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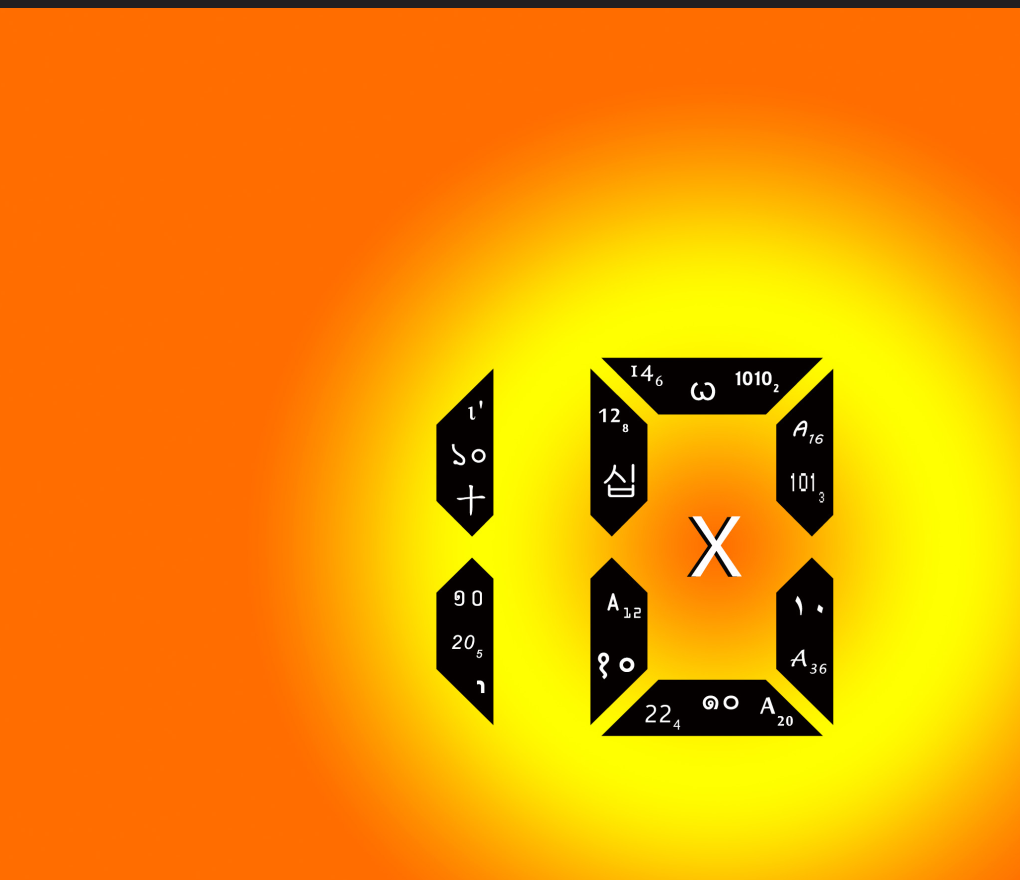

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EDITORIAL – From the Faculty Editor

So the iSCHANNEL has made it to 10 years old. We should really celebrate with a cake with candles but that isn't really in the spirit of this journal. If we are anything, we are forward looking. Our place is charting the future not the past and our regularly changing authors, reviewers and editors ensure this. Only myself – as so called Faculty editor – had remained around to steer the ship (though these days it mostly pilots itself and I simply pen these editorials).

This year's articles reflect the iSCHANNEL's forward-looking trend. Big data is reviewed by Maximilian Mende - though, reflecting our teaching here at the LSE, the focus is not on the hyperbole of this new trend, but on the limited rationality available to managers and the imposition of a technical rationality which remains inherently bounded. Also trailblazing is an article by Atta Addo on BitCoin– that most current of topics – exploring the entanglement of materiality, form and function. Drawing upon Prof. Kallinikos' work, this article stands back to explore what currency is as a digital artefact of varying form. Similar questions are asked of cars in Tania Moser's article which explores ubiquitous computing's impact on transportation. This includes the famous quote *"The most profound technologies are those that disappear. They weave themselves into the fabric of every day life, until they are indistinguishable from it"* (Weiser, 1991).

What however excited me within this issue were two articles which rejected the inherent assumption of this quote, realising that while technology disappears for some, it becomes very much present for those it marginalises. Whether through economics, disability or location the brave new digital world is a barrier to many. It was therefore pleasing to see articles addressing the obstacles of old age in the adoption of telecare (in an article by Karolina Lukomska), and finally a paper by Matteo Ronzani on digital technology and its impact on replicating existing patterns of resource distribution which support global inequality. These are topics of our time and it is wonderful to see this journal tackle them.

I very much wish the iSCHANNEL a productive second decade and hope our readership will continue to benefit from its insights.

Best wishes,

Dr. Will Venters

Faculty Editor

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Big Data and Its Implications

An Overview of Managerial Implications from Technical-Rational and Socially Embedded Perspectives

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KEYWORDS

Big Data
Bounded Rationality
Managerial Rationality
Social Embeddedness

ABSTRACT

Big Data has been shown to have strong influence on decision making processes, and organizational setups across all kinds of organizations. This critical literature review draws on peer-reviewed literature to identify scholars' perspectives on different implications, and questions the assumption that today's data offers the basis for completely rational decision making. Therefore process-inherent boundaries like irrational human interaction and data quality issues are identified. Apart from the technical-rational dimension, Big Data has an impact on the social environment. This includes questions about the ethical legitimacy of data accumulation and usage. The literature review concludes that there is further shaping of organizations necessary, in order to leverage the potential Big Data offers. Lastly it addresses a number of research questions, which bear the potential to further develop this field of study.

Introduction

During the 2002 Major League Baseball (MLB) season, the until then mediocre team of Oakland Athletics surprisingly won the national championship despite a below average budget. The secret to their success was the deviation from the traditional experience-based decisions in the transfer market, to an approach based on rigorous statistical analysis. Their success proved them right, so that today this methodology is referred to as sabermetrics. This is the combination of SABR, which is the acronym for the *Society of American Baseball Research* and metrics, which highlights the analytical component. Michael Lewis was following the team during its 2002 season and packaged the insights into his best-selling novel *Moneyball* (Lewis 2004).

This is only one very prominent example of Big Data significantly impacting management decision making. This paper aims to provide an overview of different perspectives on managerial rationality, and outline interesting avenues for future research in this regard. The term managerial rationality refers in this context to the underlying drivers that define the decision making process as well as the setup of an organization. Working definitions for technical-rationality, bounded-rationality and social embeddedness will be given throughout the paper.

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The literature review is structured as follows. Section one provides an overview about different perspectives on beneficial implications of Big Data on managerial rationality from a formal technical-rational perspective. In the following section, inherent boundaries to the rational implications as proposed by the literature are highlighted. Section three looks at the detrimental implications from a socially embedded perspective. Finally, future research questions are addressed, which have the potential to advance the scientific insights in this field.

Although the impact of Big Data is significantly broader than is examined in this critical literature review, in order to give a detailed insight, it will focus only on managerial rationality. Further research should discuss also the implications from an engineering- and economic-rationality point of view.

Implications of Big Data on Managerial Rationality from a Formal Technical-Rational Perspective

Formal technical-rationality refers to the perspective that corporate behavior is completely rational. It is derived from 'best practice', which can be proven with mathematical evidence. For example, in a rational company every investment decision is justified by sound mathematical models and is linked into the general business strategy.

Implications for Decision Making

Multiple authors who adopt this view implicitly assume that Big Data heavily influences the process of decision making. It is assumed to shift from what McAfee et al. call a hippo approach – highest paid person's opinion (McAffee et al. 2012) – towards one based largely on algorithms and mathematical patterns. These algorithms are used to predict the future and thus to define business strategy (LaValle et al. 2011; Andrejevic 2014). Chen, Andrejevic and LaValle build on this view stating that this shift is applicable in any context independent of function or industry (Chen, Chiang & Storey 2012; Andrejevic 2014; LaValle et al. 2011).

Anderson and Rosenzweig even extend this point to a more absolute level. In their opinion, the statistical examination of Big Data is superior to, and should replace, any other legacy decision making tool (Anderson 2008; Rosenzweig 2014). They point out that a decision making process based on Big Data is superior to traditional methods, as it prevents inherent human biases (Rosenzweig 2014). The argument of flaws emerging from human interaction in heuristics is supported by Goldstein and Gigerenzer: the authors state that at some point problems and solutions consist of too many variables to be grasped by human cognitive abilities, leading to mistaken decisions (Goldstein & Gigerenzer 2009).

The prevalent assumption behind the above outlined views is that underlying data sets are neither flawed nor biased. This is justified by Mayer-Schönberger and Cukier, as well as Booch's view that the mass of data can eliminate any flaws in its subsets, hence bringing us closer to objective truth (Mayer-Schönberger & Cukier 2013; Booch 2014). However the essay will further examine potential boundaries to this assumption at a later point.

Big Data supports decision making	
La Valle et al. (2011)	– In the future algorithms will be used, to help define business strategy – This shift is applicable independent of function or industry
Andrejevic et al. (2014)	
Chen et al. (2012)	
Big Data should replace legacy ways of decision making	
Rosenzweig (2014)	– Decisions based on Big Data are superior to and should consequently replace traditional decision making techniques
Anderson (2008)	
Goldsetein & Gigerenzer (2009)	– Limited human cognitive abilities promote use of Big Data
Big Data provides flawless insights	
Mayer-Schönberger & Cukier, 2013	– Combining data sets and leveraging the bulk of data can eliminate flaws in subsets
Booch, 2014	

Table 1. Classification of Scholars - Decision Making Benefits of Big Data

Implications for Organizational Design

In general, managerial rationality is not limited to decision making processes; furthermore it also takes into account effective organizing in order to achieve improved organizational performance. This includes, but is not limited to, setting rules and norms, obligations and roles, as well as hierarchical structures in an organization. LaValle et al. (2011) identified the impact of Big Data on this specific part of managerial rationality. They claim that insights gathered from internal data on process efficiency can be applied to streamline the internal flows of an organization. This is supported by McAffee et al.'s empirical research showing that companies applying Big Data are performing better in regard to productivity and profitability (McAffee et al. 2012). Pentland's case study shows the effect of Big Data in action. He outlines an analysis of the timing of coffee breaks and its subsequent optimization, which led to significant efficiency increases for a call center operator (Pentland 2013).

McAfee et al. and LaValle et al. examine the organizational implications in more detail (McAffee et al. 2012; LaValle et al. 2011). They highlight the need to set up suitable organizational structures and build strong analytical capabilities within the workforce, in order to support the data driven organization. This can be considered a technology deterministic point of view, where the social and organizational context follows technical advances.

Linked to those organizational changes McAfee et al. and the Journal of Strategic Direction see an additional implication, stating that not only will the processes and organization change, but also the distribution of power in the executive boards will shift towards the positions responsible for holding and analyzing data (McAffee et al. 2012; Strategic Direction 2012).

Pentland takes an even more radical view on Big Data's implications, and expands the technology deterministic view that Big Data will not only shape organizational processes, but it will go beyond and shape entire organizations, cities and governments, predicting that those will be significantly more efficient in the aftermath (Pentland 2013). This view seeing the impact of Big Data beyond the organization is shared by Brown et al., who assume that analytics will determine how companies and also nations compete and prosper (Brown, Chui & Manyika 2011).

The implications of Big Data on managerial rationality offered are twofold: first it will drive executives into a more rational decision making through mathematically supported insights and guidelines. The most absolute position in this context is taken by Rosenzweig, proposing that organizations should rely on decisions based solely on Big Data, as this would eliminate any human bias (Rosenzweig 2014). The second implication offered is that process redesign and organizational reorganization based on insights gained from Big Data will significantly increase efficiency and productivity in an organization. The more absolute perspective in this case is led by McAfee and Pentland, who claim that Big Data will not only affect organizations, but is basically applicable in any context to improve efficiency and shift power distributions (McAffee et al. 2012; Pentland 2013).

Big Data helps build stronger organizations	
La Valle et al. (2011)	– Analysis help restructure organizations
McAffee et al. (2012)	– Empirical studies show Big Data increases performance
Pentland (2013)	– Case study where Big Data improved performance – Big Data will not only improve corporate performance, but shape companies, cities and countries' competitive positions
Brown et al. (2013)	– Big Data goes beyond the organization and will define how corporations and nations prosper
Big Data requires new organizations and capabilities	
McAffee et al. (2012)	– To leverage the full potential of Big Data, companies need to build new analytics capabilities and reshape their organization
La Valle et al. (2011)	

Table 2. Classification of Scholars - Organizational Benefits of Big Data

Inherent Boundaries to Implications of Big Data on Managerial Rationality

The previous section outlined the implications of Big Data on an organization under the assumption that actors behave completely rationally. Still this view might not be universally applicable, as multiple scholars highlight constraints to managerial rationality based on Big Data. The views through this lens can be classified as bounded rationality, which depicts limited cognitive abilities of people and limited capabilities of technology.

Generally the identified boundaries can be grouped into two broad categories: the first is based on misapplication of tools or human error, whereas the second is emerging from the constraints inside the underlying data sets.

Boundary from Misapplication

In regard to misapplication of data, scholars identified two common patterns: first Bollier and Fioramonti independently from one another argue that any data is exposed to assumptions and human filtering. In their opinion, this is a necessary phenomenon, as the amounts of structured and unstructured data are just too vast to be fully analyzed. Hence human filtering is required to reduce complexity and make data usable in the context of Big Data (Bollier 2010; Fioramonti 2014).

The second limitation is identified by Boyd and Crawford, as well as Leinweber. Those scholars highlight the phenomenon of apophenia in the analysis of data (Boyd & Crawford 2012; Leinweber 2007). Apophenia refers to the idea that statistically significant patterns in data are identified, that are only coincidental. Leinweber (2007) refers in this case to the example of a statistically significant relationship between the development of the S&P500 index in the USA and butter production in Bangladesh, which is to our current knowledge not directly interlinked.

Considering the above boundaries of human filtering and over-interpretation, further research will be required in order to validate the degree to which Andrejevic (2014) and LaValle et al.'s (2011) claim that patterns identified in Big Data shape strategies and decision making is true. In addition the view of Rosenzweig (2014) that Big Data is eliminating human bias needs reconsideration, taking into account that human bias could affect the data already before its automated analysis.

Boundary from Data Quality

The second set of boundaries emerges from issues in the quality of underlying data sets. Boyd and Crawford (2012) state that often sources underlying the decision making process are flawed and do not provide statistically significant data sets. They provide the example of data gathered from social media sites. The authors claim, that this kind of data cannot be statistically accurate to the degree implied by technical-rational scholars, as for example social media is assumed not to be used by a statistically significant sample of people. This view is amplified by Wigan and Clarke (2013), who take into account the process of building data sets where different data from various sources and with different original purposes is combined. The authors claim that often data sets seem complementary, even though they are really not and by combination provide erroneous results. In addition, they highlight that the combination of different quality data sets reduces the overall quality to the level of the set with the lowest quality. This is a strong contrast to the objective truth implied by Mayer-Schöneberger & Cukier and Booch, who justified the rationality behind decisions based on Big Data with the elimination of data quality issues through the accumulation and combination of multiple data sets (Mayer-Schönberger & Cukier 2013; Booch 2014).

According to Wigan and Clarke (2013), one method to prevent wrong decisions based on error prone data is to verify the results through additional validation. However at the same time taking an economic perspective, the authors state that due to cost and time lags incurred by advanced validation those steps are most of the time not taken by organizations. This in turn leads in the worst case to wrong decisions based on low quality data. Still this solution requires further elaboration, as even the best additional analysis cannot be unbiased, when based on flawed data.

Taking the managerial rationality perspective again, Wigan and Clarke (2013) claim that although wrong, those decisions are most of the time authorative, due to the setup in organizations. This point is supported by Rosenzweig, who identified that the growing popularity of sophisticated statistical approaches promotes a mentality of blind-trust into numbers, rather than one that promotes critical thinking and a mentality of questioning their validity (Rosenzweig 2014). On the other hand Redman (2013) claims that this mentality of relying on decisions supported only by data is often not sustainable. He observed that once a significant decision is taken wrong, managers tend to completely abolish their positive feeling towards data based decisions and return to processes based radically on gut feeling and experience. This issue implies that with a growing influence of Big Data corporate mentality needs to be redefined (Redman 2013).

Drawing on the organizational setup, Redman (2013) and the Strategic Direction Journal (2013) identify an additional boundary to the rational implications of Big Data. They state that already today knowledge workers tend to work 50% of their time correcting errors and trying to validate given data sets. According to a survey based study of the Strategic Direction Journal (2013) most internal IT functions today are unable to cope with the vast amounts of data. This view however does not contrast the implications seen by the technical-rational scholars, furthermore it supports their perspective that one implication of Big Data will be the reshaping of the organizational setup. In addition it supports the point made earlier, that organizations today do not possess the necessary capabilities to make sense of the benefits Big Data could offer (McAfee et al. 2012; Pentland 2013).

Misapplication compromises influence of Big Data	
Bollier (2010) Fioramonti (2014)	– Any data is subject to assumptions and filtering, in order to reduce complexity – this creates space for human bias
Boyd & Crawford (2012) Leinweber (2007)	– Risk of apophenia is deeply embedded in Big Data
Data Quality compromises influence of Big Data	
Boyd & Crawford (2012)	– Data sources today (e.g. Social Media) are unreliable
Wigan & Clarke (2013)	– Often really incompatible data sets are combined, limiting significance of results – Combination of flawed data sets reduces overall quality
Organizational culture compromises influence of Big Data	
McAffee et al. (2012)	– To leverage the full potential of Big Data, companies need to build new analytics capabilities and reshape their organization
Redman et al. (2013)	– Mentality in most companies does not yet accept Big Data for decision making or quickly abolishes it

Table 3. Inherent Boundaries to Application of Big Data

A practical example where all aforementioned biases were present is given by Hoffmann and Podgurski from the public health sector. First they highlight existing errors in data capturing and processing, due to workload and misunderstanding, subsequently they identify filtering errors in the selection of relevant data sets for electronic health records (Hoffman & Podgurski 2013).

Finally, it is important to see that none of the authors supporting a bounded rationality in this case completely contradicts the beneficial implications promoted from a technical-rational point of view. Still they highlight significant drawbacks that limit the rationality of data based organizations and put forward questions that should be considered in future research.

Implications from Big Data originating from the social Environment

Big Data is not a stand-alone phenomenon, au contraire: it is deeply embedded in the context of today's social environment. Data privacy is the most prominent theme in this regard. It links to the question about ethical norms and guidelines for the accumulation and use of data.

Considering the existence of norms for data accumulation, one statement of Boyd and Crawford is central: "Just because it is accessible, does not make it ethical" (Boyd & Crawford 2012, p. 671). As Davenport (2011) outlines in his case study, the basic set of ethics in regard to data is most often company specific. According to Booch (2014) these guidelines are currently not clearly defined on an international level, as only in some places like the European Union strong data privacy regulations are applied. The paradox leading to the inherent complexity of this topic is described by Nissenbaum (2010): He states that today privacy is mostly contextual, whereas data, as seen in the previous section by Wigan and Clarke, Müller-Schönberger and Cukier, as well as Booch, is often de-contextualized, which in turn compromises its privacy pledges (Wigan & Clarke 2013; Mayer-Schönberger & Cukier 2013; Booch 2014). A very severe case of this paradox is outlined in Davenport's case study, where the decision is at hand to sell customer data thus compromise customer relationships and privacy for financial benefits (Davenport 2011). A question implied by this discussion about data usage is about its ethical boundaries. Considering again the example of public health, the sharing of electronic health records could have the potential to greatly advance human understanding of different diseases; still it would imply disclosure of the most private kinds of personal data. A potential solution to this problem could be the usage of anonymous data. However this view can also be considered flawed, considering Booch's assumption that in the future the vast amounts of data and their inter-linkages will give the possibility to retrace any kind of data based on only two or three variables (Booch 2014). In order to further evaluate this topic, future research should engage in the question which scope for national or even international data privacy laws would be desirable.

Big Data brings ethical / privacy issues	
Boyd & Crawford (2012)	– Availability and usage of data do not necessarily go hand in hand
Davenport (2011)	
Booch (2014)	– There is a lack of data privacy guidelines and international collaboration on this topic
Nissenbaum (2010)	– Problems emerge from the paradox of contextual nature of private data and its de-contextual use in companies

Table 4. Social Issues of Big Data

Conclusion and further Research Questions

The view on Big Data with a focus on managerial rationality promotes three implications: firstly, Big Data can be used to support organizational decision making. However, the claim of scholars to completely replace legacy decision making tools and rely solely on analytics should be refuted, as this essay identified persisting problems of data quality, which are linked to human filtering, as well as the combination of data sets. In addition, the current organizational capabilities and mentalities show a need for transformation for organizations to be able to fully make sense of available data. This is the second implication and it includes not only the potential for streamlining existing organizations, but also building new organizational capabilities in order to improve human filtering mechanisms and prevent apophenia. Lastly, the ethical implication of Big Data persists, which focuses on the misuse of private data. This can also be considered a managerial implication, as it has lead and will lead to norms and guidelines that will shape the new data driven organization. During the course of this critical literature review questions have been identified that could drive the future research agenda in this field:

- Does the combination of data sets, like Mayer-Schönberger and Cukier (2013), as well as Booch (2014) state, provide an objective truth, or does it compromise the overall data quality like Wigan and Clarke (2013) indicate? Again this question might be highly context specific, as the nature of examined data sets is determining if results are improved or compromised.
- To what extent does human filtering compromise the rationality of Big Data? This includes the question if despite improving processing capabilities this step of complexity reduction will still be required in the future, as well as the question whether human filtering compromises or complements the analysis conducted by machines? As this question will be highly context specific, it would be reasonable to assess it under variable circumstances.
- Which options exist for data scientists to increase prediction accuracy and prevent apophenia in Big Data analysis, building on the idea of additional validation runs, by Wigan and Clarke (2013)?
- Which impact does Big Data have on corporate mentality, and which steps need to be taken to promote sustainable decision processes based on Big Data? This question could be extended by the research of Goldstein and Gigerenzer (2009), who are contrasting heuristic and statistical approaches to decision making.

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Function, Form, Materiality and the Enigma of Digitality

Is Bitcoin Remaking Money as We Know It?

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KEYWORDS

Bitcoin
Crypto Currency
Digital Objects
Materiality

ABSTRACT

This article suggests that computation and digitality can reconfigure the entanglement between function, form and materiality and in the process change the signification of traditional material forms. To illustrate these claims, bitcoin, a digitally constituted currency dubbed by proponents as 'a new kind of money', is analyzed in its reconfiguration of traditional material forms of money. The case of bitcoin instantiates reconfiguration through a series of digitally mediated steps: (1) Abstraction of finite and material money supply into an infinite process of cryptographically secured record keeping, constrained only by computational capacity (the blockchain) (2) Decentralization and decontextualization of actions and processes of bitcoin creation and dissemination (mining which decenters intermediaries and regulators in supply), and (3) Deconstruction of formal and material sources of signification, legitimation, meaning and control of money (such as material substrates used to signify value and the formal authorities that legitimate such). These insights call for critical reflection of paradigmatic assumptions of sociomateriality in Information Systems research, particularly, in relation to computational and digital artifacts and their implication for materiality, form and function.

Introduction

Are form and materiality required for function? This article argues that computation and digitality reconfigure the entanglement between function, form and materiality and in the process change the signification of traditional material forms. Digital currency, specifically, the cryptocurrency, bitcoin—whose function as medium of exchange or money is only marginally material but relies chiefly on bits, bytes and complex computation and has been dubbed by proponents as a "new kind of money"*—is used as an illustrative case study to support this claim. The relationship between function, form and materiality of money—an entity with social, functional, formal and material significance—is studied to yield a richer understanding of the bitcoin case itself and to further interrogate sociomateriality assumptions in light of emerging work on digital artifacts and systems. The article proceeds with theoretical discussions of sociomateriality, digitality and money, followed by presentation of the bitcoin case and an analysis in light of the theoretical discussion.

*Bitcoin.org, 2014

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Theoretical Framing

Technology, Form, Function and Materiality

Function may be conceived as the purpose fulfilled by an object whereas form is what "provides the mold to which matter enters [...] the *causa formalis* (the receptacle, design, eidos) of a particular object or artifact, distinguished and to some degree juxtaposed to the *causa materialis* (matter, hyle)" (Kallinikos, 2012, pp. 71–72). Materiality is simply taken to mean the "material or physical constitution (or lack of) of technological object and the implications (social and technical) such a constitution has for design, making and use" (ibid, p.69). Functions are often embodied by their material constitution and hence function and matter may closely relate and be related to the range of social practices related to their use. Technology and technological objects can therefore be said to embody function and form in addition to materiality (Ibid).

In theorizing technology, Information Systems research has typically focused on the materiality of technology, and its use in specific contexts (Kallinikos, 2011; Leonardi, 2011; Markus & Silver, 2008; Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007). This understanding invariably enlists materiality in the understanding of function, and subsequently delimits understanding of technology to immediate, contextual settings and practices where materiality is discernible. Sociomateriality, a major perspective in Information Systems research, is pertinent to this tradition (see for discussion, Leonardi, Nardi, & Kallinikos, 2012; Leonardi, 2013). Sociomateriality—the idea that "the social and the material are to be considered inextricably related [and that] there is no social that is not also material, and no material that is not also social" (Orlikowski, 2007, p. 1437)—has tended to view technology in its time-space situated context of use where the interaction of humans (the social) and material (technological artifacts) are most observable (Boudreau & Robey, 2005; Malhotra & Majchrzak, 2004; Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1988; Orlikowski, 2007a; Schultze & Orlikowski, 2004).

For not ontologically disentangling materiality from the social and its context, e.g. through the 'practice lens' (Orlikowski, 2007b), sociomateriality is criticized as 'over-socialized' and insufficiently theorizing technology itself (Leonardi, 2013, p. 64). But such critiques of sociomateriality, Leonardi (2013) notes, tend to give technology more of a causal role in our understanding of the social application of technology. Consequently, such a discursion from the perceived socialized view of sociomateriality leads to the treatment of technology *per se* as a structure, not unlike certain kinds of institutional structures (Kallinikos, Hasselbladh, & Marton, 2013; Kallinikos, 2009a, 2009b), and inevitably leads to accusations of technological determinism (Kallinikos, 2002; Smith, 1994; Winner, 1993).

Yet, even if one rejects technological determinism in its weak or strong forms, the sociomateriality approach in Information Systems faces a challenge to reconcile contemporary technological developments that punctuate the comfortable balance between abstract, non-localized technological operations and the materiality of 'real things' (Feenberg, 2005; Kallinikos, 2012). This study proposes that with increasing sophistication of computation and digitalization, progressive reconfiguration of the assumed coupling between function and materiality of technology requires recognition, if not reconciliation with sociomateriality's assumptions.

Kallinikos (2012) argues that "the bonds tying the invention and making of technological objects and patterns to matter have increasingly become loosened over the course of technological evolution" due largely to the flexible, abstract, and logical nature of computational software that undergirds many technologies (p.83). Hence, "technological operations could ultimately be seen as decontextualized conceptual arrangements (templates or matrices) on the basis of which reality is ordered to objects or patterns." (ibid). From such a perspective, an implication of computational technology is that while materiality is necessary for instrumentality, it is not sufficient. Generally, the relationship between function and materiality is mediated by form (design) –the application of matter to functional ends. Thus, technological artifacts can be seen to combine form and materiality in a continuum of proportions to arrive at various functions. At the two ends of such continuum, a crowbar for example, might admit more matter than form for the performance of its function whereas a piece of digital software requires more form than matter (Kallinikos, 2012, p.71).

This view not only suggests some partial independence of form, function and materiality but also puts function—rather than materiality—at the center of understanding technology and technological processes (see e.g., Kallinikos' (2009) characterization of technology as essentially functional simplification and closure). Function, given such fluid interrelation with form and substrate, is thus not merely material but also requires social and communal understandings against a background of established beliefs, and practices (Pinch, 2008). Function should therefore be studied with this in view and not separately given that the enactment of function can take on a communal understanding beyond situated practice.

Challenging the assumed enduring entanglement of form, function and materiality rather than admitting it as a given (see e.g. Kallinikos, 2012, p. 83; Pinch, 2008), is neither to argue for a diminished importance of materiality nor to suggest a 'non material' view of technology. Rather, the suggestion is that by adopting a focus on function rather than materiality, digital technology may be better theorized in its functional abstractions and processes of instrumentalization rather than their immediate application in a material *milieu* by actors in a situated context, as has typically been the mode in sociomateriality research.

The Challenge of Digitality

The nature of digital artifacts creates an enigma in the way goods and services are produced and consumed virtually. This enigma of function, form and materiality might be understood by first understanding the nature of digital artifacts and related computation. Digital forms because of their lack of stability, endurance, and their general dissimilarity to objects have been described as "non-material" (Faulkner & Runde, 2009, 2011), as having a "dubious ontology" (Allison, Currall, Moss, & Stuart, 2005, p. 364), as "quasi-objects" (Ekbia, 2009) and as having "ambivalent ontology" (Kallinikos, Aaltonen, & Morton, 2013).

Digital systems comprise functions, relations and artifacts that can often be recombined across platforms and infrastructures to create new products and production systems that often push previous boundaries (Langlois, 2002; Merrifield, Calhoun, & Stevens, 2008; Yoo, Henfridsson, & Lyytinen, 2010). They are often characterized by incompleteness which allows 'generativity', constant making and remaking of new functions and forms (Garud, Jain, & Tuertscher, 2008; Zittrain, 2006, 2008), a process that happens through data homogenization (binary code), reprogramming and self-referentiality (Yoo et al., 2010).

Based on such properties, how do digital processes reconfigure function from form and from materiality? Faulkner & Runde (2009,2011) in their study of computer files note how non-material bit strings emancipate digital functions from their material bearers or substrates such as hard drives, CD-ROMs etc. Yoo et al., (2010) also highlight the embededdness of digital code into layered and modular architectures that still allow separation of content from physical devices and infrastructures. Ekbia (2009) further emphasizes the processual and relational significance of digital artifacts that go beyond their implicit materiality.

Kallinikos' (2012) description of 'loosening' between function, form and matter brought on by digital code is further elaborated in Kallinikos et al., (2013) where they suggest an encompassing framework of four digital attributes: editability, interactivity, reprogrammability/ openness and distributedness. These core digital attributes push against the boundaries of material objects, with profound implications for how we understand the relation between form, function and materiality of technology. The authors show that the ontology of digital artifacts challenges the nature of objects, established institutions and practices as their form, meaning and functions are digitalized.

What is money?

Money is not easy to define (see discussions in Smithin 2000), but has been described as an object or verifiable record that is *generally* accepted as payment for goods and services and repayment of debts in a particularly country or socio-economic context (Mishkin, 2007; Smithin, 2000; Tobin, 2008). The commonly held functions of money are as a *medium of exchange, a unit of account, and a store of value*. These conditions: (1) general use (2) store of value (3) unit of account and (4) Medium of exchange are considered necessary conditions for money to exist as such (Mankiw, 2009). Money has evolved from commodity money such as gold, silver, conch shells etc., to representative money (using paper, coinage or some other artifact to represent commodity value), and in contemporary times to fiat money, which is legally backed artifact like paper without underlying commodity or intrinsic value (Mankiw, 2009, pp. 80–81).[†]

The use as money of cigarettes in WW2 and stones on the island of Yap, illustrates two critical aspects of money: (1) Money may be viewed as an abstract social institution constituted by information, shared norms, agreement and common understanding.[‡] (2) Simultaneously, money is an entanglement of form, function and materiality in varying degrees at different times and contexts, all undergirded by information and social signification. Gleick (2010) observes that,

> *[...] Money itself is completing a developmental arc from matter to bits, stored in computer memory and magnetic strips [...] Even when money seemed to be material treasure, heavy in pockets and ships' holds and bank vaults, it always was information. Coins and notes, shekels and cowries were all just short-lived technologies for tokenizing information [...]*

But even if we hold, as Gleick (2010) does, that money "always was information" and that physical material is "just short-lived technologies for tokenizing information" (presumably not much different from bits and bytes as information tokens), one might still ask to what extent the functioning of money can be separate from its materiality; that is, if digital money requires materiality? To be sure, electronic payment transactions and the digitalization of finance, especially in banking and retail sectors, has a long history and is by no means novel (see for discussion, Good, 2000; Gosling, 1999; Vogelsang, 2010). Solomon (1997) notes the staggering amount of virtual money circulating the globe, with just the Federal Reserve's Fedwire and the New York-based CHIPS technology system making up over 2 trillion dollars daily.

To clarify the differences between previous forms and bitcoin, two concepts are useful: monetary space and monetary hierarchy (OECD, 2002). Monetary space refers to the domain wherein a particular form of money serves its function (ibid). For example, the US dollar bill is usable in the United States but could also be used in the international gold market in London. Monetary hierarchy exists within a monetary space and refers to the relation between different forms of money and the degree to which they are generally preferred to each other and are convertible across forms (from the most preferred e.g., sovereign debt such as government issued currency to softer forms like vouchers, coupons, frequent flyer miles, Facebook credits etc.). General preferredness depends primarily on two attributes: liquidity (ease of conversion to a dominant currency) and effectiveness at performing the general functions of money (medium of exchange, unit of account and store of value) (ibid).

By evaluating against these two concepts, it is clear that discussions of electronic or "e-money" are often not concerned with new forms of money *per se* but rather, new ways that existing forms can be used within the same or different monetary domains and hierarchical frames (Figure 1). This is an important distinction to make if one is to appreciate the difference between bitcoin and previous forms, even if one rejects bitcoin's novelty or legitimacy on some other grounds.

† Two special cases help clarify the points raised. The first is the use of cigarettes as a form of commodity money in special situations such as during WWII by Nazi prisoners of war (Radford, 1945). The second case involves money on the small Pacific Island of Yap, called *fei*. Fei was stone wheels up to 12 feet in diameter that could be carried around laboriously for exchanges, and could thus be seen as something between commodity and fiat money. Given the cumbersome physicality of the fei it soon became common practice to exchange the claim to the *fei* rather than the *fei* itself. The limit of this practice was tested when a valuable *fei* stone was lost at sea during a storm. Since the owner lost his money accidentally and not through neglect, people of Yap agreed to honor his claim to the *fei* and it remained valuable for generations even though no one alive had seen his stone (Angell, 1929, pp. 88–89).

‡ See Searle (1995a, 1995b) for extensive discussion of the ontology and implications of social realities such as money

Aglieta also suggests that a threefold rationale of abstraction, centralization, and control can be used as a framework to distinguish between various forms of money (OECD, 2002,pp.31-68). Abstraction refers to the changing definitions of the unit of measurement that are becoming increasingly abstract through the detachment of the unit of money from the unit of weight through collective acceptance of nominal value (e.g. monetary evolution from objects like stone to intrinsically valuable objects like gold, to fiat, to representative tokens like credit cards, to virtual units like bitcoin); centralization refers to the processes by which a central issuer renders general acceptance to the definition of the unit of measurement within a payment system consisting of trading relations among networks or network of networks; control (regulation) refers to the processes by which trust is maintained between debtors and creditors within the monetary system in order to avoid a breakdown of the relational flow of economic value.

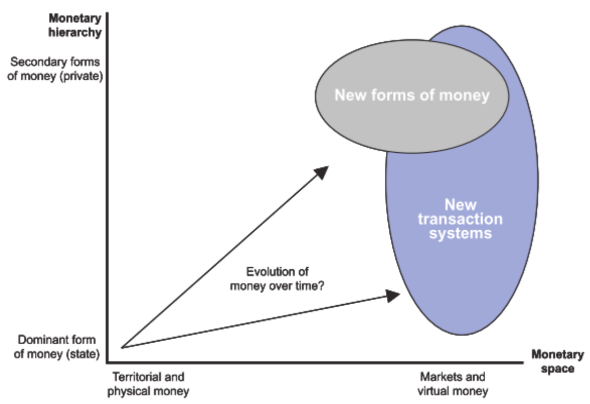

Figure 1. Possible Paths for the Future of Money (Miller, R., OECD 2002)

Case of Bitcoin: Money and the Challenge of the Digital Form:

A 'Problem' of Materiality

Am I the only person in the world who doesn't have bitcoin jangling in a cryptographic wallet? [...]"Are any of them, maybe, lodged between my sofa cushions?"

(Schwartz, 2014)

Bitcoin started as an attempt to eliminate dependence on "trusted third parties" such as banks and governments in the creation and circulation of money (Bitcoin.org, 2014; Nakamoto, 2008). The perceived 'problem' of "trusted third parties" relates to the materiality of fiat money and its precedents, which could be physically seized, stolen or restricted within and across jurisdictions; and whose value could—if a central issuer such as a government chose—be inflated for political or other reasons by increasing supply.

Bitcoin's innovation is to disintermediate the role of "trusted third parties" and reduce the risks imposed by materiality by digitalizing and decentralizing money, that is, by relying on a distributed peer-to-peer network to control the creation and distribution of money. However, in creating a "purely peer-to-peer version of electronic cash" (Bitcoin.org, 2014), a second problem emerges: how to ensure integrity of the system without requiring trust in the decentralized network; specifically, how to prevent the problem of 'double spending' where a user spends the same bitcoin several times by manipulating the digital record (Nakamoto, 2008).

Bitcoin's distinctiveness is its solution to this second problem with public-key cryptography and 'proof-of-work' in a peer-to-peer network to create a 'blockchain'—a sequential and synchronized record of all transactions that is broadcast over the network as a way of keeping a verifiable record. This innovation represents decades of research in Computer Science in the area of Cryptography and Cryptocurrency, particularly the underlying puzzle of 'The Byzantine Generals Problem' (BGP) (see for discussion, Lamport, Shostak, & Pease, 1982).

Computation and Digital Constitution of Money

Two aspects are needed to understand computational and digital dimensions of bitcoin, and consequently, claims by proponents that bitcoin is a "new kind of money". These are: (I) bitcoin as a decentralized digital record of transactions (a sort of virtual ledger that acts as an authenticable record) and (II) bitcoin as a practical solution to an old computational/algorithmic problem in distributed systems, the BGP, a solution that makes arms-length decentralized interaction possible without the need for counter party trust.

(I)

Bitcoin, unlike object-based money such as commodity, fiat or versions of representative money, is a digital record of transactions whose authenticity can be verified. Bitcoin is public, open-source software that nobody owns or controls, and anyone can partake without approval. The function of public-key cryptography is to secure integrity of this process of digital record entry whereas 'proof-of-work' serves to enable verification and authentication in order to allow secured transactions.

The 'coin' in 'bitcoin', rather than signifying materiality, is a metaphor to describe the virtual 'slots' available in the digital transaction record. There is no material as the name might misleadingly imply, whether by proxy to some underlying physical currency or digitalization of some material form. One buys into the ledger by purchasing one of a fixed number of slots by exchanging something (selling) or with fiat money such as dollars. Similarly, one sells out of the ledger by trading with someone who wants in. Bitcoins are exchanged (or signed over) from one address to another with users potentially having many addresses (public key cryptographic signatures) for transactions.

Each transaction is broadcast to the network and included in the blockchain so that the included bitcoins cannot be spent twice. Roughly, every ten minutes, a set of new transactions called a 'block' is added to the blockchain. After a further brief period, usually an hour or two, transactions are "locked in time" by the large amount of decentralized processing power that grows the blockchain (Bitcoin, 2014).

In order to control the potential for inflation, the number of bitcoins is fixed at a maximum of 21 million by keeping the rate of block creation at roughly six per hour and reducing the number of bitcoins generated per block geometrically by 50% every four years (the rate and algorithms were chosen to mirror the rate of mining commodities like gold) (Bitcoinwiki, 2014).

This process of adding transactions to the blockchain, known as 'mining' enables Bitcoin nodes to reach secured, tamper-proof consensus on transactions in the blockchain. This is also the process by which bitcoins are introduced into the system. Mining is deliberately resource intensive, requiring heavy computational power of several hardware and powerful software machines, in order to control the rate and security of bitcoin creation. To incentivize this resource intensive process within the peer-to-peer network, miners are awarded some fractional value of bitcoins themselves. The role of miners may therefore be seen as a system maintenance and administration one, rather than constitutive of bitcoin itself.

(II)

The problem of being able to transact over a decentralized network without requiring trust or goodwill of the counter-parties is a tricky one that had motivated research in Distributed Systems and Computer Science for several years. The conundrum can be expressed colloquially through the BGP. The original paper to pose the BGP, states it as follows, "[consider] a group of generals of the Byzantine army camped with their troops around an enemy city. Communicating only by messenger, the generals must agree upon a common battle plan. However, one or more of them may be traitors who will try to confuse the others. The problem is to find an algorithm to ensure that the loyal generals will reach agreement" (Lamport, Shostak, & Pease, 1982). As a rule, a lone attempt to invade fails and ends in annihilation of the invaders' armies, making it vulnerable to attack by the other Byzantine generals who also covet and scheme against each other. Moreover, the enemy city's defenses are so strong, that it takes more than half the of the generals' armies attacking simultaneously to overcome. However, if one or more of the generals are untrustworthy and renege then all the attacking armies will be annihilated including the traitors. It is thus a network without trust whose parties must nevertheless cooperate to achieve a shared goal.

For cooperation, the generals communicate without meeting by messages sent and subsequent confirmations received (for lack of trust and in order not to violate the decentralization condition). If a message recipient agrees to a communication, they append a signed and sealed (verified) response to the message, then transmit copies of the combined message to all other generals, asking each to do the same. The result, which will be the agreed and verified battle plan, will be a message chain with signatures and seals of all generals confirming the plan. All other message chains that do not carry all signatures and seals of the generals will be promptly discarded. A problem arises with this arrangement, namely, that if each general sends one message to all generals at the same time there will be a confusingly large number of messages en route, all with conflicting information. Furthermore, some untrustworthy generals may agree to more than one message and transmit more than one message chain, intending to mislead others. The system will thus quickly disintegrate.

Bitcoin's solution to this abstracted computational problem is to add a cost to sending messages in order to slow down the rate of message transmission and at the same time adding an element of randomness so that only one general can send a message at a time. The cost bitcoin imposes is the 'proof of work'—a computation of input into a random hash algorithm consisting of 64-digit alphanumeric string. Bitcoin's input data is the entire blockchain up until the last transaction, and though a hash value can be calculated quickly, only a hash value with 13 zeros in front can be accepted by the system as the 'proof of work'. The random generation of such a hash code is unlikely and takes the whole distributed Bitcoin network about ten minutes of computation before one is generated out of several billion attempts (hence the maximum possible six blocks per hour).

A machine in the network (a general in the BGP analogy) that computes the latest valid hash code takes all previous messages, append their own entry, signs and seals before transmitting to the rest of the network. Public key cryptography tools built into the bitcoin client is what enables the signing and sealing of new transactions into the blockchain. This is the equivalent of the generals' signatures and seals used to verify messages as a way of securing trust and agreement in an otherwise untrustworthy network arrangement.

When the network receives and verifies this updated record, each machine stops its current computation, updates its blockchain and restarts new calculations with this as the latest input. The network therefore constantly synchronizes so that all computers always have the latest blockchain to use as input in computing the next hash code. During the ten minutes the blockchain is updated and synced across all machines in the network, new transactions added to the blockchain in the previous ten minutes are included and synchronized, thereby reconciling the blockchain among all network members. The hashing algorithm is also updated every two weeks to maintain the difficulty and approximate ten minutes it takes to compute as new machines are added to the network.

This 'proof of work' process is what slows the flux of interaction between peers in the network, allows for authenticating and verifying the digital blockchain and thereby solving the BGP. The implications of a solution to this problem are far reaching because it provides a way for anonymous distributed members of a virtual network such as the Internet to exchange digital value in a secure way and leave an authentic, verifiable record of the exchange accessible by the entire network.

Discussion

From Material to Function

This paper suggests that the bitcoin illustration can help answer the question of whether form and materiality are required for function, and specifically, whether form and materiality are required for money to function as money. Aglieta's threefold rationale for understanding the evolution of money—abstraction, centralization, and control is used here as a framework to evaluate bitcoin reconfiguration of money (OECD, 2002,pp.31-68). As outlined, abstraction refers to the changing definitions of the unit of measurement that are becoming increasingly abstract; centralization refers to the processes by which an issuer renders general acceptance to the definition of the unit of measurement within a payment system; control (regulation) refers to the processes by which trust is maintained between debtors and creditors within the monetary system in order to avoid a breakdown of the relational operations of money.

The bitcoin case shows how computation and digital processes reconfigure the entanglement between function, form and materiality along the three rationales of abstraction, centralization and control. This view assumes technology as functional simplification and closure (Kallinikos, 2009c); that is, as a means for reducing money into a function that can be executed to completion (in this case secure, verifiable digital record keeping).

Computation and digital processes achieve this in three main ways. Abstraction occurs by rendering money as a record-keeping digital artifact (the blockchain) rather than a physical object or material token. The blockchain is in constant flux and transfiguration and could hence better be viewed as a computational process of digital transaction entry, authentication/ verification, retransmission and synchronization, rather than a stable artifact. Computational and algorithmic functions, as well as the four characteristic digital properties identified by Kallinikos et al., (2013)—editability, interactivity, reprogrammability/ openness, and distributedness—lie at the core of this processes of abstraction.

Centralization occurs via the blockchain, the central cryptographically secured record of transactions. However, issuing of bitcoin ('mining') is a decentralized process involving the peer-to-peer community. Bitcoin is 'mined' through decontextualizing transaction entry, authentication/ verification and transmission by decentralizing computation over several network actors across space and time, thus becoming "decontextualized conceptual arrangements (templates or matrices) on the basis of which reality is ordered to objects or patterns" (Kallinikos, 2012, p. 82). This process of decontextualization challenges conventional sociomaterial axiom about the relevance of understanding technology in its material and situated context. Given that at any given time, the 'action' of bitcoin mining is happening in various places over several distributed machines and systems, humming away in the background, it is challenging if not impossible to understand technology in light of situated action with recourse to its materiality.

Control (regulation) is reconfigured by disintermediating the formal and material sources of signification, legitimation and meaning of the object of money (sidestepping the so-called "trusted third party" such as government and banks) and relying on a distributed peer-to-peer network of volunteers for issuing, maintaining and securing supply and use. Such material sources of signification, legitimation and meaning include but are not limited to checks, certificates of deposits, bonds, fiat currencies (printed on security paper with the graphical imprints of symbols of power and legitimacy such as presidents, monarchs, pyramids and the like). This process of decentralized control has profound implications for the role of institutions like government and banks in monetary matters and market regulation. Figure 2 summarizes some implications of digital and computational attributes on the three suggested dimensions of evolution of money.

Is bitcoin money? (Implications of reconfiguration of form, function and materiality)

Matter and meaning are not separate elements. They are inextricably fused together, and no event, no matter how energetic, can tear them asunder. Even atoms, whose very name, ἄτομος (atomos), means "indivisible" or "uncuttable," can be broken apart. But matter and meaning cannot be dissociated, not by chemical processing, or centrifuge, or nuclear blast. Mattering is simultaneously a matter of substance and significance [...]

(Barad, 2007, p. 3)

Following the view of money as (1) an abstract social institution constituted by abstract information (verifiable record), shared norms and agreement and a common understanding (2) an entanglement of form, function and materiality in varying amounts at different times and contexts, all undergirded by social signification; bitcoin appears to be functioning as a "kind of money" as claimed by its proponents. Nevertheless, is bitcoin really money? Is Gleick (2010) right in suggesting that the materiality of money does not matter? And is Barad's (2007) claim that matter and meaning are "inextricably fused" applicable in the case of bitcoin? What are the implications of the effects of digital form and computation on abstraction, centralization and control?

		Rationale/dimension of money evolution		
		Abstraction	**Centralization**	**Control**
Attributes of Digital Artifacts	Editability	• Bitcoin dynamic user interface is editable digital artifact synced to wallet and miners.		• Editable Wiki platform to enable coordination (devolved control) through knowledge homogenization in peer-to-peer community
	Interactivity	• Processes between components like 'wallet' and mining are interactive • Front-end processes like buying, selling, storing etc. interactive via APIs	• Centralized entry via interactive artifact (blockchain) accessible through distributed private wallet and constantly maintained by distributed peer-to-peer network of miners	• Wiki platform has interactive forums and chat room for peer-to-peer community enabled by interactivity of digital code
	Reprogrammability/ Openness	• Blockchain is cryptographic record that is constantly updated and secured via networked peer-to-peer computational nodes • Production set to fixed ceiling of 21 million BTC which is maintained by geometrically halving bitcoin per block every four years	• Centralized entry via reprogrammable artifact (blockchain) accessible through distributed private wallet and constantly maintained by distributed peer-to-peer network of miners	• Trust maintained via cryptography program • Openness enables free dynamism of unit of exchange in line with supply and demand
	Distributedness	• Transaction entry, authentication/ verification, retransmission and synchronization enabled by distributedness of digital code	• Decentralized peer-to-peer production ('mining') diminishes need for centralization	• Devolved/ shared coordination by bitcoin community overcomes need for a central control (regulation)

Table 1. Implication of Digital Attributes on the Reconfiguration of Money by bitcoin, an Application of Aglieta (OECD, 2002) and Kallinikos et al., (2013)

It appears that bitcoin's function as money is partial compared to conventional money and there are limitations that the digitally mediated processes of abstraction, centralization and control impose. In particular, bitcoin fails to meet all four basic criteria for money: (1) general use (2) store of value (3) unit of account and (4) Medium of exchange. While it functions as a medium of exchange among a select group, it fails to function as an enduring unit of account and store of value because of two main limitations related to the system and its broad perception.

Systemic problems of bitcoin regard the nature of its abstraction and consequent volatility (Lee, 2013; Tucker, 2013). Bitcoin volatility in 2013 was up to 400% that of a typical stock and its exchange rate about 1000% that of major currencies like the Euro and Yen (Yermack, 2014). Volatility remains a significant drawback because of, among other things, the flux and instability of the digital form. While volatility is partly market-driven, the dynamism of digital form and computation heightens such risks, which are strictly not unique to bitcoin but exists in other complex, distributed electronic transaction systems (e.g., the US stock market's infamous Flash Crash of 2010 brought on by a series of triggers in high frequency algorithm trading (see for discussion, CFTC & SEC, 2010)). Furthermore, the fallibility of the computational systems contribute to volatility. For example, recent losses of over USD 480 million involving the Mt. Gox bitcoin exchange highlighted the potential vulnerabilities in the supposedly hack-proof system (Abrams & Popper, 2014; Dougherty & Huang, 2014).

Such systemic issues drive a faltering perception of bitcoin due to lack of trust. Its complex nature creates a gap in understanding between ordinary people and savvy technologists who are familiar with its complexity (see e.g., Andreesen, 2014). Furthermore, the lack of central authority acts as a double-edged sword by also affecting perceived legitimacy of bitcoin (if no one controls it where does its legitimacy come from; technical arrangements alone? Even if the cryptographic component is 'fool-proof', technical hitches at Mt. Gox and other exchanges raise doubt about the system as a whole). Finally, in the case of cryptocurrency like bitcoin, does diminished materiality hamper trust in its function as money? What about the importance of institutional legitimation? These issues are open-ended but may hold clues for bitcoin's potential to pass or fail the ultimate criterion for money: general use.

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From Building Cars to Selling Ubiquitous Computing Systems

A Socio-Technical Approach towards Connected Cars in Light of Human-Computer Interaction

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KEYWORDS

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ABSTRACT

The automotive industry is undergoing a technological revolution with the development of Connected Cars. The empowerment of in-vehicle Ubiquitous Computing (UbiComp) does not only shape drivers' behaviour but is also shaped by the drivers' psychology. Drawing on academic literature, this paper will show that acceptance and success of UbiComp in the context of the Connected Car is dependent on social norms and behaviours. Major components such as security, privacy and the loss of autonomy need to be taken into account when modelling a Connected Car. In conclusion, the ongoing changes and trends towards connected cars can only be successful if Original Equipment Manufacturers (OEM) address socio-technological questions to smoothen a social adaptation to the driver and its environment.

Introduction

In the past, technological advances have dominated the automotive competition. Today, the competitive landscape, widely driven by connectivity of vehicles, is rapidly changing. The Connected Car or the so-called Smart Car has a two-side optimizing approach: it is "able to optimize its own operation and maintenance as well as the convenience and comfort of passengers using on board sensors and Internet connectivity" (McKinsey, 2014). McKinsey (2014) has estimated that the value of connectivity components and services will have increased from €30b to €170b in the global automotive sector by 2020. This drastic change was caused by UbiComp combining network technologies with Internet capability, sensor networks, human computer interaction and artificial intelligence (Mai et al, 2011). Integrating new stakeholders such as software and telecommunication firms into the automotive market challenges the OEMs: They have to secure control over these technologies and dispel consumer's doubts of both insecure information flow and the loss of social interactivity and autonomy. In order to do so it is crucial to understand how the change of this digital business model influences vehicle drivers and its society (Sandhu & Thomas, 2004).

This paper seeks to analyse Connected Cars within the issue of social interactions and information control flow by using a socio-technical approach. Since driving a Connected Car is intertwined into the human daily activities, it is important to address socio-technical issues of UbiComp into a larger social setting relating to sociological, cognitive, economic and legal aspects of our lives (Sandhu & Thomas, 2004). The socio-technical perspective will thus integrate the significance of human attitudes and behaviours towards UbiComp innovation by going beyond a system-centric technical/rational perspective (Avgerou & McGrath , 2007).

First, I will commence with reviewing literature on the effect of UbiComp concerning social acceptance and integration. Hereby it becomes apparent that fundamental sociological drivers are positively and negatively correlated in the context of Connected Cars. I will then elaborate on the changing process of human-computer interaction. Thirdly, the reciprocal levels of social interactions within human-computer systems will be examined: *configuration* and *implementation*. Within those two levels, socio-technical key drivers for the adaptation of Connected Cars will be defined. Lastly, I will feature limitations of my analysis regarding technical and rational aspects.

Literature Review: Social acceptance and integration of UbiComp

Smart objects are integrated into our daily life (Sen, 2012). They have been an area of research not only in the technological field but also in the domain of encompassing sociology. Technology is becoming more and more capable and pervasive within the

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automotive industry. This is gradually leading to the socially complex question of how to appropriately integrate the new car's capabilities within the driving experience. At this, a main focus is to be found in the question of how to deal and to cope with autonomy and trust, privacy and security profiles, social interactivity, efficiency and enjoyment (Stanton et al, 2001).

According to Marsden & Stanton (1996), UbiComp increases efficiency because the focus changes from physical control and driving to a more cognitive task, a "supervisory control" for the human being. This results in the enhancement of the driver's attention and of the monitoring management skills as well as in the improvement of his or her situational awareness (Endsley, 1995). Moreover, the pervasive and permanent feedback system of a connected vehicle ensures a "closed-loop behaviour" (Annett & Kayl, 1957) whereby the immediate action-feedback setup creates the most effective performance and learning curve for the driver (Stanton & Young, 1998). Due to higher efficiency, Stanton et al (2001) argue that UbiComp increases the enjoyment of driving a vehicle as this is dependent on social-psychological variables such as the driver's feedback, perceived safety and time urgency.

Conforming to Hongladarom (2013), sharing and distributing information with other entities such as drivers or car maintenance stations creates a faster empathy between entities and thus between human beings. As a result, boundaries to the "outside world" will constantly be reduced. Sandhu & Thomas (2004) even take a step further by categorizing this un-restrictedness as the new concept of dynamic trust relationships in which anonymous identities are dependent on communication.

Contrary to this, McCaulder et al (1997) argue that UbiComp puts too much trust and autonomy into Connected Cars. Since vehicles are empowered, drivers neither feel full responsibility nor full control anymore. This external "Locus of Control" (Parkes, 1984) arises in the wrong perception of individuals attributing malfunctioning and failures to technology which result in events such as accidents. This "over-trust" can lead to the overuse of technology, lower intervention and eventually to the loss of autonomy (McCaulder et al, 1997).

Opposed to Hongladarom, West (2011) believes that this inter-connectedness has the potential to decrease social activity. Since human nature is less familiarized with computer-machine interaction, it might trigger negative reactions towards communication with other entities.

Lastly, privacy and security profiles will influence social acceptance. According to Sen (2012), the mistrust of secure data protection is very high since a vehicle is not a "trivial or fun application" like a smartphone. Because of the large amount of smart entities and the uncontrollable spontaneous network, human beings are socially reluctant to this non-transparency, especially because a driver needs to fully trust the car.

Therefore, one can argue that social context and behaviour will influence the acceptance of in-vehicle connected capabilities. Due to the emergence of connected features and entities, OEMs and their stakeholders have to use a socio-technical lens to derive the right innovation in the automotive industry (Avgerou & McGrath, 2007).

The Changing Process of Human-Computer Interaction

"The most profound technologies are those that disappear. They weave themselves into the fabric of every day life, until they are indistinguishable from it" (Weiser, 1991). Taking this quote as the crux of the matter, a real path of generation-evolution concerning UbiComp can be traced. The first generation, which can be roughly placed between 1991 and 2005, was driven by the idea of an omnipresent and absolute connectedness embracing the emerging availability of technology (Connectedness). The goal of creating and implementing autonomous systems was achieved by literally connecting everything to everything. The first phase was followed by the second generation focusing on the so-called awareness (Awareness, 2000-2007). The former focus on the overall-connection had shifted to an overall-awareness, including context-awareness, resource-awareness, and, eventually, self-awareness. Based on this heritage of both, connected awareness and aware connection, the third generation (Smartness, from 2004 on) attempted to finally allocate a meaning to situations, actions and circumstances. The main focus was (and still is) to create intelligent, smart, highly complex and diversely-structured systems that would and will, to speak in Weiser's words, be indistinguishable and be part of a silent integration. (Davies et al, 2011)

From a socio-technical perspective, autonomy has been undergoing constant changes in the course of the above stated generations. Precisely spoken, autonomy is a two-sided term which shall not be restricted to the generally found unilateral definition: It can be referred to as the ability to construct one's own goals and values as well as to have the freedom of taking one's own decisions (Davies et al, 2011). Additionally, autonomy means monitoring, controlling and optimizing in order to allow smart and connected technologies a maximum of control. The third generation has been accompanied by a drastic and bipolar change regarding autonomy (Porter& Heppelmann, 2014). Whilst the autonomy in terms of knowledge-based monitoring, analysing and planning has constantly increased and finds itself on the verge of (semi-)absolute autonomy, the autonomy considering the exposure of data and personal information is constantly decreasing.

In fact, it is not only the above stated profound technology which disappears gradually. At the same time, the autonomy regarding the control of exposed personal data vanishes, whereas the autonomy in terms of technology increases. This correlates with an increasing awareness of privacy and the reluctance of today's "generation connected" to give personal information away (Sen, 2012).

With regard to Connected Cars, attention shall be drawn to external and internal social factors, which are crucial of how UbiComp might shape the future generation.

Shaping Connected Cars in the Process of Social Acceptance

When it comes down to the process of acceptance of Connected Cars, one has to distinguish between two interacting, interdependent and communicating levels: *configuration* and *implementation*. Regarding the *configuration* procedure of this digital business model, two major *external* factors are decisive. Firstly, a successful configuration demands for a regulation of personal information, the protection of security and a careful information management. Secondly, the already mentioned loss of autonomy, which results from this digital business model, requires a careful approach in terms of individual preferences and moral principles.

Once the configuration of Connected Cars has been completed, two major *internal* effects can be seen from this digital business model when it comes down to its *implementing* into the society. In other words, one can conclude that only the interplay between external configuration-factors and internal implementation-factors allows a complete understanding of the '*seat of the matter' ('sedes materiae')* and is the keystone for a successful and accepted multidisciplinary implementation. (Porter & Heppelmann, 2014)

Security matters, and so does privacy. A global survey stated that nearly 90% of people are worried about the exposure of personal data (Spiekermann, 2012). This fear originates from the danger being unavoidable linked to such a ubiquitous business model. A huge amount of information is generated and stored in several, mostly unknown and unreachable data storages and sources. With an increasing amount of heterogeneous data from a variety of sources, the complexity, the reproducibility and also the quality of the stored information increases (Conti et al, 2012). Besides car-relevant information, consumer-based and thus sensitive information is gathered on a long-term availability base. As a result, the idea of so-called "movement patterns" arises from a socio-technical point of view. A huge set of data might result in a very fine and personal recreation of the consumer's profile. For this reason, the complexity of the fictional cyber world calls for a modification in the way humans share information (Conti et al, 2012). In Europe, the European Data Protection Directive 95/46 EC is a first step towards the (careful and attentive) regulation of private information flows. This Directive demanding for a national transposition requires e.g. a purpose specific processing, transparency vis-a-vis data subjects (with a consent possibility), the right of information and complying with data subjects. In addition, it ensures the confidentiality and security of personal data and norms rules for its safeguarding. The directive is both a legal and especially a socio-cultural expression of an underlying desire and need: Extended UbiComp demands for a well-designed infrastructure showing consideration of this privacy issue. If this configuration factor is taken into careful consideration, a positive benefit results in two effects. The configuration of Connected Cars equals with its acceptance. Thus, the regulation of private information data includes advantages for the automotive industry such as a better understanding of customers' needs and demands, a more appropriate customer service, the development of a Car Lifecycle Concept and a higher utilization of facilities such as repair shops (Bajic & Chaxel, 2002). Second, the consumer itself prefers "being liked matters". Especially the "generation connected" is highly influenced and influenceable by the community and online friends. Thus, they "trust the wisdom of the crowd" (Bai & Krishnamachari, 2010) which can also be described as the generation "we-feeling", especially once the protection and regulation of safety issues is assured.

Besides security, another factor is essential from a socio-technical perspective: the loss of autonomy. Having already been mentioned, the philosophical ideal of autonomy, which is strongly related to the principle of freedom, has long been defended as a main goal of our society. A UbiComp model such as Connected Cars curtails this aspect of self-governance from various aspects. In order to guarantee a flexible and need-satisfying digital business model, the ability among the technical devices and their feature of adapting to any occurring automotive scenario is crucial. For this reason, Connected Cars demand for a self-managing, self-adaptive, self-executing and self-executive system, preventing the customer from staying in the control loop (Conti et al, 2012). This lack of autonomic behaviour can but does not have to be a negative aspect. In fact, the aim of a successful configuration is to bridge the gaps and to "pave the way" in terms of a lacking autonomic behaviour. Additionally, a so-called loss of autonomy can be considered a gain of a different form of autonomy at the same time. First of all, being autonomous implicates the possibility of equal input into moral principles, which can be considered the reflection of individual preferences (Brey, 2006). Self-governance is thus inseparably related to self-realisation (Dworkin, 1988). Therefore, individual autonomy is the breeding ground for all personal developments. However, this does not mean that a lack of autonomic behaviour is negatively connoted: a loss on one side can be considered a gain on another side. Firstly, UbiComp only means a delegation of control (Brey, 2006). The control of the delegated matter is still an autonomous action, even perhaps a more complex and more demanding form of control. Secondly, a general "loss" of autonomy generates and nourishes the just developed "we-feeling" and thus only changes the breeding ground, not the fundamental ethical question of human autonomy.

As a result, one can conclude that a socio-technical approach demands for a ubiquitous service to be tailored to both, the user's context and its requirements and especially needs to take care of the privacy issue and the shifted, simply modified need for a control of (delegated) autonomy.

Socio-Technical Repercussion on Human Being and Social Behaviour

The implementation of the framed and tailored digital business has two major effects on the human being and its behaviour. The alteration from a rigid to a flexible, service-on-demand model introduces a new medium. Speaking in the metaphor of an ecosystem, the implementation of a UbiComp system is nothing less than the creation of a new system with new players and new restrictions, new boundaries, new value chains and new components (Mai et al, 2011). Since the OEM-software holds ultimate responsibility for the safety of their products and services, a trespassing protection throughout the system is insured allowing different participants of the business system the same treatment. One effect is the change of form. The indirect contact with customers through mass-market advertising is gradually replaced by a direct marketing strategy through apps and services to customer (Komninos & Zaharakis, 2012). The main effect of the implementation is the increasing brand-loyalty due to improved consumer behaviour patterns and a more valuable and more customer-need-based vehicle marketing. Additionally, an innovative on-demand service, a customer care and aftersales-service as well as infotainment result from it (Capgemini, 2014).

From a socio-technical view, the modified interaction with the human being does not deprive him or her from taking autonomous decisions, but instead focuses on a higher-level task (Brey, 2006). As a result of more closely-supervised and existing data samples, all of them within the legal boundaries, UbiComp can make it easier for human to achieve certain goals, destinations and to react to certain (unexpected) situations. In other words: By requiring less physical and thus more cognitive effort, the human environment can be considered a more controllable environment. Nevertheless, one should bear in mind that any "control ideal" is connected to the danger of losing its own smartness. This is so because any UbiComp can become paradoxically reverted: "Devices and applications which have become physically unobtrusive, could turn out to be psychologically obtrusive" (Gupta, 2002).

Limitations and Future Research

This paper contributes to the socio-technical perspective of OEMs towards the acceptance of Connected Cars in society. I have offered an approach in which the interplay between external configuration-factors and internal implementation-factors will forge the success of this digital business model. However, it does not address any rational key success factors. Technological prerequisites such as a powerful wireless connection system might not be found in all parts of the world. An example is China, where rural areas struggle with an operating wireless connection system. Furthermore, I have not addressed mobility management in the area of technical aspects such as algorithms and non-compatible software. Even though this paper focuses on the acceptance and sociological consequences of customers, it leaves out the elaboration of the customer's willingness to pay for additional features within the connected system.

Conclusion

The carefully-balanced interaction of internal and external factors is essential for the understanding of the human behaviour in its sociocultural context. Thus, the complexity and the shown demand for the implementation of a digital business model require the development of self-organized strategies. In this context, the question regarding the nature of this environment can be located. One may wonder what will come next after the generations of connectedness, awareness and smartness? It is likely that the multidisciplinary endeavour will result in a generation of "absolute autonomy", a system in which smart, aware and (inter-) connected products can function in full autonomy (Heppelmann et al, 2014). Likewise, it shall be possible that we find ourselves on the edge of a parallel cosmos (Conti et al, 2012) in which the physical world being populated by tangible entities is connected via UbiComp as a connective link to the cyber world consisting of compromised data.

As Milon Gupta has phrased it: "In a way, it is quite a relief to know that all things in your home (...) are dumb. They give you the feeling that you are always in control. This feeling is in danger, if (they) suddenly turn smart." Great efforts in both technology development and social policy will be necessary. As long as the ethical issue of privacy is carefully considered, Weiser's statement considering the process of invisibility can be modified as the follows: With the right social adaptation and in consideration of the driver's consent, ethical rights and the need for certain - visible and thus controllable - privacy regulation, the ubiquitous system will be a major part of OEMs in the future.

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Identifying and Addressing the Main Obstacles to the Successful Implementation of Telecare for the Elderly

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ABSTRACT

Telecare is growing in prominence as the solution to the challenges posed by an ageing society, yet there are still widespread difficulties with its execution. The source of these challenges can be found in the complexity of telecare, as it encompasses technological and organisational innovations, which create many obstacles to implementation. On top of that, policy makers and health officials often forget that technology, such as telecare, is embedded in a much wider context than solely the technical artefact, as it also incorporates the socio-economic aspect. Using research on potential barriers to the successful implementation of telecare, this paper seeks to find the main hindrances to its execution in order to identify where the biggest problems lie. Based on these findings it then proceeds to analyse the ingredients of success that researchers are proposing. It concludes with the idea that the most important factor that has hitherto created severe impediments to the successful implementation of telecare is the lack of enough attention being given to hearing out the actual needs of the elderly and their thoughts about telecare.

Introduction

In the UK and Europe the proportion of older people in the population is increasing and will continue to increase for at least the next three decades. Some of the recent population projections for Europe show that the proportion of people aged over 60 is set to rise from 15.9% in 2005 to 27.6% in 2050 (Milligan et al., 2011). This data has sparked an enthusiasm amongst policy makers and health officials around e-health systems, which can help improve the quality and efficiency of care being delivered (Mair et al., 2012). One of such systems is telecare for the elderly. It is important to note at this point that a big problem for researchers in this field is the loose terminology as 'telecare', 'telehealth' or 'telemedicine' are often used interchangeably (Barlow et al., 2006). In this paper the word telecare is going to be used, which can be defined as the remote monitoring and delivery of health and social care to older people using ICT.

Telecare has been popular amongst policy makers as it addresses the preference of the elderly to live in their own house and choose their own lifestyle (Rocha et al., 2013) rather than unnecessarily spending time in hospitals (WSD Programme, 2011) or end up in care homes, which are increasingly seen as the *"option of last resort"* (Milligan et al., 2011). Moreover, this technology has become a desirable solution not only because the patient doesn't need to visit a clinic, but mainly for two policy reasons. Firstly, there is an expected growth in the percentage of people who are 65 and over (Heart & Kalderon, 2013), which will put an even greater strain on the healthcare system. Secondly, this is due to the average annual cost of health care for this segment (Heart & Kalderon, 2013). Nevertheless, although telecare has been around for some time, not much has changed with its adoption. Therefore, this paper aims to identify the main obstacles to the successful implementation of telecare for the elderly and to propose ways of addressing them.

The debate in the literature seems to revolve around two issues, whether such a system can be efficient and beneficial and whether it can be successfully implemented. The literature review part of this paper shows that telecare can be efficient and beneficial and that it can be implemented, yet in order for this to be done successfully two factors have to be given more weight - the socio-economic aspect of telecare and the complexity of this new technology. Keeping these two factors in mind, the paper then uses Fleuren's framework that outlines determinants central to innovation implementation (Postema et al., 2012) and uses it in the context of telecare; this analysis highlights the main obstacles to the successful implementation of telecare. Then an examination of the ingredients of success researchers are proposing

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is carried out. Next a discussion is provided that critically examines the research provided and makes future proposals. Finally, a conclusion is reached proposing that disregarding the socio-economic aspect of telecare is the critical factor that stands in the way of its successful implementation.

Literature Review

Can Telecare be Efficient and Beneficial?

Most ICT projects for the elderly remain at the state of research (Ludwig et al., 2012), because academics and professionals cannot agree on whether telecare for the elderly would produce efficient results - whether it would be cheaper in comparison to standard hospital care, and whether it would be more beneficial for the elderly. One of the ways in which cost-effectiveness is measured is by looking at the number of clinic visits. A number of research projects have found that using ICT to provide care for the elderly has led to time reduction in ambulatory visits and a reduction in hospitalization (Or et al., 2009; Steventon et al., 2012). However, due to the projects being conducted on small samples there was a lack of convincing evidence to support the claim that home telecare is efficient (Or et al., 2009). There have also been contentious discussions in determining whether telecare is beneficial for the elderly. The views ranged from asserting that it would not be beneficial, as the elderly are not yet ready to adopt health-related ICT (Heart & Kalderon, 2013) to the views that if only the human factors and ergonomic concerns surrounding ICT were resolved there would be a potential for success (Or et al., 2009). Thus for a period of time there was no clear and affirmative answer to whether telecare for the elderly can be efficient and beneficial. This contention changed with the introduction of the Whole System Demonstrator Programme (WSD).

The WSD was set up to show what telecare is capable of (WSD Programme, 2011) and was conducted on a much bigger (in comparison to previous studies) sample of people. The WSD was launched in 2008 and is the largest randomised trial, involving 6.191 patients, of telecare in the world (WSD Programme, 2011). Early findings show that if used correctly, telecare can deliver a substantiate reduction in costs, such as a 15% reduction in Accident & Emergency visits and most strikingly a 45% reduction in mortality rates (WSD Programme, 2011). These results show that telecare has the potential of delivering both efficient and beneficial outcomes. Despite the WSD having played an important role in the progression of the implementation of telecare, it may be questioned whether it was a watershed moment for the rise of telecare. Although the benefits of telecare were finally formally acknowledged, concrete guidelines and solutions were not provided in key areas such as cost effectiveness (Henderson et al., 2013) or barriers to participation and adoption (Sanders et al., 2012), which might be one of the reasons why WSD's results did not coincide with a sudden rise in the adoption of telecare.

Can Telecare be Successfully Implemented?

The second part of the debate concerns the successful implementation of telecare. The first strong strand in the literature points to the complexity of telecare as one of the main obstacles to its successful implementation. It is a complex process as it involves a combination of technological and organisational innovations (Barlow et al., 2006) that result in a time consuming struggle of satisfying diverse stakeholders (Mair et al., 2012). Telecare involves a large number of stakeholders as the parties involved are from across health and social care services; there are divergent views in terms of perceptions of risk and value systems between different parts of the care system; often individual stakeholders have an incomplete understanding of the technology proposed; finally costs and benefits may prioritise some stakeholders over others (Barlow et al., 2006). Although this reasoning seems quite straightforward, the interesting fact is that the extent of complexity surrounding the implementation of telecare for the elderly proved to be much higher than initially anticipated (Watson, 2010).

The second strand in the literature derives from the Ensemble View of Technology. There is a tendency in the IT field for accepting the IT artefact for granted without considering its interdependence with the social context (Orlikowski & Iacono, 2001). This appears to be the case in the context of telecare as great weight is given to the technology itself, but not to the implementation process. The Ensemble View of Technology says that while the technical artefact may be the central element, in this case the health enabling technologies, one must not forget about applying the technical artefact to some socio-economic activity, in this case the needs of the elderly (Orlikowski & Iacono, 2001). Yet this is exactly what is being omitted as there is a lack of proper guidelines for implementation (Koch, 2006), which results in problems with information access, communication and patient self-management (Or et al., 2009).

These findings highlight that implementation of telecare for the elderly is a complex process, which requires paying attention not only to the technology involved, but more importantly getting a wider perspective on how this technology can change our perspective of care. Only by understanding what changes this technology will bring and what hindrances have to be tackled along the way can we think about successfully implementing telecare.

Analysis

1 The Main Obstacles to Implementation

Before going into a discussion and evaluation of the main obstacles to implementation, one must understand the context in which home telecare is placed. As identified above, home telecare is seen as a solution to the problem of the increasing proportion of the population aged over 60, which is why policy-makers and health officials are so eager to push it through. However, this eagerness to implement telecare as swiftly as possible has resulted in the industry being dominated by suppliers that are driven by a technology-push rather than a demand-pull approach (Milligan et al., 2011). Such an approach completely opposes the valuable claims propagated by the Ensemble View of Technology by not even considering whether there is a demand for telecare by the elderly. This has resulted very often in an *"absence of a "clear set of users" who expressed a demand for the service"* (Barlow et al., 2006), which highlights the extent of ignorance of the socio-economic aspect of technology. If such attitudes were prevalent over the years, one should not be surprised that the implementation of telecare did not proceed as planned.

Nevertheless, after 2007 research in this domain shifted from concentrating on mere organisational issues towards socio-technical issues (Mair et al., 2012), which suggests that policy makers must have recognised that their perspective was too narrow. A helpful way of evaluating healthcare implementation success in general has been proposed by Fleuren in her literature review, where she lists five domains that should be considered: innovation characteristics, the socio-political context, the characteristics of the adopting persons, the characteristics of the organization and the implementation strategy (Fleuren et al., 2004). Some scholars include more detailed dimensions. For example, Barlow et al. (2006) take into account the availability of a local support framework and top management support. There are also other approaches that may be adopted such as the Normalisation Process Theory, which "*assists in explaining the processes by which complex interventions become routinely embedded in health care practice*" (May, 2007) by looking at four key factors that can either promote or inhibit the embedding of a complex intervention, such as telecare, which are: interactional workability, relational integration, skill-set workability, and contextual integration. Nevertheless, having critically reviewed the literature on the topic of telecare for the elderly, the determinants that kept on being repeated from paper to paper and have been found to be central to innovation implementation are: the characteristics of the person adopting the innovation (user) (Fleuren et al., 2004) and the implementation strategy, the so-called stakeholder involvement (Postema et al., 2012).

1.1 The Characteristics of the Person Adopting Innovation

The characteristics of the person adopting innovation (user of the innovation), such as knowledge and skills (Fleuren et al., 2004) play a crucial role in implementation, as only by understanding the targeted demand group can an innovation be successfully implemented. As telecare offers a completely different experience of care from the ones previously known to elderly people, one of the main characteristics that create obstacles to implementation is the elderly's uneasiness and anxiety about technology (Sanders et al., 2012). This uneasiness and anxiety can produce a lot of impeding implications to the adoption intention such as discomfort with the technology of telecare, concerns about competency to operate the equipment (Sanders et al., 2012) or a reluctance to accept telecare (Rahimpour et al., 2008). Related to reluctance is a second characteristic that creates obstacles to implementation, which is resistance to change. Research has shown that some patients do not feel comfortable with the changes the new equipment might bring, such as time pressure and disruption to their daily activities (Sanders et al., 2012), as they may feel the aforementioned anxiety related to the new technology being offered and they may question their abilities to operate it. This is why working on the elderly's self-efficacy is such an important task, as it can broaden their knowledge on the topic of telecare and thus improve their beliefs in their own abilities. Furthermore, by targeting such fears with educational interventions (Barlow et al., 2006), even more personal concerns related to technology, such as threat to identity (Sanders et al., 2012) or security and safety concerns (Mair et al., 2012), can be tackled.

1.2 The Implementation Strategy

The implementation (innovation) strategy is perceived as a crucial component to innovation implementation (Postema et al., 2012), such as telecare, as it simultaneously acts as a bridge and a trigger between innovation determinants and the innovation process as seen below:

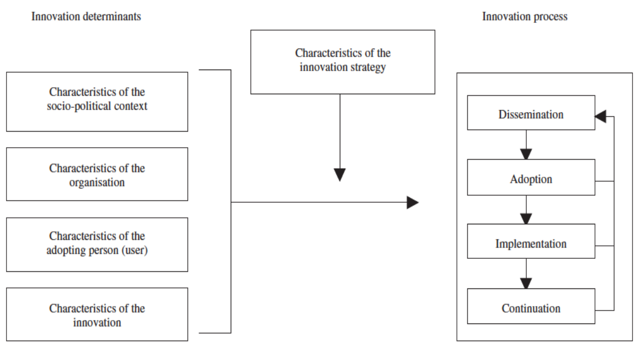

Figure 1. Framework Representing the Innovation Process and Related Categories of Determinants (Fleuren et al., 2004, p. 108)

The figure (Fleuren et al., 2004) highlights the significance of the implementation strategy as it shows that strategy facilitates the implementation process. Therefore, it should come as no surprise that one of the main obstacles to implementation is that implementation instruments are not being designed in alignment with goals (Kapsali, 2011). Different goals require different strategies, approaches, stakeholder involvement and structure (Van Offenbeek & Boonstra, 2010). This observation may serve as an explanation as to why many telecare projects have not been successfully implemented. In order to better understand implementation strategy, one should consider one of its key components - successful stakeholder involvement, which is especially true in the domain of telecare where there is a diverse stakeholder body involved. *"The more stakeholders there are, the harder the implementation will* *be"* (Barlow et al., 2006) - as telecare involves many complex arrangements, the key to its successful implementation lies in diligently planning the innovation strategy and most importantly, aligning it with the goals set.

2 Ingredients of Success that Researchers are Proposing

The analysis of the characteristics of the person adopting innovation and the implementation strategy have provided us with a clearer picture of the obstacles to implementation and the ways in which they can impede the implementation process. Leading on from these observations, it will now be considered how some of the impediments created by the characteristics of the person adopting the innovation and the implementation strategy can be resolved.

2.1 Training

As identified above (see 1.1), one of the main determinants that can impede implementation are the characteristics of the person adopting innovation (user) (Fleuren et al., 2004). In the case of telecare, one of the most important obstacles to implementation is anxiety about technology. Researchers have shown that technology anxiety does not necessarily remain constant over time (Sintonen & Immonen, 2013) and that such fears can be targeted by educational interventions (Barlow et al., 2006). These are promising observations, which show that such impediments can be tackled. The question that then follows is how to successfully do so. What has to be remembered is that the adoption intention differs amongst potential elderly telecare users, who can be broadly divided into two groups, the well-coping senior citizens and the frail senior citizens (Sintonen & Immonen, 2013). Therefore when considering how to alter the elderly's level of anxiety it should be remembered that training has to be targeted appropriately to an individual's level of knowledge, skills (Sintonen & Immonen, 2013) and their perception about technology in general. Moreover when aiming at the older segment of the population it should be acknowledged that in terms of technology their abilities will be inferior to those more accustomed with technology, and this insight should be considered as early as in the design phase of the service. Only with a design that is easy to learn, will it be possible to train the elderly to accept the new service being proposed to them and thus successfully implement it.

2.2 Consideration of Patients' Expectations and Perception

Another impediment that can be resolved with a little bit of work is the elderly's reluctance to change, which stems from their concern about the potential disruption that may be caused by telecare to their daily lives (Rahimpour et al., 2008). This concern can be resolved by considering the patients' expectations and perceptions about telecare. This conception is in line with the Ensemble View of Technology; when dealing with the implementation of telecare is should be held in mind that "as we shape technology, so we build society and that nothing is purely social or purely technical" (Hendy & Barlow, 2012). For this reason a good way of resolving the issue of reluctance to change is by involving older people from the outset in discussions around the way telecare could be developed (Milligan et al., 2011). The elderly should have the opportunity to discuss their expectations and perceptions of the forms of care proposed, which could then be used in the design and implementation stages (Sanders et al., 2012). The elderly themselves have pointed out in one study that those designing new technologies should take into account the older people's need for meaningful human interactions (Milligan et al., 2011). The extent to which human contact is valued by older people is exemplified by the findings of several researchers, where it was found that telecare should not act as "a replacement of physical care, but as an enhancement of quality of care" (Postema et al., 2012), or, even more strongly, that "technology has a part to play but it is not a substitute" of care (Milligan et al., 2011). These insights show how strongly older people value face-to-face contact, which indicates that when thinking about successful implementation of telecare human interactions should not be ignored, but should still play a part.

2.3 The Importance of Champions in Implementation

The second potential obstacle to implementation that has been considered in this paper was the implementation strategy. It was found that a good implementation strategy is imperative for implementation success, yet the question remains, how to achieve that. An extensive strategy analysis could go for pages, hence this paper is going to concentrate on the role of champions, which figures as an essential ingredient in the domain of telecare. In healthcare there is a general acceptance that 'champions' play a vital role in organisational change (Hendy & Barlow, 2012). Research has shown that *"the success of home telecare…is critically dependent on enthusiastic champions along the implementation trajectory"* (Postema et al., 2012). The reason for this can be found in the idea of recruiting local champions as a way of promoting telecare (Mair et al., 2012) in an environment of diverse stakeholders. Such champions become key figures not only in the promotion of telecare, but also in convincing all of the stakeholders to work for the same cause. This task is extremely difficult, but can be achieved more quickly if there is support from front-line staff and management (Hendy et al., 2012). Once this is achieved, the task of promoting a new innovation, such as telecare, becomes easier. However, the role of champions should be looked at with caution as, given the strength of their role, it could become a double-edged sword. The reason being that if a champion ends up having a negative attitude towards telecare, staff commitment could be jeopardized and this could significantly impede implementation (Mair et al., 2012). On this point some authors have found that organizational champions are effective in the first phase of adoption, however when moving beyond local contexts their effectiveness can vary, with many becoming very reluctant to share their ideas outside their sphere of power (Hendy & Barlow, 2012). Such reluctance can create severe obstacles to implementation, which is why although champions can speed up the success of implementation, change should be cautiously placed in the hands of only a few individuals.

Discussion

The first goal of this paper was to identify the main obstacles to the successful implementation of telecare for the elderly. This was carried out following Fleuren's framework, which outlines determinants central to innovation implementation. The conclusion reached is that the main obstacles in the domain of telecare are characteristics of the person adopting innovation, and the implementation strategy. Fleuren's approach was adopted because it coincided with other papers, on the topic of telecare for the elderly, in the identification of factors considered as hindering successful implementation of telecare. In order to strengthen the analysis of this paper, a more extensive and devised methodological approach could be adopted; such an approach could provide different or additional obstacles that could be considered in more depth and perhaps shed a different light on the issue of implementation.

Furthermore, as telecare is still dominated by small-scale trials and has not moved towards mainstream deployment, it is particularly challenging to conduct any research into telecare implementation. The complexity of telecare does not help either, creating further challenges for research. Once telecare moves beyond this 'pilot' stage, assessing the key ingredients for its successful implementation will be certainly easier and will provide more valuable insights.

The second goal of this paper was proposing ways of addressing the main obstacles to the successful implementation of telecare for the elderly; three main suggestions were considered: training, consideration of patients' expectations, and perceptions and the importance of champions. Having identified the main obstacles to be characteristics of the person adopting innovation and the implementation strategy, the suggestions were matched accordingly. A limitation of this paper may be the fact that it concentrated only on two main obstacles. If there had been more hindrances identified, there would have been more proposals made and perhaps the arguments of this paper would have been stronger. Therefore, a suggestion for further research would be to carry out a more comprehensive study.

Conclusion

The aim of this paper was to get a deeper understanding of the way the main obstacles act as a barrier to successful implementation and the way in which these impediments could be resolved. The paper identified that the main hindrances were the characteristics of the person adopting innovation and the implementation strategy. These findings emphasize the complexity of the implementation process of e-health systems, such as telecare. They indicate that in order to carry out successful implementation of telecare, we must firstly look back to the design phase and take account of the views of the target group (the characteristics of the person adopting innovation) and secondly put great emphasis on the implementation strategy due to the diverse body of stakeholders, which characterizes the domain of telecare.

The second part of the paper concentrated on evaluating the ingredients of success that researchers are proposing. The first two paragraphs concentrated on the 'human' aspect of technology and proposed that technological anxiety related to telecare could be resolved by training and taking into account patients' expectations and perceptions. This is a very significant finding as it gives weight to the need of applying the technical artefact to socio-economic activity (Orlikowski, 2011). Although it has been identified that human interaction should play a prominent role in telecare, the key task is finding the perfect balance between technology and human interactions, which is where policy-makers should divert their main attention.

Finally the role of champions was analysed as a way to speed up the process of telecare implementation. It was found that with eager and enthusiastic champions implementation might proceed much more swiftly and efficiently, yet it should be kept in mind that one should be cautious with giving too much power to just a few individuals. In conclusion, the implementation of telecare is an extremely complex process, which needs a lot of planning, patience and most importantly understanding the needs of the elderly, which hitherto has been a largely underestimated factor.

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Digital Technology and Inequality

The Last Promethean Gift?

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KEYWORDS

Diffusion
ICT
Inequality
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ABSTRACT

This paper aims to assess the impact of the diffusion of ICTs on resource distribution on a global scale. The exponential improvement trajectories of digital technologies are making devices and computerised means of production cheaper and more efficient. This is drastically reducing the competitive advantage of human labour over machines. This issue has significant implications in terms of resource distribution and inequality; that is because digital technology is creating immense wealth for a small fraction of the population. Since capital now has higher rates of return than economic growth, it is possible to consider digital technology as a force that is aimed at preserving the status quo, through a replication of the existing pattern of resource distribution.

Introduction

ICT is often perceived as a mere means through which incredible ends can be achieved. Something similar can be said about technology more generally: in the last two centuries technology has dramatically increased productivity and, as a consequence, wages have increased. For this reason, there tends to be a sense that, from a historical point of view, technology has helped everyone. However, judging technology and ICT in the light of a means/ends dichotomy overshadows the often perverse effects that such technical ways of mastering the physical and intellectual environment can have on society. The reduction of ICT to a mere 'technology' is not neutral. That is because using ICT as a technical means is possible to achieve opposite ends, and insofar opposite ends are opposite because they use the same means, the ends are subjected to the means. It seems necessary to look at the effects that ICT has on society from a disenchanted perspective, avoiding the ceremonial rhetoric that celebrates the 'intrinsic goodness' of digital technology, conceived as an emancipatory force.

This paper argues that ICT diffusion on a global scale can have ambivalent societal consequences, which are often concealed under the rhetoric of free accessibility of information. The first part of this paper aims to give a perspective on the development of digital technologies, which takes place at an accelerating rate, and the exponential diffusion of digital devices. These improvements relate to increasingly more systematic computerisation of jobs. The second part intends to correlate the issues of computerisation and inequality in resource distribution. This view challenges the assumption that technology is intrinsically beneficial and historically benefited almost everyone. The third part attempts to connect the patterns of evolution of digital businesses and their social consequences. The final section argues that the domain of economic action is becoming more and more abstract because of digitised information. Moreover, it is argued that it is necessary to find a way to pay the monetary value of information to the people who create it in order to challenge the existing state of affairs, which is characterised by an intolerable level of inequality.

The Exponential Improvement Trajectories of Digital Technology

A fundamental concept that helps making sense of the history and development of digital technology is Moore's Law. The simplified version of Moore's Law states that the processing power of computers increases at an accelerating rate and doubles approximately every two years (Moore, 1995). This 'law' is not an immutable scientific law, rather an illuminating observation about technological development on which there is substantial agreement (Brynjolfsson & McAfee, 2012; 2014; Lanier, 2014; Sneed, 2012). Moore's law suggests that technological improvements do not accumulate linearly, but they increase exponentially. The exponential increase in processing power relates to increasing the capacity of computers to process and manipulate always bigger amounts of data (Moore, 1995). These improvements - in connection with other technological upgrades - are changing the ways in which things are done on a daily basis in virtually every economic activity.

As Ian Morris (2010) points out, a fundamental trigger of the Western social development* was the Industrial Revolution. In this context, the systematic

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* Namely: "a group's ability to master its physical and intellectual environment to get things done" (Morris, 2010, p. 73).

application of technology as a means of manipulating the physical environment led to a dramatic social change that overshadowed all previous discoveries in the radicalism of its impact. In that context the invention and perfection of the steam engine and other technological developments "made mockery of all that had gone before" (Morris, 2010, p. 246). Contrariwise, the digital revolution is based on technologies that have hardware, software and networks as their basis. These technologies are influencing our world in a way that might be considered even more radical than what happened before. As Brynjolfsson and McAfee (2012) point out, the main difference between the two revolutions is in that the digital one not only is multiplying the power of our muscles, but also the power of our brains, extending the domain of our intellectual environment. Computers are now reaching power and sophistication that can outperform humans in many tasks, which are not strictly 'computational' but also eminently 'human' (Levy & Murnane, 2004) – e.g. driving a car or automatically generate a report. Not only algorithms are always more refined, but machines are becoming capable of mastering complex abilities of pattern recognition, complex communication and artificial intelligence (Levy & Murnane, 2004).

The set of activities that can be performed resorting to digital technologies is increasing, and digital capabilities† are more and more crucial in business practices. Notwithstanding this, there is a rather counterintuitive constraint in computerisation, known as Moravec's Paradox. According to Moravec (1988, p. 15), "it is comparatively easy to make computers exhibit adult-level performance […] and difficult or impossible to give them the skills of one-year-old when it comes to perception and mobility". This paradox highlights that highly computational/logical processes are translatable into algorithmic language, whereas 'basic' sense-making and sensorimotor abilities need incredibly high amounts of resources and processing power. This paradox explains why 'knowledge work' is more threatened by computerisation than other professions that are eminently practical (McKinsey Global Institute, 2013).

Both in the industrial and digital revolutions technology reduced the comparative advantage of human labour over machines (Levy & Murnane, 2004). However, the impacts of technologies and their social consequences are substantially different in the two cases. Items that fall under Moore's Law increased dramatically in recent years: everything that has moved from the analogue domain to the digital one (e.g. cameras) became a computer component, and "as they did so, they became subject to the exponential improvement trajectories of Moore's Law" (Brynjolfsson & McAfee, 2014, p. 51). In the light of Moore's Law, it is possible to argue that "eventually most productivity *will* become software-mediated. Software could be the final industrial revolution" (Lanier, 2014, p. 3). When it comes to digital technology a difference in *degree* – namely the progressive application of technology as a means of production – became a difference in *kind* (Brynjolfsson & McAfee, 2014) – namely it has become something qualitatively different from what it was before. That is because technologies not only are making production always more efficient, but are progressively eroding always more domains of human activity.

The Connection between Computerisation and Inequality

> *For almost two hundred years, wages did increase alongside productivity. This has created a sense that technology helped (almost) everyone. But more recently, median wages have stopped tracking productivity, underscoring the fact that such a <u>decoupling</u> is not just a theoretical possibility but also an empirical fact in our economy.*

(Brynjolfsson & McAfee, 2014, p. 128, emphasis added)

It is possible to break down the issue of the decoupling highlighted by the quote above into two parts. One is computerisation and the social consequences that derive from it; those consequences are profit rises of firms and dismissal of workers. The second issue relates to inequality. It is possible to establish a causal link between the systematic application of computerization and the accumulation of immense wealth, at the expenses of the well-being of the 'middle class'.

Research has shown that both low-skills (CBRE & Genesis, 2014) and middle-skills level jobs (McKinsey Global Institute, 2013; Tüzemen & Willis, 2013) are threatened by computerisation. Moreover, according to Frey and Osborne (2013), 47% of jobs in the US is at risk because of computerisation. Technological advancement is making mechanisation cheaper; as result initial investments in setting up mechanised plants significantly decreased over the last three decades (Grant, 2012). Thus the cost of capital associated with mechanised plants is decreasing and the outputs are comparatively higher in many sectors‡ (Grant, 2012) – Moreover, this way many constraints associated to the unionised workforce are avoided. As a result, owners of the 'means of production' accumulate more wealth with less human labour involved.

The fact that mechanisation is cheaper devalues labour because the imperative of profit maximisation implies that an economically rational employer would not pay an hour of work to a person more than the cost that is incurred by machines. It is worth pointing out that virtually every economy in history has been resorting to technology in order to exchange

† Digital capabilities are "time and space-contingent abilit[ies] to perform a particular productive activity" (Jacobides & Winter, 2012, p. 1635) resorting extensively to IT-based processes.

‡ This relates both to the 'hard' side of production, namely machines used to produce goods, and IT investments associated to ERPs and information systems. In the particular case of substantial IT investments, in order to see the performance benefits it seems to be necessary to wait approximately 5-6 years (Brynjolfsson & Hitt, 2003); however in the long run these investments seem to be worthwhile.

capital for labour, however, the changes that we are experiencing now for the first time undermine the role man is playing in regulating technologies. Moreover, "when a technology becomes software-mediated, the structure of the software becomes more important than any other particularity of the technology in determining who will win the power and the money when technology is used. Making fabrication software-mediated turns out to be a step toward making the very notion of a factory, as we know it, obsolete" (Lanier, 2014, p. 77).

Computerised production is among the causes of decoupling between average salary and global GDP (Brynjolfsson & McAfee, 2012; 2014; Lanier, 2014). According to Piketty & Saez (2006), the share of wealth owned by the top 1% of the population in the US doubled since the 1980s, reaching a peak in 2012 when the top 1% earned 22% of total income. Moreover, according to Piketty (2014), in the 30 years 1977-2007, 60% of US national income went to the top 1% earners. This leads to the fact that, over the same period, the earnings of the top 1% increased by approximately 270%, whereas the middle class saw an increase of just 35% of income (Brynjolfsson & McAfee, 2014). For these reasons – and many others including inherited wealth – the level of inequality in the US "is probably higher than any other society at any time in the past, anywhere in the world" (Piketty, 2014, p. 265).

It is not possible to attribute the issues mentioned above to the systematic use of digital technology because *correlation does not imply causation*; however the existence of a causal link is undeniable. The next paragraph will clarify the sense in which the evolution patterns of digital business are contributing to this disproportionate distribution of wealth.

The Patterns of Evolution of Digital Business and their Social Consequences

To identify the patterns of evolution of digital business, it is necessary to give a definition of the category. McDonald and Hartman (2013) define digital businesses as based on "digitalization as the transformative process for turning digitized resources into new sources of revenue, growth and operational results. Creating a competitive premium is the goal of a digital business. Digital businesses create competitive edges based on unique combinations of digital and physical resources. They do things that others cannot and in ways that build comparative advantage".

It seems in the very nature of digital business to be associated to comparative advantage, which in turn is connected to the process of disruptive innovation. The notion of disruptive innovation can be interpreted as a contemporary reformulation of the broader concept of *creative disruption* presented by Schumpeter (2010) as fundamental aspect of capitalist societies. Disruptive innovation is more context-specific, in the sense that it seems inseparable from the domain of technological development (Christensen e*t al.*, 2004). Disruptive innovation is not to be confused with break-through innovation or invention of totally new and superior products/services, rather it relates to the transformation of an expensive and complicated product into something that is not necessarily better, but easier to use and cheaper (Christensen e*t al.*, 2004; Yu & Hang, 2010).

As the name itself suggests, disruptive innovations have the tendency to subvert existing market balances, as they erode competitive advantages of established players in the market. The unexpected imposition of disruptive innovations in the market, due to the fast-evolving nature of technology, has made market changes faster, more radical and less predictable (Grant, 2012). The macro-level outcome of the frenetic market dynamics of digital businesses – in connection with phenomena such as network externalities and competition for standards – is the so-called 'winner-taking-all distribution' (Anderson, 2009). This configuration, which is a situation in which very few firms do well and the vast majority fails or barely survives, is typical – for instance – of tech start-ups (Burns, 2010). In the tech start-ups context, which is characterised by an approximate failure rate of 80% (Burns, 2010), among the few survivors only an incredibly small number succeeds – and as a consequence quickly amass incredible fortunes (Lanier, 2014).

In the recent past these factors led to the creation of a 'star system' or 'winner-taking-all' distribution (Anderson, 2009), which has made the rich richer and penalised the middle class. In this sense the "new digital economy, like older feudal or robber baron economies, is thus far generating outcomes that resemble a 'star system' more often than a bell curve" (Lanier, 2014, p. 34). Conversely, a bell-curve distribution is dominated by a prominent bulge of average earners and few super-rich and poor people at the extremities. This distribution, apart from being more balanced, is also functional to the development of a thriving economy because there are more people in conditions to purchase goods and sustain economic growth (Rifkin, 2014; Stiglitz, 2013). As it has been pointed out, winner-taking-all distribution is typical of digital businesses, which additionally have the tendency of engulfing smaller thriving businesses. These tendencies of digital corporations relate directly with the accumulation of immense wealth of small elites, and this pattern of distribution seems to assert itself progressively (Lanier, 2014; Stiglitz, 2013).

Economic analysis confirms this trend: nowadays capital tends to produce rates of return in the 4-5% range, whereas economic growth is in the range of 2-3% (Piketty, 2014). The consequence is that owners of great fortunes (and their heirs) are better off because their fortunes grow more and faster than the economy§ (Stiglitz, 2013 and 2014; Piketty, 2014). Moreover, these issues have great impact in terms of political economy: political systems seem to go in the direction

§ These figures do not relate only to 'digital businesses', but include the category. The reference is not only to the 'usual suspects' (Google, Amazon, Facebook, etc.), but to all business who highly resort to IT-based resources and capabilities, as well as to automation based on IT.

of serving the interests of the owners of capital, hence this resource distribution has the tendency of undermining democracy (Stiglitz, 2013; 2014; Piketty, 2014).¶ This is even more dangerous in relation to digital businesses that highly resort to Big-Data and 'Siren Servers' (Lanier, 2014): if those elites not only have control on capital itself, but also on confidential information about individuals, the situation might be even worse. The next paragraph relates the issues mentioned above with digital economics, and the significance of digitized information in relation to resource distribution.

The Value of Information

Digitised information, namely information encoded "as a stream of bits" (Shapiro & Varian, 1998, p. 3), is a fundamental dimension of our economy. Information has always been crucial in business and all the domains of knowledge; for this reason information is regarded as a source of power (Buchanan & Huczynski, 2010). However, the importance of information in the digital age has changed, creating a different and new domain of economic action (Jacobides & Winter, 2012). Digitised information is based on bit-strings, namely "everything that can be stored in computer memory and transmitted over the Internet" (Quah, 2003, p. 2). In light of that, a digital good can be defined as a set of bit-strings that is relevant in terms of payoff (Quah, 2003). Some of the most striking features of digital economics caused by digitised information are: 1) 'elimination' of costs related to gathering information;** 2) elimination of transaction and reproduction costs; 3) 'perfect' information flow among economic agents; 4) resizing of the role played by scarcity in economics; 5) information tends to be non-rival and does not get 'used-up'; 6) intelligent infrastructures and markets (cf. Quah, 2003; Anderson, 2009; Brynjolfsson & McAfee, 2014).

The significance of digitised information is evident when it comes to big data. Big data technologies are "a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data by enabling high-velocity capture, discovery and/or analysis" (IDC, 2011). Many fierce criticisms towards big data relate to the issue of privacy. However the focus here is the ownership of information, which is more relevant in relation to resource distribution. One of the most subtle analyses in this regard is Jaron Lanier's (2014). There seems to be a lack of understanding and regulation in relation to the information that people share online; however there are companies that made fortunes out of the manipulation and interpretation of these data. The most important misconception relates to the label '*free*', which is often associated to many online services. Lanier frames this 'misconception' as an 'accounting fraud'; that is because big data is not the product of digital parthenogenesis, rather they are built on information willingly provided by people who do not know the aggregated value of what they are sharing. Thus "dominant principle of the new economy, the information economy, has lately been to conceal the value of information, of all things […] [for this reason] your lack of privacy is someone else's wealth" (Lanier, 2014, p.11). In fact business models of many thriving digital corporations – such as Google and Facebook – are based on the assumption that information is free; however they are making billions out of something free, hence there is a logical fallacy in the process which is functional to their interests.

Conclusion

The issue of ownership of information relates to what has been said before about computerisation in the following way: if the 'physical' dimension of production is progressively removed from the domain of human activities by machines, the only dimension of economic interaction that remains is the one that relates to information. Tolerating a *status quo* that – under the rhetoric of free accessibility of information – contributes to sustaining the above-mentioned level of inequality by eliminating the ownership of information, seems to be irresponsible and naïve. Since the competitive advantage of human labour over machines appears to be gone for good, it is not possible to neglect that the new domain of economic action is intrinsically *abstract*, and is achieved through a process of progressive emancipation from 'objective' reality.†† Thus, it seems necessary to find a way of paying the monetary value of information to the original creators, in order to contrast the disproportionate distribution of resources that characterises the 21st century.

In this sense, academic disciplines of digital business and information systems have the occasion of unveiling their potential of fostering a social change that is in the interest of the betterment of society. In order to achieve this goal, it seem necessary to understand that ICT is not a mere means for achieving comparative advantage. The means overtakes the end because it becomes what is to be acted upon; thus the way of deliberating about the means is technical. In this sense, the reduction of ICT to mere 'technique' is not neutral, because using ICT as a technical means is possible to achieve opposite ends, and insofar opposite ends are opposite because they use the same means, the ends are subjected to the means. As long as ICT is regarded as a technical means, it is uncontrollable and passible of being used to realize contradictory ends – which are in favour of preserving the existing *status quo*.

In order to achieve this goal it necessary to foster a critical interpretation of the role information systems

¶ It is worth pointing out that US government revenues from corporate income taxes has plummeted from around 39% in 1943 to below 10% in 2012 (Stiglitz, 2014).

** It is not correct to say elimination of costs, rather it seems to be more appropriate to talk about cost shift. Research in behavioural science has shown that, especially in online shopping, great availability of options and the fact that is possible to gather information for free, has dramatically increased the time spent choosing (Fasolo *et al.*, 2009). Hence digitised information, thanks to hyperlinks, has 'eliminated' the cost of acquiring information but has increased the cost of 'making-sense' of information.

†† Separated from the 'physical referents' of information.

and ICT play in society. Since these technological constructs play a crucial role as part of communicative social practices, they "can properly be viewed as having both emancipatory and repressive effects at any instant of time" (Gallhofer & Haslam, 2003, p. 13). Instead of focusing on the ethical ends these technology can achieve, it seems more meaningful to analyse the assumptions that characterise such technologies, as *media* to achieve specific ends in organisations and society. This form of analysis is intrinsically critical, and questions the mainstream view that considers digital businesses and ICT emancipatory in nature.

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Within LSE's Department of Management, we form the leading European university-based research cluster focusing on Information Systems and Innovation, and are recognised widely as amongst the top ten such clusters in the world. We have 12 full-time academics and benefit from the contributions of Visiting Professors, all of whom are scholars of international repute and leaders in the field, from Visiting Fellows who are experts in their respective fields, and from project researchers and our PhD students.

Faculty are active in the International Federation of Information Processing (IFIP), the Association for Information Systems (AIS), the UK Academy for Information Systems (UKAIS), the British Computer Society (BCS), and other national and international organizations including United Nations and European Union bodies. They are Editors-in-Chief of major journals including JIT, ITP) and variously serve as Senior and Associate Editors on most high quality refereed journals in the IS field (e.g. MISQ, MISQE, ISR, EJIS, ISJ plus over 20 others).

Teaching in Information Systems has been rated as excellent by the UK's Quality Assurance Agency and its research is recognized as internationally excellent by the Higher Education Funding Council for England. Awards and recognition are extensive and include Frank Land's Leo award of the AIS for Lifetime Exceptional Achievement, Ciborra's AIS Distinguished Member award, and Willcocks's Price Waterhouse Coopers/Corbett Associates World Outsourcing Achievement award for academic contribution to this field.

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