

Chiha, Asma; Verbrugge, Sofie; Colle, Didier

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Monetizing 5G Capabilities: A Socio-Economic Perspective

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Monetizing 5G Capabilities: A Socio-Economic Perspective

Asma Chiha,
IDLAB
imec-ugent
Ghent, Belgium

Sofie Verbrugge,
IDLAB,
imec-ugent
Ghent, Belgium

Didier Colle,
IDLAB,
imec-ugent
Ghent, Belgium

Abstract— Mobile Network Operators continue to face challenges in generating sufficient revenue streams from 5G networks, especially in use cases where societal value far exceeds immediate financial returns. Safety-critical applications, such as real-time emergency response, autonomous vehicle coordination, and drone-based emergency services, demonstrate unique capabilities of 5G in delivering ultra-low latency and high reliability. However, these applications often struggle to justify network investment purely on commercial grounds. This research argues for a broader, impact-driven perspective that recognizes the socio-economic and environmental value these solutions deliver, particularly in alignment with global sustainability goals. Focusing on Belgium, this study investigates the deployment of a 5G-based Safety Drone Shield solution designed to support emergency services with real-time situational awareness through drones equipped with advanced imaging, sensors, and ultra-reliable connectivity via 5G networks. We adopt a hybrid socio-economic assessment framework, combining qualitative tools (interviews and surveys) with quantitative methods including Social Return on Investment (SROI) and sensitivity analysis. This enables us to evaluate both tangible and intangible impacts in a rigorous and structured way. Our findings show that the 5G Safety Drone solution generates up to €28 of societal value per €1 invested, which means an SROI ratio of 28:1. Positive impacts are particularly pronounced in relation to the UN Sustainable Development Goals (SDGs), notably Goal 3 (Good Health and Well-being), Goal 9 (Industry, Innovation and Infrastructure), and Goal 11 (Sustainable Cities and Communities).

Keywords: 5G networks, socio-economic assessment, SDG, drone, emergency services, SROI

I. Introduction

Mobile Network Operators (MNOs) have been facing significant challenges in generating adequate revenues from the capabilities of 5G networks [1]. Much of the current discourse remains focused on direct revenues derived from traditional customer segments, whether through B2C or B2B models. Yet, 5G was designed to deliver more than just enhanced connectivity. It was built to support safety-critical use cases such as real-time emergency response systems, autonomous vehicles, and remote surgeries. These applications highlight the technical strengths of 5G, particularly its ultra-low latency and high reliability. However, while they require substantial investment in infrastructure, their direct financial returns often remain limited [2]. Despite this, the societal and environmental benefits they offer are profound. These include saving lives, improving public safety, and enabling significant reductions in CO₂ emissions. The mismatch between the financial return and the broader value delivered reveals the limitations of traditional evaluation metrics.

This disconnect underscores the need for a more holistic approach, one that extends beyond conventional financial indicators to account for the societal and environmental value enabled by 5G. Rather than viewing 5G infrastructure solely as a commercial asset, it should also be recognized as a foundational enabler of sustainable development and public value creation. This is especially important because, unlike previous generations of wireless technologies, 5G is the first to explicitly target socio-economic transformation across diverse vertical sectors.

One particularly promising application enabled by 5G is the Drone-as-a-Service (DaaS) solution [3]. Leveraging the capabilities of 5G, DaaS aims to revolutionize emergency response operations by providing timely and effective support in critical situations.

The core concept behind DaaS is the deployment of drones equipped with advanced imaging systems, sensors, and communication tools to assist emergency services. Powered by robust 5G connectivity, these drones can rapidly collect and transmit real-time data and video streams from the scene of an incident to first responders. This immediate access to accurate situational information can significantly enhance the speed and effectiveness of emergency interventions, potentially saving lives, reducing injuries, minimizing property damage, and optimizing the use of emergency service resources.

However, to fully understand the 5G-based DaaS impact, it is essential to move beyond purely economic assessments. A comprehensive evaluation must also consider the socio-economic implications, capturing both the tangible benefits and any potential drawbacks.

To ensure that the impact of such solutions is fully understood and appropriately valued, this study aims to answer the following three research questions:

1. What are the societal, economic, and environmental impacts of deploying a 5G-based DaaS solution?
2. How does this implementation align with the United Nations' 2030 Sustainable Development Goals (SDGs)?
3. How can the identified impacts be effectively quantified?

Socio-economic assessment (SEA) refers to a structured process for evaluating the potential social, economic, and environmental impacts of a given project, policy, or intervention on individuals, communities, and society at large [4]. Unlike traditional assessments focused solely on financial performance, SEA aims to capture broader dimensions of impact, including well-being, equity, and long-term societal value. This makes it a valuable tool for informing decision-makers, particularly in the context of emerging socio-technical systems such as Drone-as-a-Service (DaaS).

A variety of SEA models exist, each offering a different lens for assessing impacts. Among the most widely recognized is Cost-Benefit Analysis (CBA), which provides a quantitative evaluation of economic costs and benefits. While useful for comparing alternative investments, CBA largely ignores social and environmental externalities, making it insufficient for evaluating complex solutions like DaaS [5]. Similarly, Environmental Impact Assessment (EIA) prioritizes environmental consequences and only superficially addresses social considerations, limiting its relevance for a project that seeks to deliver broader societal value [6]. Social Impact Assessment (SIA), in contrast, places a stronger emphasis on understanding how communities are affected by proposed interventions. While its qualitative approach provides richer social insights than CBA or EIA, it remains methodologically constrained and often lacks the comprehensive scope needed to evaluate multi-dimensional impacts [7]. Shared Value Analysis (SVA) offers a more integrative framework by linking business performance with societal progress. However, its tools and practices remain underdeveloped and difficult to operationalize in public or research-led innovation contexts [8]. Social Return on Investment (SROI) has gained traction as a method for quantifying social and environmental outcomes in financial terms, drawing from both cost-benefit analysis and social accounting. While it is effective for assessing completed projects, its strong quantitative focus limits its usefulness for early-stage initiatives where qualitative assessments are more appropriate [9]. In this regard, recent tools such as the SDG Impact Assessment Tool (SDG IAT) and the SDG Check Tool (SDG CT) offer more promising methodologies. Both align project impacts with the United Nations Sustainable Development Goals, providing structured approaches for qualitative and semi-quantitative assessment across environmental, social, and economic domains [10][11]. Finally, Multi-Criteria Analysis (MCA) offers flexibility in integrating diverse indicators and data types. Although its adaptability is a strength, the lack of standardization in weighting and scoring often reduces the comparability and transparency of results [12].

To fully address the research questions, a comprehensive socioeconomic assessment should encompass the following components: a qualitative and quantitative analysis, environmental and social impact assessments, an evaluation of SDG impacts, and a feasibility study. However, none of the models or tools previously discussed is capable of independently covering all these dimensions. *Table 1* highlights the key strengths and limitations of each model concerning the above criteria.

Table 1 SEA models and tools comparison.

	CBA	EIA	SIA	SVA	SROI	SDG IAT	SDG CT
Qualitative approach				X	X	X	X
Quantitative approach	X	X	X	X	X		
Environmental impact assessment		X		X	X	X	X
Social impact assessment			X	X	X	X	X
SDGs impact assessment						X	X
Feasibility study	X	X			X		

As indicated in *Table 1*, no existing model fully meets all research requirements, revealing a clear gap in the literature. To address this, the study proposes a novel, systematic framework for socioeconomic analysis that integrates qualitative and quantitative methods, assesses social, economic, and environmental impacts, and aligns with the SDGs. This model builds on the strengths of existing tools while addressing their limitations, offering a more comprehensive and robust approach.

II. Hybrid Socio-economic assessment framework

The proposed Hybrid Socio-Economic Assessment (HSEA), presented in Figure 1 combining qualitative and quantitative approaches to evaluate a project's social, economic, and environmental impacts, particularly concerning the SDGs, which serve as a globally unified framework for identifying and communicating impact. The qualitative assessment consists of two complementary strategies: an online questionnaire and face-to-face interviews. The questionnaire follows the SDG Impact Assessment Tool (SDG IAT) and Check Tool (SDG CT), enabling stakeholders to assess the project's relevance and potential impact on the 17 SDGs. It includes a first-level screening of SDGs and a second-level rating of relevant targets using a -3 to +3 scale. Respondents first provide background information to support result segmentation.

Given the limitations of online responses, in-depth interviews are conducted with selected experts. These interviews follow the same logic as the questionnaire but are adapted to maximize information quality within a limited time. Participants pre-identify the SDGs they are most familiar with, allowing interviews to prioritize the most relevant content. Each interview consists of a project introduction, a tailored SDG assessment, and an open-ended discussion to collect qualitative insights not possible through structured surveys.

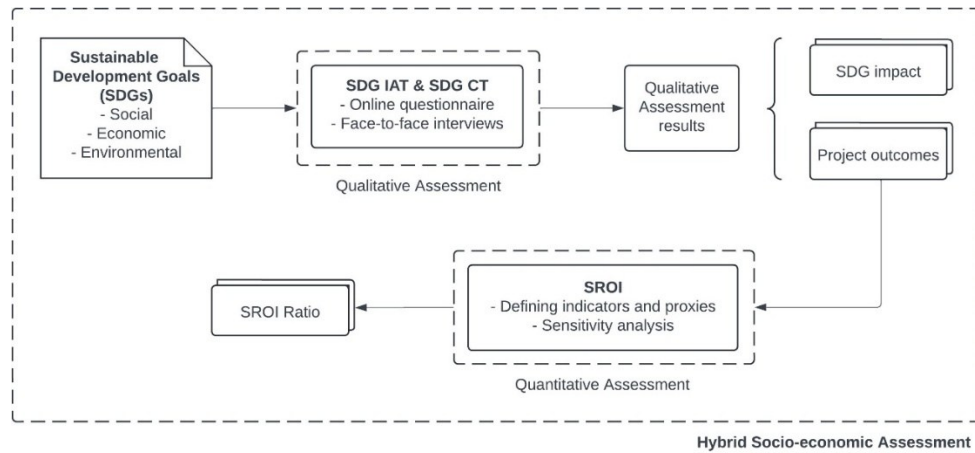


Figure 1 Structure of the HSEA Framework

The quantitative assessment employs the Social Return on Investment (SROI) methodology to monetize the outcomes identified during the qualitative phase, presented in Figure 2. It involves mapping project impacts, selecting indicators and financial proxies, and calculating a benefit-cost ratio that reflects the project's net social value. The SROI process is iterative, allowing for continuous refinement as new data, stakeholders, or outcomes emerge. Only outcomes that can be reliably quantified and attributed to primary stakeholders are included in the final ratio, while others remain part of the qualitative analysis for future integration. Recognizing the potential influence of assumptions on SROI outcomes, a sensitivity analysis is incorporated to address uncertainties. This technique systematically examines how variations in model inputs affect the results, ensuring the robustness and reliability of the assessment.

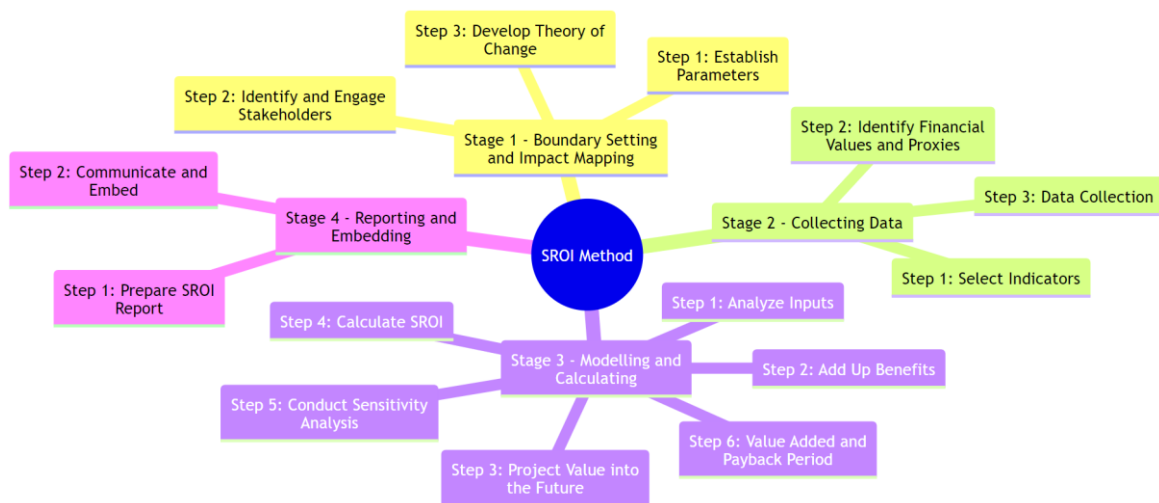


Figure 2 The 4 stages of an SROI Framework

To conduct the SROI framework properly, we employed the SROI Impact Map, also known as the Value Map [13], which serves as a structured tool for organizing and documenting every stage of the analysis. This map guides the identification and alignment of inputs, outputs, outcomes, indicators, and financial proxies for each stakeholder involved. By systematically filling in each component of the map, we ensure consistency, traceability, and clarity throughout the process. The Value Map plays a crucial role in enabling a transparent and robust calculation of the Social Return on Investment, as it captures the logic behind how social value is generated and allows for a well-grounded valuation of impact concerning the resources invested.

Stage 1		Stage 2			
Stakeholders	Intended/unintended changes	Inputs		Outputs	The Outcomes
		Description	Value £		Description
Who do we have an effect on? Who has an effect on us?	What do you think will change for them?	What do they invest?		Summary of activity in numbers	How would you describe the change?

Stage 3						
The Outcomes (what changes)						
Indicator	Source	Quantity	Duration	Financial proxy	Value £	Source
How would you measure it?	Where did you get the information from?	How much change was there?	How long does it last?	What proxy would you use to value the change?	What is the value of the change?	Where did you get the information from?

Stage 1 duplicate	Stage 2 duplicate	Stage 4			
Stakeholders	The outcomes	Deadweight	Attribution	Drop Off	Impact
		%	%	%	
Groups of people that change as a result of the activity	How would you describe the change?	What would have happened without the activity?	Who else contributed to the change?	Does the outcome drop off in future years?	Quantity times financial proxy, less deadweight, displacement and attribution

Stage 5					
Calculating Social Return					
Discount rate (%)		3.5%			
Year 1 (after activity)		Year 2	Year 3	Year 4	Year 5

Figure 3 SROI Impact Map Excel Spreadsheet Example from the SROI Network [14]

III. Implementation of the HSEA Framework in the Safety Drone Shield Pilot Project: A Case Study

This section presents a case study of Citymesh’s Safety Drone Shield in Belgium to demonstrate the practical application of the HSEA framework. The structure is as follows: first, an overview of the program and its operational characteristics; second, a step-by-step application of the HSEA model, including both qualitative and quantitative components; and finally, a discussion of key findings and implications. The case illustrates how the HSEA framework supports the systematic evaluation of socio-economic and environmental impacts of DaaS solutions.

III.1. Case Study Overview

Emergency call centers in Belgium receive over two million urgent calls annually [15]. These calls demand rapid and informed decisions by emergency services, often made with incomplete information. Citymesh, the fourth mobile operator in Belgium, addresses this challenge with a DaaS solution tailored for emergency operations. The system uses a fleet of drones equipped with high-resolution cameras, sensors, and 5G communication modules to provide real-time situational data. The 5G-enabled infrastructure allows for high-speed, low-latency communication between drones, ground crews, and command centers, ensuring timely data transmission and coordinated action. 4.1.2. Pilot Project in Genk

The City of Genk has served as a testing ground for this solution, deploying a fully automated “drone-in-a-box” system capable of BVLOS (Beyond Visual Line of Sight) operations. Upon receiving a 112 emergency call, a drone is autonomously launched and can reach the scene in under two minutes. A dedicated 5G network slice supports secure and uninterrupted communication, transmitting live video to emergency teams and municipal authorities. This successful pilot supports broader implementation and offers valuable insights into the system’s technical and social performance.

III.2. HSEA: Qualitative Assessment

As described previously, the qualitative assessment comprises an online survey and semi-structured interviews to gather stakeholder perspectives and alignment with SDG outcomes. The responses were analysed to identify key perceived benefits, risks, and outcome indicators that would feed into the subsequent SROI calculation.

In total, 14 respondents participated in answering the online questionnaire, including representatives from Citymesh (5), emergency services (3), academic researchers (6), and Belgian citizens (3).

In total 7 interviews have been conducted with frontline emergency service professionals; including two commanders (Fire department Gent), two drone pilots who also serve as firefighters (Fire department Gent), and one firefighter (Fire department Gent), Head of Emergency Region (Jordi Mas, Girona) and Technical Inspector (Lluís Tresserras, Fire Protection, Girona), yielded a rich collection of operational and strategic insights concerning the potential and limitations of the Safety Drone Shield.

III.2.1. Stakeholder perceptions on SDG relevance and impact

Stakeholders participating in the study were asked to assess which SDGs they believe the project contributes to. Their ratings provided insights into the perceived societal and environmental value of the initiative. In this study, SDGs are considered relevant if at least 30% of the respondents voted for them. Therefore, SDGs 1, 2, 4, 5, 6, 10, 12, and 16 are discarded, and the rest are analysed further. Figure 4 shows the most relevant SDGs according to this qualitative assessment.

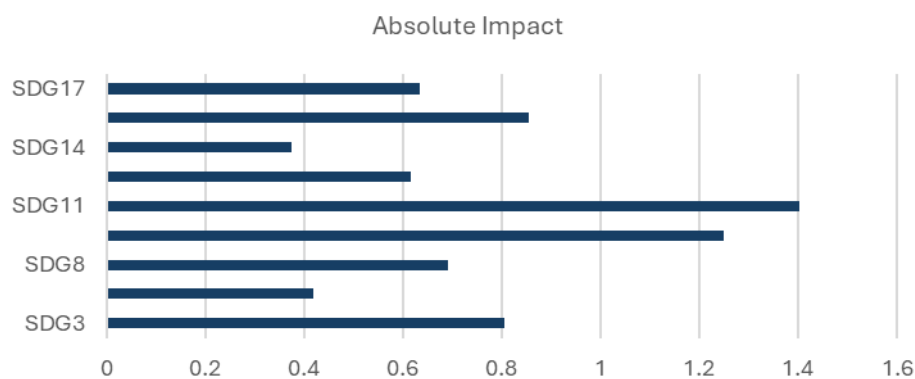


Figure 4 The absolute impact of the relevant SDGs.

After analysing the responses to the questionnaire and interview, it can be concluded that SDGs 9 (industry, innovation, and infrastructure) and 11 (sustainable cities and communities) are important to the stakeholders, followed by SDGs 13 and 15, climate action, and living on land. SDGs 3 and 8, good health, well-being, decent work, and economic growth, are also important, according to the respondents. This information is very useful for identifying and defining the impacts and outcomes that stakeholders expect to see as a result of project implementation. Most of these outcomes will be related to the SDGs with the highest relevance and impact.

The following section identifies the impacts and outcomes based on the conclusions drawn from the qualitative study. These outcomes will be related to environmental protection (SDGs 11, 13, 15), people's well-being (SDGs 3, 8), and economic growth (SDGs 8 and 9).

III.2.2. Identification of Project Outcomes

Based on stakeholder input, the DaaS solution is expected to contribute to a broad range of social, environmental, and economic outcomes. Key outcomes are summarized below, categorized by theme:

A. Social Impact

- Reduced fatalities and injuries in fire and crowd-related incidents through improved situational awareness and faster response (SDG 3.6, 11.5, 11.b).
- Lower disappearance rates via aerial support during mass events and search operations, enabling faster discovery of missing persons (SDG 16.1, 11.7, 3.d).
- Suicide prevention by detecting and assisting individuals in distress in high-risk locations (SDG 3.4, 16.1).
- Improved mental health by minimizing exposure to traumatic events and hospitalizations (SDG 3.4, 3.d).

- Enhanced population well-being through greater public confidence in emergency response (SDG 3.4, 16.6).

B. Environmental Impact

- Reduced CO₂ emissions from wildfires, as faster extinguishing lowers biomass combustion (SDGs 3.9, 15.5–15.8).
- Lower pollution-related health risks near fire zones (SDGs 3.3–3.5).
- Mitigated biodiversity loss by protecting ecosystems and carbon sinks.
- Protection of agricultural resources, limiting crop and livestock loss.
- Reduced emergency fleet emissions via optimized dispatch and routing.

C. Economic Impact

- Improved resource efficiency, including emergency vehicles and personnel (SDGs 8.4, 11.2, 11.6).
- Reduction of property damage, lowering recovery costs and economic losses (SDGs 11.5, 8.1, 9.1).
- Enhanced worker safety and potentially increased job satisfaction and loyalty (SDGs 8.6–8.8).
- Reinforced institutional capacity for climate adaptation (SDGs 13.1, 13.3).
- Reinforcement of long-term partnerships and collaboration networks (SDGs 8.1–8.5).
- Increased company security and reputation in event management and public services.
- Improved stakeholder image through leadership in safety and innovation (SDGs 9.2, 9.4).
- Boosted research and innovation through data generation and experimental validation (SDGs 9.5, 9.b, 9.c).

The inclusion of the aforementioned impacts and outcomes in the quantitative analysis (i.e., the SROI calculation) is guided by three key criteria. First, stakeholder relevance: only outcomes identified as significant by key stakeholders are considered, while those recognized solely by indirect stakeholders are excluded. Second, data availability: each outcome must be supported by sufficient data, either from stakeholders or existing literature, to enable quantification; without adequate data, the outcome is excluded. Third, material significance: outcomes with minimal or negligible monetary value are not included in the SROI analysis to maintain focus on those with meaningful impact.

III.3. HSEA: Quantitative Assessment

The quantitative component of the HSEA framework builds on the Social Return on Investment (SROI) model. Two commonly referenced versions of the SROI framework exist: a four-stage model developed by the New Economics Foundation (nef) [13], and a six-stage version presented in the updated guide by Social Value UK [9]. While both frameworks include the same core steps, they differ in how these steps are grouped and structured. In this study, we follow the four-stage version proposed by nef [13]. Below, we outline how this model was applied to the case study.

III.3.1. SROI model

Stage 1: Boundary setting and impact mapping

- **Step 1:** Establishing the parameters for the SROI.

This study conducts a forecast SROI analysis to estimate the social impact of Citymesh's 5G-based Drone-as-a-Service solution in emergency scenarios such as fires and rescue operations. It quantifies expected benefits, including faster response times, enhanced safety, resource optimization, and potential lives saved.

- **Step 2:** Identifying, prioritizing and engaging stakeholders.

Stakeholder identification, prioritization, and engagement are essential to the SROI process. Stakeholders include those directly or indirectly affected by the project, such as individuals in

emergencies, the wider public, government bodies, and the environment, as well as contributing partners like Citymesh. Engaging key stakeholders helps clarify priorities, refine the analysis, and ensure a comprehensive assessment of the social value generated. Prioritizing stakeholders is essential, as not all can be consulted. Key stakeholders are selected based on their impact, influence, and relevance to the project. Table 6 lists them with the rationale for their inclusion.

Table 2 List of key stakeholders for the DaaS solution project.

Key stakeholders	Reason for inclusion
Citymesh	The Drone as a service solution project would not exist without the main developer.
Firefighters and rescue teams	The emergency services have the resources and expertise to make good use of the information collected by the drones.
Emergency medical services	
Civil protection organizations	
Belgian society	Central to the project's mission.

- **Step 3: Developing a theory of change**

The theory of change outlines how resources lead to meaningful societal impact, serving as a roadmap from inputs to outcomes. It captures the sequence from investments (e.g., funding, personnel, infrastructure) to activities, outputs, and ultimately stakeholder outcomes. These outcomes may be positive or negative, intended or unintended. Final impacts are then adjusted for attribution, deadweight, and displacement to reflect the net contribution of the project. *Table 3* defines key terms used in the SROI approach.

Table 3 Key terms related to the SROI approach: inputs, activities, outputs, outcomes, impacts, attribution, deadweight, and drop-off.

Key terms	Definition
Inputs	The resources used to run the activities such as money, people, facilities, and equipment.
Activities	This is the intervention provided.
Outputs	The direct and tangible products from the activity.
Outcomes	The changes that occur to stakeholders because of the activity.
Impacts	The difference made specifically by the organization or project in achieving the outcomes
Attribution	It is an assessment of how much of the outcome was caused by the contribution of other organizations or people.
Deadweight	It is a measure of the amount of outcome that would have happened even if the activity had not taken place.
Drop off	It refers to a decrease in the amount of a particular outcome over time, typically calculated by deducting a fixed percentage from the remaining level of outcome at the end of each year.

Table 4 presents the theory of change for the DaaS solution, based on stakeholder input. It maps inputs and activities to resulting outputs and stakeholder-perceived outcomes. While some actors, like Belgian society, do not contribute inputs or outputs, they experience significant outcomes.

Table 4 Inputs, outputs, and outcomes for each stakeholder.

Stakeholders	Inputs		Outputs	Outcomes
	Activity	Description	Description	Description
Citymesh	5G-based Safety Drone Shield deployment.	Equipment, infrastructure, softwares, trained drone pilots, regulatory approvals and permits.	Aerial real-time data collected by de drones.	Improved company image
			Income for providing the Safety Drone service.	
			Trained personnel capable of operating drones in emergencies.	
Emergency centers	Utilization of Citymesh's Safety Drone Shield for rapid response to emergencies.	Emergency call data, geographical information.	Real-time information on the emergency's status.	Reduction in firefighters' injuries and deaths.
		Payment to Citymesh for the service provided.		Enhanced use of emergency vehicles.
Belgian society	Assisted in emergencies.	N/A	N/A	Reduction in civil injuries and deaths.
				Reduction in carbon emissions from wildfires.
				Reduction in crop and livestock losses.
				Reduction in real estate loss and personal property.
				Reduction in carbon emissions from burning fuel.

Stage 2: Data collection

- **Step 1:** Select indicators.

Indicators are essential for measuring whether an outcome has changed. As this is a forecast SROI, historical data is not available, so assumptions must be made to estimate potential benefits. In this study, we apply two key assumptions: A1 (5%), representing the assumed reduction in deaths and injuries, based on [17], and A2 (10%), representing the assumed improvement in resource efficiency and emissions reduction, inspired by [16].

These improvements reflect general operational enhancements in emergencies, not drone use alone. Table 5 shows the stakeholders' outcomes and their associated indicators and calculation formulas.

Table 5 Stakeholders' outcomes and their associated indicators

Stakeholders	Outcomes			
	Description	Indicator	Calculations	Source
Citymesh	Improved company image	Increased profits as a result of implementing the DaaS solution.	63% of the profits	[18]
Emergency centers	Reduction in firefighters' injuries and deaths.	Number of firefighter injuries prevented as a result of the DaaS solution.	A&* reduction	[19]
	Enhanced use of emergency vehicles.	Number of emergency vehicles prevented from being replaced.	$\frac{\#vehicles * 1}{service\ life\ [years]} * A1$	[19], [20]
		Amount of fuel saved for emergency vehicles.	$\#interventions * distance[km] * consumption \left[\frac{l}{100\ km} \right] * A2$	[19],[21], [22]
Belgian society	Reduction in civil injuries and deaths.	Number of civil lives saved as a result of the DaaS solution.	annual average number of civil deaths *A1	[22]
		Number of civil injuries prevented as a result of the DaaS solution.	annual average number of civil injuries *A1	[19]
	Reduction in carbon emissions from wildfires.	Amount of Carbon emissions from biomass burning avoided.	$\#Burnedhecteres[ha] * Stored\ carbon \left[\frac{MtC}{ha} \right] * A2$	[23], [24]
		Amount of Carbon emissions from the loss of biomass on forest land avoided.	$\#Burnedhecteres[ha] * Stored\ carbon \left[\frac{MtC}{ha} \right] * A2$	[23], [24]
	Reduction in crop and livestock losses.	Crop acres loss avoided.	$\#Burnedhecteres[ha] * A2$	[23]
	Reduction in real estate loss and personal property.	Real estate and personal property loss avoided.	$\#Residential\ fires * A2$	[19]
	Reduction in carbon emissions from burning fuel.	Amount of Carbon emissions from burning fuel avoided.	$\#interventions * distance[km] * carbon\ emissions \left[\frac{gCO2}{km} \right] * A2$	[19],[21]

- **Step 2&3:** Identify financial values and proxies.

The next step involves assigning financial proxies and defining outcome durations. *Table 6* presents each indicator, its calculated value, duration, and selected proxy. Most outcomes are assumed to last 5 years (project forecast), except for avoided carbon emissions from forest biomass loss, which is set at 100 years, the estimated time for forest regeneration [36].

Table 6 Stakeholders' indicators, their value, duration and financial proxy associated.

Stakeholder	Outcomes				
	Indicator	Value	Duration (years)	Financial Proxy	Source
Citymesh	Increased profits as a result of implementing the DaaS solution. [€]	63% of the profits	5	N/A	Citymesh forecast
Emergency centers	Number of firefighter injuries prevented as a result of the DaaS solution.	39	5	Value of a Statistical Serious Injury (VSSI): 940,000 €/person	[24]
	Number of emergency vehicles prevented from being replaced.	48.75	5	Average cost of a fire truck: 500,000 €	[26]
	Amount of fuel saved for emergency vehicles. [l]	569,832	5	Diesel cost (21/05/2024): 1.69 €/l	[27]
Belgian society	Number of civil lives saved as a result of the DaaS solution.	31	5	Value of a Statistical Life (VSL): 5,400,000 €/person	[24]
	Number of civil injuries prevented as a result of the DaaS solution.	705	5	Value of a Statistical Serious Injury (VSSI): 940,000 €/person	[24]
	Amount of Carbon emissions from biomass burning avoided. [tC]	1735.3	5	Social Cost of Carbon (SCC): 51 €/tC	[28]
	Amount of Carbon emissions from the loss of biomass on forest land avoided. [tC]	1735.3	100	Social Cost of Carbon (SCC): 51 €/tC	[28]
	Crop hectares loss avoided. [ha]	18.68	5	Estimated loss: 254.7 €/ha*year	[29]
	Real estate and personal property loss avoided. [dwellings]	796.2	5	Average cost of housing: 322,780 €	[30]
	Amount of Carbon emissions from burning fuel avoided. [g]	244,213,800	5	Social Cost of Carbon (SCC): 51 €/tC	[28]

Stage 3: Modelling and calculating the SROI

In this third stage, we assign monetary values to each outcome using the previously defined indicators and financial proxies. These values are then adjusted to reflect only the portion attributable to the drone intervention, accounting for attribution, deadweight, and drop-off. To estimate attribution, two drone pilots from the Genk pilot were consulted and asked to rate the importance of various factors in firefighting operations. Based on their input, an attribution rate of 21.9% was applied. In most cases, only attribution was applied, as deadweight and drop-off were considered negligible.

Table 7 Final impact on each outcome.

Stakeholders	Outcomes	Impact [€]	Total impact over 5 years with 3.5% discount rate [€]
Citymesh	Improved company image	365,769	365,769
Emergency centers	Reduction in firefighters' injuries and deaths.	802854	7,229,570.94
	Enhanced use of emergency vehicles.	533812.5	
		210401.4225	
Belgian society	Reduction in civil injuries and deaths.	3666060	348,163,846.70
		14513130	
	Reduction in carbon dioxide emissions from wildfires.	19381.5718	
		19381.5718	
	Reduction in crop and livestock losses.	1041.957324	
	Reduction in real estate loss and personal property.	56282438.48	
	Reduction in carbon dioxide emissions from burning fuel.	2727.623932	
Total Value of Outcomes [€]			355,759,186.94
Net Present Value [€]			343,067,929.94
SROI ratio			28:1

The SROI ratio is defined as the division of the net total value of the outputs by the total value of the inputs (the investment made by Citymesh to deploy the project nationwide). The calculated SROI ratio is 28:1, which means for each 1 euro invested, 28 euros is generated as societal, economic, and environmental value. This ratio underscores the significant value created and indicates the strong positive influence of the project on societal well-being and environmental improvement, confirming its effectiveness in enhancing the community.

The next step will be to conduct a sensitivity analysis. This analysis will account for the uncertainties and variations in the data and assumptions used in the SROI calculations to reinforce the reliability and robustness of our results.

III.3.2. Sensitivity analysis

Sensitivity analysis examines how uncertainty in model outputs can be traced to different input variables. It is a valuable tool for testing assumptions, assessing risk, and exploring alternative scenarios. Adjusting input values helps identify which factors most influence results and ensures the robustness of decision-making. In this SROI analysis, two key assumptions were made: a 5% improvement in outcomes related to injury and death reduction (A1), and a 10% improvement in carbon emissions and resource optimization (A2). While these reflect general emergency operation trends—not solely drone impact—sensitivity analysis tests their influence. We evaluated all combinations of A1 and A2 in 10% increments. As expected, higher percentages yield higher SROI ratios. The minimum ratio (A1 = 5%, A2 = 5%) is 18:1, while the maximum (A1 = 100%, A2 = 100%) is 378:1. Notably, A1

has a stronger impact on the ratio. This confirms that the original assumptions are conservative, with SROI values closer to the lower bound. Graph 8 illustrates how the ratio increases with A1 and A2.

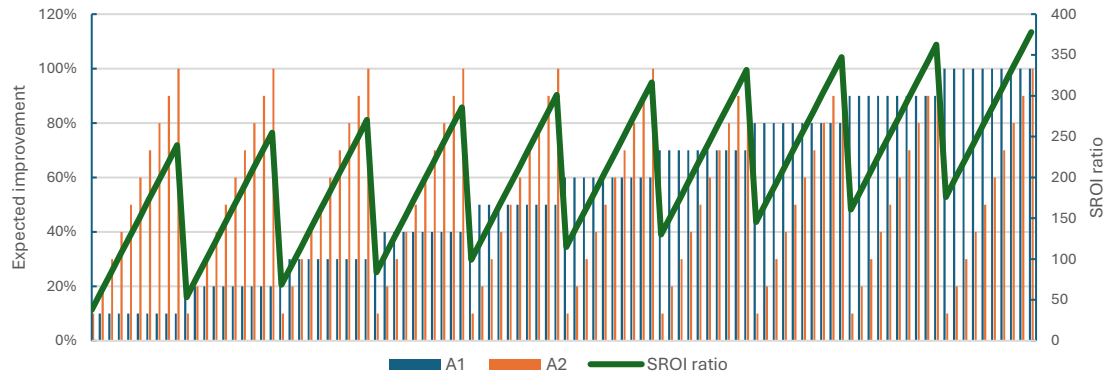


Figure 5 SROI ratio depending on assumptions A1 and A2.

IV. Conclusion and future research perspectives

This paper has examined the socio-economic impact of a 5G-enabled DaaS solution, focusing on Citymesh's Safety Drone Shield solution in Belgium. A novel Hybrid Socio-Economic Assessment (HSEA) model was developed and applied, integrating qualitative insights and quantitative evaluation through the SROI methodology. The qualitative analysis, based on stakeholder engagement, revealed that the DaaS project is expected to generate meaningful contributions to several SDGs, particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities), followed by SDG 13 (Climate Action), SDG 15 (Life on Land), SDG 3 (Good Health and Well-being), and SDG 8 (Decent Work and Economic Growth). Stakeholders emphasized the project's role in enhancing emergency response, reducing injuries and fatalities, and limiting property damage. From an environmental standpoint, the solution also contributes to emissions reduction and biodiversity conservation. The SROI analysis yielded a ratio of 28:1, indicating that for every euro invested, €28 in social value is generated. The most influential outcomes were the reduction in civilian casualties and property losses. Sensitivity analysis confirmed the robustness of these findings, showing that even in conservative scenarios, the project maintains strong value generation.

The findings highlight that 5G networks should not be assessed solely based on financial returns, but recognized as critical enablers of societal and environmental progress. The application of the HSEA framework to Citymesh's Safety Drone Shield project demonstrates the significant potential of 5G-enabled solutions to enhance public safety and contribute to sustainability goals. This approach reinforces the value of integrating both qualitative insights and quantitative evaluations to capture the full spectrum of socio-economic impacts. The HSEA framework not only enables a more comprehensive understanding of the benefits generated by such technologies but also offers a flexible and adaptable methodology suitable for diverse contexts. It serves as a practical tool for stakeholder engagement, facilitating early-stage dialogue on sustainability priorities and informing future research, investment decisions, and policy development.

To strengthen the robustness and applicability of this framework, future work should broaden stakeholder participation to enrich the qualitative analysis and identify additional relevant outcomes. On the quantitative side, more precise estimation of attribution, deadweight, and drop-off effects is needed, potentially through expanded data collection and expert validation. Further application of the HSEA model across different use cases and geographic settings will be essential to confirm its scalability and relevance to a wider policy landscape.

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