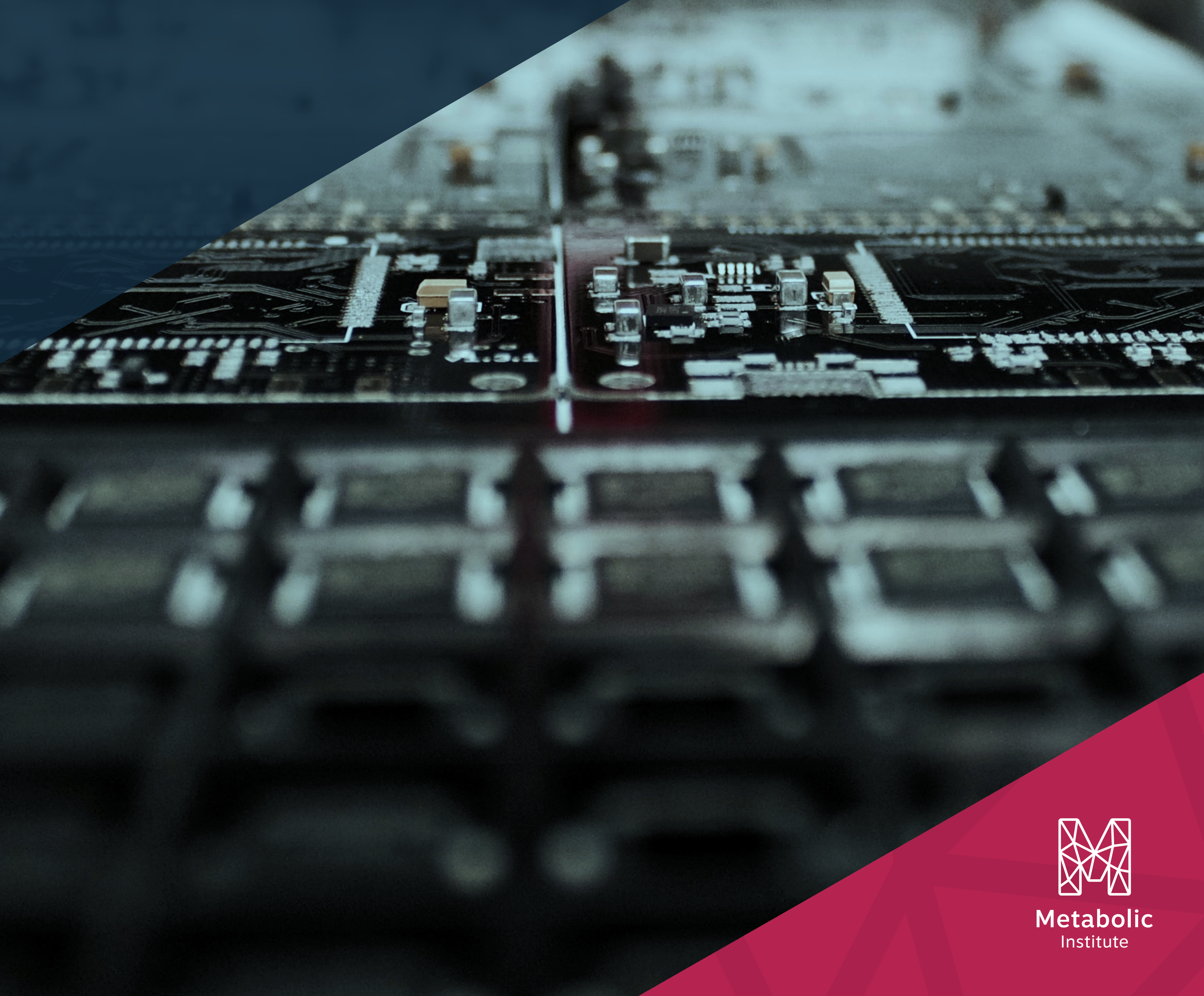
One planet
handle with care

Harnessing digital technologies for the Circular Economy

A SHORT BRIEF ON KEY TECHNOLOGIES, CHALLENGES, AND SOLUTIONS AHEAD



Metabolic Institute

INTRODUCTION

Data, digital technologies and related innovations are sweeping the planet at an exponential rate with the potential to unleash major structural economic, environmental, and social transformations at a global scale. By the end of 2023, over 60% of global GDP will pass through digital channels, 4 billion people will be influenced by social media, and 2 billion people will consume online.

Meanwhile, our current linear economy has caused global humanitarian issues such as climate change, material scarcity and pollution, increased vulnerability to global shocks, and of course the economic and environmental impacts associated with the inefficient production, use, and loss of products and materials. This current situation has led to the development of a new economic paradigm over the last decade called the circular economy. The urgency and benefits of moving towards a circular economy are clear. By shifting to such an economy we can preserve the value of materials and products, increase employment opportunities, boost innovation, and safeguard the ecological systems on which we depend. This shift goes beyond simply recycling and recovery technologies, to redesigning our economic system into one that is regenerative and inclusive by design.[1]

One of the urgent priorities is therefore to direct the trajectory of digital transformation so that it also accelerates and scales environmentally and socially sustainable products and services as well as behaviors and lifestyles. However, policy guidance is now needed on how different digital technologies can be combined and leveraged to lay a progressive digital foundation for the circular economy. In this context, the One Planet Network is developing its future digitization strategy focused on setting a critical roadmap towards the circular economy through digital technologies for the next few years.

The One Planet Network is therefore assessing current and short-term opportunities brought about by digital technologies to accelerate the development of the circular economy. While this is quite a broad topic, this project is looking specifically at data collection & integration, data analysis, automation, and data communication & dissemination by focusing on a few key enabling digital technologies.

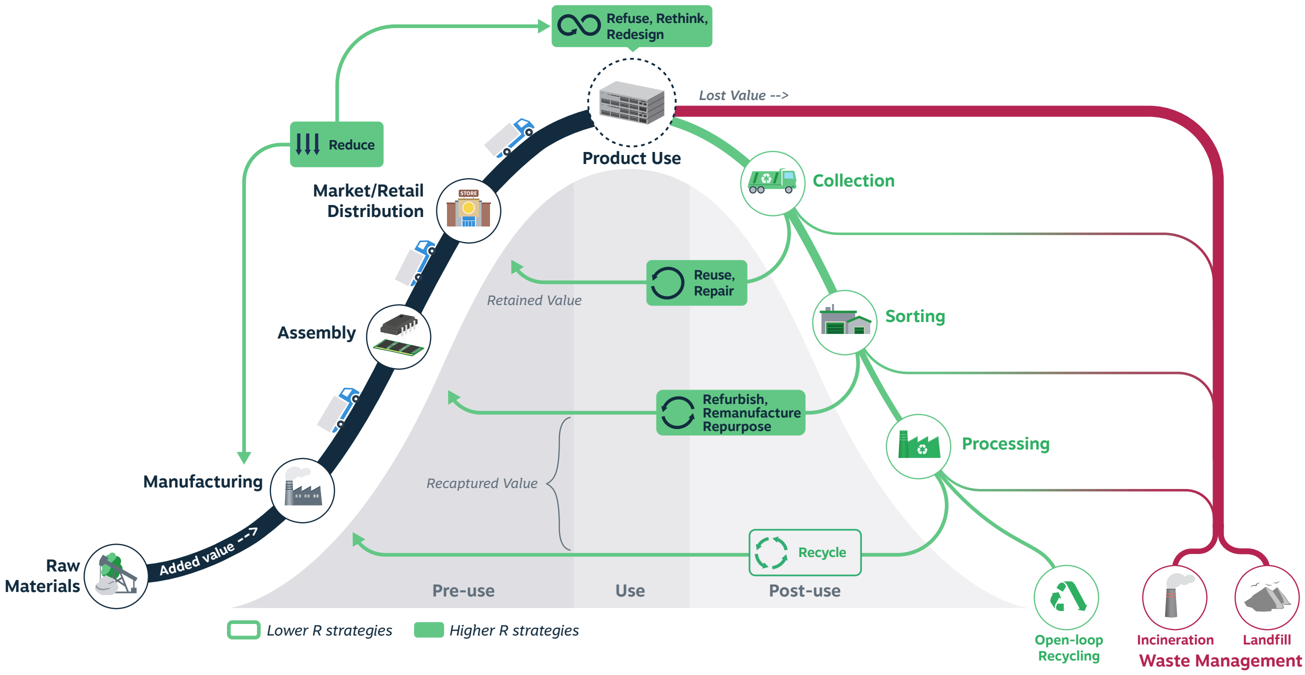
This short brief is meant to provide background information and context to the questionnaire that was sent alongside it. It summarizes the main thinking and trends of the academic literature on the potential of key digital technologies for the circular economy. The questionnaire aims, on the other hand, to collect insights from key experts in areas of digital technologies, circularity and sustainability in order to complement the academic field's view with a broader set of perspectives and practical expertises, and ultimately help shape a clear roadmap for the coming years.

DIGITAL FUNCTIONS AND CIRCULAR ECONOMY STRATEGIES

Technology is a prerequisite for upscaling the circular economy (CE). It allows for the creation and processing of the data and information for circular business models to fulfill the complex demands of circular supply chains. However, different technologies may fulfill different functions.[2] As such, the most critical functions that act as enablers of the circular economy are defined below based on our literature review.

Digital function	Definition
Data collection and integration	The first process collects data from physical and virtual sources. Information is mostly generated by descriptive analytics in the data integration process.
Digital analysis	Builds on the first process to generate knowledge and wisdom. "Knowledge" here refers to diagnostic analytics with understanding and meaning, while "wisdom" refers to discovered, predictive, or prescriptive insights.
Automation	This function captures the self-organized robotics control and decision-making processes that occur without human interference.
Communication and Dissemination	This function specifically informs and influences human behavior and decision-making

Each of these digital functions may be useful for a variety of Circular Economy strategies, grouped under three broad categories, namely, '*effective use of material*', '*extend lifespan of product and its parts*', and '*smart product use and manufacturing*'. These strategies are shown on the 'Value Hill'[3] which illustrates the full life cycle of any given product, from extraction and manufacturing through use and eventual disposal. Value is added as the product moves "uphill" in the supply chain, and where circular strategies keep the product at its highest value (top of the hill) for as long as possible. In this circular supply chain, products are designed to be long lasting and are suitable for maintenance and repair, thus slowing resource loops and prolonging the use phase of the product. When a product starts to move 'downhill', it is done as slowly as possible so that its useful resources can still be of service to others. The first circular strategy on the " effective use of material" is essentially focused on *recycling*,[4] while the second circular strategy, aims to "extend lifespan of products and its parts" through *reuse, repair, refurbish, remanufacture,* and *repurpose*. The third circular strategy focuses on "smarter product use and manufacture", mainly through practices of *rethinking, redesigning, refusing* and *reducing*.



EFFECTIVE USE OF MATERIAL

Recycle
Process materials to obtain the same (high grade) or lower (low grade) quality.

EXTEND LIFESPAN OF PRODUCTS AND ITS PARTS

Reuse
Reuse by another consumer of discarded product which is still in good condition and fulfils its original function.

Repair
Repair and maintenance of defective product so it can be used with its original function.

Refurbish
Restore an old product and bring it up to date.

Remanufacture
Use parts of discarded product in a new product with the same function.

Repurpose
Use discarded product or its parts in a new product with a different function.

SMARTER PRODUCT USE AND MANUFACTURING

Reduce
Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.

Refuse
Make product redundant by abandoning its function or by offering the same function with a radically different product.

Rethink
Make product use more intensive (e.g. by sharing products or by putting multi-functional products on market).

Redesign
To revise the product in appearance or function.

An adaptation of the Value Hill Model to include the 9R Framework. Buren, N., Demmers, M., Heijden, R., & Witlox,F. (2016). Towards a Circular Economy: The Role of Dutch Logistics Industries and Governments. | Circle Economy (2016). Master Circular Business With The Value Hill. | Kirchherr, J., Reike, D. & Hekkert, M. (2017). Conceptualizing the Circular Economy: An Analysis of 114 Definitions. | Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2017). CIRCULAR ECONOMY: MEASURING INNOVATION IN THE PRODUCT CHAIN.

KEY DIGITAL TECHNOLOGIES TO ENABLE THE CIRCULAR ECONOMY

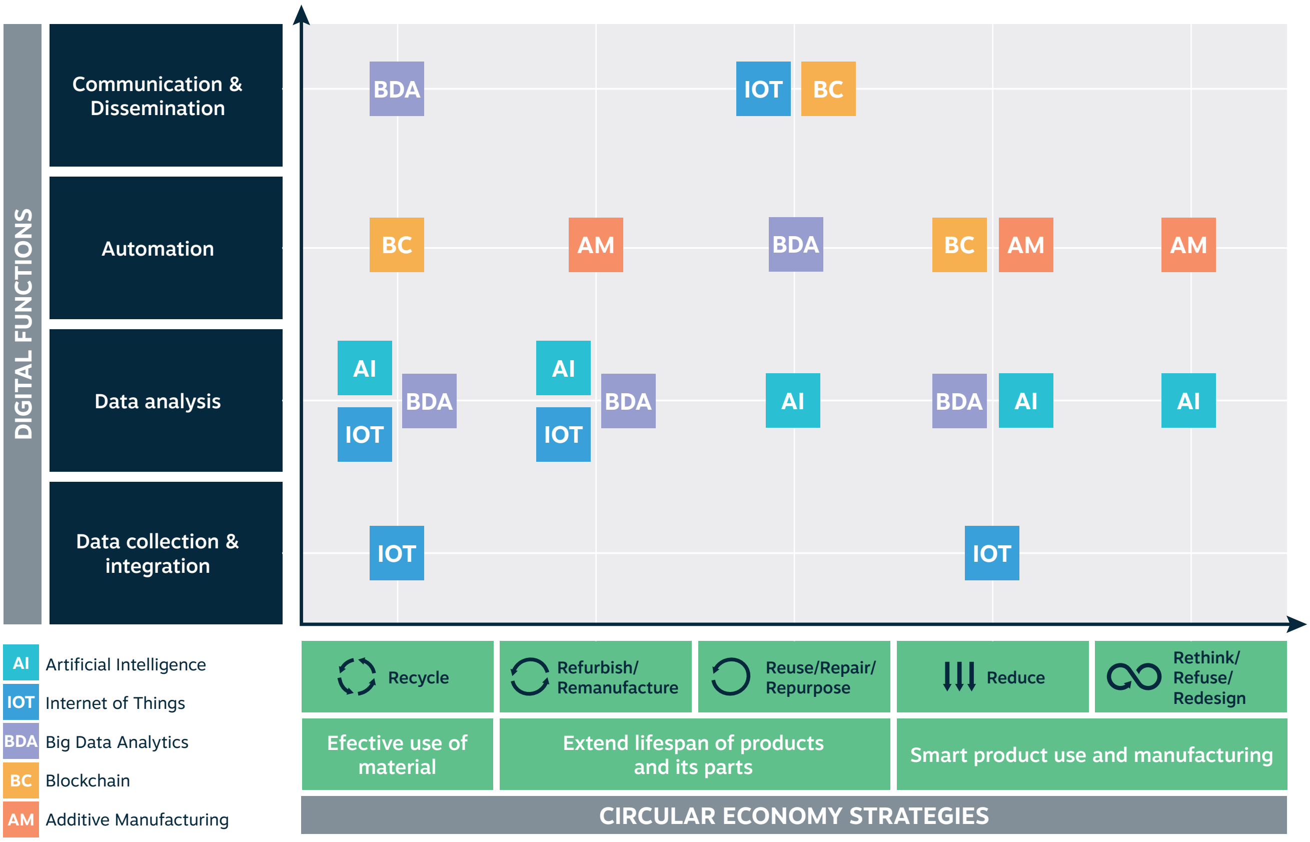
Based on an extensive literature review[5] numerous digital technologies were analyzed and reviewed for their potential to support the development of the Circular Economy. Five of the most frequently highlighted technologies were selected, based on 1) their immediate potential to influence the Circular Economy in the next 2 to 4 years, hence necessitating a certain level of maturity 2) the critical functions they can fulfill in the Circular Economy, and 3) their application have been proven, at least at pilot scale, in any circular process. These five digital technologies are:

Five digital technologies:

- Internet of Things
- Big Data Analytics
- Artificial Intelligence
- Blockchain/Digital Ledger Technologies
- Additive Manufacturing

These technologies were further analyzed using a state-of-the-art analytical framework[6] to understand which critical digital functions each of them fulfill (y-axis) applied to support which circular strategies (x-axis).

Below, we have placed the five technologies further analyzed across the resulting matrix.



A short overview of each of the selected technology's potential to fulfill key digital functions for circular economy strategies can be found below.

Internet of Things

Internet of Things (IoT) is the network of physical objects (things) which are embedded with software, sensors, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. IoT technologies are capable of collecting continuous data about the changes in the state of processes, conditions or materials, such as temperature and moisture, production and machine conditions, product usage performance by the customer, and waste bin conditions. IoT can therefore inform **circular economy** strategies by providing real-time information on product status, describing and monitoring the type, quantity, and timing of input for current material flows.[7] In terms of digital functions, 1) **data collection** 2) **data analysis**, specifically for monitoring and optimizing and 3) **communication and dissemination** are therefore the most critical functions fulfilled by IoT.

The rise of IoT enables businesses to **rethink** their operation and pivot towards product-service systems, a key circular business model. For example, RFID chips are a rising application of IoT that facilitate companies' transition towards a product-service system since it facilitates the tracking of their assets in real-time. Additionally, through the use of embedded sensors and the IoT, companies can reduce the majority of the uncertainties faced during **remanufacturing**, achieve efficient planning of operations, prevent damage during product dismantling, and optimize value creation during remanufacturing. For instance, General Electric transportation division gathers performance data from sensors attached to locomotive engines while they are in use to determine whether parts and products need a full or partial makeover. This automation process has reduced costs during locomotive rebuild.[8] Finally, IoT devices and sensors can help to increase the efficiency of **recycling** by optimizing waste collection and reverse logistics. For example, 'smart bins' such as *Smartup Cities*, can send the data on the type of waste received to the waste collector, who can identify the level and quantity of waste to be recycled as well as send appropriate vehicles for waste collection.[9]

Big Data Analytics

Big data analytics (BDA) are a collection of analytical methods, tools and applications used to collect, process, and derive insights from high volumes of highly varied data, produced at high velocity.[10] These datasets may come from a variety of sources, such as web, mobile phones, emails, social media, and networked smart (IOT) devices. In terms of digital functions, BDA is relevant across three digital functions: **data analysis**, **automation**, and **communication and dissemination**. In practice however it is mostly used for data analysis, and increasingly linked to other DT's such as AI where big data is used to create computerised models.

A particular promising application of BDA is the optimization of manufacturing and logistics processes. This optimization not only spares the environment of unnecessary pollution, but it helps the company avoid unnecessary resource use such as fuel costs and wages.[11]

The goal of optimization is often to improve performances and reduce negative impact, such as increasing efficiency and reliability in the production system while **reducing** emissions, and material and energy consumption. Big Data Analytics can be built upon the data gained from customers behaviour and product usage as well as collected during production processes. An example of this is UPS, the world's largest package delivery company, that uses Big Data to calculate the optimal routes for its drivers, reducing by million the number of kilometers travelled. This optimization not only spares the environment of unnecessary pollution, but it also saves the company millions on unnecessary resource use such as fuel costs and wages.[10]

Overall, BDA reduces the complexity of generating insights from the data and increases the understanding of the optimal set of actions based on descriptive, prescriptive, and predictive data insights.[12] As such, BDA already plays an increasingly critical role for the entire emerging reverse logistics industry, which in turns enables **remanufacturing**, **recycling**, and **reuse** of parts or components at the end of the product's life.[13] For example, in Manchester, a waste management company uses big data to understand which communities are producing the most waste and targeting them for greater educational outreach on **reducing** waste and **recycling**.[14]

Artificial Intelligence

Artificial Intelligence (AI) is an overarching term for a collection of technologies which deal with computer models and systems that perform functions related to human intelligence such as reasoning and learning.[15] AI has potential uses in industries such as energy, agriculture, housing or mobility to reduce energy and resource consumption, support decarbonisation, and advance the circular economy.[16] Since AI softwares is capable of learning from experience, they can provide firms with the necessary support to implement, validate, and test CE solutions.[17] Meanwhile, the data-driven nature of machine learning algorithms allows for generating large amounts of data from small samples which supports exploration of new emerging areas like CE in addition to saving time and expenses.[6] **Data analysis**, especially for innovation, forecasting, and optimization is the most critical function fulfilled by AI for the circular economy.

There is immense potential for **rethinking** and **redesigning** through AI. For instance, catalytic upgrading of biowaste to chemicals and fuels can be aided through combining multiscale computational techniques and machine learning.[18] Applications of AI in the agro-food industry include predicting the resource and energy needs such as greenhouse lighting, which can guide the design of new production lines or farming arrangements.[19] AI can also be applied for urban data capture and modeling smart cities through forming digital twins, thus promoting construction waste **remanufacturing**.[20]

AI technologies also enable businesses to optimise the value chain and better predict the availability of waste materials and the demand for refined goods in the marketplace, thus **reducing** waste. AI can also be used as a **repair** strategy by extending machines and products lifespan through predictive and prescriptive maintenance, which means carrying out customized maintenance tasks on devices before the actual breakdown happens. Finally, they can help reveal to estimate if the by-product of a production chain which can be used as materials in other industries, thus determining whether or not a product can be **recycled**.[21]

Blockchain/Digital Ledger Technologies

Blockchain is an immutable, tamper-proof distributed ledger technology (DLT), which is utilized in a shared and synchronized environment where all transactions are validated by users and traceable. It enables a decentralized environment where all the members of the network can interact securely without the need for a trusted authority. Information transparency, reliability, and automation provided by blockchain can effectively leverage CE initiatives. For instance, the source of materials and products, involved actors, processes, energy consumption, and end-of-lifecycle are types of information that can be made available on blockchain ledgers. In terms of digital functions, 1) **automation** and 2) **communication and dissemination** are the most critical functions fulfilled by blockchain.

A blockchain solution that is integrated with tracking (IoT) devices – for example a global positioning system (GPS) – can enable materials and products tracing throughout their life-cycle. Used especially in the construction industry, these material passport characteristics can set the foundation for **reusability** and **recycling** programmes and circularity performance management.[22,23] In the apparel e-commerce industry, blockchain can be used to track and trace products, especially secondhand clothing, to their origin to reduce the risk of counterfeiting.[24] Blockchain has also found application in the agriculture, forestry and fishing industry. For instance, Bumble Bee Foods is using blockchain to improve their seafood traceability and safety through QR codes allowing information access to both retailers and consumers.[25]

Additive Manufacturing

Additive Manufacturing (AM) means manufacturing an object through the successive addition of material. This is contrary to the typical "subtractive" manufacturing process that begins with a mass of material and removes material until the intended form is created. Products or their parts that are created using additive manufacturing are usually done so layer by layer. AM contributes to the circular economy by the mechanisms of introducing new manufacturing processes and material-efficient designs. In terms of digital functions, AM fulfills the digital function of **automation**.

By using AM technologies, production and services guided manufacturing can achieve production efficiency within a circular economy framework.[26]

AM also contributes to **reducing** the amount of waste generated in the process[27] compared to subtractive manufacturing processes. Polymers, ceramics, metals and composite materials are presently undergoing intensive research to improve their use in AM to promote **recyclability** and **reuse**. The use of PLA (Polylactic Acid) is the most commonly mentioned plastic recycling methodology connected to AM.[29] An early example of using AM processes for redesigning products from closed-loop waste valorization is processing polymer waste from refrigerators to produce new furniture products, such as chairs or lamps.[30] Another promising application of AM is related to the **repair**, **renovation**, and **remanufacturing** processes of metal and ceramic products.[31]

CURRENT BARRIERS TO DIGITAL TECHNOLOGIES DEPLOYMENT TO THE CIRCULAR ECONOMY

The deployment of these digital technologies is hampered by a set of recurrent barriers readily identified in the academic literature. We classified these barriers into four categories. The categories are "Willingness to adopt", "Financial", "Technology and Data", and "Policy & Regulations".

Adoption willingness

It is common in an innovation's journey towards mainstream adoption that it faces unwillingness to be integrated in day-to-day processes during its early days. By and large, there is a **lack of knowledge** of existing digital solutions, the concept of 'Industry 4.0' and its effect on the circular economy.[32]

Directly connected to the latter barrier, the **lack of know-how and training** in different working areas that may benefit from these digital technologies are substantial obstacles to effective implementation. Specifically, digital literacy and technical expertise for the maintenance of technological infrastructure is often lacking.[33] The lack of competencies lead to a low readiness level in companies, and result in a slow adoption of technologies such as IoT, AI, and BDA.[34]

Additionally, **privacy concerns** are of paramount importance, especially regarding BDA, AI, and IoT, which may halt their adoption.[35] Their inability to sometimes guarantee user anonymity and cyber security, which may lead to information leakage, is a major hurdle.[36] More generally, **ethical concerns** are also significant, especially in BDA or AI applications. There have been multiple examples of AI generalizing groups in society unfairly, leading to further marginalization.[37] The models reflect the data and if the data is biased in the first place, then the models will also be biased. This risk may naturally lead to hesitancy when adopting solutions in manufacturing, logistics, and customer use processes.

There is also some **inertia** within companies that prevent them from implementing successful circular business models. Most companies are **risk-averse**, especially traditional and established companies (some with major economic influence), which causes them to avoid innovative projects due to the risks involved.[38] The **lack of collaboration** between possible partners in the supply chain is also a significant barrier in the successful implementation of smart circular business models. Specifically, collaboration and coordination between the different life cycle stages (e.g., production, manufacturing, distribution) is often lacking, thus limiting the effective exchange of data, and ultimately the usefulness of these digital technologies.

Financial Barriers

As it is frequent with technological innovation, each of these technologies is facing **high initial costs** and **uncertainty** about financial returns,[39] which may lead to a lack of confidence. Specifically upfront costs can be high and at times prohibitive for some businesses to set up data infrastructure to track and monitor their supply chain.[40] This may be due to budget constraints and a lack of public and private funding that limit companies investment capabilities.[41]

Additionally, the absence of long-term planning in most organizations is a difficult hurdle. The lack of immediate results may **discourage** companies that are focused on short-term profitability. Finally, the markets of these technologies themselves are highly **fragmented**, leading to vertically-oriented closed systems that on one-hand may hinder open and integrated environment across supply chains, necessary for a thriving circular economy, and on the other create confusion about the capabilities of these technologies to deliver on their promises, thus limiting their 'investability' profiles.[42]

Technology and Data Barriers

Data unavailability and **poor data quality** are core barriers for the successful use of BDA and AI. Data infrastructure (inclusive of IoT infrastructure) are lacking in scale, thereby limiting the amount of data captured and subsequently the insights extracted by analytical models.[43]

Some of the newer technologies like Additive Manufacturing and IoT have yet to prove their technical scalability. For additive manufacturing, the process is heavily dependent on the material used in manufacturing. This influences how well the technology can be scaled. For IoT devices, the multiplication of devices in near proximity creates a **risk of interference** with the connections which render the communication between different devices to be imperfect.[44]

The **lack of interoperability and adaptability**, especially concerning upgradeable software and hardware are key challenges, especially in IoT.[45] This also lead to limiting the synergistic benefits that can occur by combining multiple technologies together, whether connecting IoT technologies (data collection) with BDA (data analysis) or IoT with Blockchain technologies (data storage and communication).

Finally, the **high energy requirements** (and carbon intensity) of certain technologies such as Blockchain[46] but also Additive Manufacturing[47] as they scale are also a key source of concern, especially in the domain of circular economy that thrive to limit their energy throughput.

Policy & Regulatory Barriers

Policy and regulations may at times hinder the deployment of digital technologies across industries. **Outdated laws** and **unstructured state policies** do not stimulate sustainability and digitalization, and may even discourage it. In the healthcare and food sectors, for example, public regulations require strict hygiene protocols around packaging that often does not allow any circular strategies to be put in place, even though new technical processes help to meet rigorous health and safety criteria. In the construction and transport industry (i.e., aviation, car), certain recycled or reused components are not allowed due to quality concerns.

Circular business models often target the recirculation of material and energy. Legislations often **disallow** the use of materials marked as "waste" in other, new products, significantly impeding companies to develop key business processes.[48] For instance, according to the European waste legislation, waste is defined as "any substance or object which the holder discards", creating grey areas on whether the use of certain materials are allowed. As a result, this may impact the application of digital technologies that work on promoting reusability or recyclability of waste into valuable resources. Globally guidelines on the reuse of material stock are **not yet standardized and highly fragmented**. This makes it difficult to manage and reuse material stock.

The slow pace of standardization relative to the pace of technological development, punctuated with changes in how standards are met can create **uncertainty** both for companies and consumers. Finally, privacy regulations, while fundamental to protecting citizen's privacy, can, if defined too broadly or with not enough specification, **limit the exchange of information** and data across economic actors or the amount of data that can be collected through technologies like IoT. Outdated laws also may hinder automation since some regulations require 'human' validation despite certain technologies having been proven to perform better.

SHORT-TERM SOLUTIONS FOR DIGITAL TECHNOLOGIES DEPLOYMENT IN THE CIRCULAR ECONOMY

To successfully direct the trajectory of digital transformation towards the circular economy, short-term solutions across the barriers of willingness to adopt, technology, policy & regulations and finance should be formulated and implemented. As the focus of this project is on the short-term, the solutions found in the literature are targeted, deployable and achieve positive results in the next **2-4 years** in response to the barriers identified above.

Willingness to Adopt

To increase the willingness to adopt most digital technologies it is important to build **coalitions** around data **transparency** and robust but practical **security standards** on **data handling** and **data privacy**. These coalitions would exist of both technical and non-technical experts, businesses, and policymakers. **Education** is another critical element to increase the future workforce's ability to integrate digital technologies in their industries. To increase society's willingness to adopt the digital technologies, a few solutions are listed:

- International organizations like the EU and UN could use their wide networks and stakeholder platforms to advance the practical implementation of digital technologies in the circular economy by bringing the relevant parties together and producing **thought-leaderships**, running **pilots**, and **scaling** existing initiatives.
- Relevant stakeholders should come together to **set international standards** and practices for new technologies on **transparency, privacy, and security**,[49] specifically focused on data sharing across supply chains and citizens/consumers data handling.
- Local governments should set "digital champions programme" initiatives that provide **support** to a set of **SMEs** in sectors with high CE-potential that currently have a low **adoption** of digital technologies.
- Expand high-school and university curricula to **increase digital technology literacy**[50] among the upcoming workforce, and more importantly its application in circular economy strategies.
- Develop **professional trainings** in high-CE potential industries for managers and decision-makers aimed at the **practical implementation** of digital technologies in their day-to-day processes

Technology and Data

Unlocking data silos by establishing norms for sharing and collecting data is a critical next step for the circular economy to fully leverage digital technologies. Supply chain-specific agreements and protocols for data sharing should be sought out. While these technologies are more or less established, most would benefit from **continuous research** and development in the different circular economy strategies. A few short-term solutions are enunciated below:

- **Public-private coalitions** which represent organizations that collect large amounts of data should set standards for data collection, curation, and how the data should be made publicly available and represented. This would include businesses, governmental organizations, and academia. This will allow third parties to **combine different datasets**.[51]
- Stakeholders in supply chains in the food, construction, consumer goods and energy supply should come together to negotiate agreements on data sharing. By aligning on the different digital technologies that should collect and share the data, they can **ensure their interoperability**[52] across their value chains and avoid **data gaps. Piloting** this across one specific supply chain (e.g., electronics) to set an example would constitute a first step towards it.
- Create public tenders for research and development to solve **connectivity issues** due the multiplication of connected devices (associated with IoT).
- Create public research tenders to develop solutions for energy **efficient applications** of digital technologies in circular economy strategies.
- Creating private-public funds to scale digital infrastructures, especially in nations with low access - aimed at research and development to make these technologies **affordable and easily accessible**.

Policy & Regulations

Short term solutions around policy and regulations have been noted to revolve around pushing forward existing mechanisms such as **taxation**, creation of **standards**, ensuring **inclusivity** and defining focal points such as **data transparency** and **waste management** for future policy development. A selection of short term actions are listed below:

- Creation of job positions for technologists within **policy focused environments** such as legislative offices, government agencies, NGOs or in the press.[53]
- Setting up of technology-specific **expert groups** in governments for the creation of data **guidelines** focused on sharing and security, such as the EU Commission High-Level Expert Group on AI.[54]
- Development of a proposal for **shifting taxes** from labor to raw materials. This can incentivise the **reduction in material use** and allow more room for digital innovation by making work less expensive.
- Create **tax incentives** and **subsidies** to encourage the purchase of digital technologies that facilitate repair, remanufacturing, and recycling activities.
- Regulation, policies, and tax schemes must be made **easy to navigate** for smaller organizations and start-ups to avoid entry barriers by the means of **support services** inclusive of financial and technical advice.
- Governments can require the **sharing of data** by adding **requirements** to businesses that receive subsidies or tax benefits to develop their circular economy business models or integrate digital technologies.
- National or pan-national bodies may encourage companies of a certain market size to **make their data available** as 'public goods', based on clear (and potentially anonymized) standardized data format.
- Establishing an international work group to ensure the legal and regulative definitions of different categories of waste do **not hinder the circular use of materials** across sectors, while still preventing health and environmental hazards.
- Setting an **international standardized policy framework** and guidelines concerning the circular use of material stock across industries, positioning digital technologies as key enablers.

Finance

The progress of financial institutions towards investing in the circular economy has been quite significant in recent years, however, financial short term solutions specifically crossing both digital technologies and circular strategies have been coincidental rather than intentional. There is a need for **alignment** across existing financial services and a push towards **innovative financial instruments** and **investments** in circular business models. Below are recommended actions which can be taken as first steps towards overcoming financial barriers:

- Research and develop policy instruments to **de-risk and incentivize** financial investments that target DT application in the circular economy. Instruments such as **blended finance** and **investment guarantees**, support public–private collaboration and the financing of CE offers a wider range of possibilities to scale circular economy finance and investments into digital technologies.[55]
- **Alignment** and **consolidation** is required between Digitisation and other ongoing Circular Economy agendas, action plans and programmes to **aggregate funding** and strategies that make digital technologies more relevant to circular economy.[56]
- Setting up of a **Community of Practice** (CoP) approach to address specific **financing** challenges for circular business models. In a CoP, financial, accounting, legal, and technology experts join a pre-competitive environment to **co-create open-source solutions** that can improve a circular business models' viability via digital technologies.[57]
- Public-private **innovation funds** to promote the use of digital technologies for the most promising circular economy strategies, with different levels of co-funding for winning projects.
- Develop proposals for a suite of national **fiscal incentives** to target key circular economy strategies to ensure that pivotal strategies are not left behind by a lack of financing tools.
- Create practical guidelines for banks, insurers and investors to **re-orient loans and investments** towards digital technologies and circular business models. For example by making financing circularity an 'opt out' option rather than an 'opt in' option in mainstream financial instruments.[58]

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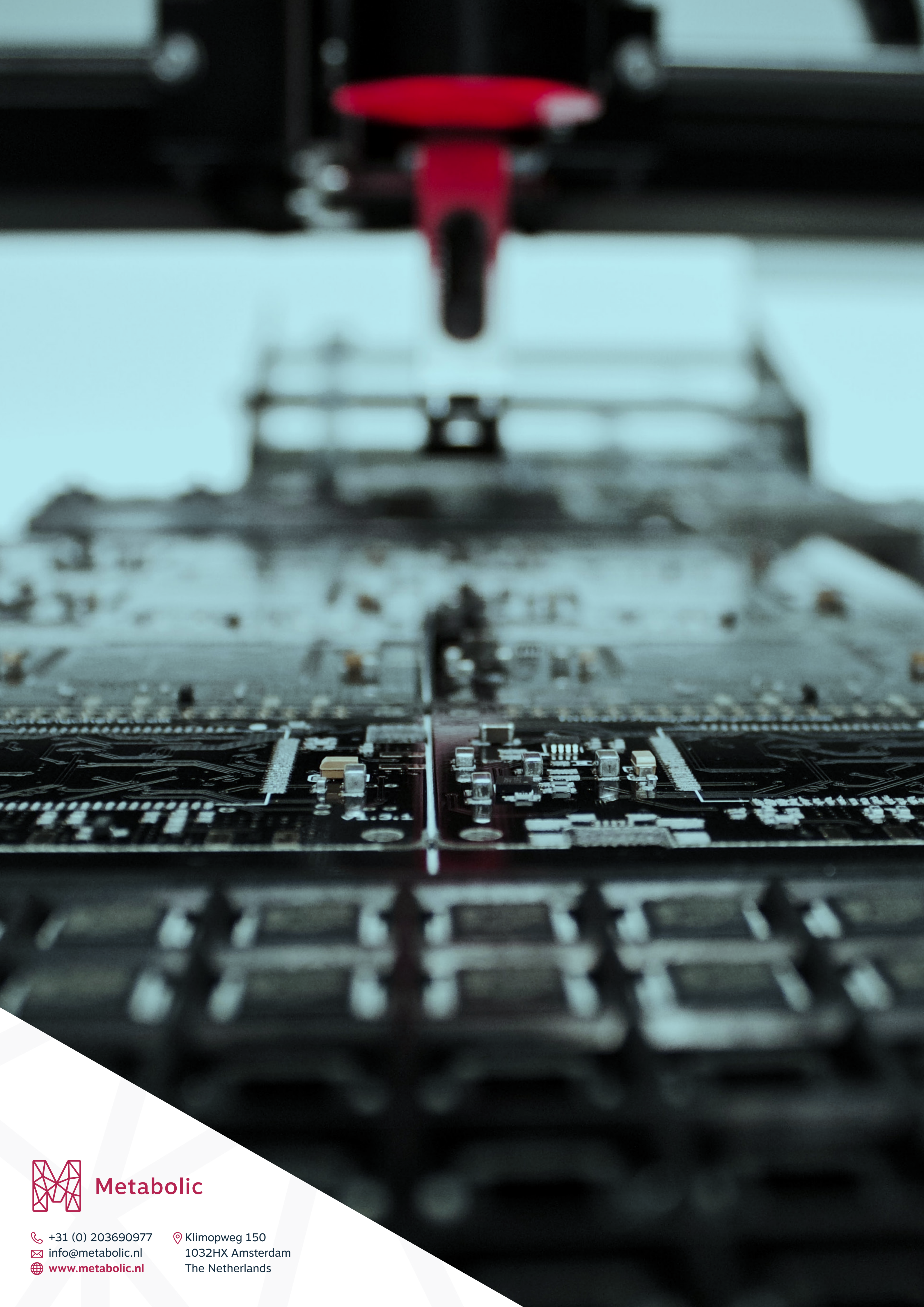

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