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Not All Innovations Are Created Equal: A Survey of Internet Computing as Disruptive Innovation in Systems Development Organizations

Jessica Carlo
Case Western Reserve University

Kalle Lyytinen
Case Western Reserve University

Gregory Rose
Washington State University

NOT ALL INNOVATIONS ARE CREATED EQUAL: A SURVEY OF INTERNET COMPUTING AS DISRUPTIVE INNOVATION IN SYSTEMS DEVELOPMENT ORGANIZATIONS[1]

Jessica Luo Carlo
Weatherhead School of Management
Case Western Reserve University
Cleveland, OH U.S.A.
jessicaluo@case.edu

Kalle Lyytinen
Weatherhead School of Management
Case Western Reserve University
Cleveland, OH U.S.A.
kalle@case.edu

Gregory M. Rose
College of Business and Economics
Washington State University
Vancouver, WA U.S.A.
grose@wsu.edu

Extended Abstract[2]

Past studies on information systems innovation have focused on explaining the innovation and adoption of information technology by the potential adopter populations in the IT market. In contrast, few studies have examined adoption of IS innovations by IS development (ISD) organizations that produce services which underlie the innovations. Disruptive technological innovations such as Internet computing have, however, become intimately intertwined with innovative activities among ISD organizations due to their critical mediating role in the IT value chain. We draw upon Lyytinen and Rose (2003a, 2003b), and identify three sets of disruptive innovations in the IT value chain: breakthroughs in computing capability and architectures (base innovations), transformative innovations in IS development (process innovations), and disruptive changes in IS services (service innovations). We conduct a cross-sector paper-based survey of 78 small ISD organizations that develop software to external clients to test the following four research questions (see Table 1 for detailed hypotheses):

1. Is the adoption of Internet computing pervasive in ISD organizations in that base technologies, processes, and services change together?

2. Do ISD organizations perceive Internet computing as radical?

3. How does the perception by ISD organizations of base innovations impact their perception of process and service innovations?

4. How do such factors as firm size, the time of adopting base innovations, and the extent of adopting process and service innovations influence these relationships?

Table 1. Hypotheses for Internet Computing as Disruptive Innovation

Pervasiveness

H1   IS base, process and service innovations occur together (in packs).

H2   The adoption of process innovations lags behind either adoption of base or service innovations.

Radicalness

H3   ISD organizations perceive all three sets of IT innovations to be radical if they adopt any of them.

H4   Perceived radicalness of base innovations is positively associated with perceived radicalness of process and service innovations.

Moderation Effects

$H5_a$ Company size is positively and directly associated with perceived radicalness of process and service innovations.

$H5_b$ The time of adopting base innovations is inversely and directly associated with perceived radicalness of process and service innovations.

$H5_c$ The extent of adopting process and service innovations is positively and directly associated with perceived radicalness of process and service innovations.

$H6_a$ Company size moderates the effect of perceived radicalness of base innovations on perceived radicalness of process and service innovations. Thus, firms with more employees will show a lesser impact of perceived radicalness of base innovations upon perceived radicalness of process and service innovations.

$H6_b$ The time of adopting base innovations moderates the effect of perceived radicalness of base innovations on perceived radicalness of process and service innovations. Thus, earlier adopters will show a lesser impact of perceived radicalness of base innovations upon perceived radicalness of process and service innovations.

$H6_c$ The extent of adopting process and service innovations moderates the effect of perceived radicalness of base innovations on perceived radicalness of process and service innovations. Thus, firms adopting more IS process and service innovations will show a lesser impact of perceived radicalness of base innovations upon perceived radicalness of process and service innovations.

Our study data indicates that Internet computing has been disruptive based upon both subjective and objective measures. First, Internet computing has been adopted by 96 percent of the responding companies in significant numbers for their development projects. Among them, 76 percent of organizations adopted innovations in all three sets. While 64 percent of the companies adopted base architectural innovations in more than half of their total projects and 65 percent of them adopted development process innovations in more than half of their total projects, 48 percent of the companies adopted service innovations in more than half of their total projects (Figure 1). As a result, we can conclude that **H1 was supported**: IS innovations were adopted together (in packs).
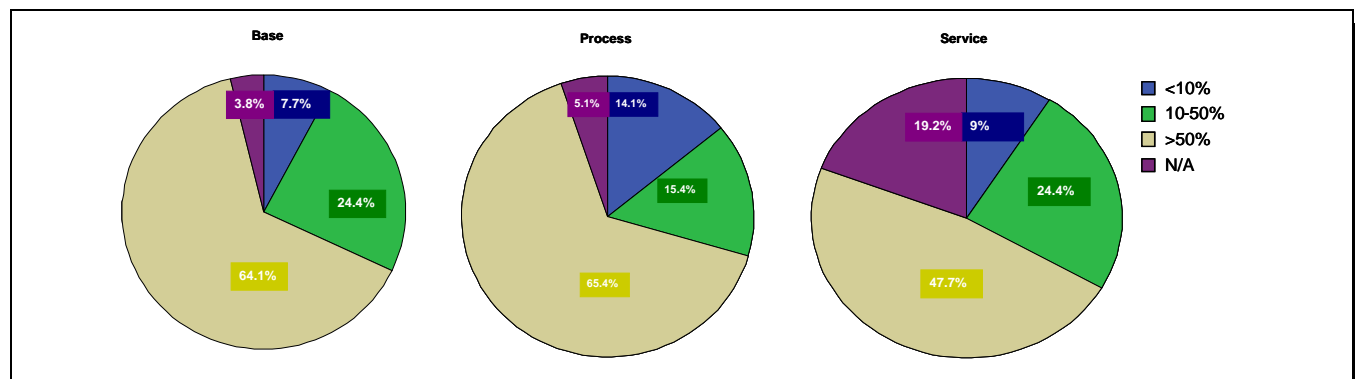

Figure 1. Internet Computing Innovations in Percent of Total Number of Projects

We also observed strong order effects (Swanson 1994) among innovation sets in that when organizations adopted all of them, their adoption started with base innovations. On average, the companies did not adopt process innovations associated with Internet computing first. Of the the 78 companies, 62 adopted Internet computing process innovations later or no earlier than Internet base or service innovations, with the average adoption year for base, process, and service innovations being 1999, 2000, and 1999 respectively (**H2**). In general, our data show that the average time lag between adopting Internet computing base, process, and services innovations is within three years. Internet computing as an architectural innovation originated in the technology base, but over time integrated co-specialized assets and spawned innovations in other areas. Due to their critical location in the IT value chain, ISD organizations faced both the pull effect from the clients to adopt new service innovations as well as the push effect from the vendors to adopt new base innovations (Lyytinen and Rose 2003b). As a result, they found themselves not only adopting IS base innovations, but also innovating in their development practices while producing novel applications. At the same time, disruptive innovations in the technology base need to be articulated in new IS services before ISD organizations can engage in innovative development practices. Due to the path dependent nature of development routines (Nelson and Winter 1982), ISD organizations have to delay the adoption of process innovations. However, technical or service innovations often call for new process features in order to absorb novel technology capability (Swanson 1994).

We also found that ISD organizations not only tend to perceive Internet computing as radical (**H3**), but also their perceived radicalness of base innovations strongly influences their perceptions of associated process and service innovations. A firm's perceived radicalness of base innovations has a very significant and positive effect on its perceived radicalness of service innovations ($\beta = .61$, t-value = 4.4, $p < 0.01$), and significant effect on its perceived radicalness of process innovations ($\beta = .32$, t-value = 2.1, $p < 0.05$) (**H4**). The time point at which the organization adopted base innovations affects negatively its perception of the level of radicalness of associated service innovations ($\beta = -.22$, t-value = -2.21, $p < 0.05$)(Figure 2, Table 2) (**H5$_b$**).
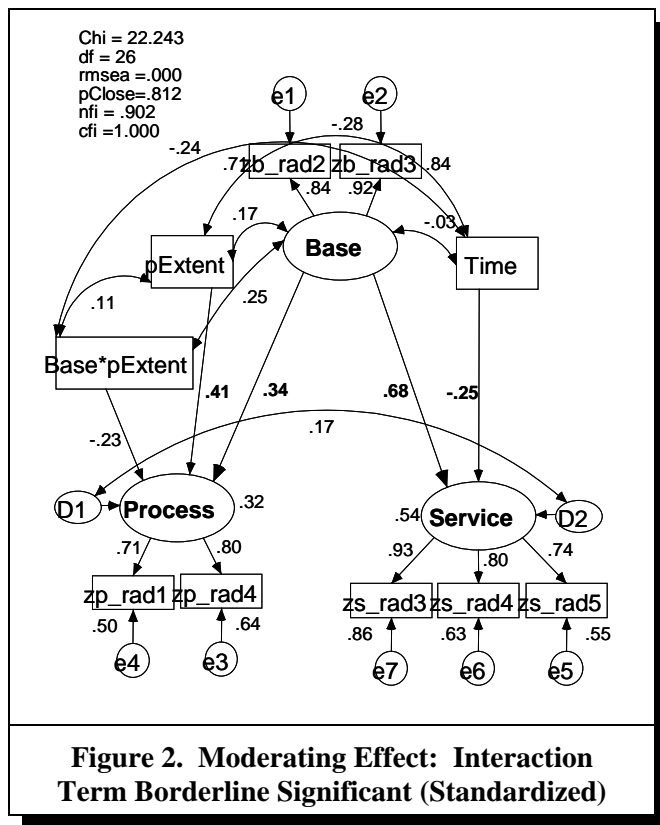

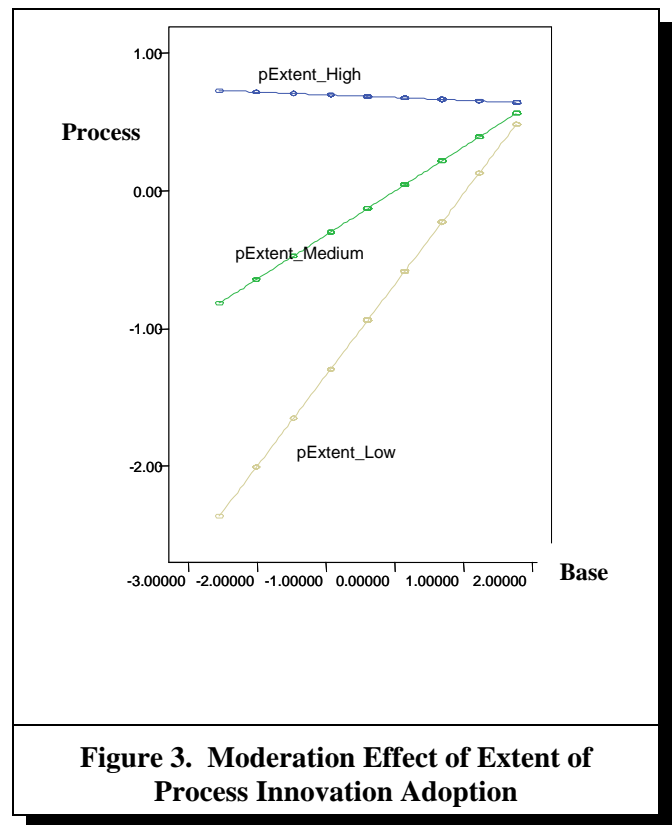**Figure 2. Moderating Effect: Interaction Term Borderline Significant (Standardized)**

Figure 3. Moderation Effect of Extent of Process Innovation Adoption

Table 2. Perceived Radicalness: Goodness of Fit Indices											
			rmsea								
Std. Path Parameter	Chi	Df		low	upper	p	nfi	cfi	pcfi	pnfi	SRM
Desired level			< .08	Range < .12		> .05	> .95		> .70		< .05
Main effect	18.789	21	0	0	.1017	.7397	.913	1	.583	.533	0.499
With interaction	22.243	26	0	0	.0876	.8122	.902	1	.578	.521	.0493

Surprisingly, the extent of adopted process innovations moderates the relationship between perceived radicalness of base innovations and perceived radicalness of process innovations (Figure 2 and 3). Organizations adopting extensive process innovations regard process innovations more radical than organizations adopting fewer process innovations. Extensive adopters' perception of process innovations is thus less dependent on their perception of the radicalness of base innovations. By contrast, light adopters of process innovations regard process innovations generally as less radical. At the same time, these perceptions are strongly influenced by their perceptions of the radicalness of base innovations (**H5c, H6$_b$**).

Overall, the findings support most of our hypotheses, except the hypotheses relating to moderation effects of company size, and the extent of adopting service innovations (**H5a, H6$_a$, H6$_b$**). Our study offers both data and theoretical triangulation and extends significantly findings associated with disruptive IS innovation theory observed in earlier longitudinal multisite case studies (Lyytinen and Rose 2003a) and lends strong support for Swanson's (1994) claim of strong order effect in IT innovations. Our findings indicate that it is important to unpack the black-box of IS innovation, and focus on different types of IS innovations and their dynamic interactions. Disruptive IS innovation is not a discrete event, but forms an ecology of innovative behaviors that varies over time in kinds of innovation and their perceived level of radicalness. Not all innovations are created equal!

Acknowledgments

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