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HOW TO LEVERAGE ARTIFICIAL INTELLIGENCE FOR SUSTAINABLE BUSINESS DEVELOPMENT

by

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LIST OF ABBREVIATIONS AND ACRONYMS

AI Artificial Intelligence

DSR Design Science Research

IS Information Systems

MDG Millennium Development Goals

OWG (United Nations) Open Working Group

SDG Sustainable Development Goals

SLR Systematic Literature Review

UN United Nations

UNCED United Nations Conference on Environment and Development

WCED World Commission on Environment and Development

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1. INTRODUCTION

1.1. CONTEXT / FRAMEWORK

The field of **Artificial Intelligence** (AI) was founded as an academic discipline in the summer of 1956 (Muthukrishnan et al., 2020) at Dartmouth College in Hanover, New Hampshire, when several field experts gathered for a workshop focused on understanding how to humanize machine functioning (McCarthy et al., 2006). However, it was not until the beginning of the 21st century that AI research boomed, as a consequence of successful applications of machine learning algorithms across both academy and industry.

Since then, it has become unquestionable that AI is set to be one of the most transformational technologies of the century. In 2018, Accenture (Plastino & Purdy, 2018) published the article "Game changing value from Artificial Intelligence: eight strategies" as an attempt to quantity the impact of this prominent technology. AI proved to impact positively all industries real annual GVA by 2035, in at least 0,9 percentual points, when comparing a projected growth baseline with or without AI industry embracement. This rases an important question that needs answer: Is this projected growth sustainable?

According to the United Nations (UN)(UN. Secretary-General & World Commission on Environment and Development, 1987), **sustainability** implies "meeting the needs of the present without compromising the ability of future generations to meet their own needs.", requiring focus not only on economic development (under analysis in the above-mentioned Accenture Study) but also on societal and environmental development, the 3 main pillars of Sustainable Development.

Empowered by this wider vision on Human Development (Ekhator et al., 2022), the United Nations Organization has been leading the global agenda for a more sustainable world , with the definition, by 2000, of the Millennium Development Goals, than were then adapted, in 2012 to the Sustainable Development Goals (SDGs). They consist of 17 goals, 169 underlying targets and 304 proposed indicators that should be used to shape and evaluate scientific and industry technological innovation.

1.2. MOTIVATION

With AI's transformational potential comes, however, increased responsibility to consider the societal, economic, and environmental implications of this technology, stressing the need to educate decision makers and the general public so they can plan for them.

According to Jason Silva (Knapp, 2011) the host of the Emmy nominated TV-series Brain Games, humankind has always leveraged technology to extent its capacity, but the way society misperceives progress and evolution of AI technology many times hinders our ability to explore how could it be used to extend compassion and purpose. There is a wider tendency to hear about the darker side of AI when it can become an exquisite tool to help us deal with several issues of public concern, that is why this study should enlighten both academy and industry on AI's ability to augment human capacity to meet the United Nations' Sustainable Development Goals.

1.3. OBJECTIVE

The main goal of this dissertation will be to understand how Artificial intelligence can speed up the uptake of the sustainable development goals SDGs. Therefore, the main research question to be answered is *How to leverage artificial intelligence for sustainable business development?*

Other underlying objectives should be met in order to achieve this main goal, namely:
- Understand the concepts revolving around artificial intelligence and sustainability
- Review the existing literature on established an emergent application of artificial intelligence that can help accelerate the road to sustainability
- Link AI applications to the impacted SDGs
- Define a recommendation framework on how to leverage AI for a more sustainable business development

2. LITERATURE REVIEW

This research proposes to consider the subsequent question: 'Can Artificial Intelligence contribute for Sustainable Development?" This should unmistakably begin with clarifying the meaning of the terms "Artificial Intelligence" and "Sustainable Development".

2.1. ARTIFICIAL INTELLIGENCE

Understanding Artificial Intelligence entails looking at its various definitions, the different disciplines that helped shape it, the various AI subfields and the boundaries of what is now achievable and what AI can do in the future.

2.1.1. CONCEPTS

The most recent definition of **Artificial Intelligence** (AI) can be found in the 2020's edition of the book Artificial Intelligence: a modern approach (Russell & Norvig, 2020) considered to be the encyclopedia of the field, where the authors define AI as "**the study of intelligent agents**", this is, agents that receive precepts from the environment and perform actions accordingly, through the application of functions. This definition intends to encompass others drawn by different authors throughout the history of AI's scientific field, that privileged one or of four characteristics of an intelligent agents: (1) acting humanly (2) thinking humanly, (3) thinking rationally, or (4) acting rationally.

Whilst the oldest definition of the term was formalized by John McCarthy (Muthukrishnan et al., 2020) an Assistant Professor of Mathematics at Dartmouth College, the first to coin the expression "Artificial Intelligence", in the proposal for the mythic 1956 summer Dartmouth conference ((McCarthy et al., 1955). In the proposal's transcript, McCarthy describes it as any aspect of learning or feature of intelligence that can be simulated by a machine.

The preceding events can suppose McCarthy to be the father of Artificial Intelligence, but the undeniable influence for AI field development of Alan Turin's famous 1950 article "Computing Machinery and Intelligence" might suggest otherwise (Muthukrishnan et al., 2020)). With a rather controversial introductory question - "Can machines think?" (Turing, 2012) the paper discusses the possibility of programming an electronic computer to behave intelligently. The reality is that Alan Turing simply didn't adopt the term Artificial intelligence, he preferred Computing Intelligence instead, defining it as the combined ability of a machine to process natural language, represent knowledge, automate reasoning and learn – the Turing Test. A wider version of the test would also require a computer vision and robotics as additional capabilities for computational or artificial intelligence.   A terminology discussion raised again in 2006 (Moor, 2006), at the 50's anniversary of Dartmouth conference, where the participants speculated about whether the field would have been any different had it been called "computational intelligence".

After a long history of disaccredit by the scientific community, that refused to acknowledge Alan Turin as the real father of AI, curiously, last year, 2021, the British Government will make him, the face

of its 50-pound note (*Alan Turing to Feature on New £50 Banknote | Bank of England | The Guardian*, 2019) recognizing his outstanding contribution to the field.

Long before Alan Turin, philosophers have been mulling over different AI questions: what does it mean to be human? What is intelligence? Can machines have real, conscious minds?... In fact, the seeds of AI were planted by classical Philosophy with later contributions from the most diverse science fields including Mathematics, Economics, Neuroscience, Psychology, Computer engineering, Control theory, Cybernetics, and Linguistics fields.

2.1.2. AREAS

AI currently encompasses a huge variety of **subfields**. Russel and Norvig (2020), distinguish 6 subfields, closely related with Turin's characteristics of computer intelligence previously mentioned. However, when acknowledging Andrew Moore's definition of AI as "the science and engineering of making computers behave in ways that, until recently, we thought required human intelligence" - one is confronted with the vast, aspirational and evolutionary nature of the term and led to believe that other subfields might arise in the future to mimic newer unexplored perspectives of human intelligence.

The objective of the AI's subfield of **Searching** is to program the behavior of problem-solving-agents: with a clearly defined problem to solve and given a specific goal, the agent searches for the best solution. Adversarial search is a particular field of Searching, specific for competitive environments, in which agents' goals are in conflicting, often known as **Games**. In AI, the most common games are two-player, zero-sum games, such as chess.

Planning is the AI subfield dedicated to devise a plan of action to achieve the problem's goals.

Machine Learning studies the agent's ability to improve its performance on solving a problem through experience. Learning takes three different forms depending on the type of feedback received. In **unsupervised learning** the agent learns patterns without any feedback provided, in **reinforcement learning**, the agent learns from a series of rewards or punishments, and in **supervised learning,** the agent is given examples of inputs and corresponding outputs and learns the function that maps the two.

Natural Language Processing is the AI subfield focused on the agent's ability to capture knowledge expressed in natural language, completing specific information seeking tasks like text classification, information retrieval or extraction.

AI's **Perception** branch studies the agent's sensorial capabilities to interpret information about the environment they inhabit.

Finally, **Robotics** is the AI subfield responsible for materializing Artificial Intelligence in the physical world – robots are physical agents that perform tasks by manipulating the physical world.

Table 1 lists the common AI methods and algorithms applied by the above-mentioned used across the above-mentioned subfields.

Table 1 – AI Subfields and Corresponding Methods & Algorithms

AI Subfield	Examples of AI Methods and Algorithms (Russell & Norvig, 2020)
Searching	Breadth-first search, depth-first search, Depth limited search, iterative deepening search, iterative lengthening search, bidirectional search
Planning	Planning domain definition language, Graph plan algorithm, Boolean satisfiability, first-order logical deduction, constraint satisfaction problem
Machine Learning	Classification, linear and logistic regression, decision trees, neural networks, nearest neighbors and locally weighted regression, support vector machines, boosting
Natural Language Processing	Probabilistic language models, CYK algorithm, lexicalized PCFG
Perception	Early vision image-processing algorithms
Robotics	Probabilistic filtering algorithms, configuration space search algorithms, potential field techniques

Besides the subfields of AI, it is important to distinguish two main types of AI. Strong AI or Artificial General Intelligence is when machines become self-aware, whereas Weak AI is for systems that focus on specific tasks.

2.1.3.   AI CHALLENGES & OPPORTUNITIES

In its short history, AI has made great progress (Russell & Norvig, 2020). Today, one can hardly avoid encountering mentions of AI, as it is being absorbed by every business sector, making it mandatory for all CEOs to share a view of it (Mueller & Massaron, 2018). The AI hype is real, drowning us in information and disinformation that make it impossible for an average reader to separate **what can AI really do today** from what is simply the product of overactive imagination.

Professors Gary Marcus and Ernest Davis (Mueller & Massaron, 2018) argue that current AI capabilities are far less impressive than the hype suggests, stating that the most successful applications of AI nowadays leverage mainly hybrid approaches, still dependent on rule-based algorithms. In the words of Taulli (2019), AI is currently at its weak stage, since no machine today is fully self-aware.

Artificial Intelligence still presents important **limits** that distinguish it from genuine intelligence. Current AI methods and algorithms, still cannot reason about things that are unusual, these are problems with limited data, since AI models' accuracy is proportionate to historical data volume. They are also unable to mimic real authentic person-to-person interaction. According to Andrew Moore, Dean of Computer Science at Carnegie Mellon (High. Peter, 2017) for the next 20 years, we will not have the technology to simulate the sort of caring needed for effective person-to-person interactions. Moore also introduces another important AI limitation: the inability to solve problems through lateral thinking or analogical reasoning. Lateral thinking allows the answer to a problem to come about by viewing the situation from a different angle while analogical reasoning tries to find the solution to a problem via preponderance of answers to like problems.

However, regardless of the previous limitations, AI does perform a significant number of useful tasks enabling millions of different AI applications (Mueller & Massaron, 2018). Applications define specific kinds of uses of AI, to name a few examples: AI is used in fraud detection, resource scheduling, complex analysis, automation, customer service, safety systems and machine efficiency. In addition, the fields

with more AI applications include Artificial life, Automated Reasoning, Automation, Biologically Inspired Computing, Concept Mining, Data Mining, Email Spam filtering, Hybrid Intelligent System, Intelligent Agent and Intelligent Control, Knowledge Representation, Litigations, Robotics and the Semantic Web.

After acknowledging where AI currently stands, a more accurate analysis can be made to the **challenges and opportunities AI brings for the future**.

Fictional narratives, such as print, music, films and television are one of the most widely recognized sources of AI's future speculation (Avin, 2019). These narratives are important to raise awareness and to broaden AI's horizon, however they seem to favour a dystopian future for AI. Prominent tech entrepreneurs like Elon Musk, CEO of Tesla, and Bill Gates, CEO of Microsoft have also expressed deep worries about AI (Taulli, 2019). Stephen Hawking even went further in the 2017 Web Summit by stating that AI can become the "worst event in the history of our civilization". All in all, there is a general concern about humankind's ability to surpass the important **challenges** AI presents, mainly related with Responsible AI, technological unemployment and the Weaponization of AI.

Responsible AI, also known as Trustworthy AI, has recently been promoted by Google, Microsoft, and IBM, among others, as a critical issue when using AI in practice (Euijong Whang et al., 2021). Its main objective is to empower not only the algorithmic phenomena but the entire data mining process with the required *explainability, fairness, robustness, transparency, and accountability*. Taking *explainability* as an example, as Donghee Shin states (Shin, 2021), AI systems are very hard to debug due to increasing complexity of the algorithms leveraged, many times coined as "black boxes". The danger of proliferating the use of algorithms than only a few can interpret is pressuring the scientific community to investigate deeper on explainability, generating a recent research trend - "Explainable AI" or XAI, defined as the set of machine learning and AI technologies that can offer human-understandable justifications for their output or procedures (Gunning et al., 2019). However, explainability is still low, one of the reasons why we are far from achieving Responsible AI, a true challenge to overcome in the future of the field.

Another critical challenge outlined by different authors is **Technological Unemployment** (Taulli, 2019), this is, how AI can lead to long term job loss. This perception about AI job loss emerged in 2013, when a pair of Oxford academics, Carl Benedikt Frey and Michael Osborne, estimated that 47% of American jobs are at high risk of automation by the mid-2030s (Press, 2019). This was a highly cited academical work, however, the authors had to latter clarify the true meaning of this estimated percentage. It did not make mention to all jobs generally but instead to half of the jobs that failed into the "high risk" of automation category, generating a complementary second Forbes article (Walch, 2019), that tried to understand if AI will be more of a job killer or job creator. After analysing different speculation sources, the author concludes that only time will allow us to measure the net impact between the new types of occupations generated by AI and the decline in workers whose job will be automated. Still, specific measures can be undertaken to ensure a smooth transition into the new age of industrialization, Industry 4.0, powered by AI, avoiding technological unemployment. According to Taulli (Taulli, 2019), these measures include government-sponsored education and transition assistance,

world democratization of minimum-average-wages for all, and AI-tax impositions for the industry's super companies.

Finally, **AI Weaponization** is the later main challenge alarming both academy and industry, defined as *"malicious AI algorithms that can degrade the performance and disrupt the normal functions of benign AI algorithms, while providing technological edge attack scenarios in both cyberspace and physical spaces."* (Yamin et al., 2021). This phenomenon enables a more efficient use of conventional modes of weapons through AI-based decision-making, leading to the most diverse episodes like the development of autonomous combat vehicles or the usage of adversarial machine learning for the false identification of cancer. This opens an overwhelming range of frightening possibilities for misused applications of AI that demand tight and rigorous regulation to be established between world leaders. They should be undoubtedly committed to place national and international security and well-being first, and politics and power relations second, a difficult task that is alarming both academy and industry.

Fortunately, the AI hype drives not only dystopian but also utopian visions for the future of AI, from those who believe AI is the fulfilment of the promise of technology (Taulli, 2019) that can act as a sweeping democratizing force, opening exquisite **opportunities** for saving money, time, and even lives. Areas where AI will most probably have an outsized positive impact on society include Drug Discovery, Autonomous vehicles, and Social Good.

Since late 2019, the world has been affected by coronavirus disease 2019 (COVID-19), said to have unprecedented impacts on individuals, healthcare systems and economies worldwide(Lorgelly & Adler, 2020) The majority of COVID-19 investment has to date been new funding, leading one to question if it might jeopardize some of AI future predictions being discussed in this section. According to recent studies (Landi, 2020), healthcare organizations are ramping up AI investments in response to the COVID-19 pandemic, this might suggest that health-oriented AI applications will be enhanced rather than jeopardized. Long before the COVID-19 outbreak(Naudé, 2020) AI was already lauded for its potential to contribute to new **drug discovery**. Deep learning ability to identify complex patterns and develop personalized treatments – such as geared to a person's genetic make-up – are the main and factors contributing for the promise of AI in this field (Taulli, 2019). However, there are still major hurdles to overcome, namely health care industry maturity in leveraging AI solutions, probability if algorithm inexplicability precluding regulatory approval, and the uncovered features of the human body.

Self-driving cars is one of the most acknowledged AI application. Its investigation dates back from the 1960s, with the construction of Stanford Cart, as part of NASA's Prospector Project, originally conceived as a remote-controlled vehicle for moon missions. Six decades after, one can already take a ride in Google Waymo's self-driving taxi, across several cities in the Metro Phoenix Area. Since transportation is the second largest household expenditure, high investments have been made in Autonomous Vehicles development, however there are still important factors to keep in mind. Namely, the technology employed is still encountering important drawback, infrastructure readiness, comprehensive regulation, and adoption – a recent survey verified that 71% of respondents are still afraid of riding an autonomous vehicle.

The later future AI-area of impact mentioned by Taulli (Taulli, 2019) is **Social Good**. AI, as a promising technology of the future, can accelerate solving world's most challenging societal problems (Chui et al., 2018). More and more, the world witnesses' different organizations challenging data practitioners to put the technology at the service of society through platforms (ex.: Kaggle and DrivenData), hackathons (ex.: IBM Big Data for Social Good Challenge, Thorn hackathon or the Bayes Impact hackathon), new academic programmes (ex.: Data Science for Social Good), the UN Global Pulse Labs, corporate funding programmes (such as Google AI for Good Grants, Microsoft AI for Humanity or Mastercard Center for Inclusive Growth) or through the organization of meetups and events focused on discussing AI for social good, a rising trend as corporations are increasingly pressured to answer the call for purpose, this is, develop innovative solutions with impact.

In conclusion, an undeniable progress was made in the AI field. A progress that, according to Alan Turing (Russell & Norvig, 2020) also reflects what still remains to be done. Regardless of all mentioned adverse challenges AI might bring to the future, there is an endless road of opportunities where AI truly has the promise for being transformative. The targeted applications of AI to the domain of social good are, indeed, the central topic of this academic work. Leading us to the next section, where social good definitions and concepts are clarified to facilitate the later definition of a Guidebook.

2.2. SUSTAINABLE DEVELOPMENT

2.2.1. SUSTAINABILITY CONCEPTS AND BACKGROUND

As reported by Higgins (Higgings, 2014) humans have long shown interest in sustainability and its practices, manifested for example through the irrigation technology of the ancient Egyptians or the ecological engineering used by the Mayans to conserve water and food. Fighting for survival and looking towards the future to assure the specie's subsistence is inherent to the human nature (Cribb, 2017). However, the modern concern with environmental and human issues increased mostly in the second half of the 20th Century.

According to Charles Kidd (Kidd, 1992) the word "**sustainability**" was first used in 1972, in a British Book, *Blueprint for Survival*, a manuscript intended to draw attention to the urgency and magnitude of environmental problem. There were different intertwined intellectual and political streams of thought that historically contributed to the sustainability concept, namely, the conservation movement of the early 20th century, the environmental movement, of the 1960s and early 1970s, the "no growth" philosophy of the early 1970s, the discipline of ecology, the counter-technology movement, the resource/environment concept and the global model approach.

In the same year of **1972** (Atapattu, 2019b) a first global conference on the environment was held at the invitation of the Nordic countries, the **Stockholm Conference on the Human Environment**, after which the **United Nations (UN)** Environmental Program was formed. "Sustainability " was first used in a United Nations document in **1978**, part of the former program. The United Nations indeed played a

pivotal role in the emergence of sustainability. Across time, the institution's conferences and reports were crucial to challenge conservative industrialized opinions in defence of the environment, as one can witness in Atapattu journal article. Here, the author takes us to a journey through the **main milestones on the evolution of sustainable development**, outlining six additional important moments following the Stockholm Conference:

(It is important to note that, as outlined by Zagelmeyer (Zagelmeyer, 2019) numerous other international initiatives were held and hosted parallelly by the United Nations, related with Business and Human Rights)

- **Appointment of the WCED and Our Common Future Report:** In **1987**, UN General Assembly appointed the World Commission on Environment and Development (WCED), who would publish the Brundtland Commission Report. This report includes the most cited definition of the term presently (Roostaie et al., 2019) according to which **sustainable development** is *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs".*

- **UN Conference on Environment and Development (UNCED)**: In **1992**, the international community gathered in this conference to adopt the Rio Declaration on Environment and Development, reaffirming a former declaration adopted at Stockholm, and seeking to build upon it. The declaration defined sustainable development in 27 principles (Leipziger, 2015). Besides the Rio Declaration (Nations, n.d.), the UNCED also known as the "Earth Summit", had other great achievements including the Convention on Biological Diversity, the Declaration on the principles of forest management and the United Nations Framework Convention on Climate Change (UNFCCC). A convention that would later be supplemented by the Kyoto Protocol in 1997 (Uddin, 2021).

- **World Summit for Social Development:** A newer declaration was adopted at the World Summit for Social Development, held in Copenhagen in **1995**. It officially introduced a third social pillar or dimension to sustainable development, providing that it includes (1) economic development, (2) social development and (3) environmental protection. The social pillar has put human rights and environmental justice under the umbrella of sustainable development.

- **World Summit on Sustainable Development:** Held in **2002**, in Johannesburg to commemorate the 20th anniversary of the Stockholm Conference and the 10th anniversary of the Rio Conference, the Summit built upon the United Nations Millennium Declaration of the year 2000, signed by 198 UN member states and over 20 international organizations. This declaration marked the beginning of the millennium and led to the creation of 8 **Millennium Development Goals (MDGs)** (United Nations, 2015b) including a total of 18 targets and 60 indicators which the international community should commit by 2015. The initial version of the goals, targets and indicators was used until 2007, when a revised MDG framework became effective, including instead 21 targets. Figure 1 provides as overview of those goals and associated targets.

Figure 1 - Millennium Development Goals (MDGs) (*Unstats | Millennium Indicators*, n.d.)

During the final years of the MDGs, the United Nations System Chief Executives Board for Coordination (CEB) promoted the MDG Reviews, which brought together UN and World Bank Group staff to systematically identify the country situation, the bottlenecks to MDG attainment, and potential solutions to be implemented. The reviews took place in sixteen countries from across the world and the Pacific Island countries and strongly advocated for cross-sectoral and cross-institutional thinking within the UN system to accelerate progress on off-track MDG targets. When analysing the key observations and lessons learned from these country reviews, the UN and the World Bank listed the subsequent 10 key takeaways.

1. Acceleration can happen, but it depends on the timeliness and effectiveness of policy instruments
2. High-impact programs depend on the efficient allocation of resources
3. Recognizing and identifying the interrelatedness of development goals at the onset is fundamental
4. Strong government involvement ensures the greatest impact of MDG-related interventions
5. Lack of quality data and analysis poses a serious constraint to timely monitoring, policy development and the ability to target interventions where most needed
6. Promoting system-wide institutional coherence in the United Nations is critical for integrated policy support and accelerated progress
7. High-level global UN system advocacy can energize acceleration in countries
8. Communities and community mobilization are central to achieving development results
9. Achieving long-term development requires bridging the humanitarian and development agendas
10. Normative agenda: Role of the UN system in pushing for inclusion of issues that may have been deprioritized at the country level

The progress report published by the UN by the end of the MDG period (United Nations, 2015a) argued that regardless of uneven achievements and shortfalls in many areas, the world had reasons to celebrate. This optimism was visible in targets reached ahead of schedule (UNDP & World Bank Group, 2016) like extreme poverty reduction (MDG 1.a), access to safe drinking water (MDG 7.c) and improving the lives of at least 100 million slum dwellers (MDG 7.d) By 2015 other targets including gender equality in primary and secondary education (MDG 3.a) and the incidence of malaria (MDG 6.c) have also been met.

However, progress on the MDGs related for example with infant, child and maternal mortality (MDGs 4a and 5a), and access to basic sanitation (MDG 7c) were lagging behind by 2015. In fact, many countries have missed one or more of the MDGs targets for 2015. Additionally, progress towards the MDGs varied sharply across the globe, with South Asia and sub-Saharan Africa being off target on most of the goals, and along the rural-urban divide, with people living in cities witnessing far more development progress than those in rural areas.

Despite the positive results outlined above in the progress report, the later more negative results are what moved experts and sceptics from different fields to identify limitations, criticisms, and missing factors on the MDGs and to urge for a post 2015-Agenda. (Sen & Mukherjee, 2014) since, as the numbers show, for millions of people around the world the job remained unfinished, urging for a new initiative arising at the Rio+20 Conference.

- **Rio+20 and the Future We Want:** As the end of the MDG period approached, the international community gathered once more in 2012 at Rio to adopt a document titled "The Future We Want" leading to the definition of the Sustainable Development Goals (SDGs) ((United Nations Development Programme, 2021)), set to replace the MDGs, embracing their legacy and lessons learned.
- **Agenda 2030 and the Adoption of Sustainable Development Goals:** The year of 2015 marks the last sustainable development milestone referred by Atapattu (Atapattu, 2019). At the UN Framework Convention on Climate Change, the international community adopted the **Paris Agreement** on Climate Change and the 2030 Agenda for Sustainable Development containing 17 SDGs with 169 targets. What sets this agreement apart from previous conventions is that it obliges all parties to pledge serious efforts to address climate change (Horowitz, 2016). The Kyoto Protocol for example, only placed enforceable duties on wealthier nations while the Paris agreement places all parties under a duty to reduce greenhouse gas emissions in accordance with their own nationally determined contributions (NDCs) (Uddin, 2021). According to Atapattu (2019), the Paris Agreement has three stated objectives: (1) to hold the increase in global average temperature to "well below" 2 degrees Celsius above pre-industrial levels; (2) to increase the ability to adapt to the adverse impacts of climate change; and (3) to make financing flows consistent with both of the above.

An additional, very recent milestone can be added to those stated by Atapattu (2019) on the evolution of sustainable development.

- **COP26:** Last year, 2021, was the 26th Annual Summit of COPs (Conference of the Parties) in Glasgow, United Kingdom. COPs was established by the UN to advance the objectives of the Paris Agreement (Arora & Mishra, 2021). The four goals set to achieve at the COP26 included (1) securing global net zero carbon by 2050, (2) protecting communities and natural habitats, (3) ensuring developed countries keep their promise of organizing USD 1000 billion for climate finance per year and lastly (4) working together to deliver on the promises of Climate change. Prior to the conference, important and contradictory steps were given by China and America in the urge for implementation. The American president Joe Biden (O'Riordan & Chakroff, 2021), unlike his predecessor, committed to the UN's 2050 net zero target, nominating the first U.S. Special Presidential Envoy for Climate Jon Kerry. On the contrary, China only committed to achieve net-zero emissions by 2060, "less ambitious than many had hoped" (Geall, 2021).

As stated by Arora and Mishra (2021), climate change mitigation efforts, which were the core of COP26 summit, are also a roadmap to Sustainable Development Goals 2030 (SDGs 2030).

2.2.2. THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

The SDGs were crafted by a UN Open Working Group (OWG) (Woodbridge, 2015) established in 2013, after Rio +20 Conference above mentioned. The group was made up of 70 countries, committed to incorporate a wide range of stakeholders into the process, including local and subnational governments and prominent actors from civil society and the private sector. As the MDGs had been widely criticized for its "developing" versus "developed" dichotomy, the working group also insured developing countries provided significant input into the negotiation.

The result was the 2030 Agenda for Sustainable Development including 17 universally applicable, integrated objectives accompanied by a total of 169 concrete targets and 232 indicators, nurtured from the MDGs, as expressed in figure 2, embedding the three dimensions of sustainable development – social, economic, and environment (Ekhator et al., 2022).
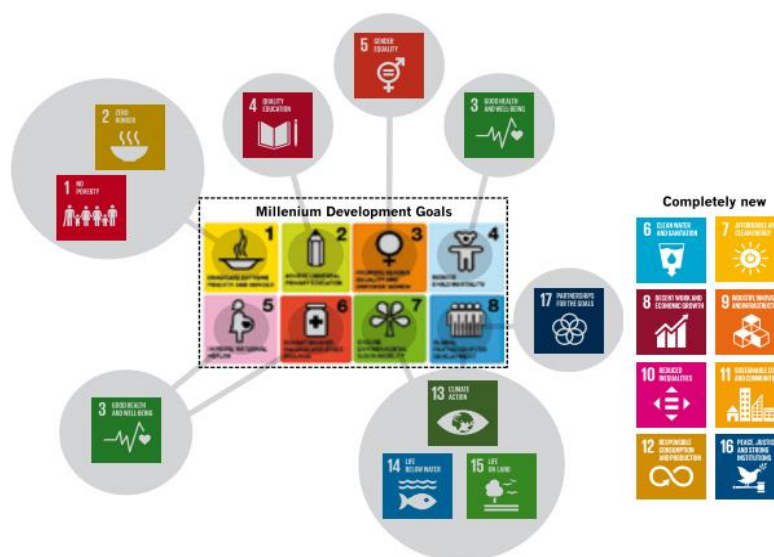
Figure 2 – Evolution from MDGs to SDGs (Zagelmeyer, 2019)

A summary of all 17 Sustainable Development Goals can be found in the table below.

Table 2 – Sustainable Development goals (United Nations Statistics Division, 2022)

#	Goal Title	Target Example
1	End poverty in all its forms everywhere	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round
3	Ensure healthy lives and promote well-being for all at all ages	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes
5	Achieve gender equality and empower all women and girls	End all forms of discrimination against all women and girls everywhere
6	Ensure availability and sustainable management of water and sanitation for all	By 2030, achieve universal and equitable access to safe and affordable drinking water for all
7	Ensure access to affordable, reliable, sustainable and modern energy for all	By 2030, ensure universal access to affordable, reliable and modern energy services
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
10	Reduce inequality within and among countries	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average
11	Make cities and human settlements inclusive, safe, resilient and sustainable	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
12	Goal 12. Ensure sustainable consumption and production patterns	By 2030, achieve the sustainable management and efficient use of natural resources
13	Take urgent action to combat climate change and its impacts	Strengthen resilience and adaptive capacity to climaterelated hazards and natural disasters in all countries
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Significantly reduce all forms of violence and related death rates everywhere
17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	Mobilize additional financial resources for developing countries from multiple sources

2.2.3.   SUSTAINABLE DEVELOPMENT CHALLENGES

Besides involving developing countries in the crafting process of the new objectives, the OWG had to take into consideration other criticism made MDGs in the drafting of post 2015-Agenda. These criticisms represent **challenges** to overcome in the implementation of the new SDGs, expected to fulfil the promise of the MDGs.

According to Woodbridge (Woodbridge, 2015) critics often mentioned the need to ensure goals' applicability to all countries of the world (developing and developed) and to guarantee a balanced regional and thematical progress across objectives (avoiding global discrepancies and countries choosing to engage with some but not all of the MDGs). Additionally, the UN (2012) themselves agreed on the need to incorporate missing targets such as decent work conditions, human rights, governance, security and peace and to avoid the lack of real-time data (UN, 2015) and inconsistencies between some goals, its targets and indicators (UN, 2013). Finally, authors like Kenny et al. (2011), or Andrews et al. (2015) criticised the need to create and implement effective strategies and policy actions beyond just objectives and targets.

Apart from the lessons learned out of the MDGs, Fukuda-Parr (2016) mentions an additional challenge that should be taken into consideration for the future: funding. Seventeen trillion dollars is the estimated amount needed to implement and monitor the SDGs, a quantity that raises a challenge for both developing and developed countries, with the latter being asked to leverage their national capital for internal implementation while providing a portion for the developing countries to complete their journey.

However, as stated in the UN's 2022 Sustainable Development Goals Report (United Nations, 2022), the **current global perspective**, with its cascading and interlocking crises, namely COVID-19, climate change, and emerging conflicts, such as the Russia-Ukraine war**, is the main impediment to achieving the SDGs**, with spill over effects on food and nutrition, health, education, the environment, and peace and security. For example, more than 4 years of progress against poverty has been erased by COVID-19, disaster-related deaths rose sixfold in 2020 and the world is enduring the highest number of conflicts since UN creation, with around 6.5 million refugees leaving Ukraine alone.

Given this global situation according to UN Secretary-General António Guterres "we need an urgent rescue effort for the SDGs" (United Nations, 2022), an urgency that drives the development of research like this dissertation, which provides the industry with a new artifact aimed at accelerating the adoption of the SDGs.

2.3. SYSTEMATIC LITERATURE REVIEW (SLR) ON AI & SUSTAINABLE DEVELOPMENT

After understanding the concepts revolving around AI and sustainability separately, a thorough review of existing literature on the intersection between the two concepts is required to answer our main research question: *How to leverage AI for sustainable business development?*

This Systematic Literature Review (SLR) (Page et al., 2021) will not only synthetize the state of knowledge for sustainable AI applications, ensuring that this study presents something new to the academic community, but also address questions that otherwise could not be answered by this individual study alone, identify research problems to be rectified and generate theories that will then corroborate and support the artifact of this dissertation.

2.3.1. SLR METHODOLOGY – PRISMA & RESULTS

For a more detailed SLR, observational studies propose leveraging the **PRISMA** methodology. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) represent widely endorsed guidelines to conduct a SLRs, published in 2009 and now cited by over 60.000 reports, making it the most suitable methodology to be followed for the SLR of this dissertation. Figure 3 presents a flow diagram of the review process, adapted from PRISMA.

Following PRISMA guidelines, the **1st Phase – Identification** when developing a Review Protocol involves choosing **the most suitable databases** for research. For the purpose of this dissertation three databases were used: Scopus, ISI Web of Science (WoS) and Google Scholar, since these respectable repositories facilitate the search for literature, articles, thesis, books, and abstracts, as well as academic editors, professional societies, online libraries, and universities, across a range of disciplines. Additionally, the Identification Phase also requires defining **the right query string** that will be used to identify the most relevant sources. Several attempts were made with 41 different query strings, experimenting different combinations of keywords to ensure full coverage of the main research question of this dissertation. The defined query string was the following:

("Artificial Intelligence" OR "AI") AND ("Sustainable Business Development")

This listed query yielded a total of (n=573) publications, these records identified by data source are distributed as follows: Google Scholar (n = 569), Scopus (n = 3) and ISI Web of Science (n = 1).

PRISMA's **2nd Phase – Screening**, consists of filtering the publications that meet the different exclusion criteria defined. The first criterion applied in this SLR was the removal of **articles published before 2017**, assuming that all publications from the last 5 years will incorporate the most recent state of knowledge in the field, perpetuating relevant older know-how if required. A total of (n=217) records were excluded based on this criterion. Subsequently, other (n=50) records were excluded for being **written in a language different than English**, which inhibits the authors ability for rigorous analysis. The next exclusion criteria aimed at the deletion of **duplicated articles**, as a consequence (n=10) records were removed since they appeared more than once across the selected databases. After screening publications based on date, language and duplication, the focus was on excluding unsuitable records based on the revision and analysis of their title, resulting in the exclusion of (n=151) publications. **Title screening** was complemented **Abstract screening**, this is, the removal of publications encompassing Abstracts that were clearly outside and/or not directly related to the scope of this systematic literature review and thus would not help us tackle our main research question. As a result (n=94) records were

removed. Additionally, it was not possible to access all the listed records, due to source's **unavailability** or limited access, leading to the exclusion of (n=13) additional sources.

In summary, considering all exclusion criteria, a total of (n=535) records were removed during the Screening Phase, indicating there were (n=38) eligible articles to be analysed in the **3rd Phase** of PRISMA's methodology – **Eligibility.** During this phase a full-text analysis is performed to analyse in detail the publication content and its significance to the topic at study. After reading the remaining records in full, some publications were still excluded (n=17), leading to a total of (n=20) articles to be included in the investigation.
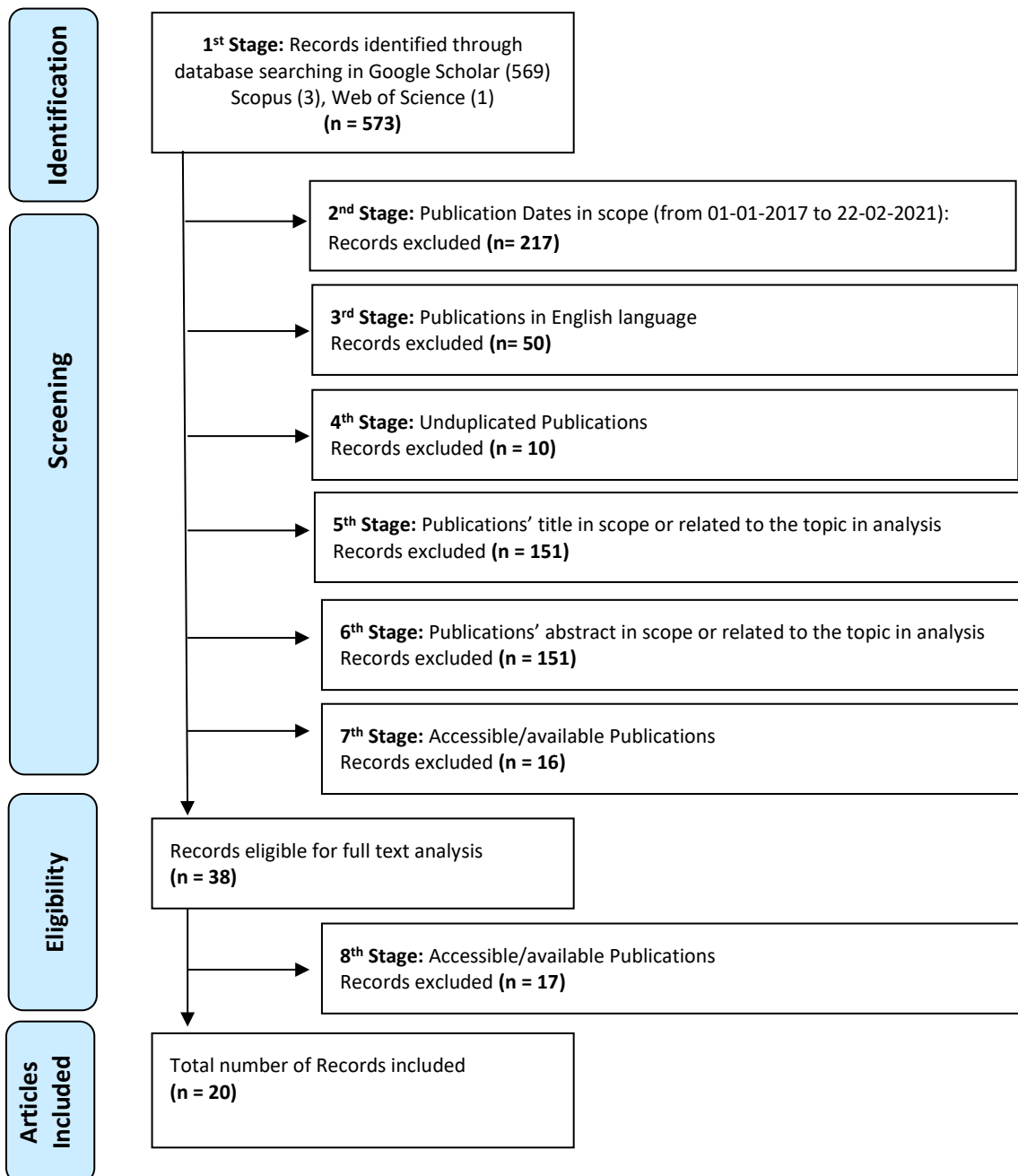
Figure 3– PRISMA flowchart

2.3.2. SLR DISCUSSION
2.3.2.1. ARTICLES OVERVIEW

Following the final selection, the included articles papers were annotated to demonstrate their vital importance and relevance in light of the research issue. This section will summarize the main findings of the selected articles and discuss their limitations, with the goal of better understanding what existing and emerging AI applications can help speed up the path to sustainability, accomplishing one of our research objectives.

To better organize and discuss included articles, a table is presented in Appendix A, showing the article's title, the reference including the year of publication, and a small content summary aligned with the objective of this SLR. Among the 20 articles selected to be included in the investigation, 4 are systematic literature reviews, 2 represent conference proceedings, 1 is a published book and the remaining 13 are journal articles. The selected articles were published between 2017 and 2021. Fig 2 presents a chronological distribution of the records which shows a growing trend in publications referring to AI and Sustainable business development. It is important to bear in mind that the query string was retrieved in the beginning of 2021 (February), justifying the decline in publications for this last year.
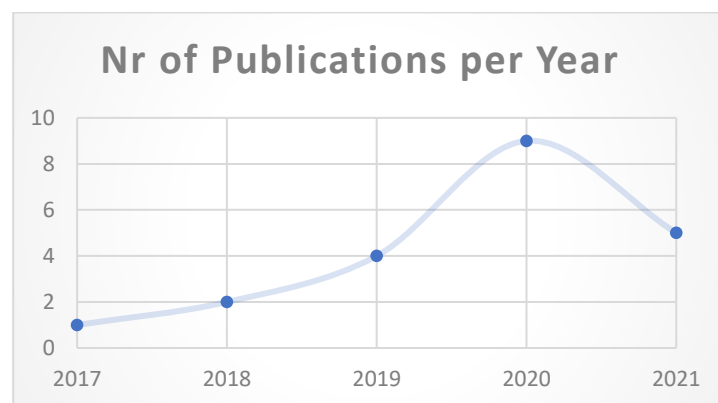
Figure 4 – Nr of publications per year

Let's begin by emphasizing the **topics consented by the various authors**, starting with the growing global concern about sustainable development, already referred to as a motivation for conducting this study. Yazdani et al., (2017) refer to it as the growing worldwide awareness for environment and sustainability, that together with stringent government directions, and increasing community knowledge, urge organizations to include sustainability concerns in the business. A reality also corroborated by (Luthra & Mangla, 2018) who state that organizations are indeed seeking to adopt sustainability aspects in their business activities. Some authors even dig deeper on the reasons behind this increasing sustainability concern. According to (Marquardt et al., 2019) businesses who worry will be the ones able to compete most effectively encourage and gain larger market shares. (Gupta et al., 2021) name the different benefits of sustainable businesses: environmental benefits, cost savings due to reduced packaging waste, reduced health and safety costs, better work environment, low cost of

worker turnover, low labour cost, guidance in shaping future regulations, shorter lead times, better product quality and most importantly, enhanced market reputation.

Another view shared by most of the selected articles is related with the fact that <u>digital is the next sustainability frontier</u>. Authors agree that the adoption of digital technologies, and specifically big data & predictive analytics, can strongly accelerate the road for sustainability. In the article of (Shayganmehr et al., 2021) technical capabilities, including the application of machine learning systems and big data, are considered the most important enablers with the strongest effect on cleaner production and circular economy implementation. Similarly(Bhamra & Hernandez, 2021)) state that AI will enable and also enhance the transition to a circular economy. In the words of (Roblek et al., 2020) the "*development and establishment of data analysis, machine learning, and artificial intelligence, (…) is crucial for the implementation of the processes, which will also affect the emergence of the potential of all three dimensions of sustainability*". This matter is indeed the central artifact of (Raut et al., 2019) study, who propose a conceptual model exploring the mediator role of Big Data Analytics (BDA) between Sustainable Business Performance and other seven factors namely (1) Management and Leadership Style, (2) State and Central Govt. Policy, (3) Supplier Integration, (4) Internal Business Process, (5) Quality Management, (6) Customer Integration, (7) Green Lean Practices (GLP).

The selected papers also show a common tendency to directly or indirectly <u>give advice on how to leverage these digital technologies for Sustainability</u>. 6 out of the 20 relevant papers actually make these recommendations the central artifact of their studies, either through the highlight of challenges to be aware or through the identification of best practices.

For example, (Luthra & Mangla, 2018) study's main objective is the prioritization of 18 key challenges to Industry 4.0 initiatives for developing sustainability in supply chains. (Dumitru & Stanculescu, 2020) also focus on the top 3 sustainability problems of today, highlighting how digital transformation / AI can contribute both positively and negatively.

Regarding best practices, (Chiappetta Jabbour et al., 2020) for example, offer 4 lessons for business practitioners aiming to use big data for sustainable supply chain practices, while (Dumitru & Stanculescu, 2020) list 8 actions for all management teams to improve sustainability. Similarly, (Isensee et al., 2020) summarize 6 propositions to encourage SMEs on the promotion of sustainable, digital development through organizational culture development. Finally, (Shayganmehr et al., 2021) and (Gupta et al., 2021) also provide guidelines for sustainability through the identification and prioritization of several Industry 4.0 enablers for a cleaner production (CP) and circular economy (CE) and several practices of circular economy, Industry 4.0, and cleaner production respectively.

For the remaining 13 papers, indirect advice is provided through the exemplification of potential AI applications for sustainability, detailed on the previous section.

If we were to categorize the different articles, they differ mainly in the width of the scope at study. Articles [1], [8] and [17] for example, explore a specific AI application for a very specific sustainability concern, proposing AI algorithms for the selection of green suppliers or logistics providers. Quite a narrowed scope when compared with articles [3], [4], [5], [11], [12], [18],[19] and [20] that

explore different AI applications across the business value chain with impact in the different sustainability dimensions.

There is also a clear distinction between articles studying a specific business industry, namely manufacturing ([1],[3],[4],[13], [18] and [19]) and tourism ([9]), and the remaining with a cross-industry nature ([2], [5], [6], [7], [8], [10], [11], [12], [14], [15], [16], [17] and [20]). The former articles rely heavily on the concept of Industry 4.0, which refers to the fourth industrial revolution. It began at the start of the XXI century, resulting from the embeddedness of the latest technologies (sensors, RFID devices, IoT, big data analytics, artificial intelligence, 3D printing etc.) into various physical equipment for real-time exchange of data and flexible manufacturing systems (Gupta et al., 2021) Industry 4.0 has the potential to revolutionize and handle 70% of the 169 targets underpinning the SDGs. The prevalence of literature analysing the manufacturing industry specifically leads one to believe that this industry is a first mover on the sustainability transformation journey.

2.3.2.2. AI APPLICATIONS FOR SUSTAINABLE DEVELOPMENT

As mentioned earlier, the main objective of this SLR is to identify the established an emergent AI applications that can help accelerate the road to sustainability. In fact, all relevant articles mentioned at least two applications, thoroughly summarized in Appendix B.

A complementary exercise was performed to assess which SDGs would be directly impacted if those applications were triggered. As it can be observed in Figure 5, the selected articles gave more examples of AI applications contributing for Responsible Consumption and Production (SDG 12), explained by the fact that, as mentioned before, several articles analyse specifically the manufacturing industry.

Figure 5 - # publications per SDG

In contrast, none of the relevant articles gave specific examples of AI applications with direct impact in SDGs 1 (End Poverty), 4 (Quality Education), 5 (Gender Equality), 9 (Industry Innovation and

Infrastructure) 10 (Reduced Inequalities) and 16 (Peace, Justice and Strong Institutions). Both (Chiappetta Jabbour et al., 2020) and (Dumitru & Stanculescu, 2020) articles demonstrated AI can be applied across all 3 sustainability pillars, and therefore the contribution of these two articles was the only accounted for these SDGs.

2.3.2.3.   SLR KEY FINDINGS

In summary, through a synthesis of the literature review, one can infer that AI and sustainable development are two emerging research agendas and their adoption may vary across industries, with the manufacturing industry being prominently featured in the relevant articles, and across companies with different dimensions, with SMEs facing more barriers for implementation.

These conclusions were drawn upon the gaps existing in the literature that this dissertation is seeking to fill in its novelty.

I.   **SDGs Aloofness:** As the different authors propose different AI applications, they are unable to evaluate their contribution at the SDG level. Recalling a previous point, authors like (Chiappetta Jabbour et al., 2020) and (Dumitru & Stanculescu, 2020), align AI applications with the 3 sustainability pillars, but there is no deeper analysis per SDG. (Dumitru & Stanculescu, 2020) themselves provide an explanation for this gap, stating that *"because AI is so novel and under constant evolution, its full impact on the SDGs is difficult to quantify and reliably predict"*;

II.   **Industry Focus:** There are significantly more scientific articles studying AI's impact in the sustainable development of manufacturing firms specifically. Analyzing more than one search string, each specified per industry might have helped overcome this challenge, however, a broader approach was chosen for this dissertation, where one expected examples from a multitude of industries, which didn't happen. Still, it is important to outline that, as stated by (Marquardt et al., 2019), "*the importance of using sustainable resources to manage the reduction of the ecological footprint (…) [is] not only to the manufacturing industry but also to other industrial sectors, the stakeholders and shareholders as sustainable business always includes the entire value chains*".

III.   **Startups & SMEs Specificity:** Only one out of the 20 relevant articles analysed the SMEs' context in particular. According to (Isensee et al., 2020) in the EU, SMEs represent about 99% of all businesses,. XXX , therefore one would expect further advise given to these types of companies in broader scope articles, or a separate sampling considered in the methodology, considerations overlooked by previous studies. The same applies for the start-up reality, evaluated solely by one of the relevant articles, where the authors (Bernal & Alba, 2018) propose a framework on the capabilities needed for Sustainable Entrepreneurship integration in start-ups. Surprisingly, nor digital or technological capabilities are proposed;

The scope of the research questions included in this dissertation will only contribute for the first two identified gaps.

3. METHODOLOGY

This dissertation must go beyond the literature review's single listing of established and emerging AI applications for sustainable business development; it must also provide an explicit solution to the main research problem, focusing on the "HOW." (*How to leverage artificial intelligence for sustainable business development?).* Thus, it will leverage Design Science Research (DSR) methodology for information systems, enabling the main asset of this dissertation to be an artifact for AI-accelerated road for sustainability.

3.1. INTRODUCTION TO DESIGN SCIENCE RESEARCH (DSR)

Design Science, which has its roots in engineering and the artificial sciences, was first introduced in 1969 to address the inability of traditional sciences, such as natural science and social science, to prescribe solutions and methods or to design new artifacts for solving given problems.(Deng & Ji, 2018) DSR is a problem-solving-oriented research paradigm, increasingly embraced by Information Systems (IS) researchers due to its ability to balance research business significance or relevance and academic rigor.

Even though different researchers had already brought design research into the IS research community, it was only in 2004 when Hevner et al. (2004) presented seven explicit guidelines to conducting DS research in the IS discipline, summarized in the table attached in Appendix C. These practice rules for conducting DSR in IS, are based in a conceptual framework presented by the authors for "understanding, executing and evaluating IS Research". According to this Information Systems Research Framework, presented in Appendix D, IS research is conducted in two complementary phases: **Develop/Build** and **Justify/Evaluate**, from which an artifact is derived that is applicable in the appropriate **environment** and that must contribute to the existing **Knowledge base**.

3.2. DSR APPLIED

For the purpose of this dissertation, what is most relevant to acknowledge is how will these complementary phases, proposed by Hevner et al. (2004) be applied in light of this study's specific objectives. This is indeed the exercise performed thereafter:

- According to Hevner et al. (2004), IS Research should start by **defining the problem** space or the environment, this content is summarized in the introductory section of this dissertation, subdivided in the context, motivation and objectives sub-sections, assuring research relevance.
- After framing the business need or "problem", **Develop/Build** activities should be triggered where the actual artifact is created. The artifact for this study is a Guidebook for the Identification and Prioritization of Sustainable AI Applications / Use Cases, summarized in Appendix E. The need for such artifact arises from the literature review where the authors effortlessly acknowledged the role of Artificial Intelligence (also referred to as Big Data and Predictive analytics) as an accelerator of sustainable business development but highlight companies urgent need for guidance on the "How". As stated by (Marquardt et al., 2019) the biggest challenge for entrepreneurs is "to fully understand the diverse potential of the functions

of artificial intelligence to support a green business model and learn how to implement them in their business operations".

The guidebook proposes 3 steps to help companies acknowledge their current (AS IS) state in terms of SDG performance and AI application, completed by other 3 steps dedicated to the conceptualization of the future (TO BE) state. After completing all steps, companies will have available an AI applications / use cases Catalog listing several initiatives, evaluated in terms of sustainable value and complexity, that materialize how to leverage AI for sustainable business development.

By doing so, this guidebook addresses several literature gaps identified by (Chiappetta Jabbour et al., 2020), namely to push forward efforts in using big data to model sustainable supply chains, to contribute for a data-driven culture fostering successful big data initiatives, to conduct more empirical research on BDPA's support in promoting resilience in sustainable supply chains and to explore the challenges and barriers faced by companies implementing big data analytics to improve sustainable supply chain management. The guidebook also answers to (Raut et al., 2019) request to deliberate on sustainable business and Big Data Analytics jointly, as opposed to what is currently done by the literature. And, as a final example, such artifact will also help tackle 7 organizational (OR) and strategic (ST) challenges out of the top 18 challenges to industry 4.0 initiatives for sustainability in supply chains(Luthra & Mangla, 2018) namely: (OR2) Low management support and dedication; (OR3) Reluctant behaviour towards industry 4.0; (OR4) Poor company digital operations vision and mission; (OR6) low understanding on Industry 4.0 implications; (ST2) Poor research & development on Industry 4.0 adoption; (ST3) Unclear economic benefit of digital investments and (ST4) Lack of digital culture.

Further details on the assumptions made for the design of the guidebook and on the design process itself are presented below in sections 4.1 and 4.2 respectively.

- Development/Built activities should undoubtably be followed by **Justify/evaluate activities** mandatory for research assessment. In this study a qualitative evaluation will be performed through 2 different focus group meetings, composed by a mix of AI, Big Data and Sustainability experts. Firstly, these experts will be asked to share their view on the guidebook proposed and to comment on its added value to companies in general and to sustainability research as a whole. In addition, they will also be asked to criticize the given guidebook, identifying the improvements and enhancements needed. The results of this phase are further detailed in section 4.4. Focus group meetings in this study act both as an assessment and as a communication instrument. In alignment with Hevner's Guideline 7, in these meeting the research was presented both to technology-oriented as well as management-oriented experts.

  Besides the focused Group meetings the results achieved by the application of this study's artifact will also be shared with the scientific community through the presentation and publication of this work to Nova IMS as a partial requirement for obtaining the Master's degree.

- As remarked by the same authors, (Hevner et al., 2004), evaluation activities can result in the identification of weaknesses in the artifact and the need to refine or reassess. Even though this process is typically described in future research direction, this study takes a step further by straightly incorporating some of the experts feedback in a refined version of the Guidebook available in section 4.4.

4. GUIDEBOOK FOR THE IDENTIFICATION AND PRIORITIZATION OF SUSTAINABLE AI APPLICATIONS / USE CASES

Based on what was studied in the Literature Review it was possible to define certain guidelines that translate the best practices used to design this dissertation's artifact, described in the section below.

4.1. GUIDEBOOK DESIGN

In the fight against sustainable business inertia, and in general, companies are mostly driven by the acknowledgment of practical initiatives performed in other companies. With AI this is no different. Understanding what AI applications are being leveraged by others for sustainability, enlightens companies on what they can do themselves, unleashing the power of exemplification - the foundation for this dissertation's artifact. Consequently, the design of the Guide Book for the Identification and Prioritization of Sustainable AI Applications / Use Cases and its 6 steps (presented in the figure below) was primarily influenced by this ideal of empowering sustainable transformation by example.
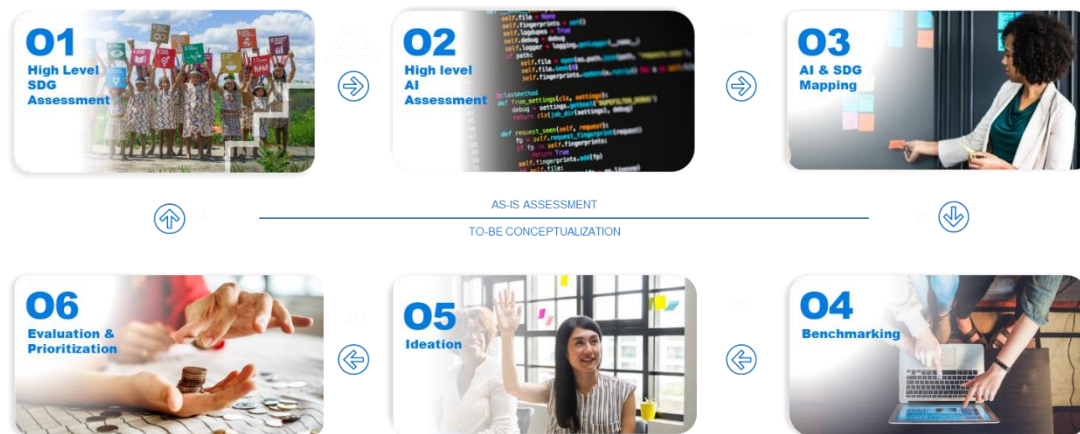
Figure 6 – Guidebook Overview

However, before looking for examples, companies need to perform an in-debt analysis of where they currently stand, to know exactly what examples to look. This need led to the creation of the 2 initial steps of the Guidebook: **(1) High Level SDG Assessment** and **(2) High Level AI Assessment**.

An important matter bearded in mind in the design of the Guidebook, was how Sustainability and AI can be easily dissociated, meaning a company can be highly sustainable without leveraging AI or highly automated and unsustainable. This is why the assessment steps had to be necessarily complemented by a third step of **(3) AI & SDG Mapping**. This step ensures the matching between the central topics of this dissertation, enabling an accurate answer to the question of how is the company currently leveraging AI for Sustainable Business development.

Steps 1, 2 and 3 complete the <u>AS-IS Assessment</u> , where companies should be able to describe their starting point in terms of SDG and AI adoption across the business, with a clear view on what Sustainable AI Applications are currently in place.

Thereafter, companies can engage in the TO-BE Conceptualization, composed by steps 4, 5 and 6, starting with the search for examples of sustainable AI applications performed in the fourth step **(4) Research & Benchmark,** that is now personalized and targeted to companies' current state. The results of the systematic literature review presented above, can serve as an accelerator of that research, since they provided a comprehensive list of all the published applications of AI for sustainable business development, presented in the Appendix B.

Knowing their reality and what others have already done, companies resort to ideation to propose new practical initiatives that can accelerate their own road to sustainability, and thus engaging in the fifth step of the Guidebook **(5) Ideation.**

Finally, in the sixth stage **(6) Evaluation & Prioritization** a rank must be established among the proposed initiatives since, as stated by (Luthra & Mangla, 2018), there are several challenges that can inhibit implementation, and therefore should be carefully evaluated.

To conclude the overview of the guidebook it is important to denote its cyclical nature, explained by the fact that the ideas and initiatives generated and prioritized after completing all 6 steps will then feed into the next Prioritization Cycle, enriching continuously the known list of practical initiatives performed by other companies with potential to be developed internally.

After acknowledging the design rational for this dissertation's artifact, schematized in Appendix E, it is crucial to dive into each step understanding its contribution to the overall cycle and to the research objectives.

4.1.1. STEP 1: HIGH LEVEL SDG ASSESSMENT

To begin with, Step 1 advises companies to leverage **SDG Action Manager**, a free online tool launched in January 2020 (B Lab & United Nations Global Compact, 2020) bringing together B Lab's B Impact Assessment and the Ten Principles of the UN Global Compact. This tool will provide companies with a comprehensive overview on SDG performance and their corresponding score evaluation to understand strengths and potential areas of improvement, targeted to the companies' size and industry.

SDG Action Manager is structured in different modules: the Baseline Module, complemented by specific modules for each SDG. The tool recommends companies on which SDGs to focus on given their context, in accordance with World Benchmarking Alliance Industry to SDG Mapping, shown Appendix F. Therefore, to avoid an overly extensive assessment covering all SDGs, companies should complete at least the 27 questions of the Baseline Module, listed in Appendix G, and the corresponding questions of the recommended SDGs to complete Step 1.

In addition, companies should also go through the final list of proposed targets and indicators, made available in the https://unstats.un.org/sdgs/indicators/indicators-list/ website, related with their industry specific Sustainable Development Goals. An exercise that will lead to a deeper understanding of the measures of impact to which the company can most probably contribute.

Objectives
• Understand companies general commitment to human rights, labour practices, environmental management systems and good governance
• Highlight key practices and measures to help achieve a particular SDG
• Acknowledge targets and indicators related with the industry's SDGs

Templates

SDG ACTION MANAGER   EXCEL LIST OF PROPOSED SDGs
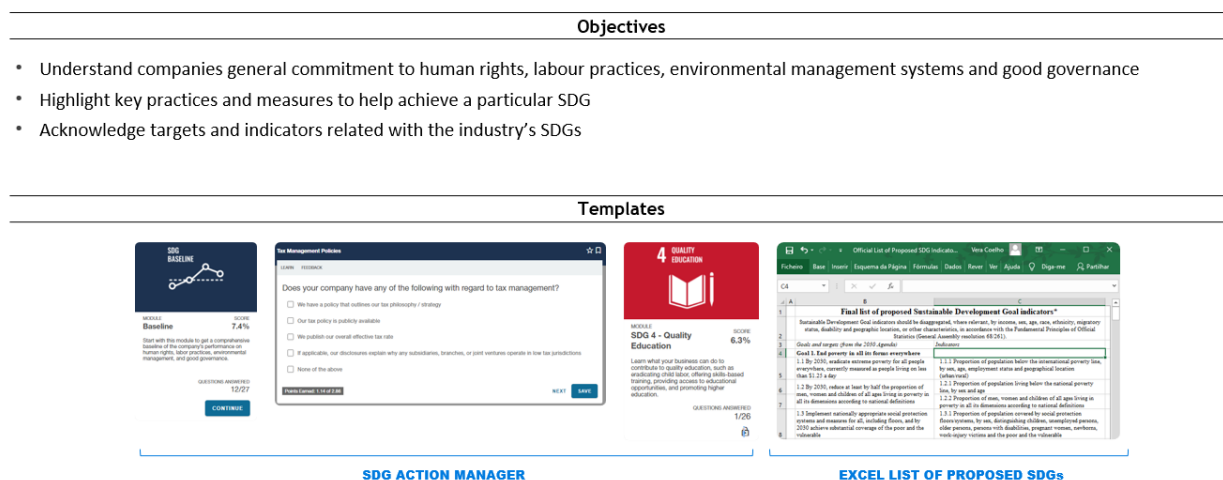
Figure 7 – Step 1 Overview

4.1.2. STEP 2: HIGH LEVEL AI ASSESSMENT

As mentioned before, the Guidebook as a whole intends to help companies come up with ideas on how to leverage AI for sustainable business development. Companies cannot ideate on the future without acknowledging the present applications of AI. This is why Step 2 encourages companies to list all the current AI applications and the associated techniques being leveraged across their value chain, creating visibility on what AI capabilities exist currently.

At first glance, this might seem quite a complex exercise, since the company is expected to reach out to all departments currently leveraging AI methods & techniques for any sort of business activity. To facilitate this exercise, this dissertation makes available an Excel template, illustrated in Figure 8, rooted in Porter's Value Chain concept (Porter, 2001).

According to Mickael Porter, *"every firm is a collection of activities that are performed to design, produce, market, deliver and support its product"* or service. These activities can be represented using a "value chain", a term first coined by Porter himself in 1985, and highly used by business managers nowadays. Every firm's value chain is composed of nine generic categories, that cover all types of activities performed within a company. Therefore, using Porter's value chain categories listed below, will help the company ensure a comprehensive cross-business assessment of AI usage.

- **Inbound logistics** – Understand how is AI leveraged in activities associated with receiving, storing and discriminating inputs (Ex: material handling, warehousing, inventory control, vehicle scheduling and returns to suppliers)
- **Operations** – Understand how is AI leveraged in activities associated with transforming inputs into the final product form (Ex: machining, packaging, assembly, equipment maintenance, testing, printing and facility operations)
- **Outbound logistics** - Understand how is AI leveraged in activities associated with collecting, storing and physically distributing the product to buyers (Ex: finished goods warehousing, material handling, delivery vehicle operation, order processing and scheduling)

- **Marketing & Sales -** Understand how is AI leveraged in activities associated with providing means by which buyers can purchase the products and inducing them to do so (Ex: advertising and promotion, sales force, quoting, channel selection, channel relations and pricing)
- **Service** - Understand how is AI leveraged in activities associated with providing service to enhance or maintain the value of the product (Ex: installation, repair, training, parts supply and product adjustment)
- **Procurement** - Understand how is AI leveraged in all purchasing activities
- **Technology Development** - Understand how is AI leveraged to support any of the numerous technologies embodied in all value activities
- **Human Resources Management** - Understand how is AI leveraged in activities of recruiting, hiring, training, development and compensation of all types of personnel
- **Firm Infrastructure** - Understand how is AI leveraged in activities like general management, planning, finance, accounting, legal, government affairs and quality management

After analyzing all the nine categories, the company will become aware of the full coverage of AI applications, being capable of answering the question "How is my company currently leveraging AI?", the main objective of Step 2.
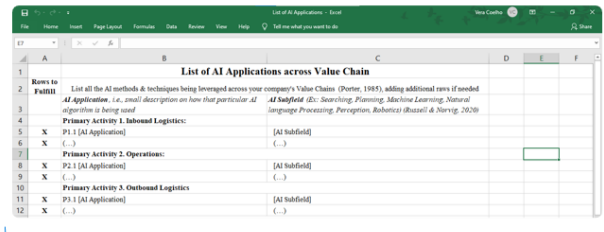
Objectives

- Assess current AI applications
- Acknowledge AI uses across the companies value chain

Templates

EXCEL LIST OF AI APPLICATIONS

Figure 8 - Step 2 Overview

4.1.3. STEP 3: AI & SDG MAPPING

After Steps 1 and 2, companies will have a comprehensive view of their current (AS IS) state in terms of SDG performance, and AI application, having found the answer for two very important questions: "How is my company contributing for sustainable development?", and, as formerly stated, "How is my company currently leveraging AI?". However, to tackle the main objective of this dissertation, a complementary analysis of the current state must be completed, leading to Step 3 of the Guide Book.

Step 3 advises companies to build a Sustainable AI Matrix, mapping all current AI applications with the corresponding SDG contribution, enabling the identification of possible gaps to be addressed. An additional template, illustrated in Figure 9, is provided to guide companies in this exercise.

- Evaluate and justify each AI application contribution to the SDGs
- Summarize overall AI contribution for sustainable development, enabling customized analysis per SDG
- Perform AI&SDG Gap Analysis to identify areas of improvement for stronger SDG contribution

Templates

SUSTAINABLE AI MATRIX

Figure 9 – Step 3 Overview

To facilitate this mapping exercise, companies can resort to the table designed during this dissertation's Systematic Literature Review, available in Appendix B. This is indeed a Sustainable AI Matrix leveraging the applications published in the literature, and therefore it can enlighten companies on what SDGs certain AI applications contribute for. Additional research may be required to understand the contribution of specific applications, especially when it is not obvious. However, companies should strongly avoid mapping pure economical contributions and forcing indirect contributions in an attempt to appear sustainable.

After listing all the AI applications and agreeing on their SDG contributions, companies should perform an AI & SDG Gap Analysis, which consists on the interpretation of the Sustainable AI Matrix results. For the sake of illustration, let's picture a hypothetical scenario of an imaginary company ("Company X"), operating in the Higher Education industry, with the Sustainable AI matrix represented below.

Table 3 – Company X Sustainable AI Matrix

AI Application Code	AI Application	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16	SDG 17
P1.1	AI Application 1			3	4													
P2.1	AI Application 2				4				8			11	12	13				17
P3.1	AI Application 3				4										14			17
P4.1	AI Application 4	1			4													17
S1.1	AI Application 5				4								12					17
S2.1	AI Application 6				4								12					17
S3.1	AI Application 7				4								12					17
S4.1	AI Application 8				4								12					17

During Step 1, through the SDG Action Manager, Company X became aware that Quality Education (SDG 4), Gender Equality (SDG 5), Decent Work and Economic Growth (SDG 8), Responsible Consumption and Production (SDG 12) and Life Below Water (SDG 14) are the recommended areas

where the company has the most opportunity to contribute for sustainability, according to World Benchmarking Alliance Industry to SDG Mapping.

In this hypothetical scenario, after completing the Sustainable AI Matrix, the Company X is able to conclude that no current AI application is contributing for SDG 5 – Gender Equality, an identified gap to be addressed in the further steps of the Guidebook. Additionally, both SDG 8 and 14 have solely one AI application with proven contribution, leaving room for improvement. Inevitably, an important question will arise - "What other AI application can enforce my company's contribution to a specific SDG?" - to be answered in Step 4.

4.1.4. STEP 4: BENCHMARKING

Step 4 advises companies to leverage Benchmarking as the managerial technique to identify new AI applications with potential impact in specific SDG, becoming crucial to start with an understanding of what benchmarking means.

According to (Adebanjo et al., 2010), Xerox Corporation was the first company to use benchmarking back in 1979, an experience portrayed in the first book on benchmarking – *The Search for Industry Best Practices that lead to Superior Performance* by Camp. In 2008, (Anand & Kodali, 2008) performed a literature review revealing that there are more than 49 different definitions of benchmarking and a wide plethora of types/approaches and process models. After analysing 35 different authors, Anand and Kodaly present a 12 phase, 54 step benchmarking process. However, as the authors themselves admit, this was a highly conceptual model, not implemented in any organization, leading to the work of Adebanjo et al.

(Adebanjo et al., 2010) main objective was to assess the practical usage of benchmarking within companies, and compare its popularity against other improvement tools. The study consisted of a questionnaire made out to 453 respondents with the results showing that the level of awareness and use of benchmarking was below other improvement techniques such as customer surveys, SWOT Analysis and Quality Management Systems. However, benchmarking techniques had the highest rates of intended future use – sustaining its use as an improvement technique within the Guidebook proposed in this dissertation. Additionally, the authors also underline that benchmarking is highly regarded as a technique that promotes and enables operational and business improvement, being widely adopted by organisations of different sizes and in different sectors in many parts of the world. These are two very relevant benefits of benchmarking, since Step 4's main objective is to improve SDG contribution and since the Guidebook is drawn to be applicable cross industry and across companies with different sizes. Lastly, in this same study, a newer form of benchmarking is introduced – **Informal Benchmarking** – considered to be the most suitable for Step 4 of this dissertation's Guidebook.

According to the same authors Informal benchmarking consists in "a*ctively encouraging employees to learn from the experience and expertise of other colleagues and organisations through comparing practices and processes".* Unlike structured benchmarking, it does not adhere to a strict process or protocol, giving businesses a fair amount of leeway in deciding what benchmarking steps to

follow. It also prevents Step 4 and the Guidebook from being too procedural to the point where adaptability and applicability to all businesses is jeopardized, this is why no specific template is provided in this step, as portrayed in Figure 10.

Objectives

- Collect experience and expertise from other colleagues and organizations on Sustainable AI Applications
- Document meaningful benchmarks (at least 3 per gap) comparing practises and processes
- Leverage research accelerators were applicable (SLR query string and findings)

Figure 10 - Step 4 Overview

Applying the concept of Informal Benchmarking to Sustainable AI means companies will resort to informal benchmark to understand how other organizations are leveraging AI to contribute for a specific SDG, identified in Step 3 as a gap. This can be achieved either through talking to work colleagues and learning from their experience, consulting with AI or Sustainability experts with proven experience, networking with other people from other organisations at conferences, seminars and Internet forums or through research on on-line databases/web sites and publications.

The literature review performed as part of this dissertation can serve as an accelerator of the informal benchmarking exercise. But how? By summarizing the different AI applications found in several publications (and available in Appendix B), the SLR is providing companies with a list of benchmarks to pick and choose, according to the results of their AI & SDG gap Analysis. Companies can also leverage a query string similar to the one defined for this dissertations SLR, replacing the sustainable business development keyword by the SDG under research. For example, for SDG 5:

("Artificial Intelligence" OR "AI") AND ("Gender Equality ")

No matter the approach, by the end of Step 4, companies must have documented research referencing meaningful AI applications that address the company's SDG contribution gaps, with at least 3 researched applications per gap.

4.1.5. STEP 5: IDEATION

By the time companies reach Step 5, they are well aware of the SDG contribution of their current AI applications as well as how other organizations are leveraging AI for sustainable business development. It is then time to brainstorm and identify new opportunities of AI applications to be developed internally, inspired by the Benchmarking results, tacking previously identified gaps.

As stated by (Kerzel, 2020) many approaches exist to identity new opportunities, with the Business Model Canvas (BMC), first proposed by Osterwalder in 2004, being a widely used one leveraged across different ideation workshops. Because of BMC's popularity several scholars thought it was worth revising, proposing new business dimensions that Osterwalder had not originally suggested. Today, Osterwalder's article has been cited by more than 3819 other articles.

Among these scholars, there is a particular group that agrees the original version of BMC is not suitable for AI initiatives and therefore propose alternative Canvas, including the Data Innovation board

(Kronsbein & Mueller, 2019), the AI Canvas Methodology (Damian Borth, 2020), the Enterprise AI Canvas (Kerzel, 2020) , the Machine Learning Canvas (Louis Dorard, n.d.), the AI Canvas by Agrawal et al. (Agrawal et al., 2018) , the AI Canvas by Dewalt (Dewalt, 2018) and the AI Project Canvas (Zawadzki, 2019) .

Step 5 proposes companies to leverage the AI Project Canvas, illustrated in Figure 11, for the analysis of future Sustainable AI applications, since it does not go through as much technical detail as the later ones, avoiding an overly complex Step 5 and an extensive number of sub steps. However, its simplicity led (Kerzel, 2020) to state that the AI Project Canvas is mainly aimed at project managers, leading to the risk of business aspects being discussed and approved before engaging with the data teams, who own in depth knowledge of the technical requirements. Mitigating this risk involves inviting data teams to be part of the ideation process from the beginning, an important advice for companies to keep in mind.

In practical terms, Step 5 will consist of one or more ideation sessions were multidisciplinary teams, preferably divided in groups, will be presented with the AI & SDG Gap Analysis resulting from Step 3 and the Benchmarks, found for each Gap in Step 4. Both will serve as innovation triggers for groups to come up with new Sustainable AI application opportunities. Opportunities will then be detailed leveraging the AI Project Canvas. Thus, the deliverables of Step 5 will consist on as many AI Canvas as the ideas generated, fulfilled with the answers given to each of the 9 business dimensions.

Figure 11 – Step 5 Overview

4.1.6.   STEP 6: SCORING & PRIORITIZATION

Unfortunately, companies most regularly don't have the time or resources to implement every new opportunity that arises. Therefore, it becomes crucial to have a raking mechanism for the different AI application opportunities detailed in Step 5, for companies to know where to start from.

For this very reason, Step 6 advises companies to score each Sustainable AI application opportunity based on two dimensions, Value and Complexity, following the Prioritization Guidelines available in Appendix H, and in the AISA Catalogue template, illustrated in Figure 12.

To facilitate the scoring exercise, Step 6's template includes a AISA Scoring sheet, also illustrated in Figure 12. In the AISA Scoring sheet, companies will fulfil each line with the Sustainable AI application brainstormed earlier, and score it according to the Value Criteria (SDG Contribution, Revenue Impact, Operational Efficiency and Customer Satisfaction) and Complexity Criteria (Technical Simplicity, Affordability, Data Availability and Stakeholders Involvement). An Overall score for Value and Complexity will be calculated within the Catalogue, as a weighted average of the different criteria. Companies can adjust relative weights in the Prioritization Guidelines to their reality, with the most relevant criteria having the higher weight. Under the Value dimension, the SDG Aligment should not have a weight lower than 30%, to constatly remind companies that Sustainability is driving the Guidebook as a whole.
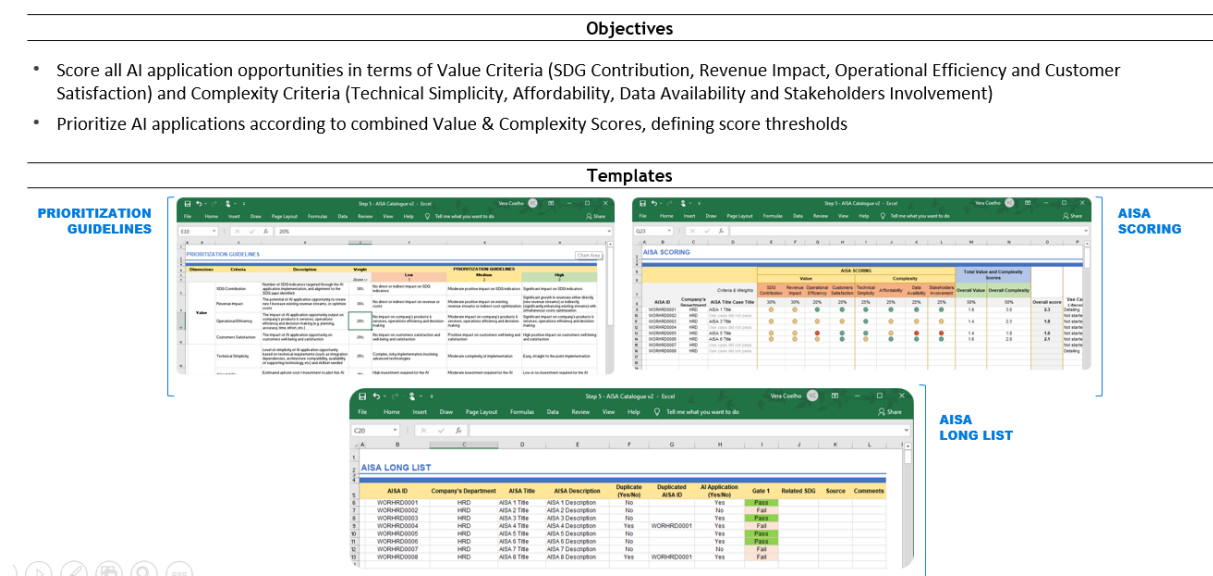
Figure 12 - Step 6 Overview

The Prioritization Guidelines were drawn based on the AI Project Canvas Dimensions, following the rational depicted in Appendix I.

For certain companies, depending on the format and number of stakeholders involved in the ideation sessions, an additional sub step might be required. Companies might need to validate if there are duplicates, i.e. departments/workgroups/teams coming up with the same new idea, and whether

these ideas are really AI applications, since, as discussed in the literature review the current AI buzz may lead to uncertainty over what ideas fall under the AI umbrella. To do so, companies have available the AISA Long List, inside the AISA Catalogue, also illustrated in Figure 12, where they can list the different Applications and document why are they duplicated or do not represent an AI initiative. The main advantage is to leave a list that will then feed and accelerate future ideation cycles.

Given the Value and Complexity Scores calculated, companies can now position the Sustainable AI Applications in a Prioritization Matrix accordingly. Lastly, they can complement this exercise with the definition of a Value and Complexity thresholds for implementation, discussing the minimum requirements for approval.

That brings companies to the end of the Guidebook for the Identification and Prioritization of Sustainable AI Applications.

4.2. GUIDEBOOK VALIDATION RESULTS: THE EXPERTS OPINION

Following the DSR Methodology, once the artifact of this study has been described, it becomes key to observe and measure how well it presents a solution to the problem at stake. This evaluation phase was brought by hosting two Focus Group meetings with different AI, Big Data and Sustainability experts.

The inaugural Focus Group meeting, with four participants, took place on June 1, 2021. The second meeting, which drew the same number of experts, took place on June 2, 2021. In both, the moderator role was performed by the author of this study. The names of the participants are not disclosed but a high-level description of their role becomes crucial to contextualize their views, thoughts, and validations over the artifact of this study.

Table 4 – Expert's Role Descriptions

Focus Group Meeting 1	I1	Data & AI Strategy Senior Manager
	I2	Machine Learning & Big Data Engineer
	I3	Industrial Engineering Associate Professor & Co-founder of Analytics Consultancy Company
	I4	Data Scientist
Focus Group Meeting 2	I5	AI Startup Founder & CEO
	I6	Business Development at Sustainability SaaS company
	I7	BA Teaching Assistant & PhD candidate in Political Philosophy on Unconditional Basic Income and Reciprocity
	I8	Sustainability Manager, Teaching & Research Assistant

An agenda and some supporting material were prepared to be presented in the Focus Group meetings, were the the sessions' tripartite structure was explained with a first slot dedicated to the presentation of the different experts in each focus group, followed by a general overview of the Thesis

Objective and Artifact and by a final slot dedicated to gathering specific feedback for each one of the 6 Guidebook steps.

The experts were also invited to fulfil a survey throughout the session. The AI4Sustainability Focus Group Meeting survey was composed of 12 multiple choice questions designed (1) to capture the experts' professional context, (2) to quantify the level of agreement with each Guidebook step, and (3) to measure general feedback around the usefulness, thoroughness, and applicability of the artefact of this study.

As a result, since all participants brought a wealth of information and expertise to the focus group meetings, only the summarized ideas/topics of feedback will be exposed in this section. A more complete transcription of both Focus groups, detailing all topics raised by each participant, can be found in Appendix J and Appendix G.

When analysing the different steps of the Guidebook, experts pointed out the artifact's virtues, points of improvement and other suggestions deemed appropriate to enhance Guidebook's ability to help companies leverage AI for sustainable business development. Figure 13 summarizes the main feedback points shared by the Focus Groups.

PROS ✓	✗ CONS	Other Step Specific Suggestions
Value Targetting Approach	Extensiveness	Step 1: Ensure Aligment with other conventions
Completeness	Clarity / Complexity	Step 2: Propose an Alternative Service Oriented Value Chain
Usefulness	Incentive to participate / Value Perception	Give Further guidance of how to fulfill Value Chain
Consolidation	Governance	Focus exclusively on Sustainability oriented AI applications
Educational	Need for exemplification	Adjust proposed AI Subfields Classification
Fit into the Momentum	Applicability to different types of companies	Step 5: Outline Sustainability's Value Proposition focus
Relevancy	Target Audience's lack of literacy	Step 6: Adjust AISA Scoring Criteria

Figure 13 – Summary of Experts Opinion

As stated, before the agenda, of the focus group session gave room for both **Step-Specific** and **Overall feedback.**

The next results section will summarize the specific feedback received, from Step 1 to Step 6 of the Guidebook.

4.2.1. STEP SPECIFIC FEEDBACK:

When questioned about **Guidebook's Step 1**, the High-Level SDG Assessment, different experts commented on the **extensiveness** of the SDG Action Manager, the tool proposed by the Guidebook. I2 and I3 agreed it's extension would harden the successful fulfilment of the assessment. To ensure companies are willing to fulfil a long questionnaire, I2 suggested (1) there should be a tangible incentive for companies willing to complete the assessment, (2) feedback should be collected from companies who already completed the assessment and lastly (3) guidance should be given regards who is the most

suitable role within a company capable of fulfilling this questionnaire easily. This last need for Governance guideline is also outlined by other experts when commenting later Guidebook steps.

Besides the extensiveness, I2 also questioned if all the questions to be answered in SDG AM weren't too complex and/or subjective.

On the other hand, I6 and I7 interpreted extensiveness as a virtue of the SDG AM, since it allows a more **complete** analysis of companies current SDG Adoption at a target and indicator level. According to I7, most companies nowadays map out commitments to SGDs simply at the goal level, using them as a communication tool and not as a real measure of impact, failing to commit at the indicator level.

I7 and I6 also praised the suggestion of a tool like SDG AM given companies current conjecture where the pressure to become sustainable is rising, making this tool very relevant and timely. I7 even anticipating her belief on a future overall rising fulfilment rate.

An additional virtue of the first step outlined by I5 and corroborated by I6 and I1 is the fact that this step introduces a strategic approach to the solution, merging what I1 described as a Value Targeting approach with a goal-oriented approach, where companies not only assess where they are but also gain visibility on "where they want to move", focusing on what brings more added value.

Lastly, 3 experts stressed the need to ensure the proposed tool – the SDG AM – is aligned with other more widely known conventions like GRI, Dow Jones Sustainability Indexes and BCorp Classification. These Indexes are already being leveraged by companies, therefore introducing a new score, might bring unwanted added complexity.

Guidebook's Step 2 collected the higher amount of suggestions among the experts. Different experts writhed to understand how exactly a company should fulfil Step 2's proposed template.

I2 and I4 struggled to interpreted Porter's Value Chain activities. As a consequence, I3 suggested the template could include more than one Value Chain tailored per industry, outlining the importance of including a specific Service-Industry-Oriented Value Chain.

If on the one hand this I3 suggestion favoured a further development of Step 2's template regarding the Value Chain, on the AI Subfields' hand, two were the experts (I1 and I5) questioning if it was really needed, after I3 sharing the proposed AI Subfields in his opinion won't fit. Their suggestion was to narrow the scope of what should be listed. This means, instead of asking companies to list all the current AI applications and their associated techniques, ask companies to list solely Sustainability oriented AI applications and eliminate the need to inform the specific AI technique, in the words of I5 "stay at the application layer". According to I1 this would avoid companies to lose focus on the final objective, simplifying the whole exercise by making it less complex and more practical for companies to fulfill, specialty larger ones, a problem raised by I4.

When discussing this matter, the issue of Governance was raise once again raised, now by I1 and I8. Both agreed it was quite important to clarify different roles would be involved in fulfilling Step 1 and 2. And if no guiding was provided, companies would lose much time looking for the right person skilled to provide the needed information.

Regarding **Guidebook's Step 3**, no specific comments were added by Focus Group 1 Experts. In rather, I7 and I8, Focus group 2 experts, shared 2 very relevant points of view.

Firstly, I7 questioned if when referring to SDG contribution, the Guidebook was considering both detrimental and incremental contributions, since an AI application can contribute both positively or negatively to a specific SDG. This led to an interesting discussion on if companies would know which SDGs Gap to choose and if it would be aligned with each companies Materiality Matrix. Would it be better for companies to prioritize uncovered sustainability goals as suggested by the Guidebook? Should the company focus on minimizing negative impacts or in maximizing positive impacts already tackled?

Secondly, I8 suggested SDG mapping should be done at a target level and not at a goal level, deepening the scope of the AI & SDG Mapping Exercise.

When analyzing **Guidebook's Step 4** – Benchmarking – experts were drawn to give general feedback on the Guidebook. This feedback was related with artifact's fitness to different types of companies and the organizational level of analysis in each step. Points of view explained below in a section dedicated to general feedback. Focusing on specific Step 4 feedback, I7 wondered if companies would be able to find benchmark information on a specific SDG, implying that could turn out to be hard.

Moving forward to experts' opinions on **Guidebook's Step 5** – Ideation – according to I4, many company stakeholders would be needed to fulfill the AI Canvas proposed in this step. Furthermore, I4 missed a specific dimension to specify SDG linkage. In alignment with I4's comment, I8 suggested the author to contrast the chosen Canvas with the Flourishing Business Canvas (FBC), that can be found in annex X.The Flourishing Businesss Canvas (FBC) was proposed by the authors Upward and Jones in 2016 as a Refinement of the Strongly Sustainable Business Model Canvas proposed by Kurucz et al. (2016), (Hoveskog et al., 2017). Descrição de em que consiste a Flourishing Business CANVAS

I8 advised the author should consider including in Step 5's template a dimension similar to the Value Co-Destructions dimension proposed by the FBC, for companies to bear in mind the detrimental SDG contribution of the idea presented. In addition, the Goal Dimension available in FBC should also be included, with its own identity as a new dimension to mirror SDGs to which the idea positively contributes.

Lastly, experts were challenged to give feedback on **Guidebook's Step 6** and its different templates. **Several experts, (**I2, I3, I4, 17) acknowledged the comprehensiveness of the Dimensions and Scoring criteria detailed, with I2 and I3 declaring they couldn't think of any additional criteria. I2 even suggested the scoring model could by simplified or adjusted, as proposed by I1, once the Guidebook is leveraged in a real company case. Step 6's complexity, in the opinion of I5, was mostly related with the difficulty companies would find in scoring all criteria under the Complexity Dimension, since, in his opinion, AI project complexity is very hard to classify. Therefore, I6 believed- little or no credibility should be given to the score of Technical Simplicity, affordability, data availability and Stakeholders Involvement would have since companies will most probability get them wrong.

This rational led the same Expert to question if Value and Complexity dimensions should be evenly weighted during prioritization. In his opinion, Step 6 should allow for alternate dimension weighting. I7 also made a comment regarding weights, questioning the minimum 30% weight demanded for the SDG Contribution Criteria. In her opinion, given this is the main objective of the Guidebook, the author should force for a 40 or 50% minimum. Another suggestion made by I8 was to add a Open / Undefined – Criteria, giving companies flexibility to add a personalized criteria that fits their organizational context, worth for example a 5% weight.

Focus Group 2 analysed more deeply the Prioritization Guidelines proposed in Step 6. I7 identified the following limitation for the first Criteria. When considering the proposed guidelines given to score SDG Contribution, which are the number of SDG indicators targeted through the AI application implementation and SDG Gap Alignment, the scoring will always favour companies that choose to tackle several Goals with incremental impact over those that choose higher focused impact on fewer goals. I8 added to this point suggesting negative impact should be deducted, decreasing the number of SDG indicators targeted. On the other hand, I5 suggested the author should consider including a wider scale for prioritization Scoring. A 5 or a 7-point scale, would avoid respondents' natural tendency to choose "Medium" value, a common behaviour detected in self scoring according to I5.

Finally, when questioned about the relevancy of having a First gate where poorly classified and Duplicated AISAs are filtered, I5 agreed it would be relevant as long as there is a helpful definition of an AI Application.

4.2.2. OVERALL FEEDBACK:

After going through each specific Step, experts were challenged to give Overall Feedback across 3 categories: (1) Guidebook's **Usefulness**, (2) **Criticism** and (3) **Implementation** potential

All experts agreed the artifact would indeed be a **very useful** tool for companies. Experts reinforced feedback already shared in Step 1 about Guidebook's increased usefulness given companies' current context, where Sustainability and AI are both trends and *"there's no way back",* quoting I6's words. I5 asserts that the risks of companies overcommunicating their net sustainability contributions are increased by sustainability trendiness. This study's artifact addresses this issue by making the sustainability discussion more practical and actionable, with the end result that *"algorithms get better and business get better by incorporating this level of transparency and sustainability,"* according to I5. I1 outlined the Guidebook is useful in its educational nature, especially on the initial steps that enable companies to understand where they stand in both topics - AI and Sustainability. I5 praised artifact's ability to be incorporated into AI companies' decision-making process of developing an algorithm considering its SDG impact, something companies are currently unable to measure. I8 corroborated this view stating:

" but I think the very beneficial part would be what I5 is saying: you would incorporate this in your ongoing decision to implement or not particular AI technology (…)you know your gaps and every time you want to implement an AI you go through this and you see, okay, maybe it doesn't make sense in

terms of sustainability – let's not go for it, or let's improve it in order to be more tailored to our sustainability gaps or sustainability."

Even though I2 agreed on artifacts usefulness, the expert believed companies aren't yet sufficiently aware to favor usefulness over the hard effort it demands to complete all steps, specifically Step 2. In I2's opinion, only some very few companies might consider it for marketing purposes. An argument offset by I1 and I4's, who shared the opinion that if a company is willing to embrace AI for Sustainable Business Development, it wouldn't find the Guidebook so complex. Then experts summarized different actions that could help demystify Guidebook's perceived Complexity, namely, exemplification with a real-word example of a company leveraging the Guidebook, implementation of a good Data strategy, where data initiatives are already governed and therefore easily listed.

When asked about any generic **critics** to the artifact of this study, different experts shared the view of I5 who stated the Guidebook is just inherently complex, given that it covers two very complex topics: AI and Sustainability, with a lot of embedded knowledge needed to complete all steps. As it become obvious in the Step-specific feedback session, Complexity was a topic raised frequently in both Focus Group meetings. However, thinking deeper on the inherent complexity, I8 admitted there was no other simpler solution, in his opinion, the artifact presents the best approach by dividing that complexity into individual steps, quite beneficial and that build upon themselves. I7 also demonstrated to be a fun of artifacts structure with different steps, stating it made everything clearer. The expert also praised the use of Templates appreciated and regular for most companies.

Another general criticism, already mention in specie steps. is related with the fact that Guidebook completion requires involvement of a lot of stakeholders, with different backgrounds to provide the information required on the different templates.

Moving forward to the third category asked in the overall feedback section, all experts confirmed **willingness to implement** the Guidebook in their own companies. I8 even acknowledged that she is now unaware of whether her organization is utilizing AI for sustainability, an answer that could be provided with artifacts implementation. In addition, I8 shared it would be interesting to leverage the artifact among students in the academical context, promoting further research on companies' usage or among NGOs and specific CSOs.

Besides the 3 categories proposed by the author, experts also made additional comments worth mentioning.

The **type of company** that would most benefit from applying the Guidebook was a subject that was brought up often by different experts with contrasting views. I6 mentioned twice that for small companies, often immature in terms of sustainability, where there isn't a Sustainability department or expert dedicated, the Guidebook wouldn't be as useful. However, the same expert added this is a trend soon to be changed given increasing small companies' consciousness on embracing sustainability. For Expert I6, the target of the Guidebook are medium or big companies. On the contrary, while commenting step 2, I4 stated the Guidebook would be most fit for small companies only. Still on this topic, both I1

and I8 agreed that the key to determining what kinds of businesses will gain most from the Guidebook is maturity, not scale. According to them, companies should be mature in both AI and Sustainability.

In addition to the previously mentioned governance advice, I7 pointed out that **timing guidelines** should be provided as well. As a result, the Guidebook should be improved with details on which stakeholders need to fulfill each template and how long it typically takes to complete. In accordance with I4, the guidebook should also be improved with an explanation of the degree of analysis anticipated for each stage, i.e., whether the author recommends completing the steps at an organizational or departmental level.

I7 and I8 agreed in other 2 final suggestions. First, they suggested the Guidebook could be **Modular**, meaning companies should be free to skip the initial step in case they already have another different Sustainability assessment in place. However, according to I6, a modular approach poses a risk that businesses would choose an assessment that does not provide the same degree of in-depth analysis at the indicator level as SDG Action Manager. Lastly, they proposed an extra step or a further guidebook development that ensures companies make public, through **reporting and communication**, the positive and negative impact of their listed new AISA ideas co-created through the Guidebook. This would unleash the power of exemplification (the artifact's foundation according to the author of this study), igniting healthy competition among those who leverage the artifact, while motivating those businesses that aren't yet using it to do so moved by the willingness to compete. Furthermore, and maybe most critically, this additional step or development would guarantee the implementation and annual monitoring of AISA, making sure ideas turn into real-world applications.

4.3. REVISED GUIDEBOOK FOR IMPLEMENTATION

Given the objectives, scope, and limitations of this research, some of the ideas/topics of feedback raised during the Focus Group Meetings did in fact offer insights that can be incorporated in a revised new version of the Guidebook, described in this section.

Starting with Step 2, its original Template asked companies to list all the AI methods and techniques being leveraged across their Value Chain, forcing companies to specify the AI subfield for each AI Applications. Given experts feedback, an adjustment was made to Step 2's template, simplifying it with the elimination of the AI subfield column. A help note with the definition of an AI application was also included to support templates interpretation and fulfillment.

In Step 3 Template's original version, companies were asked to map SDG Contribution, plotting the Matrix solely with the number of the impacted SDG. After considering experts opinion, the revised guidebook will advise companies to specifying with a (+) plus or a minus (-) according to if the contribution is detrimental (negative) or incremental (positive), giving companies a wider more realistic view on the real impact of their AI applications, avoiding the risk of negative impact being overlooked. For example, in a hypothetical scenario where a given company is positively contributing for 5 SDGs with 3 (out of its 5) AI Applications while detrimentally contributing for the same 5 SDGs with its remaining 2 AI applications**,** SGS's were positive and negative contributions neutralize each other will also, and

correctly so, classify as gaps. For those SGS the aggregated contribution is null an companies should take it into consideration.

Improvements were also included in Step 5's template, the AI project Canvas. The original Value Proposition dimension should be transformed into 2 dimensions: Value Co-creations and Co-destructions, following FBC rational, as advised by the experts. On both value dimensions SDG contributions should be specified.

Lastly, Step 6's templates also enjoyed different enhancements in Guidebook's revised version:

- Under the AISA Scoring model the minimum proposed weight for the SDG Contribution Criteria under the Value Dimension is 40%
- Prioritization Guidelines for the SDG Contribution Criteria were adjusted

In the Refined version of the artifact, the author also decided to create a one-pager, a single page document introducing the Guidebook and all its templates meant to facilitate companies' embracement. Here, the cyclical nature of the Guidebook, the need to implement the ideated applications and its agility to be embraced at a company-wide or department-specific level are outlined, as proposed by the experts

5. CONCLUSIONS

5.1. SYNTHESIS OF THE DEVELOPED WORK

This study begun with an overview on the two fields considered relevant for this thesis, Artificial Intelligence and Sustainable Development, followed by a SLR on the intersection between the two concepts. As performed, a Guidebook for the Identification and Prioritization of Sustainable AI Applications / Use Cases was built. Guidebook's qualitative validation was carried through 2 Focus Group Meetings with 8 experts, from different backgrounds, who provided critical feedback and suggestions used to improve and enhance the initial Guidebook presented.

By stringently following this method, the initial study objectives defined were achieved. After applying the 6-step methodology made available by this study's artifact, which is in itself a recommendation framework, companies will dispose of a prioritized list of ideated future Sustainable AI applications set to speed up the uptake of the SDGs considered relevant. Their implementation will prove AI can be used to extend purpose. In addition to enabling this listing, the templates suggested throughout the steps offer businesses a thorough analysis of their SDG performance, a list of their current AI applications, an AI & SDG Gap Analysis and a collection of AI best practices addressing those identified gaps - all-determinant tools for building awareness on SDGs, on AI, and most importantly, paraphrasing Jason Silva's philosophical words, for enlightening both academy and industry on how can AI enhance human capacity to meet the UN Sustainable Development Goals.

5.2. LIMITATIONS

It is crucial to acknowledge what are the limitations of this research.

One limitation that this research faced was that there is no blueprints or potential methodological frameworks enlightening the scientific community on how different AI applications positively or detrimentally contribute for the SDGs, leading any mapping exercise done across this dissertation (see appendix B) to be subjective to the authors view and interpretation on what each SDG represents. A limitation that will span across companies that decide to leverage de Guidebook.

Additional two limitations are noticeable in the process of demonstration and validation. Due to time restrictions, it was not possible to experiment nor to revalidate the revised Guidebook, which has been improved as described in the 4.4 section above. Experimenting the artifact, in the particular case of this dissertation, would involve the utilization of the guidebook by a specific company in the form of a case study.

Consequently, and most importantly to focus on the objectives and nature of this study, the scope of final revised version of the Guidebook might be said to ignore some of the **criticism** identified by the experts in the Focus Group meetings. Namely:

- Guidebook Step 1 starts by imposing an SDG assessment tool – SDG AM – that is still not as widely spread throughout the industry, that is currently leveraging other conventions. A limitation that might be contradicted with the rising awareness of the tool and with future work previously suggested.

- Guidebook Step 3 does not advise companies on which Gaps to prioritize after completing the Sustainable AI Matrix in Step 3. Going back to the example used in section 4.4., uncovered SGDs will be treated equally as other SGS where detrimental and incremental contribution neutralize each other. Therefore, companies will need to resort to other tools available, like their corporate sustainability strategy or Materiality Matrix to decide which gaps to tackle first

- Guidebook Step 5 requires companies to mandatory score three criteria under the Complexity Dimension considered by I5 to be impossible to measure.

- No room is left for companies to propose a personalized criteria of their own

- The 3-point scoring scale proposed by the author might contribute for a natural bias towards, the "Medium" value, with potential score impact

And, generally speaking:

- There is no tangible incentive for companies to complete the different, rather complex, steps of the Guidebook, therefore only those companies with high AI and Sustainability Maturity will see the artifact as a necessary sustainable business development tool.

- Guidebook does not educate on Governance guidelines, leaving unanswered the questions of how many and which stakeholders should be involved to complete all 6 steps.

- All steps of the Guidebook are mandatory, this might make the exercise rather tedious or repetitive in some cases

5.3. FUTURE WORK

Given what was concluded and discussed in and after both Focus Meetings and also bearing in mind this study's limitations, it is imperative to present new research directions and ideas that can result from this dissertation.

A first future, very interesting, research topic would be on the alignment between the different Sustainability Assessments identified by the Experts as the most know across industry: GRI, BCorp, Dow Jones Sustainability Index and SDG. One of the biggest challenges around sustainability nowadays is its inherent subjectiveness, i.e., how different official organisms decide to evaluate companies following different impact metrics. Such research would then help standardize sustainability measurement frameworks, avoiding subjectiveness by clarifying how answers or scores obtained in one framework map to another framework. Additionally, this would indirectly encourage more companies to utilize the Guidebook, namely those who might refrain when they realize Step 1 makes use of SDG AM, an assessment framework that differs from the one they might typically use for assessment.

Another relevant future research direction to explore would be to engage one or more suitable companies in case-study research meant to study the Application of the Guidebook in their real-word context. This case-study would be testifying the virtues and points of improvement point out by the experts in this study. The real word application would also contribute for defining a framework on Guidebook's Governance, enabling a deeper and factual analysis on which roles would companies mobilize to fulfil the different Templates available in each step and how long did it take on average.

As part of the same study or maybe in a different one, an improved version of the Guidebook could be presented incorporating future development suggestions made by the experts. This 2.0 Guidebook version, if case-study results justify it, would (1) deepen the Information required in Step 2 and 3, with suggestions of different Value Chain activities tailored per Industry and requiring companies identify gaps at a target level, or even (2) suggest a new Step. This step would encapsulate the final overall feedback exposed in the results section, making Monitorization, Reporting and Communication of AISAs mandatory, ensuring companies not only co-create but most importantly apply AI for Sustainable development.

Lastly, as stated by the experts, this study deals with two very-complex and hyped fields of study. As a consequence, in the future there should be more research within the intersection of both to keep up and constantly adjust to the fast-paced scientific community highly motivated to leverage technology for good, as the applications that are available may and should multiply to ensure sustainable business development.

BIBLIOGRAPHY

Adebanjo, D., Abbas, A., & Mann, R. (2010). An investigation of the adoption and implementation of benchmarking. *International Journal of Operations & Production Management*. https://doi.org/10.1108/01443571011087369

Agrawal, A., Gans, J., & Goldfarb, A. (2018, April 17). *A Simple Tool to Start Making Decisions with the Help of AI*. https://hbr.org/2018/04/a-simple-tool-to-start-making-decisions-with-the-help-of-ai

Alan Turing to feature on new £50 banknote | Bank of England | The Guardian. (2019). https://www.theguardian.com/business/2019/jul/15/alan-turing-to-feature-on-new-50-note

Anand, G., & Kodali, R. (2008). Benchmarking the benchmarking models. *Benchmarking: An International Journal*, *15*(3). https://doi.org/10.1108/14635770810876593

Andrews, N., Khalema, N. E., & Assié-Lumumba, N. T. (2015). *Millennium Development Goals (MDGs) in Retrospect*. Springer Cham.

Arora, N. K., & Mishra, I. (2021). COP26: more challenges than achievements. *Environmental Sustainability*, *4*(4), 585–588. https://doi.org/10.1007/s42398-021-00212-7

Atapattu, S. (2019a). From "Our Common Future" To Sustainable Development Goals: Evolution of Sustainable Development Under International Law. *Wisconsin International Law Journal*, *36*(2), 215–246. https://search.ebscohost.com/login.aspx?direct=true&db=lgs&AN=138600688&lang=pt-br&site=ehost-live

Atapattu, S. (2019b). FROM "OUR COMMON FUTURE" TO SUSTAINABLE DEVELOPMEN... *Wisconsin International Law Journal*, 215–246. http://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=d93d89db-66f9-4537-9dd2-13c4403994e5%40pdc-v-sessmgr05

Avin, S. (2019). Exploring artificial intelligence futures. *Journal of Artificial Intelligence Humanities.Vol*, *2*.

Bhamra, T., & Hernandez, R. J. (2021). Thirty years of design for sustainability: an evolution of research, policy and practice. *Design Science*, *7*(Rainey 2006), 1–17. https://doi.org/10.1017/dsj.2021.2

Chiappetta Jabbour, C. J., Fiorini, P. D. C., Ndubisi, N. O., Queiroz, M. M., & Piato, É. L. (2020). Digitally-enabled sustainable supply chains in the 21st century: A review and a research agenda. *Science of the Total Environment*, *725*, 138177. https://doi.org/10.1016/j.scitotenv.2020.138177

Chui, M., Harryson, M., Manyika, J., Roberts, R., Chung, R., Heteren, A. van, & Nel, P. (2018). *Applying AI for social-good: Discussion paper*. 52. https://www.mckinsey.com/featured-insights/artificial-intelligence/applying-artificial-intelligence-for-social-good

Cribb, J. (2017). The Urbanite (Homo urbanus). In J. Cribb (Ed.), *Surviving the 21st Century: Humanity's Ten Great Challenges and How We Can Overcome Them* (pp. 147–169). Springer International Publishing. https://doi.org/10.1007/978-3-319-41270-2_8

Damian Borth. (2020). *Scaling Artificial Intelligence in Companies - The AI Canvas Methodology*.

Dewalt, K. (2018). *Become an AI Company in 90 Days*. Prolego.

Dumitru, V. F., & Stanculescu, S. M. (2020). New Trends in Sustainable Business and Consumption. *New Trends in Sustainable Business and Consumption*, *June*. www.editura.ase.ro

Ekhator, O. E., Miller, S., & Igbinosa, E. (2022). *Implementing the Sustainable Development Goals in Nigeria*. https://www.routledge.

Euijong Whang, S., Hyun Tae, K., Roh, Y., & Heo KAIST, G. (2021). *Responsible AI Challenges in End-to-end Machine Learning*.

Fukuda-Parr, S. (2016). From the Millennium Development Goals to the Sustainable Development Goals: shifts in purpose, concept, and politics of global goal setting for development. *Gender & Development*, *24*(1), 43–52. https://doi.org/10.1080/13552074.2016.1145895

Geall, S. (2021). *China, climate politics and COP26*. https://about.jstor.org/terms

Gunning, D., Stefik, M., Choi, J., Miller, T., Stumpf, S., & Yang, G. Z. (2019). XAI-Explainable artificial intelligence. *Science Robotics*, *4*(37). https://doi.org/10.1126/scirobotics.aay7120

Gupta, H., Kumar, A., & Wasan, P. (2021). Industry 4.0, Cleaner Production and Circular Economy: an integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations. *Journal of Cleaner Production*, *295*, 126253. https://doi.org/10.1016/j.jclepro.2021.126253

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). DESIGN SCIENCE IN INFORMATION SYSTEMS RESEARCH 1. In *Design Science in IS Research MIS Quarterly* (Vol. 28, Issue 1).

Higgings, K. L. (2014). *Economic Growth and Sustainability: System Thinking for a Complex World* (Academic Press, Ed.). https://books.google.pt/books?id=HzunBQAAQBAJ&dq=higgins+2015+sustainability+Egyptians+&lr=&hl=pt-PT&source=gbs_navlinks_s

High. Peter. (2017, October 30). *Carnegie Mellon Dean Of Computer Science On The Future Of AI*. https://www.forbes.com/sites/peterhigh/2017/10/30/carnegie-mellon-dean-of-computer-science-on-the-future-of-ai/?sh=2db2b26f2197

Horowitz, C. A. (2016). *Paris Agreement*. *55*(4), 740–755.

Hoveskog, M., Halila, F., Mattsson, M., Upward, A., & Karlsson, N. (2017). Education for Sustainable Development: Business modelling for flourishing. *Journal of Clearer Production*, 4383–4396. https://doi.org/10.1016/j.jclepro.2017.04.112

Isensee, C., Teuteberg, F., Griese, K. M., & Topi, C. (2020). The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production*, *275*, 122944. https://doi.org/10.1016/j.jclepro.2020.122944

Kenny, C., Sumner, A., Kenny Andy Sumner, C., Carin, B., Leo, B., Sandefur, J., Wheeler, D., Barder, O., Clemens, M., & Manning, R. (2011). *More Money or More Development: What Have the MDGs Achieved?* http://ssrn.com/abstract=1973010www.cgdev.orghttps://ssrn.com/abstract=1973010Electroniccopyavailableat:http://ssrn.com/abstract=1973010http://www.cgdev.org/content/publications/detail/1425806www.cgdev.org

Kerzel, U. (2020). Enterprise AI Canvas Integrating Artificial Intelligence into Business. *Applied Artificial Intelligence*, *35*(1), 1–12. https://doi.org/10.1080/08839514.2020.1826146

Kidd, C. v. (1992). The evolution of sustainability. *Journal of Agricultural and Environmental Ethics*, *5*(1), 1–26. https://doi.org/10.1007/BF01965413

Knapp, A. (2011, August 5). *Jason Silva Muses on Humans Turning Into Gods*. https://www.forbes.com/sites/alexknapp/2011/08/05/jason-silva-muses-on-humans-turning-into-gods/?sh=7baaf3ab301a

Kronsbein, T., & Mueller, R. (2019). Data Thinking: A Canvas for Data Driven Ideation Workshops. In *Proceedings of the 52nd Hawaii International Conference on System Sciences* (Vol. 6). https://doi.org/10.24251/hicss.2019.069

Landi, H. (2020, November 4). *Healthcare is ramping up AI investments during COVID. But the industry is still on the fence about Google, Amazon. Here's why | FierceHealthcare*. https://www.fiercehealthcare.com/tech/healthcare-ramping-up-investments-ai-during-covid-but-industry-still-fence-about-google-amazon

Leipziger, D. (2015). The Rio Declaration on Environment and Development. *The Corporate Responsibility Code Book: Third Edition*, *II*, 255–306. https://doi.org/10.9774/gleaf.9781783530670_17

Lorgelly, P. K., & Adler, A. (2020). Impact of a Global Pandemic on Health Technology Assessment. *Applied Health Economics and Health Policy*, *18*(3), 339–343. https://doi.org/10.1007/s40258-020-00590-9

Louis Dorard. (n.d.). *The Machine Learning Canvas* .

Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, *117*, 168–179. https://doi.org/10.1016/j.psep.2018.04.018

Marquardt, K., Olaru, M., & Arp, A. (2019). New Trends in Sustainable Business and Consumption. *New Trends in Sustainable Business and Consumption*, *17*(Special No. 9), 1127–1128.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (1955). *A proposal for the Dartmouth summer research project on artificial intelligence*.

Moor, J. (2006). Artificial Intelligence Conference : The Next Fifty Years. *AI Magazine, January 2006*.

Mueller, J. P., & Massaron, L. (2018). Artificial Inteligence for dummies. In *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* (Vol. 53, Issue 9). Learning Made Easy. http://publications.lib.chalmers.se/records/fulltext/245180/245180.pdf%0Ahttps://hdl.handle.net/20.500.12380/245180%0Ahttp://dx.doi.org/10.1016/j.jsames.2011.03.003%0Ahttps://doi.org/10.1016/j.gr.2017.08.001%0Ahttp://dx.doi.org/10.1016/j.precamres.2014.12

Muthukrishnan, N., Maleki, F., Ovens, K., Reinhold, C., Forghani, B., & Forghani, R. (2020). Brief History of Artificial Intelligence. *Neuroimaging Clinics of North America*, *30*(4), 393–399. https://doi.org/10.1016/j.nic.2020.07.004

Nations, U. (n.d.). *United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3-14 June 1992 | United Nations*. United Nations. Retrieved October 22, 2022, from https://www.un.org/en/conferences/environment/rio1992

Naudé, W. (2020). *Artificial Intelligence against COVID-19 : An Early Review*. *13110*.

O'Riordan, T., & Chakroff, P. (2021). America's Zero Carbon Action Plan: The Zero Carbon Consortium, Sustainable Development Solutions Network, New YorkSDSN 2020, America's Zero Carbon Action Plan (New York: Sustainable Development Solutions Network [SDSN], 2020). In *Environment* (Vol. 63, Issue 2, pp. 28–32). Routledge. https://doi.org/10.1080/00139157.2021.1871294

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1), 89. https://doi.org/10.1186/s13643-021-01626-4

Plastino, E., & Purdy, M. (2018). Game changing value from Artificial Intelligence: eight strategies. *Strategy & Leadership*, *46*(1), 16–22. https://doi.org/10.1108/SL-11-2017-0106

Porter, M. E. (2001). The value chain and competitive advantage. *Understanding Business Processes*, *2*, 50–66.

Press, G. (2019). *Is AI Going To Be A Jobs Killer? New Reports About The Future Of Work*. https://www.forbes.com/sites/gilpress/2019/07/15/is-ai-going-to-be-a-jobs-killer-new-reports-about-the-future-of-work/?sh=1cc26f08afb2

Raut, R. D., Mangla, S. K., Narwane, V. S., Gardas, B. B., Priyadarshinee, P., & Narkhede, B. E. (2019). Linking big data analytics and operational sustainability practices for sustainable business

management. *Journal of Cleaner Production*, *224*, 10–24.
https://doi.org/10.1016/j.jclepro.2019.03.181

Roblek, V., Thorpe, O., Bach, M. P., Jerman, A., & Meško, M. (2020). The fourth industrial revolution
and the sustainability practices: A comparative automated content analysis approach of theory
and practice. *Sustainability (Switzerland)*, *12*(20), 1–28. https://doi.org/10.3390/su12208497

Roostaie, S., Nawari, N., & Kibert, C. J. (2019). Sustainability and resilience: A review of definitions,
relationships, and their integration into a combined building assessment framework. *Building and
Environment*, *154*(March), 132–144. https://doi.org/10.1016/j.buildenv.2019.02.042

Russell, S., & Norvig, P. (2020). *Artificial Intelligence - A modern approach* (S. Russell & P. Norvig, Eds.;
4th ed.). Pearson.

Sen, G., & Mukherjee, A. (2014). No Empowerment without Rights, No Rights without Politics: Gender-
equality, MDGs and the post-2015 Development Agenda. *Journal of Human Development and
Capabilities*, *15*(2–3), 188–202. https://doi.org/10.1080/19452829.2014.884057

Shayganmehr, M., Kumar, A., Garza-Reyes, J. A., & Moktadir, M. A. (2021). Industry 4.0 enablers for a
cleaner production and circular economy within the context of business ethics: A study in a
developing country. *Journal of Cleaner Production*, *281*, 125280.
https://doi.org/10.1016/j.jclepro.2020.125280

Shin, D. (2021). The effects of explainability and causability on perception, trust, and acceptance:
Implications for explainable AI. *International Journal of Human Computer Studies*, *146*, 102551.
https://doi.org/10.1016/j.ijhcs.2020.102551

Taulli, T. (2019). Artificial Iintelligence Basics: A Non-Technical Introduction. In *Artificial Intelligence
Basics*. Apress. https://doi.org/10.1007/978-1-4842-5028-0_9

Turing, A. M. (2012). Computing machinery and intelligence. *Machine Intelligence: Perspectives on the
Computational Model*, *59*(236), 1–28. https://doi.org/10.1093/mind/lix.236.433

Uddin, M. M. (2021). *Climate Change Law, Technology Transfer and Sustainable Development*
(Routledge, Ed.; 1st ed.). https://www.routledge.com/Routledge-Research-in-International-
Environmental-

UN. Secretary-General, & World Commission on Environment and Development. (1987). *Report of the
World Commission on Environment and Development : note / by the Secretary-General.*

UNDP, & World Bank Group. (2016). Transitioning from the MDGs to the SDGs. *The United Nations
Development Programme (UNDP) and the World Bank Group (WGG)*, 1–176.
http://www.undp.org/content/undp/en/home/librarypage/sustainable-development-
goals/transitioning-from-the-mdgs-to-the-sdgs.html

United Nations. (2015a). *The Millennium Development Goals Report 2015 Regional Fact Sheet*.

United Nations. (2015b, July 6). *Millennium Development Goals Indicators*.

United Nations. (2022). *The Sustainable Development Goals Report*.

United Nations Development Programme. (2021). *Background of the Sustainable Development Goals | UNDP*. https://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html

United Nations Statistics Division. (2022). *SDG Indicators*.

unstats | Millennium Indicators. (n.d.). Retrieved February 17, 2021, from http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/About.htm

Walch, K. (2019, November 24). *Is AI A Job Killer Or Job Creator?* https://www.forbes.com/sites/cognitiveworld/2019/11/24/is-ai-a-job-killer-or-job-creator/?sh=7b2755fc37e8

Woodbridge, M. (2015). From MDGs to SDGs: What are the Sustainable Development Goals? *Urban Issues*, *01*(01), 04.

Yamin, M. M., Ullah, M., Ullah, H., & Katt, B. (2021). Weaponized AI for cyber attacks. *Journal of Information Security and Applications*, *57*, 102722. https://doi.org/10.1016/j.jisa.2020.102722

Yazdani, M., Chatterjee, P., Zavadskas, E. K., & Hashemkhani Zolfani, S. (2017). Integrated QFD-MCDM framework for green supplier selection. *Journal of Cleaner Production*, *142*, 3728–3740. https://doi.org/10.1016/j.jclepro.2016.10.095

Zagelmeyer, S. (2019). MNEs and human rights: from responsibilities to rights to governance. *Critical Perspectives on International Business*, *16*(2), 117–135. https://doi.org/10.1108/cpoib-07-2018-0063

Zawadzki, J. (2019, January 30). *Introducing the AI Project Canvas*. https://towardsdatascience.com/introducing-the-ai-project-canvas-e88e29eb7024

APPENDIX

A.   Filtered Articles to be Included in the Investigation

#	Title	Reference	Summary
[1]	An integrated framework for sustainable supplier selection and evaluation in supply chains	(Yazdani et al., 2017)	After reviewing all previous green supplier selection methods, the authors propose a new analytical method leveraging 8 customer requirements (ex:: waste disposal program, reverse logistics) and 7 evaluation criteria (ex: green design, re-use and recycle rate). This new method is then implemented within the procurement and logistics department of the Iranian Kalleh Dairy Company, demonstrating that important sustainable variables like green design or re-use and recycle rate were being neglected in the original supplier selection approach.
[2]	Determining the Sustainable start-up company	(Bernal & Alba, 2018)	After a theoretical review on the concept of Sustainable Entrepreneurship (SE), the authors propose a framework on the capabilities needed for SE integration in start-up companies, tested and adjusted with 4 start-ups: MindAffect, Nowi Energy, Fich Buildings and Aqysta. MindAffect and Nowi Energy leverage AI capabilities to deliver their value proposition.
[3]	Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies	(Luthra & Mangla, 2018)	Based on experts' input and literature review, the authors identify 18 key challenges to Industry 4.0 initiatives for developing sustainability in supply chains. Challenges are then evaluated by different Indian manufacturing companies that prioritized the identified dimensions of challenges as given, from the most to the least critical: Organizational, Technological, Strategic and Legal and ethical issues.
[4]	Linking big data analytics and operational sustainability practices for sustainable business management	(Raut et al., 2019)	Based on a literature review and identified research gap, the authors develop a conceptual model on the predictors of sustainable business performance, testing 8 different hypotheses in interviews with managers from the Indian manufacturing Industry. Management and leadership style, state and central-government policy were identified as the two most important predictors of big data analytics, proven to positively influence sustainable business performance.
[5]	New Trends in Sustainable Business and Consumption	(Marquardt et al., 2019)	The authors compile a series of papers that were part of the 2019 BASIQ International Conference on "New Trends in Sustainable Business and Consumption". For the purpose of this SLR, two papers in particular should be highlighted: (1) *Green Business Model Innovation: enhancing business processes through application of AI in order to reduce the Ecological footprint* (2) *Corporate Social Responsibility for Industry 4.0. The case study of the Italian Company operating in Poland*. In the first paper, the authors list existing AI functions and investigate their influence on procurement, production and after sales services, clarifying how AI combined with green business model innovation can strengthen business competitiveness. In the latter, authors list the steps on FCA value chain, giving examples on existing sustainable practises implemented at the Polish factory.
[6]	Social and Environmental Accounting (SEA)	(Gray et al., 2019)	A book providing an overview on Social Environmental Accounting with a chapter entitled "Artificial Intelligence", where the authors explain AI's impact on the development of the field, providing insights over more data and the causality of human action.
[7]	A machine learning framework for multi-hazards modelling and mapping in a mountainous area	(Yousefi et al., 2020)	The authors model the probabilities of snow avalanches, landslides, wildfires, land subsidence, and floods in a mountainous region of Iran using 3 different machine learning models and assessing their accuracy.
[8]	Applying the triple bottom line in sustainable supplier selection: A meta-review of the state-of-the-art	(Rashidi et al., 2020)	The authors conduct a systematic meta-literature review on sustainable supplier selection methods, acknowledging a study leveraging an artificial neural network as one of the most cited in the field.
[9]	Aspects of Digitalization and Related Impact on Green Tourism in European Countries	(Saseanu et al., 2020)	The authors leverage AI techniques to analyse the influence of digitalization and tourists' preferences in terms of accommodation and economic well-being implying sustainability, proving, for example, that the use of internet traveling search engines raises green tourism bookings.
[10]	Bagging ensemble of multilayer perceptrons for missing electricity consumption data imputation	(Jung et al., 2020)	The authors develop an ensemble network that learns electric energy consumption data with explanatory variables and imputes missing values for a more accurate electric load forecasting.
[11]	Digitally-enabled sustainable supply chains in the 21st century: A review and a research agenda	(Chiappetta Jabbour et al., 2020)	The authors conduct a systematic literature review providing an overview on digitally-enabled sustainable supply chains, identifying 7 research gaps and 4 lessons for business practioners aiming to use big data for sustainable supply chain practices, giving examples on applications across the 3 sustainability pillars.

[12]	New Trends in Sustainable Business and Consumption	(Dumitru & Stanculescu, 2020)	The authors compile a series of papers that were part of the 2020 BASIQ International Conference on "New Trends in Sustainable Business and Consumption". For the purpose of this SLR, one paper in particular should be highlighted: *Sustainable Businesses enhanced through digital transformation and Artificial Intelligence in the context of Industry 4.0.* Here, the authors start by listing eight actions for all management teams to improve sustainability, to then clarify how AI can contribute to the 4 Sustainability Pillars and tackle the top sustainability problems in terms of GHG emissions.
[13]	The Fourth Industrial Revolution and the Sustainability Practices: A Comparative Automated Content Analysis Approach of Theory and Practice	(Roblek et al., 2020)	The authors compare the thematic concerns exposed in scientific journal's articles versus the newspapers and magazines on sustainable development and industry 4.0, noting that both sources promote energy-saving technologies and reduction of carbon dioxide emissions. However scientific literature focuses more on changes in business models, production processes, and technologies enabling sustainable development. While media articles write more about sustainable or green investment, sustainable standards, and sustainable reporting.
[14]	The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review	(Isensee et al., 2020)	After a theoretical review on the 3 topics at study (organizational culture, environmental sustainability and digitalization), the authors update the BAO framework, summarizing 6 propositions to encourage SMEs on the promotion of sustainable, digital development through organizational culture development.
[15]	Smart inspection and maintenance: Aerial drones	(Spaniol, 2020)	Different authors present 3 prospect aerial drone applications in smart inspection and maintenance for maritime and offshore industries: (1) Drones for predator bird handling at aquaculture farms (2) Drones for offshore maintenance and repair (equipped with cutting arms, precision grinders, manipulators, and/or welding equipment) (3) Drones for de-icing offshore windmills.
[16]	An Insight into Reverse Logistics with a Focus on Collection Systems	(Alkahtani et al., 2021)	A systematic literature review on the topic of Reverse Logistics. The authors mention AI as one possible solution methods to solve reverse logistics problems.
[17]	Evaluation of logistics providers for sustainable service quality: Analytics based decision making framework	(A. Gupta et al., 2021)	Based on literature review, the authors identify 17 attributes related to sustainable service quality, formulating a 5C framework for the selection of appropriate logistics service providers (LSPs) , posteriorly leveraged to evaluate 3 Indian logistics providers.
[18]	Industry 4.0 enablers for a cleaner production and circular economy within the context of business ethics: a study in a developing country	(Shayganmehr et al., 2021)	From the literature the authors identify several Industry 4.0 enablers for a cleaner production and circular economy, creating a framework, evaluated by industry experts and deployed in one of the largest Iranian textile manufacturing companies. Technical capability, including the application of machine learning systems and big data, was considered the most important enablers that had the strongest effect on CP and CE implementation.
[19]	Industry 4.0, Cleaner Production and Circular Economy: an integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations	(H. Gupta et al., 2021)	The authors identify practices of circular economy, Industry 4.0, and cleaner production, and combines them into a framework for assessing and guiding sustainability performance of manufacturing companies, testing it with 5 manufacturing companies.
[20]	Thirty years of design for sustainability: an evolution of research, policy and practice	(Bhamra & Hernandez, 2021)	The authors give their own personal perspective on the development of the field of design for sustainability. A speculative chapter about the Future is available where artificial intelligence is referred to as an enabler of circular economy through (1) machine learning assisted design processes (2) pricing and demand prediction, predictive maintenance and smart inventories, and (3) Improving reverse logistics

B. AI Applications for Sustainable Development references in the Filtered Articles

#	Title	Reference	AI Application Examples	Directly Impacted SDGs
[1]	An integrated framework for sustainable supplier selection and evaluation in supply chains	(Yazdani et al., 2017)	● Select Green Suppliers	| 12 |
[2]	Determining the Sustainable start-up company	(Bernal & Alba, 2018)	● Give locked in patients interaction abilities through brain signals (MindAffect) ● Find the best setting that will collect the most power (Maximum Power Point Tracking) (NOWI)	| 3 | 7 |
[3]	Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies	(Luthra & Mangla, 2018)	● Monitor & Control important production parameters in real time (production status, energy consumption, flow of materials, customers' orders, and suppliers' data)	| 7 | 12 |
[4]	Linking big data analytics and operational sustainability practices for sustainable business management	● (Raut et al., 2019)	● Supply chain and operations management performance ● Optimize location of manufacturing plants and warehouses and the allocation of resources to the various stages of a supply chain ● Sustainable manufacturing ● Sustainable procurement and enhanced business values ● Maintenance cost estimation and CBM (condition based management) policy optimisation.	| 12 |
[5]	New Trends in Sustainable Business and Consumption	(Marquardt et al., 2019)	● Procurement Automation ● Predictive Maintenance ● Facility Monitoring (Ex: Drone with cognitive abilities) ● Supply chain optimization ● Eco-driving recommendations ● Smart charging ● Optimized engine cooling systems	| 7 | 12 |
[6]	Social and Environmental Accounting (SEA)	(Gray et al., 2019)	● Find causality of human action on environment	| 8 | 13 |
[7]	A machine learning framework for multi-hazards modelling and mapping in a mountainous area	(Yousefi et al., 2020)	● Calculate probability of natural disasters (snow avalanches, landslides, wildfires, land subsidence, and floods)	| 13 |
[8]	Applying the triple bottom line in sustainable supplier selection: A meta-review of the state-of-the-art	(Rashidi et al., 2020)	● Select Green Suppliers	| 2 | 12 |
[9]	Aspects of Digitalization and Related Impact on Green Tourism in European Countries	(Saseanu et al., 2020)	● Real-time Territory mapping	| 8 |
[10]	Bagging ensemble of multilayer perceptrons for missing electricity consumption data imputation	(Jung et al., 2020)	● Improve missing electric consumption data for more accurate electric load forecasting	| 7 |

[11]	Digitally-enabled sustainable supply chains in the 21st century: A review and a research agenda	(Chiappetta Jabbour et al., 2020)	● Sustainable Supply Chains	| 1 | to | 17 |
[12]	New Trends in Sustainable Business and Consumption	(Dumitru & Stanculescu, 2020)	N/A	| 1 | to | 17 |
[13]	The Fourth Industrial Revolution and the Sustainability Practices: A Comparative Automated Content Analysis Approach of Theory and Practice	(Roblek et al., 2020)	● Monitor & Control the material world ● Identify real-time events and predict future events ● Select value chain partners ● Prevent the occurrence of bottlenecks in advance ● Predict problems related with the health of the soil, plants, vegetables, and vines.	| 8 | 12 |
[14]	The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review	(Isensee et al., 2020)	● Prevent Pollution ● Promote resource efficiency ● Product stewardship	| 12 | 13 |
[15]	Smart inspection and maintenance: Aerial drones	(Spaniol, 2020)	● Deter predator birds at aquaculture farms ● Allow for automated offshore maintenance and repair ● Facilitate de-icing of offshore windmills	| 7 | 14 |
[16]	An Insight into Reverse Logistics with a Focus on Collection Systems	(Alkahtani et al., 2021)	● Determine the right location for collection and distribution centres in reverse logistics ● Identify take-back patterns of scrap cars ● Choose the best disposition strategy ● Solve vehicle rooting problem for distribution optimization	| 11 | 12 | 14 | 17 |
[17]	Evaluation of logistics providers for sustainable service quality: Analytics based decision making framework	(A. Gupta et al., 2021)	● Select logistics provider based on sustainable service quality. ● Reply to queries to improve service providers communication	| 12 | 17 |
[18]	Industry 4.0 enablers for a cleaner production and circular economy within the context of business ethics: a study in a developing country	(Shayganmehr et al., 2021)	● Optimize usage and utilization of resources ● Improve the monitoring of product lifecycle step ● Enhance production efficiency and product and service design. ● Standardize & Optimize Cleaner production and Circular Economy implementation processes	| 7 | 12 |
[19]	Industry 4.0, Cleaner Production and Circular Economy: an integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations	(H. Gupta et al., 2021)	● Optimize resource allocation in smart production system with strong supplier communication. ● Build visibility and traceability of products post-consumption required for recovering components and rare earth materials. ● Understand patterns of consumption, waste generation, maintenance requirement and end of life of the product ● Enable real time data collection and analysis throughout the supply chain for energy efficiency, waste and return management, service and equipment maintenance ● Automate production systems	| 7 | 12 | 17 |

			● Calculate effectively end of life for component extraction, reuse and recycling	
[20]	**Thirty years of design for sustainability: an evolution of research, policy and practice**	(Bhamra & Hernandez, 2021)	● Assist design processes that will favour rapid prototyping and testing ● Enable Price and demand prediction, predictive maintenance and smart inventories ● Improve Reverse logistics	| 6 | 8 | 11 | |12 | 13 | 14 |15 |

C. Design-Science Research Guidelines (HEVNER ET AL., 2004)

Table 1. Design-Science Research Guidelines	
Guideline	**Description**
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

D. Information Systems Research Framework (Hevner et al., 2004)

Figure 2. Information Systems Research Framework

01 High Level SDG Assessment

Leverage **SDG Action Manager** for a comprehensive overview on companies SDG performance with a score evaluation to understand strengths and potential areas of improvement, targeted to the companies size and industry.

SDG ACTION MANAGER

02 High Level AI Assessment

List current AI Applications across the business and the associated techniques, complemented by a list of the current data domains available and governed.

LIST OF AI APP. & DATA DOMAINS

03 AI & SDG Mapping

Build a **Sustainable AI Matrix**, mapping all current AI applications with the corresponding SDG contribution, identifying possible gaps to be addressed.

AI APP./ USE CASE CATALOG

AS-IS ASSESSMENT

TO-BE CONCEPTUALIZATION

AI & SDG GAP ANALYSIS

06 Evaluation & Prioritization

Evaluate each idea of AI application/use case based on Value and Complexity, positioning them in a prioritization matrix accordingly. Complement the exercise with the definition of Value and Complexity thresholds for development.

AI APP./ USE CASE IDEAS

05 Ideation

Brainstorm and propose new AI use cases inspired in the results of the Research & Benchmark, tacking the previously identified gaps.

STATE OF THE ART

04 Research & Benchmark

Conduct market research to identify how other governments and companies are applying AI for Sustainable business, leveraging as accelerators the proposed research strings and the results of the Systematic literature Review.

F. World Benchmarking Alliance Industry to SDG Mapping

SDG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Energy			■			■	■						■	■	■	■	■
Materials		■	■			■	■	■			■	■	■	■	■	■	■
Capital goods							■	■	■			■	■				■
Commercial & professional services								■									■
Transportation			■				■	■	■		■		■				■
Automobiles & components			■				■				■	■	■				■
Consumer durables & apparel					■	■		■			■	■					■
Consumer services				■	■			■				■		■			■
Media				■	■					■						■	■
Retailing								■				■					■
Food & staples retailing		■	■									■	■	■	■		■
Food, beverage & tobacco	■	■	■		■	■		■				■	■	■	■	■	■
Household & personal products			■									■					■
Health care equipment & services			■		■							■					■
Pharmaceuticals, biotechnology & life sciences			■		■												■
Banks	■				■		■	■	■	■		■	■			■	■
Diversified financials							■	■	■			■	■				■
Insurance	■	■	■					■		■			■				■
Information & communication technology	■	■	■	■	■		■	■	■	■	■	■	■			■	■
Telecommunication services	■	■	■	■	■			■	■	■						■	■
Utilities	■		■		■	■	■	■	■	■			■				■
Real estate							■				■	■	■				■

G. SDG Action Manager – Baseline Module Questionnaire

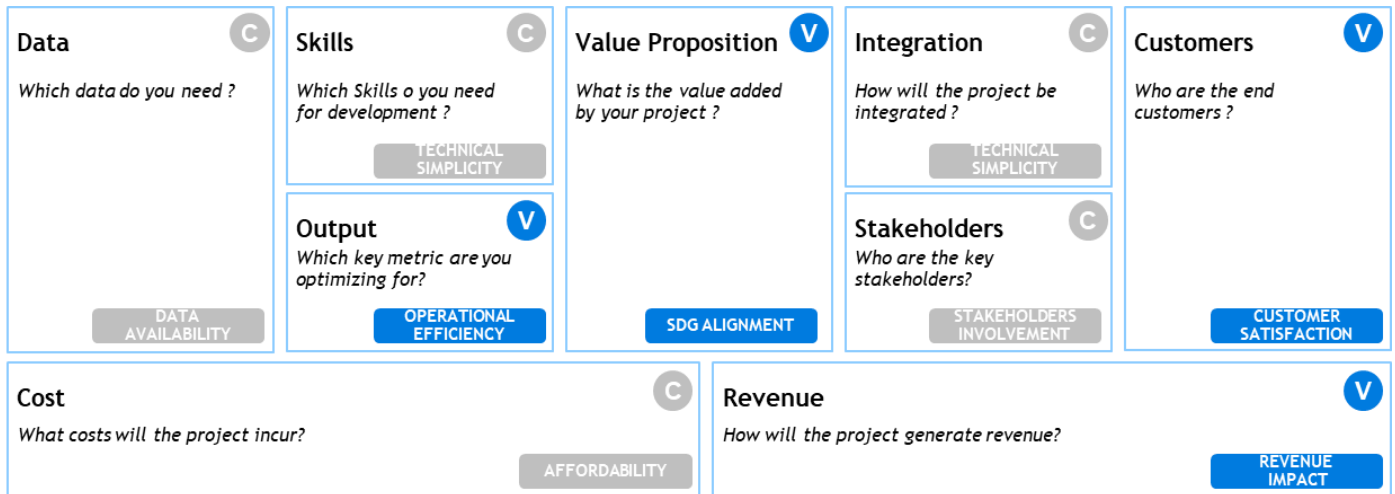| #	Sub Section	Question
[1]	Introduction	Does your company operate in any of the following industries or sell any of the following types of products?
[2]	Introduction	Has your company done any of the following to specifically contribute to the Sustainable Development Goals?
[3]	Introduction	Has your company done any of the following to measure and manage the results, outcomes, effects, or impact of its business activities on the Sustainable Development Goals?
[4]	Introduction	Has your company done any of the following to engage stakeholders about your social and environmental performance?
[5]	Introduction	Separate from a mission statement, what has your company done to legally ensure that its social or environmental performance is a part of its decision-making over time, regardless of company ownership?
[6]	Introduction	How does your company take part in civic engagement?
[7]	Introduction	What does your company formally screen for regarding the social or environmental practices and performance of your suppliers?
[8]	Introduction	Does your company have any of the following with regard to tax management?
[9]	Introduction	Number of Total Full-Time Workers
[10]	Introduction	Number of Total Part-Time Workers
[11]	Introduction	Number of Total Temporary Workers
[12]	Introduction	Total Earned Revenue from the last fiscal year
[13]	Human Rights	Which of the following is true for your company's human rights policy?
[14]	Labor	What is included in your company's written and accessible employee handbook?
[15]	Labor	Which of the following is true with regards to company commitments to offer a living wage to its workers?
[16]	Labor	What is the annual minimum number of paid days off (including holidays) for full-time employees?
[17]	Labor	Does your company have any of the following practices with regards to workers' freedom of association and right to collective bargaining?
[18]	Labor	Does your company do any of the following to protect workers from and prevent workplace harassment including physical, verbal, sexual or psychological harassment, abuse, or threats?
[19]	Labor	What is covered in your company's written non-discrimination policy on hiring and the workplace?
[20]	Environment	Does your company have an environmental management system (EMS) covering waste generation, energy usage, water usage, and carbon emissions that includes any of the following?
[21]	Environment	How does your company manage its greenhouse gas emissions for at least Scope 1 and 2?
[22]	Environment	Does your company monitor and manage your water usage?
[23]	Environment	Does the company have any of the following practices for encouraging the development and use of environmentally friendly technologies?
[24]	Anti-Corruption	What information does the company make publicly available and transparent?
[25]	Anti-Corruption	What is required by your company's Code of Ethics?
[26]	Anti-Corruption	How does your company instruct employees regarding your Code of Ethics on behavioural expectations, bribery, and corruption?
[27]	Anti-Corruption	How does your company instruct employees regarding your Code of Ethics on behavioural expectations, bribery, and corruption?

H. STEP 6 – Prioritization Guidelines

Dimension	Criteria	Description	Prioritization Guidelines		
			LOW	MEDIUM	HIGH
VALUE	SDG Contribution	Number of SDG indicators targeted through the AI application implementation, and alignment to the SDG gaps identified	No direct or indirect impact on SDG indicators	Moderate positive impact on SDG indicators	Significant impact on SDG indicators
	Revenue Impact	The potential of AI application opportunity to create new / increase existing revenue streams, or optimize costs	No direct or indirect impact on revenue or costs	Moderate positive impact on existing revenue streams or indirect cost optimization	Significant growth in revenues either directly (new revenue streams) or indirectly (significantly enhancing existing streams) with simultaneous costs optimization
	Operational Efficiency	The impact of AI application opportunity output on company's products & services, operations efficiency and decision-making (e.g. planning, accuracy, time, effort, etc.)	No impact on company's products & services, operations efficiency and decision-making	Moderate impact on company's products & services, operations efficiency and decision-making	Significant impact on company's products & services, operations efficiency and decision-making
	Customers Satisfaction	The impact of AI application opportunity on customers well-being and satisfaction	No impact on customers satisfaction and well-being and satisfaction	Positive impact on customers well-being and satisfaction	High positive impact on customers well-being and satisfaction
COMPLEXITY	Technical Simplicity	Level of simplicity of AI application opportunity based on technical requirements (such as integration dependencies, architecture compatibility, availability of supporting technology, etc) and skillset needed	Complex, risky implementation involving advanced technologies	Moderate complexity of implementation	Easy, straight to the point implementation
	Affordability	Estimated upfront cost / investment to pilot this AI application	High investment required for the AI application piloting	Moderate investment required for the AI application piloting	Low or no investment required for the AI application piloting
	Data Availability	Existence, accessibility and readiness of required datasets for AI application including the request of additional datasets from other External Entities	Data does not exist	Data exists but is not accessible	Data exists, is accessible and ready to be used
	Stakeholders Involvement	Level of involvement of different internal and external company stakeholders	Complex implementation requiring engagement with several teams including external stakeholders	Moderate complexity of implementation requiring the engagement with several internal teams	Easy implementation requiring the engagement of a few internal teams that already work collaboratively

I. STEP 6 – Prioritization Dimensions & Criteria

Data (C)

Which data do you need ?

DATA AVAILABILITY

Skills (C)

Which Skills o you need for development ?

TECHNICAL SIMPLICITY

Output (V)

Which key metric are you optimizing for?

OPERATIONAL EFFICIENCY

Value Proposition (V)

What is the value added by your project ?

SDG ALIGNMENT

Integration (C)

How will the project be integrated ?

TECHNICAL SIMPLICITY

Stakeholders (C)

Who are the key stakeholders?

STAKEHOLDERS INVOLVEMENT

Customers (V)

Who are the end customers ?

CUSTOMER SATISFACTION

Cost (C)

What costs will the project incur?

AFFORDABILITY

Revenue (V)

How will the project generate revenue?

REVENUE IMPACT

(V) VALUE Dimension   (C) COMPLEXITY Dimension   ▭ Scoring Criteria

J. Focus Group Meeting 1 Transcription

<u>**STEP 1:**</u>

I1. Just one question, are those KPIs aligned with the Dow Jones [Sustainability Indexes] or not? I am asking this because almost all organizations have to answer the Dow Jones rate for sustainability. So, imagine, even if the tool is assigning them [companies] specific targets or specific KPIs, are they aligned? If it is the case, ok, they will follow the same. If it is not the case, is [SDG Action Manager] a toll that will help organizations highlight or do more in regards to their maturity, or not?

Moderator: So, regarding the Dow Jones, I would have to investigate further because I'm not 100% sure it is aligned. But I can tell you that, from my research, there are many different institutions trying to implement scores for companies to adhere. And so what the United Nations is trying to do is to set just one tool where everyone can have, and use the same KPIs and use the same measures to have implemented. But as this has been released after the Dow Jones score, maybe all companies are now moving to this tool. But well, regarding the Dow Jones that is the answer I have to you.

Regarding the maturity what happens is: in each question you have a list of, let's say, best practices around each SDG, having your score, you know exactly how far you are from the top score. And you know, you have guidelines, on how you could reach a higher score. That answers the question of maturity.

From here [SDG Action Manager Tool] you could easily understand what it takes for you to be better at the specific SDG. If you guys want to see specific examples of questions, we can go through them. But as companies do this questionnaire, they become a lot more aware of what each SGD actually implies, because sometimes companies have this, let's say overall idea, but they're not specifically aware of how the United Nations is actually calculating this impact.

[(…) Further details on the SDG Action Manager (…)]

So do you have any other recommendations. Is there anything missing in this step? Does it make sense to be the first step? What do you guys think?

I1: In my opinion makes lots of sense, because it is a kind of Value Targeting, you start understanding what are your business questions or business goals and after this identify the specific initiatives or the specific KPIs, so… it's quite aligned with the Value Targeting that you do for Analytics, so I think it's okay.

I2: Let me just ask something. Hum… so basically, you're saying that that's the list of questions that you ask to any business, any company, right?

Moderator: Yes.

I2: Do you have any trouble on getting those companies to answer that list? Because, from what I've seen, it's quite a bit… quite a big list, right?

Moderator: Right. Yeah, yeah, that's an awesome feedback. So, as I told you, I haven't applied this to a particular company, so I did this in a hypothetical use case. A hypothetical use case that actually leveraged data from a real company, they didn't want to be identified. From this experience it took them around three days, to be able to answer the main questions I asked them to answer in this stage, because some questions require quite a wide overview on what the company is doing that it's not concentrated in one employee. So, the company, maybe we'll have to ask more than one employee and more than one department what they're doing or what they're not so… I think that's a super good insight. So, in some companies, it might be hard to answer these questions because they might not have full information. The good thing is you actually have the answer, "I don't know, in some, in many, questions. In this case, there is a score thought also for the example of, "I don't know".

I2: One other thing, are you positive that everyone understands what are those questions, I mean, to the full extent of the question? Because I mean because I mean sometimes it might be misunderstood? .

Moderator: Or somewhat subjective?

I2: Yeah, Yeah.

Moderator: Well, what I was telling before to I2, also applies here. So, some of this terms they're quite subjective and the United Nations has been doing an effort to unify this things and to make sure everyone understands. The tool has always [a support service]… you can ask for help here in the tool, which is good and you have more information available on the website to have further clarifications on the questions, but that is [indeed] a risk. Your point is valid.

I3: Just to add up on I2's comment, my personal experience, I've developed a couple of years ago together with Nova SBE an assessment for basically the Analytics Maturity of companies. An exercise that turned out to be quite complex. Humans are lazy, right? And since they are not seeing an immediate retribution for their work… uhm.. maybe what I view would be to have here some type of swipe that you could give to companies as they fill in these steps, I'm not sure… You know, even the benchmark (as I1 said), something that would give the feeling of accomplishment. Otherwise, it's just such a long journey, uh, that it may be actually quite hard. And the second thing is something that you mentioned that I think is quite important: who will be filling this, the governance of the thing is quite important because we found, at that time with Nova [previous experience], it was really hard to have one guy that was really understanding everything, but then it was hard to to pull a group of people to fill the survey, which seems like a nightmare. So, there is a tradeoff there between completeness, but then, uh, who feels it? I know it's not such an interesting research topic, but from the practical point of view, I think that that's quite something important too.

Moderator: That's super good feedback. I was aware of that risk. I'm just leaving that to the consideration of companies because they will be leveraging a tool that is worldwide, they will also manage to have an overview on topics that maybe they haven't thought about. So, the good thing about doing a more extensive questionnaire is that you get more in depth of where you are and where you should be. But of course, that comes with risks, obviously. But well, it's super good feedback! From my experience, as I told you, I've took the data from an actual organization, and in the end, even though they took three days, they said that it was great insight, they become aware that many things they weren't still doing. That is a little bit of the tradeoff that you will have…

I3: One [company] that you can talk to, at least the only ones I know in Portugal is Symington. Symington is a B Corp, Symington States Family from Port Wine. So they are a big corporation, so they have went through all this process. So it may be good just to ping someone at Symington and understand, what was their experience filling in, it would be nice.

STEP 2:

I3: I think two things that might be interesting. One is that there are a couple of adaptations of the Value chain, for example, for the service industry. Because I think this is really hard for a company (ex: Accenture) to fill this, right? So, you may want to at least have two worksheets where you have actually the service value chain, which will be much more about knowledge management and etc. There's kind of, uh, the same thing, but, transporting Porter's into the service industry. Porter was 85, I think now most of the companies are actually working on in the service industries, right? So, it may be interesting for you to have this adaptation. And then, I will also look to these AI subfields. It seems to me that it doesn't really… these examples, they don't relate too much to me and so, I would, I don't know… Searching? I'm not really seeing it as an AI Subfield, you know?

I2: As an example, here, at Company Y, what we do is trying to understand what's the behavior of the several agents and try to leverage AI into understanding if there is any anomaly or not. Where do you see this? Can this fit here? I would say like, uh, Support Activity 2 – Technology Development - to technology development. Would you say that?

Moderator: Anomalies in what?

I2: Anomaly detection on user behavior.

Moderator: Okay. So for me, um, I would say yes, yes. Yeah.

I2: It makes sense for me. I mean, I'm not recalling any [other value chain possibility]

Moderator: Here there is no right and wrong, the only thing is that if you were to implement this at Company Y, for example, and you would see, uh, all the AI algorithms that you guys have implemented, you would just have to make sure that inside Company Y, everyone understands what is Procurement, what is Marketing and Sales, and then you would list the applications and put them in the different buckets. Okay. Here, I just use these different categories to make sure that companies don't forget to look, because sometimes they have algorithms running inside a technology that is outsourced and they haven't ever realized that it is leveraging AI for something. Okay. If your company includes this in technology development and another company in another area, that's actually not a problem. The only thing you have to make sure is that insight Company Y, when people see these buckets, they will all understand what this procurement or the services within marketing and sales, …

I2: One additional thing, in the example of Company Y, I see Company Y fitting in at least three or four, is there a problem?

Moderator: No, no, no, no, you, you don't have to fill them all.

I2: For you to try to figure out what are the answers, it could be a problem, I'm not sure, that's why I asked.

Moderator: In this sense it does not have implication in neither steps. For applying the guidebook, if in this case you didn't have all the primary activities fulfilled, there will not be a problem. The idea was: I wanted to give these activities just for the companies to have a way to see all the steps of the value chain and make sure they don't forget anything, but it doesn't have any implication for the further development of the guidebook.

I4: I think this might work okay for small companies, but in a large company, it needs to be much, much, much more granular than this. For example, in an extreme, you can put AWS into line 22 pretty much. Um, and then if you're going to classify AWS, you're just going to have everything and then it's going to be really complicated to do the matrix for sustainability.

I1: I just think we are losing the focus. Our focus is to understand what is the maturity of the initiatives regarding AI, or if there are AI initiatives that are linked with sustainability? I think it is the second.

Moderator: The second one will be in the third step. Okay?

I1: I know, I know, I know what I'm saying is we are asking, we know this is a difficult part to identify all the AI initiatives we have within the company. It will be complicated to link this with the maturity of the initiatives. And maturity is not adding value for the aim of the work [Guidebook development]. So, you are just trying to identify AI initiatives and sustainability targets, right? I'm not sure if you need the second one. Yeah.

Moderator: Here, the idea was more for companies to first think of the things separately and then merged them together because then you have more, more material to work in. But I understand what you are saying, that you might have a lot of effort and then don't leverage many of the applications you had. It's great feedback. Yeah.

I1: And the other point is, (…) I think that maybe it is a good idea to have a step zero where you write some recommendations regarding governance, because the people that will feel the sustainability part is not exactly the same people that will feel these initiatives, the AI initiatives' list. So maybe you could give some tips.

Okay. Okay.

STEP 3:

No further comments added

STEP 4:

I4: I have a doubt going back to dimensionality of things. Three steps before, when you had the department before the matrix, by each department you were stating what kind of ML they are using. Then, you stay at that level and say how that maps to the goals. When you benchmark you are benchmarking the whole company? Or you are benchmarking the department?

Moderator: That was my fault because I didn't explain that. So, here, what is proposed in this guidebook is that you research the gaps that you have identified. For example, as I've shown you before here, in this example, I would focus my research on the goals I'm not contributing as much as I should.

I4: So here it would be at the department level more or less: logistics, marketing and so on… ?

Moderator: Yeah, but you would research specifically, for example, applications that will highly contribute to SDG 5 because it's the one you should be contributing for and you're not contributing in any manner.

I4: So, each use case or each usage of AI, an application, that is the dimensionality you're using pretty much.

Moderator: Yes, exactly. (…) In the example we've see, your benchmark would find how are other companies leveraging AI to contribute to SDG 5, 8 or 14?

I4: Can you have that information at an application level for other companies?

Moderator: I've seen examples of many at the SDG level. For example, poverty or hanger, hanger is SDG one. There are many zero hunger applications that will have an impact. The only thing here is many times one application does not have a single contribution. Many times, when you're contributing to one, you're also contributing to others. So here it would be key for the company to really see what is the one that has the higher impact on the gaps that you've identified.

STEP 5:

I4: I think for you to fill this up, you're going to need a lot, a lot of people in the company. I mean, it's going to be really hard to get a room full of people to do this for the whole company.

Moderator: Again, sorry, maybe I didn't make myself clear. (…) You'd have to do one per idea. It was not one for the whole company.

I4: It's exactly the same that we do on Value Targeting. We have one initiative and after this, we need to identify exactly what are the requirements to develop the initiative. My only point here is I think we should have one category about what is the link with a sustainable goal. Just this.

I5: Yeah. Yeah. I specify that. When I explained the value proposition dimension, it has to include the contribution to the SDGs, maybe, I should have given you guys an example of a sustainable AI application, actually this one can map to specific SDGs, but as I'm advising companies to do in this dimension, they must mention the contribution to the SDGs. Sorry, my bad. I didn't explain it correctly.

STEP 6:

I2: To be honest, I'm not recalling anything else to there.

I4: Shouldn't affordability be in Value?

Moderator: Here what I was thinking was affordability in terms of implementation cost, and so that's kind of related with complexity. At least that was the way I was thinking, but it makes sense what you're saying.

I4: Possibly even swap Affordability and Operational Efficiency.

I3: How were these weights defined?

Moderator: I say that the companies, according to their business priority and what they have, they can personalize each weight. So, for example, if for my company it's more important, the revenue impact,

I will give all the weight to the revenue impact. If it isn't, I will give less weight. Okay? The only recommendation I give is that the SDG contribution is not lower than 30%, otherwise I give total freedom to companies, according to the strategy they're following, the resources they have available, etc. to personalize these weights.

I3: Yeah. I cannot think about anything else. Maybe, if we could… I'm trying actually to make it shorter.

Moderator: I think another critique we can have here is that, I'm trying to do very straightforward criteria, but then we're actually not being quantitative. We're just giving rates of low, medium and high, but that's because, from my experience, it would be really hard to have quantitative values here. I just want the different stakeholders to be challenged to think about it.

I1: I think your drivers are pretty much comprehensive.

I2: I think so too, the thing is that, I mean, to be honest it is quite a lot of information to process right now. And that is why we cannot add that much. It seems like it is quite complete, I still think it is going to be a little bit hard for any company to fill all of those questions, because it's going to take a while, but surely it is really complete. I think.

I1: I think it is the balance between a complete framework or approach that you need for your thesis, the theoretical exercise, and after this you can refine when you are in a practical project. Imagine if I don't want to use six drivers, I will use three, but at least you are providing all the hypotheses.

I2: Yeah.

OVERALL FEEDBACK:

I2: To be honest, I think it is quite useful. My only problem is trying to convince someone or some company to fulfill that, it is going to be hard for you. But I think it is really, really complete and as I1 said you have to find a balance between the two things: being a complete guide and also being something that companies actually see value in doing and actually spend some time doing it. But I think it is pretty useful.

Moderator: If you had to implement it in your company, would you implement it?

I2: To be honest, I would say so. But the thing is trying to find some time to do that… that's the big challenge here. Because if I were to implement it, either I would answer the way I know or to be completely honest I would have to spend a few days asking people about all the product that we have, about what we do for example, in HR, in sales, I'm not completely sure if we have AI products there…

I1: You just need to have a really strong Data Strategy. If you have a really strong Data Strategy you will have for sure a formal backlog of initiatives, so it will be straight forward. It is my suggestion. I think you have 2 big challenges. The first one is low literacy regarding data and the second one is even lower literacy about sustainability. So, you are trying to add to areas where people are not getting the value yet. So, I think this is the first obstacle.

I2: To be honest, I think the fist one is a nightmare and the second one is even worse. And most people don't really care about that, they pretend to do, but I mean… But the first one is what gives me crisps because everyone says they did something with AI, even though they just mostly do data engineering

or so. And I think that is going to be a little bit hard to get people to understand what do they have in house. But let's see, you have to maybe guide them through the questions or so… not sure how you are going to…

Moderator: I think it would be very useful to have a real use case.

I2: Yeah, and use examples like: this is considered to be an AI project, this is not… For example, if you are saying that you are doing a Dashboard, that, for me, is not an AI project but most companies would say that is Data Science and it is not.

I4: I was thinking a little bit about it, but for example spending one, two months doing this doesn't seem too much, either you care about sustainability and you care about AI, and one/two months is not that much at all, or you don't care and it doesn't really matter, because you are never going to care enough to change anything. So…

I2: That's pretty much investment…

I4: Uh, I was thinking that it might be a little bit too cumbersome, but then I changed a little bit my mind in the sense that it's not that much.

I1: I agree if, if you want to do a proper job, eight weeks is not so much. In my opinion, one of the strengths of your tool, or of the overall approach is, at least in the first stage, that it is more educational than other thing. You are opening minds, saying to organizations: "this is more than environment". So, I think this is one of the good parts. So, you can not only apply this in a more practical way, but also in the educational part.

Moderator: Another question that came to my mind is, do you guys believe that once a company decides to invest in this and complete it, they will actually do it more than once? Or you think this will be a one-time thing and that they will not look at it again?

I1: I think for sure they will need to start thinking on sustainability. Yes or Yes! Uh, what I'm not sure is the link between AI and sustainability because it, it requires much more effort than thinking on sustainability as a whole.

I2: Well, to be honest, I think, regarding what Sarah said that companies need to start to look into these objectives, I'm not quite sure if they will, unless they're really required to. Because, I mean, everyone knows that this is at the door, but no one really wants to do something about it. And basically, if you ask any company, if they want to meet the 17 objectives, they would say: "Yes, of course, because that's good for our marketing. That's good for us as well". Uh, but if you say: "Would you consider like spending 20% of your time doing stuff towards that?", they will say: "Uhm… would that bring me any money or would that bring me any profit?". That's where I think it's going to be a little bit harder, but as soon as they find that these two objectives cross paths, I think they're going to think a little bit more on that. And that's it, I think it's hard, but at some point they will have to!

I4: I think for large companies, it's really easy to have someone full-time dedicated to this or, or a small team because it's their interest and it is probably net cash positive even. Uhm, for smaller companies, it's going to be harder. Meaning, I can see, for example, Company Z doing cycles, because they sell stuff like renewable energy and so on and so, having sustainability is really important and it's really

easy to have a dedicated team. Um, for example, Company Y would be smaller company, uh, and, uh, yeah, much harder for them in the sense that they are a fast-paced company and this might be a drag even for them. So, uh, it depends on the scale to answer your question.

I2: Picking up the example on Company Y, the only thing that I've seen they might want to do that is because it is good for Marketing, that's why I think they should. I mean, it doesn't mean people here are not conscious, they are conscious and the Management [layer] is pretty conscious, but I mean, it's like what I4 said, s, it's you have everyone dedicated to work, to improve the products, right?

Moderator: This could even generate new product ideas…

I2: It's true. It's true. And to be honest, we have a very good policy here. Once per year, we have a Hackathon across the company. Uh, and actually from that Hackathon there are pretty good ideas that come along. We invest, but then we get the results, uh, and it's much more valuable. And that can be one of those things, you're completely right, but I don't know. I don't know. Maybe I'm not seeing something here.

Moderator: No, no, that's, that's, that's perfect. Okay guys, I don't want to lose any more of your time. We have 15 minutes left, so I'll just thank you for joining.

K. Focus Group Meeting 2 Transcription

STEP 1:

Moderator: Were you guys aware of this tool [SDG Action Manager]?

I7: Yes

I5: No.

I6: Not really, this new match between the B lab and the SDGs, no, not yet.

Moderator: Okay. Okay. I7, you said you are, do you know companies that have been leveraging it? Do they think it's easy?

I7: No. Sorry. I know some companies, but small ones, especially ones who are already B Corp, which in Portugal are not a lot, who are already engaging with it. But I don't know if you wanted me to provide feedback already on that, but, um, the whole point with the SDGs and with trying to map out commitments within the SDGs and trying to map out also goals and targets, from my experience with big companies has been a challenge. So, most of the times companies have done shortcuts and they have used the SDGs more as a tool, a communication tool, which is fine, where they add on to their already existing tools for disclosing particular KPIs on sustainability, not necessarily ESG, but related. Because most of the times companies already use GRI as a tool to disclose nonfinancial information. So, my first comment would be, I think it's cool. And I think companies will start doing it more often, but adding on to what they already have is always a big challenge. You should keep that in mind.

I6: Can I also add something here? First, my curiosity, when was this match between the SDGs and the B Lab launched?

Moderator: It was January, 2020.

I6: Okay. Okay. Because actually there's something, I don't know if you're aware, but no the GRI and the SDGs, it was launched last year also, a connection, an official link between the GRI and the SDGs. Uh, I mean, it doesn't go in detail through the targets and the indicators, I think it's only about the GRI and the 17 SDGs. Uh, but what I feel, and I totally agree with I7, is that companies in general they map the 17 SDGs, but they don't go through the details in terms of targets and indicators. Uh, so yes, I think it could be very interesting to insist or to try something more detailed in that scenario.

Moderator: [Further details on the SDG Action Manager}

I6: This is a very interesting tool, I think. It's very similar to B Impact Assessment itself. So, uh, actually we did the B impact assessment at Company Z. We did it last year, but related to the previous one, 2019. And yes, as I can see, it's very similar the way you fill in the data and all the details. And then I think you can get a report, have an access to an improvement report, right?

Moderator: Yes, that's it. Yep. What are your thoughts on this being the first step?

I5: I mean, personally, I think it's always a good idea to set benchmarks and set goals and set a framework for people to understand these concepts. I think that that's really important just to set context for, you know, all actions moving forward and give people an idea of how these things can be achieved. So I think it's a really good first step.

I6: Yeah, I agree. I agree.

I7: I think it's also great. My only question would be whether you could have… uh, this would be cool for a company who's starting to benchmark or hasn't have a lot of information. It would be good to have a second possibility for those companies who already have that process in place. And so they could move on from this first step instead of having to create it from scratch. Yeah. Yeah.

Moderator: The only experience I have now is what I6 was saying. I know that the GRI is now aligned with the SDGs, but it is not such a deep analysis. And so maybe they will need to start from scratch either way.

I6: Just a question, this will work like a diagnosis for the companies? Right? The first step, to see where they are and to where they want to move.

Moderator: Yes.

I6: Okay, perfect. Yes. Makes sense.

STEP 2:

I5: Would this include applications that companies are using, that utilize AI? Um, or would this just be core applications that an internal company has developed for themselves?

Moderator: It would be everything, because imagine later in the third step you want to map this with a SDG, and so if you have providers and you want to make sure, for example, they're providing transparency in the algorithms that they do, or they're doing Responsibility AI in the sense of ensuring unbiases and everything, so that would apply to them and to their providers.

I6: The idea is to make organizations conscious of the importance of the technology, uh, AI solutions, right? To work together with the first step, with the diagnosis and then like a way to implement the diagnosis they did in the first step, like a tool to help them. Am I right?

Moderator: I think what you're saying will be Step , here I'm just in other leading them to open their minds. So, thinking in Sustainability in one side – Step 1. In Step 2 I'm thinking: "What do I have? What is everything I have developed in AI within?". And then in the third step, you will see that I'm going to make them think about how do they map it.

I6: So here it is to identify these kind of AI solutions to improve their work in terms of sustainability?

Moderator: Yeah.

I6: OK.

I8: Perhaps you are already considering this in your thesis, but I would suggest to make really clear what kind of people would be involved in each step. So, who would be involved in Step 1, who'd be

involved in Step 2, etc. and really the kind of professional roles and engagement within the organization, otherwise I think companies will lose much time looking for the right person to tell them the information. And so, if you could advance that on your tool, I think it would be great for them.

Moderator: Ok

I6: That's right, that's an interesting point.

I7: Can I just add something on this? I know very little on AI, so I don't think I can add much, but the only thing I wanted to add is: I was thinking whether you are considering companies vertically integrated or companies that have a good relationship with other parts of the value chain, because I think it's critical that they do account for the entire value chain, both for sustainability and in AI too. But in some aspects of the value chain, that companies might not have a super clear image or do not have control because they outsource. So, my question would be, are you considering the outsourced parts of the value chain? Or only parts of the value chain where companies are in full control?

Moderator: Yeah, I think that's aligned with the question that I5 was asking earlier and here, what I want them to have is a full picture. If you want all your algorithms to have, let's say, a sustainable direction, you need to be aware of all the algorithms you have, either if they're insourced or outsourced. So, it's supposed to cover everything, which I know comes with a risk, which is - you have extra complexity.

I5: My only feedback about that complexity is that some types of decisions, um, if you look at the documentation, can be 80 pages long describing the algorithms and what they're doing… I don't know if you're trying to stay at the application layer or if you're trying to get to the algorithm level? I think that nuance is going to be really important for these definitions. Are we worried about the indecision and how that correlates to sustainability, or are we worried about, you know, how the inner workings of creating that decision play a role in sustainability? And I think that distinction, at least to AI operators is going to be important because it just, it it's the level of complexity involved in these definitions.

Moderator: I totally understand your point. I did not specify that level. Um, and so I would say I would leave it to the companies if they want to do such an in-depth analysis, but it's great to have both perspectives.

I5: The way that I read it, just to give you a light, I read this at the application level, and I think that's the easiest level for a company to relate to, um, which seems to be where you're going here and is very practical, they should have like a DPO or a Machine Learning head who has this information practically on hand. So, I don't find this to be terribly complex if it's held at the application level, but you might not get, you might lose the nuance that you're interested in. So, there's just a balance. Yeah.

Moderator: Lovely… Now you made me think, according to what you're saying, for example, you might have an application that straightforward does not have an implication on a goal, but maybe you want to make sure that you're using the data the right way, and so maybe that will be that the depth will lead to that two thoughts. And so, it might be good in that sense.

I5: This are rabbit holes; we can get into that conversation at any time. I read it at the application level. I think you're going to achieve the goal at that level.

STEP 3:

Moderator: Third step is just, let's say a summarizing exercise where you map what you've did in the first step with what you did in the second step. It's a very simple, do you guys have any comments here?

I7: So, it is from the positive side. it's the way the AI applications contribute to a given SDGs?

Moderator: Yeah. That's great feedback actually.

I7: Because I would have both if I would have to consider. So, I would have one, which I think it's cool to start with the positive - in which way our applications contribute to our given goals - but also in which way, particular applications that we have are detrimental to certain goals. Because it's no point to have a lot of things contributing to them, but then having a lot of detrimental aspects to certain. For example, you might be contributing a lot to SDG 4 and 17, but then you have a lot of applications that are really are detrimental for SDG 4 or 1. So, for me, the gaps should come from, from both detrimental and positive aspects.

Moderator: Yeah. That's great feedback makes total sense.

I8: And also for me, the question would be: imagine that different AI applications would be contributing to different SDG targets, do you consider that in that stage or will it come in a different one? Because I think would be important to really look in depth on the targets that they are leveraging instead of just the goal as a whole.

Moderator: Yeah. I'm here staying at the goal level. I was not thinking of going at the target level, but I think that might then come naturally because previously they have done a more in depth analysis… but yes, I'm staying at the goal level, not at the target level.

I8: And also, from a strategic level, would the company know from this mapping what are the primary goals that I really want to contribute to a positive change, or they want to tackle as I7 was saying from a negative perspective. At least for me here, they're all at the same level, and perhaps there are different levels of intensity that strategically that company wants to give, either for both positive and negative.

Moderator: Here the solution you would say is actually, maybe define your ranking for each SDG or something like that?

I8: Yeah. Like a materiality SDG [matrix].

Moderator: In terms of materiality, in the first step, when you use the tool, it already includes materiality, so it already gives you indication of… They've leveraged a thing, which is the Industry Alliance for the SDGs, a worldwide framework where they've assessed different industries and said: "This industry will most probably contribute to these types of objectives and that industry will most probably contribute to other". Well, the company has guidance according to what is defined in the SDG Action Manager but then, afterwards, if they want to first look at for example SDG 5, because it's

more strategical for them, or as I7 said, because marketing wise it would be trendier, I think that's a discussion that then they can have. I'm not giving any recommendations at that level for them to discuss rankings, I'm just telling them to look at the recommended ones. That's the only guideline I'm giving, but it's a great point. Thank you.

STEP 4:

I6: Can I ask you a question? It just came to my mind: which are your targets here in terms of organizations? Big ones and medium ones? Because we know that the small ones are not that… their maturity is not that big. So, that's why I'm asking.

Moderator: I had not set a target in terms of size of companies, but that's perfect feedback. If you believe that maybe this is not as suitable for com for smaller companies, that's a super good feedback.

I6: I'm saying this according to my experience. According to it, we feel that [the target is] big organizations, because they already have a sustainability department or experts doing this kind of work or medium companies also. But when you try to reach the smaller ones, you feel like they are totally… we use an expression… "lost in ESG". We need to convince them first to do a diagnosis, but with the help of a consultancy firm, otherwise this is not a priority for them. So, this is something that they need to be aware of, but they need help. So I think this could be perfect for medium or big companies, but for smaller ones maybe it's more difficult to make them look at this as a priority. This is totally according to our experience in, in my company.

Moderator: Yeah, makes sense. I5, here, I don't know if you want to give your opinion because maybe you have vision from other markets?

I5: Regarding the size of the company that we should be targeting?

Moderator: Yeah.

I5: So, I think that there is like a natural filter in this conversation, which is if you're using AI. And I think that that's naturally going to arrive at a different size of business. I mean, I run a company who believes that anybody who is driving decision-making with AI needs to be responsible about it, so I might have a biased opinion, but I think that it's a good conversation to have with different size organizations. But I think the feedback that you just received from I6 is very right. The organization itself might not be wholly focused on these topics, but I still think it's an important conversation to have, but there is going to be friction. A smaller organization isn't necessarily going to know how to answer all of these questions maybe as specifically as you would like. Um, whereas a bigger organization is going to have natural conflicts, just finding the people to give you the right answers. So, I think that there's going to be conflicts on both sides, but I think the natural filter is if you're using AI, it is an important conversation to have. But I'm 100% biased. [laughs]

Moderator: I8 or I7 I don't know if you have any comments on this one.

I7: I agree. I agree with them both.

STEP 5:

Moderator: So, this is Step 5.

I8: If you can go back to the Canvas, please? I don't know if you can propose a new AI canvas, but, um, I, I don't know if I shared with you previously the Flourishing Business Canvas because I really like one of the sections that they have, which is… Right at the center you have the Value Proposition and below it you have Value Co-Destructions and I think that section would be really important to cover what I7 was saying. Perhaps there are things that they have to keep in mind in this project that will impact negatively the SDGs, and so that's a way to always keep in mind and always remember that there might be something that we should improve on a sustainability perspective. And so, I would include that specifically below the Value Proposition.

Moderator: Value Destruction, right?

I8: Value Co-Destructions, yeah. I will share with you the Flourishing Business Canvas. And Well, there's another section that they have there, which is in between costs and revenues, in the below part, which is the goals. And I think this section would also make sense to your tool, because you are trying to bring together two…

Moderator: What you mean is the SDG? TGs no. Yeah.

I8: The SDG goals. Yeah. And I think that would be even more explicit when they would be creating this AI Project Canvas.

Moderator: So, I was earlier explaining that I would include that here in the Value Proposition, but what you're proposing is to have a specific dimension so people won't forget, right?

I8: Exactly.

Moderator: Ok, makes sense.

STEP 6:

I7: Cool. It looks difficult I would say, but it looks good. From what I could understand is a good matrix for them also to clean their heads and understand in a particular idea how they can prioritize it. It's nice. The only thing I was thinking about is whether 30% is not too low in the sense that if you, if it's a big component, should it be 40, even 50%? Shouldn't be half and half? Although I understand that's ambitious, but if we are thinking about true value creation (where economic, social and environmental value fit together) shouldn't be bigger? And the second point would be: why customer satisfaction instead of stakeholder satisfaction? I'm asking this because you might have particular applications which are geared towards an internal stakeholder, for example, or a particular supplier. Of course, you can then say that the customer doesn't have to be the end customer and we can define it in a different way… But, in my head, when I saw customer satisfaction, I automatically think my end customer being B2B or B2C oriented, so I would maybe specify that it's the customer for the particular application, which means that it might be an employee might be a supplier, …

I6: Makes sense. Yeah.

Moderator: So, so I haven't gone as deep on that. I think that's a great point. I think it would depend on how you have defined the AI Project Canvas. Okay? Here is something that I had prepared in case

you you've asked that, this was the rationale I've used to build the different criteria. And in this sense, I think that would highly depend on how you have fulfilled the AI Project Canvas. So, when you are defining the score afterwards, you will look at what is written in the matrix. Do you think there is any criteria missing?

I8: I was thinking, following that idea, and now that it was really clear how you have created these different criteria aligned with the AI Project Canvas, which is great… Um, if we add that new section on Value Co-Destruction, do you think it would make sense to instead of giving points, taking out points? SDG contribution would have like a double [perspective], you could, you could have a 3 but then if you are doing the other way round, it could even take you net negative points on that.

Moderator: That would be a possibility, yeah.

I8: And now just an idea, I don't know if it makes sense. I just wanted to tell this for brainstorming. Do you think it would make sense to have a specific criterion, even if it's worth like 5%, that really fits each organization that would be using your tool? Because you are creating a standard thing and maybe they are one criterion that is really important for stakeholders, that is really important for the organization itself or for regulatory alignment, I don't know… And maybe it makes sense to have a specific…

Moderator: A free criterion?

I8: Yeah. A free criterion.

I5: My only, my only feedback on this is that AI project complexity is just notoriously hard to plot, to classify – that's the only thing that I think is hard here, but otherwise I agree that SDG could be on sort of a higher ground. Um, I think that probably really good feedback. Um, but the complexity of it, I think that you address that with [the fact that] the customers can change the weight. Can they change the end result? Um, so are complexity and value weighed evenly?

Moderator: I've proposed that they are equally weighted, but that' good feedback for that also to be personalized, right?

I5: I think so, only because complexity is, is really… they're going to get it wrong. You should just assume that they're going to get it wrong. So, if we assume that they're going to get it wrong, then, should we be looking at value more than we're looking at complexity? I mean, I think that allowing it to have a lot of unknown unknowns, right. There are known unknowns, which you are kind of going after here, right? But there are unknown unknowns about a lot of these issues. Like 95% accuracy has a lot to do with, and at least in the example that you gave - medium motor ads, an unknown unknown, I don't know if you can achieve that and so, I might try to allow for an alternate weighting just based on that idea.

Moderator: Ok, ok. Thanks. And in regard to the first gate, I don't know if you guys have any opinion on this? Or if it's relevant to have this first gate, either?

I5: Let me restate the purpose of this, is this to recognize whether something is an AI application and if it is not a duplicate? And if those both evaluate to true, then it passes?

Moderator: Exactly.

I5: I think it's helpful if you have a helpful definition of an AI application, because again, you want people to focus on the right things and people do muddy those things, those concepts pretty often. So, I think, because again, you want people to focus on the right things and people do muddy those things, those concepts pretty often.

Moderator: Okay, perfect. About how I define below medium or high, I don't know if you guys want to go into detail, but as I told you was, this is highly a qualitative exercise. You either say you have low, medium or high.

I7: The only thing that I'm thinking, I'm not sure if I'm able to give feedback on all, but in the first one, on the SDGs (because we saw a lot about it), you seem to have what can be two measures of analysis, because you have one which says "Number of SDG indicators targeted through the AI application implementation" and then you have the other one, which is the "alignment to the SDG gaps". And I'm thinking that when you are assessing a project, you might have those two levels of analysis. And when you are assessing two, you might apply one or the other, which means that you might happen to do comparability. What I'm saying is you might be assessing one project that seems to target a lot of SDGs or targets in a very strong way (particular SDGs), while you might have another, that's not so strong, but my target is very important gap that you had identified. And I'm not sure if the criteria and the levels of prioritization that you are included highlights those two different things. I'm thinking that a company might want to prioritize those applications that lead to covering gaps (because they say, here we have a strong performance, gaps are more important) while another one is really trying to cover the whole scope (if it has applications that are very strong in a number of SDGs, they would prioritize it). For me, it seems two different levels of analysis that should be either tailored to a particular aspect that a company wants to focus more or less, or then you should have subdivisions. You have 30% and so you would have for example, 20% for gaps, if you think gaps are more important (which it seems to you because of the first state of the art) and then you will have 10% for applications which are incremental for already covered SDGs. And so, I would divide the prioritization.

Moderator: Got you. But then that's quite subjective too, right? Because a company might really want to focus on gaps and another one says: "No, I want to cover as many SDGs as I could."

I7: You can have the two levels in your suggestion. I imagined that you have SDG as first criteria, and then you have two lines where you have 20% for gaps and 10% for incremental. But as you are saying to others, you can say to companies: "Look, but if you have very little, incremental is good for you or increasing is good". So maybe their 30% would be for applications that cover the whole scope and increase SDGs. While other companies say: "No, we already do a lot on SDGs, our problem is gaps -we have to cover gaps. We want 30% and we want to prioritize applications that cover only gaps". And so, they tailor it. The only thing I'm saying is I think you should highlight that those are two different levels of analysis and companies should prioritize one or the other.

Moderator: Yeah. Those are very good points.

I5: Do we have space for just like one question and one piece of feedback? What is the underlying, maybe I missed this in your description but, what role does this low, medium or high grade play in the algorithm?

Moderator: You get different points. If you choose low, medium, or high. High, you get higher points, medium, you get less and low even less. When you get a score, then it gets weighted by the weights you've chosen. Okay.

I5: Okay. My only question then, and I'm sure that you've thought about this, but like a typical Likert scale, cause I'm noticing in your medium column all begin with moderate. You might have a bias towards number two, nobody likes to give number 1 and maybe people are extreme about giving number 3. And so, you might have a bias towards number 2 and you might want to consider like a pure 5-point Likert scale where you just say: "This is low and this is high" because you'll find that in that valley is going to be the truth. You might get a more true assessment of how they actually think about if that makes any sense.

Moderator: It makes, it makes. So, you're suggesting completely eliminating the medium?

I5: My suggestion would just be to assess different scoring mechanisms or like, think about a 5 point or 10 point because the truth probably lies in between these extremes. And I think that people are less likely to pick extremes when they're doing self assessments. And so, um, it might be just something to consider that you might get higher fidelity data from something that expands that scoring range beyond three points.

I6: You are suggesting to consider five levels.

I5: I'm suggesting that low and high are very well-defined, moderate is a little bit median est. And so I'm saying 5 points or 10 points with a 1 and a 10 or a 5 sort of representing the poles of that belief.

I6: It makes sense and even when you do, for example, a benchmark analysis or a materiality analysis, it's very common to have those five levels. II think I5 is right. Um, makes sense to have a bigger range in terms of options to choose.

I5: But I don't think it's going to play like a truly important role in your assessment. I would just say with this score you're going to have people naturally biased towards 2. And I think that you want to probably get, if you're interested in higher fidelity data, then I would say, you know, an alternate score might be helpful. But if that's not a big role, then, you know, self scoring and self scoring, you're just going to have a bias towards the middle.

Moderator: Thank you, thank you. Makes sense, I don't know if you guys have anything more to add in terms of criteria, weight, value.

I6: Do you have any other criteria below complexity or no?

Moderator: No, here are just notes. The notes I have here say that it's highly qualitative.

I6: Yeah, you have explained that.

Moderator: And that you can allocate the weights as you wish, except for one which cannot go lower than 30%. These are the notes I have here.

OVERALL FEEDBACK:

Moderator: Do you consider that the proposed guidebook is useful? Yes or no? Why yes, why not? By useful I mean that it answers problems that companies are having today and it will help them solve some of those issues they're encountering.

I6: As I said previously, I think it's very useful, but for some companies, for some organizations. For maybe smaller ones or the ones that are not that mature in terms of sustainability, I think it's not a priority for them, unfortunately yet, but yes, for some companies, I think it's totally useful.

Moderator: When you say "yet" you believe this might change?

I6: I think so, because according to my experience, and I work in sustainability now for three years I can see the difference. We are members of the BCSD, the business council for sustainable development, and we notice a lot of difference in terms of new memberships in smaller companies. They are getting more conscious, embracing sustainability in a different way. So, I think things are moving on in a very soft rhythm, but I can see the difference. So, I don't know, I hope so.

I8: If I can add on this? I don't know much about the AI ecosystem, but I think this is a problem for both organizations that are not matured at a sustainability level, but also at an AI level. I don't know if every organization would know their AI applications or what to do from those, do you know what I mean? I think it's for both sides. Here at Nova, I'm thinking who would be the ones able to tell me, maybe the IT? But well, you know what I mean. It's the basic tools. Uh, but in regard to the tool, I really think it's useful because more than … I think what it brings is it is really a map, like a full picture of how both can integrate but with a balance of each one. So after doing this, I know more about sustainability, I know more about AI, I know more about my organization and how to move forward. And I think that's already a good step because sometimes different teams have ideas, but then they don't know how to implement them and what would be needed and how it actually engages with the SDGs. I think this is really a good mapping tool that can leverage impact in the future. So yes.

I5: What I really liked about it personally, I mean, so we develop and deploy AI models all the time, that's all we do. And I think incorporating into our decision-making process, how our decisions relate to sustainability is really important. And I don't think we're able yet to quantify that, we just do it in broad strokes. And I think that this applies rigor to the way that you prioritize and then does provide sort of a metric that you can weigh against core decision making, which I think is a really hard thing to do and a really beneficial thing to do. So, I definitely think it's helpful.

I8: I think I5 has a point. I'm not sure if this would be possible for step 2, but it would be helpful if it could be more a module, that it can be tailored to particular aspects. What I'm thinking is you might have companies that want to start this from scratch and so they're going to use it also to map the gaps in the beginning and they will move from there. But you can also have companies that already have a very clear analysis of their gaps (It's not common!) and maybe they want to incorporate this not only on the first step (in their like first big picture of their AI and how it might fit within their sustainability decisions), but I think the very beneficial part would be what Matt is saying: you would incorporate this in your ongoing decision to implement or not particular AI technology and I'm going to say it like this because it's a very broad concept for me. So, you have this in an ongoing process where you know your gaps and every time you want to implement an AI you go through this and you see, okay, maybe

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it doesn't make sense in terms of sustainability – let's not go for it, or let's improve it in order to be more tailored to our sustainability gaps or sustainability. If it is like this – modular - where you can go to a company and say: "Start from scratch, understand your AI and how they fit within sustainability and for that, you have to look at your sustainability gaps, but look, you already know this and do this quite often, then you can simply incorporate this in your decision making process of implementing certain AI or not." I think that could be good and it can make it broader, you can make it more appealing to different types of companies.

Moderator: And what about general criticism? Because we went directly to the different steps and maybe in the beginning you had general comments about if it has too many steps or not, etc. I just wanted to go first deeply because maybe some of the doubts you have in the beginning then got cleared, and so now I wanted to get your general comments on the Guidebook as a whole.

I5: I think the only criticism is that it's just inherently complex. You're dealing with two very complex issues. And I think it's going to involve a lot of stakeholders. And I think that there's a few different pieces of complexity that make it difficult, but I don't recognize a different [solution], I think that you've arrived at the right method by encapsulating that complexity in independent sort of steps. And so, I think that you've simplified it in a way that's really helpful and it builds upon itself. Um, but I think that there's a lot of embedded knowledge needed for those independent steps, but I don't, I don't know if it's avoidable, it's just sort of a comment more than a criticism.

Moderator: Maybe related with the lack of literacy on both topics, no?

I5: I think there's a natural filter here, sort of what I6 was saying. It's like, people are going to know about these things and be able to answer these questions. If they're not, I think it's going to be very binary. And so I think that itself filters itself, which is really great, but the people who answer these questions are often going to be different people. And so who has an idea of sustainability who has an idea of where these AI algorithms are integrated and then who has an idea of prioritization? Those are not going to be the three same people all the time. Um, even at our organization, I can tell you that it's, it's, you know, we are small and it's not the same people. Um, I think those are just facts, but I think that the audience naturally filters itself, for sure it is a complex instrument, but you've done a good job of encapsulating that complexity and sort of productive ways, but I don't think it can be ignored.

Moderator: Thank you. Well, lastly, would you consider implementing it? Here we can talk about whether you would implement it in your company or you'd suggest other companies to implement it…

I7: On implementing, I'm not in a company, so I'm probably not the best to answer that now, but on the criticisms, I think it's very clear. You make something that seems rather difficult to do very clear at least for me, especially with templates, companies like them (I think all of us like templates). But, the only two things that I would say, not as criticism, more as things to consider is I'm not sure if the goal is very clear from the onset, the goal and what is the output for the company. It became clear for me when I saw the steps, but I would say that in the general presentation (probably you didn't have time and we were also not the target), but I think it should be clear, meaning we want you to incorporate this in decision-making when going for an algorithm, or we want you to incorporate this now to try to understand within your AI algorithms, how they are working in terms of sustainability… Whatever it is, the different goals or different aspects that it can help a company with. And I think it also should have

an analysis of time, saying that maybe this will take you X. I'm sure this is difficult because we saw how complex it is, but maybe this will need a multidisciplinary team as I8 was saying and have different types of people. Then you would say who does people are and the amount of time that this might take at least from the beginning when you are doing it for the first time, something like that. And a third thing: I was very interested in something you said in the beginning that you were building something based on the idea that companies like to see other companies doing this. And that's a very good insight, from my experience, companies are competitive, so they usually like to compete and to see how they are comparing with others. So, you said that in the beginning, but I didn't really saw that in the tool. I don't know if it's incorporating it in other way? Or if they're going to have a score in the end or something like that? That they can make public and say: "We already went through this process and 70% of our AI technology fares very well in sustainability or integrates both economic and social value in a certain way." This way they can disclose and communicate, I think that in the end it would help getting on to what you were saying.

Moderator: Yeah. That's s great. Actually, I think you have some areas where they are able to do that. For example, in the first step, they're able to see exactly what's their score in the SDG Action Manager, but that is just related with a sustainability. But in the end you don't have that comparison. In the benchmark, when you're doing the benchmark, you're seeing what others are doing leading you automatically to think "Ok, maybe a competitor of mine or a similar company is already thinking about this, so I should be thinking also about this". When you start researching, sometimes you realize there was already people going into this direction. But, I think you're right, it's not as clear because in the end you are not able to have like a specific score indicating if you're leveraging sustainability better or worse than others. I think that's actually great feedback.

And About if you would propose this to other companies or even leverage it in your own company? For example, I8, I don't know, if you at your company have a Data Science knowledge center, would you think they would be interested in leveraging this? And do ideation? Or do you think it does not apply to your reality?

I8: For sure. I think the data science, you can definitely talk with the Data Science lead. I think there is an opportunity of engaging students with this kind of tool and also from a research perspective, to really understand whether these is leveraged in real life in different projects, I think it would be relevant also for our faculty in that sense. Also, because they do work with civil society organizations, the new name for NGOs, perhaps this is relevant as well. I don't know… for specific CSOs where they are working. Yeah, I think there might be different opportunities from an institutional level. As I was saying, I don't really know how we are using AI for sustainability, which is something that we should perhaps be looking at. But again, as I5 was saying, I think this is more of a tool for organizations already mature in AI, so for AI organizations that are trying to bring sustainability in, that's your target, right? Yeah, I think that's it.

I6: Sustainability and AI, it's a trend and there's no way back. So I think, as you mentioned in the beginning, big organizations lead the way, so I really think that this is a very useful tool, at least a very interesting process to be considered by the big organizations. So, yeah, I, I totally agree with everything said. So yes, I think this is a trend, this is the present and a future.

I8: I just wanted to reinforce one point that I7 did, which is the reporting. Perhaps it would really make sense to include that step, a specific step for reporting and communication. They have gone through

all this work and then in the end, they have to be compliant and transparent, right? I think reporting, not in the sense of marketing, training, etc., but really in the sense of what they're doing and if the numbers are not great at this point, maybe it's a way of improving. It's a journey, right? And next year they would be better and better. Really try to make that explicit in your tool, the importance of reporting and assessing your impact, either negative or positive.

I6: Let me correct what I said previously, because this is not a trend, basically. I think these concepts now define organizations' success. They need to bring all these [concepts]: technology, innovation, sustainability into their strategies in terms of businesses. So, more than a trend, uh, I think that sustainability and innovation technology will define the organizations success and their sustainability in the market.

Moderator: Yeah. I8, just on your point… You were saying like an extra step that you would monitor if the initiative was implemented? If it was up to the expectation set, right?

I8: Yes.

Okay.

I5: We would 100% implement the guidebook at our organization. What's difficult about sustainability I think is the way we talk about it is very trendy, which is a problem, right? Because I think that it's an idea that people have that, you know, we're just trying to net improve things when in reality, these technologies improve when they, you know, um, when sustainability is evolved. And so, I think that that conversation needs to just be more practical, and you've made that conversation practical and you've made it actionable, which is really important. So, I think this actually takes it out of this trendy conversation, which I think is actually pretty true, and puts it into practical terms how do you make decisions? The net result is that algorithms get better, business gets better by incorporating this level of transparency and sustainability. I think would do it because we recognize the benefits, there's just not something out there to make this actionable. And I think that this helps make it actionable.

I8: If I can ask you something… you submit your thesis and then what will happen to this tool? what's your next step?

Moderator: For me, it was really a pity in not to have an actual company implementing this, because I think that way, we would maybe tune it a little more and identify things that were a little bit more theoretical. My professor said that's more normal in a post-doctoral degree, where you actually go into a company and it takes several months for them to implement it or just to gather everyone together and get the approval to have this implemented within… So, I would say that I would love the next step to be to see this implemented in a specific company. and maybe if the company sees value in it, automate some of the templates, because of course they are in Excel and maybe this can be a broader tool. But I think implementing it in real life would enlighten me a lot more about its potential and how can I develop it further. I would like that, but we will see how everything goes. Thank you very much. Asking for two hours of your precious time, it was quite a request… you're all super successful, and thus with very tight schedules… But I think it was really an insightful conversation... If you go home and have additional comments, bring them in, just send me an email, I'll be more than welcome to add them. Another comment is we need an arguer at the dissertation. So, the day I defend my thesis, you might be contacted in case you're interested in

being in arguer. I believe you have to have an academic role, but an arguer is someone that will come into the discussion when I'm defending my dissertation and will just do what you guys did, provide feedback. Okay? But my professor will reach out to you to understand if this is a possibility, but I'll let you guys know soon. I really cannot thank you enough, it was a great session.

I5: Congrats. Good luck.

I6: Congratulations

I8: Okay.

I7: Thank you. Bye-bye.