

INTERNET-OF-THINGS AS A PLAYGROUND FOR PARTICIPATORY INNOVATION AND BUSINESS POTENTIALS IN COMPLEX MODERN ECONOMIES

KAROLINE BILLE SAHLERTZ
COPENHAGEN BUSINESS SCHOOL
KSA.ITM@CBS.DK

JANNI NIELSEN
COPENHAGEN BUSINESS SCHOOL
JN.ITM@CBS.DK

LEIF BLOCH RASMUSSEN
COPENHAGEN BUSINESS SCHOOL
LBR.ITM@CBS.DK

RASMUS ULSLEV PEDERSEN
COPENHAGEN BUSINESS SCHOOL
RUP.ITM@CBS.DK

ABSTRACT

The Internet and the Web are evolving embracing semantics and pragmatics of data, information and knowledge. Part of this evolution is Internet-of-Things (IoT) in various forms. This includes design principles based on the original idea of the Internet and the Web: free of charge, bottom-up approach, self-organizing and co-creation.

In this paper we will unfold how it is possible to use the IoT as a playground in a digital and social development, where the traditional simple dichotomy between state and market description of economies is challenged by the complexity of new institutional economies, transaction cost theories, commons based peer-production and governance of common pool resources.

By using these new economies we envision that Participatory Innovation and Business Opportunity should take place in polycentric units of relations, where *production*, *exchange* and *consumption* of

IoT resources are ‘designed’ based on self-organizing principles.

We identify and combine four approaches to each of these three relations. Together they provide a diversity of 64 potentials for participatory innovation and business potentials in producing, exchanging and consuming IoT resources.

INTRODUCTION

In the program for this conference on Participatory Innovation we are told that “The coming decade will likely experience new (digital and social) developments of increasing complexity”. We take this as a starting point. We are all aware of this – so many articles, books, cases and practices have similar statements – even to the point of being trivial. We will start from this ‘common truth’ and propose two developments which are of special interest: Internet-of-Things (IoT) as a technological (digital) development and new economies as a social development. Both developments are adding to the increasing complexity in societies. Our challenge is to suggest ways of ‘handling’ all three - IoT, new economies and complexity - in order to create participatory innovation and business potentials.

We start by explaining our understanding of IoT and new economies. Then we look at complexity in order to understand the challenges in governing these two developments. In that way we hope to show that

governance of IoT, new economies and complexity cannot be separated from handling ‘the larger system’ of production-, exchange- and consumption relations. We suggest that participatory innovation must address self-organizing in order for business potentials to emerge in complex modern economies. Finally we use the EU project FI-WARE to illustrate how participatory innovation may support the development of business potentials based on IoT as a commons.

INTERNET-OF-THINGS AS A BRIDGE TO NEW ECONOMIES

IoT means network based man-machine communication. By force of the Internet, it is now possible for computerized devices and sensors (“things”) to have geographically unlimited on-line communication with other devices and sensors, i.e., they – as well as human beings - can collect, send, receive, analyse and react to data and information from each other. This may include human intervention, but it may also function as a purely technical ‘communication’. Some advanced devices and sensors can learn from “experience”, i.e., become increasingly better at doing the particular function they are designed for (for instance, real-time forecasts for power demand, for weather forecasts or for the development on the stock exchange).

The Internet and the Web are evolving into being able to embrace semantics and pragmatics of data, information and knowledge. Part of this evolution is Internet-of-Things in various forms¹. Hence IoT is part of the overall development of the future of social and informational connectivity as illustrated by Nova Spivack in fig. 1.

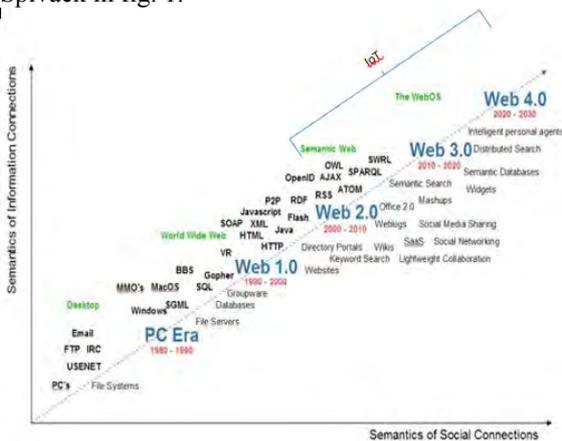


Fig. 1. IoT as Informational and Social Connectivity (based on Nova Spivack, RADAR Networks, 2008)

IoT itself may be the target for participatory innovation in order to create business potentials. But it is our contention that we are witnessing a joint development in technology and economics that needs to be addressed

¹See f.ex. fi-ware.org

(as mentioned in the PIN-C programme). So in the next section we try to show a similar development in economics.

NEW ECONOMIES LINKING TO COMPLEXITY

Economic thinking aims at creating abundance, i.e. the availability to every individual of courses of action and instruments necessary for them, which are perfectly efficient for the attainment of any end (Ackoff, 1971). Though economics try to be the most ‘scientific’ of the social sciences it includes a wide variety of approaches and theoretical perspectives. They range from classic/neo-classic economics, competence based economics via behavioral and evolutionary theory of the firm to new institutional economics, transaction cost theory, commons based peer production and governance of the common pool resources (see www.nobel.org for a historical overview and Wickham (2004) for an overview of economics for strategic entrepreneurship).

We show the development as a dialectics between effectiveness and quality in producing and in consuming. Historically it shows a move from wealth to utility to welfare – with worth as a potential for the future.

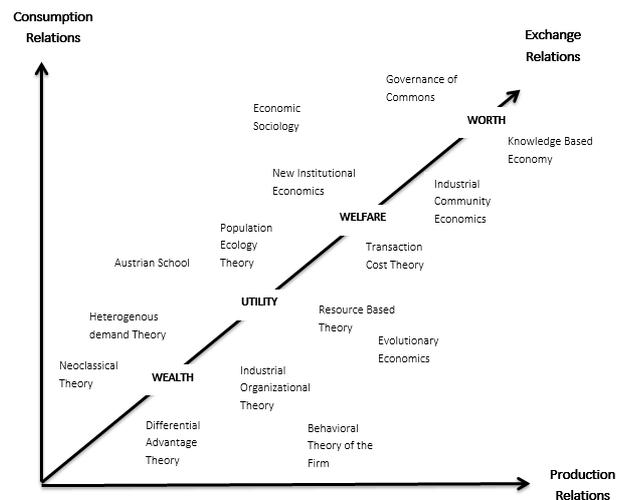


Fig. 2. The development towards modern complex economies. Based on Economic Theories in Strategic Entrepreneurship. Wickham (2004) and a selection of Nobel Prize winners.

Both the development in IoT and the new economies move towards higher complexity. In order to handle complexity there are two choices: either reduce it, or embrace it and use complexity in our governing. We will look at the second opportunity, which is the only way forward according to cybernetics (see f.ex. the works of Norbert Wiener (1948, 1950), Ross Ashby (1956), Stafford Beer (1959, 1966), Niclas Luhman (1984)).

Cybernetics tell us that handling complexity with complexity can only be achieved through self-organizing in such a way that the complexity (variety) in the signals ‘controlling and organizing the system’,

i.e. any local or global society, must be greater than the complexity in the system (Ashby's law on requisite variety).

This is why participatory innovation as a model for the emergence of business potentials will have to be self-organized. We'll show a way of handling complexity that is in accordance with these 'cybernetic laws'. And we will use IoT and modern economies to do so.

HANDLING COMPLEXITY

Different conceptualizations have different advantages. In the tremendous success of the industrial age, linear thinking was viable. However, in the "glocal" world today, the technological and the economic development have changed everything into a hyperlink way of relating. Complexity proliferates. It would be an illusion to reduce complexity and control into closed hierarchical structures. The challenge is to govern complexity with more complexity and let the development be driven by decentralized self-organizing systems in networks - in Yochai Benkler's term peer-to-peer production and in Elinor Ostrom's term: polycentric governance.

Karl Marx told us that three relations were needed in order to understand society. Production-, Exchange- and Consumption Relations. In order to uncover these three we combine the works of Benkler and Ostrom as they represent the spearhead of complex modern economies. Benkler's work is primarily on Production- and Exchange Relations while Ostrom's work are focusing on Consumption- and Exchange Relations. However their work on Exchange Relations – though slightly different in approach and concepts – give us a glue for joining these two streams of theory and practice, resulting in three dimensions in the development of economic thinking:

The *first dimension* provides an explanation of the production relations: This explanation is grounded in Benkler's adaption of Coase's Transaction Cost Theory. The Theory is described by Benkler in Coase's Penguin as: either to minimize transaction cost in business by Externalizing and sharing these costs (External TAC) or to minimize transaction cost by Internalizing these cost through hierarchies based on competition (Internal TAC). In his later writings, Benkler enhanced the theory with the categories Trust and Nature based on forms of cooperative networks, as he became aware of the importance of "The Wealth of Networks" (2006) as described in the book by the same name.



Fig. 3 The first dimension: Production Relations

The *second dimension* provides an explanation of the exchange relations between the production side and the consumption side: This dimension is grounded in Benkler's ways of handling "Benefit acquisition" and Ostrom's ways of handling "Difficulty of Excluding Potential Beneficiaries". Benkler provides an explanation of benefit acquisition as a trade-off between property rights like patents and giving goods away for free to obtain other benefits. Ostrom provides an explanation of the difficulty of excluding by analysing the degree to which individuals can be excluded from goods. For example individuals cannot be excluded from breathing the air, but individuals can be excluded from using others' automobiles. Even though Ostrom states that her two dimensions are continua we use the discrete terms expressed by Benkler² for Exchange Relations and our own stipulation for the Consumption Relations.

The term Copyright (Benkler's term: Rights based exclusion) is used as the exchange, where power and enforcement are involved power, e.g. financial power or legal power. The term Copyleft (Benkler's term: Non-exclusion-Market) means that the exchange are taking place without exercising power. The term "barter" (Benkler's term: Non-Exclusion Nonmarket) is an exchange that are based on different goods being involved in the exchange without any formal payment or power being involved. Finally the term 'no constraint' see exchange as a free and mutual trust based way of supporting each other.

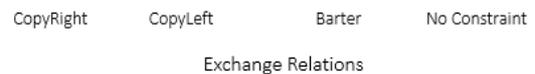


Fig. 4 The second dimension: Exchange Relations

The *third dimension* is based on consumption relations and provides an explanation to which degree one consumer's use of goods influences others' use: This dimension is grounded in Ostrom's - Subtractability of Use, also a continuum. Ostrom's has researched to which degree one individual's use of a good diminishes others' use. For example, the learning of languages does not demise others learning (termed low). Overfishing will affect others in terms of low fish stocks (termed high). In this paper we – again – reduce 'complexity' into a division in four modes of consumption relations. In this we use our own categories. *Consuming* means to subtract the good 'once-and-for-all'. *Co-existing* means a relation, where there is mutual respect for each other's needs, so that the consumption is not subtracting all, but

² The idea of continua in all three dimensions add to the complexity, but we keep Benkler's explanation to hold a sufficient amount of complexity to warrant our suggestions for participatory innovation in IoT.

‘keeping an eye towards the needs of another’. *Co-creating* means that there are production relations involved in the consumption in such a way that subtraction is balanced with production in another resource (so-called ‘circular economy’). Finally we take *Making* to be a mutual expansion of resources in such a way that sustainability is achieved.



Fig. 5 The third dimension: Consumption Relations

In sum we identify and combine four approaches in each of these three relations as shown in fig. 6: The PEC-Space.

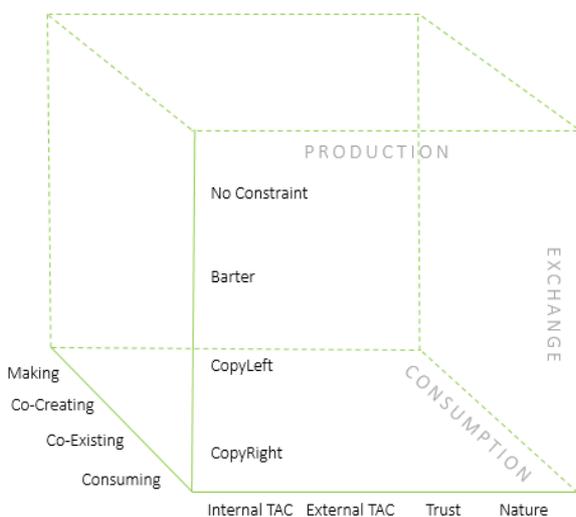


Fig. 6 The PEC-Space for participatory innovation and business potential in IoT.

Producing: Internalizing Transaction Costs, Externalizing Transaction Cost, Trust, Nature (based on Yochai Benkler: government, market, social, natural)

Exchanging: Copyright, Copyleft, Barter, No-Constraint (Based on Yochai Benkler: state, property and contract, social norms, no constraint and Elinor Ostrom: from high – low difficulty of excluding potential beneficiaries)

Consuming: Consuming, Co-Existing, Co-Creation, Commons (based on Elinor Ostrom: from high – low subtractability of use)

The combination provides a diversity of 64 potentials for participatory innovation and business potentials. If we take them to be continua the amount of opportunities are truly unimaginable. We will only show a few examples based on EU’s FI-WARE programme.

FI-WARE AS IOT PLAYGROUND

FI-WARE³ is an EU project that aims at creating the Future Internet. It consists of 18 consortia and a great amount of strategic enablers based on open source software and open data (see FI-WARE.org for details). We take it to be the best example of fulfilling the ideas of Tim Berners-Lee in building the Future Internet based on a bottom up approach with open data and open.

As an illustration of our use of FI-WARE as IoT Playground in Fig. 1 we will introduce four general examples that may inspire Participatory Innovation and Business Potentials in Complex Modern Economies. This also implies new interpretations of the actors involved, because we take the basis of innovation and business to be commons based peer-to-peer relations.

FI-WARE is a platform, driven by the European Union, for the development and global deployment of applications for Future Internet. The use of FI-WARE is open and royalty-free, where the involvement of users and developers is critical for the platform to become a universal standard and reusable solution. The objective of FI-WARE is to facilitate development of services in a variety of areas, including smart cities, sustainable transport, logistics, renewable energy, and environmental sustainability.

FI-WARE wants to capture opportunities derived from the new wave of digitalization of life and businesses. Its strategy is to build an ecosystem that will work as a catalyst for capturing the potentials. It wants to lead openness in the IoT wave of digitalization of life and businesses.

FI-WARE rests on 5 pillars:

- a generic, open standard platform which serve the needs of developers in multiple domains
- a meeting point where innovation takes place, an opportunities can be incubated
- a program that funds developers and entrepreneurs, and ignites roll-out of the ecosystem
- a suite of tools easing deployment and operation of FI-WARE instance nodes
- a global footprint: open to regions sharing the ambition

We have chosen FI-WARE as an IoT Playground because the implementation of FI-WARE will take place through 18 cross-sectorial and cross-disciplinary consortia (at the moment) and what is called generic enablers, which are platform developed by the consortia using open source and open data. Thereby the FI-WARE programme is open for anyone and may use all the opportunities in the PEC-Space.

³ The wording in our FI-WARE description is based on official material.

EXAMPLES: FI-WARE AND HACKER PRINCIPLES

As an illustration in fig. 7 we have chosen three consortia from FI-Ware: Finodex, FI-ADOPT and Fabulous - and a fourth based on Hacker Principles.

The Finodex project will use FI-WARE technologies as well as the reuse of open data to promote the creation of innovative ICT (software and/or hardware) services and products for the market in different business sectors (environment, health, transport, finance and bottom up). Applications are open to European SMEs, individuals or groups of individuals up to four members. Selection will be based on technical excellence, impact and implementation process. No research projects are expected, but ideas for real products being ready to be into the market in a period of less than a year.

The FI-ADOPT accelerator will create a technological and business ecosystem in which SMEs and web-entrepreneurs will be supported to develop highly innovative applications for corporate and citizen's learning/training, healthy behaviour shaping and social integration purposes. They will employ rich media, social networking, and mobile apps and gaming principles. Selection criteria will be based on technological excellence, FI-WARE Adoption acceleration, and market readiness.

FABulous aims to foster the innovation and web-entrepreneurship ecosystem for 3D printing in Europe bringing together FI assets, infrastructures and investors with innovators and entrepreneurs in the field of design manufacturing, logistics and content-based services to establish the European Network of Manufacturing Innovation Labs.

The principles of openness has led us to examine hacker communities and their potential for enabling and exploring IoT and new economies. Their principles seem to be rebellion, passion, ambition, diversity, sharing and community. That may be what is called for, when we try to find natural ways of production with no constraints in exchange and in order to turn consuming into making.

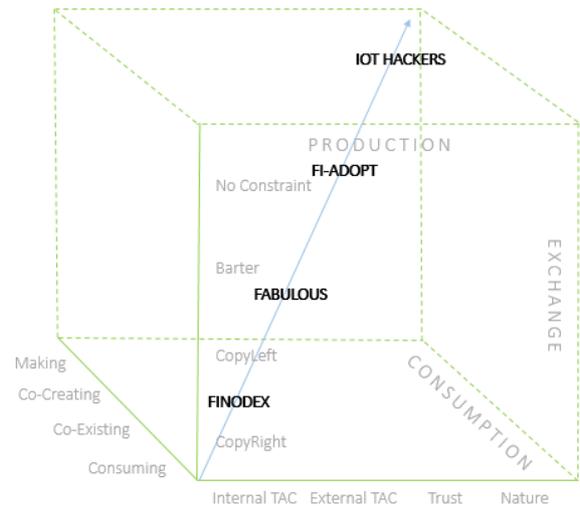


Fig. 7. IoT as playground for participatory innovation and business potential in a knowledge landscape of production-, exchange- and consumption relations.

These 64 combinations are a knowledge landscape of production-, exchange- and consumption relations that can use the IoT Playground. These combinations open for participatory innovation and business potentials that are not just tied to the market and/or the state as in neo-classical economic thinking. There are many more opportunities to explore as the Internet of the Future (as IoT) open our knowledge landscapes.

In order, however to accomplish this digital and social promise we need self-organizing. But: self-organizing needs guiding principles.

GUIDING PRINCIPLES FOR SELF-ORGANIZING

In any play we need principles – and we need to break principles – in order for things and humans to move and emerge; in order to handle complexity. In an earlier paper to PIN-C (Bach, Bruun de Neergaard, Nielsen & Rasmussen (2011), suggested eight guiding principles for participatory innovation. In a learning mode 2015 we still have them with us – but now qualified through IoT, new economies and complexity thinking. They are the landscape of ‘playfulness’ in which we may work:

- Developing a new understanding of control and management through leadership and governance of paradoxes and dilemmas
- Designing appropriate uses of power, i.e. dialogue on ideology and the dynamics of inclusion and exclusion
- Establishing self-organizing learning teams for the emergence of innovation and business opportunity
- Developing multiple cultures
- Handling uncertainty
- Improving group learning skills
- Creating resource slack

- Create permanent dialogue on private and public identity formation, meaning of life and work, power relations in cooperation and good leadership

CONCLUSION

Conclusion is based on the Latin word: Concludere. This word means ‘to shut up together’. It implies that one has done one’s work as best one could – now the time has come to relax, create new resources – and then: start anew. So we will make no conclusion, nor any solution, but we do hope that the suggestions in the paper will be of value for dialogue on participatory innovation in digital and social developments.

REFERENCES

- Ackoff, Russel L. (1971). *Scientific Method*, Wiley
- Ashby, Ross (1956). *An Introduction to Cybernetics* Cybernetics, Chapman & Hall.
- Bach, Martina Sophia, Bruun de Neergaard, Thea, Nielsen, Janni & Rasmussen, Leif Bloch. (2011). *Mobilizing local and regional knowledge for innovation*, PIN-C, SDU, Sønderborg,
- Beer, Stafford (1959): *Cybernetics and Management*, English Universities Press
- Beer, Stafford (1966): *Decision and Control*, Wiley, London
- Berners-Lee, T., Hall, W., Hendler, J. A., O’Hara, K., Shadbolt, N., & Weitzner, D. J. (2006). *A framework for Web science*. *Foundations and Trends in Web Science*, 1(1), 1–130.
- Benkler, Yochai (2002) *Coase's Penguin, or Linux and the Nature of the Firm*, 112 *Yale Law Journal* 369. Also on <http://www.benkler.org/CoasesPenguin.html>
- Benkler, Yochai (2006) *The Wealth of Networks: How Social Production Transforms Markets and Freedom*, Yale Press, also on <http://www.benkler.org/wonchapters.html>
- Benkler, Yochai. *Commons and Growth* (2012). *The essential role of Open Commons in Market Economies*, in Frischmann, Brett M.: *Infrastructure: The Social Value of Shared Resources*, Oxford University Press,
- Castells, Manuel (2011). *A Network Theory of Power*, *Inf. Journal of Communication*, Vol. 5.
- FINODEX (2014). *Handbook for Entrepreneurs*, Version 1, finodex-project.eu
- Hall, Wendy (2011). *The Power of Networks*, *International Journal of Communication*, Vol. 5, pp. 651-664
- Hess, Charlotte & Ostrom, Elinor (2007). *Understanding Knowledge as a Commons From Theory to Practice*, The MIT Press, Cambridge.
- Luhman, Niclas (1984) *Soziale Systeme: Grundriß einer allgemeinen Theorie*, Frankfurt: Suhrkamp (English translation: *Social Systems*, Stanford: Stanford University Press, 1995)
- McGinnis, Michael D. (2011). *An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework*, *The Policy Studies Journal*, Vol. 39, No. 1
- Ostrom, Elinor. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.
- Ostrom, Elinor (2010). “Beyond Markets and States: Polycentric Governance of Complex Economic Systems”, *American Economic Review* 100 (3): 641–72., also at http://www.nobelprize.org/nobel_prizes/economics/laurates/2009/
- Poteete, Amy, Marco Janssen, and Elinor Ostrom. (2010). *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton, NJ:
- Prahalad, C.K. & Krishnan, M.S. (2008). *The new Age of Innovation – Driving Co-Created Value through Global Networks*, McGraw-Hill
- Pyka, Andreas & Scharnhorst, Andrea (eds.) (2009). *Innovation Networks – New Approaches in Modelling and Analyzing*, Springer Verlag, Heidelberg
- Spivack, Nova: www.radarnetworks.com
- Stacey, Ralph D. (2001). *Complex Responsive Processes in Organizations. Learning and Knowledge Creation* (London & New York: Routledge),
- Tuomi, Ilkka (2002). *Networks of Innovation*, Oxford University Press
- VTT Technical Research Center of Finland (2013). *Productivity Leap with IoT*
- Wickham, Philip A. (2006). *Strategic Entrepreneurship*, Pearson
- Norbert Wiener, Norbert (1948): *Cybernetics: Or Control and Communication in the Animal and the Machine*. Paris, (Hermann & Cie) & Camb. Mass. (MIT Press)
- Wiener, Nobert (1950): *The Human Use of Human Beings*. The Riverside Press (Houghton Mifflin Co.)
- Uckelmann, Dieter; Harrison, Mark & Michahelles, Florian (eds.) (2011). *Architecting the Internet-of-Things*, Springer Verlag.

COLUMNS ON THE FINAL PAGE SHOULD BE OF EQUAL LENGTH