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[1]Look Beyond Utility Model—Disruptive Cloud Computing For Future ICT4D Research

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Abstract: Cloud computing is becoming a buzz word for both academic discussion and industrial practice. Not only for firms but also for general pubic service is increasingly relying on cloud computing to transform ICT-based innovation. Given the ICT4D specific context, the research is cornered around leveraging cloud computing utility model to benefit the general development issues. In this paper, I bring the new perspective of industrial innovation and strategy research—disruptive innovation theory into ICT4D discussion. By pointing out the technical as well as social weakness in applying utility model of cloud computing service in ICT4D study, I introduced the disruptive cloud computing innovation for development model with a brief illustrative case analysis from "100$ laptop" public education project. The proposed disruptive potential of cloud computing service in ICT4D research provides an alternative model for future ICT/cloud computing enabled empirical research and can be leveraged to guide further ICT4D theorizing process.

Keywords: Disruptive innovation, Cloud Computing, ICT4D, IT application, E-education, E-society

1. Introduction

ICT/internet computing technology has emerged as one of the most innovative technology areas impacting a wide range of industries, business models and social patterns. The convergence of information technology that allows Brazil, Russia, India, China (BRIC countries) and so many other developing countries to become part of the coherent global value chain for service and manufacturing. More and more enterprises, governments and general public in these emerging markets are taking the advantage of globalization and IT innovation to better position themselves in this great globe flattening process. The effect of cloud computing service as the latest cutting-edge IT innovation on development model evolution and general public development in these emerging markets have gained attention as part of ICT for Development(ICT4D) study.

Cloud computing as a new technology innovation has been widely accepted in academia (Armbrust, Fox et al. 2010). Given its general-purpose, internet-based, pay-on-demand characteristics, scholars and practitioners tend to simplify the real situation and apply the utility model (Carr 2008)--the same logic of water supply, electrical grids, to analyze the ubiquitous nature of cloud computing brought up with in the process of transforming social and technical innovation.

Especially for the ICT4D research field, cloud computing is regarded to help developing countries leapfrog the developed world (Cleverley 2009), as the ubiquitous nature of cloud computing service flattened the world by providing state of the art managerial capabilities and systems to underprivileged governmental administrations, agencies and citizens.

However, when taking a closer examination of such utility model, there are problems of comparing cloud computing service to plug-and-play electricity model (Brynjolfsson, Hofmann et al. 2010). In this research paper, I attempt to review the technical as well as business, social weakness of applying utility model in conducting cloud computing research in ICT4D context, furthermore, by incorporating the latest theory development from research streams of strategic management and innovation, the cloud computing-based disruptive innovation for development model will be presented as an alternative model for future ICT4D research.

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2. Cloud Computing and Utility Model

Since the origin of Cloud computing service, the expensive, complicated, desk-top based individual software computing clients suddenly find the panacea to sweep the mess and adjust a trouble-free, pay on demand utility computing service. Such a great transformation attracts both academic and industrial concerns in recent years (Hayes 2008; Buyya, Yeo et al. 2009; Armbrust, Fox et al. 2010).

After viewing the over optimistic realization of cloud computing as the fifth utility after water, electricity, gas, and telephony (Buyya, Yeo et al. 2009), I endeavored to review the technical weakness and social impact flaws of simply applying utility model in analyzing cloud computing service, in particular, the review will address the research concerns of ICT4D specific scenarios.

2.1. Technical Weakness

It seems nature for resource scarce, capability limit developing world to allocate the development priority on cloud computing service in order to achieve cost effective in implementation ICT infrastructure service. However, in the critical transforming period from ICT4D1.0 to ICT4D2.0 (Heeks 2008), without full understanding of the technical weakness, the mass adoptions are doom to fail.

After acknowledging the general-purpose similarity between electricity grid and cloud computing in facilitating complementary innovation (Carr 2008), a set of technical weakness of cloud computing service has been identified (Armbrust, Fox et al. 2010; Brynjolfsson, Hofmann et al. 2010). As we stand on the threshold of ICT4D 2.0(Heeks 2010), a period of moving ICT from telecentre to uncharted application roadmap for international development. Latency and scalability are the main two technical weaknesses in addressing the ICT4D application of cloud computing service.

Latency: in the networked era, latency remains a formidable challenge (Brynjolfsson, Hofmann et al. 2010). Most of cloud providers relocate their mass data centers close to the energy production in order to achieve cost efficiency and stable supply capability of transforming electricity to computing. For developing world, there are few choices for either adopting foreign based cloud computing service or building cloud service infrastructure in-house, neither of such options is appealing to the poor world. Buying the cloud service from foreign land runs the latency concerns of data transfer bottlenecks and performance unpredictability (Armbrust, Fox et al. 2010). Given the poor ICT infrastructure in most of developing world, building the cloud service in-house requires accompanied upgrades of many already wait-to-be-fixed infrastructures. Such latency concerns should be particularly addressed before plug-into the cloud.

Scalability: the increasing computing capability requires extensible and scalable cyber infrastructure while not all problem can be solved by the uniformed architecture processing (Brynjolfsson, Hofmann et al. 2010). The distributed multi-request coming from different sources ask for many-to-many communication pattern that individual sever handling multiple clients while each single client invoking programs on multiple serves (Hayes 2008). The richness of application programming interface (API) from disparate clients and agencies brings new challenge for less tech-savvy developing world; such system complication will eventually offset the benefit from cost saving than simply keeping IT in-house.

2.2. Social Impact Weakness

Besides the technical drawbacks of cloud computing service for development, the flaws from social aspect, especially privacy and security concerns loom large in cloud computing analysis (Brodkin 2008; Gellman 2009; Anthes 2010). In the special promise of ICT4D research, although the shift from analogue age to digital era brings new opportunity to empower marginalized communities, new initiatives should be driven by poor and underdeveloped communities rather than any technologies themselves, the choice of the technical solution also depends on a range of social, economic and ideological impact (Unwin 2009).

Unlike electricity, water, gas utility, the computing service contains so much information and dataset about the clients either as a company, a government or a private user. Most of the times such information and data source are critical and classified for the clients, such characteristics has no analog in traditional utility model (Brynjolfsson, Hofmann et al. 2010). It brings new opportunity to identify alternative model that could leverage cloud computing service in ICT4D research.

3. Cloud Computing-based Disruptive Innovation Model

Given the under defined ICT4D 2.0 perspective, new technologies and theories from relevant field can be borrowed to help generate out-of-the-box thinking. By incorporating latest development of innovation and strategy stream of research with cloud computing service, I endeavored to present a complementary layer--disruptive cloud computing for development model, which looks beyond the traditional utility-based view.

3.1 The Disruptive Innovation Theory

Originally coined by Harvard Business School professor Clayton Christensen in 1997(Christensen 1997), the theory is focused on disruptive technologies—a term developed from analysis of industrial data from disk drive industry between 1975-1990 to explain the phenomenon why market incumbent failed to dominate new competition when challenged by disruptive technologies equipped market entrant. He further points out two forms of disruptions strategy: new market disruption (bring in non-consumers from existing value network) and low end disruption (provide cheap but good enough products in mainstream value network) (Christensen, Raynor et al. 2003) for market entrant to attack incumbent's internal weakness on organizational asymmetric motivation (Christensen and Bower 1996).

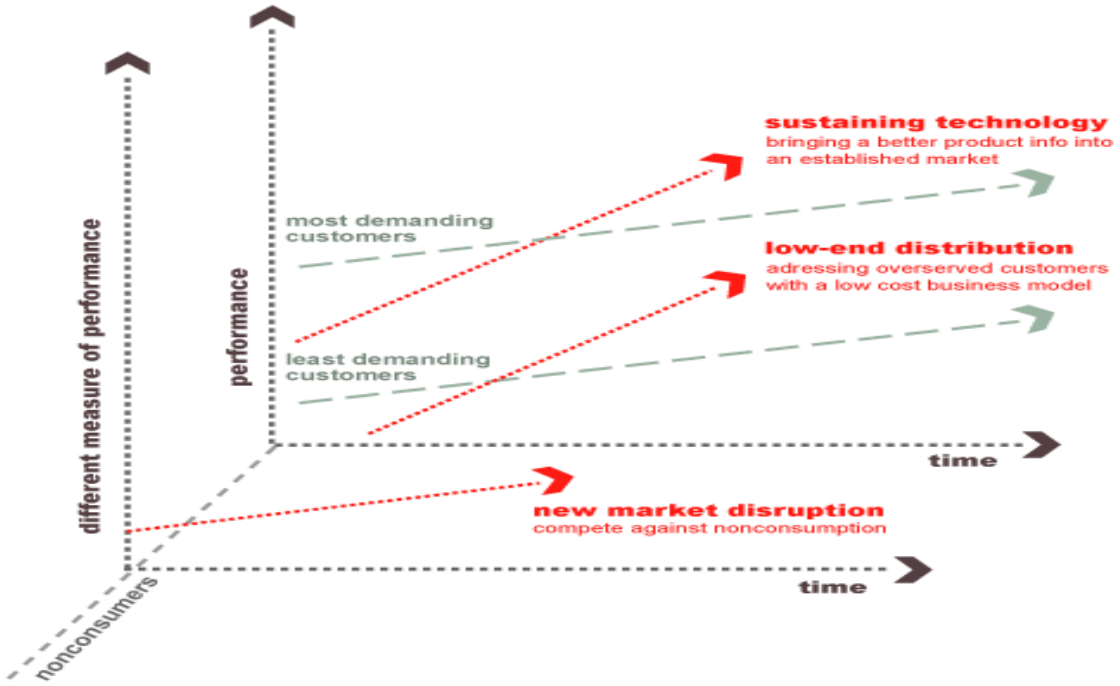

Fig1 Disruptive Innovation (Christensen, Anthony et al 2004)

Over time, the same logic has been developed to explain all kinds of disruptive innovations and emerging market evolution. From digital media's sweeping power to dismay CD, DVD based music industry, from wide accessible internet based searching and categorical web service to replace traditional paper-delivered local ads, even the latest electric driven vehicle has put immerse pressure on traditional auto industry evolution. He states that almost all the failed market leaders have the capacity and resource to fight, but did not react until it's too late to be displaced by the new paradigm of value proposition introduced by disruptive innovation (Christensen 1997). He further expands the theory application in analyzing many other social problem solutions, includes, education, healthcare, aviation etc (Christensen, Anthony et al. 2004).

Similarly, like companies have two basic options when they seek to build new-growth businesses: they can try to take an existing market from an entrenched competitor with sustaining innovations when they are among the resource-abundant market leaders, or they can try to take on a competitor with disruptive innovations that either create new markets or take root among an incumbent's worst customers (Christensen, Raynor et al. 2003). It's very interesting to apply the same underpinning logic to modeling cloud computing enabled ICT4D research.

3.2 Disruptive Cloud Computing For Development

In the context of ICT4D research, one important issue is the cost. For developing world, ICTs are crucial in improving health and education service and creating new sources of development opportunity for the poor. However, Cost sensitive is key factor to determine the success of the overall project implementation. Besides the utility characteristics of cloud computing, it can also view as either the "new-market" style or "low-end" style disruption in approaching the specific development issues.

Cloud computing is viewed as one of the four force to change the face of IT and business (Gartner 2010). The cutting-edge, while cheap, and convenient nature brings the mass "non-consumers" in developing world an opportunity to drive national competitiveness, economic growth and social development. When the application of cloud computing enabled service in health care and education becomes pervasive, it will harness the "asymmetric motivation" of the suffering public service and eventually move up the value trajectory to help more people to access the improved public service.

In the analysis of the disruptive cloud computing model for development, my approach will focus on the disruptive potential discussion of cloud computing service rather than the social and political battle for public sector reform. There will be endless debates in terms of defining a better development strategy. Nevertheless, I envision of the cloud computing enabled development disruption will make the mass poor a winner to better drive the social and economic development.

Nevertheless, from the social development view, public welfare improvement is for social good, which means everyone deserve the same quality of service for education, health care and housing etc; while disruptive innovation, like cloud computing is less mature and only setting for "low-end" market as most of developing world looks like. So there might be argument to challenge the promise of modeling disruptive innovation for development issues (Christensen, Anthony et al. 2004). My response to this concern is the definition of quality, although cloud computing is cheap in cost and not fully functionalized so far as most disruptive innovation, the enabled service and the metrics of performance goes beyond the traditional social welfare could possibly offer. By briefly analyzing the case from ICT/cloud computing application in education, I will better explain the value proposition mechanism.

100$ laptop project, is an educational initiative runs by One laptop per Child(OLPC) a non-profit organization, it's mission is to "create educational opportunities for the world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning. When children have access to this type of tool they get engaged in their own education. They learn, share, create, and collaborate. They become connected to each other, to the world and to a brighter future". (www.laptop.org) by applying the basic hardware computing function and incorporating free online cloud computing service for underprivileged children. This small laptop-XO reflects the disruptive potential for future education service in poor countries.

Fig 2 100$ laptop XO (www.laptop.org)

A simple, attractive, more convenient and most importantly cheap end-user products bring all attributes a disruptive innovation has to equip for children's education. Contrast to the mainstream laptop products, this machine adopts a set of open source, free software systems, coupled with other cloud computing enabled recreational and educational online service. Once take roots in the low-end (children in poor countries) or a new market (children in developed countries). The disruptive improvement lifecycle begins, since the

releasing of XO-1 in 2006 more than two million of free books are available for these OX machines, thanks to the cooperation with a cloud computing service (Internet Archive a nonprofit digital library). With the goal of "one laptop per child" these machines are distributed by government and given to students and remains the property of the holder. More than 1,490,000 laptops are ordered by 20 different governmental or private agencies since 2007. Uruguay becomes the first country to mass order more than 200,000 OX laptops to cover all public schools for children between 6 and 12 years old (http://wiki.laptop.org). By changing the perception of expensive laptop for developing world and injecting the new value proposition mechanism, XO machines invoke the non-consumers and low-end market simultaneously, after setting the foothold in these untapped markets first time, the growth potential for public education in developing world is immense as the case indicates.

4. Conclusion and Future Research

In this paper, the cloud computing-based disruptive innovation for development model is defined narrowly to fit into a particular context and explaining the potential relationship between ICT4D and other relevant dependable variables with cloud computing service. Such description introduces new perspectives for disruptive innovation research with more empirical evidence and, even more importantly, challenges the current ICT4D research theorizing with out-of-the-box thinking and more actionable managerial implication.

The future research requires intensive empirical study to further solidify the theory prediction. The cyclical pattern of theory development process hardly yields mutually exclusive or collectively exhaustive categorization. In particular for the uncharted ICT4D 2.0 landscape, new discovery should always be carefully scrutinized. Secondly, given the disruptive nature of cloud computing service on business and social development, the technical architecture requirement goes beyond the concerns of information technology per se, the articulation of disruptive social impact attributes with extensive organizational and technological system application study will intrigue interesting conceptual and empirical exploration as part of my work initialed. A set of social, ICT development phenomenon waits to be examined by this new perspective. Once the disruptive innovation approach has been comprehensively explored and defined, it could be potentially leveraged as an important pattern for ICT4D study.

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