ISSN 1023-2842
中山管理評論 2022年二月號
第三十卷第一期 p.37-80
DOI: 10.6160/SYSMR.202202_30(1).0002

企業資訊系統採用：基於 TOE 模型之整合性分析

Organizational Adoption of Information Technology: A Meta-Analysis Based on the TOE Model

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本文引用格式建議：周彥君、黃冠傑、梁定澎，2022，「企業資訊系統採用：基於 TOE 模型之整合性分析」，中山管理評論，30 卷 1 期：37~80。
Suggested Citation: Chou, Y. C., Huang, G. J., and Liang, T. P., 2022, “Organizational Adoption of Information Technology: A Meta-Analysis Based on the Toe Model,” **Sun Yat-sen Management Review**, Vol. 30, No. 1, 37-80.

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摘要

企業對於資訊系統的採用是一個重要的研究議題，然而在過去相關的研究，對於可能影響因素及所產生的效果，彼此間有一定程度的分歧，因此本研究預期透過整合分析(meta analysis)彙整企業資訊採用文獻，而彙整的架構則使用整合各方觀點的 TOE 框架，完整將過往文獻所發現的影響因素依照科技、組織以及環境三構面加以統整，並透過整合分析的統計分析得出各因素在考量不同研究後的匯總效果，尤其所採用的隨機整合模型(random effect model)，對於估計出的匯總效果，具有外推到未知樣本(如：未收集或未來可能相關研究)的效力。本研究預期提出綜整性的企業資訊採用模型，嚴謹彙整出過去文獻顯著且一致的影響因子，更重要的是探討各因素在不同情境下的差異，顯示企業資訊系統採用的權變性質。

關鍵詞：科技-組織-外在環境框架(TOE)，組織採用，資訊科技，整合分析

Abstract

The organizational adoption of information technology (IT) has been an important research area for decades. A number of factors have been investigated, but some previous findings about their effects are inconsistent and need further consolidation. To address this need, this study aggregates previous findings using the meta-analysis. The TOE model is a major framework that includes factors associated with technology, organization, and environment, and it is comprehensive enough to absorb various variables examined in literature. Meta-analysis allows us to aggregate previous findings statistically to draw more robust conclusions regarding their effects. The random effect model can extend in-sample estimates to out-of-sample generalizability. While knowledge of some factors suffers from insufficient study and/or inconsistent findings, we identify factors that are significant and stable across studies. Furthermore, direction and strength of a factor is distinct across studies. We use the moderation analysis to show that effects of factors are contingent on the three contextual factors. Overall, we propose an integrated model for organizational IT adoption. The TOE framework provides the comprehensive dimensions, and 14 factors are identified with rigorous support of the meta-analysis. More importantly, the moderation analysis explores the impacts of contextual factors, relationships that may not necessarily be apparent from individual studies, leading to an extended TOE framework.

Keywords: Technology-Organization-Environment Framework, Organizational Adoption, Information Technology, Meta Research

1. Introduction

The organizational adoption of information technology (IT) has transformed business operations and significantly changed the way businesses compete. It has also been a major line of research in the Information Systems (IS) field. A major portion of IT adoption literature focuses on individual adoption, and several theories and some meta-research have been published (e.g., King & He, 2006; Ma & Liu, 2004; Sabherwal et al., 2006; Wu & Lederer, 2009). In contrast, organizational IT adoption has received less attention due to research complexity and the lack of a generally accepted theory. This gap may hinder our understanding of the role of IT in organizations.

IT innovation has profound impacts on firms. For example, organizational researchers have argued that IT infrastructures and process-compatible information systems are essential for firms to acquire competitive advantages (Buhalis, 1998; Broadbent et al., 1999). Although previous literature has studied the factors that influence firms' IT adoption (e.g., Kuan & Chau, 2001; Gu et al., 2012; Awa & Ojiabo, 2016), inconsistent and conflicting findings are not uncommon (Hameed et al., 2012). For example, some have argued that organizational size is associated with diverse resources and processes, which in turn positively affect organizations' capability to adopt innovations (e.g., Thong & Yap, 1995; Lin, 2014). In contrast, others have argued that small firms are more likely to adopt innovations because they have greater flexibility (e.g., Thong, 1999; Zhu & Kraemer, 2005). Additional studies have challenged the generalizability of findings. For instance, some studies have proposed that distinct samples, such as small and medium firms and countries other than the U.S., may be different (e.g., Al-Qirim, 2007; Lin & Ho, 2009; Ifinedo, 2011). Given these inconsistencies, Lee & Xia (2006) have conducted a meta-analysis of the role of firm size, while Hameed et al. (2012) have performed a meta-analysis of ten organizational factors to determine their relative impact and strength. These prior studies provide preliminary insights but do not propose a comprehensive theoretical framework that can integrate various dimensions of organizational IT adoption.

Given the lack of theoretical framework, Oliveira & Martins (2011) have conducted a literature review on firms' IT adoption and concluded that the technology, organization, and environment (TOE) framework is a solid theoretical basis to include various factors, and it has the potential to organize factors at the firm level. Following their suggestion, this study uses TOE as the theoretical framework to consolidate previous studies on organizational IT adoption. In order to examine the effect of the identified factors, we use meta-analysis to *rigorously* aggregate reported empirical findings. Our goal is to provide a more powerful observation of the factors that influence IT adoption at the organizational level and answer the following questions:

1. *What technological, organizational, and environmental factors have a significant effect on the adoption of IT innovation in organizations?*
2. *What are the relative effect sizes of these significant factors?*
3. *Do the effects of these factors vary between small and large firms, across different regions, and over time?*

Prior studies have revealed diverse factors associated with organizational IT adoption. An integrated framework to organize factors which are consistent across studies is needed to reveal the accumulation from the field, and pinpoint places for further exploration. Our goal is thus to use meta-analysis to robustly consolidate prior studies (e.g. Hameed et al., 2012; Gerow et al., 2014), and develop the integrated framework with rigorous statistical support. Specifically, we adopt the random-effect model for the meta-analysis, which is advantageous because the results are not limited to the collected studies but are generalizable to other related studies that are not addressed here (Hedges & Vevea, 1998; Card, 2012). The remainder of this paper is organized as follows. Section 2 summarizes relevant prior studies on firms' IT adoption and discusses the integrated TOE framework. Section 3 describes the steps of meta-analysis, and section 4 presents our findings on influential factors and the effect of the region of sample and time of study. Section 5 discusses research implications and potential directions for future research. Finally, section 6 concludes the paper.

2. Organization Adoption Of IT

2.1 Theoretical Background and Research Model

Research on IT adoption follows two major lines of inquiry: individual acceptance and organizational adoption. The former is based on human behavior and the factors associated with individuals (e.g., attitude and intention to use), while the latter is based on the assessment of net benefits and the impacts on organizations (e.g., firm performance). Research in organizational adoption includes two main theoretical lenses: economic and institutional perspectives. The economic perspective focuses on financial factors that affect the introduction of IT into an organization. In addition to rational decision theory in economics, which assesses feasibility by weighing the cost and benefit, another approach is the real option theory, which treats IT adoption as a real option (e.g., Benaroch and Kauffman. 1999; 2000). The institutional perspective is based on institutional theory, which argues, "*one cannot explain everything that happens in organizations by considering only the rational actions of managers, but rather one must find a means for taking into account the 'irrationalities' arising within the institutional context that surrounds organizational actors*" (Mignerat & Rivard, 2009). In other words, organizations must take the surrounding environment into account when making a technology adoption decision.

The TOE model Tornatzky & Fleischer (1990) have proposed is a popular framework for organizational IT adoption and is derived from the institutional perspective. It proposes three main dimensions that influence the adoption and/or implementation of innovations in organizations: features of the technology, organizational factors, and the context of the organization. This framework has been applied to analyze the adoption of a variety of technologies, such as enterprise resources planning (Pan & Jang, 2008), electronic commerce (e.g. Al-Qirim, 2007; Ifinedo, 2011), and cloud services (e.g. Hsu & Lin, 2016). Many factors associated with these dimensions have been identified and investigated in previous literature (see Reference for sample studies). Hsu et al. (2006) comment that the dimension of external context makes the TOE model appropriate for intra-firm IT innovations. Oliveira and Martins (2011) further suggest that, among various theories used in the literature about IT adoption, the TOE model is the comprehensive framework for IT adoption at the firm level.

Thus, in this study, our goal is to use the TOE framework as the theoretical underpinning to organize diverse factors of firms' IT adoption. To identify factors for each dimension of the framework, we use the meta-analysis to consolidate related literature (e.g. Wu & Lederer, 2009) and conclude those factors consistent across studies. Furthermore, inconsistent findings of determinants of organizational IT adoption are not uncommon. We aim to examine the moderation of contextual factors (see Section 2.4 for details). Overall, we would like to propose an integrated model of organizational IT adoption. Specifically, the integrated model is based on the three dimensions of the TOE framework. The integrated model thus contributes to the literature by specifying the content of each dimension with rigorous support of the meta-analysis, and take one step further to explore impacts of contextual factors, resulting in an extended TOE framework (see Figure 1).

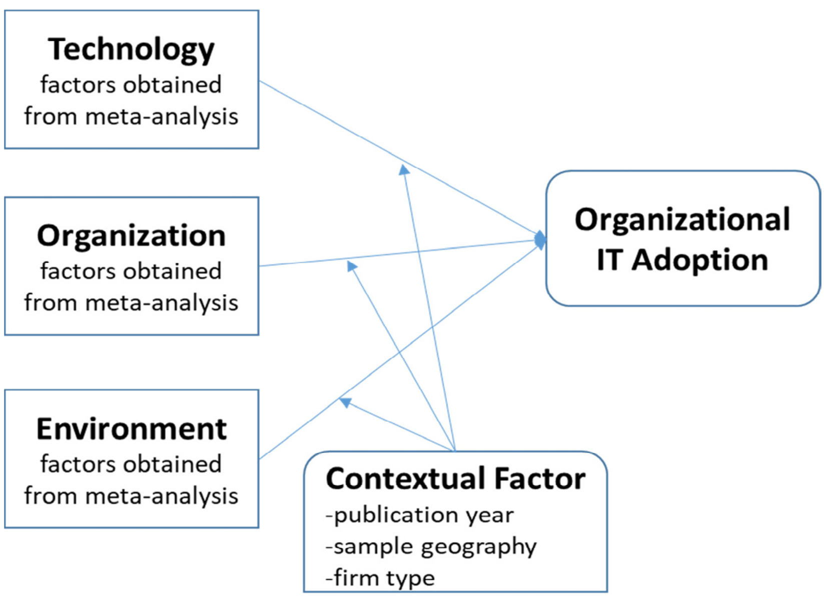

Figure 1: The research model

Data source: this research

2.2 Profile of Previous Organizational Adoption Research

In order to have a complete profile of previous literature related to the use of the TOE framework in IS research, we conducted a comprehensive literature search on Web of Science covering both journals (~12,000) and conference proceedings (~160,000). Key words used included "organization* adopt*" and "enterprise adopt*" to find relevant publications at the firm level, and "technology* adopt*," "ERP adopt*," and "enterprise resource planning adopt*" to broaden the coverage. The publication years ranged from 1986 to 2016, and the search resulted in 1,574 items. Figure 2 shows the trend of publication.

The results from the first search included a substantial quantity of articles that are not closely related to the organizational adoption of information technologies, and many do not provide adequate information for further analysis. Hence, we excluded studies that are not at the organizational level, such as those concerning individual and family adoption and those that were irrelevant to IT (such as studies related to agriculture or medical innovations). Conceptual pieces without empirical data were also excluded. This second screening resulted in 69 solid empirical studies closely related to the organizational adoption of IT and the TOE framework. Among the 69 studies, e-commerce and ERP are the top two applications, each accounts for 14 studies separately. Adoption about IT infrastructure, i.e. 5 studies for ICT, 4 works on RFID and, 3 papers on EDI, comes after.

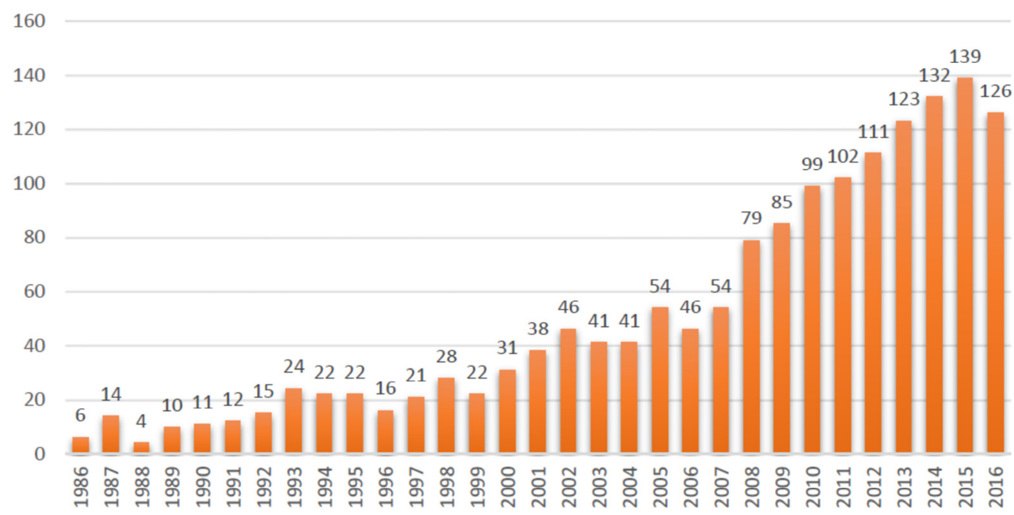

Figure 2: The trend of publications
Data source: this research

2.3 Key Factors that Influence Organizational Adoption

From the 69 studies, we identified major factors and their reported effects. Tables 1 show the frequency of factors associated with TOE and the findings from previous studies. Both significant and insignificant cases were counted. These tables indicate that the top three factors are perceived benefits (e.g. Awa & Ojiabo, 2016; Hoque, 2016), technological compatibility (e.g. Ahmad et al., 2015), and the relative advantages of new IT for technology (e.g. Hsu & Lin, 2016); top management support (e.g. Zorn et al., 2011; Sila, 2013), organization size (e.g. Al-Qrim, 2007; Ko et al., 2008); and IT competence for the organization (e.g. Hung et al., 2010); and competitive pressure (e.g. Lin, 2014), regulatory support (e.g. Ainin et al., 2015); and government support for the environment (e.g. Lin & Ho, 2009). The findings provide a profile of factors that have been investigated in previous studies, as well as factors that need further meta-analysis to examine their aggregated significance and effect sizes.

Table 1: Summary of studies for IT adoption

Factors	Significant	Insignificant
Technological Factors		
Perceived benefits	20	1
Technological compatibility	16	2
Relative advantages of new IT	13	1
Technological complexity	8	2
Perceived ease of use	6	2
Perceived usefulness	6	1
System security	5	0
Perceived system quality	3	0
Organizational Factors		
Top management support	25	3
Organization size	20	3
Organizational IT competence	16	0
Organizational readiness	15	2
Financial costs	8	2
Organizational knowledge capability	6	0

Factors	Significant	Insignificant
Organizational structure	6	1
Strategic intent	6	1
Subjective norms	4	1
Communication	4	0
Scope of business operations	4	1
Product champion	2	0
Environmental Factors		
Competitive pressure	20	5
Regulatory support	10	2
Government support	8	0
Trading partner's pressure	6	5
Social influence	6	0
Support from external consultants	2	3

Data source: this research

2.4 Contextual Factors

In addition to the main factors that have direct effects on organizational adoption, some aspects of the context of the study may moderate the impact of certain factors. The geographical region of the sample is a common contextual factor in the literature, as different regions and countries may have different cultures in terms of adopting technology. For example, Dewan and Kraemer (1998) have shown positive returns from IT investments for 17 developed countries, but each presented a different increasing rate. Similarly, some studies have used a mixed sample from countries in Asia and Western countries (e.g., Kim & Garrison, 2010; Ifinedo, 2011). It is worth examining whether different sample sources may moderate the effects.

The time a study was conducted is another key factor, as IT has evolved quickly. Different factors may be considered for the same organization with a technology adopted ten years ago and one adopted today. Most published literature uses the cross-sectional approach to collect and analyze data at a single time point. Hence, it is worthwhile to compare whether concerns vary over time through a meta-analysis. The third factor that is often used as a moderator is the type of firm, i.e., large firms and SMEs (small- and medium-sized enterprise). Previous research has reported that large firms have richer and more diverse resources that can contribute to adoption, while small businesses suffer from resource poverty (Lee & Xia, 2006); therefore, the two types of firms may react to IT adoption differently. Some studies have deliberately focused on small-to-medium enterprises (SMEs) and examined their reactions to IT adoption (e.g., Kuan & Chau, 2001; Ifinedo, 2011). Overall, sample geography, publication year, and firm type are three contextual factors that may moderate the effect of TOE factors.

3. Research Method

3.1 Sample Selection

Based on the 69 studies obtained from the screening described in Section 2.2, we further included six studies from Oliveira & Martins (2011) for a total of 75 studies as the sample for the meta-analysis (see References). We examined each paper carefully to distill useful data for analysis. Ultimately, we had to restrict our sample to studies that allowed for the statistical analysis of effect sizes.

First, we made sure that the target or the dependent variable was IT adoption. That is, we focus on whether a firm owns the type of information technology regardless of usage level.[1]. Studies that discussed the consequences or advantages of IT adoption but did not include adoption as a dependent variable were excluded. Furthermore, to integrate the magnitude and direction of each determinant, we removed studies without quantitative data, qualitative studies, cases, and literature reviews. Finally, we checked to make sure the paper provided correlation coefficients for the statistical aggregation of effect sizes. We used *correlation* instead of regression-like coefficients because the coefficients from regression-like models (traditional linear, logistic, and SEM) can be quite different when the variables used in the model are different. Missing variables or different control variables of models can lead to inconsistent and incomparable results. Effort was also spent to determine whether the unit of analysis was at the organizational level. Studies that did not meet all of the requirements were excluded from further analysis.

[1] Note that we consider usage of an information system as an indicator of adoption/ ownership of that information system. Because correlation coefficient is the key to perform the meta-analysis but quite a few do not supply this information, we then use this definition hoping to incorporate more studies for analysis.

After the strict screening process, we had 31 studies (listed in Appendix A) with which to perform rigorous statistical analysis. Table 2 shows the profile of these papers by their publication year, firm type, and sample geography. The type "*mixed*" indicates that a study contained more than one category, e.g., samples from both large and small firms. "*Not provided*" indicates a lack of clear description in the paper.

Table 2: Profile of 31 studies

Publication Year	Number	Firm Type[2]	Number	Sample Geography	Number
before 2000	2	large	5	Asia	18
2001–2005	4	small to medium	10	non-Asia	9
2006–2010	10	mixed	12	mixed	2
2011–2016	15	not provided	5	not provided	2

Data source: this research

3.2 Construct Coding

A total of 260 variables were identified from the 31 studies. For a meta-analysis, we needed at least two independent studies. Hence, we removed those with only one study to result in 185 variables covered by at least two studies.

The next step is to code the reported findings. It is possible that variables with the same names may not measure the same concept. Therefore, we read the definition and measurement of these variables to ensure that they could be compared properly. For example, "environmental uncertainty" in paper#56 is closer to "competitors' pressure" as defined in other studies. In paper#22, "cost" is actually cost savings, whereas others papers refer to the variable as "costs spent." In this case, the reported correlation coefficient was reversed in coding to reflect the opposite meaning in measurement. This calibration allowed the 185 variables to be grouped into 28 technological, organizational, and environmental factors. Tables 3-5 show the name and definition of each factor, as well as the associated alternative names used in the original studies.

[2] One of the studies provides empirical results for both small and large firms, leading 32 observed effects from 31 studies.

Table 3: Technological factors

Factor	Definition	Name of variables w/ similar meaning
Technological complexity	The level of difficulty the organizations perceive	Complexity, Perceived ease of use, Effort expectancy
IT infrastructure	Supporting hardware, software, IT staff for adopting new innovations	ICT infrastructures, Network reliability, Technology competence, IT capability
Technological compatibility	The extent to which the new innovation fits into existing processes and IT applications	Compatibility, Organizational compatibility, Technology integration
System security	The level at which the new innovation can protect important data assets	Security
Perceived benefits	Expected benefits from the new innovations	Perceived values, Awareness of benefits, Perceived relative advantage
Perceived usefulness	The extent to which the new innovations can enhance job performance	Perceived usefulness, Ubiquity
Relative advantages	The advantages of the new innovation relative to existing IT	Relative advantage, Performance gaps

Data source: this research

Table 4: Organizational factors

Factor	Definition	Name of variables w/ similar meaning
CEO age	CEO or senior management's age	CEO age
CEO education	CEO or senior management's education level	CEO education
Innovation of senior executives	CEO or senior management's attitude toward new innovations	CEO innovativeness, Innovation of senior executives, Openness
Competent project managers	Project manager's skills in problem-solving	Competent project managers, Self-efficacy
Subjective norms	Culture or social influences of an organization	Subjective norms, Social influence
Financial support	Expected financial resources for the new innovation	Financial support, Organizational budget, Financial commitment, Financial resources

Factor	Definition	Name of variables w/ similar meaning
Financial costs	Expected tangible costs of the new innovation	Financial costs, Cost savings
Top management support	CEO or senior management's involvement or attitude toward the new innovations	Top management support, Management attitude, CEO attitude, Perceived leadership in the field, Encouragement for innovation, Management support and commitment, Top management leadership, CEO's involvement
Technical know-how	A firm's IT capability, especially regarding knowledge of the new innovation	Technical know-how, Perceived technical competence, CEO IT knowledge, Employees' competence in IS, IS capabilities of staff, IT knowledge, Specialization, Skills of project team, IS expertise
Firm size	The number of employees	Size of the firm, Business size, Business scale, Size of organization, Number of employees, Size, Firm size, Company size
Organizational readiness	A firm's perceived resource readiness toward the new innovation, such as IT infrastructure, employee training, consultants, and budget	Organizational readiness, Maturity of information system, Facilitating condition, Coordination of organizational resources, Resource availability, Technology competence
Information intensity	The level of information intensity from the existing IS of a firm	Information intensity, Information strength, System quality
Champions	Leaders of the new innovation within a firm, who may not be top management but first-line workers	Champions
Global scope	The extent to which a firm is in the international market	Scope of business operations, Global scope, International scope

Factor	Definition	Name of variables w/ similar meaning
Absorptive capacity	A firm's absorptive capacity toward new knowledge	Knowledge management capabilities, Absorptive capacity
Satisfaction with existing IS	The level of user requirements matched by existing IS	Satisfaction with existing IS

Data source: this research

Table 5: Environmental factors

Factor	Definition	Name of variables w/ similar meaning
Partner's pressure	The force due to supply chain partners' adoption of the new innovation	Partner's pressure, Customer's pressure, Normative, Coercive, Lack of trading partner readiness
Institutional pressure	The force due to government regulations	Perceived government pressure, regulatory environment, Institutional pressure, Regulatory support
Competitive pressure	Competitiveness within the industry	Competitive pressure, Perceived industry pressure, Pressure from competitors, Competitiveness of environment, Degree of business competition, Competition intensity, Competitor scanning, Expected practice, Environmental uncertainty, Mimetic, Market uncertainty
External support	Government's or third-party institutions' support, e.g., subsidy or technical seminars	External support, Government support, Accountability
System provider's technical support	External IT support from consultants	Assistance from information consultants, System provider's technical support ability, IT support, Support from technology vendors, External change agents

Data source: this research

3.3 The Meta-analysis

The data coded in the previous step were further analyzed to separately calculate their aggregated effects on IT adoption. When the findings from different studies are consolidated, common concerns include the unequal sample sizes of studies, heterogeneities among research contexts, and the statistical inference of the aggregated findings. We applied the procedure of the meta-analysis to properly address these concerns and derive the aggregated effects from studies with rigorous steps. In particular, we applied the random effect model, whose findings are not limited to the collected studies, but are more likely to be generalized to a population of potentially related studies (Hedges & Vevea, 1998; Card, 2012). The details of each step are summarized in the following:

(1) Aggregate Correlation Coefficients from Studies: Unequal Sample Size Correction

After collecting correlation coefficients (*r*) over studies, the first step is to turn correlation into Fisher's Z *(Z_r)*. Because the correlation coefficient is not normally distributed and its variance is not constant, the Fisher's Z transformation is performed for the statistical inference of the aggregated effect from studies. Throughout the process, we used Fisher's Z for analysis. When reporting results, we then turned Fisher's Z back into the correlation coefficient, as the interpretation of the latter is more intuitive.

$$\mathrm{Z}_r = \frac{1}{2}\ln\left(\frac{1+r}{1-r}\right) \qquad\qquad \mathrm{r} = \frac{e^{2\mathrm{Z}_r}-1}{e^{2\mathrm{Z}_r}+1}$$

When aggregating findings over studies, we used weights to reflect various sample sizes. The diagram below shows that it is not reasonable to take a simple average of these studies. Study 1 has a small sample and has an estimate with variations, whereas study 2, which has a larger sample, shows a reliable estimate with little variability.

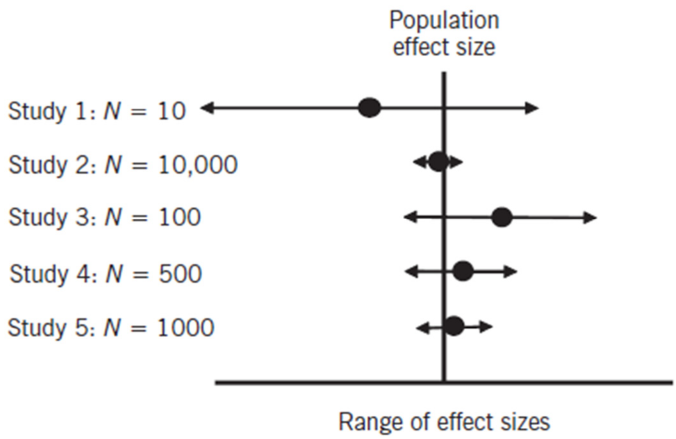

Figure 3: Illustration of effect sizes from studies

Data source: Card (2012)

The standard error of the Z-effect is inversely related to the sample size (N). We further used the inverse of the standard error (SE) to calculate the weight of each study (w). Therefore, the larger the sample size, the smaller the standard error, and the larger the weight (importance) of the study.

$$\mathrm{SE}_{Z_r} = \frac{1}{\sqrt{N-3}} \qquad w_i = \frac{1}{{SE_i}^2}$$

Accordingly, we used weights to aggregate estimates from studies with various sample sizes. The aggregated Fisher's Z ($\overline{ES}$) was calculated as in the following equation, where w_i is the weight of each study and ES_i is the Fisher's Z of each study:

$$\overline{ES} = \frac{\sum(w_i ES_i)}{\sum w_i}$$

The weighted average calculated from prior studies is then the expected effect of a factor on a firm's IT adoption. We note that this calculation is the so-called *fixed effect model*. The effect of a factor is considered fixed/constant.

(2) Check for Publication Bias

The meta-analysis we performed is based on the studies collected and by nature is limited because it cannot include the whole research population.

Publication bias, or "the file-drawer problem," refers to situations in which significant results are more likely to be published or emphasized in research keywords, while non-significant results tend to be neglected to file drawers or are undetected in keyword searches. As a result, our aggregated findings may be biased toward significant results. To address this concern, we computed the failsafe numbers (failsafe N) for the robustness check. The failsafe N indicates that the number of additional studies with zero effect size is required to make the aggregate effect have a non-significant level (Rosenthal, 1979). Therefore, the more additional studies are required, the more stable the meta-analysis is.

The calculation is as follows:

$$\mathrm{N} = \mathrm{k}\left(\frac{Z_c}{Z_\alpha}\right)^2 - \mathrm{k}$$

where the effect of each study is transformed into the normal deviate ($Z_i = \frac{ES_i}{SE_i}$); Z_c is the aggregation of the normal deviate of observed studies; Z_α is the significance level, e.g., 95% significance of the normal deviate; and k is the number of collected studies. The intuition of the statistic is to compare the observed significance level from the studies (Z_c) and the threshold level (Z_α). The result (*N*) is the additional studies with zero effect size that would make the observed significance level drop to the threshold, the border of the significance level. We note that the failsafe N shows the number of studies required to turn a coefficient into a *non-significant* level, so it is only meaningful to perform the robustness check on the *significant* aggregated coefficients.

(3) Apply the Random Effect Model for Generalizability

After checking the robustness of the findings against publication bias, we further applied the random effect model to address the issue of generalizability. In contrast to the random effect model, the fixed effect model assumes a fixed population effect size, and the aggregation from the collected studies is then the estimate. When applying another set of studies, the estimate is likely to be different. Thus, the estimate from the fixed effect model is limited to the set of collected studies (Hedges & Vevea, 1998). Instead of a fixed effect, the random effect model assumes that a population effect follows a distribution with mean and variations (see the diagram below). Each study provides an estimate whose confidence intervals overlap with the *distribution* of the population effect. The aggregated effect from studies is not fixed but the mean of the distribution allows for different estimates among studies. Thus, the aggregated effect from the random effect model is not limited to the collected studies but can be generalized to a population of potential studies, and those included are representative.

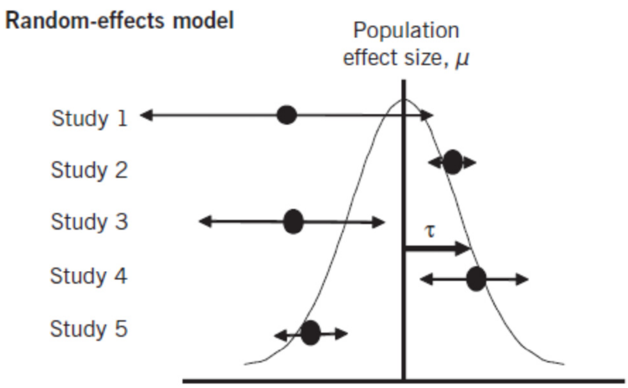

Figure 4: Random-effects model

Data source: Card (2012)

A simple example can illustrate the distribution assumption. Each person's height has an effect on weight. However, such an effect is not fixed but rather shows variations for different gender, age, or geographical groups. Therefore, the population effect should be a distribution that allows variations among groups. τ in the diagram indicates the variation of the distribution. In other words, we assume that each study is heterogeneous due to distinct contextual backgrounds. Thus, in addition to the sampling error of a study (SE), the random effect model considers the heterogeneity of a sample and includes the population variation (τ^2) in the weight of each study (w_i^*). The estimation of τ^2 is related to study heterogeneity and is discussed in the next step.

$$w_i^* = \frac{1}{\tau^2 + SE_i^2}$$

(4) Check the Applicability of Random Effect Model: Study Heterogeneity

To support the random effect model, the heterogeneity test is performed. The idea of the heterogeneity statistic (Q) is to compare the variability of effect size between studies ($(ES_i - \overline{ES})^2$) with the variability within a study (w_i=1/SE_i^2).

$$\mathrm{Q} = \sum (w_i (ES_i - \overline{ES})^2) = \sum \frac{(ES_i - \overline{ES})^2}{{SE_i}^2}$$

where w_i is the weight of the i-th study, ES_i is the effect size of the i-th study, and $\overline{ES}$ is the weighted average of effect sizes from studies without considering between-study variability. When the statistic is close to one, the variability between studies comes from sampling errors within a study. In other words, effect sizes have no variations, and studies are homogeneous. In contrast, when studies are heterogeneous, we would expect the heterogeneity statistic to be greater than one. The Q statistic follows the chi-square distribution. When the value of the Q statistic exceeds the threshold, we can reject the null hypothesis that studies are homogenous. In addition, we use the Q statistic to compute the between-study variability, i.e., the estimate of population variability. The equation is specified as follows:

$$\tau^2 = \frac{Q - (k-1)}{(\sum w_i) - \frac{(\sum {w_i}^2)}{(\sum w_i)}}$$

where τ^2 is the population variation, Q is the heterogeneity statistic, k is the number of studies, and w_i is the original weight of the i-th study. We also report the percentage of between-study variability relative to the total variability of an effect and indicate whether the result is statistically significant using the heterogeneity test.

(5) Adjust Aggregations Considering Population Variance and Examine the Confidence Interval

Finally, we used w_i^* to integrate effects over studies. $\overline{ES}$ is the weighted average Fisher's Z of a factor aggregated from the literature. Because Fisher's Z follows the normal distribution, we were then able to compute the

95% confidence interval for statistical inference (ES_{LB} and ES_{UB}).

$$\overline{ES} = \frac{\sum(w_i{}^* ES_i)}{\sum w_i{}^*} \qquad Z = \frac{\overline{ES}}{SE_{\overline{ES}}} \qquad SE_{\overline{ES}} = \sqrt{\frac{1}{\sum w_i{}^*}}$$

$$ES_{LB} = \overline{ES} - Z_{1-\alpha} SE_{\overline{ES}} \qquad ES_{UB} = \overline{ES} + Z_{1-\alpha} SE_{\overline{ES}}$$

We further transformed Fisher's Z back to the correlation coefficient (see the equation above). The correlation coefficient indicates the relationship between a factor and firms' IT adoption accumulated from the literature, the positive and negative sign, and the magnitude of the relationship.

4. Analysis Results

4.1 Overall Findings

Table 6 shows the results from the meta-analysis. For each factor, we report the number of studies included, the aggregated sample size, the fixed effect and random effect correlation, the percentage of random effect variance, and the fail-safe N. Overall, the cumulative sample size of all 31 studies is 14,450, and the sample size of individual correlation ranges from 281 to 10,294 with a median of 1,939. The aggregated effect is calculated using both the fixed effect and the random effect models. The random effect model assumes that an effect follows a distribution with mean and variations. Thus, the estimated distribution mean can allow variations not only from the collected studies but also from unseen studies. For generalizability, we interpreted findings mainly based on the random effect model. The fixed-effect and random-effect correlation coefficients were transformed from the aggregated Fisher's Z for better interpretation. We further calculated the 95% confidence interval for statistical inferences.

The percentage of random effect variance indicates the level of heterogeneity among studies and is used for the heterogeneity check. We performed a statistical test (Q statistic) to check for the significance of heterogeneity. The data associated with most factors met the heterogeneity requirement, as their between-study variations accounted for more than 50% of total variations. Thus, the use of the random effect model is appropriate, and the aggregated effect is not limited to the collected studies but, following the distribution assumption, is generalizable to other potential studies. The results in Table 6 show that most factors, except four organizational ones, satisfy the significance test of between-study heterogeneity.

To address the concern of publication bias, we included the failsafe N,[3] which indicates the number of additional studies with zero effect size required to make the effect of a factor be insignificant. In this study, we used the 95% significance level to calculate the number of additional studies required. In other words, we calculated the difference between the observed significance level and the threshold of a 95% level, and we used the gap to calculate the number additional studies required to reduce the observed level to below the 95% level. The stricter the significance threshold, the smaller the failsafe N number. In addition, the statistic is only meaningful for significant findings, and the notation "--" indicates no result for insignificant findings. Overall, the average of failsafe Ns is 692 for significant factors, and the majority of their failsafe Ns is greater than 100.

From Table 6, the effects of all seven identified factors in the technology dimension are significant. The perceived benefits, perceived usefulness, and technological compatibility of new IT innovation and firms' existing IT infrastructure were found to have significant and positive influence on firms' IT adoption, while the technological complexity of new IT was found to have a negative and significant effect on firms' IT adoption. Among these significant factors, we note that perceived usefulness is explored in only two studies and has a small failsafe N. While the effect is significant, we should interpret the result with caution. It is questionable whether this construct, while popular in individual adoption, is useful for organizational adoption. One possibility is to combine the concept into perceived benefits. Another finding that merits special attention is that the significance of the technological features of IT innovations, such as system security and relative (tech)

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[3] We note that the calculation of Zc for failsafe N is based on sampling errors only because all we know about a single study is its sampling errors (SEi). That is, failsafe N is based on fixed-effect estimates where only sampling errors are considered. In contrast, random-effect model has larger SE, sampling error and study heterogeneities, which makes estimates lean to the insignificant side. So, failsafe N from the fixed effect model is the upper bound of additional studies required for the random effect model.

advantages, are marginal ($p < 0.1$). The effect size of system security is high, which indicates its importance, but its role may vary in different adoption process.

Regarding the organizational dimension, 16 variables were identified, and many have only two to four studies (out of 31). This may indicate a problem, in that previous researchers did not have a set of common knowledge with respect to what organizational factors are important in adoption IT innovation. Organizational readiness, top management support, and technical know-how are the top three significant factors for IT adoption, while financial support and financial costs are financial factors with substantial impacts. In addition, firm size is often the critical factor discussed in the literature. Our findings are consistent with the literature in concluding that firm size has a significant, positive association with a firm's IT adoption. Interestingly, global scope as a factor related to firm size did not show a significant effect in the analysis.

The learning capability (absorptive capacity), competent project manager, and CEO age had weak and positive correlations with IT adoption, but the effects are not reliable given the small failsafe N. Other factors such as champions (system supporters), innovation of senior executives, and CEO education that were considered important in some studies were found to be insignificant. Furthermore, subjective norms, information intensity provided by existing IS, and satisfaction with existing IS were also found to be insignificant. In fact, we are not certain why an individual-level construct (e.g., subjective norms) was included in organizational-level studies. Those potentially important but marginally significant or insignificant factors may indicate potential research opportunities.

Regarding the environmental dimension, competitive pressure was the most popular construct and is shown to have a highly significant effect on IT adoption, but partner's pressure had the highest correlation coefficient. Institutional pressure (e.g., government regulations) was also a key environmental driver for IT adoption. The other two factors (external support and system providers' technical support) were significant in the fixed effect model but not significant in the random effect model. The results show that more studies are necessary before we can draw a definitive conclusion on their effects.

Table 6: Meta-analysis findings

Factor	# of studies	Sample size	Fixed -effect correlation	Random-effect correlation	% of random-effect variance	Failsafe N
Technological Dimension						
Perceived benefits	12	3,199	0.410***	0.453***	0.90***	2,705
Perceived usefulness	2	433	0.374***	0.389***	0.67*	49
IT infrastructure	10	5,619	0.371***	0.328***	0.98***	2,331
Technological compatibility	9	3,284	0.363***	0.268***	0.92***	826
Technological complexity	11	2,532	-0.231***	-0.193***	0.84***	385
System security	4	750	0.493***	0.409+	0.97***	209
Relative advantages of new IT	7	957	0.253***	0.208+	0.90***	111
Organizational Dimension						
Organizational readiness	7	5,088	0.448***	0.436***	0.97***	1,793
Top management support	14	3,803	0.373***	0.356***	0.91***	2,388
Technical know-how	12	4,519	0.311***	0.32**	0.98***	1,818
Financial support	4	2,098	0.325***	0.305***	0.70*	279
Financial costs	8	1,781	-0.294***	-0.245**	0.89***	322
Firm size	12	7,144	0.254***	0.299**	0.98***	1,319
Global scope	5	2,956	-0.018	-0.11	0.98***	--
Absorptive capacity	2	378	0.217***	0.213***	0.13	9
Competent project manager	2	1,347	0.133***	0.122**	0.40	11
CEO age	2	1,190	0.057*	0.057*	0	0
Champions	2	281	0.223***	0.313+	0.67+	11
Innovation of senior executives	5	806	0.211***	0.206+	0.90***	57
CEO education	2	1,190	-0.003+	0.066	0.75*	--
Subjective norms	2	793	-0.275***	-0.298	0.99***	49
Information intensity	4	589	0.088*	0.082	0.94***	2
Satisfaction with existing IS	3	353	-0.067	-0.021	0.45	--
Environmental Dimension						
Partner's pressure	7	4,394	0.296***	0.234**	0.91***	505
Competitive pressure	20	10,294	0.211***	0.203*	0.99***	1763
Institutional pressure	6	3,435	0.158***	0.172**	0.89***	158
External support	5	2,357	0.266***	0.203	0.99***	216
System provider's technical support	5	1,651	0.14***	-0.067	0.96***	0

+p<0.1, *p <0.5, **p<0.01, ***p<0.001

Data source: this research

4.2 Moderation Analysis

In order to explore the effect of three contextual variables associated with these studies (see Section 2.4), we conducted the moderation analysis. Our sample was coded into groups: sample geography (Asia and Non-Asia), firm type (small-to-medium, large, and mixed), and publication year (before 2010 and since 2010.[4] For each sub-group, we followed the steps of Section 3.3 to perform the meta-analysis and compare their results. Tables 7-9 show the significant results of the moderation analysis.

(1) Effect of sample geography

As researchers are interested in the culture effect, we compared sample sources from Asia and non-Asia firms (e.g., Kim & Garrison, 2010; Ifinedo, 2011). Our results in Table 7 show that the effects of factors differ between these two regions. Among these factors, IT infrastructure is significant only for non-Asia firms. Technological complexity and perceived benefits, top management support, existing technical know-how, and firm size are significant for both Asia and non-Asia firms, but their effects are stronger for Asian firms. Technological complexity and existing technical know-how have smaller failsafe Ns for non-Asia firms, which may mean that the comparison between Asia and non-Asia firms for these two factors should be interpreted with caution. Interestingly, competitive pressure is not significant in either geographic subsample. It is possible that competitive pressure is prominent for some industries only. This also indicates that *the findings reported in empirical studies need to be interpreted carefully, even when the effect is statistically significant*.

[4] We note that some studies do not provide sufficient contextual information for subsample classification, e.g. not disclosing firm type. Alternatively, some studies provide subsample analysis by the contextual information. Thus, it is possible that the number of studies of the moderation analysis may be greater or smaller than the original number of studies.

Table 7: Moderation analyses of sample geography

Variable		# of studies	Sample size	Random-effect correlation	Failsafe N
IT Infrastructure	Asia	5	2,239	0.216	--
	Non-Asia	4	1,062	0.394*	295
Technological complexity	Asia	7	1,637	-0.224**	217
	Non-Asia	4	895	-0.136**	20
Perceived benefits	Asia	10	2,575	0.472***	1,888
	Non-Asia	3	899	0.351***	136
Top management support	Asia	9	1,888	0.385***	980
	Non-Asia	4	869	0.303**	116
Technical know-how	Asia	8	1,753	0.387*	1,039
	Non-Asia	3	1,720	0.145*	25
Firm size	Asia	6	807	0.415**	246
	Non-Asia	4	3,856	0.308*	588
Competitive pressure	Asia	10	2,339	0.14	--
	Non-Asia	6	4,345	0.244	--

+p<0.1, *p <0.5, **p<0.01, ***p<0.001

Data source: this research

(2) Effect of firm type

Although firm size was already included in the prior studies as a variable, some studies have focused on a specific type of firm (e.g., small and medium or large firms). Hence, it is worth examining whether focusing on different firm types may affect the role of different factors. Table 8 shows the significant results on firm type, which are divided into small, large, and mixed subgroups. Moderation effects exist for seven variables, especially between large and small-to-medium groups. *Perceived benefits, top management support, IT infrastructure*, and *competitive pressure* have stronger effects for large firms than those for small-to-medium firms. Among these factors, *perceived benefits* and *top management support* are also significant for small firms but with smaller effects, while *IT infrastructure* and *competitive pressure* are insignificant for small firms. Other than these four factors, *technological complexity*, *technical know-how*, and *firm size* are significant for the small-to-medium firm group. All factors are significant for the mixed group.

Because the availability of prior studies was restricted in some contingencies (e.g., IT infrastructure for large firms), their estimated effects are naturally associated with a smaller failsafe N (i.e., a less reliable result). A small failsafe N may also indicate a mixed result from prior studies. Hence, we should interpret the results with caution if the failsafe N is relatively small.

Table 8: Moderation analyses of firm type

Variable		# of studies	Sample size	Random-effect correlation	Failsafe N
IT Infrastructure	Small-medium	2	523	0.446	--
	Large	1	163	0.266^{***}	0
	Mixed	7	4,933	0.3^{**}	1,260
Technological complexity	Small-medium	5	1,143	-0.166^{*}	56
	Large	1	39	-0.109	--
	Mixed	5	1,350	-0.228^{**}	131
Perceived benefits	Small-medium	5	1,825	0.46^{***}	774
	Large	3	476	0.597^{**}	113
	Mixed	3	620	0.397^{**}	92
Top management support	Small-medium	6	1,105	0.28^{***}	194
	Large	2	313	0.457^{***}	42
	Mixed	4	1,231	0.453^{**}	403
Technical know-how	Small-medium	5	1,560	0.461^{*}	785
	Large	3	1,289	0.142	--
	Mixed	2	346	0.238^{***}	13
Firm size	Small-medium	4	807	0.295^{***}	90
	Large	2	313	0.177	--
	Mixed	5	2,921	0.278^{*}	36
Competitive pressure	Small-medium	8	1,966	0.042	--
	Large	4	515	0.268^{***}	43
	Mixed	5	3,581	0.202^{***}	197

+p<0.1, *p <0.5, **p<0.01, ***p<0.001

Note that both technological complexity and IT infrastructure for large firms are identified in one study only. For these two, the random-effect estimate is the same as the fixed-effect estimate, as variations require estimates from multiple studies.

Data source: this research

(3) Effect of publication year

Another interesting issue is determining whether the effect of variables changes over time. The collected studies were divided into two subgroups: before 2010 and since 2010 (including 2010). For one thing, the time division makes the two subgroups, the prior composed of 14 studies, and the latter of 17 studies, with comparable sample sizes. For another, most sample studies are from two time periods: 2000s and 2010s (see Table 2). As most published literature uses cross-sectional data at a single time point, it is worthwhile to compare whether effects of factors vary over time. Table 9 shows the significant relationships. Overall, we find that the effects of *perceived benefits, top management support,* and *technological complexity* are stronger before 2010, whereas t*echnical know-how* and *competitive pressure* are insignificant before 2010 but become significant since 2010. While the above results are mostly reliable (failsafe N > 100), only one paper studied technological complexity before 2010, but more than 10 papers included it since 2010. This difference in study numbers shows that *the popularity of technological complexity, perceived benefits, and top management support has increased substantially*.

Table 9: Moderation analyses of publication year

Variable		# of studies	Sample size	Random-effect correlation	Failsafe N
IT Infrastructure	Before 2010	6	4,570	0.306^{*}	1,045
	Since 2010	4	1,049	0.359^{*}	251
Technological complexity	Before 2010	1	574	-0.41^{***}	39
	Since 2010	10	1,958	-0.166^{***}	174
Perceived benefits	Before 2010	4	862	0.618^{***}	331
	Since 2010	8	2,337	0.388^{***}	1,136
Top management support	Before 2010	4	899	0.424^{**}	259
	Since 2010	10	2,904	0.33^{***}	1,065
Technical know-how	Before 2010	5	2,030	0.36	--
	Since 2010	7	2,489	0.272^{***}	413

Variable		# of studies	Sample size	Random-effect correlation	Failsafe N
Firm size	Before 2010	7	6,003	0.268^{+}	556
	Since 2010	5	1,141	0.34^{*}	158
Competitive pressure	Before 2010	10	7,304	0.172	--
	Since 2010	10	2,990	0.236^{+}	469

+p<0.1, *p <0.5, **p<0.01, ***p<0.001

Note that technological complexity before 2010 is identified in one study only. For this factor, the random-effect estimate is the same as the fixed-effect estimate, as variations require estimates from multiple studies.

Data source: this research

5. Summary and Discussion

We have conducted a meta-analysis of the TOE model for the organizational adoption of innovative technology. We obtained a sample of 1574 potentially related papers to build a general profile, identified 69 empirical studies from further screening to remove inappropriate articles, and further identified 31 papers on 14,450 sampled firms, which provided adequate data for rigorous meta-analysis. A total of 260 variables were identified, and these were divided into 28 groups based on their similarity in definitions. Our analysis resulted in 14 variables that are significant ($p<0.05$), reliable (failsafe N > 100), and generalizable (the assumption of random effect variance significant). They are shown in Table 10. The effect magnitude of the factors indicates variable importance.

Still, other factors are significant with small failsafe Ns or are marginally significant. The reasoning is that those factors are dispersed in the literature, which indicates research opportunities to further confirm the findings. In addition, insignificant factors are originated from insufficient studies and/or inconsistent findings across studies. For example, prior studies for the effect of system provider's technical support are quite mixed (half positive and half negative), and therefore the aggregated effect is found to be insignificant. A potential research would be to examine the role of system provider's technical support, and even take one step further to discuss what moderators can explain the mixed results. Same applies to factors of satisfaction with existing IS, information intensity, subjective norms, CEO education, and innovation of senior executives. They all have different levels of mixed results in the literature, which requires researchers for further exploration.

Table 10: Supported TOE factors from the meta-analysis

Technology	Organization	Environment
Perceived benefits (r= 0.453)	Organizational readiness (r= 0.436)	Partner's pressure (r= 0.234)
Perceived usefulness (r=0.389)	Top management support (r= 0.356)	Institutional pressure (r= 0.203)
IT infrastructure (r= 0.328)	Technical know-how (r= 0.32)	Competitive pressure (r= 0.172)
Technological compatibility (r= 0.268)	Financial support (r= 0.305)	
Technological complexity (r= -0.193)	Financial cost (r=-0.245)	
	Firm size (r= 0.299)	

Data source: this research

Hence, our results make a significant contribution toward consolidating our knowledge about the role of TOE factors in organizational adoption. We further extend the model to include contextual factors; Figure 5 shows the resulting extended TOE model from our meta-analysis. The model includes 14 key variables that have been used in prior, published research and have been confirmed to have a significant effect on the organizational adoption of IT. Their individual effects are also moderated by the publication year, firm type, and sample geography.

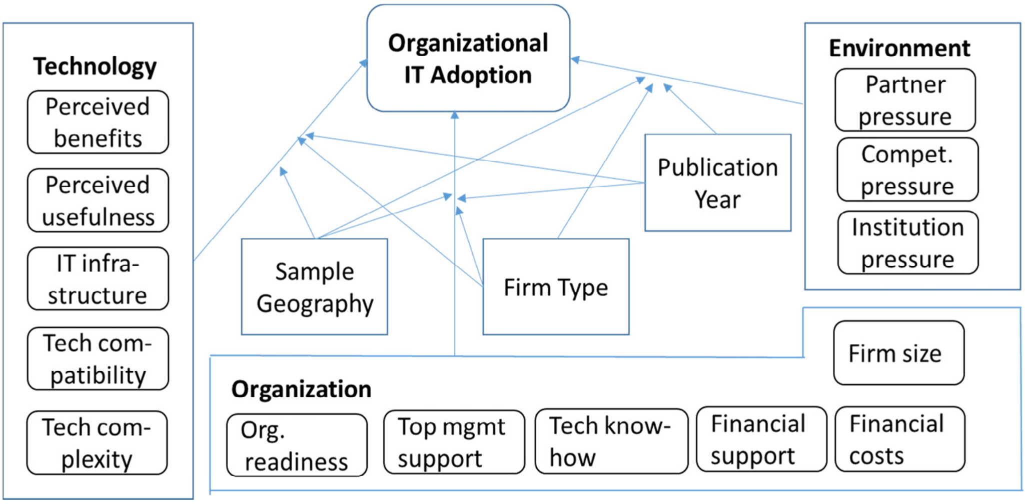

Figure 5. Resulting extended TOE Model

Data source: this research

The moderation effects are understandable, as different data sources indicate the effect of culture and many other social factors. Interestingly, we find that the top three effects are *perceived benefits, firm size*, and *technical know-how* for Asian firms, while the top three are *IT infrastructure, perceived benefits*, and *firm size* for non-Asian firms. This may indicate the relative lag of the IT infrastructure of Asian firms (insignificant), as they did not have a mature IT infrastructure compared with that of non-Asian ones. For common factors, the correlations of Asian firms are also higher in general. The effect of competitive pressure disappeared after dividing into two subgroups; thus, a potential follow-up study could explore whether the effects of competitive pressure exist in certain industries.

Publication year shows the evolution of the business and technology environment. When these papers were divided into two groups, *perceived benefits, top management support,* and *technology complexity* were the top three factors for studies published before 2010, whereas *perceived benefits, IT infrastructure,* and *top management support* were the top three factors for studies published since 2010. *Technical know-how* and *competitive pressure* ($p<0.1$) were not significant before 2010 but became significant afterward. The effect of *firm size* increased since 2010, which means that the larger firms capable of handling technology complexity were more willing to adopt IT. It is also interesting to see that *competitive pressure* was not significant before 2010 and became marginally significant afterward; this may indicate an increase in competitive pressure in the past.

When sample firms were divided into three subgroups by firm type, we also found some differences among them. All seven factors were significant for the mixed sample, while *IT infrastructure* was insignificant for small firms and *technology complexity, technical know-how,* and *firm size* were not significant for large firms. This makes sense, as small firms may not have mature IT infrastructure, and firms larger than a certain size can better handle technology complexity and technical know-how.

We notice that some estimated effects for the moderation of firm type were associated with a small failsafe N. For example, the effect of firm size was insignificant for large firms and was significant for the mixed samples with a small failsafe N. We further examined the original data in our sample and found that both positive and negative correlations were reported. The *insignificant result reflects the paradoxical effect of large firms in IT adoption (Thong & Yap, 1995; Thong, 1999; Lin, 2014), and it indicates that more studies are required.* In addition, a small failsafe N may indicate that few studies are in our sample (e.g., only one study for IT infrastructure for large firms). These factors also present potential research directions.

Our study is not without limitations. First, the meta-analysis was based on correlation coefficients; thus, studies that did not report correlation data were excluded. In addition, when performing the moderation analysis, some studies did not specify adequate contextual information, such as firm type and geographical area, which may cause misleading results. Furthermore, many studies do not cover several factors, and hence our results about them require more studies for confirmation. Given these limitations, our findings based on available data still provide a robust way to show factors that affect IT adoption at the organizational level.

6. Conclusion

The aim of this study was to consolidate technological, organizational, and environmental factors associated with IT adoption at the organizational level from previous studies. We integrated previously reported results and used meta-analysis to produce more robust findings. We adopted the *random effect model* for effect aggregation to find 14 significant factors out of 28 identified ones and the moderation effects of contextual factors such as sample geography, publication year, and firm type. The aggregated effect is *not limited to the collected studies*, but can be *generalized to other potential studies*.

The study has both academic as well as practical implications. From the academic front, as distinct results may be found in each study, we integrate those prior studies in terms of magnitude and direction of each determinant with a rigorous procedure. The consolidated findings allow scholars to have a better understanding of what factors are important for organizational adoption. This is especially valuable, as there are far fewer studies on organizational adoption than those on individual adoption. Furthermore, our meta-analysis also lists not-supported factors which either are dispersed or show mixed findings in the literature. Our analysis pinpoints these research gaps. For example, while top management support is with substantial influence, other roles like project managers and product champions are less important. A possible research question is to explore importance of these roles in organizations and even discuss heterogeneities of these roles. Researchers can benefit from these inconsistent findings for further exploration. Finally, the moderation analysis provides ample insightful knowledge about the contingency effect of different factors. Although the effects of some factors are common, others vary substantially in different contexts. This provides a rich basis for future research and new lenses for interpreting the effect of certain factors. Finally, the combination of our findings extends the TOE model, which suggests that researchers should explicitly include certain moderators when using the model in the future.

As for practical implications, the 14 key variables with substantial and robust effects can serve as a common guideline for practitioners facing adoption of distinct ITs at the organizational level. The proposed guideline is robust against 14,450 firms for various IT adoptions and effective in different time periods. In addition, magnitudes of these factors indicate that organizational and technological factors have larger associations than environmental factors. As a result, at the operational level, firms can allocate efforts and resources accordingly. Last, effects of factors vary by context. For example, existing IT infrastructure is not critical to Asian and small firms, but it matters, otherwise, to non-Asian and large firms. Firms are suggested to explore impacts of contextual factors and adjust adoption strategies accordingly.

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* indicating the initial 75 studies for the meta-analysis

Appendix A: studies matched with criteria of the meta-analysis

Studies	Year	Area	Firm Size
A model of adoption determinants of ERP within T-O-E framework	2016	Port Harcourt, Nigeria	SME
A model of the adoption of radio frequency identification technology: The case of logistics service firms	2012	Taiwan	mixed (large and SME)
A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework	2001	Hong Kong	SME
Adoption of information and communication technology for development: A case study of small and medium enterprises in Bangladesh	2016	Bangladesh	SME
An Empirical Analysis of Factors Influencing Internet/E-Business Technologies Adoption by SMEs in Canada	2011	Canada	SME
An Empirical Study of Factors Affecting e-Commerce Adoption among Small- and Medium-Sized Enterprises in a Developing Country: Evidence from Malaysia	2015	Malaysia	SME
CEO Characteristics, Organizational Characteristics and Information Technology Adoption in Small Businesses	1995	Singapore	SME
Critical factors influencing the adoption of data warehouse technology: a study of the banking industry in Taiwan	2004	Taiwan	non-SME
Critical Factors of ERP Adoption for Small- and Medium-Sized Enterprises: An Empirical Study	2012	Taiwan	SME
Critical factors of hospital adoption on CRM system: Organizational and information system perspectives	2010	Taiwan	mixed (large and SME)
Determinants of government bureaucrats' new PMIS adoption: The role of organizational power, IT capability, administrative role, and attitude	2008	South Korea	mixed (large and SME)
Enterprise resource planning adoption and satisfaction determinants	2016	An European country (Portugal)	mixed (large and SME)
Factors affecting the adoption of B2B e-commerce technologies	2013	North America	mixed (large and SME)
Factors affecting the adoption of cloud services in enterprises	2016	Taiwan	non-SME and SME

Studies	Year	Area	Firm Size
Impact of adoption of Green IT practices on organizational performance	2016	Iran	mixed (large and SME)
Institutional and Non-institutional Influences on Information and Communication Technology Adoption and Use Among Nonprofit Organizations	2011	Not provided	Not provided
Organizational characteristics and the CRM adoption process	2008	Korea	mixed (large and SME)
Post-Adoption Variations in Usage and Value of E-Business by Organizations: Cross-Country Evidence from the Retail Industry	2005	Brazil China Denmark France Germany Japan Mexico Singapore Taiwan (China) United States	mixed (large and SME)
Propensity to adopt technological innovations: the impact of personal characteristics and organizational context	1999	USA	non-SME
RFID technology adoption and supply chain performance: an empirical study in China's logistics industry	2009	China	mixed (large and SME)
The adoption of e-Commerce communications and applications technologies in small businesses in New Zealand	2007	New Zealand	SME
The Effect of System Characteristics, Stage of Adoption, and Experience on Institutional Explanations for ERP Systems Choice	2009	Not provided	Not provided
The entrepreneur's perception on information technology innovation adoption: An empirical analysis of the role of precipitating events on usage behavior	2012	Malaysia	SME
The indirect impacts of management support and commitment on knowledge management systems (KMS) adoption: Evidence from Malaysian Technology Industries	2011	Malaysia	Not provided

Studies	Year	Area	Firm Size
Understanding the determinants of electronic supply chain management system adoption: Using the technology-organization-environment framework	2014	Taiwan	non-SME
Understanding the Determinants of Information Technology Adoption. Evidence from Italian Manufacturing Firms	2007	Italy	mixed (large and SME)
Understanding users' behaviors regarding supply chain technology: Determinants impacting the adoption and implementation of RFID technology in South Korea	2010	South Korea	Not provided
Unified Modeling Language (UML) IT adoption—A holistic model of organizational capabilities perspective	2012	North American	mixed (large and SME)
Determinants of e-business diffusion: A test of the technology diffusion perspective	2008	Taiwan	non-SME
The Process of Innovation Assimilation by Firms in Different Countries A Technology Diffusion Perspective on E-Business	2006	Brazil China Denmark France Germany Japan Mexico Singapore Taiwan (China) United States	mixed (large and SME)
Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors	2003	Germany UK Denmark Ireland France Spain Italy Finland	Not provided

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