WORLD
ECONOMIC
FORUM

Future of Digital Economy and Society System Initiative

Internet of Things
Guidelines for Sustainability

January 2018

Contents

1. Introduction

The World Economic Forum has a **vision to shape a sustainable, inclusive and trustworthy digital future**. To deliver the critical outcomes to achieve this vision, we are focusing on six key areas across the Digital Economy and Society System: Access and adoption; Responsible digital transformation; Fit for purpose informed governance; Secure and resilient people processes and practices; Robust and interoperable digital ID for all; and The benefits of data sharing while respecting privacy.

The internet of things (IoT) is undoubtedly one of the largest enablers for responsible digital transformation. It is estimated that industrial IoT alone can add $14 trillion of economic value to the global economy by 2030.The economic value increases even more once consumer and public sector IoT are included. Additionally, as the converging point of several technologies of the Fourth Industrial Revolution like artificial intelligence, cloud computing or block-chain, the IoT has also tremendous potential to deliver social value.

Our analysis[1] shows that 84% of IoT deployments are currently addressing, or have the potential to address, the Sustainable Development Goals (SDGs) as defined by the United Nations. The analysis supports the intuition that many share – that IoT has development benefits that could be maximized without compromising the commercial viability. The reason that the IoT could become a game-changer for sustainability lies in its technology. At its core, IoT is about measuring and remotely controlling previously unconnected "things", reaching people and objects that technology could previously not reach and in the process also supports sustainable development elements.

However, the awareness of this link between IoT and sustainable development is limited.

There are multiple case studies that illustrate how the prioritization of sustainability objectives could lead to increased commercial results and benefits across multiple stakeholders. As a generic example, let's take a smart building energy solution deployed in commercial and residential complexes which leads to a substantial reduction in energy bills for the owners. However, the benefits extend beyond the monetary savings: IoT solution providers benefit from the commercial results from the solutions deployed, governments at local, regional and national level eventually will benefit from the collective energy savings which equates to energy production and, ultimately, the broader society will benefit from the reduction of greenhouse gas emissions that contribute to climate change.

These guidelines are, therefore, relevant for all the stakeholders in the IoT ecosystem including the private sector – from technology providers to vertical industries implementing IoT solutions – governments at local, regional and national level, as well as development agencies, civil society, not-for-profit organizations and others actors of the ecosystem. **The objective of these guidelines is to encourage the prioritization of sustainability goals as part of the design of commercial projects to maximize social impact while still delivering, and potentially also increasing, commercial value**. Each guideline identifies the primary and secondary stakeholder who needs to take action and is segmented in three areas:

1. Collaboration models and incentives alignment (5)

2. Business and investment models (3)

3. Impact measurement (3)

These guidelines are based on research and insights collected during more than 40 interviews with executives and IoT experts from 28 organizations.

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1 http://wef.ch/IoT4D

2. IoT Guidelines for Sustainability

Area	Guidelines
Collaboration models and incentives alignment	1. Provide structural incentives to encourage the prioritization of sustainability objectives at the design phase of the IoT projects
	2. Integrate technologies and drive use cases-based growth under solid and collaborative partnerships to overcome the limitations of fragmentation
	3. Address infrastructure solutions first to enable business models and facilitate scale
	4. Simplify legal frameworks, accelerate procurement processes and engage the experts to enhance the pace of IoT deployments and reduce the risk of political cycles
	5. Establish early the data governance terms for ownership, privacy, usage and sharing as a central pillar of the partnership
Business and investment models	6. Exercise flexibility in designing and executing business models
	7. Develop cross-industry solutions to unlock mutual benefits and enable new monetization models
	8. Achieve scale by demand consolidation and bundling to attract alternative funding sources (e.g. institutional investors)
Impact measurement	9. Embrace a sustainability awareness culture to respond to new generational demand, enhancing brand reputation and attracting top talent
	10. Adopt a framework based on the UN Sustainable Development Goals to evaluate potential impact and measure results
	11. Identify potential Sustainable Development Goals and targets addressable by your IoT project and incorporate them into the commercial design

Table 1: Guidelines– Action, Key Opportunity and Risk Summary

Area	Guideline	For action by	Key opportunity	Key risk
Collaboration models and incentives alignment	1. Provide structural incentives to encourage the prioritization of sustainability objectives at the design phase of the IoT projects	Governments / Private sector/ Non-profit	Maximize sustainable development impact of the IoT projects	Sustainability continues to be an "accidental afterthought"
	2. Integrate technologies and drive use cases-based growth under solid and collaborative partnerships to overcome the limitations of fragmentation	Private sector / All	Deliver outcomes despite relatively immature market and fragmented landscape	Loss of business opportunities as customers wait for industry consolidation
	3. Address infrastructure solutions first, to enable business models and facilitate scale	Governments / Private sector/ Non-profit	Unlock $14 trillion of economic value to the global economy by 2030	Subdued or subpar growth of an otherwise promising sector
	4. Simplify legal frameworks, accelerate procurement processes and engage the experts to enhance the pace of IoT deployments and reduce the risk of political cycles	All	Streamline processes to achieve the full scale of the opportunities efficiently	Subdued or subpar growth of an otherwise promising sector
	5. Establish early the data governance terms for ownership, privacy, usage and sharing as a central pillar of the partnership	All	Leverage the full potential of one of the world's most valuable resource – data	Potential conflicts and failure in delivering the promised outcomes
Business and investment models	6. Exercise flexibility in designing and executing business models	Private sector / All	Maximize revenue opportunities in a relatively nascent industry	Missed revenue and growth opportunities
	7. Develop cross-industry solutions to unlock mutual benefits and enable new monetization models	Private sector	Innovation driving new revenue streams	Missed revenue and growth opportunities
	8. Achieve scale by demand consolidation and bundling to attract alternative funding sources (e.g., institutional investors)	All	Achieve the true scale of opportunities by bringing in new class of investors	Missed revenue and growth opportunities
Impact measurement	9. Embrace a sustainability awareness culture to respond to new generational demand, enhancing brand reputation and attracting top talent	Private sector / All	50% of world population is < 30 years – align with their priorities	Decreased competitiveness and brand obscurity
	10. Adopt a framework based on UN Sustainable Development Goals to evaluate potential impact and measure results	Private sector / All	Homogenize the language and goals used for sustainable development	Siloed, sector/industry specific impact measurement not understood by the wider global community
	11. Identify potential Sustainable Development Goals and targets addressable by your IoT project and incorporate them into the commercial design	Private sector / All	Maximize sustainable development impact of IoT projects	Sustainability continues to be an "accidental afterthought"

For action by

Primary stakeholder

Secondary stakeholder

Guideline 1

Provide structural incentives to encourage the prioritization of sustainability objectives at the design phase of the IoT projects
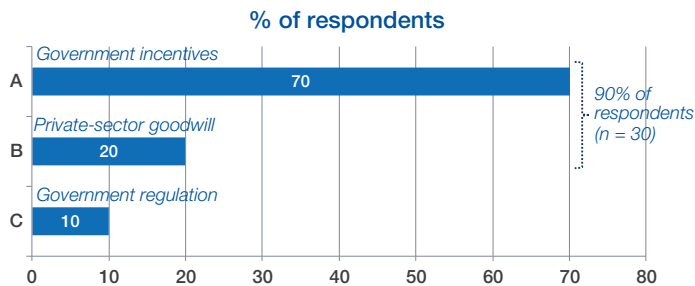
[Primary Action: Governments]
[Secondary Action: Private Sector/Non-profit]

Context

The IoT market is still relatively in its early days – witnessed by the fragmentation in the IoT ecosystem, relative lack of mature and large-scale business models and the high number of proof of concepts and pilots. There is reasonable confidence to assume that, in the long term, the private sector and market forces would be able to unlock the trillion-dollar IoT opportunity, by itself, and provide massive support to the SDGs in the process. However, in the short term, government support and guidance are definitely needed.

The full potential of IoT as an enabler for sustainable development is achieved when sustainability is incorporated at the design phase of the IoT projects. However, there is no consensus on the best mechanism to achieve this. Almost 90% of the interview respondents in this study (n =30) preferred a combination of government incentives (tax credits, or other monetary benefits) or relying on the private sector goodwill to drive this. Only 10% supported any form of government regulation.

Figure 1: Preferred mechanism to encourage sustainability at the design phase of IoT projects

% of respondents

Government incentives	
A	70
Private-sector goodwill	
B	20
Government regulation	
C	10

90% of respondents (n = 30)

0   10   20   30   40   50   60   70   80

Some participants added a time element– stating that Option B might work in 20 years once industry matures, Option C in 10 years (as government regulations tend to have a lag) – Option A is the only way to achieve quick adoption now.

To provide structural support the governments can consider doing the following:

1. Facilitate preferential loan terms

Governments can encourage banks and financial institutions to provide preferential loan terms for any entity which can demonstrate and quantify sustainable development benefits from the IoT project at the design phase. The higher the benefits, the easier it would be to gain loans on preferential terms (however, the project should also be commercially viable). This facilitation could be a strong incentive for the growth of IoT projects and provide much needed structural support at this early stage of the market.

Example: Some financial institutions provide preferential terms if the entity seeking the loan can show adherence to certain environment social and governance targets; e.g., cap on energy/CO_2 emissions.

2. Provide tax credits

Tax credits are one of the more conventional and well-known ways of providing structural incentives. The governments can consider providing tax credits contingent on the sustainable benefit impact of the projects. There is a cost and oversight element associated with administering any tax credit programme to prevent its misuse. However they have been successfully used in the past to provide structural support in other industries.

Example: Tax credits were provided by country governments to encourage investment in mobile infrastructure in rural and remote areas. Tax credits were also instrumental in the rise of renewable (solar, wind, etc.) energy farms worldwide. As the technology matured (and drove down the costs) the need for tax credits also dropped.

3. Incorporate sustainable development requirements for government tenders

Governments are a big procurer of products and services and could use their buying power to drive the need for vendors to quantifiably demonstrate sustainable benefits from participating in the procurement programmes.

Example: "Local source" requirements have been very successful in ensuring that local community benefits from any large-scale government programmes (infrastructure and others).

4. Create value-sharing mechanisms among industries and sectors

While the business models are still maturing, governments could ensure that value is shared by the ultimate beneficiary of IoT projects and is disbursed to other parts of the IoT value chain, particularly if industries are widely separated in the value chain.

Example: Companies providing a sensor-based flood abatement programme may only make a couple of dollars per sensor a year. The insurance industry could be the ultimate beneficiary from this project – saving millions of dollars in actuarial outlook. A government-designed mechanism (details to be worked out) can ensure that the insurance company provides an equitable share to the IoT providers, thus strengthening the business model and the case for even larger-scale deployments.

5. Support standardization of IoT proof of concept and pilot projects

Proof of concepts (PoC) and pilot programmes are being developed worldwide while the short-term business model for the IoT market remains challenging. This leads to a situation where vendors need to provide costly PoC multiple times to various customers. There is a need to do fewer but better PoCs and pilots, which once successful, are accepted for deployment elsewhere. A rigorous process is required to manage this, akin to the clinical research process in the pharma industry where research outcomes, once achieved, are accepted worldwide. Some entities have recognized the issue and have taken positive steps in this direction.

Example: Marketplace.city is a platform that allows technology providers to showcase their products (including past successes) and city/government employees to find, compare and evaluate thousands of smart technology products with actual results from past implementations. The platform also provides a direct communications channel to access the providers and past buyers of the technology. Cities can vet solutions with reviews and validations among their peers and other cities internationally and, as a result, can skip the tedious PoC and pilot stage, with confidence, while procuring technology solutions.

"

Government support is definitely required in the short term.

"

– Executive, global technology company

Guideline 2

Integrate technologies and drive use cases-based growth under solid and collaborative partnerships to overcome the limitations of fragmentation

[Primary Action: Private Sector]
[Secondary Action: All]

Context

The IoT market is still evolving and the growth is likely to come on the back of use cases. However, the large number of players in the IoT ecosystem (e.g., over 400 IoT platform providers) driving the development and deployment of IoT solutions lead to fragmentation – which is likely to continue for a while in the absence of any external interventions or shocks. While competition is always perceived to be healthy for the end users, excessive fragmentation has certain negative effects as well. These include:

– Higher costs – hardware and others – due to lack of economies of scale
(e.g., lack of standardized sensors)

– Lack of industry-wide standards as there are too many parties and interests
(e.g., over 400 IoT platform providers with "open" or "closed" solution architecture)

– Interoperability suffers due to large number of interfaces
(e.g., a predictive maintenance solution provider has to adapt the solution to the different IT systems deployed by the end customer)

– Too many end customers continue to wait because they feel technology is still evolving
(e.g., a smart city project is on hold for years because the city government is unsure of which connectivity option to use

– Sub-scale projects which are not interesting to institutional investors
(e.g., local smart city solutions deployed piecewise, keeping the project values below the threshold of large institutional investors, such as private equity, development bodies, sovereign wealth funds, etc.)

The approach to tackle the negative effects of fragmentation would depend on the time horizon

1. Short term – collaborative partnerships (technical and non-technical) are the solution

One way of countering the above effects of fragmentation is by developing solid and collaborative partnerships (technical and non-technical). There are many examples of successful partnerships and collaborations, all of which share some common characteristics:

1. They sell outcomes to the end users, rather than technology, and drive growth via use cases

2. The partners integrate technologies upfront and present a united interface to the end user

3. They actively share the data with other partners and monetize collateral benefits

Example: A city created a public-private partnership (PPP) to develop and implement an IoT model for more than 10 areas for smart city projects (e.g. environmental, ICT, mobility, water, energy, waste matter, nature, domain, public space, open government, information flows and services) to provide services to its citizens and businesses. The partnership grew to run more than 20 major programmes and over 80 separate projects in these areas. The city also established an operating system that sits atop its established network of sensor technology to collate and analyse data from all the projects. The operating system is thus the equivalent of a unified network/interface of what otherwise would have been a large number of possibly incompatible networks or interfaces. The data sharing and analytics opened up more revenue streams for the partnership.

2. Long term – market forces will eliminate or reduce the negative effects of fragmentation

In the long term, market forces are likely to address some of the negative effects of fragmentation; i.e. higher costs, lack of industry-wide standards and interoperability. The IoT market is maturing, which will lead to higher customer confidence in use cases and bigger scale of the IoT projects. The time horizon of when this maturity is achieved is difficult to predict though and collaborative partnerships will continue to be the principal pivot to counter the negative effects of fragmentation.

Guideline 3

Address infrastructure solutions first, to enable business models and facilitate scale

[Primary Action: Governments]
[Secondary Action: Private Sector/Non-profit]

Context

The IoT market is still in its nascent stage but is a strong enabler for economic growth and sustainable development. Governments (national, regional, and city) have a critical role in ensuring that full potential is reached and structural challenges are overcome. One such challenge is solving the "infrastructure versus services issue", which is akin to the "chicken-and-egg" dilemma. Many entities/players/end users are willing to pay for the services but not for the infrastructure.

Example: A city's citizens may be willing to pay to know parking availability (via an app) but they may not want to install the sensors at public expense. This creates a chicken-and-egg dilemma where IoT infrastructure is needed before services can be provided. Service business models are required to drive the infrastructure. It is in the interest of governments to facilitate creation of large-scale IoT infrastructure. The exact mechanism would need to be worked out on an individual government basis and will depend on the political will, investment availability and public opinion.

Infrastructure is a prerequisite for services. One interview participant aptly compared the state of the IoT landscape to the early days of the railroad network in the United States. For services to exist (e.g., ticket counters, station cafés etc.), we need railroads (infrastructure) for the trains to run first. There are many similarities because both of these inventions are industrial revolutions with the ability to change everything.

Governments could:

1. Enact and implement consistent, clear and transparent regulatory and policy frameworks

This is required to encourage the type of long-term investment necessary to build infrastructure necessary for IoT. This includes streamlined permitting and approval process, certainty in tax, property law, contract law, reasonable infrastructure rules, and tariffs and fees whose only aim is to recover regulator costs.

Example: A reasonable system of time-bound approvals, with defined hearings scope, speeds building of the necessary wireless infrastructure. The US Federal Communications Commission and the Government of India have time frames (referred to as "shot clocks") within which local jurisdictions must act on applications for wireless communication facilities. In the US, this has resulted in a significant reduction in application backlogs at the municipal level.

2. Provide appropriate policy incentives to utilize existing private infrastructure

Example: IoT applications generally require access to physical infrastructure components – power, fibre, etc. – which are typically available at office and residential buildings. State and local governments could, in a complement to broad IoT network facilitating licensing of government-owned "street" furniture or other public properties, encourage sharing of such privately owned infrastructure for deployment of IoT solutions by giving building owners incentives, such as property tax breaks for providing use of their private property for public good, or budgetary support for participating sub-governmental agencies. This would allow the use of existing utilities for citizenship services, avoid the need to build additional infrastructure and provide a reasonable incentive to private building owners/public property managers.

No services are possible without the infrastructure in place. Particularly in the case of IoT, at some point in the future revenues may come from the services associated with data, but without addressing the infrastructure solutions first that day is still far away. Governments worldwide should take the lead in addressing this as it is unlikely that the relatively nascent IoT market can provide a solution on its own in the near term.

"

You need the railroads before you can start selling tickets at the ticket counter.

"

– Executive, technology company

Guideline 4

Simplify legal frameworks, accelerate procurement processes and engage the experts to enhance the pace of IoT deployments and reduce the risk of political cycles

[Primary Action: All]
[Secondary Action: n/a]

Context

There is a need to streamline the processes that drive the pace of IoT deployments from design to implementation. Without a decent deployment pace there is a risk that the technology is outdated by the time the roll out is completed. Leadership and political cycles also affect this pace and the stakeholders need to acknowledge this susceptibility and take suitable steps. We asked the interview participants to identify the steps that could be taken to increase the pace of deployment of IoT solutions. Their suggestions are listed below:

1. Simplify legal frameworks in partnerships

Legal frameworks are important to establish and drive all types of partnerships. They should be seen as an extension of trust and bonafide intentions of the participants that have agreed to form a partnership in the first place. There is sometimes a tendency to overcomplicate the legal frameworks, which either inculcates a sense of fear of participation or makes the project execution very cumbersome (resource-wise). This becomes particularly important in the case of PPPs, where public entities that have responsibility for taxpayers' money engage with the private sector that has a fiduciary duty to shareholders. Here are three examples to illustrate the point on simplification:

1. Consider a cap on liability instead of complex mechanisms to establish liabilities of each participant

2. Provide an opt-out clause for participants after an initial minimum commitment period if the project duration is too long or outcomes too uncertain

3. Create SPVs (special purpose vehicles) in case existing frameworks (e.g., government department rules) are not fit for purpose and need simplification to encourage private-sector engagement

2. Accelerate procurement processes

Slow procurement cycles are quoted as one of the biggest pain points, particularly in public and PPP environments. Very often the cycle times are driven by government or department procurement policies (and there are strong reasons to have such policies in the first place). However, given the early days of the IoT market, there are not many players with the financial resources to cope with the extensive procurement cycles. The slow procurement process is particularly detrimental to start-ups. Given how important a role start-ups play in innovation, there is a strong rationale to simplify and accelerate the procurement especially for proof of concept and IoT project pilots.

3. Engage the experts

It is recommended to engage experts if organizations lack the competency to decide the commercial or technical merits of the IoT solutions.

Example: Certain cities in the US have engaged the telecom companies via a master service agreement to act as an intermediary to evaluate and procure IoT technological solutions. Relying on the expertise of the telecom companies, which are closer to the technology, has enabled a faster deployment cycle for the cities.

The above three suggestions, if implemented correctly, will go a long way to ensure that the deployments are rolled out efficiently and the impact of political cycles (elections) are suitably managed. These risks affect all industries but they are even more critical to manage for a relatively nascent IoT market.

"

For a start-up that is externally funded, six months is a lifetime. It's not the technology, not the competition, it's the procurement process that kills it.

"

– Senior industry leader, IoT

Guideline 5

Establish early the data governance terms for ownership, privacy, usage and sharing as a central pillar of the partnership

[Primary Action: All]
[Secondary Action: n/a]

Context

The IoT is about mass connectivity and mass transparency. In the process, it also generates a huge amount of data that is becoming a source of competitive advantage. For any partnership to thrive, it is critical that the governance terms for data ownership, privacy, usage and sharing are established as the central pillar of the partnership early on. These topics are high in the minds of IoT industry executives. When responding to the question, "What would you ask if you had a blank cheque?", top answers focused invariably on data: data ownership; gaining data usage rights; and protecting privacy. Data security and standards are also important and here evolution is driven by the industry and technology maturity.

Data is a symbol of power and entities want to keep the power balance in their favour.

– Executive, software company

1. Data ownership

Data ownership is one of the most contentious topics and companies, global bodies and national governments continue to grapple with the issue. There is an emerging view in some corners that data should ultimately be owned by the end user and not any intermediary. The end user may then choose to share the data (with or without monetary benefit). However, there are multiple views, and while this debate is being resolved, it is critical in any partnership that data ownership is agreed on unambiguously and with complete transparency.

2. Data usage and sharing

There are multiple options for data sharing in a partnership, including but not limited to:

Option A: In its simplest form complete data sets can be shared among the partners

Option B: Sensitive data could be made available after stripping out any privacy critical data

Option C: Aggregated or macro level insights can be provided instead of sharing raw data insights

Any data usage and sharing solution must be fit for purpose. For example, the provider of a predictive maintenance solution may want the serial number of devices, real-time error codes and maintenance schedule for the plant – any form of data aggregation compromises the ability of the solution to function properly. Hence, options B and C, in this case, are not fit for purpose.

3. Data privacy and sensitivity

It is critical that data governance in a partnership clearly requires stakeholders to receive informed and meaningful consent from consumers/end users before collecting data and has safeguards in place for data that is either proprietary, impacts public safety or can undermine reputation of the stakeholders if in the wrong hands. Data privacy and sensitivity are fast becoming a top concern to the extent that perceived risks can outweigh the value propositions of IoT altogether. The data laws are usually subject to national jurisdictions and should be adhered to all times.

Data and data rights today are where human rights were centuries ago – with the advancement in technology we would need a charter and commitment to data rights the same way we have for human rights.

– Senior industry leader, IoT

Guideline 6

Exercise flexibility in designing and executing business models

[Primary Action: Private Sector]
[Secondary Action: All]

Context

The IoT market is still in its nascent stage, with the business and investment models still evolving. For example, there are a lot of ongoing proofs of concepts and pilot projects funded mostly from the "innovation" or "digital" budgets rather than the actual profit-and-loss budgets of the business units.

It is important to be flexible in designing and executing business models while scaling up, even for more mature solutions.

1. Be proactive in identifying incremental revenue streams and splitting cost buckets

Example: A global provider of IoT solutions targets urban service providers as the main customers (rather than focusing only on city governments). It seeks incremental revenue streams (e.g., installing additional cameras and sensors on LED street-light poles – resulting in incremental revenue from urban service providers and city departments on top of the energy savings from LEDs) and provides flexibility in the business model where the costs are split into capital expenditure and operational expenses to suit customer preferences (with some financial risk on the provider's books).

2. Provide flexibility especially if it facilitates quick deployment of new technologies

Example: When smart parking solutions were in their early days, a start-up in the US provided a choice of pay-off models for the customer:

Option A: A fixed sensor installation cost plus a monthly service fees (per sensor)

Option B: A fixed percentage of incremental revenue from the parking fines (based on the smart parking solution) with no sensor installation cost or service fees; all risks to be borne by the start-up

In the end, the customer decided on Option A (more conventional pay-off model for their contracts). However the initial display of flexibility helped to create trust that led to a confirmed contract from the customer and, more importantly, won an early success for the start-up.

3. Solution as a service, with the provider bearing all the risks (see also Guideline 4)

Example: To convince a large customer to try a new solution, a fleet and asset tracking solution was provided as a service. The solution provider paid for the capital expenditure to install all hardware. The customer paid only a monthly service fee to access the solution and all the associated data analytics. Once success was demonstrated at a large scale, the provider was able to change the model and partially share the capex expenses with the new customers.

Some use cases are relatively more mature; e.g., smart cities. Previously, PPPs or public grants were driving the smart cities solution pilots with city governments perceived to be the end user. However, evidence now suggests that there is a market need for the solutions, which reduces the role of city governments to simply the procurer of IoT solutions with urban service providers or even the citizens being the end user. This leads to more standardized business models, which help to achieve scale.

> **Business model efficiency is so critical – the current revenue margin is minuscule for IoT devices – the short-term business model is definitely challenging.**
>
> – Executive, global technology company

Guideline 7

Develop cross-industry solutions to unlock mutual benefits and enable new monetization models

[Primary Action: Private Sector]
[Secondary Action: All]

Context

The key strength of IoT is in creating mass connectivity and mass transparency. The core of this value proposition is best realized in cross- and previously unconnected industry solutions. Developing a cross-industry solution is not easy as conventional industries and players are optimized around certain core competencies – critical to survive in the competitive landscape. One downside is that innovation capabilities are quite limited and frequently de-prioritized versus day-to-day activities. To overcome this situation the entities should:

1. Engage with industries and sectors outside the regular value chain

Example: A data centre has been built in the middle of the city (versus normally remote locations). The heat generated by the data centre is used to provide district heating to the residents. This is a win-win solution as data centres usually have to pay to get rid of the heat and residents usually have to buy heating from utility providers. A unique business model has thus evolved.

2. Open up data to drive cross-industry solutions

Data is a source of competitive strength and it is understandable that enterprises want to keep the data close to its chest. If they are serious about innovation and cross-industry solutions, the enterprises should consider giving access to the data to other players while complying with the data laws. By doing this they open up a world of possibilities as cross-industry solutions can then be devised on the back of this data sharing.

Example: A large technology company in the US opened up the data from all existing smart city solutions. An accelerator firm conducted a hackathon with the aspiring community of local developers – which identified the top solutions – and provided structural support to grow these solutions (via a start-up mechanism). The technology company also benefited from these innovative solutions, which otherwise would not have been developed.

3. Enable new monetization models

Selling data from IoT sensors is frequently cited as an additional monetization strategy on top of the core revenue model. There are multiple opportunities further downstream as well, such as data marketplaces where data packs could be bought at a fixed price (when value of the data for the counterparty is known) or at auction (when the value of the data is unknown). Mass data availability is also encouraging traditional companies to experiment with platform business models on top of conventional business models.

Example: A global healthcare company brought in data from disparate systems (including data from IoT sensors) into one platform and is now using a platform-based monetization strategy to create additional value with the community of partners, developers and end users (on top of the traditional product business model).

"

Traditional companies need 'innovation factories' – not as an incubator or laboratory on the fringes but as a mission-critical part of a deliberate strategy to create the next generation of products and services with top talent, leaders and innovation mandate.

"

– Senior industry leader, IoT

Guideline 8

Achieve scale by demand consolidation and bundling to attract alternative funding sources (e.g., institutional investors)

[Primary Action: All]
[Secondary Action: n/a]

Context

The institutional investors (private equity, infrastructure funds, sovereign wealth funds, etc.) bring an attractive alternative source of funding and have been successfully supporting large-scale civil, power and telecom infrastructure projects worldwide. Due to the relatively early days of the IoT market, currently most IoT projects fall below the investment threshold of institutional investors. There are two ways to achieve scale:

1. Consolidate the demand: The most practical way to increase the scale of deployment is to consolidate the demand, where possible. The responsibility to do so lies mostly with the procurer of the solution (customers). However, other members of the partnership (vendors or solution providers) should also help to make the case by providing a clear cost-benefit analysis to support consolidating the demand.

Example: Government can consider consolidating the procurement of smart city solutions in multiple cities at once instead of individual procurement by city. This is a good mechanism to create scale for five SDGs where IoT is already providing good support (SDG 3, good health and well-being; SDG 7, affordable and clean energy; SDG 9, industry, innovation and infrastructure; SDG 11, sustainable cities and communities; and SDG 12, responsible production and consumption).

2. Bundle the projects: Bundling the IoT projects increases the total ($) ticket size of the project and makes it more appealing to the institutional investors. Bundling can be deployed both by customers and vendors. For example, an entity could consider:

– Bundling multiple projects of the same kind (e.g., smart parking solutions in 20 cities in a province)

– Bundling different IoT projects together (e.g., full suite of smart city solutions as one project).

Bundling also solves a critical problem. Not all IoT solutions will provide return on investment (ROI). In some cases, critical benefits are distributive and difficult to quantify. For example, in the context of smart city solutions, citizen services such as security and environment (e.g., air quality) are hardest to show ROI and probably the most important from a city government's point of view.

Example: Safe environment for cities and businesses is an absolute necessity; however, current business models frequently do not stand on their own. By bundling these difficult-to-prove ROI solutions with the more conventional ones (such as smart parking, street lighting, and waste management), one could create a way to scale and deliver the full range of smart city solutions for the benefit of the citizens. This will also make the overall bundle size interesting to institutional investors.

Venture capital is another source of funding driving innovation in the IoT ecosystem. However, this source alone will not be enough to achieve the true potential of the IoT as an enabler for sustainable development. Large-scale institutional funding would be required to roll out deployments that benefit the global community.

It is in the interest of all the participants in the IoT ecosystem to strengthen the business and investment models and thus achieve scale to attract alternative funding.

"

There is a gap between those who have the technology and those who have the money.

"

– Executive, technology company

Guideline 9

Embrace a sustainability awareness culture to respond to new generational demand, enhancing brand reputation and attracting top talent
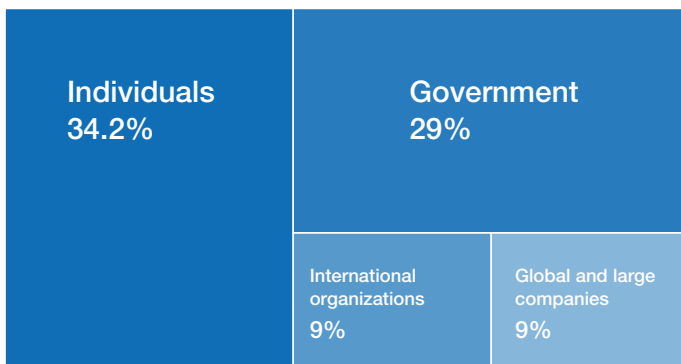
[Primary Action: Private Sector]
[Secondary Action: All]

Context

Of the world's population, 50% are under the age of 30 and sustainable development is very important for them. Some findings from the World Economic Forum's Global Shapers Survey provide insights into how this demography thinks about sustainable development.
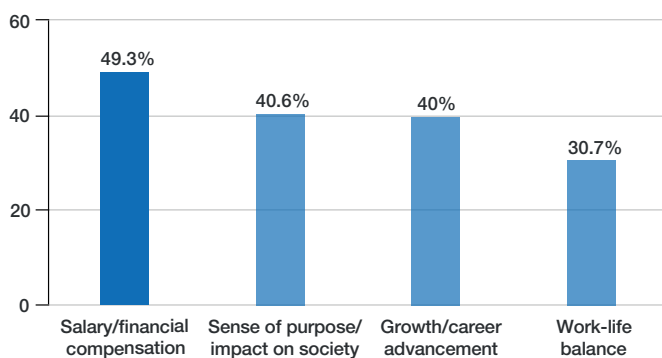
1. They have a sense of responsibility and responsiveness – They are proactive in how to make the world a better place.

Who has the greatest role to play in making the world a better place? (N=24272)

Individuals 34.2%	Government 29%	
	International organizations 9%	Global and large companies 9%

2. They seek reward, purpose and growth – "Sense of purpose and impact on society "is the second most important criteria when considering job opportunities; entities which give importance to societal impact (such as sustainable development) are likely to attract top talent.

What are your most important criteria when considering job opportunities? (N=20070)

Bar chart values:
- Salary/financial compensation: 49.3%
- Sense of purpose/impact on society: 40.6%
- Growth/career advancement: 40%
- Work-life balance: 30.7%

Percentage of unique votes. Respondents were allowed to choose up to 3 answer choices. Next leading choices are "Flexibility/autonomy" (28.1%), "Company culture / quality of colleagues" (26.8%).

3. Young people care about corporate responsibility – They are becoming ever-more conscious about what they consume and where it comes from. They are also careful about where their loyalty lies. It is critical for companies to get their branding right.

How do you decide whether a company is responsible or not? (N=19826)

- Sustainability / social responsibility reports: 59.6%
- Media reports: 40.6%
- Insider stories: 38.4%
- Industry reports: 36.1%
- Annual reports: 35.7%
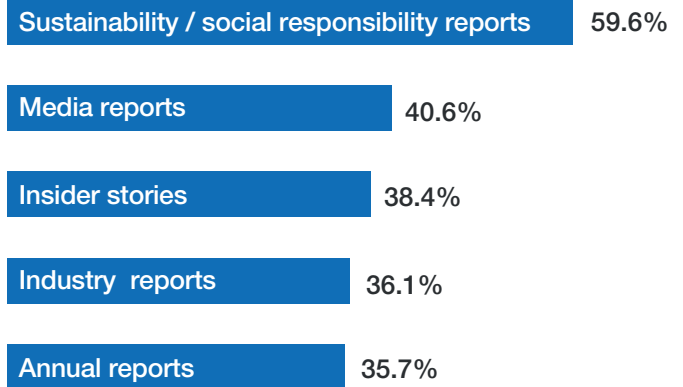
Percentage of unique votes. Respondents were allowed to choose as many answer choices as applicable. Next leading choices are "Online articles/commentary" (30.7%), "Friends / network" (26.9%).

Sustainability is regularly cited as one of the top three factors in the capital allocation, capital investment and capital purchase decision of many large-scale institutional investors, such as sovereign wealth funds, pension funds and endowments. Indeed, some institutional investors now operate a sophisticated policy on sustainability with mandatory expectation documents on water management, human rights, children's rights, tax and transparency, and climate change for their portfolio companies. This trend is likely to become stronger in future.

Thus, sustainable development continues to move into the boardroom, government manifestos and the mainstream (social) media. All stakeholders should benefit from aligning their value proposition with sustainable development. This is no longer about being a responsible global citizen but about retaining access to capital and maintaining a long-term competitive advantage, as an employer and provider of products and services, with the next generation.

The next two guidelines elaborate on how different entities could use the SDGs as a reference to ingrain sustainability as a core part of their value proposition.

Guideline 10

Adopt a framework based on the United Nations Sustainable Development Goals to evaluate potential impact and measure results

[Primary Action: Private Sector]
[Secondary Action: All]

Context

The IoT industry is very heterogeneous, with applications in many industry verticals. To analyse and develop a common understanding of how IoT and its multiple applications can be used for sustainable development, a robust, comprehensive and widely accepted reference is required. The UN's 17 SDGs fit this criteria.

1. The SDGs are robust and developed after a multi-year global process of debate and negotiations

The SDGs are part of a wider 2030 Agenda for Sustainable Development. They were developed after a multi-year process involving civil society, government, the private sector and academia, with the support of 193 countries.

2. The SDGs are comprehensive and cover all major dimensions of sustainable development

The SDGs with 169 targets are broad in scope and address the root causes of poverty and the universal need for development that works for all people. The goals cover the three dimensions of sustainable development: economic growth, social inclusion and environmental protection.

3. The SDGs are the most widely accepted common language across sectors

The SDGs appear to be the closest to a common classification system widely adopted across the public and private sectors. There are other ways to think and classify sustainable development, however none comes close to the level of robustness, comprehensiveness and acceptance as SDGs.

Figure 2: The UN 17 Sustainable Development Goals

75% of IoT projects focus on 5 SDGs
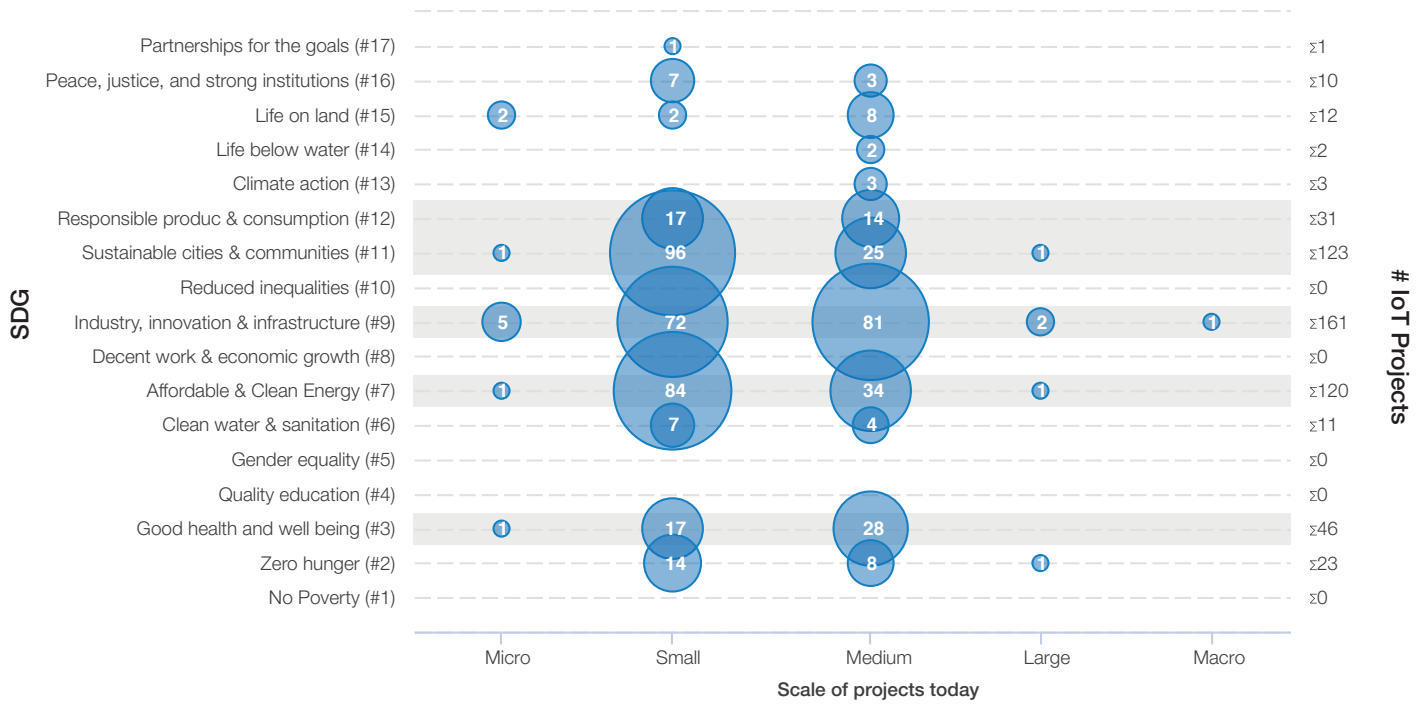
Source: IoT Analytics database of 640+ IoT projects

The IoT is an enabler for achieving the SDGs within the commercial framework. In phase one of this study (visit http://wef.ch/IoT4D) a database of over 640 IoT projects were mapped against 17 SDGs with the following results:

– 84% of the 643 analysed IoT deployments support or have the potential to support the SDGs

– 75% of these focus on five SDGs which are closer to commercial and industrial applications; SDG 9 (industry, innovation and infrastructure), SDG 11 (sustainable cities and communities), SDG 7 (affordable and clean energy); SDG 3 (good health and well-being), SDG 12 (responsible production and consumption)

– 95% of projects are small/medium-sized

The study supports the intuition many private sector executives share – that IoT has development benefits that could be maximized without compromising the commercial viability. The reason the IoT could become a game-changer for sustainability lies in its technology. At its core, IoT is about measuring and remotely controlling previously unconnected "things". The technology reaches people and objects that technology could previously not reach.

However, the awareness of this link between IoT and sustainable development is limited. To remedy this, start by increasing the awareness of SDGs in your organizations to see how IoT projects support sustainable development. For example:

1. An IoT-enabled predictive maintenance solution that increases production efficiency in an old manufacturing plant supports SDG 9, industry innovation and infrastructure, target 4

"By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally …"

2. A flood abatement programme using sensors to monitor storm water supports SDG 9, sustainable cities and communities, target 5

"By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters…"

3. Smart city energy LED lighting project supports SDG 7, affordable and clean energy, target 3

"By 2030, double the global rate of improvement in energy efficiency."

Sustainable development is not a fringe benefit of IoT projects. In many cases, by delivering what they were designed to do, as part of a commercial framework, the IoT projects also support the sustainable development goals.

"

Over 90% of our projects are purely commercial with no sustainability element whatsoever.

"

– Executive, large technology company

Guideline 11

Identify potential sustainable development goals and targets addressable by your IoT project and incorporate them into the commercial design

[Primary Action: Private Sector]
[Secondary Action: All]

Context

The best way to maximize the sustainable development benefits is to analyse and ascertain the development metrics at the design phase of the IoT projects. Resource constraints and lack of awareness of sustainable development (see previous guideline) were identified as the two most important barriers. Resource constraints are a bigger issue for start-ups and small to medium-sized enterprises (SME). However, by tailoring the sustainable development analysis sophistication to the resource availability, even resource constrained entities can make a start. For example

1. Start-ups: Identify, via a simple mapping exercise, if the IoT projects benefit any of the SDGs.

2. Small and medium enterprises: Do a more detailed self-analysis. There is no widespread easily available framework to conduct this analysis. One framework is proposed as part of this study where five KPIs are used to ascertain the impact level (visit http://wef.ch/IoT4D)

The conventional impact measurement models like "natural capital model" needs extensive customization as it is context specific. The "triple bottom line" analysis also requires a resource level that may be beyond certain SME budgets.

3. Large corporations: Spend more resources to accurately analyse the project impact or even consider getting an external accreditation. Currently, no external accreditation programme specific to IoT and SDGs is available. Developing an accreditation programme presents a huge opportunity for entities that take sustainable development seriously.

Example: The concept of external accreditation is well-developed elsewhere. For example, Leadership in Energy and Environmental Design (LEED; https://new.usgbc.org/leed) is the most widely used green building rating system in the world. It provides a framework to create healthy, highly efficient and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement in the construction industry.

There is an opportunity to develop a similar accreditation programme for the IoT industry. It is critical that any accreditation programme is robust, fair and relatively inexpensive. It should not be seen as an attempt to create unfair barriers for others. The IoT industry and the world community have an incentive in ensuring that this is done right.
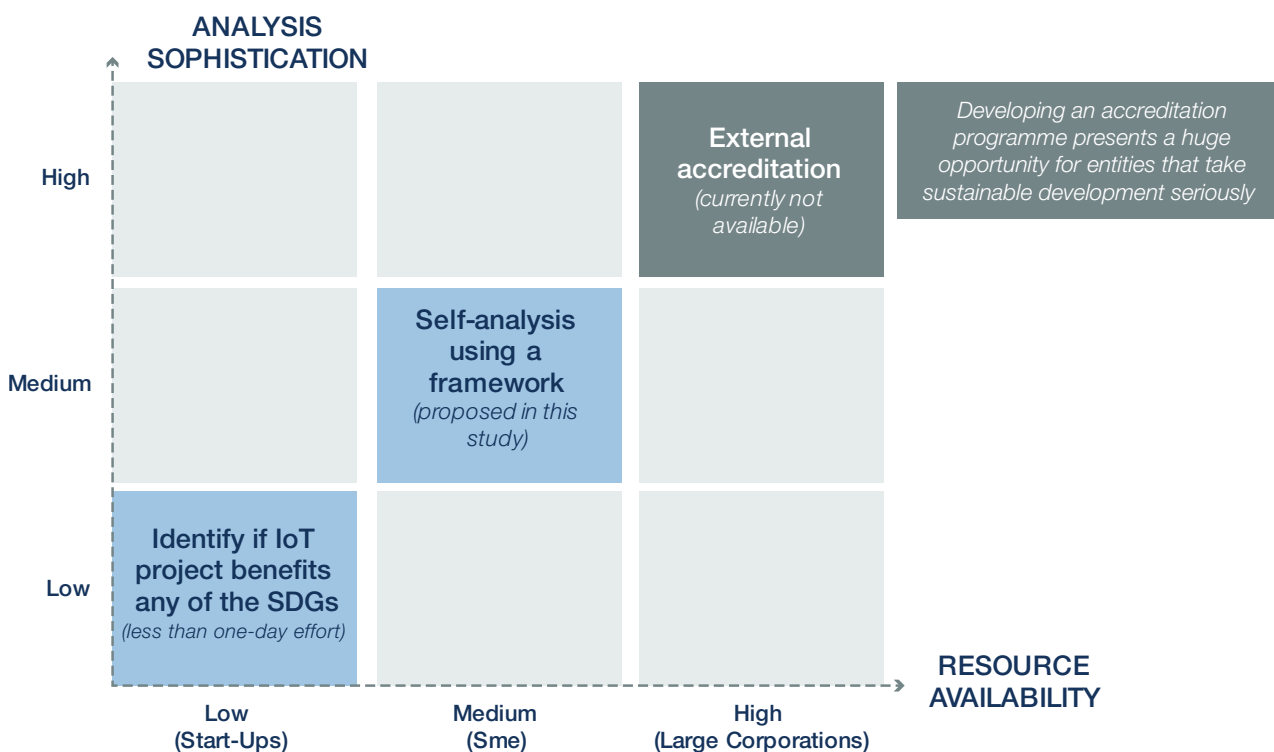
> **"**
>
> **I don't think sustainability is a consideration at all in the design phase; 'accidental sustainability' is sadly true in many IoT projects.**
>
> **"**
>
> – Executive, large technology company

Figure 3: Tailor the sustainable development analysis to the resource availability

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