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# Understanding the determinants of electronic supply chain management system adoption: Using the technology–organization–environment framework

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ABSTRACT

Based on the technological innovation literature and technology–organization–environment framework, this study develops a research model to investigate the determinants of electronic supply chain management system (e-SCM) adoption across non-adopters and adopters. The research model examines the influence of technological context (perceived benefits and perceived costs), organizational context (firm size, top management support, and absorptive capacity), and environmental context (trading partners and competitive advantage) on e-SCM adoption. Data gathered from 283 IS managers (127 for non-adopters and 156 for adopters) in large Taiwanese firms were employed to test the relationships between the research model constructs using the logistic regression analysis. The results reveal that firms with certain perceived benefits, perceived costs, top management support, absorptive capacity, and competitive pressure are more likely to adopt e-SCM. While technological context is a major determinant of the decision to adopt, it has no direct effect on the extent of e-SCM adoption. The extent of e-SCM adoption is mainly determined by organizational and environmental contexts. Implications for practice and research are discussed.



## 1. Introduction

Electronic supply chain management system (e-SCM), as a form of Internet-based interorganizational system (IIOS), offers firms a platform to enhance communication, coordination, and collaboration across organizational boundaries, and thus is essential to increased competitiveness [1]. Compared to early forms of IIOS, such as Internet-based electronic data interchange (EDI), e-SCM relies heavily on socio-technical interactions (e.g., shared database and joint decision making support) to permit the integration of fragmented, silo-oriented supply chain processes with low cost and rich content [2,3]. E-SCM has been discussed in the literature as a technology that can provide adopters with several operational and strategic advantages. While the short-term, operational goal of e-SCM is to increase productivity and reduce inventory and cycle time, the long-term objective focuses on the improvement and innovation of the end-to-end processes between companies, their customer, and suppliers [3–5]. Although e-SCM efforts sometimes fail to reach forecasted results, e-SCM is now a strategic management system to improve competitive position and a major concern for top-level managers [6,7]. Therefore, identifying and understanding the factors influencing the e-SCM adoption decision is one of the fundamental requisites for development of e-SCM solutions.

Although e-SCM adoption is considered a core competence that organizations use to achieve business success, organizations face several critical challenges to adopt e-SCM. These challenges are identified below. First, the *technological challenge* facing organizations is to analyze the costs and benefits associated with e-SCM adoption. E-SCM adoption requires investment in necessary Internet technologies, as

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well as other supporting hardware, software and employee training [8]. Firms are often concerned with the expected costs versus benefits of adoption. Therefore, perceived benefits and costs of e-SCM influence its adoption and diffusion. Second, the *organizational challenge* is to foster a progressive and innovative organizational culture. The effectiveness of new technology adoption mainly depends on investment of time and effort in learning. Insufficient knowledge and skills for managers and employees can therefore become a serious barrier to e-SCM success [9]. Previous studies have shown that management commitment and employment involvement are important to new technology adoption [10,11]. Finally, the *environmental challenge* is to closely collaborate with trading partners (i.e., suppliers, carrier partners, and customers) and thus motivate e-SCM adoption and diffusion. Previous researchers have observed that firms can successfully adopt e-SCM both by establishing long-term mutual trust relationships and improving communication among supply chain members [12].

The challenge can be resolved by identifying various contextual factors that determine firm adoption decisions regarding e-SCM, which can be either internal or external to the organizations. For example, IS studies have suggested that the advantages and disadvantages of supply chain software, including its perceived benefits and costs, significantly determine adoption decisions in organizations [13]. Since adopting e-SCM involves substantial effort in development organizational change and significantly impacts business processes, many organizational factors may influence this adoption decision [4,14]. Moreover, Ke et al. [2] and Wu and Chang [15] suggested that environmental factors related to customers, business partners, as well as competitors influence Internet-enabled supply chain innovations. Despite growing recognition of the importance of technological, organizational, and environmental factors in e-SCM adoption intention, we know of no prior empirical studies that directly explored the influence of technological, organizational, and environmental factors on the decision to adopt e-SCM and the extent of e-SCM adoption.

This study aimed to examine the influence of technological context (perceived benefits and perceived costs), organizational context (firm size, top management support, and absorptive capacity), and environmental context (trading partners and competitive advantage) on e-SCM adoption. The research model and hypothesized relationships are tested by data collected from IS managers in Taiwan. Furthermore, the findings of this study contribute to empirical research on contextual factors that influence e-SCM adoption decision using a broad data set rather than a few isolated cases. From the managerial perspective, given the importance of e-SCM adoption in contemporary organizations and also in the future, the findings of this study are designed to enable e-SCM project managers and practitioners in formulating policies and targeting appropriate contextual factors to support effective e-SCM adoption.

## 2. Theoretical background

The two main areas of research that provide theoretical foundations for this study are the technology adoption perspective and the contexts of e-SCM adoption. Key research on these areas is briefly reviewed below.

### 2.1. Technology adoption perspective

The relationship between IS applications and organizational change is always a central concern in the field of IS innovation [16]. The phenomenon of IS-driven organizational change can be termed an information technology (IT) innovation [17]. According to the technological innovation literature [18,19], IT innovation adoption generally refers to the adoption of new methods, processes, or production systems; it intends to maintain or improve firm performance and to respond to changes in the external environment [20,21]. Unlike early forms of IIOS, e-SCM uses different features, including information exchange capabilities, joint decision making support and business process integration, to conduct value chain activities [2,3].

The adoption of e-SCM also significantly impacts business process change, collaborative relationships among trading partners, and even business transformation [22,23], therefore, e-SCM adoption can be viewed as an "IT innovation adoption". The process of IT innovation adoption has been divided into a variety of stages; for instance: initiation, adoption, and implementation [24]; comprehension, adoption, implementation and assimilation [25]; knowledge awareness, evaluation, adoption, implementation and expansion [26]; and initiation, adoption and routinization [27]. As stated earlier, these stages can be grouped into two more general stages of initial adoption decision and post-adoption (continued use), often referred to as initiation (adoption decision) and implementation [19,28]. Therefore, based on the above theoretical considerations and literature review, this study specifies two levels of e-SCM adoption: likelihood of e-SCM adoption and extent of e-SCM adoption. The former refers to whether the firm has begun to adopt e-SCM. The latter involves the extent to which the firm had implemented e-SCM to support various business functions in the supply chain.

### 2.2. The contexts of e-SCM adoption

A theoretical model for e-SCM adoption must consider factors that influence the propensity to evaluate, adopt, and implement the IT innovation, which are rooted in specific firm technological, organizational and environmental contexts. The technology–organization–environment (TOE) framework serves as an important theoretical perspective for studying contextual factors [29]. The TOE framework identifies three aspects that may influence organizational usage of IT innovation: (1). technological context refers to adopter perceptions of technological attributes; (2). organizational context refers to descriptive characteristics of the organization, including firm size and scope, complexity of firm managerial structure, and quality and degree of its human resources; and (3). environmental context refers to the firm industry and its dealings with trading partners, competitors and government [29].

The TOE framework has consistent empirical support in the IS domain. For example, empirical studies using the TOE framework have examined and consistently found support for

determinants of electronic data interchange (EDI) adoption, including perceived cost–benefits of EDI, financial resources, IT resources, and the regulatory environment [30–32]. Hsu et al. [33] applied the TOE framework in U.S. firms to explain determinants of e-business use, finding support for the importance of perceived benefits, organizational readiness, and external pressure, as well as the regulatory environment. A more recent survey by Teo et al. [14] developed a perception-based TOE framework incorporating six factors (perceived benefits, perceived costs, firm size, top management support, information sharing culture, and business partner influence) as important antecedents of e-procurement adoption intention. Drawing on the empirical evidence, combined with the literature review and theoretical perspectives discussed above, this study hypothesized that the TOE framework is appropriate for studying e-SCM adoption, because e-SCM is enabled by the characteristics of IT innovation itself, driven by organizational readiness, and influenced by environmental factors, especially the situations of suppliers, customers, and competitors [8].

## 3. Research model and hypotheses

Grounded in the two levels of e-SCM adoption and technology adoption contexts discussed above, this study develops the research model as shown in Fig. 1. Drawing on earlier discussion, this study posits that likelihood of e-SCM adoption and extent of e-SCM adoption are dependent variables. The research model also incorporates technological, organizational, and environmental contexts as important determinants of two levels of e-SCM adoption. After reviewing the TOE framework and considering the context of e-SCM, this study proposes those factors that are expected to influence e-SCM adoption. First, the technological context comprises the characteristics of e-SCM that reflect its advantages and disadvantages to businesses. The main focus of technological context is on how technology characteristics influence the adoption decision. Increased availability of cost–benefit information can significantly increase firm motivation to adopt e-SCM [9,13,32]. E-SCM involves the use of the Internet and related technologies to perform integration activities across an organization and throughout the supply chain, and the literature has strongly emphasized particular collaborative relationships rather than the general IS adoption environment [34,35]. Because e-SCM integrates suppliers and customers to achieve the integrated value chain activities, it may have new features compared to previous generations of IS adoption. When an organization makes a decision on whether to adopt a new technology, a cost–benefit analysis is considered an unavoidable process [36]. Therefore, this study incorporates perceived benefits and costs within the technological context.

Second, firm size is one of the organizational characteristics that have been found to influence an organization's success in IS adoptions. Frambach and Schillewaert [37] stated that larger organizations are more inclined to adopt IS-enabled innovations to support and improve their performance. E-SCM adoption requires changes in the workflow and business processes of firms and their trading partners [38]. Therefore, top management support is essential to overcome barriers and resistance to change. Additionally, firms with greater ability to acquire, assimilate, transform,

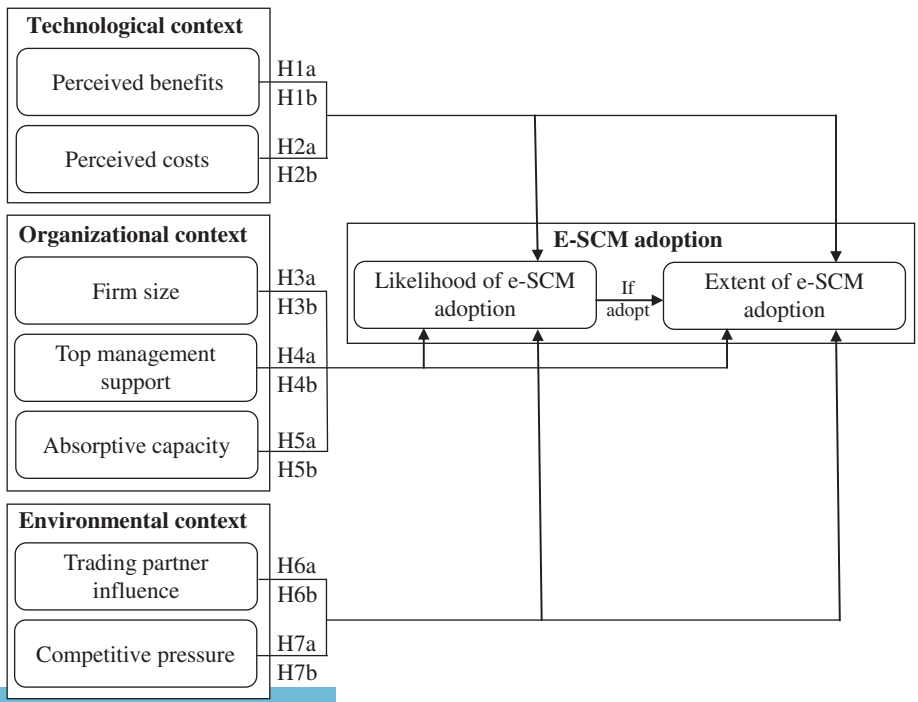


**Fig. 1.** Research model.

and strategically exploit knowledge and skills (i.e., to build absorptive capacity) are more likely to have and implement formal plans for IS development [39,40]. Thus, this study includes firm size, top management support, and absorptive capacity within the organizational context.

Third, because the environment presents both opportunities and constraints for IT innovation adoption, e-SCM is influenced by environmental factors related to competition and interorganizational relationships [34,38]. Furthermore, e-SCM involves multiple business functions that enable firm to trade with wider partner base and compete in broader market segments [41], trading partner influence and competitive pressure would be significant facilitators to e-SCM adoption. Therefore, trading partner influence and competitive pressure are critical factors that should be examined within the environmental context.

In summary, this study adopted the TOE framework and adapted it to the e-SCM domain, thus providing a conceptual guideline for explaining important determinants of e-SCM adoption. The research model (see Fig. 1) with the two levels of e-SCM adoption is a function of technological (perceived benefits and perceived costs), organizational (firm size, top management support, and absorptive capacity), and environmental contexts (trading partner influence and competitive pressure). The variables in the research model and hypotheses are detailed below.

### 3.1. Technological context

Perceived benefits refer to the degree to which e-SCM is perceived as providing the benefits to the organization. Moore and Benbasat [42] found that perceived benefits of an innovation are positively related to the rate of adoption. Correspondingly, the potential of e-SCM reported obvious benefits such as facilitating information sharing both within the firm and among trading partners, providing better products or services, and enhancing competitive advantages [6,43]. Although the construct of perceived benefits has been operationalized somewhat differently across different IS studies, it has consistently been found to be a significant predictor of IS adoption [14,44,45], as well as the extent of use [46]. In general, when decision makers perceive clear overall organizational benefits of e-SCM, they are more likely to expedite e-SCM adoption or increase the extent of e-SCM adoption. The above arguments lead to the following hypotheses:

**H1**. Perceived benefits of e-SCM will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

Prior studies have shown that costs inhibit technology adoption [32,36,47]. Smooth adoption of e-SCM requires substantial administrative and implementation costs, as well as investment in operating, setup, and training costs. Firms which perceive these costs to be unduly high or that are unable to invest financially will be reluctant to adopt e-SCM. Zhu et al. [8] further argued that the cost of implementing necessary technologies for online transactions, including installing hardware and software, as well as employee training, was a significant barrier for some organizations to adopt e-business initiatives. The above arguments lead to the following hypotheses:

**H2**. Perceived costs of e-SCM will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

### 3.2. Organizational context

Firm size has been established in previous research as an important determinant of IT innovation adoption [48,49]. Larger organizations have been found more likely to adopt new technology, as they have more resources, flexibility and ability to take risks [50,51]. The adoption of e-SCM requires greater technological and financial resources, and is more easily achieved in large firms [52]. It is therefore hypothesized that:

**H3**. Firm size will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

To create a positive environment for IS adoption, top management is crucial in influencing organization employees, and in providing organizational vision or commitment [46]. Previous studies have identified top management support as crucial in enhancing the incorporation of technology into business processes, which facilitates IS adoption and usage [53–56]. Intervention from top management is necessary to ensure commitment of resources and cultivation of organizational climate conducive to successful e-SCM adoption. In this study, top management support refers to the degree to which top management understands the importance of e-SCM adoption and the extent to which top management is involved in the e-SCM projects. Managing employees and promoting their acceptance of e-SCM projects are possibly the main consideration for firms to adopt and continue using e-SCM. It is therefore posited that:

**H4**. Top management support will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

Absorptive capacity is defined as the ability to enable firms to effectively acquire and utilize external and internal knowledge, and thus create an opportunity for profits [57,58]. Zahra and George [59] further specified that absorptive capacity is a set of organizational routines and processes, by which firms acquire, assimilate, transform, and exploit knowledge to create other capacities and ultimately to promote change in the organization. Although e-SCM adoption has technical components, management issues must be addressed regarding changes in organizational processes and interaction both within a firm and among firms [11]. Firms might confront significant barriers in conducting IT innovation adoption, such as lack of absorptive capacity among knowledge workers [39,40]. Schilling [60] stated that through absorptive capacity, firms expand their knowledge and skill base, improving their ability to facilitate the future IS development. Tu et al. [61] also suggested that firms with a greater absorptive capacity put more effort in interorganizational collaboration relationships. In the context of e-SCM adoption, a firm may absorb knowledge from supply chain partners on how to adopt e-SCM initiatives between the

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two organizations. Firm absorptive capacity can determine organizational adaptability [62], and thus is expected to increase the likelihood and extent of e-SCM adoption. Based on that discussed above, it is suggested that:

**H5**. Absorptive capacity will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

E-SCM differs from stand-alone technologies in that it must be co-adopted by multiple organizations. This means that, to gain more benefits, organizations that have adopted e-SCM wish to see their trading partners also adopt the technology. Hence, trading partner influence is a key ingredient for the successful implementation of e-SCM [11]. In fact, previous researchers have examined that the influence of trading partners is a crucial factor on inter-organizational systems and EDI applications [63–65]. Yao et al. [5] also claimed that e-SCM can deal with uncertainty by creating interorganizational links that can enable firms to maintain long-term benefits by links between firms and their trading partners. Accordingly, organizations are expected to maintain effective buyer–supplier relationship to increase the likelihood and extent of e-SCM adoption. It is argued, therefore, that:

**H6**. Trading partner influence will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

Competitive pressure drives organizations to seek competitive advantages by adopting a new technology. Numerous studies have identified competitive pressure as an important determinant of degree of computerization [66], EDI diffusion [67], adoption and use of e-business [68], or cloud computing adoption [49]. This study defines competitive pressure as pressure resulting from a threat of losing competitive advantage, forcing firms to adopt and implement e-SCM. E-SCM can be viewed as a form of technological and business services innovation with the potential to improve organizational and supply chain-wide performance by increasing transaction efficiencies and coordination effectiveness [5]. Firms that are first-movers in deploying e-SCM have tended to derive the greatest advantages. Hence, e-SCM is expected to be adopted and implemented most successfully in highly competitive environments. Based on the discussion above, it is suggested that:

**H7**. Competitive pressure will be positively related to (a) the likelihood of e-SCM adoption and (b) the extent of e-SCM adoption.

## 4. Research methodology

### 4.1. Sample and data collection

Empirical data to test the hypothesized relationships were obtained by using a mail survey of large Taiwanese companies. The questionnaire items were revised on the basis of results of the expert interviews and refined through rigorous pre-testing to establish content validity. The pre-testing focuses on instrument clarity, question wording and validity. During the pre-testing, three MIS management professionals and three IS managers were invited to comment on the questions and wordings of questionnaire. The comments of these six individuals then provided a basis for revisions to the construct measures.

The participants of this study were randomly selected from 1000 firms of the top 1600 Taiwanese firms, published by 2011 Common Wealth Magazine. To ensure that IS managers received the questionnaire and maximize the response rate, four research assistants spent one month telephoning these 1000 firms; they asked for the name of the IS managers in their companies. A cover letter explaining the study objectives and a stamped return envelope were enclosed. Follow-up letters were sent approximately one month after the initial mailing.

Two hundred ninety one of the 1000 firms responded, with 283 having complete data available for subsequent analysis, yielding an effective response rate of 28.3%. Based on self-reported e-SCM adoption, the sample was split between non-adopters and adopters. Respondents, whose companies had not adopted e-SCM, were classified as non-adopters, whereas respondents whose companies had adopted e-SCM were classified as adopters. The final sample consisted of 283 respondents, of which 127 were non-adopters and 156 were adopters. Table 1 shows the characteristics of the responding firms in terms of industry, total assets, number of employees, working experience, and respondent title.

**Table 1**
The characteristics of the sampling firms and respondents.

| Demographics | Non-adopters ($n_1 = 127$) | | Adopters ($n_2 = 156$) | |
|---|---|---|---|---|
| | Frequency | % | Frequency | % |
| *Industry types* | | | | |
| Traditional manufacturing | 52 | 40.9 | 36 | 23.1 |
| High-tech manufacturing | 33 | 26.0 | 71 | 45.5 |
| Service (software/retailing) | 42 | 33.1 | 49 | 31.4 |
| *Number of employees* | | | | |
| Less than 500 | 25 | 19.7 | 28 | 17.9 |
| 501–1000 | 40 | 31.5 | 31 | 20.0 |
| 1001–3000 | 34 | 26.8 | 34 | 21.8 |
| 3001–5000 | 21 | 16.5 | 40 | 25.6 |
| More than 5000 | 7 | 5.5 | 23 | 14.7 |
| *Total assets (NT$)* | | | | |
| Less than $10 billion | 48 | 37.8 | 41 | 26.3 |
| $11–$50 billion | 46 | 36.2 | 63 | 40.4 |
| $51–$100 billion | 20 | 15.7 | 27 | 17.3 |
| More than $100 billion | 13 | 10.2 | 25 | 16.0 |
| *Working experience* | | | | |
| Less than 5 years | 11 | 8.7 | 15 | 9.6 |
| 5–10 | 37 | 29.1 | 42 | 26.9 |
| 10–15 | 43 | 33.9 | 45 | 28.9 |
| 15–20 | 20 | 15.7 | 31 | 19.9 |
| More than 20 | 16 | 12.6 | 23 | 14.7 |
| *Respondent title* | | | | |
| Chief information officer | 50 | 39.4 | 72 | 46.2 |
| IS manager | 36 | 28.3 | 40 | 25.6 |
| Other manager in IS department | 25 | 19.7 | 31 | 19.9 |
| Others (IS analyst, IS specialist/ engineer, other manager) | 16 | 12.6 | 13 | 8.3 |

Additionally, this study conducts two statistical analyses to ensure the absence of non-response bias [69]. First, this study compares the responding and non-responding firms in terms of company assets and employee numbers. This information is available from the 2011 Common Wealth Magazine, and the independent sample *t*-test revealed no significant difference between the two groups ($p = 0.092$ and 0.121, respectively). The respondents are then divided into two groups based on return dates. Comparison of the two groups in terms of company assets and number of employees again revealed no significant differences based on the independent sample *t*-test ($p = 0.313$ and 0.106, respectively). Therefore, non-response bias should not be a problem in this study.

### 4.2. Measures

Measurement items were developed on the basis of a comprehensive review of the literature and modified to suit the e-SCM context. The definitions for all measurement items are listed in Appendix A and discussed below.

#### 4.2.1. Independent variables

Perceived benefits were measured by four items that reflect the potential benefits of e-SCM to increase sale revenue, expand markets for existing products or services, improve coordination with suppliers and customers, and generate competitive advantage [23,34]. Perceived costs were measured by five items taken from Chau and Hui [31], which cover costs related to time, training, setup, and IT infrastructure involved. Firm size was measured by the number of employees in the entire organization, log-transformed to reduce data variance [70]. Top management support assessed the level of top management commitment to e-SCM projects using four items [25]. The operationalization of absorptive capacity was based on Szulanski [71] with four items assessing the extent to which the ability of an organization to recognize the value of knowledge, assimilate it, and apply it in e-SCM settings. Trading partner influence was measured using four items derived from Chau and Hui [31]. Respondents were asked to rate the degree of influence of their trading partners on the e-SCM adoption decision. Competitive pressure, which measures the degree of pressure exerted by competitors on the e-SCM adoption decision, was assessed using two items based on guidelines provided by Premkumar and Ramamurthy [25]. A five-point Likert scale ranging from "(1) disagree strongly" to "(5) agree strongly" was used for all items (with the exception of firm size).

#### 4.2.2. Dependent variables

There are two measures for the dependent variable. The first measure, likelihood of e-SCM adoption, was operationalized as a dichotomous variable, whether a company was an adopter or non-adopter of e-SCM (0: non-adopter; 1: adopter). The second measure of e-SCM adoption, extent of e-SCM adoption, was operationalized by an aggregated index: whether a company had used e-SCM to support various business functions in the supply chain. The seven items, including internal and external supply chain activities, were adapted from the works of Ranganathan et al. [34] and Ramamurthy et al. [72] and listed in Appendix A. Then, this study aggregates 7 items and converted them into a five-point scale to form the dependent variable, extent of e-SCM adoption. This approach has been suggested by the literature to measure IT implementation [73].

## 5. Data analysis and results

### 5.1. Validity and reliability assessment

The measurement model was evaluated for reliability, convergent validity and discriminant validity. Construct reliability or internal consistency was assessed by computing Cronbach alpha. As shown in Table 2, Cronbach alpha was found to be ranging from 0.724 to 0.928 for all constructs that exceeded Nunnally's [74] criterion of 0.7. Hence, the scales for all constructs were deemed to exhibit adequate reliability.

Convergent validity and discriminant validity were assessed by factor analysis with varimax rotation. As shown in Table 2, the factor analysis results satisfied the criteria of construct validity including both the convergent validity (eigenvalues greater than 1, item loading greater than 0.5) and discriminant validity (cross loading of items less than 0.5) [74,75]. Convergent validity and discriminant validity are therefore demonstrated.

The correlation matrix for likelihood of e-SCM adoption was examined for the extent of multicollinearity problems (see Table 3). The highest squared correlation among the

**Table 2**
Factor analysis and reliability assessment.

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 |
|---|---|---|---|---|---|---|
| *Perceived benefits* | | | | | | |
| PB1 | 0.790 | | | | | |
| PB2 | 0.812 | | | | | |
| PB3 | 0.883 | | | | | |
| PB4 | 0.824 | | | | | |
| *Perceived costs* | | | | | | |
| PC1 | | 0.722 | | | | |
| PC2 | | 0.820 | | | | |
| PC3 | | 0.757 | | | | |
| PC4 | | 0.862 | | | | |
| PC5 | | 0.838 | | | | |
| *Top management support* | | | | | | |
| TS1 | | | 0.819 | | | |
| TS2 | | | 0.818 | | | |
| TS3 | | | 0.733 | | | |
| TS4 | | | 0.861 | | | |
| *Absorptive capacity* | | | | | | |
| AC1 | | | | 0.850 | | |
| AC2 | | | | 0.761 | | |
| AC3 | | | | 0.829 | | |
| AC4 | | | | 0.884 | | |
| *Trading partner influence* | | | | | | |
| TI1 | | | | | 0.832 | |
| TI2 | | | | | 0.907 | |
| TI3 | | | | | 0.913 | |
| TI4 | | | | | 0.901 | |
| *Competitive pressure* | | | | | | |
| CP1 | | | | | | 0.813 |
| CP2 | | | | | | 0.809 |
| Eigenvalue | 3.140 | 4.141 | 3.543 | 2.491 | 3.626 | 1.639 |
| Variance | 14.407 | 16.942 | 12.525 | 10.357 | 15.120 | 6.421 |
| Cronbach alpha | 0.905 | 0.876 | 0.916 | 0.911 | 0.928 | 0.724 |

**Table 3**
Correlation matrix for likelihood of e-SCM adoption.

| Constructs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Perceived benefits | 1.000 | | | | | | | |
| 2. Perceived costs | −0.172* | 1.000 | | | | | | |
| 3. Firm size | 0.201* | −0.344** | 1.000 | | | | | |
| 4. Top management support | 0.381** | −0.132 | 0.246** | 1.000 | | | | |
| 5. Absorptive capacity | 0.139 | −0.068 | 0.192* | 0.486** | 1.000 | | | |
| 6. Trading partner influence | 0.195* | −0.164* | 0.013 | 0.324** | 0.276** | 1.000 | | |
| 7. Competitive pressure | 0.311** | −0.267** | 0.145* | 0.401** | 0.360** | 0.176* | 1.000 | |
| 8. Likelihood of e-SCM adoption | 0.255** | −0.078 | 0.086 | 0.456** | 0.247** | 0.115* | 0.173* | 1.000 |

* $p < 0.05$.
** $p < 0.01$.

independent variables was 0.236 between the aggregated measure of top management support and absorptive capacity. None of the squared correlation coefficients are above the 0.8 level [75], thereby indicating that there is no problem of multicollinearity. Similarly, the correlation matrix for extent of e-SCM adoption was examined (see Table 4). The highest squared correlation among the independent variables was 0.253 between the aggregated measure of top management support and absorptive capacity. Such a test result indicated that multicollinearity is not a problem for this study.

### 5.2. Hypothesis testing

The individual hypotheses with regard to the decision to adopt e-SCM were tested by using logistic regression analysis. Since the dependent variable was dichotomous (non-adopters versus adopters), the logistic regression analysis was applied to examine the research model. This approach requires fewer assumptions in theory, is more statistically robust in practice, and is easier to use and understand than discriminant analysis [76]. Table 5 shows the results of logistic regression analysis. The chi-square test was significant (Omnibus $\chi^2 = 137.621$, $df = 7$, $p < 0.001$) and two Pseudo $R^2$ (Cox and Snell $R^2 = 0.48$; Nagelkerke $R^2 = 0.55$) proved satisfactory. The Hosmer and Lemeshow goodness-of-fit test ($\chi^2 = 22.398$, $df = 7$, $p = 0.417$) indicates that the proposed model is not significantly different from a perfect one that can correctly classify all respondents into their respective groups: non-adopters and adopters [36]. The research model thus exhibits a good fit with the data.

With respect to overall discriminating power, the results (see Table 5) also indicate a prediction accuracy of 73.6% by the logistic regression model. As there are 127 non-adopters and 156 adopters, the classification accuracy by random choice would result in $(127/283)^2 + (156/283)^2 = 50.53\%$. Thus, this study concluded that the logistic regression model has much higher discriminating power than the random choice model. In Table 5, the Wald statistic and the corresponding level of significant test the effect of each of the independent variables in the research model. In terms of hypothesized factors associated with the likelihood of e-SCM adoption, five factors (perceived benefits, perceived costs, top management support, absorptive capacity, and competitive pressure) were significant at the 0.05 level. Thus, hypotheses H1a, H2a, H4a, H5a, and H7a were supported. However, firm size and trading partner influence were found to be non-significant discriminators. Hence, hypotheses H3a and H6a were not supported.

The hypotheses relating to the extent of e-SCM adoption were tested by partial least squares (PLS) approach. In this study, the software program used to conduct the PLS analysis was PLS-Graph Version 3.0 [77]. PLS is a structural equation modeling technique that simultaneously assessed the measurement model and the theoretically constructed structural model [78]. Although the measurement and structural parameters are estimated together, a PLS model is analyzed and interpreted in two stages. The measurement model was estimated using confirmatory factor analysis to assess reliability and validity of the measures of theoretical constructs, and the structural model was analyzed to examine the associations hypothesized in the present research model.

To validate the measurement model, construct reliability is evaluated by computing composite reliability, while convergent validity is evaluated by the average variance extracted

**Table 4**
Correlation matrix for extent of e-SCM adoption (Adopters only).

| Constructs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Perceived benefits | 1.000 | | | | | | | |
| 2. Perceived costs | 0.109 | 1.000 | | | | | | |
| 3. Firm size | 0.228** | −0.143 | 1.000 | | | | | |
| 4. Top management support | 0.402** | −0.267** | 0.149 | 1.000 | | | | |
| 5. Absorptive capacity | 0.185* | −0.101 | 0.275** | 0.503** | 1.000 | | | |
| 6. Trading partner influence | 0.383** | −0.315** | 0.328** | 0.271** | 0.146 | 1.000 | | |
| 7. Competitive pressure | 0.367** | −0.219** | 0.136 | 0.196* | 0.213** | 0.268** | 1.000 | |
| 8. Extent of e-SCM adoption | 0.147 | 0.248** | 0.134* | 0.235** | 0.377** | 0.306** | 0.203** | 1.000 |

* $p < 0.05$.
** $p < 0.01$.

**Table 5**
Results of logistic regression analysis.

| Constructs | Coefficient | Wald statistic | Significant |
|---|---|---|---|
| Perceived benefits | 0.381* | 3.390 | 0.026 |
| Perceived costs | −0.233* | 2.581 | 0.027 |
| Firm size | 0.106 | 0.222 | 0.284 |
| Top management support | 0.414** | 5.386 | 0.016 |
| Absorptive capacity | 0.742** | 11.463 | 0.001 |
| Trading partner influence | 0.170 | 1.004 | 0.130 |
| Competitive pressure | 0.243* | 2.951 | 0.037 |

*Goodness-of-fit*

Omnibus $\chi^2 = 137.621$, $df = 7$, $p < 0.001$.
−2 log likelihood value = 243.682.
Cox and Snell $R^2 = 0.48$; Nagelkerke $R^2 = 0.55$.
Hosmer-Lemeshow $\chi^2 = 22.398$, $df = 7$, $p = 0.417$.

*Discriminating power*

| | | Predicted | | % correct |
|---|---|---|---|---|
| | | Non-adopters | Adopters | |
| Observed | Non-adopters | 93 | 34 | 73.10 |
| | Adopters | 116 | 40 | 74.10 |
| Overall | | | | 73.60 |

* $p < 0.05$.
** $p < 0.01$.

[79]. Acceptable values for composite reliability and average variance extracted are 0.7 and 0.5, respectively [80]. As shown in Table 6, all the constructs were reliable and met the condition for convergent validity. To evaluate discriminant validity, the average variance extracted was compared with the squared correlations among the constructs [79]. In all cases, the average variance extracted was greater than the squared correlations among the constructs, indicating that the test of discriminant validity was acceptable. Additionally, the dependent variable, the extent of e-SCM adoption, has a significant $R^2$ of 52%, meaning that 52% of the variance can be explained by the seven independent variables. Four of the standardized path coefficients were significant at the 0.05 level. The results supported hypotheses H3b, H4b, H5b, H6b, and H7b. The extent of e-SCM adoption was significantly associated with firm size, top management support, absorptive capacity, trading partner influence, and competitive pressure. Perceived benefits and perceived costs were not significantly related to the extent of e-SCM adoption; therefore, the hypotheses H1b and H2b were not supported by the data.

**Table 6**
PLS analysis of extent of e-SCM adoption (Adopters only).

| Constructs | Measurement model | | Structural model |
|---|---|---|---|
| | Composite reliability | Average variance extracted | Path coefficient |
| Perceived benefits | 0.88 | 0.72 | 0.109 |
| Perceived costs | 0.90 | 0.81 | −0.078 |
| Firm size | 1.00 | 1.00 | 0.241** |
| Top management support | 0.93 | 0.85 | 0.190* |
| Absorptive capacity | 0.89 | 0.78 | 0.437** |
| Trading partner influence | 0.78 | 0.64 | 0.295** |
| Competitive pressure | 0.83 | 0.67 | 0.178* |

*Notes*: $R^2 = 0.52$.
* $p < 0.05$.
** $p < 0.01$.

## 6. Discussion

The objective of this study was to extend understanding of e-SCM adoption by identifying contextual factors as significant discriminators between non-adopters and adopters of e-SCM. In general, the results provide support for the research model. The results reveal that firms with certain technological context (perceived benefits and perceived costs), organizational context (top management support and absorptive capacity), and environmental context (competitive pressure) are more likely to adopt e-SCM. Further, of the three contexts identified in the research model, two (organizational and environmental contexts) are of primary importance in determining the extent of e-SCM adoption. In the following section, this study discusses each of the factors that have been identified in the proposed model.

### 6.1. Technological context

The data analysis shows that technological context strongly affects the decision to adopt e-SCM. Perceived benefits significantly and positively affected firm decisions to adopt e-SCM. As Chwelos et al. [67] noted, expected benefits can provide motivation for IS adoption because employee appreciation of the relative advantages of the new system improves work efficiency and productivity. If e-SCM adoption is considered better than existing enterprise systems, for example based on having improved operations efficiency and a better relationship with trading partners, then a favorable attitude toward the e-SCM adoption is more likely to be formed. On the other hand, perceived costs were observed to significantly and negatively influence the likelihood of e-SCM adoption. This finding not only empirically supports the previous literature, but also reinforces the argument that cost influences e-SCM adoption. Although the setup costs may not be very high if subsequent training costs and other ongoing expenses during usage are included, the associated financial expenses may still be an obstacle. Additionally, both the internal and external business processes may also need changing following adopting e-SCM. Staff training is essential to properly implement the new technology. These costs create barriers to firm investment in and adoption of e-SCM.

Surprisingly, perceptions of technological characteristics do not significantly affect the extent of e-SCM adoption. While technological contexts may influence the initial decision to adopt e-SCM, they do not affect the extent of e-SCM adoption subsequently. Most prior studies on IIOS implementation had found perceived benefits and costs to be significant [8,14]. One possible explanation is that firms continue to use e-SCM because it has become strategically necessary to business survival rather than because they perceive associated cost–benefits. The other possible explanation is that perceptions of technological characteristics may be important for initial adoption decisions because the cost–benefits of e-SCM are more visible and measurable. However, continued future use requires adopters to pay more attention to the long-term benefits and hidden costs of

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e-SCM implementation, and to base their decisions on their own evaluation of the implementation of such systems.

### 6.2. Organizational context

Firm size is significantly related to the extent of e-SCM adoption. This relationship is not surprising, as larger firms tend to use e-SCM more extensively than smaller firms. Larger firms also have more adequate technological and financial resources to increase the extent of e-SCM adoption. However, firm size does not significantly affect firm decision to adopt e-SCM. One possible explanation is that larger firms have multiple levels of bureaucracy and their long decision chains result in slow reaction times, which can impede decision-making processes regarding new ideas and projects [81].

This study shows that the emergence of top management support obviously is a key determinant of the likelihood and extent of e-SCM adoption. This finding is consistent with prior studies by Lee and Kim [46] and Theodosiou and Katsikea [82] and implies that firms tend to adopt and diffuse new technology when top management support is strong. This result is also in line with previous qualitative studies that emphasized senior management attitudes and beliefs positively influence sustainable SCM practices [9]. E-SCM is a radical IT that alters existing business models and processes [5]. Consequently, high e-SCM adoption requires top management support, because a supportive top management team can encourage user participation and resolve conflicts among trading partners.

Unsurprisingly, absorptive capacity is the most significant discriminator between non-adopters and adopters of e-SCM. Since e-SCM is changing rapidly, companies must develop a systematic process for absorbing knowledge about technological developments and enhance the cross-border transfer of individual knowledge into organizational knowledge. Open sharing of knowledge and exchange of ideas within and outside the organization will ensure that all parties involved become aware of and familiar with the e-SCM and that resistance to adoption is minimized. This result is consistent with the findings of other studies in the IT innovation adoption literature [39,40,83]. Similarly, absorptive capacity is the most significant organizational context that determines the extent of e-SCM adoption. Fostering knowledge absorptive capacity among organization members enables them to learn and seek new ideas. Therefore, a better level of absorptive capacity can stimulate creative and innovative thoughts (higher education, employee development and innovation tendency) that may eventually facilitate the extension of e-SCM into deeper levels of organizations.

### 6.3. Environmental context

Contrary to expectations, this study did not support the hypothesis that trading partner influence significantly discriminates between e-SCM non-adopters and adopters. One possible explanation for the insignificant relationship between trading partner influence and the likelihood of e-SCM adoption is that adoption decisions may be more affected by factors other than trading partners, such as internal or company specific objectives and concerns. Another likely explanation is that the study sample comprises Taiwanese large firms, which tend to use persuasion or coercion to influence trading partner adoption of e-SCM. Furthermore, this study found that higher trading partner influence significantly affects the extent of e-SCM adoption. The finding implies that increased e-SCM adoption requires building tight relationships with trading partners. Firms thus should develop and sustain effective relationships with trading partners if they want to use e-SCM more widely.

This study also shows that the emergence of competitive pressure is a key determinant of the likelihood e-SCM adoption. This finding is consistent with previous studies by Low et al. [49] and Lin and Lin [68] and implies that competition causes environmental uncertainty and increases both the need to adopt IT innovations, and also the speed of adoption. Competitive pressure was also observed to significantly and positively influence the extent of e-SCM adoption. Firms under greater competitive pressure are more motivated to more widely adopt e-SCM. This implies that firms tend to implement changes more aggressively when they face strong competition.

## 7. Conclusion

### 7.1. Implications for research

This study makes a number of contributions to the academic literature on e-SCM adoption. To the best of our knowledge, this study is the first study to theoretically specify or empirically test the determinants of e-SCM adoption by integrating previously separate strands of the e-SCM theory, technological innovation theory and technology–organization–environment framework. Although previous research has suggested the existence of significant technological, organizational and environmental challenges facing the evolution of e-SCM development, few studies have empirically examined these effects [9,84]. For these reasons, this study developed and validated the research model to examine the influence of seven contextual factors on e-SCM adoption. This study is significant because it proposes theoretical foundation to investigate the determinants of e-SCM adoption from various perspectives, and thus contributes to the literature on e-SCM adoption.

Another contribution of this study is that it fills the current gap in the e-SCM literature by confirming the usefulness of the TOE framework for studying e-SCM adoption. Most previous studies examined how e-SCM adoption benefits organizations [85,86]. This study suggests that the extent of e-SCM adoption not only is determined simply by the characteristics of the technology itself, but also depends on other factors related to the internal organization and the external environment. The results show the utility of the proposed model, which is potentially a theoretical framework for studying other IT innovations such as radio frequency identification (RFID) and cloud computing services.

Finally, this study examined both non-adopters and adopters to eliminate bias in the sample population. Previous studies have mainly focused on the adoption intentions of non-adopters or adopters. Furthermore, by examining the intention to adopt e-SCM for non-adopters and the extent of

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e-SCM adoption for adopters, this study has looked at two measurement variables that best suit these two groups.

### 7.2. Implications for practice

This study results in several key insights for managers, and should help managers better understand the factors and conditions that influence the migration to e-SCM. First, mangers can draw on the research model to assess the suitability of existing conditions for e-SCM adoption (in terms of the likelihood and extent of e-SCM adoption). The research model includes the technological characteristics describing the nature of e-SCM innovation, which may help managers evaluate the benefits and costs of e-SCM initiatives. The research model also covers a series of organizational and environmental conditions. Managers must consider these contextual factors to ensure effective adoption and continued use of e-SCM.

Within the technological context, perceived benefits and costs are important predictors of e-SCM adoption decision. Firms should recognize and positively perceive the benefits of e-SCM as a first step towards deciding to adopt e-SCM. Managers should actively seek information on the benefits of e-SCM adoption. Such information combined with success paradigms from other organizations, can publicize success stories to employees and trading partners. Moreover, the findings of that perceived costs are important to e-SCM adoption decisions which also suggests that managers need to conduct comprehensive analysis and comparison of e-SCM investments more economically. Another important message for mangers is to ensure that firms gain more opportunities to increase sales and reduce costs as supply chains become electronically-enabled and inter-enterprise collaboration.

In organizational contexts, the results highlight the critical influence of top management support on both the likelihood and extent of e-SCM adoption. E-SCM adoption is not a simple technology implementation exercise that is developed and designed to enhance the efficiency and effectiveness of intra- and inter-organizational business operations at both the operational and also the managerial and strategic levels. Adopting e-SCM and incorporating it into organizational practices are difficult managerial tasks, and thus top management must be aware of their obligation to provide e-SCM project management with adequate resources. Top management support can take various forms, such as encouraging user participation in e-SCM initiatives, offering educational programs, and resolving conflicts among stakeholders. These practices facilitate e-SCM adoption and increase its extent. Furthermore, in the context of e-SCM, knowledge absorptive capacity occurs both within firms and between firms and their trading partners. The systematic acquisition and dissemination of knowledge regarding new technology can enable employees to appreciate the importance of technology-led innovations for long-term organizational prosperity, and develop novel solutions to problems that significantly improve on current practices. Consequently, absorptive capacity is an emerging capability that can facilitate extensive use of e-SCM within and outside the firm. That is, successful e-SCM adoption and diffusion increasingly depend on knowledge acquisition and assimilation capabilities.

Finally, in the environmental dimension, the success of e-SCM adoption depends heavily on the enthusiasm of trading partners for using Internet technologies to communicate with the company and perform transactions and other activities. Firms with stronger collaboration with their trading partners will have more chances to successfully adopt e-SCM. Furthermore, the emergence of competitive pressure as a key variable emphasizes the need to view e-SCM adoption as a means of achieving strategic advantage rather than a tool for operational efficiency. As competition intensifies, firms may feel the need to adopt e-SCM more extensively to provide online visibility and inter-enterprise collaboration, which in turn boosts competitive advantage. Competitive pressure necessitates effective e-SCM adoption; managers should rapidly respond nto changes in the competitive environment, and may consider e-SCM as an essential tool to compete in intra- and inter-organizational adaptations.

### 7.3. Limitations

Despite some intriguing findings, the results of this study should be interpreted with caution due to the following limitations. First, since the dataset is cross-sectional and not longitudinal, the posited casual relationships could only be inferred rather than proven. Future research should collect longitudinal data to determine the causal links more explicitly. Second, this study focuses only on the likelihood and extent of e-SCM adoption. To gain a holistic understanding of e-SCM adoption, the impacts of e-SCM adoption on firm performance should be examined. Third, besides the factors proposed here, numerous other technological, organizational, and environmental factors also affect the adoption of e-SCM. Product characteristics, demand uncertainty, and market volatility have all been identified as potential antecedents of the level of participation in business-to-business electronic marketplaces [87]. Future studies can test whether these variables also affect the adoption of e-SCM. Fourth, although hypothesized, there was no significant relationship between technological characteristics (perceived benefits and costs) and the extent of e-SCM adoption. These insignificant findings deserve further scrutiny. RFID and nontechnology can enhance supply chain integration by improving supply chain visibility, product authenticity, tracking and traceability and ultimately benefiting to trading partner [88]. Future research can extend the research model to investigate how advanced IT solutions (such as RFID, nanotechnology and other technology tools) influence the extent of e-SCM adoption. Finally, the sample was drawn from Taiwanese IS managers. Hence, the research model should be tested further using samples from other countries, since the findings may be influenced by cultural differences between Taiwan and other countries, and further testing thus would provide a more robust test of the hypotheses.

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## Appendix A. Measurement items

### A.1. Part I: Independent variables

#### A.1.1. Perceived benefits

Your firm expects the following benefits of using e-SCM …

PB1: increasing sale revenue.
PB2: expanding markets for existing products or services.
PB3: improving coordination with suppliers and customers.
PB4: generating competitive advantage.

#### A.1.2. Perceived costs

PC1: Lead time to install e-SCM is relatively long.
PC2: Lead time to complete training before starting to use e-SCM is long.
PC3: E-SCM has high setup costs.
PC4: E-SCM has high running costs.
PC5: E-SCM has high training costs.

#### A.1.3. Firm size

Number of employees in your firm (logarithm-transformed)

#### A.1.4. Top management support

TS1: Top management is highly interested in using e-SCM.
TS2: Top management is aware of the benefits e-SCM for future success of firm.
TS3: Top management has allocated adequate financial and other resources for the development and operation of e-SCM.
TS4: Top management has a vision to project in your company as a leader in the promotion of e-SCM.

#### A.1.5. Absorptive capacity

AC1: Your firm has rich information on the state-of-art of e-SCM.
AC2: Your firm has a clear division of roles and responsibilities to implement e-SCM.
AC3: Your firm has the necessary knowledge to learn and implement e-SCM.
AC4: Your firm has the competences to implement e-SCM.

#### A.1.6. Trading partner influence

TI1: Major trading partner requested adoption of e-SCM.
TI2: Important trading partner requested adoption of e-SCM.
TI3: Major trading partner recommended adoption of e-SCM.
TI4: Important trading partner recommended adoption of e-SCM.

#### A.1.7. Competitive pressure

CP1: Your firm experienced competitive pressure to adopt e-SCM.
CP2: Your firm would have experienced a competitive disadvantage if e-SCM had not been adopted.

### A.2. Part II: Dependent variables

#### A.2.1. Likelihood of e-SCM adoption

Has your firm adopted the e-SCM application? (0: No; 1: Yes.)

#### A.2.2. Extent of e-SCM adoption

Does your firm use e-SCM to support any of the following business functions? (0: No; 1: Yes.)

(1) to support accounting management
(2) to support product and service delivery management
(3) to support warehousing and inventory management
(4) to support productions and operations management
(5) to facilitate purchase ordering and fulfillment management among trading partners
(6) to facilitate electronic data interchange among trading partners
(7) to facilitate immediate supply chain information sharing among trading partners

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