Rethinking the Strategic Cannibalization in ICT Industry: Technology Adoption and Diffusion

Min Jae Park

Department of e-Business

Ajou University

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Article Published (Aug 2020, TFSC)

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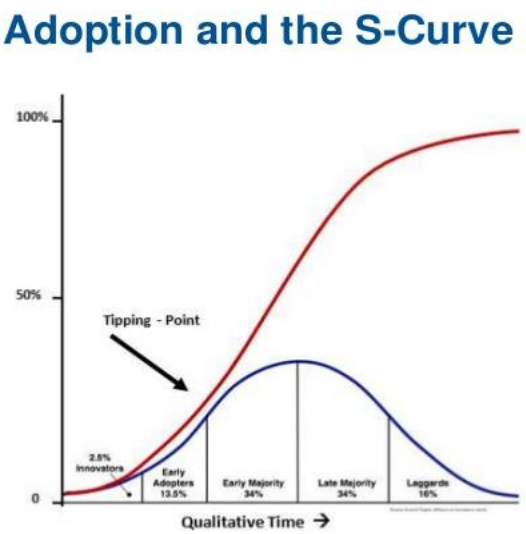
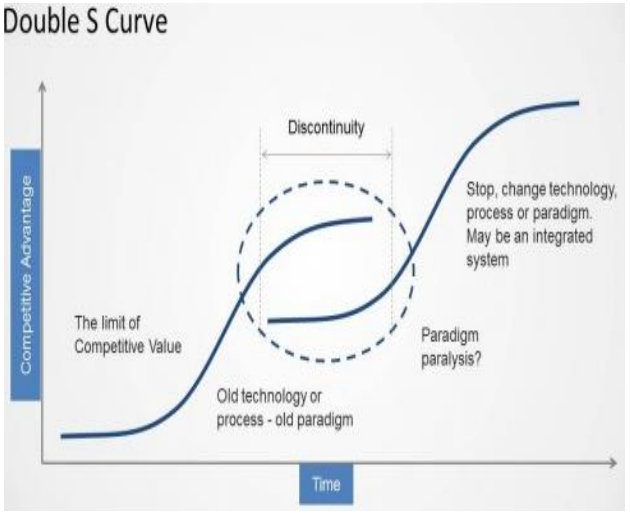
Under Review (2nd Round, JBR)

Rethinking the Strategic Cannibalization in ICT Industry

Research Background : Cannibalization & Double S-Curve





Steve Jobs (1998)

- Product cannibalization is a well known phenomenon in marketing and new product development and describes the case when one product steals sales from a product pertaining to the same brand.
- Apple's Product Strategy: Line-up & Cannibalization
- Cannibalization Phobia
- Innovation Diffusion Model: Bell-shaped curve / S-Curve
- Double S-Curve [Rethinking the Strategic Cannibalization : When? How? Chasm ? & *etc*]

Research Background : ICT Ecosystem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Mobile services with handset bundling and governmental policies for competitive market

Dongsuk Kang [a,1], Min Jae Park [b,*], Duk Hee Lee [a,*], Jae Jeung Rho [a]

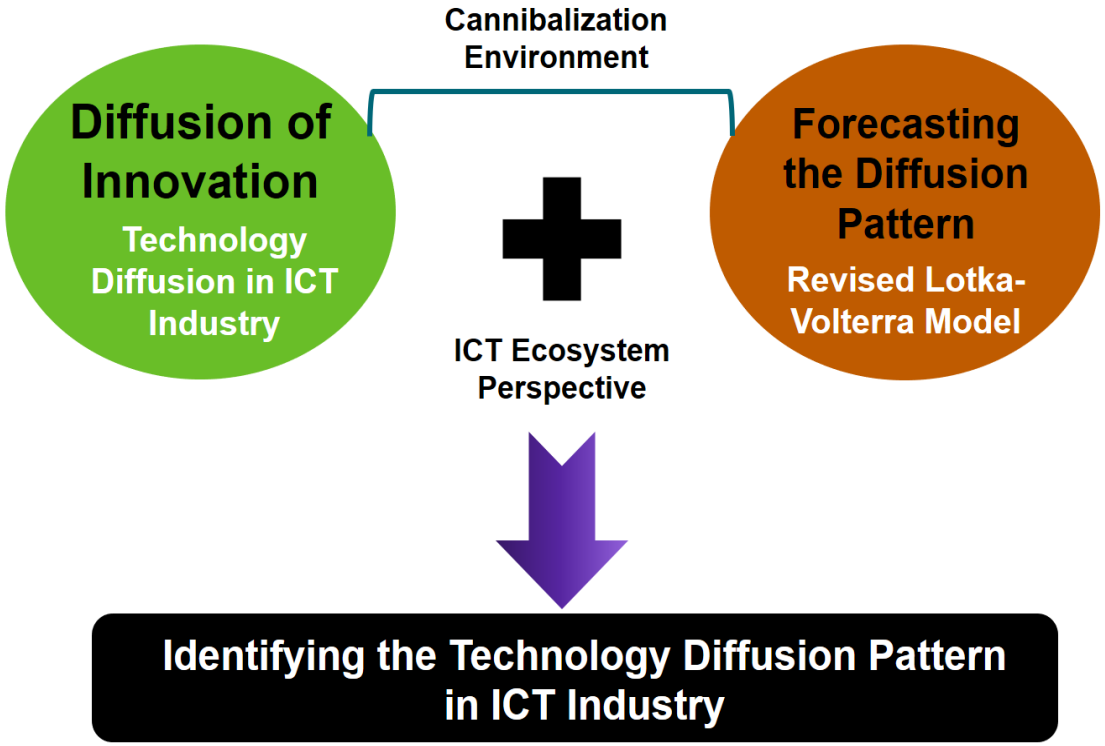
ARTICLE INFO

ABSTRACT

- ICT Ecosystem: Contents, Platform, Network & Device
- Cannibalization in the ICT Market : Three Type
- Handset Bundling in Korea / Strong Tie between Network and Device

- The diffusion of technology occurs in various patterns depending on the relationship between the four elements of the ICT ecosystem.
- Focusing on "Device"

Research Purpose



- This study presents a revised Lotka-Volterra model with asymmetric competition, which is useful to describe cases of product cannibalization.

- This study applies the model to *the case of Apple Inc, where iPhone sales concurred to determine the crisis of the iPad (comparative analysis with Samsung)*

Related Research : Technology Diffusion Model

- Diffusion models for competition have often focused on modelling the interaction between two products by splitting the *word-of-mouth in two parts*: the within product word-of-mouth, which is due to product's specific sales, and the cross product word-of-mouth, which is due to competition and may imply either a negative or a positive effect

- Bass Model, Logistic Model, Gompertz Growth Model & etc.
  - Coefficient of Innovation (p), Coefficient of Imitation (q) & Market Size (m)

[Bass Diffusion Model]

- Bass model consists of a simple differential equation that describes the process of how new products get adopted in a population.
- Three parameters
  - 1) p = the coefficient of innovation
  - 2) q = the coefficient of imitation
  - 3) m = market size

$$\frac{f(t)}{1-F(t)} = p + qF(t)$$

Where:

- $f(t)$ is the change of the installed base fraction
- $F(t)$ is the installed base fraction
- p is the coefficient of innovation
- q is the coefficient of imitation

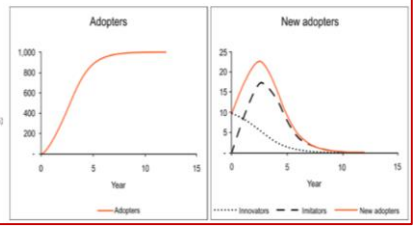
Sales $S(t)$ is the rate of change of installed base (i.e. adoption)

$$S(t) = mf(t)$$

$$S(t) = m\frac{(p+q)^2}{p}\frac{e^{-(p+q)t}}{(1+\frac{q}{p}e^{-(p+q)t})^2}$$

The time of peak sales t^*

$$t^* = \frac{\ln q - \ln p}{p+q}$$



- Steam of Study on Technology Diffusion Model in the ICT Ecosystem **(3 C)**

Context
- New variables and method reflecting market context
- e.g. the role of advertisement, network effect, epidemic effect

Case
- Applied to business model cases of various industries and firms
- e.g. Game industry, Generation switch in Display Industry

Condition
- Market conditions such as market competition structure and government regulation
- e.g. Market entrance (synchronic, diachronic), Monopoly, Duopoly

Model: LVch model

- Typical case of cannibalization in which competition has an asymmetric nature, so that the cannibalizing product is able to steal market to the other, while obviously the cannibalized cannot do the reverse.

- Analyzing the case of intra-brand competition between Apple iPhone and iPad, which gave rise to a case of product cannibalization, which is well described by *the Lotka-Volterra model with asymmetric competition, a special case of the LVch model.*

- The Lotka-Volterra with churn model, LVch, by Guidolin and Guseo (2015) is described by a system of differential equations, namely,

$$
\begin{aligned}
z_1'(t) &= \left[p_{1a} + q_{1a}\frac{z_1(t)}{m_a}\right][m_a - z_1(t)], \quad t \le c_2 \\
z_1'(t) &= \left[p_1 + \frac{a_1 z_1(t) + \alpha_2 b_1 z_2(t)}{m_1 + \alpha_2 m_2}\right][(m_1 - z_1(t)) + \alpha_2(m_2 - z_2(t))] \\
z_2'(t) &= \left[p_2 + \frac{a_2 z_2(t) + \alpha_1 b_2 z_1(t)}{m_2 + \alpha_1 m_1}\right][(m_2 - z_2(t)) + \alpha_1(m_1 - z_1(t))].
\end{aligned}
$$

  - First equation describes the stand-alone phase: when the first product acts as a monopolist in the market [may see that the product is assumed to behave according to a standard Bass model]
  - The second and third equations are defined for t >c_2, when the second product has entered the market, and describe competition dynamics.

Model: LVch model

1st stage: iPhone

$$z_1'(t) = \left[p_{1a} + q_{1a}\frac{z_1(t)}{m_a}\right][m_a - z_1(t)], \quad t \le c_2$$

2nd stage: iPhone

$$z_1'(t) = \left[p_1 + \frac{a_1 z_1(t) + \alpha_2 b_1 z_2(t)}{m_1 + \alpha_2 m_2}\right][(m_1 - z_1(t)) + \alpha_2(m_2 - z_2(t))]$$

2nd stage: iPad

$$z_2'(t) = \left[p_2 + \frac{a_2 z_2(t) + \alpha_1 b_2 z_1(t)}{m_2 + \alpha_1 m_1}\right][(m_2 - z_2(t)) + \alpha_1(m_1 - z_1(t))].$$

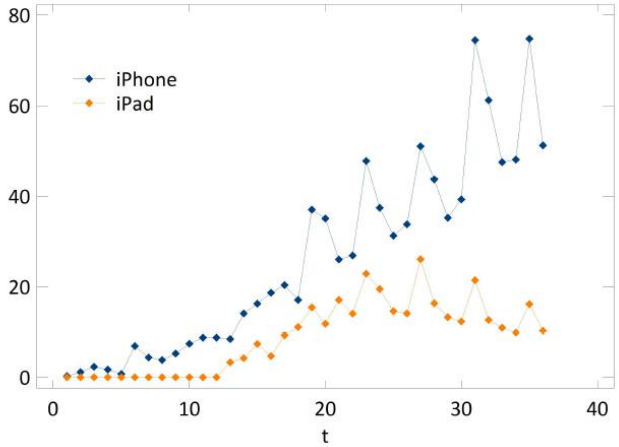
Variable parameters a_1 & a_2 that control a sort of "churn" effect between the two competitors
[$0< a_1 <1$, $0< a_2 <1$, $a_1 = 1$ (or 0) & $a_2 = 1$ (or 0)], *Totally 5 types*

Each product's rate sales, $z_i'(t), i = 1, 2$, for $t > c_2$, are proportional to the corresponding residual $[(m_i - z_i(t)) + \alpha_j(m_j - z_j(t))], i = 1, 2, j = 1, 2, i \neq j$, where m_i is the product's specific market potential under competition and $z_i(t), i = 1, 2$, represent the cumulative sales at time t.

P_i, i=1,2, is innovative behavior in adoption, while the WOM components have a more complex structure made of a within-product element $[a_1 z_1(t)/(m_1 + \alpha_2 m_2)]$ and of a cross-product one, $[\alpha_2 b_1 z_2(t)/(m_1 + \alpha_2 m_2)]$, for the first competitor and, similarly, $[a_2 z_2(t)/(m_2 + \alpha_1 m_1)]$ and $[\alpha_1 b_2 z_1(t)/(m_2 + \alpha_1 m_1)]$ for the second. Notice that α_1 and α_2 operate on both the WOM and the residual market potentials.

Method

- The statistical implementation of the models presented in previous section is based on nonlinear least squares (NLS), under a convenient stacking of the two sub-models; the stacking procedure is necessary in order to obtain a unidimensional nonlinear model estimated with standard NLS methodology, under *Levemberg-Marquardt algorithm*



Quarterly unit sold of iPhone and iPad (data source: Apple Inc).

- the iPhone entered the market in Q3/2007 (t1) and is still experiencing an increasing trend
- the iPad entered the market in Q3/2010 (t13) and is characterized by an evident declining trend, having already undertaken the life cycle peak
- both products are characterized by an evident seasonal component;
- Apple reports sales data of all its products without making a distinction between product generations.

Empirical Evidence

- Parameter estimates of a standard Bass model for Apple iPhone before t=13; Marginal linearized asymptotic 95% confidence limits into brackets. Estimates performed on instantaneous data.

m_a	p_a	q_a	R^2
145.809	0.005	0.265	0.8083
(-163.199)	(-0.001)	(-0.001)	
(454.817)	(0.011)	(0.531)	

- Parameter estimates of LVch model.

  Marginal linearized asymptotic 95% confidence limits into brackets. Estimates performed on instantaneous data.

DW: Durbin-Watson statistic

p_1	a_1	b_1	α_2	m_1	R^2
-0.010	0.526	-0.840	0.998	1347.57	0.8766
(-0.037)	(0.002)	(-8.050)	(-7.668)	(661.55)	
(0.015)	(1.049)	(6.370)	(9.665)	(2033.60)	
p_2	a_2	b_2	α_1	m_2	DW
0.011	0.167	1.058	0.001	378.76	2.073
(-0.096)	(-1.081)	(-395.802)	(-0.989)	(-21.38)	
(0.118)	(1.417)	(397.918)	(0.993)	(778.91)	

In particular, we may see that $a_2 = 0.998$ and $a_1 = 0.001$, which suggests a polarization of the two parameters

Following this observation we estimated this reduced version of the model by setting $a_2 = 1$ and $a_1 = 0$.

Also, we interpreted the negative estimate of parameter , $p_1 = -0.010$ (which is incoherent with the theory of diffusion models), as a signal of the absence of an innovative component for the iPhone within the competition phase

We therefore estimated a reduced version of LVch model, a LV model with asymmetric competition ($a_2 = 1$, $a_1 = 0$. $p_1 = 0$)

Empirical Evidence

- Parameter estimates of LV model with asymmetric competition and $P_{1c} = 0$. Marginal linearized asymptotic 95% confidence limits into brackets. Estimates performed on instantaneous data.

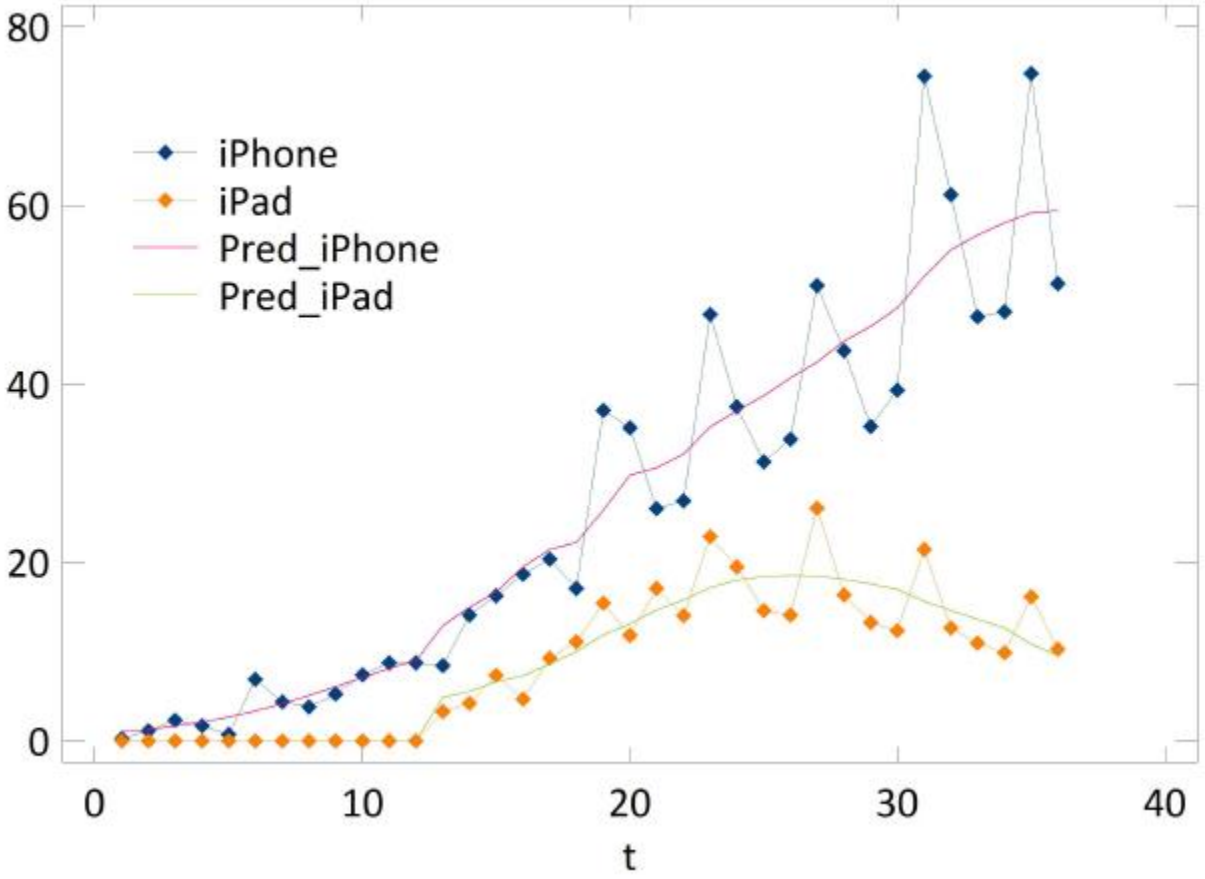
a_1	b_1	m_1	R^2
0.238	-0.260	1798.18	0.8733
(0.146)	(-0.493)	(1415.45)	
(0.328)	(-0.028)	(2180.90)	
p_2	a_2	m_2	DW
0.011	0.172	379.71	2.077
(-0.004)	(0.077)	(299.54)	
(0.027)	(0.266)	(459.89)	

The results show that the residual market for the iPhone is given by $(m_1 - z_1(t)) + (m_2 - z_2(t))$, that is the residual market of the iPad results to be completely available to the iPhone. Conversely, by setting $\alpha_1 = 0$, the residual market for the iPad is just given by $m_2 - z_2(t)$, and the cross-product WOM vanishes, $[\alpha_1 b_2 z_1(t)/(m_2 + \alpha_1 m_1)]$

- iPad is described by an independent standard Bass model and is therefore not influenced by the iPhone, while the iPhone has been affected by the iPad both in negative and positive terms.
- In fact, the iPad implied an extension of the iPhone's residual market but also a negative cross product WOM [since parameter b_1 is negative,

Empirical Evidence

Lotka-Volterra model with asymmetric competition for iPhone and iPad



Implications

- LV with asymmetric competition
- the competing role of the iPad had both a negative and positive role: on the one hand the iPad has exerted competition on the iPhone through a negative WOM, but its presence has also been beneficial since its residual market potential is completely available to the iPhone.
- Moreover, through *a non dimensional representation of the proposed LV model* we are able to show that competition has implied a delay in the peak time of the iPhone:
  - ✓ so the entrance of the iPad has been strongly beneficial for the iPhone, in terms of market potential definition and length of life cycle.

Taking the first derivative of x_1' with respect to x_1 and setting it equal to zero we obtain the maximum density condition, $\hat{x}_1$

$$\hat{x}_1 = \frac{1}{2} + \frac{s}{2}(1 - F_2) - \frac{s}{2v}F_2 = \frac{1}{2} + \frac{s}{2}\left(1 - F_2 - \frac{F_2}{v}\right).$$

Since $v = a_1/b_1$ is typically negative because b_1, expressing the cross WOM effect, is negative, $(1 - F_2 - F_2/v)$ will be positive.
Reminding that $s = m_2/m_1$ we may rewrite $\hat{z}_1 = m_1\hat{x}_1$ in a more interesting form

$$\hat{z}_1 = m_1 x_1 = \frac{m_1}{2} + \frac{m_2}{2}\left(1 - F_2 - \frac{F_2}{v}\right).$$

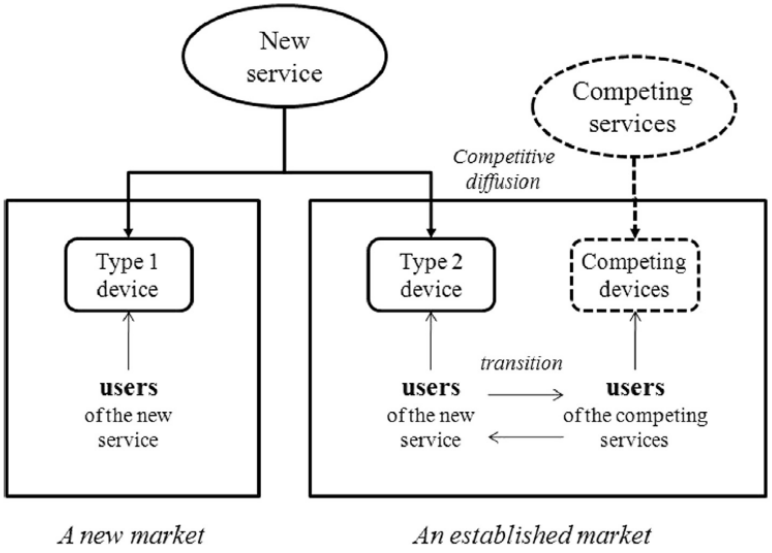
- Equation highlights that as long as the market potential of the second entrant m_2 increases, the maximum peak for z_1 is delayed and reached beyond $m_1/2$.

$$\hat{x}_1 = \frac{1}{2} + 0.08327477(1 + 0.04669954\, F_2(\tau)).$$

$$0.58327377 \leq \hat{x}_1 \leq 0.58716$$

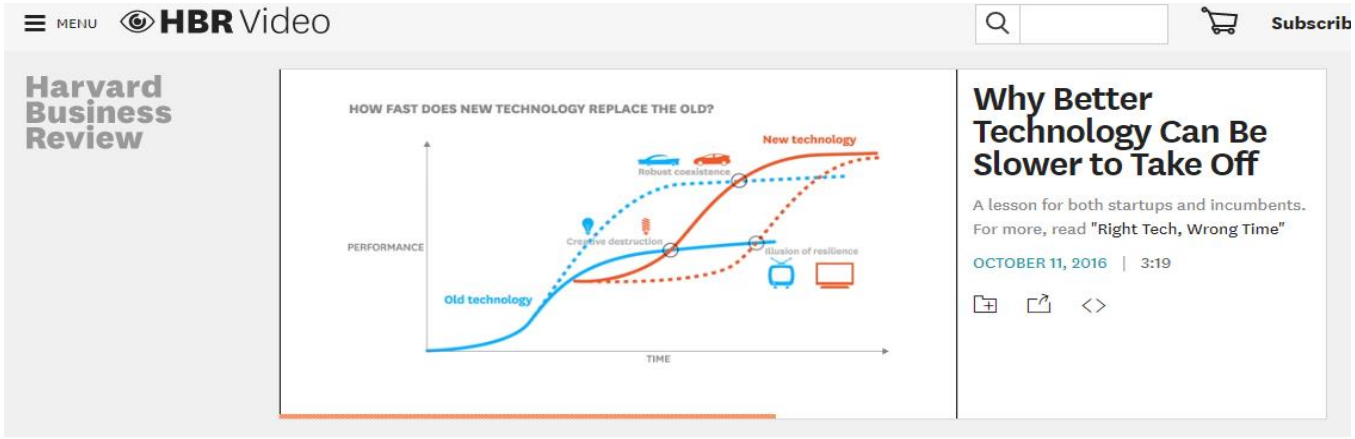
Future Research

- Strategic Cannibalization in ICT Industry
- Limitation: Reflecting the Seasonality / SARMAx Model
  Quarterly Data, Data by the Generation (iPhone 6 vs 7)
- Comparison with SAMSUNG
- The Structure of ICT Ecosystem: C-P-N-D /the effect of cannibalization
- Legacy System vs Cloud Computing [Private, Public & Hybrid] / Right Mix

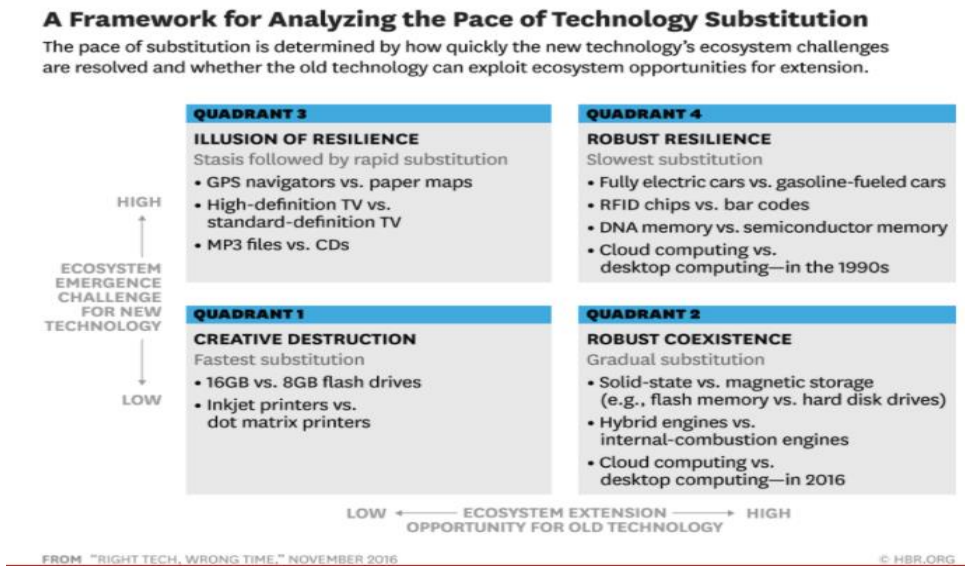


Implications

- A delay in the peak time of the iPhone:



https://hbr.org/video/5155033576001/why-better-technology-can-be-slower-to-take-off



Smart factory adoption in small and medium-sized enterprises: Empirical evidence of manufacturing industry in Korea

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Smart factory adoption in small and medium-sized enterprises: Empirical evidence of manufacturing industry in Korea

Jeong Yeon Won[a], Min Jae Park[b,*]

[a] Department of Business Administration, Seoul School of Integrated Sciences and Technologies (aSSIST), 46, Ewhayeodae 2-gil, Seodaemun-gu, Seoul, South Korea
[b] Department of e-business, School of Business, Ajou University, 206 Worldcup-ro, Yeongtong-gu, Suwon, Republic of Korea

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SMEs
Adoption and implementation
Logistic regression
Determinants of technology innovation

ABSTRACT

This paper examines the factors and effects of smart factory adoption of Small and Medium-sized Enterprises (SMEs). With the emergence of the 4th industrial revolution, the use of information technologies has been gradually emphasized in order to improve the company's competence in manufacturing. Moreover, observations from various cases of government support and academic research have reportedly been stressing the impact of the information technologies on the economy. But there is little research about the adoption intentions and implementation for the SMEs. An analysis of the 2012 SMEs in Korea shows that the experienced benefits of prior information and the unique characteristics of SMEs do not have a significant influence on the adoption intention of smart factory. On the contrary, the existing information investments and efforts appear to create a large amount of resistance. This study aims to help executives and policymakers make the right decisions by understanding the meaning of smart factories as well as the conditions and impact of innovations that affect SMEs.

Research Purpose

Does IS use level put different emphasis on value activities (primary activities, support activities)?

- Rethinking the Porter's Value Chain in the Perspective of IS

What are the determinants of a paradigm shift in information systems in the 4th industrial revolution?

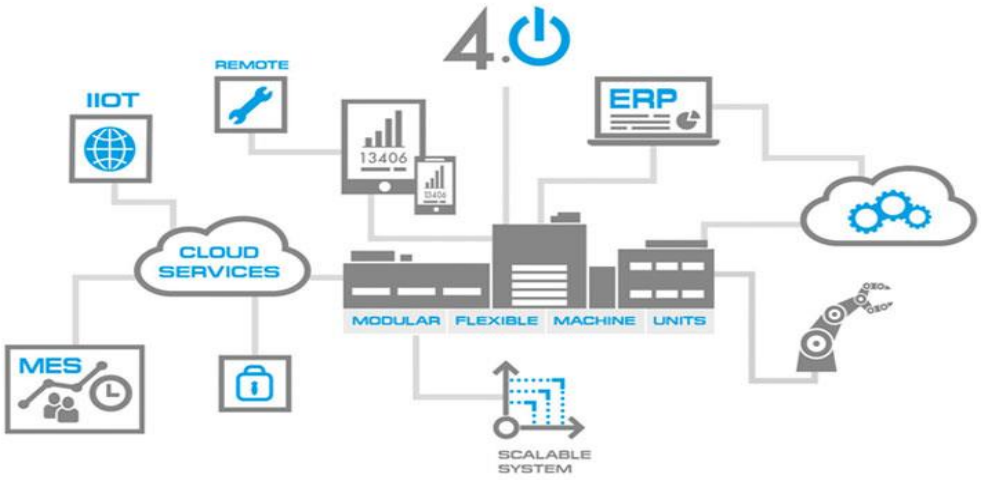
- Smart Factory Adoption or Implementation

Overview of Research

- The structural change in the manufacturing industry is being promoted as a Smart Factory.

- This study look at how IS utilization level, corporate capability and environment interact with the introduction of Smart Factory.

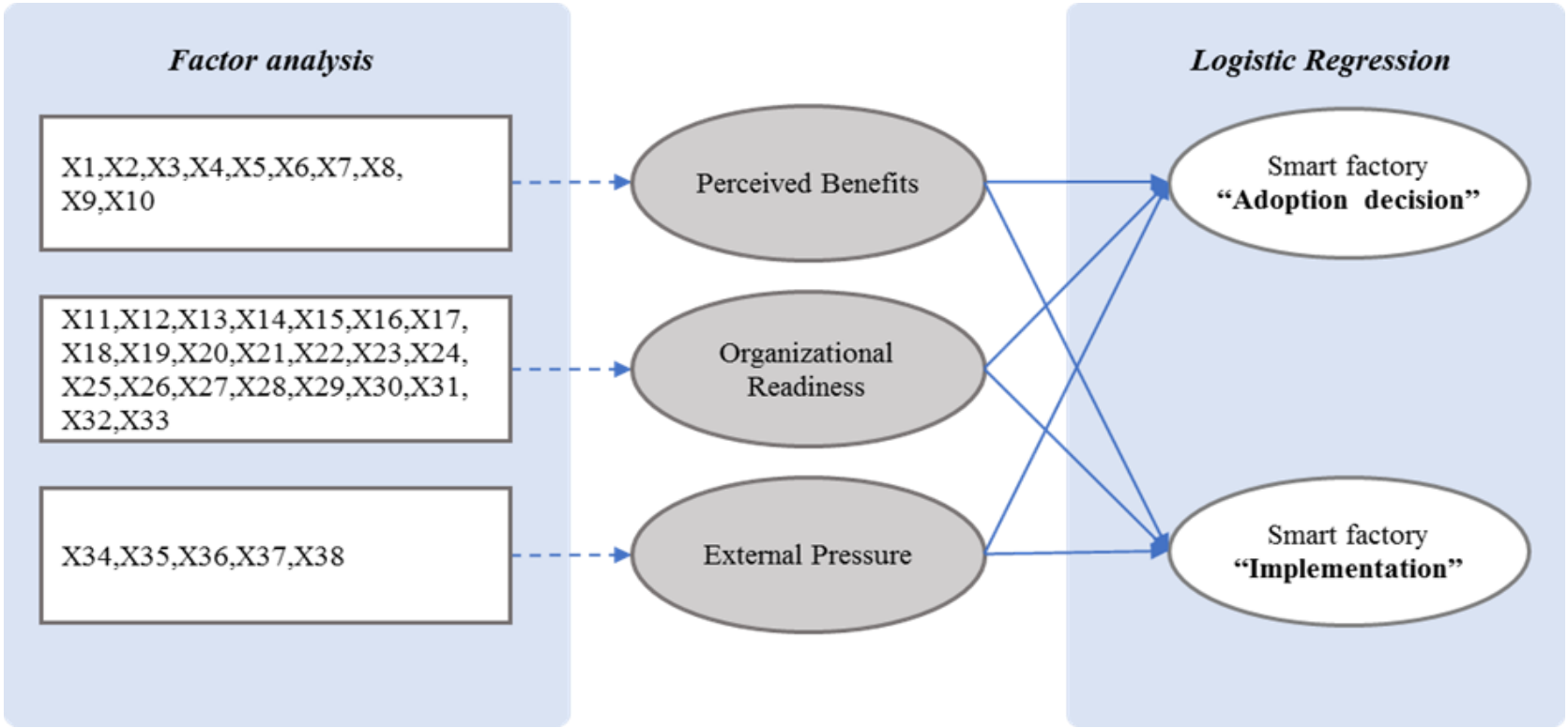
- The relevant data were collected from the sample (2,012 SMEs), and the research hypotheses were verified through logistic regression analysis.



Research Purpose

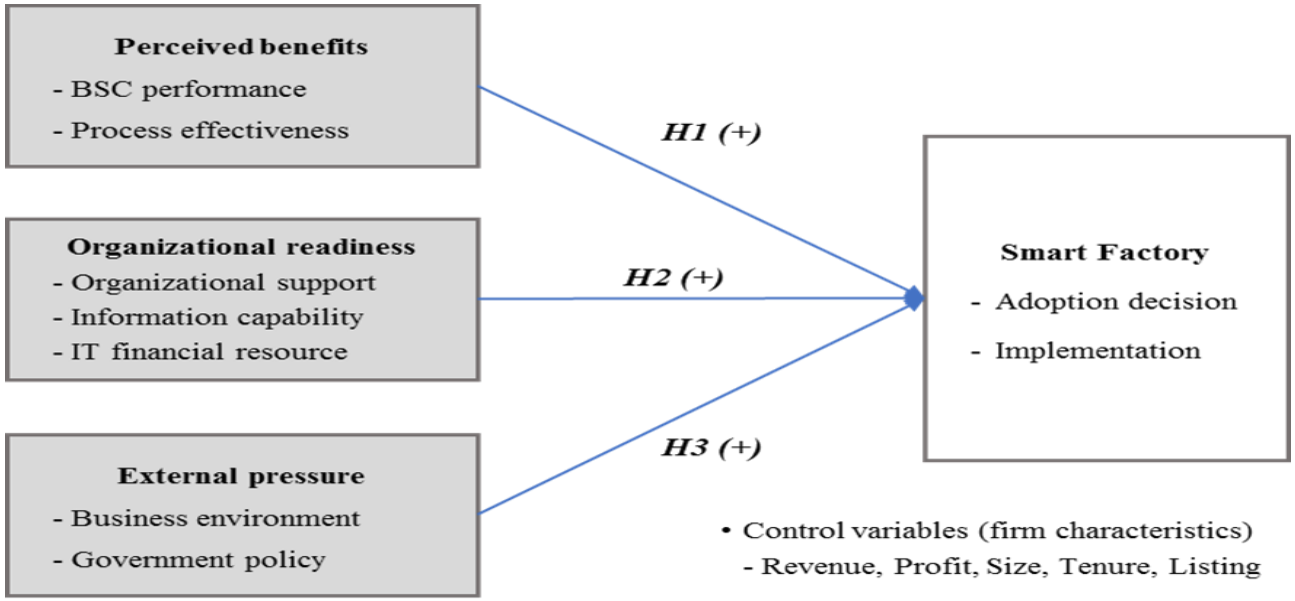
- This study aims for three goals.
  - First, it is to identify the determinants of introducing the smart factory to a small and medium sized manufacturer.
  - Second, in the context of the manufacturing industry, it is to investigate the empirical data of Korea's small and medium sized enterprises on the impact of these determinants in the introduction and application of the smart factory.
  - Comparison between **Implementation and Adoption**

Research Framework



- the sample: 2,012 SMEs
- Factor Analysis + Logistic Regress

Research Model / Hypotheses

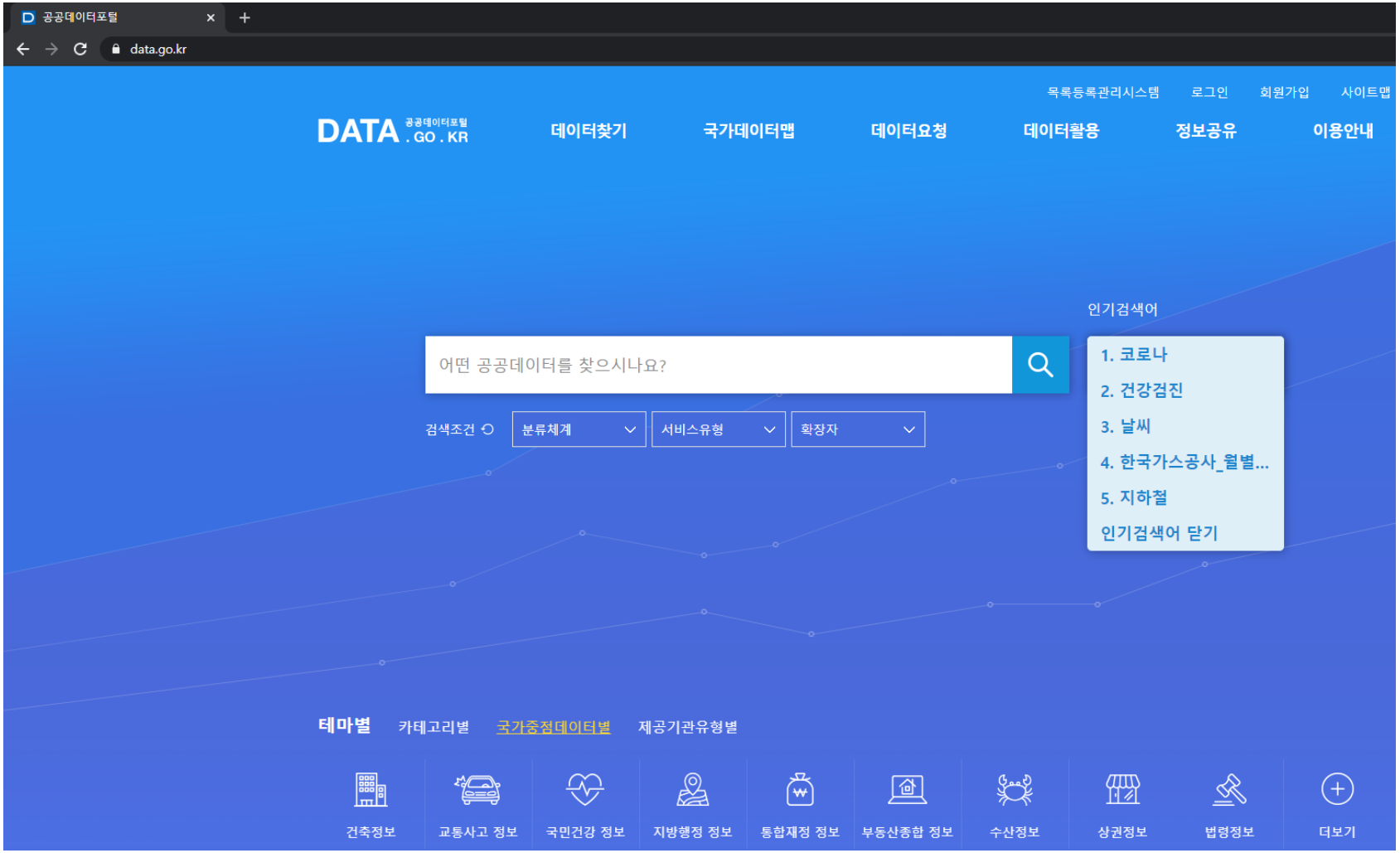


H1: Perceived benefits that gain a successful experience through the BSC performance and process innovation positively influences the adoption and use of smart factory by the SMEs.

H2: Organizational readiness such as organizational support, information capabilities, IT financial resources positively influences the adoption and use of smart factory by the SMEs.

H3: External pressure such as business environment and government policy positively influences the adoption and use of smart factory by the SMEs.

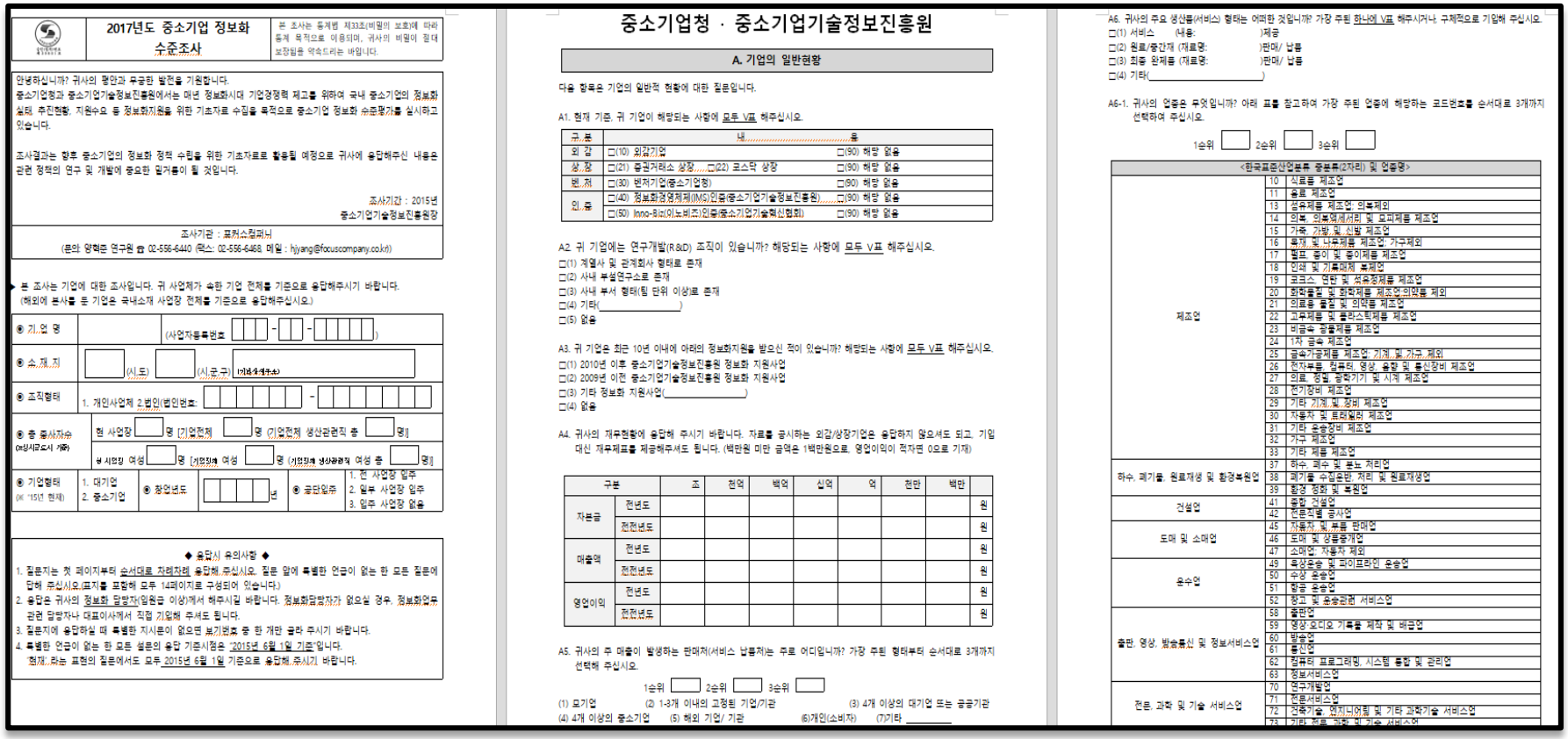
Data



data.go.kr

Data

- Open Data (data.go.kr)
- Annually surveyed by Ministry of SMEs and Start-ups
- 4,303 Companies (Year 2016 ~ 2018)



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조사결과는 향후 중소기업의 정보화 정책 수립을 위한 기초자료로 활용될 예정으로 귀사에 응답해주신 내용은 관련 정책의 연구 및 개발에 중요한 밑거름이 될 것입니다.

조사기간 : 2015년
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조사기관 : 포커스컴퍼니
(문의 양혁은 연구원 ☎ 02-556-6440 (팩스: 02-556-6468, 메일 : hjyang@focuscompany.co.kr))

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중소기업청 · 중소기업기술정보진흥원

A. 기업의 일반현황

다음 항목은 기업의 일반적 현황에 대한 질문입니다.

A1. 현재 귀 기업이 해당되는 사항에 모두 V표 해주십시오.

구분	내용	
외감	□(10) 외감기업	□(90) 해당 없음
상장	□(21) 증권거래소 상장 □(22) 코스닥 상장	□(90) 해당 없음
벤처	□(30) 벤처기업(중소기업청)	□(90) 해당 없음
인증	□(40) 정보화경영체제(IMS)인증(중소기업기술정보진흥원)	□(90) 해당 없음
	□(50) Inno-Biz(이노비즈)인증(중소기업기술혁신협회)	□(90) 해당 없음

A2. 귀 기업에는 연구개발(R&D) 조직이 있습니까? 해당되는 사항에 모두 V표 해주십시오.
□(1) 계열사 및 관계회사 형태로 존재
□(2) 사내 부설연구소로 존재
□(3) 사내 부서 형태(팀 단위 이상)로 존재
□(4) 기타(_____)
□(5) 없음

A3. 귀 기업은 최근 10년 이내에 아래의 정보화지원을 받으신 적이 있습니까? 해당되는 사항에 모두 V표 해주십시오.
□(1) 2010년 이후 중소기업기술정보진흥원 정보화 지원사업
□(2) 2009년 이전 중소기업기술정보진흥원 정보화 지원사업
□(3) 기타 정보화 지원사업(_____)
□(4) 없음

A4. 귀사의 재무현황에 응답해 주시기 바랍니다. 자료를 공시하는 외감/상장기업은 응답하지 않으셔도 되고, 기업 대신 재무제표를 제공해주셔도 됩니다. (백만원 미만 금액은 1백만원으로, 영업이익이 적자면 0으로 기재)

구분		조	천억	백억	십억	억	천만	백만	
자본금	전년도								원
	전전년도								원
매출액	전년도								원
	전전년도								원
영업이익	전년도								원
	전전년도								원

A5. 귀사의 주 매출이 발생하는 판매처(서비스 납품처)는 주로 어디입니까? 가장 주된 형태부터 순서대로 3개까지 선택해 주십시오.

1순위 ☐ 2순위 ☐ 3순위 ☐

(1) 모기업 (2) 1-3개 이내의 고정된 기업/기관 (3) 4개 이상의 대기업 또는 공공기관
(4) 4개 이상의 중소기업 (5) 해외 기업/ 기관 (6)개인(소비자) (7)기타 _____

A6. 귀사의 주요 생산품(서비스) 형태는 어떠한 것입니까? 가장 주된 하나에 V표 해주시거나 구체적으로 기입해 주십시오.
□(1) 서비스 (내용:)제공
□(2) 원료/중간재 (재료명:)판매/ 납품
□(3) 최종 완제품 (재료명:)판매/ 납품
□(4) 기타(_____)

A6-1. 귀사의 업종은 무엇입니까? 아래 표를 참고하여 가장 주된 업종에 해당하는 코드번호를 순서대로 3개까지 선택하여 주십시오.

1순위 ☐ 2순위 ☐ 3순위 ☐

<한국표준산업분류 중분류(2자리) 및 업종명>

제조업	10	식료품 제조업
	11	음료 제조업
	13	섬유제품 제조업; 의복제외
	14	의복, 의복액세서리 및 모피제품 제조업
	15	가죽, 가방 및 신발 제조업
	16	목재 및 나무제품 제조업; 가구제외
	17	펄프, 종이 및 종이제품 제조업
	18	인쇄 및 기록매체 복제업
	19	코크스, 연탄 및 석유정제품 제조업
	20	화학물질 및 화학제품 제조업;의약품 제외
	21	의료용 물질 및 의약품 제조업
	22	고무제품 및 플라스틱제품 제조업
	23	비금속 광물제품 제조업
	24	1차 금속 제조업
	25	금속가공제품 제조업; 기계 및 가구 제외
	26	전자부품, 컴퓨터, 영상, 음향 및 통신장비 제조업
	27	의료, 정밀, 광학기기 및 시계 제조업
	28	전기장비 제조업
	29	기타 기계 및 장비 제조업
	30	자동차 및 트레일러 제조업
	31	기타 운송장비 제조업
	32	가구 제조업
	33	기타 제품 제조업
하수, 폐기물, 원료재생 및 환경복원업	37	하수, 폐수 및 분뇨 처리업
	38	폐기물 수집운반, 처리 및 원료재생업
	39	환경 정화 및 복원업
건설업	41	종합 건설업
	42	전문직별 공사업
도매 및 소매업	45	자동차 및 부품 판매업
	46	도매 및 상품중개업
	47	소매업; 자동차 제외
운수업	49	육상운송 및 파이프라인 운송업
	50	수상 운송업
	51	항공 운송업
	52	창고 및 운송관련 서비스업
출판, 영상, 방송통신 및 정보서비스업	58	출판업
	59	영상·오디오 기록물 제작 및 배급업
	60	방송업
	61	통신업
	62	컴퓨터 프로그래밍, 시스템 통합 및 관리업
	63	정보서비스업
전문, 과학 및 기술 서비스업	70	연구개발업
	71	전문서비스업
	72	건축기술, 엔지니어링 및 기타 과학기술 서비스업
	73	기타 전문, 과학 및 기술 서비스업

Data

B. 정보화 추진의지 및 계획

다음은 정보화 추진의지 및 계획에 대한 질문입니다.

정보화: 정보통신기술을 활용하여 조직의 경영 효율화를 달성하도록 전환, 개선하는 활동

정보화투자: 정보시스템 구축비용, 뿐 아니라, IT활용 교육비용, IT 관련 인건비, PC등 하드웨어 및 소프트웨어 구입비용, 유지보수 비용 등 정보화 및 IT와 관련된 모든 지출

B1. 최고경영자, 임직원의 정보화 관심도는 어느 수준인지 해당란에 V표 해주십시오.

구분		매우 높음	높음	보통	낮음	매우 낮음
CEO/임원	정보화에 대한 관심(필요성)	(5)	(4)	(3)	(2)	(1)
	정보화 시스템구축 및 투자계획	(5)	(4)	(3)	(2)	(1)
직원	정보화에 대한 관심(필요성)	(5)	(4)	(3)	(2)	(1)
	정보화 시스템 활용능력	(5)	(4)	(3)	(2)	(1)

B1-1. 귀사의 임원들은 자사에 적합한 정보화 솔루션이나 소프트웨어, 시스템 등에 대해 정확히 알고 있습니까?
□(1) 정확히 알고 있음
□(2) 관심 및 필요성은 있으나, 무엇이 필요한지는 정확히 모름
□(3) 알지 못하고 관심이 없음

B1-2. 귀사의 CEO나 정보화 투자 권한이 있는 임원들은, 모바일, 클라우드, SNS 등 최근 새롭게 떠오르는 IT에 대해 얼마나 관심이 있습니까?
□(1) 관심이 크고, 해당 분야 투자를 진행 중
□(2) 관심이 있으나, 투자를 실시하지는 않고 있음
□(3) 관심이 없고, 필요성을 느끼지 못함

B2. 정보화 추진계획이 수립되어 있습니까?
□(1) 계획대로 실행 중, □(2) 계획 수립되었으며 실행예정 □(3) 계획 수립 중 □(4) 계획 수립 예정 □(5) 계획 없음

B3. 전전년도 1월 이후 정보화 투자타당성 분석을 실시한 적이 있습니까?

정보화 투자타당성 분석: 정성적평가(시급성, 만족도 난이도 개선 등), 단면적평가(생산 및 개발주기 단축, 재고율 감소 등), 분석적평가(ROI, TCO, IT BSC등) 등

□(1) 사전타당성 및 사후성과분석 모두를 실시하였다.
□(2) 사전타당성 또는 사후성과분석 중, 한가지를 실시한 적이 있다.
□(3) 사전타당성과 사후성과분석을 실시한 적이 없다.

C. 정보화 추진환경

C1. 귀사의 정보화 구축 수준은 다음 어디에 해당됩니까?

정보시스템: 조직이 수행하는 업무 및 관련 정보를 전산화한 체계로 소프트웨어, 하드웨어 및 통신망, 데이터베이스 관련 인력 등의 일체를 포함(FRP, CRM 등과 같은 시스템, 뿐만 아니라, 전자세금계산서 발행을 위한 재무회계시스템 그룹웨어, 이메일 메신저 등 2인 이상의 네트워크를 기반으로 한 IT활용시스템을 의미)

□(1) 하나 이상의 정보시스템이 회사 자체로 구축되어 있음(패키지 구매 구축 포함)
□(2) 자체구축 정보시스템은 없으나, ASP(SaaS) 등의 외부서비스를 이용하고 있음(예: 외부업체의 회사 전용 메일계정 및 홈페이지 서비스 이용 등)
□(3) 개별 PC 등을 통해 인터넷 기반의 상용화된 외부 프로그램(포털의 이메일이나 메신저 등)만을 이용함

C2. 귀사의 정보화 투자(지출) 비용은 얼마입니까?
(PC 구입, 유지 보수비용 및 IT 인력 인건비, ISP 비용 등을 모두 포함)
※ 1백만원 미만의 경우 1백만원으로 표기

구분		전년도(실적)(원)							당해연도(예상)(원)						
		조	천억	백억	십억	억	천만	백만	조	천억	백억	십억	억	천만	백만
정보화투자비	신규투자(업그레이드 포함)														
		또는 매출액의 약(.....)%							또는 매출액의 약(.....)%						
	유지보수														
		또는 매출액의 약(.....)%							또는 매출액의 약(.....)%						

C3. 귀사는 사내 임.직원에 대해 정보화 교육(OA 포함, IT 활용, 교육)을 실시하고 있습니까?
□(1) 예 □(2) 아니오 [→ C4 번으로]

C3-1. 정보화 교육 실시대상은 누구인지 해당사항에 모두 V표 해주십시오.
□(1) 일반직원 □(2) 정보화 담당직원 □(3) 임원급 □(4) 최고경영자

C3-2. 지난 한 해 동안 정보화교육 수강인원 및 비용은 어느 정도입니까?

구분		전년도	당해연도(예상)
교육인원	전체	명 (또는 종사자수의 약 %)	명 (또는 종사자수의 약 %)
	여성인력	명 (또는 종사자수의 약 %)	명 (또는 종사자수의 약 %)
전체 종사자수 1인당 연평균 횟수		회	회
교육비용		만원 (또는 매출액의 약 %)	만원 (또는 매출액의 약 %)

C4. 귀사에는 IT 투자계획을 수립하고 운영하는데 내.외부 전문 인력 또는 전문 컨설팅회사 등을 통한 전문 자문 체제가 확보되어 있습니까?
□(1) 있음 □(2) 필요성을 느끼고 있으나 현재 없음 □(3) 없음

C5. 사내에 정보화 담당 인력이 있습니까? 현재 정보화 담당 인력 현황(상주하는 아웃소싱 직원 포함)을 기입해 주십시오.

정보화 담당 인력: 정보화 추진 및 전략의 기획/관리, 개발, 운영/유지보수 인력

담당인력.수			추가필요 인력
구분	남성	여성	
□ 전담인력(자사인력 및 아웃소싱 상주인원 포함)	명	명	남성 : 명
□ 겸임직원(자사직원)	명	명	여성 : 명
□ 외주관리(아웃소싱 단기 파견직)	명	명	
□ 담당인력 없음			

C6. 정보화 업무의 아웃소싱 비율은 어느 정도입니까? (ASP 서비스는 아웃소싱에 해당됩니다)

구분	정보화업무				향후 아웃소싱 도입/ 확대계획
	완참(V)	자체수행	아웃소싱		
전체 정보화업무	□	%	%	100%	(1) 있다 (2) 없다

[→ 아웃소싱을 전혀 하지 않고 계획도 없는 경우는 C7번으로 이동]

C6-1. 정보화 아웃소싱을 도입하신 (또는 도입/확대하려는) 이유는 무엇인지 해당사항에 모두 V표 해주십시오.
□(1) 핵심 역량에 집중(Focus on Competency)
□(2) 비용 감소(Cost Reduction)
□(3) 품질 향상(Improved Quality)
□(4) 제품 출시 속도 개선(Increased Speed to Market)
□(5) 보다 빠른 혁신(Faster Innovation)
□(6) 기타( )

C7. 정보화를 위한 업무혁신은 어느 정도로 이루어지고 있습니까?
□(1) 별도의 업무혁신체계 및 조직이 없음
□(2) 크게 문제되었던 일부 업무만 일시적으로 혁신
□(3) 부서별로 정기적 업무혁신활동 전개
□(4) 전사 차원에서 혁신활동을 추진 중
□(5) 구체적인 업무혁신체계 및 조직을 바탕으로 혁신문화 정착에 주력

C8. 귀사는 정보보안 마스터플랜(계획)이 수립되어 실행되고 있습니까?
□(1) 계획대로 실행 중 □(2) 계획 수립되었으며 실행예정 □(3) 계획 수립 중
□(4) 계획 수립 예정 □(5) 계획 없음

C9. 다음은 정보보안에 관련된 보안침해 사례입니다. 2011년 이후 경험한 피해 사례에 대해 해당사항에 V표 한 후 피해 내용을 직접 기입해주십시오.

해킹	(1) 없음 (2) 있음 (_____)
바이러스	(1) 없음 (2) 있음 (_____)
스팸메일	(1) 없음 (2)정보지로만 이용됨 (3)업무지장초래 (4)피해가 컸음
내부정보유출	(1) 없음 (2) 있음 (_____)

Results

Logistic regression of factors related **to the adoption decision** of smart factory

Variables			β	S.E.	Est. Wald	df	Sig.	Exp(B)
(Constant)			-5.885	0.880	44.747	1	0.000	0.003
Perceived Benefits	Performance expectation		0.161	0.149	1.161	1	0.281	1.175
Organizational readiness	Organizational support***		0.707	0.161	19.239	1	0.000	1.980
	Information capability***		0.722	0.115	39.595	1	0.000	2.083
	IT infra operation		-0.185	0.138	1.784	1	0.182	0.837
	IT investment	New project	-0.001	0.001	2.270	1	0.132	0.998
		Operation	0.001	0.001	0.978	1	0.323	1.002
		IT staff**	-0.401	0.154	6.776	1	0.009	0.639
External pressure	Competition pressure		0.138	0.077	3.199	1	0.074	1.139
	Market & policy pressure	R&D	0.065	0.046	2.069	1	0.150	1.085
		Export ratio	-0.007	0.101	0.005	1	0.942	1.003
		License**	0.572	0.203	7.936	1	0.005	1.791
Control variables		Revenue	0.000	0.000	0.015	1	0.903	1.000
		Profit	0.000	0.000	0.471	1	0.492	1.000
		Firm size*	0.006	0.002	5.972	1	0.015	0.349
		Biz. Period	-0.009	0.010	0.842	1	0.359	0.991
		Listing status	-1.018	0.538	3.577	1	0.059	1.005
2LL=956.898, Cox and snell R^2=0.098, Nagelkerke R^2=0.224 Hosmer and Lemeshow chi-squared=4.055 (d.f.=8, p=0.852)								

- **License :** Whether they have government license such as IMS, innoBiz and mainBiz and Venture (+)
- IT Staff : In the SME context, much more investment to HR, when compared to manufacturing system (-)

[Trade-off relationship]

Results

Logistic regression of factors related **to the implementation decision** of smart factory

Variables			β	S.E.	Est. Wald	df	Sig.
(Constant)			-6.330	2.509	6.366	1	0.012
Perceived Benefits	Performance expectation**		1.348	0.393	11.753	1	0.001
Organizational readiness	Organizational support		0.796	0.451	3.119	1	0.077
	Information capability		0.003	0.286	0.000	1	0.992
	IT infra operation		-0.271	0.361	0.563	1	0.453
	IT investment	New project	0.001	0.002	0.495	1	0.482
		Operation*	0.007	0.003	5.261	1	0.022
		IT staff	-0.645	0.346	3.469	1	0.063
External pressure	Competition pressure		-0.187	0.189	0.982	1	0.322
	Market & policy pressure	R&D	0.066	0.115	0.334	1	0.563
		Export ratio	0.165	0.246	0.449	1	0.503
		License	0.470	0.498	0.893	1	0.345
Control variables		Revenue**	0.000	0.000	7.802	1	0.005
		Profit**	0.000	0.000	7.130	1	0.008
		Firm size	0.001	0.005	0.037	1	0.847
		Biz. Period	-0.020	0.023	0.805	1	0.370
		Listing status	-0.843	1.503	0.314	1	0.575
2LL=153.541, Cox and snell R^2=0.305, Nagelkerke R^2=0.425 **Hosmer and Lemeshow chi-squared=7.693 (d.f.=8, p=0.464)**							

- **Performance Expectation / Investment to operation** (+)
- Revenue/ Profit (+) : The volume of sales and corporate profitability - > Smart Factory Implementation

Results

Results of Hypotheses Test

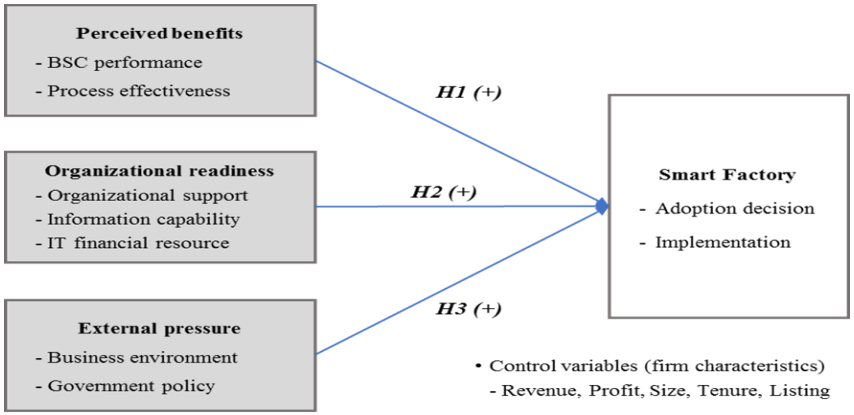
Variables	Significant effect on Adoption	Significant effect on Implementation
Perceived Benefits		
- Performance expectation	No	Yes (+)
Organizational readiness		
- Organizational support - Information capability - IT investment (Operation) - IT investment (Staff)	Yes (+) Yes (+) No Yes (-)	No No Yes(+) No
External pressure		
- Policy pressure (License)	Yes (+)	No
Control variables		
- Revenue - Profit - Firm size	No No Yes (+)	Yes (+) Yes (+) No

Discussion

- Clear understanding of determinants for smart factory adoption and its influence will aid managers and staff of small and medium sized.

- Comparison between Adoption and Implementation

- Moreover, this study is to assist the number of methods already in progress or in the planning stage by the policy-making authorities and the academia to anticipate its effectiveness on accomplishing its goals.

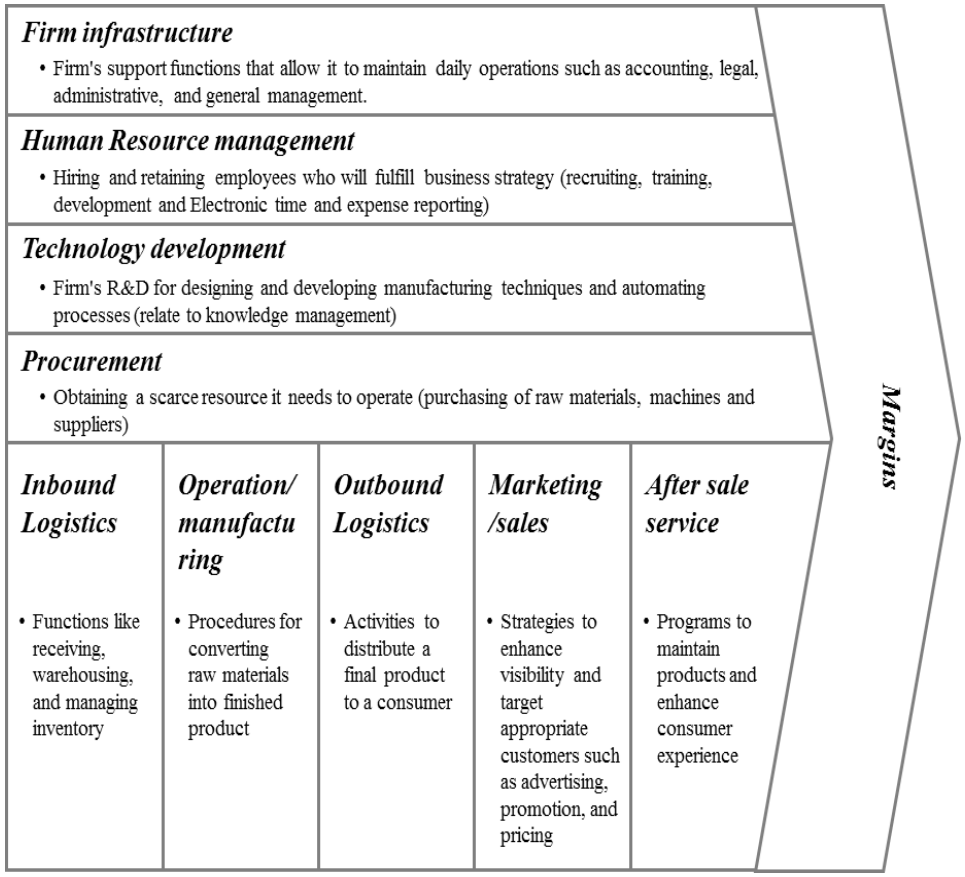


IS Use and SME's Characteristics in Value Chain Activities

Journal of Business Research (2020)

[Under Review, 2nd Round]

Value Chain Activities



Note: adopted from Porter and Millar (1985)

- Information systems are affecting the entire process of products and services developed by companies
- Value activities can be divided into nine categories.
- The main activities are the primary activities for carrying out the business.
- Supporting activities are composed of a substructure that enables the input of factors and primary activities.

Information systems has been gradually embedded in most of value chain activities of enterprise

Research Agenda

The main research agenda can be described in two main ideas.

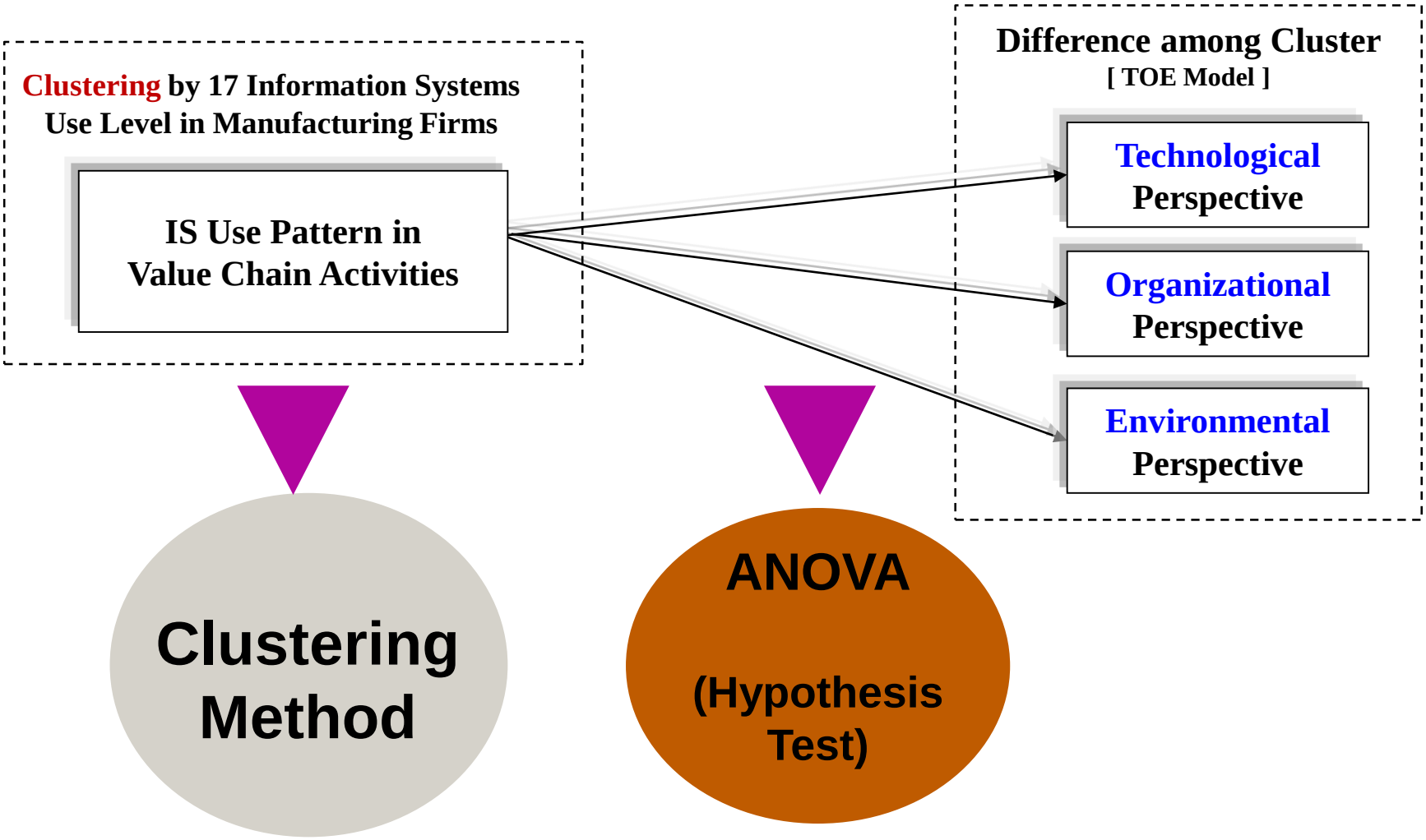
1)

The first was to discover the popular pattern of utilizing information systems based on the overall value chain activity of small- and medium-sized manufacturers.

2)

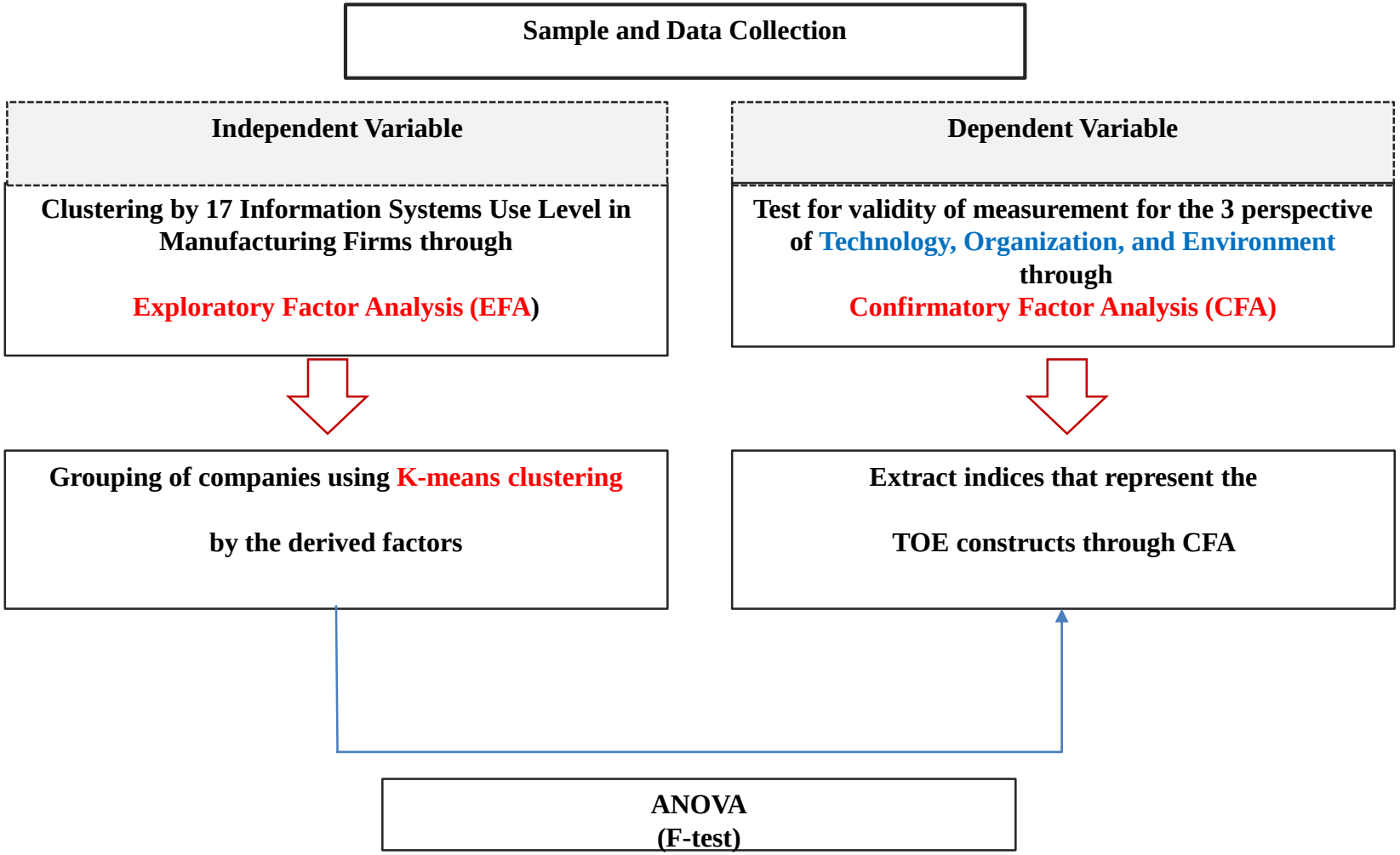
Second, it sought to determine whether there were significant differences in corporate characteristics, including corporate performance, coming from the utilization pattern of value chain-based information systems.

Research Model



Method

Totally, 2,012 sample data were used.



Method

Profile of sample companies

Characteristics (N = 2,012)		Frequency	%
Number of employees (Persons)	Less than 5	265	13.2
	6 ~ 10	594	29.5
	11 ~ 50	837	41.6
	51 ~ 100	193	9.6
	More than 100	123	6.1
Business periods (Years)	Less than 5	198	9.8
	6 ~ 10	528	26.3
	11 ~ 20	773	38.4
	21 ~ 30	357	17.7
	More than 30	156	7.8
Industry type (based on technology intensity level)	High Technology	635	31.6
	High-medium Technology	505	25.2
	Medium-low Technology	629	31.3
	Low Technology	243	12.1
Total		2,012	100

Results

Clustering

*Cluster mean: based on five-point Likert scale

		Mean*	Cluster#1 Preemie	Cluster#2 Logistic expert	Cluster#3 Mr. Everyman	Cluster#4 Follower	Cluster#5 All-round Leader
		2,012	530 (26.3%)	443 (22.0%)	408 (20.3%)	389 (19.4%)	242 (12.0%)
Primary activities	Inbound logistics	1.97	0.47	1.27	2.36	3.49	3.49
	Operation & Manufacture	1.72	0.94	1.00	1.34	3.12	3.18
	Outbound logistics	1.93	0.08	3.76	0.13	3.47	3.27
	Marketing/Sales	1.93	0.76	1.27	2.41	2.94	3.34
	After sale service	1.23	0.94	0.95	1.07	1.52	2.21
Support activities	Firm infrastructure	2.54	2.24	2.16	2.49	3.00	3.32
	HR Management	1.64	1.35	1.35	1.43	1.71	3.08
	Tech. development	0.74	0.46	0.34	0.44	0.02	3.80
	Procurement	1.36	0.97	0.94	1.17	1.83	2.63

- 9 variables related value chain activities
- 5 Clusters was derived and labelled by the clustering results

Results

Factor Analysis (PCA)

Factors	Factor loads	Eigen-values	Cum. % variance explained	Cronbach Alpha	AVE
Factor 1: Technological factor		2.280	16.289	0.645	0.416
Information sharing	0.737				
Cloud adoption	0.688				
Organizational IT support	0.642				
Level of system operation	0.542				
System development	0.445				
Factor 2: Organizational factor		2.892	36.945	0.616	0.381
Revenue	0.833				
Profit	0.789				
Firm size	0.778				
Business period	0.510				
Export ratio	0.486				
Listing status	0.473				
Competition pressure	-0.353				
Factor 3: Environmental factor		1.371	46.740	0.435	0.345
Industry type	0.784				
Industrial complex	0.733				

KMO measure of sampling adequacy=0.816; Bartlett test of sphericity=6174.894; $p<0.000$.

- All variables are well loaded and derived by the measurement items.

Results

ANOVA Test : Technological Perspective

Technological Perspective	Preemie (cluster 1)	Logistic expert (cluster 2)	Mr. Everyman (cluster 3)	Follower (cluster 4)	Leader (cluster 5)	F-value
Information sharing	0.59[a] (2,3,4,5)[b]	0.98 (1,3,4,5)	1.09 (1,2,4,5)	1.76 (1,2,3)	1.95 (1,2,3)	1436.66 [c] p<0.000
Cloud adoption	1.51 (4,5)	1.47 (4,5)	1.63 (4,5)	2.03 (1,2,3,5)	2.76 (1,2,3,5)	108.18 [d] p<0.000
Organizational IT support	3.51 (2,3,4,5)	3.66 (1,4,5)	3.69 (1,4,5)	3.97 (1,2,3,5)	4.21 (1,2,3,4)	218.34 [c] p<0.000
System development	2.55 (4,5)	2.58 (4,5)	2.55 (4,5)	2.72 (1,2,3,5)	2.90 (1,2,3,4)	33.57 [d] p<0.000
Level of system operation	3.87 (3,4,5)	3.96 (3,4,5)	4.12 (1,2,4,5)	4.36 (1,2,3,5)	4.64 (1,2,3,4)	193.53 [c] p<0.000

[Note]
- Underlined values indicate significance at a= 0.01
[a] Mean based on comparing the 2,012 samples. (Average of samples included in each group)
[b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at a=0.05.
[c] F and corresponding p-values based on Kruskal-Wallis test.
[d] F and corresponding p-values based on ANOVA test.

H1. Different IS-use clusters demonstrate different corporate characteristic levels in the perspective of Technology

[Significant]

Results

ANOVA Test : Organizational Perspective

Organization Perspective	Preemie (cluster 1)	Logistic expert (cluster 2)	Mr. Everyman (cluster 3)	Follower (cluster 4)	Leader (cluster 5)	F-value
Revenue	7.51[a] (3,4,5)[b]	7.62 (4,5)	7.86 (1,4,5)	8.61 (1,2,3,5)	8.87 (1,2,3,4)	219.35[c] p<0.000
Profit	4.97 (3,4,5)	4.97 (3,4,5)	5.29 (1,2,4,5)	5.66 (1,2,3)	5.95 (1,2,3)	104.89[c] p<0.000
Firm size	19.55 (3,4,5)	19.82 (4,5)	27.07 (1,4,5)	45.20 (1,2,3)	54.20 (1,2,3)	230.36[c] p<0.000
Business period	15.29 (5)	14.93 (5)	15.45 (5)	16.25 (5)	18.33 (1,2,3,4)	21.74[c] p<0.000
Listing status	1.01 (5)	1.00 (4,5)	1.02 (5)	1.04 (2)	1.10 (1,2,3)	12.26[d] p<0.000
Export ratio	0.30 (5)	0.33 (5)	0.37 (5)	0.42 (5)	0.65 (1,2,3,4)	8.90[d] p<0.000
Competition pressure	2.96 (4,5)	2.94 (4,5)	2.80 (5)	2.57 (1,2)	2.47 (1,2,3)	13.24[d] p<0.000

[Note]
- Underlined values indicate significance at a= 0.01
[a] Mean based on comparing the 2,012 samples. (Average of samples included in each group)
[b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at a=0.05.
[c] F and corresponding p-values based on Kruskal-Wallis test.
[d] F and corresponding p-values based on ANOVA test.

H2. Different IS-use clusters demonstrate different corporate characteristic levels in the perspective of Organization

[Significant]

Results

ANOVA Test : Environment Perspective

Environment Perspective	Preemie (cluster 1)	Logistic expert (cluster 2)	Mr. Everyman (cluster 3)	Follower (cluster 4)	Leader (cluster 5)	F-value
Industry type	2.02[a] (3,4,5)[b]	2.20 (5)	2.22 (1,5)	2.20 (1,5)	2.85 (1,2,3,4)	29.07 [d] p<0.000
Industrial complex	2.52 (5)	2.49 (5)	2.40	2.42	2.21 (1,2)	5.81 [d] p<0.000

[Note]
- Underlined values indicate significance at a= 0.01
[a] Mean based on comparing the 2,012 samples. (Average of samples included in each group)
[b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at a=0.05.
[c] F and corresponding p-values based on Kruskal-Wallis test.
[d] F and corresponding p-values based on ANOVA test.

H3. Different IS-use clusters demonstrate different corporate characteristic levels in the perspective of Environment

[Significant]

Discussion

- This study compared the key characteristics of companies involved in the promotion of informatization, comparing the entire value chain activity, not the individual activities of a company.

- It was discovered that companies focused on the primary activities for business operations of the *status quo* but exhibited very low utilization patterns in the development of technology.

- In the perspective of policy, information support must be addressed from the viewpoint of optimizing the entire value chain, not the improvement of partial value activities of companies.

Contribution

- **Academic Perspective**
  - Investigating the new determinants to adopt IS in SME / Korea Context
  - Rethinking the value chain activity
- **Practical Perspective**
  - Understanding the principal drivers to adopt IS in SME
  - Clustering the SME companies by variables related IS use
- **Empirical Perspective**
  - Open Data
  - IS use and competitiveness of SME from data, 4,303 Companies
- **Methodological Perspective**
  - Utilization of diverse research methodologies and their convergence
  - Regression (Multiple & Logistic) / Clustering method / ANOVA test

Research in Progress

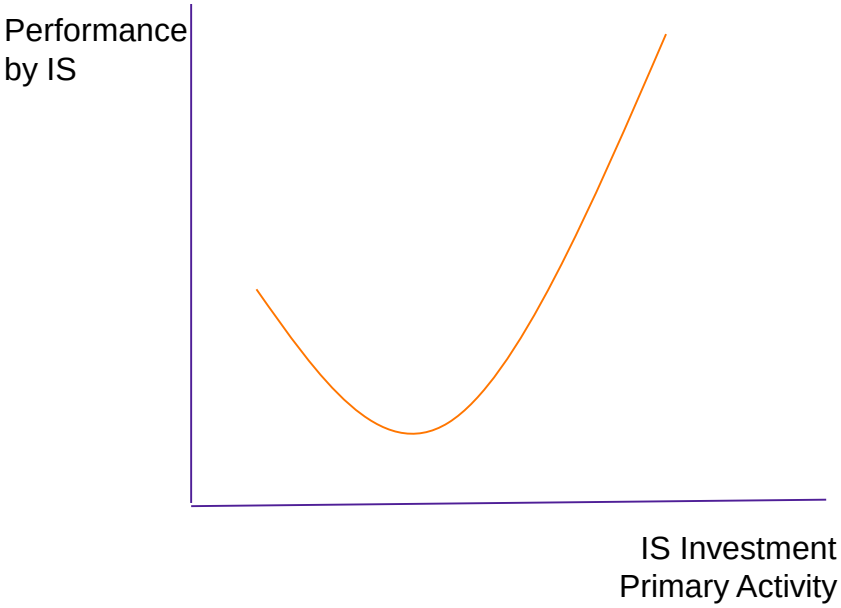
All good things require effort: U-shaped relationship between information systems and firm performance

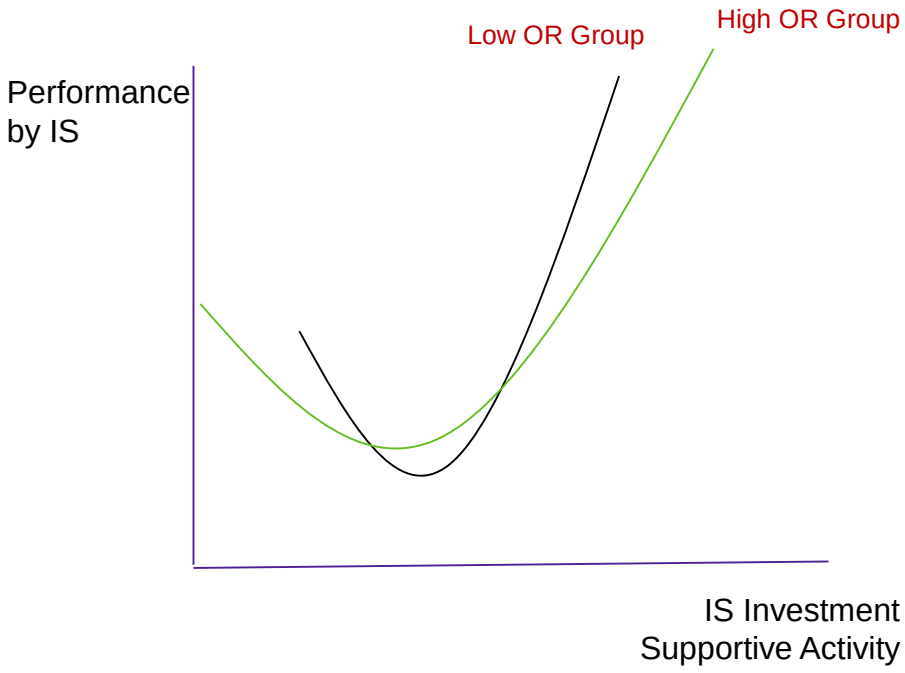
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Dependent Variable					**Performance**					
Main Effects										
PA		0.012$^{n.s.}$	**-0.308*****	0.017$^{n.s.}$	**-0.204*****	**-0.162****	**-0.182*****	**-0.144****	**-0.186*****	**-0.182****
SA		**-0.326*****	**-0.317*****	**-1.015*****	**-0.954*****	**-0.871*****	**-0.773*****	**-0.878*****	**-0.794*****	**-0.917*****
OR		**-0.288*****	**-0.289*****	**-0.280*****	**-0.281*****	**-0.309*****	**-0.317*****	**-0.306*****	**-0.303*****	**-0.339*****
PA^2			**0.054*****		**0.037*****	**0.025****	**0.034*****	**0.023****	**0.034*****	**0.030****
SA^2				**0.129*****	**0.119*****	**0.105*****	**0.078*****	**0.106*****	**0.082*****	**0.115*****
Interaction Effects										
OR * PA						**0.044*****				0.040$^{n.s}$
OR * SA							**0.077*****			**0.308*****
OR * PA^2								**0.006*****		-0.002$^{n.s}$
OR * SA^2									**0.010*****	**-0.046*****
Control Variable										
Dummy_Conglomerate	0.045$^{n.s.}$	**0.183***	**0.183***	0.112$^{n.s.}$	0.112$^{n.s.}$	0.128$^{n.s.}$	0.104$^{n.s.}$	0.131$^{n.s.}$	0.115$^{n.s.}$	0.085$^{n.s.}$
Dummy_KOSPI	-0.193$^{n.s.}$	0.146$^{n.s.}$	0.088$^{n.s.}$	0.014$^{n.s.}$	-0.014$^{n.s.}$	-0.058$^{n.s.}$	-0.040$^{n.s.}$	-0.057$^{n.s.}$	-0.032$^{n.s}$	-0.064$^{n.s.}$
Dummy_KOSDAQ	-0.070$^{n.s.}$	**0.220***	**0.171***	**0.170***	0.140$^{n.s}$	0.094$^{n.s.}$	0.117$^{n.s.}$	0.098$^{n.s.}$	0.125$^{n.s}$	0.088$^{n.s}$
Tenure	**0.004*****	**0.003***	**0.003***	**0.002***	**0.002***	**0.002***	**0.002****	**0.002***	**0.002****	**0.002***
Log(employees)	**-0.190*****	**-0.061*****	**-0.058*****	**-0.052*****	**-0.051*****	**-0.047****	**-0.050****	**-0.049****	**-0.050****	**-0.045****
Log(Sales)	**-0.092*****	**-0.035****	**-0.034****	**-0.029***	**-0.030***	**-0.030****	**-0.030***	**-0.030***	**-0.030***	**-0.030****
R^2	0.176	0.349	0.355	0.366	0.369	0.375	0.374	0.374	0.372	0.379

[Note]
PA: Primary Activity, SA: Supportive Activity, OR: Organizational Readiness/ *:p-value<0.05, **: p-value<0.01, ***:p-value<0.001, n.s.: not significant

Research in Progress

All good things require effort: U-shaped relationship between information systems and firm performance

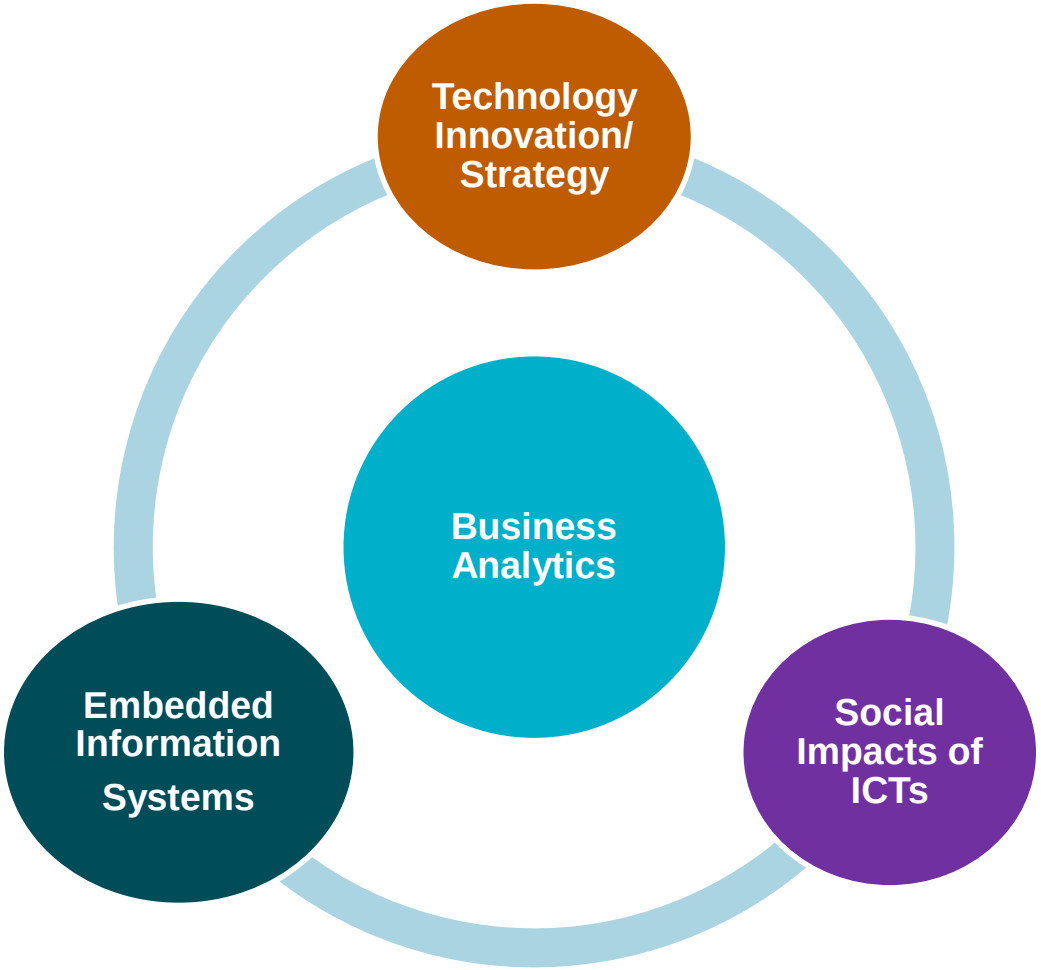




- The Paradox of IS Investment : Resistance
- High Assimilation Capacity : Mitigating effect

Future Research and Plan

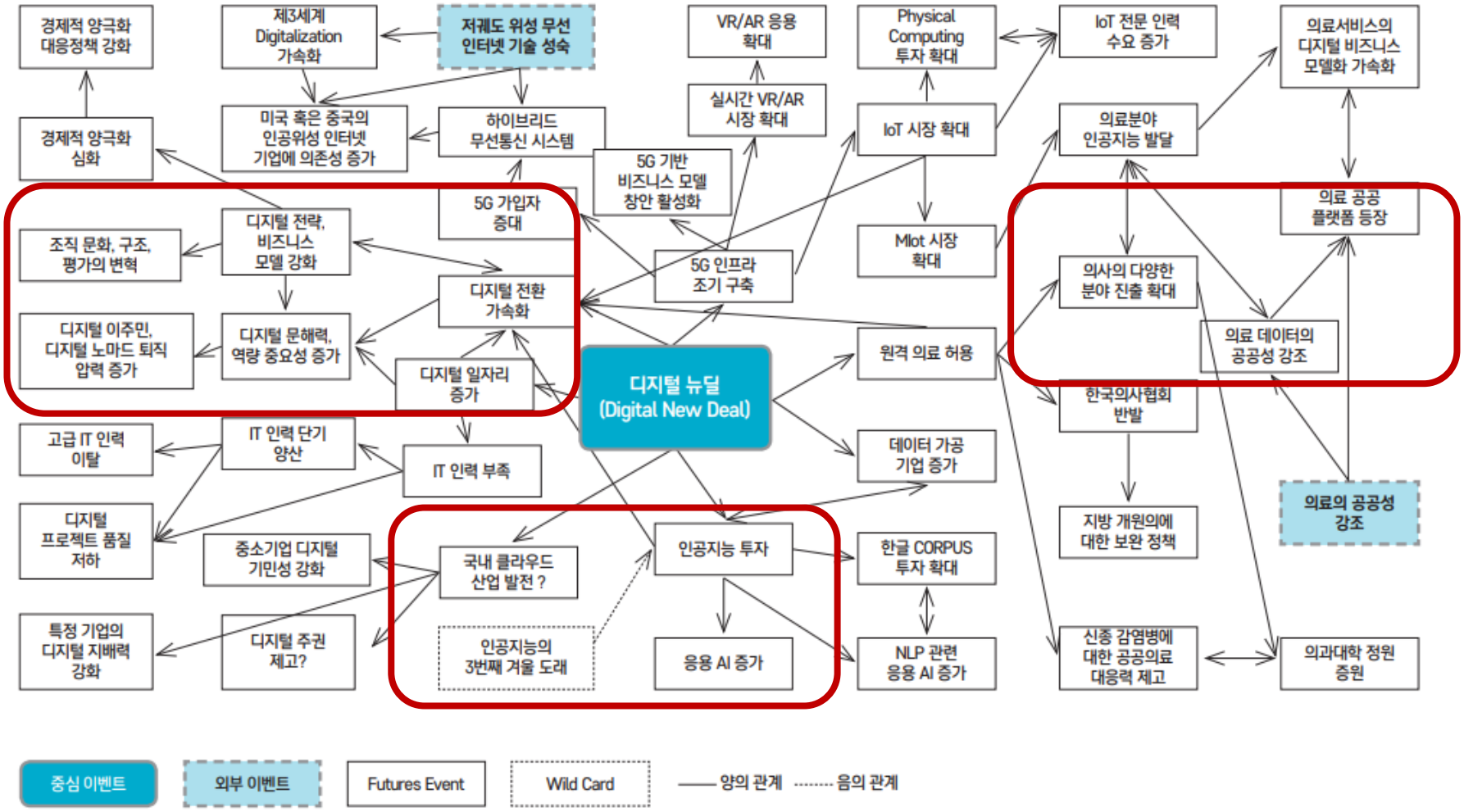
Research Goal



- Research Project
- Intelligent Government / Algorithm as an Infrastructure /AI Governance
- ICT4D (ICT for Development) with AfDB

Research Goal

Digital New Deal



THANK YOU