Academia f. Subject Matter Experts (SMEs) **2. Product and Service Delivery** The smart city domains* which can beneficiate from technology development. a. Mobility b. Safety & Security	**1. Social - Enhancing the Quality of Life** The measurement of the impact on the happiness levels of citizens and visitors. a. Increased citizen and community well-being i. Health complications and anxiety ii. Death, crime and accident rates iii. Inclusivity indexes and program participation iv. Cultural diversity of the citizens b. Increased accessibility and efficiency of public services i. Waiting and delivery times and unnecessary interactions ii. Emergency response rates iii. Net Promoter Score (NPS) for convenience and customer satisfaction iv. Average distance to key infrastructure as education, health, transportation, housing c. Increased access to technology i. Public wi-fi users and access points ii. Digital literacy indexes and program participation iii. E-government and information portals users **2. Economic - Creating Economic Value** The assessment of the impacts on GDP, employment and competitiveness of a city.

a. Public and Private Partnerships i. Joint venture ii. Concession agreement iii. Build-operate-transfer model b. Government Funding i. Regional funding ii. National funding c. Private Investment d. Own Budget i. Taxes ii. Fines iii. Assets iv. Consumption-based finance & user fees **4. Regulatory Framework** The legal environment where the project is to be implemented. **5. Interoperability Standards** The technical requirements that guarantee technology intercommunication and vendor-agnostic solutions.	c. Energy & Environment d. Government & Education e. Health & Well-Being f. Economy *smart city vertical domains instituted by ISO 37120 (2018): norm for "Sustainable development of communities" by the World Council on City Data. **<u>Horizontal Services:</u>** Interconnectivity and integration of data services which enable better responses to challenges. **3. Project Iterations** The project development phases which are sequential. a. Piloting b. Deployment c. Implementation d. Evaluation & Improvement	a. Increased businesses and technological development i. Number of new startups and scaleups ii. Number of new global companies & research centres with presence in the city iii. Number of programs promoted by innovation ecosystem enablers and participation b. Increased employment rates c. Increased investment i. Venture Capital (VC) and Private Equity (PE) investment rounds volume ii. Private investment in R&D d. Increased international travels and tourism e. Reduced shadow economy i. Number of transactions registered through improved payment systems f. Increased cost savings i. Efficiency in government operations: average service delivery time, number of manual operations eliminated from workflow ii. Total Ownership Costs (TOC) for businesses in terms of CAPEX and OPEX iii. Average spending amounts in family budget items **3. Environmental - Contributing for Sustainability** The evaluation of impacts on the environmental domains of the city.

		a. Reduced greenhouse gas (GHG) emissions i. Public transportation and soft modes of mobility users ii. Conscious construction and materials usage iii. Traffic congestion rates iv. Air quality indexes b. Improved energy efficiency i. Renewable sources production and usage rates ii. Energy consumption and prices c. Improved water and waste management systems i. Service disruption rate ii. Recycled waste amounts iii. Average time of urban cleaning routes d. Improved green areas and preserved natural landscapes i. People flow indexes ii. Fauna and flora conservation interventions **4. Scalability Potential - Becoming a Hyperconnected City** The assessment of the capacity to replicate the solution in broader contexts. a. Scalable at City or Neighbourhood level b. Scalable at Country level c. Scalable at Region level
Ensuring Governance - Building Trusting Relationships Transparency when designing and implementing public policies to guarantee a solid relationship based on trust, with stakeholders. This will increase the overall city reputation and citizen engagement.		

7. The Exacerbation of Inequalities

Inequity, social vulnerability and power distance get aggravated as consequences of adaptation interventions to climate change. According to Atteridge and Remling (2017) and Eriksen et al. (2021), these endeavours lead to the global re-distribution of risks or vulnerabilities to communities that are already marginalized and vulnerable.

In what concerns smart city investment, the exacerbation of inequalities materializes at two different levels (ABI Research, 2018):

1. Within Cities: several large cities have marginalized areas often excluded from accessing technology. It is important to note that financing new technologies and business models which impact a greater number of people can provide better returns than expanding current services and products.
2. Between Cities: governmental measures, such as tax incentives, aimed at increasing competition between cities and attracting businesses can create imbalances in city growth within national contexts. This especially impacts smaller cities which are often disadvantaged due to limited financial resources and a lack of in-house expertise.

Furthermore, a study by McKinsey (2018) analysed 50 cities around the world and concluded that although wealthier cities are growing smart faster, many have reduced public awareness and low usage of the technology they have implemented. Cities in Europe, North America, China and East Asia lead the digital transformation race, while those in Latin America, Africa and India fall behind.

Nevertheless, it is important to note that technology represents a mere tool to address the needs and desires of citizens. Developed cities like New York, London or Tokyo might beneficiate from high impacts on income, greenhouse gas (GHG) emissions per capita or formal employment rates. On the other hand, developing cities such as Lagos or Johannesburg might target death rates, the overall disease burden per capita or the average commute time (McKinsey, 2018).

Therefore, the impact assessment exercise must be adapted to the diverse city contexts and always reflect inclusivity goals since the benefits of smart systems multiply as more people use them.

7.1. The Smart Return on Investment Matrix

The Smart Return on Investment Framework (Table 5) can help policymakers, businesses and other organisations assess the impact of smart city projects. When performing investment decisions, they need to evaluate the expected SEE impact, against the required TI. The SMROI matrix, in Figure 1, can provide a useful benchmark to compare the relative SEE/TI ratios from different projects. For example, it can guide the assessment of returns from installing new electric vehicle charging stations or from implementing new weather stations. In any case, it is important to note that the final projections are expected to represent a lower-bound estimate of the potential returns, given the difficulty in assessing non-financial benefits.

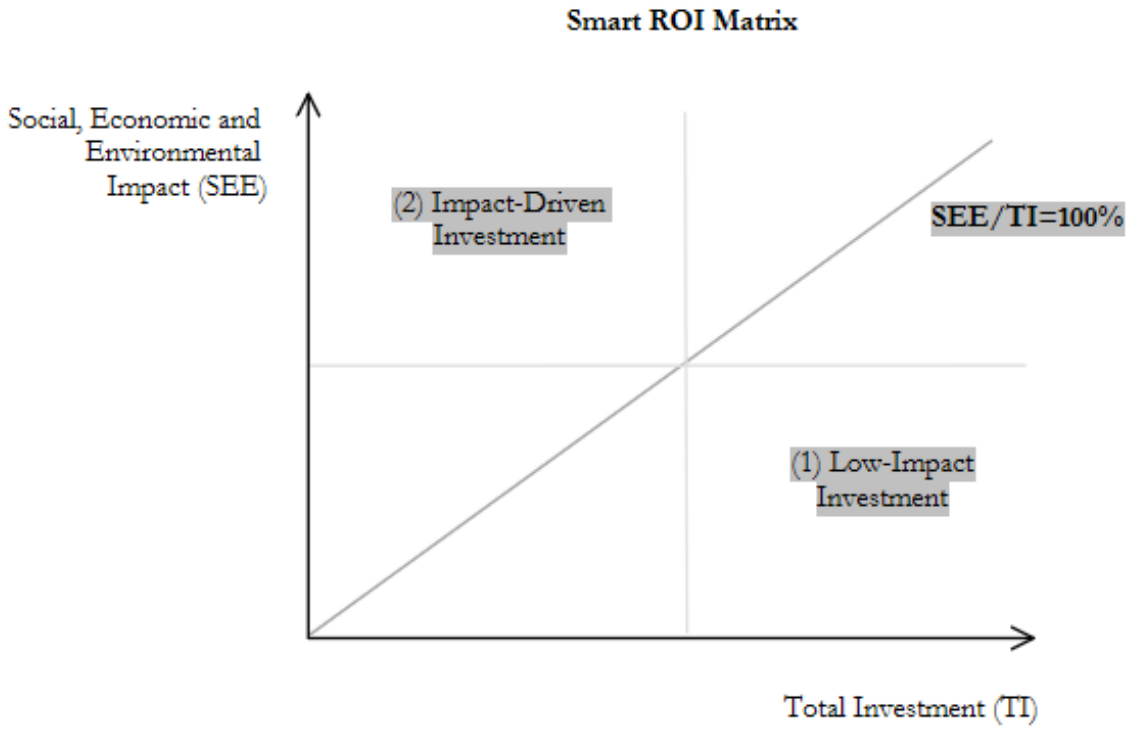

Figure 1 - Smart Return on Investment Matrix. Source: Own Elaboration.

According to the matrix, when directly comparing expected impact against the total investment required, one should consider the efficiency frontier as the line where the SEE/TI ratio is equal to 100 per cent. From this analysis, one can arrive at two scenarios:

(1) **Low-Impact Investment:** describes a project where the expected impact is always lower than the investment required. These initiatives provide a SEE/TI ratio lower than 100 per cent.

(2) **Impact-Driven Investment:** refers to projects which require lower amounts of investment when compared to the overall projected impact. Therefore, the SEE/TI ratio attained is greater than 100 per cent.

Therefore, smart return on investment (SMROI) is attained when the investment efficiency is maximized, with low investment when compared to the benefits expected, achieving a SEE/TI ratio greater than 100 per cent.

Decision-makers should cluster projects when performing a relative analysis to guarantee that they compare the same levels of investment and impact, rather than pursuing trade-offs where return seems the greatest in absolute terms. For example, for the same level of impact, an investor would always prefer projects which require a lower level of investment, but deploying new and innovative technological solutions can require greater amounts of capital, when compared to the ones already existing in the market. In contrast, an investor will always prefer projects which provide greater impact in terms of number of users, for the same level of investment, however, this could contribute for the exacerbation of inequalities and marginalisation by discarding minority groups.

In conclusion, cities should pursue projects which provide a SEE/TI ratio greater than 100 per cent, making sure that decisions are made in the presence of a representative group of stakeholders. Any player in the ecosystem with an interest in the project should be considered and expectations must be managed.

8. Conclusion

Evaluating the impact of smart city projects from a return-on-investment perspective is crucial for assessing the long-term success and sustainability of these projects. Traditional Cost-Benefits analysis bears some limitations, not fully capturing the broader social, economic and environmental impacts that smart city projects can have on communities.

To measure the extra-financial impact of smart city projects, it is important to use a combination of quantitative and qualitative metrics that consider factors such as improved quality of life of citizens, economic development and enhanced environmental sustainability. This requires a comprehensive and collaborative approach that involves stakeholders from across the ecosystem, including government, businesses, academia, NGOs and, most importantly, the citizens.

Following a holistic approach of assessment, practitioners can make more informed investment decisions and allocate resources in a way that maximizes the benefits for all stakeholders. Moreover, it enables them to demonstrate the value of smart city projects to the public and garner support for future initiatives.

Nevertheless, the distribution of benefits is a critical consideration in the development of smart cities. While these projects have the potential to bring about significant benefits to communities, it is important to ensure that the benefits are distributed equitably across different segments of society. This requires a concerted effort to address issues such as the digital divide, access to key infrastructure and services or inclusivity.

In conclusion, measuring the impact of smart city projects is critical for ensuring efficient resource allocation, in alignment with public policy strategy. Considering a wide range of factors, decision-makers can make informed investment decisions and help create more liveable, resilient, and prosperous communities. However, it is important to ensure that these projects are designed and implemented in a way that promotes equitable distribution of benefits, actively contributing for the attainment of the United Nation's Sustainable Development Goals.

9. Appendices

Appendix 1– Measuring Smart Return on Investment of an Energy Management System

Considering a fictional case of implementation of a Smart Energy Management System in a public building. How can practitioners assess the return on investment of the project?

[Assessing Inputs: Total Investment required]

First, practitioners should collect data on the required inputs for the project. Considering the most relevant Key Performance Indicators (KPIs) and milestones can help to identify change management activities and to place them in the overall project timeline.

Moreover, it is crucial to estimate the overall funding required to support the costs of the project, in terms of capital (CAPEX) and operating expenditures (OPEX). This can be done by conducting market research, historical data analysis and expert consultancy. The CAPEX can include hardware, such as smart devices, sensors and control systems and software, such as the platform and applications for monitoring, analyzing and controlling energy consumption. The expenses related to the installation, configuration and integration of these components into the existing energy infrastructure should also be considered. Additionally, as is typical in smart city projects, the supporting network and data storage infrastructure also represent relevant cost structures. The OPEX can comprehend costs of employing or outsourcing human capital responsible for managing and operating the system, the tools to analyze energy consumption patterns, identify potential areas for optimization and track overall performance as well as the communication services, such as connectivity and internet access.

These costs, if not fulfilled by own budget, can be supported by several funding mechanisms, such as Public and Private Partnerships (PPPs), national or regional government funding or private investment. Regardless of the source, it is important to guarantee an efficient allocation of resources.

Lastly, it is relevant to consider regulatory implications and interoperability standards, to ensure the future scalability of the project. In this case, ensuring the application of determinant national rules and international standards can help scale the Smart Energy Management System to other buildings in the city and further deployment at the national and regional levels.

[Describing Activities]

The project in analysis addresses the Energy & Environment vertical, directly impacting the building users and occupants as well as building owners and facility managers. Nevertheless, it is also important to engage with other relevant stakeholders in the ecosystem to provide a more comprehensive and inclusive assessment of the project. Involving the private sector, namely energy companies or technology providers, the governmental agencies and regulatory bodies, the community and Non-Governmental Organizations (NGOs), the research and academic institutions and environmental and sustainability experts can bring important insights and perspectives to discussion. Note that it is crucial to manage the expectations of all these stakeholders, guaranteeing they understand that innovation requires iteration. The project can start as a pilot, to test the solution on a controlled environment before proceeding to full deployment and implementation. Taking the example, the Smart Energy Management System can be applied to one building floor and then scaled to the rest of the building. Stakeholders should be aware that pivoting through the solution requires investment and might lead to failure.

[Assessing Outputs: Social, Economic and Environmental benefits]

Regarding social, economic and environmental benefits, it is important to note that the accuracy of monetized values depends largely on the available research, data and knowledge of the experts involved in the process.

Social benefits can include improved indoor comfort for building occupants and a healthier environment. This can translate into reduced health complications and anxiety. By determining the average number of sick leave days taken by occupants before and after the project implementation and then multiplying the reduced sick days by the average daily salary can provide an estimate of cost savings. Moreover, determining the increased productivity resulting from improved indoor comfort, considering factors such as improved focus, reduced errors and increased output can be quantified by multiplying the increased productivity by the average salaries. Lastly, there is a potential reduction in healthcare costs associated with enhanced indoor air quality. This can include factors such as reduced respiratory illnesses, allergies or other health conditions. The estimate of the cost savings can entail the average healthcare expenses per individual or specific treatments avoided.

Economic benefits can entail cost savings from optimizing energy consumption and reducing waste, leading to the reduction energy bills for public buildings. Additionally, there can

be observed impacts on job creation, derived from the demand for skilled professionals in system installation, maintenance and data analysis. Moreover, local businesses can increase sales because of increased demand for energy-efficient technologies and services.

Finally, estimating environmental benefits can comprehend the reduction in GHG emissions, deriving from the better monitoring and control of energy consumption. Moreover, the increased renewable energy integration, such as solar panels, into the city's power grid can result in a decreased reliance on fossil fuels and promote a cleaner energy mix. These benefits can be monetized following a market-based pricing approach. This includes assessing the carbon and renewable energy certificate markets, which assign a monetary value to the reduction of GHG or the usage of renewable energy. Estimating the market price of carbon credits or renewable energy certificates can help monetize this value.

[Calculating the SEE/TI Ratio]

Finally, to compute the SEE/TI ratio, it is important to ensure that benefits are discounted to the present value, using an appropriate discount rate and time horizon, as presented in Figure 2. By dividing the value of (9) the present value of benefits by (1) the total investment required to implement the project, the ratio will provide a value greater or inferior to 100 per cent. The final step includes making the business case, comparing the expected outcomes of the project and the overall investment required and incorporating that information into the decision-making process.

TI Required	**(1) = (2) + (3)**	**SEE Benefits**	**(3)= (4) + (5) + (6)**
CAPEX	**(2)**	**Social Benefits**	**(4)**
Hardware		Reduced Sick Leaves	
Software		Increased Productivity	
Installation, Configuration & Integration		Reduced Healthcare Costs	
Supporting Network Infrastructure		**Economic Benefits**	**(5)**
OPEX	**(3)**	Reduced Energy Bills	
Human Capital		Job creation	
Analytical Tools		Increased Sales of Local Businesses	
Communication Services		**Environmental Benefits**	**(6)**
		Reduced GHG Emissions	
		Increased Renewable Energy	

Discount rate	**(7)**	**Present Value of Benefits**	**(9) = (3) / (1 + (7)) ^ (8)**
Time horizon	**(8)**	**Total Investment**	**(1)**
SEE/TI Ratio			**(9)/(1)**

Figure 2 - Calculating the SEE/TI Ratio for a Smart Energy Management System. Source: Own Elaboration.

10. Bibliography

ABI Research (2017). Smart Cities, IoT and Cost Savings. Available at https://www.abiresearch.com/market-research/insight/1029089-smart-cities-iot-and-cost-savings/

ABI Research. (2018). The role of Smart Cities in Economic Development. Available at https://www.caba.org/wp-content/uploads/2020/04/IS-2018-215.pdf

Addy, C., Chorengel, M., Collins, M., & Etzel, M. (2019). Calculating the Value of Impact Investing. *Harvard Business Review,* Retrieved November 12, 2022, from http://hbr.org/2019/01/calculating-the-value-of-impact-investing

Agrawal, A., & Hockerts, K. (2021). Impact investing: Review and research agenda. *Journal of Small Business and Entrepreneurship*, 33, 153–181. https://doi.org/10.1080/08276331.2018.1551457

Aich, S., Thakur, A., Nanda, D., Tripathy, S., & Kim, H. (2021). Factors affecting ESG towards impact on investment: A structural approach. *Sustainability*, 13(19). https://doi.org/10.3390/su131910868

Alareeni, B., & Hamdan, A. (2020). ESG Impact on Performance of US S&P 500-Listed Firms. *Corporate Governance: The International Journal of Business in Society*, vol. 20, no. 7, 26, pp. 1409–1428, https://doi.org/10.1108/cg-06-2020-0258

Aly, H. (2022). Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing? *Review of Economics and Political Science*, Vol. 7 No. 4, pp. 238-256. https://doi.org/10.1108/REPS-11-2019-0145

Arvidsson, S., & Dumay, J. (2021). Corporate ESG Reporting Quantity, Quality and Performance: Where to Now for Environmental Policy and Practice? *Business Strategy and the Environment*, vol. 31, no. 3, 24, https://doi.org/10.1002/bse.2937

Atteridge, A., & Remling, E. (2017). Is adaptation reducing vulnerability or redistributing it? Wiley Interdisciplinary Reviews: Climate Change, 9(1), e500. https://doi.org/10.1002/wcc.500

Banga, J. (2018). The Green Bond Market: A Potential Source of Climate Finance for Developing Countries. *Journal of Sustainable Finance & Investment*, vol. 9, no. 1, pp. 17–32, https://doi.org/10.1080/20430795.2018.1498617

Blasi, S., Ganzaroli, A., & De Noni, I. (2022). Smartening sustainable development in cities: strengthening the theoretical linkage between smart cities and SDGs. *Sustainable Cities and Society*. https://doi.org/10.1016/j.scs.2022.103793

Brown, S. (2020). Why ESG is here to stay. *McKinsey & Company*. Retrieved November 6, 2022, from https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/why-esg-is-here-to-stay

Buallay, A., El Khoury, R., & Hamdan, A. (2021). Sustainability Reporting in Smart Cities: A Multidimensional Performance Measures. *Cities*. https://doi.org/10.1016/j.cities.2021.103397

Busch, T., Bruce-Clark, P., Derwall, J., Eccles, R., Hebb, T., Hoepner, A., Klein, C., Krueger, P., Paetzold, F., Scholtens, B., & Weber, O. (2021). Impact investments: a call for (re)orientation. *SN Business & Economics*, 1(2). https://doi.org/10.1007/s43546-020-00033-6

Capelle-Blancard, G. & Monjon, S. (2012). Trends in the Literature on Socially Responsible Investment: Looking for the Keys under the Lamppost. *Business Ethics: A European Review*, vol. 21, no. 3, June 2012, pp. 239–250, https://doi.org/10.1111/j.1467-8608.2012.01658.x

Casalini, F., & Vecchi, V. (2022). Making Impact Investing More Than Just Well-Meaning Capital. *Business & Society*. https://doi.org/10.1177/00076503221112864

Cornell, B. (2020). ESG Investing: Conceptual Issues. *The Journal of Wealth Management*, 23(3), 61–69. https://doi.org/10.3905/jwm.2020.1.117

Deloitte (2021). Urban Future with a Purpose Study. Available at https://www.deloitte.com/content/dam/assets-shared/legacy/docs/perspectives/2022/deloitte-urban-future-with-a-purpose-study-set2021.pdf

Economist Impact (2022). The Digital Cities Index. Available at: https://impact.economist.com/projects/digital-cities/

Economist Intelligence Unit (2022). The Liveability Index Report. Available at: https://www.eiu.com/n/campaigns/global-liveability-index-2022/

Edelman Trust Barometer (2021). Tech Sector Report. Available at https://www.edelman.com/sites/g/files/aatuss191/files/2021-03/2021%20Edelman%20Trust%20Barometer%20Tech%20Sector%20Report_0.pdf

Elkington, J. (1994) Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. *California Management Review*, 36, 90-100. https://doi.org/10.2307/41165746

Elkington, J. (2018). 25 years ago I coined the phrase "triple bottom line." Here's why it's time to rethink it. *Harvard Business Review*, 25, 2-5. Available at https://hbr.org/2018/06/25-years-ago-i-coined-the-phrase-triple-bottom-line-heres-why-im-giving-up-on-it

Emerson, J., & Twersky, F. (1996) New Social Entrepreneurs: The Success, Challenge, and Lessons of Non-Profit Enterprise Creation. *The Roberts Foundation, San Francisco.* Available at https://redfworkshop.org/wp-content/uploads/2017/03/New-Social-Entrepreneurs-Intro.pdf

Eriksen, S., Schipper, F., Scoville-Simonds, M., Vincent, K., Adam, N., Brooks, N., Harding, B., Khatri, D., Lenaerts, L., Liverman, D., Mills-Novoa, M., Mosberg, M., Movik, S.,

Muok, B., Nightingale, A., Ojha, H., Sygna, L., Taylor, M., Vogel, C., & West, J. (2021). Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance*? World Development*, 141. https://doi.org/10.1016/j.worlddev.2020.105383

Escrig-Olmedo, E., Férnandez-Izquierdo, M., Ferrero-Ferrero, I., Rivera-Lirio, J. & Muñoz-Torres, M. (2019). Rating the Raters: Evaluating How ESG Rating Agencies Integrate Sustainability Principles. *Sustainability*, vol. 11, no. 3, p. 915. https://doi.org/10.3390/su11030915

ESI ThoughtLab (2018). Smarter Cities 2025 – Building a Sustainable Business and Financing Plan Whitepaper. Available at https://thoughtlabgroup.com/smarter-cities-2025/

ESI ThoughtLab (2019). Building Hyperconnected Cities Available at https://www.re-cities.org/_files/ugd/71fc8b_df8afb7346d6449697b9d33e5085ab64.pdf

ESI ThoughtLab (2019). Smart City Solutions for a Riskier World. Available at https://econsultsolutions.com/smart-city-solutions-for-a-riskier-world-2/

European Commission (2014). Guide to Cost-Benefit Analysis of Investment projects, Economic appraisal tool for Cohesion policy 2014-2020. *Regional and Urban Policy*. Available at https://poseur.portugal2020.pt/media/40474/guide-to-cost-benefit-analysis-of-investment-projects.pdf

European Commission (2023). New European Bauhaus Progress Report. *European Commission.* Retrieved January 17, 2023, from https://new-european-bauhaus.europa.eu/system/files/2023-01/CP-003%20-%20Report%20from%20the%20Commission%20%28EN%29%20Part%201.pdf

European Investment Bank. (2021). Digitalization in Europe 2020-2021: Evidence from the EIB Investment Survey. *European Investment Bank*. Available at https://www.eib.org/en/publications/digitalisation-in-europe-2020-2021

Falck, O., & Heblich, S. (2007). Corporate social responsibility: Doing well by doing good. *Business Horizons*, 50(3), 247–254. https://doi.org/10.1016/j.bushor.2006.12.002

Farinha, J. (2003) Corporate Governance: A Survey of the Literature. *Universidade do Porto Economia*. Discussion Paper No. 2003-06, http://dx.doi.org/10.2139/ssrn.470801

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment,* 5(4), 210–233. https://doi.org/10.1080/20430795.2015.1118917

Gabor, D. (2019). Securitization for Sustainability - Does It Help Achieve the Sustainable Development Goals? *Heinrich Böll Stiftung North America*. Retrieved January 19, 2023, from https://us.boell.org/sites/default/files/gabor_finalized.pdf

Gillan, S., Koch, A., & Starks, L. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 66, 101889. https://doi.org/10.1016/j.jcorpfin.2021.101889

Gouldson, A., Sudmant, A., Khreis, H., & Papargyropoulou, E. (2018). The Economic and Social-Benefits of Low-Carbon Cities: A Systematic Review of the Evidence. *Coalition for Urban Transitions, London*. Available at https://ledsgp.org/app/uploads/2018/06/The-Economic-and-Social-Benefits-of-Low-Carbon-Cities-A-systematic-review-of-the-evidence.pdf

Government & Accountability Institute (2021). Sustainability Reporting In Focus. *Government and Accountability Institute. Retrieved* October 9, 2022, from https://www.ga-institute.com/2021-sustainability-reporting-in-focus.html

Greenfield, A. (2013). Against the Smart City: A Pamphlet. This is Part I of "The City is Here to Use". *Do Projects*. Available at https://www.worldcat.org/pt/title/935510282

Halbritter, G., & Dorfleitner, G. (2015). The wages of social responsibility — where are they? A critical review of ESG investing. *Review of Financial Economics*, 26(1), 25–35. https://doi.org/10.1016/j.rfe.2015.03.004

Harberger, A. Jenkins, G. & Kuo, C. (2007). Cost-benefit analysis of investment decisions. Boston, Harvard Institute for International Development. Available at: https://www.researchgate.net/profile/Arnold-Harberger/publication/242736382_COST-BENEFIT_ANALYSIS_FOR_INVESTMENT_DECISIONS/links/5443db460cf2a6a049ab0487/COST-BENEFIT-ANALYSIS-FOR-INVESTMENT-DECISIONS.pdf

Helliwell, J. F., Layard, R., Sachs, J. D., De Neve, J.-E., Aknin, L. B., & Wang, S. (2022). World Happiness Report 2022. New York: Sustainable Development Solutions Network. Available at https://worldhappiness.report/ed/2022/

Hoͤchstädter, A., & Scheck, B. (2015). What's in a name: An analysis of impact investing understandings by academics and practitioners. *Journal of Business Ethics*, 132, 449–475. https://doi.org/10.1007/s10551-014-2327-0

Huang, D. (2021). Environmental, social and governance (ESG) activity and firm performance: a review and consolidation. *Accounting & Finance*, 61(1). https://doi.org/10.1111/acfi.12569

Hvidkjær, S. (2017). ESG investing: a literature review. *Report prepared for Dansif*. Available at https://dansif.dk/wp-content/uploads/2019/01/Litterature-review-UK-Sep-2017.pdf

IMD & The World Competitiveness Center (2023). The Smart City Index Report. Available at https://www.imd.org/wp-content/uploads/2023/04/smartcityindex-2023-v7.pdf

Institutional Shareholders Service. (2023). Actionable Insights: Top ESG Themes in 2023. *ISS*. Retrieved January 31, 2023, from https://www.issgovernance.com/esg/actionable-insights-top-esg-themes-in-2023/

International Data Corporation. (2019). Worldwide Semiannual Smart Cities Spending Guide. *IDC*. Retrieved January 18, 2023, from http://www.g20ys.org/upload/auto/b203c99bf4e726ef44d9e4330c8db08caf29e2b2.pdf

International Standards Organization. (2018). Sustainable cities and communities — Indicators for city services and quality of life Available at: ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life

Khagram S. (2020). Global Climate Restoration for People, Prosperity and Planet: $Trillions in Market Opportunities and Economic, Social, Environmental Benefits. *Thunderbird School of Global Management.* Available at https://www.carbonremovalpartnership.net/sites/thunderbird-micro/files/thunderbird-micro/home-page/new-investments-and-research-indicate-multi-trillion-dollar-market-for-climate-restoration-through-carbon-capture.pdf

Kim, J. (2017). A letter from Jim Yong Kim, World Bank Group President. *World Bank*. Available at https://www.ifc.org/wps/wcm/connect/CORP_EXT_Content/IFC_External_Corporate_Site/Annual+Report+2017/2017-Online-Report/Leadership-Perspectives/

Li, T., Wang, K., Sueyoshi, T., & Wang, D. (2021). ESG: Research Progress and Future Prospects. *Sustainability*, 13(21), 11663. https://doi.org/10.3390/su132111663

Loonam, J., Eaves, S., Kumar, V. & Parry, G. (2018). Towards Digital Transformation: Lessons Learned from Traditional Organizations. *Strategic Change*, vol. 27, no. 2, pp. 101–109, https://doi.org/10.1002/jsc.2185

Manda, M. & Dhaou, S. (2019). Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance.* https://doi.org/10.1145/3326365.3326398

McKinsey (2018). Smart Cities: Digital Solutions for a More Livable Future Full Report. Available at https://www.mckinsey.com/~/media/McKinsey/Industries/Public%20and%20Social%20Sector/Our%20Insights/Smart%20cities%20Digital%20solutions%20for%20a%20more%20livable%20future/MGI-Smart-Cities-Executive-summary.pdf

McKinsey (2019). Unlocking the Full Potential of City Revenues. Available at https://www.mckinsey.com/industries/public-and-social-sector/our-insights/unlocking-the-full-potential-of-city-revenues

Merritt, J. (2020). Interview with Jeff Merritt, Head of IoT and Urban Transformation, World Economic Forum (M. Antunes, Interviewer) [Review of Interview with Jeff Merritt, Head of IoT and Urban Transformation, World Economic Forum]. In *Deloitte - Urban Future with a Purpose Series.* Available at https://www.deloitte.com/global/en/Industries/government-public/perspectives/urban-future-with-a-purpose.html

Millar, R. & Hall K. (2013). Social Return on Investment (SROI) and Performance Measurement. *Public Management Review*, vol. 15, no. 6, pp. 923–941, https://doi.org/10.1080/14719037.2012.698857

Nicholls, J. (2017). Social Return on Investment—Development and Convergence. *Evaluation and Program Planning*, 64, 127–135. https://doi.org/10.1016/j.evalprogplan.2016.11.011

Nicholls, J., Lawlor, E., Neitzer, E., & Goodspeed, T. (2012). A guide to Social Return on Investment. *Social Value UK.* Available at https://socialvalueuk.org/wp-content/uploads/2016/03/The%20Guide%20to%20Social%20Return%20on%20Investment%202015.pdf

Organisation for Economic Cooperation and Development. (2016). A quantitative framework for analysing potential bond contributions in a low-carbon transition. *OECD Publishing*. Available at https://www.oecd.org/cgfi/quantitative-framework-bond-contributions-in-a-low-carbon-transition.pdf

Organisation for Economic Cooperation and Development (2021). Measuring smart city performance in COVID-19 times: Lessons from Korea and OECD countries: Proceedings from the 2nd OECD Roundtable on Smart Cities and Inclusive Growth, OECD Regional Development Papers, No. 19, *OECD Publishing*, Paris, https://doi.org/10.1787/72a4e7db-en

Organisation for Economic Cooperation and Development - Work on Cities (2022). Building a Trusting Relationship with Citizens. Available at https://www.oecd.org/cfe/cities/

Pathak, P. & Dattani, P. (2014). Social Return on Investment: Three Technical Challenges. *Social Enterprise Journal*, vol. 10, no. 2, 4 Aug. 2014, pp. 91–104. https://doi.org/10.1108/sej-06-2012-0019

Porter, M., & Kramer, M. (2011). Creating shared value. *Harvard Business Review*, 89(1/2), 62-77. Retrieved from https://hbr.org/2011/01/the-big-idea-creating-shared-value

Renneboog, L., Ter Horst, J., & Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking & Finance*, 32(9), 1723–1742. https://doi.org/10.1016/j.jbankfin.2007.12.039

Research and Markets. (2022). Global Smart Cities Market by Focus Area - Forecast to 2027. *Markets and Markets*. Retrieved January 17, 2023, from https://www.researchandmarkets.com/reports/5146372/global-smart-cities-market-by-focus-area-smart#src-pos-1

Rey, H. (2015). Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. *National Bureau of Economic Research*. Available at https://www.nber.org/papers/w21162

Rotheroe, N., & Richards, A. (2007). Social Return on Investment and Social Enterprise: Transparent Accountability for Sustainable Development. *Social Enterprise Journal*. https://doi.org/10.1108/17508610780000720

Roundy, P., Holzhauer, H., & Dai, Y. (2017). Finance or philanthropy? Exploring the motivations and criteria of impact investors. *Social Responsibility Journal*, 13, 491–512. https://doi.org/10.1108/SRJ-08-2016-0135

Sassen, R., Hinze, A. & Hardeck, I. (2016). Impact of ESG Factors on Firm Risk in Europe. *Journal of Business Economics*, vol. 86, no. 8, pp. 867–904, https://doi.org/10.1007/s11573-016-0819-3

Sharif, M. (2020). Interview with Maimunah Mohd Sharif, Executive Director, UN-Habitat (M. Antunes, Interviewer) [Review of Interview with Maimunah Mohd Sharif, Executive Director, UN-Habitat]. In *Deloitte - Urban Future with a Purpose Series*. Available at https://www.deloitte.com/global/en/Industries/government-public/perspectives/urban-future-with-a-purpose.html

Sharpe, W. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19(3), 425–442. https://doi.org/10.1111/j.1540-6261.1964.tb02865.x

Singhania, M., & Saini, N. (2021). Quantification of ESG Regulations: A Cross-Country Benchmarking Analysis. *Vision: The Journal of Business Perspective*, https://doi.org/10.1177/09722629211054173

Statman, M., & Glushkov, D. (2009). The Wages of Social Responsibility. *Financial Analysts Journal*, 65(4), 33–46. https://doi.org/10.2469/faj.v65.n4.5

Stern, N. (2018) Implementing the SDGs in a Changing World: Localization, Inclusiveness, and Investing for Impact. *Speech at the World Bank Bali International Convention Centre.* Available at https://live.worldbank.org/implenting-SDGs-changing-world?CID=ECR_TT_worldbank_EN_EXT_AM2018-sdgs

Stockholm Environmental Institute for the Coalition for Urban Transitions (2019). Climate Emergency and Urban Opportunity. Available at https://urbantransitions.global/wp-content/uploads/2019/09/Climate-Emergency-Urban-Opportunity-report.pdf

Tewathia, N., Kamath, A., & Ilavarasan, P. V. (2020). Social inequalities, fundamental inequities, and recurring of the digital divide: Insights from India. *Technology in Society*, 61, 101251. https://doi.org/10.1016/j.techsoc.2020.101251

Turečková K & Nevima J. (2020). The Cost Benefit Analysis for the Concept of a Smart City: How to Measure the Efficiency of Smart Solutions? *Sustainability*. 12(7):2663. https://doi.org/10.3390/su12072663

United Nations Task Force on Financing for Development (2022). Financing for Sustainable Development Report 2022. *United Nations*. Retrieved January 19, 2022, from https://financing.desa.un.org/about/about-financing-sustainable-development-office

United Nations. (2015). Transforming Our World: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs. *United Nations*. https://sdgs.un.org/2030agenda

Vuppuluri, P. (2020). Council Post: Investing in Innovation: The Rise of the Smart City. *Forbes*. Retrieved January 19, 2023, from www.forbes.com/sites/forbesfinancecouncil/2020/12/03/investing-in-innovation-the-rise-of-the-smart-city/?sh=6d84652a5ba6

Wahba, S. (2020). Interview with Sameh Wahba, Global Director, Urban, Disaster Risk Management, Resilience and Land Global Practice, World Bank (M. Antunes, Interviewer) [Review of Interview with Sameh Wahba, Global Director, Urban, Disaster Risk Management, Resilience and Land Global Practice, World Bank]. In *Deloitte - Urban Future with a Purpose Series*. Available at https://www.deloitte.com/global/en/Industries/government-public/perspectives/urban-future-with-a-purpose.html

World Bank. (2017). Maximizing Finance for Development: Leveraging the private sector for growth and sustainable development. *World Bank, Washington, DC*. Available at https://www.worldbank.org/en/news/video/2018/04/10/maximizing-finance-for-development

World Bank (2022). The Social Progress Index. Available at 2022 Social Progress Index Executive Summary_4.pdf

Yates, B., & Marra, M. (2017). Social Return on Investment (SROI): Problems, solutions… and is SROI a good investment? *Evaluation and Program Planning*, 64, 136–144. https://doi.org/10.1016/j.evalprogplan.2016.11.009

Zamchick (2018). Cartoon of the Smart City Talk. *Interacting with Technology Lab*. Retrieved November 6, 2022, from https://toch.tau.ac.il/cartoon-of-the-smart-city-talk/

Annexes

Annex 1 – Cartoon Inspiration

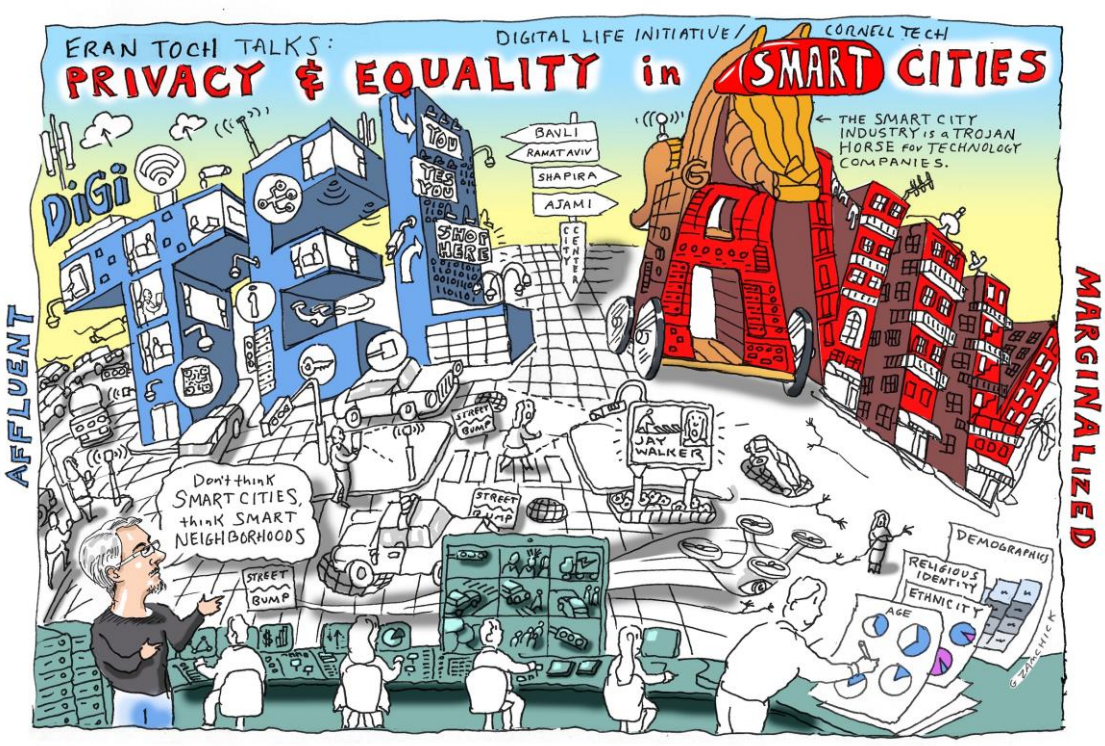

Figure 3 - Privacy & Equality in Smart Cities. Source: Zamchick (2018). Available at: https://toch.tau.ac.il/cartoon-of-the-smart-city-talk/

Annex 2 – Interview Guidelines

[Context]

1. Please describe your background and experience in the context of smart city projects.
2. Can you provide an example of a specific project you were involved in and how technology was used to improve the quality of life for citizens or the overall environmental sustainability?

[Impact Assessment]

3. Is it a common practice for your organization to perform a return-on-investment analysis before deciding to implement a new project? Please explain why.
4. Do you consider relevant to include environmental, social and governance (ESG) dimensions when assessing return on investment? Please explain why.
5. Which metrics and benchmarks do you consider adequate for quantifying extra-financial (ESG) return? Please provide some examples.
6. Do you consider relevant to involve the citizen when assessing the impact of a specific project? Please explain why.
7. In your opinion, what are the main challenges of performing this type of evaluation? Please explain why.

[Smart City Investment and Social Inequalities]

8. How can you ensure that the technology used in smart city projects is accessible and inclusive for all citizens? E.g. people with disabilities or limited access to technology
9. Do you agree that smart cities can help reduce social imbalances? Or do they further exacerbate the existence of marginalized communities? Please explain why.
10. Would you agree with the following statement: "The technology being tested in developed countries can be scaled and applied to developing cities, countries, or regions, therefore reducing the development gap". Please explain why.
11. Would you agree with the following statement: "Smart cities play a key role in achieving the United Nation's Sustainable Development Goals (SDGs)"? Please explain why.

[Conclusion]

12. Do you believe there is a real benefit in investing in Smart City projects? Please identify the 3 main conditions required to achieve a positive return on investment on smart city projects.