

Metaverse for UN SDGs – An Exploratory Study

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Abstract

This exploratory paper is driven by a basic question: what is metaverse and can it accelerate the advancement of SDGs? Additional questions are: can developing nations benefit from metaverse, and what type of policies will be needed to address the challenges and risks introduced by metaverse? To answer these and other related questions, a multidimensional framework is proposed for metaverse and the 17 SDGs are systematically reviewed to explore how metaverse could help accelerate the needed progress. Key social and legal challenges are raised, and a sandbox is proposed for developing countries and policy makers.

Introduction to Metaverse

Metaverse, coined in 1992 by the science fiction novelist Neal Stephenson [1], described a virtual world that only existed on the internet. As the internet grew, the metaverse concept also grew into a large-scale virtual environment in the online space. Lately, it has gained more popularity and morphed into a concept that integrates the following core technologies (let's call them "*Meta Technologies*" for convenience):

- Blockchains (a digital ledger that cannot be modified) and NFTs (Non-Fungible Tokens) -- a non-interchangeable unit of data stored on a blockchain that can be sold and traded.
- Web 3.0 (semantic web content that can be understood by other machines and is stored on a blockchain) – every web page is a block on the blockchain.
- AR/VR (Augmented Reality that is a mixture of real artifacts that are enhanced by Virtual Reality).
- AI/ML (Artificial Intelligence and Machine Learning where machines learn directly from data without human intervention).

Although each of these Meta Technologies is strong enough in its own right, but when integrated together and further supported by other digital technologies, metaverse paints the picture of an extremely powerful virtual environment in the internet with almost unimaginable opportunities and implications [2].

Although the metaverse concept has been actively adopted by the gamers and social media giants such as Facebook (now known as "Meta"), the idea is now being considered for a wide range of applications. The main objective of this exploratory study is to answer the following key questions:

- Q1: What is metaverse and can it be used to represent, replace, augment or innovate the

services in the public and private sectors? See Section II for answers.

- Q2: Can metaverse be used to accelerate the advancement of SDGs? Additional sub-questions are: a) can developing nations benefit from metaverse, can current enterprises be transformed rapidly to metaverse, and are there methodologies and toolkits available to accelerate the progress? Section III provides some ideas.
- Q3: What challenges could metaverse raise for SDGs, what type of policies will be needed to address these challenges, and what type of approaches (use cases) could be of value? See Section IV for details.

Metaverse as a Digital Enterprise

Simply stated, a digital enterprise is an organization where nearly all significant services and relationships with customers, suppliers, and employees are digitally enabled and key corporate assets are managed through digital means [3]. However, enterprises evolve through gradual adoption of digital technologies. This evolution can be represented *explicitly in terms of a few digital technologies*. This article proposes ten basic dimensions of digital technologies that represent a multidimensional space shown in Figure 1. This model identifies the specific digital technologies that help the enterprises to progress through various stages. For each dimension, a set of values, {Low, Medium, High}, based on an informal estimation, indicate the adoption. In this model, enterprises conduct business by exploiting the major digital technologies displayed in Fig. 1 (starting from Web and going clockwise).

Figure1. Dimensional View of Digital Technologies (Extension of Umar [4, 5])

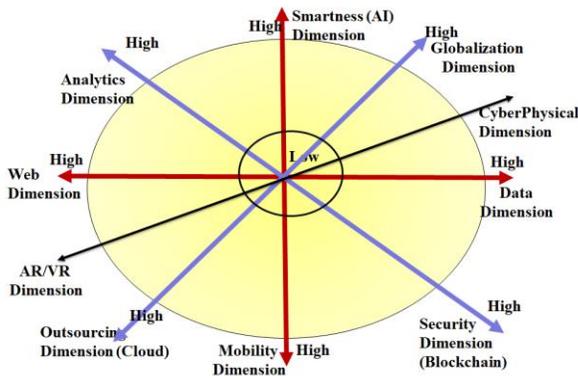


Table 1 shows the same information but explicitly shows what Low, Medium and High could be for each technology. These ten technologies faithfully capture the essence of digital enterprise that range from low tech small businesses (represented by the inner circle in Fig1) to the outermost circle of Fig. 1 that captures the spirit of Next Generation Enterprises (NGEs) and metaverse. Thus, the Metaverse Model could be viewed as an NGE with very powerful digitally enabled services.

Table 1. The Ten-Dimensional Model as a Table

	Low	Medium	High
Web Technologies	Web1.0	Web 2.0	Web3.0
Data Analytics	Descriptive	Predictive	Prescriptive
Smartness (AI)	Basic AI	Machine Learning	Deep Learning
Globalization	Local Sites	Regional	Global
Cyber-Physical systems that are internet enabled	Mostly Physical	Half-Half Roughly	Mostly Cyber (Virtual)
Data Management	Spreadsheet	Database Systems	Big Data
Security and Blockchain	ID-PW Credentials	Crypto-based	Blockchain
Mobile Apps and Wireless	2G Networks	3G Networks	5G Networks
Outsourcing (Cloud)	Private Cloud	Public Cloud	Mixed Cloud and "Fog"
AR/VR and XR	AR or VR	AR and VR	XR (Extended)

Meta4SDGs – A Quick Analysis

Can metaverse be used to accelerate SDGs? Table1 suggests some Meta-Roles (the roles that metaverse

could possibly play) to accelerate the 17 SDGs. The table shows that metaverse could in fact accelerate economic development, education, climate control and many other aspects of SDGs.

Table 2. Role of Metaverse to Support the SDGs (An Extension of Umar [4])

Goal1.End poverty in all its forms everywhere. Meta-Role: Metaverse advertisements to promote cottage industries and entrepreneurship.
Goal2. End hunger, achieve food security and promote sustainable agriculture. Meta-Role: AR/VR tutorials for complex and expensive agriculture machinery and blockchains for secure storage and distribution of food
Goal3. Ensure healthy lives and promote well-being for all at all ages. Meta-Role: Meta-enabled healthcare services that integrate e-learning, e-health and e-administration to offer healthcare to remote populations.
Goal4.Ensure quality education and promote lifelong learning for all. Meta-Role: Immersive tutorials, gamifications and simulations for educating diverse populations that include students with disabilities.
Goal5. Achieve gender equality and empower all women and girls. Meta-Role: Metaverse Hubs that can be universally available to all genders
Goal6. Ensure availability and sustainable management of water and sanitation for all. Meta-Role: Metaverse hubs can support "Digital Water" initiatives and sensor enabled smart water pumps and sanitation outlets
Goal7. Ensure access to affordable, reliable, sustainable and modern energy for all. Meta-Role: Extensive use of IoTs, AI, Big Data, and Blockchains to manage and control energy consumption
Goal8. Promote sustained, inclusive and sustainable economic growth: Meta-Role: Extensive use of metaverse to support tourism, fisheries, entrepreneurship and cottage industries in different geographical areas
Goal9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. Meta-Role: Aggressively exploit innovative applications of all metaverse technologies to promote and support Industry4.0 and Manufacturing4.0,
Goal10. Reduce inequality within and among countries. Meta-Role: Meta hubs, interconnected to other hubs, available to all countries and to all populations.
Goal11. Make cities and human settlements inclusive, safe, resilient and sustainable. Meta-Role: Smart cities, towns and communities can use metaverse extensively
Goal12. Ensure sustainable consumption and production patterns. Meta-Role: Explore Metaverse capabilities for production, inventory management and for supply chain improvements
Goal13. Take urgent action to combat climate change and its impacts. Meta-Role: Use metaverse for sophisticated models for climate change and to detect and measure changes in ocean waves and weather conditions, and detect earthquakes

Goal14. Conserve and sustainably use the oceans, seas and marine resources. Meta-Role: Use metaverse extensively for different aspects of Blue Economy and Undersea Explorations
Goal15. Protect, restore and promote sustainable use of terrestrial ecosystems. Meta-Role: Use connected alarm systems and AI/ML capabilities across high density urban areas to quickly notify residents of fast-moving fires
Goal16. Promote peaceful and inclusive societies. Meta-Role: Use metaverse with IBM Smarter Planet model in which several agencies interact and support each other for improved governance
Goal17. Strengthen the global partnership for sustainable development. Meta-Role: Establish communications between hubs by using latest developments in B2B, G2G and metaverse services

Policy Issues and Risks

Metaverse technologies, as displayed in the previous section and Table2, have transformative potential in significantly accelerating SDG support. However, they raise several policy and legal issues such as the following [6] - [9]:

- Data stewardship is a key policy concern because as AR/VR becomes common in homes and classrooms, it will be important to protect children’s emotional wellbeing if they cannot distinguish real artifacts from virtual.
- Bad actors may take advantage of metaverse’s reality-altering capabilities to inject political or dangerous messages or trigger false alarms and disasters that look very real.
- New laws will be needed to grapple with new situations such as NFTs and ownership rights, more data about expressions and physical behavior due to AR/VR could lead to wrong inferences, and machine-generated content by Web3.0 could challenge frameworks such as the General Data Protection Regulation (GDPR) [10].
- Expert systems of the past are morphing into digital avatars that look and behave like us. This creates numerous legal and social issues. For example, if my avatar attacks another, then can I be sued for assault and battery; if my avatar produces an artifact, then whose Intellectual Property is it; and could “Avatar Lawyers” emerge to offer services like company incorporation and arbitrating use of digital land for unlawful activities (some law firms have already established offices in the metaverse [9]).
- A major drawback of metaverse for developing nations is that it requires expensive equipment. An idea is that Smart Metaverse hubs could be housed in a remotely accessible “Smart Village” to offer

needed services for the developing countries. We are currently investigating this option (see Annex A for details).

Basically, metaverse could trigger a new wave of “Meta-Crime” that would need a new breed of lawyers with “Meta-Forensics” skills. Policy makers will need to update their skills to make sure that public safety, security, accessibility and inclusion requirements drive the technologies that benefit as many people as possible from the outset.

Concluding Remarks

As can be seen, metaverse is offering many opportunities and could be of tremendous value to many SDGs. But several challenges are also being raised. We have developed a methodology and a toolkit that has been designed to accelerate the SDGs especially for developing countries. This toolkit, presented in Annex A, has been used heavily [4, 5], [11 - 15]. We are currently extending this toolkit and will have a basic Meta4SDG version ready with a Smart Global Village in May 2022.

ANNEX A: A Digital Transformation Lab for Metaverse

Figure2 shows a *Digital Transformation Lab* that has been developed primarily due to our collaborations with enterprises around the globe and the UN ICT4SIDS Partnership. The transformation is based on the evolution of digital enterprises into the following approximate stages based on Figure1 and Table1. For example:

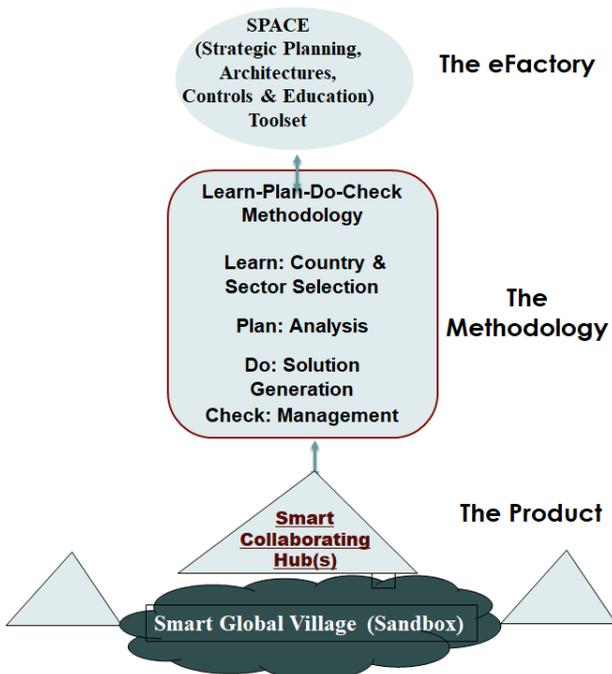
- Stage 0: Brick and Mortar Enterprises (no digital technologies). Organizations typically in the rural areas of developing countries fall into this category.
- Stage 1: Simple (Low Tech). Examples are restaurants that just display their menus on a website for advertisement.
- Stage 2 and 3: Medium to High Tech Sites. For example, eCommerce sites and B2B collaborations that allow consumers to buy and sell over large-scale networks.
- Stage 4: Next Generation Enterprises (NGEs). Industry 4.0 and *Metaverse fall into this category*.

This Lab helps organizations to move from one stage to the next by using three major components, as shown in Figure 2: an e-Factory that produces the artifacts, an agile methodology (the process) that is used to produce the artifacts, and Smart Collaborating Hubs that are the end results (the product). Some of these hubs could be

metaverse hubs (this is work in progress at the time of this writing). Specifically:

- The e-Factory is a Toolset, called SPACE (Strategic Planning, Architecture, Controls & Education), that provides an extensive array of capabilities for digital transformation [14]. These include a patterns repository, gamifications, decision support advisors such as an SDG Advisor and a Digital Transformation Advisor, planning tools, and specialized tools that invoke different capabilities for different types of scenarios (e.g., entrepreneurship and economic development).
- The agile methodology supports the entire Learn-Plan-Do-Check cycle that depicts the preprocessing, production, post-processing and customer support activities of a typical e-Factory. These phases invoke different capabilities of SPACE as needed. For example, the SDG Advisor is invoked to produce a healthcare hub (SDG 3) for a metropolitan area in Nigeria. This advisor reviews the SDG indicators for Nigeria and initiates the production of a healthcare hub that is suitable for Nigeria.
- The main product produced by the SPACE e-Factory is a *Smart Collaborating Hub* -- a center of activity that contains highly specialized and smart artifacts such as an Administrative Portal, a Citizen App, Training Materials and relevant Policies on a particular topic. *These hubs may have stage1, 2, 3, 4*

Figure 2. The SPACE e-Factory and Digital Transformation Lab

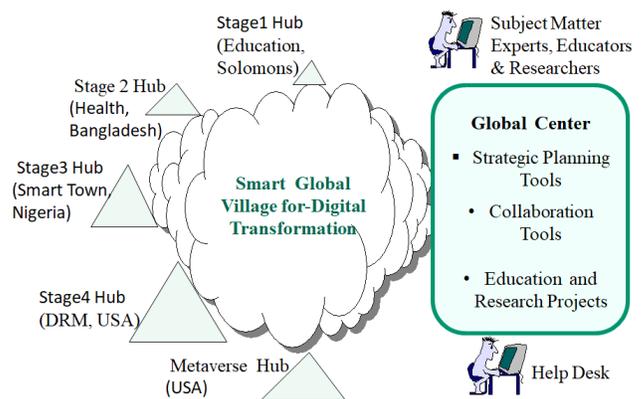


and metaverse capabilities and have prefabricated capabilities for collaboration with each other to form a *Smart Global Village*. SPACE has the capability to generate location and topic specific hubs. For example, SPACE will automatically generate a healthcare hub that has *some* metaverse capabilities for a Nigerian metropolitan area but will skip metaverse capabilities for a village in Negeria.

The Smart Global Village is populated by this Lab and currently houses more than 1100 smart hubs that represent more than 130 countries and support 12 industry and government sectors. This Village is an excellent sandbox for students, industries and government officials for digital transformation and economic development experiments. Additional details about this eFactory and Lab can be found in Exhibit1 and research papers that have been written on this topic [4, 5], [11, 12].

Figure 3 shows a closer view of the Smart Global Village that could be used as a valuable Metaverse Sandbox of high value to the developing countries. It shows several highly specialized smart hubs in rural and urban locations in different parts of the world. Please note that these hubs are in different stages of digital transformation (Stage1 to Stage4), locations (Africa, Asia, USA) and provide services in different SDG topics (education, health, smart towns, and disaster resilience & management - DRM). A Global Center supports and monitors the collaborations of this Village. The Digital Transformation Lab and the Smart Global Village are currently operating as part of our UN ICT4SIDS Partnership.

Figure 3. A Use Case for the Smart Global Village



We are currently exploring a metaverse hub (Stage4+) for advanced experiments in immersive education, tourism and disaster resilience. In particular, we are interested in studying the collaboration scenarios between metaverse and lower stage hubs in developing countries. We are also contemplating developing a

Policy Advisor for Metaverse that could suggest different policies for different collaboration scenarios.

Exhibit1: The Evidence -- Videoclips & Hands on Experiments

For Videoclips of specific Tools and Techniques:

- What is the SPACE Factory: 2 Minute Video Clip (<http://ict4sids.com/ved9.html>)
- What is a Smart Hub: 3 Minute Video Clip (<http://ict4sids.com/ved14.html>)
- How Does Collaboration Help a Smart Global Village: 4 Minute Video Clip (<http://ict4sids.com/ved4.html>)
- Computer Aided Planning Methodology: 5 Minute Video Clip (<http://ict4sids.com/ved6.html>). For more details (<http://ict4sids.com/methodology.html>)
- SDG Advisor: Video Clip (<http://ict4sids.com/ved7.html>), Link to the Tool (<http://space4ict.com/pages/sdgsadv.aspx>)
- UN ICT4SIDS Partnership site video tour -- please go to the site (www.ict4sids.com), and click on 'Video Gallery' (Red Button on Top of the screen). This will show you a list of many video clips

Digital Transformation Advisor & Planner Toolkit, <http://www.dt.ngespace.com/dtgame/default.aspx>, (accessed Jan.23, 2022).

The SPACE site (www.space4ict.com) provides complete information about different layers of SPACE. Please login as a guest and conduct different experiments.

ICT4SIDS Partnership Site, UN Partnership #8005, www.ict4sids.com. This site houses several tools such as the SDG Advisor and many articles and results of our work so far.

Smart Cities and Communities Lab

(www.ict4sids.com/scc.htm) shows interesting examples of the smart hubs in operation at present. For hands-on experiments on SCC Lab, please login as a guest.

Smart Global Village (SGV) Sandbox

(<http://space4ict.com/njsamples/countryCount.aspx>) shows over 700 portals in 130 Countries. Please login as a guest.

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