ABSTRACT
The concept of digital sustainability is mentioned in research on
digital preservation as well as on openness topics. Both streams of
literature point out the necessary discussion how to create, use,
and regulate digital resources in order to maximize their value for
our society today and in the future. This paper therefore reviews
current work on digital sustainability, presents a list of six character-
istics how to define digitally sustainable goods, and draws the
link to aspects of e-government.

Categories and Subject Descriptors
K.4.1 Public Policy Issues: Ethics, Intellectual property rights,
Regulation, Use/abuse of power

General Terms
Economics, Legal Aspects, Management, Standardization, Theory

Keywords
Sustainability; Digital Sustainability; Digital Preservation; Open
Source; Open Data; Open Government

1. INTRODUCTION
This article explains the concept of sustainability to the digital
world based on the definition of sustainable development in the
Brundtland report 1987 [16]: Sustainable development is develop-
ment that meets the needs of the present without compromising the
ability of future generations to meet their own needs.

The virtual character of digital goods leads to opportunities as
well as challenges. Digital assets are naturally non-rivalrous in the
sense of economic goods so they may be used and distributed at
marginal cost. However, digital assets are not always public goods
because they are excludable. Data may be stored in proprietary
formats or software may be available in binary versions only thus
for example excluding non-paying users.

Previous research has defined the term digital sustainability in
two different ways: Digital preservation literature mentions digital sustainability in the context of conserving data and information,
openness literature (open source, open data etc.) uses the term
digital sustainability to extend its meaning also in the legal con-
text of accessing and modifying source code and data.

2. DIGITAL PRESERVATION
The stream of literature on cultural heritage and digital humanities
positioned digital sustainability in the field of digital preservation
[11]. Its main topic is the technical longevity of digital information ranging from storing data on appropriate hardware devices
to standardization of file formats and persistent identifier schemes
for data structures. In order to maintain a stable technical infra-
structure also economic incentives such as business models and
sponsoring organizations for the data repository are necessary argues Kevin Bradley [2]. An extensive review of funding models
is also part of the final report of the Blue Ribbon Task Force on
Sustainable Digital Preservation and Access [1].

Preserving digital information is a challenge because of the sheer
size of data produced in our today’s information society. Back in
2011 IBM stated every day 2.5 quintillion (10^18) bytes of data are
produced [9]. In 2013 the Scandinavian research organization
SINTEF estimated that in the last two years alone 90% of all the
data in the world had been generated [6]. Thus there are technical
as well as economic barriers preserving this data.

Choosing what to preserve is another challenge. For example only
in 2010 the Library of Congress decided to store all public mes-
sages from Twitter [10]. Gladly Twitter Inc. agreed to hand out all
tweets since its inception and providing all future microblogging
messages to the library leading 2013 to an archive of 170 billion
tweets. Other problems such as security and quality of electronic
signatures and longevity of digital certificates are elaborated by
Szádeczky [15]. He explains the dilemma of long-term preserva-
tion of data while securing it with modern cryptography such as
asymmetric key cryptography.

3. OPENNESS MOVEMENT
An extended concept of digital sustainability was introduced by
Marcus Dapp in recent years based on the work of Volker Grass-
muck on information freedom and the tragedy of the commons
[7]. Dapp defines digital sustainability as following [5]:

Digital resources are handled sustainably if their utility for socie-
ty is maximized, so that digital needs of contemporary and future
generations are equally met. Digital needs are optimally met if
resources are accessible to the largest number and reusable with
minimal restrictions. Digital resources encompass knowledge and
cultural artefacts represented in digital form, e.g. text, image,
audio, video, or software.

For Dapp openness is a pre-requisite for maximized reuse of
digital resources and thus unrestricted access and reuse of digital
assets are key for digital sustainability. As a logical consequence
open content, open data and open source are considered ideal
forms of freely accessible and modifiable digital assets. By defini-
tion they provide content, data, and software below open licensing
regimes granting unrestricted access, unrestrained use, unlimited
redistribution, and unconfined modification.

An additional dimension to this notion is brought by Thorsten
Busch in his 2008 essay on open source software and sustainabil-
ity [3]. He connects the digital divide discussion with literature on
open knowledge and open source software. Based on the argumen-
tation that proprietary software creates new vendor dependen-
cies with corporations, developing countries should favor open
source software. Busch concludes that from an ethical point of
view all firms that claim to be good corporate citizens should
offer open source solutions to their customers [4].

In 2013 Melanie Griesser merged the concept of digital sustaina-
bility with current literature on sustainability in her master thesis
[8]. She concludes applying the concept of sustainable develop-

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ment on the digital field is possible and very much recommended in order to address current challenges in the information society.

4. CHARACTERISTICS
In order to decide if a digital good is sustainable or not from a digital perspective I propose to define certain characteristics. Formulating a set of requirements has helped open source software [12] as well as open data [14] to become clearly distinguishable from proprietary software respectively non-open data. Based on the rules of sustainable development in the environmental context defined by Spindler [13] I suggest the following six characteristics that define digital sustainability:

1. Intergenerational justice: Digital goods such data, content, and software must be made available in a way that their long-term usability is ensured. This concerns not only the data itself, but also the knowledge required for their interpretation and use. Prerequisite for this is a transparent information architecture. Legal, organizational, technical or financial obstacles must not obstruct their use, modification and redistribution of digital assets.

2. Regenerative capacity: Information and communication technologies are subject to constant change. Therefore, everyone must have the option to participate in the production, development and dissemination of digital goods. It is thus a prerequisite for digital sustainability that implicit knowledge (tacit knowledge) about a digital good resides not only within a person or a single organization. The tacit knowledge must be distributed over many actors allowing them to share their innovations with one another freely.

3. Economic use of resources: Obviously digital goods are not subject to economic rivalry. However, if people are excluded to access digital information, they need to recreate it in order to use it. This contradicts the idea of economical use of resources. Thus unrestricted technical and legal use of resources must be ensured.

4. Risk reduction: The production and use of digital goods involve numerous risks, such as the creation of vendor dependencies or the risk of erroneous interpretation. Digital goods should therefore be designed so that they do not create dependencies towards their manufacturers, are trustworthy and can be interpreted correctly by all users. Prerequisite for this is their verifiable and transparent information architecture.

5. Absorptive capacity: Information overload is a reality in today’s world. Thus society must be able to absorb digital resources in order to be able to use and adapt them appropriately towards new needs and requirements. This concerns issues such as comprehensible structuring, documentation, discovery, and filtering of information.

6. Ecological and economic added value: Digital goods must be made freely available in order to be shared to the largest extent possible enabling the potential for innovation and full value for society. Therefore it is necessary to establish the appropriate conditions on a regulatory level so freely accessible digital resources promoted and distribution channels such as the Internet are equally accessible to everybody. Closed, proprietary software environments and standards are opposed towards the maximum economic benefit for society.

5. CONCLUSION
The challenge remains to implement this concept of digital sustainability in the e-government world. As in the concept of environmental sustainability also the characteristics of digital sustainability are barely achievable. Today’s situation in e-government is as far away from reaching digital sustainability as today’s physical world is far away from ecological sustainability. Nevertheless it makes sense to define a vision in order to guide governments in their daily decisions on procuring and managing digital assets in a digitally sustainable way.

Based on this introduction many interesting research questions follow: How can governments facilitate the production of digitally sustainable resources? In what way need public-community partnerships be organized to optimize collaboration with citizens and innovators? How do public procurement processes need to be designed in order to prioritize digitally sustainable e-government solutions? These and more research questions guide future work on digital sustainability.

REFERENCES