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Group-level effects of facilitating conditions on individual acceptance of information systems

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Abstract Much of the research effort in the area of technology acceptance has been directed to investigating the effects of various variables operating at the individual-level without considering the conjoint effects of group-level variables on individual acceptance. The present research addresses this issue by proposing a group-level variable, organizational facilitating conditions, and examining its effects on the unified theory of acceptance and use of technology model, a widely used individual user acceptance model. Two field studies were conducted to explore the multilevel nature of technology acceptance. In the first study, we refined the construct of facilitating conditions and developed a new measure of facilitating conditions to explicitly add the organizational facilitating conditions dimension as well as to augment the existing measure. Subsequent testing of the measure confirmed the multilevel nature of the construct. In the second study, we examined the effects of the organizational facilitating conditions on individual acceptance behaviors by utilizing the hierarchical linear modeling approach. The results indicate that the two constructs, individual facilitating conditions and organizational facilitating conditions, are distinct and that, compared to individual facilitating conditions, the organizational facilitating conditions as a group-level variable explain a larger amount of variance in individual acceptance behavior. The resulting model offers a multilevel perspective to the technology acceptance research area while the study results provide an augmented way to evaluate facilitating conditions with a prescriptive guidance to managers.

Keywords Hierarchical linear modeling · IT implementation · Multilevel modeling · Facilitating conditions · Technology adoption · Unified theory of acceptance and use of technology

1 Introduction

Determining the key factors that facilitate user acceptance of information systems (IS) is one of the most mature and central research streams in contemporary IS literature [49]. However, although researchers have proposed various theoretical models over the past two decades, relatively little effort has been made to empirically examine the effects of both individual and group-level variables from a multilevel perspective. Studies in individual-level research typically focus solely on the individual-level of analysis, while group-level or organizational-level studies often ignore individual variations. Burton-Jones and Gallivan [7, p. 657] describe this single level approach as possibly leading to an “unnatural, incomplete, and very disjointed view of how information systems are used in practice.”

From a methodological perspective, it is challenging to examine variables at two distinct levels and to test their

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interplay across the different levels. However, more recently, modeling techniques have become advanced to appropriately analyze a phenomenon from a multilevel perspective, and as a consequence, more recent studies in other fields have investigated the relationships between the group-level variables and individual-level variables by taking advantage of the multilevel modeling techniques [24].

By nature, institutions and organizations in which individuals function as members are multilevel systems. Individual user behaviors as micro phenomena are often embedded in macro contexts [24, 47]. In turn, group-level variables as macro-level elements often have an effect on individual user behaviors through the interactions and dynamics of micro-level elements. Thus, a multilevel perspective is needed to adequately explain the interactions and dynamics of user acceptance of information technology (IT) because only limited conclusions can be drawn from a single-level perspective. While numerous variables have been studied under the IT acceptance research stream, in this research we focus on a variable that is considered as one of the salient determinants of technology acceptance behavior [36, 44] and also directly relevant for multilevel analysis—the facilitating conditions variable.

Facilitating conditions refer to "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" [49, p. 453]. Thus, the construct is essentially built upon the idea of the perceived availability of resources needed to engage in the target behavior [2], where resources are the organizational means or individual skills required for the implementation of the behavior. If organizational factors that support or hinder the use of the system change, the construct is likely to reflect this environmental change. Similarly, if the individual's need or ability regarding the system use changes, it is also likely that the construct reflects this personal change. Therefore, the construct is jointly shaped by organizational factors as well as individual factors, lending it desirable for a multilevel analysis.

Some studies have noted the significance of the issue of multilevel analysis in understanding user acceptance of technology (e.g., [7]), but very few studies, if any, have empirically examined the effects of group-level variables on individual user's technology acceptance. In particular, no studies to the best of our knowledge have proposed or investigated the multilevel nature of technology acceptance by modeling facilitating conditions at the group and individual-levels conjointly. The present research addresses this issue by splitting the facilitating conditions variable into two levels—the individual-level and the group-level. More specifically, we propose a group-level variable, organizational facilitating conditions, and examine its effect on improving the explanatory power of the *unified theory of acceptance and use of technology* (UTAUT) *model* [49]. From a theoretical perspective, this study advances IT acceptance research by developing a new, multilevel perspective recognizing that individual-level phenomena are nested within group-level contexts. By investigating group-level contexts, which could be boundary conditions and situational contingencies related to the individual-level phenomena, we hope to provide an IS acceptance model that is more accurate and truthful to the phenomena it captures. From a practical perspective, this study aims to provide an augmented way to evaluate facilitating conditions and in turn enhance the understanding of IT acceptance and help IS managers in the design of IS implementation strategies.

2 Theoretical background and hypotheses

2.1 The unified theory of acceptance and use of technology model

Over the past decades, IS researchers have proposed several competing models that can explain and predict individual usage behavior. Venkatesh et al. [49] integrated the elements from eight prominent models of IT acceptance and unified those elements into one model. The UTAUT identifies four constructs as direct determinants of user acceptance and usage behavior: performance expectancy (the degree to which an individual believes that the use of the system will help achieve gains in job performance), effort expectancy (the degree of ease associated with using the system), social influence (the degree to which an individual perceives that important others believe he or she should use the system), and facilitating conditions. Additionally, four moderators (gender, age, voluntariness, and experience) were found to improve the predictive ability of UTAUT and are included in the model as depicted in Fig. 1.

UTAUT predicts that performance expectancy, effort expectancy, and social influences are direct determinants of behavioral intention. Behavioral intentions and facilitating conditions are direct determinants of use behavior. Venkatash et al. [49] reported that UTAUT outperformed eight prior models in explaining the amount of variance in user intentions to use IT and conclude that "UTAUT is a definitive model that synthesizes what is known and provides a foundation to guide future research in this area" [49, p. 467]. Thus, rather than proposing significant changes to UTAUT, which has been validated in various settings, our investigation essentially builds upon the UTAUT model to incorporate group-level variables, with the intention to deepen our understanding of technology acceptance rather than broaden it, per Bagozzi [5].

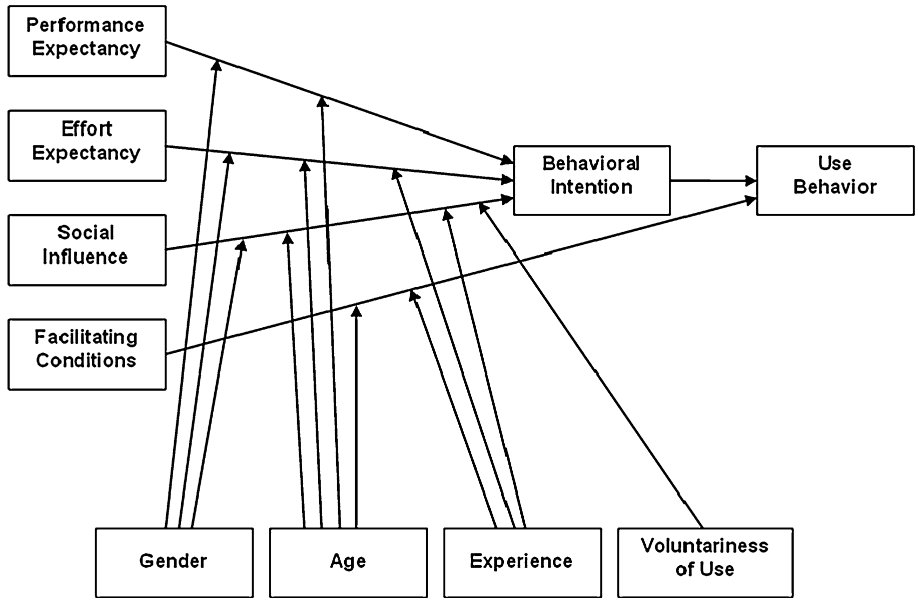

Fig. 1 UTAUT model (*Source*: [49])

2.2 Multilevel structures of IT acceptance

In an organization,[1] individuals are commonly embedded in groups, and groups are embedded within the organization. In this nested, hierarchical structure of an organization, organizational factors may have direct or moderating effects on the behavior of individual members working in groups [47]. Hierarchical linear modeling (HLM, a multilevel analysis) is an advanced form of regression analysis. In dealing with nested data, which includes both collective-level variables and individual-level variables, traditional regression approaches model all effects as occurring at a single level, either aggregating individual-level variables to the collective-level or disaggregating collective-level variables to the individual-level, thus often introducing serious biases in estimating regression coefficients. In contrast, HLM captures systematic variability at both the collective-level and the individual-level, allowing variance in the dependent variable to be analyzed at multiple levels without artificially flattening the levels and thereby allowing the variables to be more accurately reflective of the multilevel phenomenon. HLM originated in the mid-1980s in the fields of educational measurement and sociology [1, 14, 28] and has been applied to other domains as the idea of individuals or objects, nested in groups, can explain additional variability of a phenomenon [15].

Although various researchers have noted that multilevel modeling is appropriate for understanding IS phenomena [7, 26, 27], most of the multilevel research in the areas of technology adoption and IT implementation have been based on conceptual papers and case studies. (See Table 1.)

Burton-Jones and Gallivan [7] presented system usage as a multilevel construct and provided an illustration of how to study it as such, but did not include any empirical data in the paper. Sarker et al. [41] argued that there was a tendency to focus either on individuals or organizations, leaving a void in the understanding of technology adoption within groups. However, in their model of technology adoption by groups, all the variables were operationalized at the group-level, including the variable of a priori individual attitudes toward the technology, which was operationalized as the group mean of the individual group members' attitudes toward the technology. Sykes et al. [42] proposed a model of acceptance with peer support that included social network constructs, showing that these social networks constructs explain additional variance in system use over and above the predictors from the individual technology adoption constructs. Although the authors extended individual-level IT adoption research to include social network constructs, it was not a multilevel study. All the variables including the social network constructs were operationalized at the individual-level. Compared to the case approach or conceptual work, our HLM approach provides a more concrete, quantifiable method of assessing the validity of a multilevel model.

In summary, our search of the literature did not find an empirical study that employed the HLM approach to analyze hierarchically nested data structure in the area of IT acceptance, in particular building upon UTAUT. Although single-level research can be useful, we argue that a multilevel study would be beneficial to providing a more complete account of

[1] In this article, we do not differentiate business organizations and non-profit institutions. The term organization will be used throughout to refer to a form of social arrangement that pursues collective goals with a boundary separating it from its environment, regardless of its profit-making nature.

Table 1 Review summary of multilevel research in technology adoption and IT implementation

Year	Cite	Study variables		Target technology & study method	Data analysis	Remarks/key findings
		Level	Variables measured			
2005	Gefen and Ragowsky [17]	IT module	Benefits gained by ERP systems	ERP system & survey (270 manufacturing organizations)	Regression	A multilevel study at the measurement level, but a single-level study at the analysis level. The benefits from ERP investments were consistently better explained at the specific IT module level
		Organization	Overall benefits gained by ERP systems, organizational characteristics (cost, product complexity, etc.)			
2005	Sarker et al. [41]	Group	Attitude, majority support, substantive conflict, opinions of high-status individuals, technology characteristics, group valence, adoption	N/A	N/A	A conceptual paper that proposes the TAG (Technology Adoption by Groups) model and suggests theoretical propositions and measurement guidelines
2006	Niederman et al. [33]	N/A		N/A	N/A	Does not contain empirical data. It presents a research agenda and proposes a multilevel framework for studying information systems using open source software
2007	Burton-Jones and Gallivan [7]	Individual	System usage	N/A	N/A	A conceptual paper. It presents system usage as a multilevel construct
		Group	System usage			
2007	Cho and Mathiassen [9]	Organization	Intra-organizational level contradictions, inter-organizational level contradictions	A tele-health innovation & interview (27 employees)	Coding analysis	A case study involving multiple sites. The multilevel analysis was based on case observations
2007	Mellarkod et al. [29]	Individual	Perceived usefulness, perceived ease of use, predetermined mindset, regarding reuse, resource allocation, social factors, infrastructure, previous experience, self-efficacy, behavioral intention	N/A & survey (207 developers)	LISREL	A single-level study. Usefulness, self-efficacy, and predetermined mindset were found important determinants of behavior intention to reuse software assets
2008	Aubert et al. [4]	Group	Project success, formal planning, team expertise, project size, etc.	Health insurance system & interview (number of subjects was not noted)	Transcript and document analysis	A case study involving a single site. An organizational-level analysis of the case from an economics perspective is combined with a project-level analysis from a risk management perspective to explain how organizational-level decisions influenced the antecedents at the project and individual-levels
		Organization	Resource availability, strategic boundary and value, economy of scale			
2009	Sykes et al. [42]	Individual	Behavioral intention, facilitating conditions, network density, network centrality, valued network density, valued network centrality	Content management system & survey (87 employees)	PLS& UCINET	A single-level study. It proposes MAPS (Model of acceptance with peer support) with social networks constructs (e.g., network density and network centrality), which explains additional variance in system use

the dynamics embedded in the nested nature of IT acceptance phenomenon. For example, individual-level studies may find some salient individual differences for a new system adoption while not paying attention to organizational factors that are important. Group-level studies may find some organizational factors, which are critical to system success while ignoring individual differences that are pertinent. Multilevel studies can bridge the conflicting arguments by filling the gap because multilevel studies examine the interactions and dynamics between levels.

Figure 2 presents the basic conceptual model depicting the interactions between group-level and individual-level variables. Our basic conceptual model is composed of salient individual-level and group-level variables integrated with the UTAUT model. In this new model, systematic differences existing at the group-level are theorized to affect individual acceptance outcomes directly and also indirectly by moderating the relationships between individual perceptions and acceptance outcomes.

2.3 Hypotheses development

2.3.1 *Facilitating conditions*

In our study, we theorize the construct of "facilitating conditions" as both an individual-level and a group-level variable impacting individual acceptance outcomes. The terminology of "facilitating conditions" originates from Triandis [46], who defines facilitating conditions as the factors in an environment that hinder or make an activity easier to perform for an individual. In the UTAUT model [49], the facilitating conditions construct is described as originating from various theories. (See Table 2.)

From the theory of planned behavior [2] and the decomposed theory of planned behavior [44], the construct of perceived behavioral control (PBC) is theorized to be closely related to facilitating conditions. PBC reflects the perceptions of the internal and external constraints on behavior and consists of self-efficacy, resource facilitating conditions, and technology facilitating conditions [2, 44, 49]. From the innovation diffusion theory, Moore and Benbasat [30] describe the construct of "compatibility," which is defined as the degree to which an innovation is perceived as being consistent with the values and requirements of a potential adopter. Finally, from the model of PC utilization [45], the facilitating condition construct is formally introduced and is based on the Triandis [46] definition of objective factors in the environment that make an activity easier. In the UTAUT model, all three of these constructs (PBC, facilitating conditions, and compatibility) are integrated into the one construct of "facilitating conditions."

Venkatesh et al. [49] note that each of these constructs captures some aspects of environmental support designed to remove barriers to system use and that these three constructs are conceptually overlapping. Furthermore, they present empirical evidence that the relationships between each of the above constructs and behavioral intention are similar and offer the measurement items in Table 3 to estimate the facilitating conditions construct.

As mentioned above, facilitating conditions are defined as the environmental support designed to remove the barriers to system use and have been shown to have an effect on the individual acceptance of IS. But what happens to the concept of facilitating conditions when the environmental support is specifically made to a group causing substantial

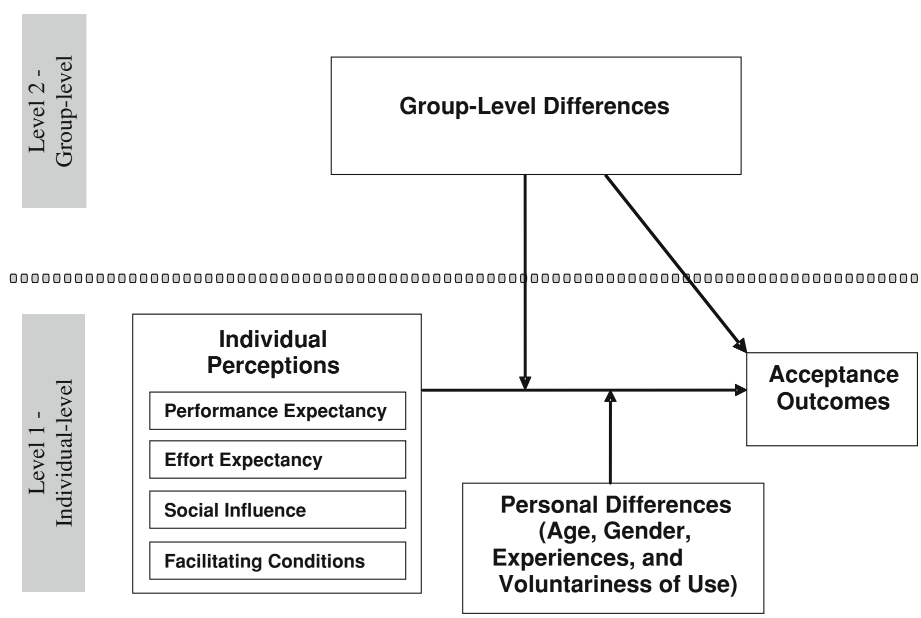

Fig. 2 Conceptual multilevel model based on UTAUT

Table 2 Three constructs embodied in the facilitating conditions construct

Construct	Theory
Perceived behavioral control (PBC)	Theory of planned behavior [2]
	Decomposed theory of planned behavior [44]
Facilitating conditions (FC)	Model of PC utilization [45]
	Model of choice [46]
Compatibility	Innovation diffusion theory [40]

Table 3 Facilitating conditions items in UTAUT [49]

Item	Definition
PBC2	I have the resources necessary to use the system
PBC3	I have the knowledge necessary to use the system
PBC5	The system is not compatible with other systems I use
FC3	A specific person (or group) is available for assistance with system difficulties

variances between the groups rather than between the individuals? A supportive resource given to a person is different from a supportive resource given to a group, and has different implications for IT acceptance and use. For example, some groups may receive more intensive training than others, leading to more uniform development of skills among the group members belonging to the same group and consequently more active use of the system. This systematic difference existing at the group-level may not be fully captured by the individual's perception of facilitating conditions if their evaluations are made locally based on the interactions they have mostly within the group he or she resides.

Extending prior research, we hypothesize that facilitating conditions can be conceptualized at two levels: (1) individual-level facilitating conditions as a user's perception of the environmental support and (2) group-level facilitating conditions as an organization's support available for groups. Individual-level facilitating conditions are defined as the factors in the environment controlled and influenced by the user, while organizational facilitating conditions are organizational resources which are controlled and influenced collectively by the group. The extent to which organizational resources are available in their working environment will influence how members perceive facilitating conditions at the individual-level. However, organizational facilitating conditions reflect more objectively the reality of the resource availability within a group and can have more common, stable, and widespread influences than the individual perceptions of facilitating conditions. Thus, we separate these two concepts and propose that individual facilitating conditions and organizational facilitating conditions are distinct. Specifically, we hypothesize:

Hypothesis 1 (*The Distinctiveness of Organizational Facilitating Conditions Hypothesis*) The organizational facilitating conditions construct is distinct from the individual facilitating conditions construct.

2.3.2 Multilevel structures of IT acceptance

As mentioned earlier, individuals are embedded within groups in an organization. A consequence of this nested data structure is that within-unit observations (e.g., employees within groups) are more similar to each other than between-unit observations (e.g., employees from different groups) [37]. Therefore, within-unit variations (e.g., within-group differences in actual usage of a system) are likely to be smaller than between-unit variations (e.g., between-group differences in actual usage of a system). It can be argued that the variations of IT acceptance behavior across the groups may result from the heterogeneity of some organizational variables such as leadership, infrastructure, regulations, and supportive resources [24]. If a study does not take these organizational-level variables into account, a major portion of the variance in IT acceptance behavior would remain unexplained. Researchers also argue that integrating variables across multiple levels of analysis may provide a more truthful account of organizational phenomena [31]. Further, the theory of planned behavior argues that the perception of one's opportunities and resources required to perform the target behavior is an important determinant of the individual's actual behavior [2]. Thus, it can be argued that at least an evident amount of variations in IT acceptance behavior (i.e., usage) will be explained by group-level variables (i.e., organizational facilitating conditions), which can be tested by the existence of between-class differences in usage. Therefore, we hypothesize:

Hypothesis 2 (*The Between-Class Differences Hypothesis*) There are between-class differences in usage that are explained by organizational facilitating conditions.

2.3.3 Individual facilitating conditions

As mentioned above, our study distinguishes individual facilitating conditions as the environmental factors influencing usage of a system that is under the control and influence of the individual. Taylor and Todd [44] noticed the theoretical overlap between PBC and facilitating conditions and proposed the measure of facilitating conditions based on individual perceptions, such as PBC2—"I have the resources necessary to use the system" and PBC3—"I have the knowledge necessary to use the system" (see

Table 3). Taylor and Todd [44] confirmed that PBC had a significant effect on usage behavior captured over a 12-week period, which is a time period identical to our study setting for this hypothesis testing. Venkatesh et al. [49] also theorized the effect of facilitating conditions on usage behavior to be significant and found partial support through their empirical studies. If individual users perceive the environmental factors such as resources and knowledge to be restrictive, the perception can play a role in discouraging actual usage of system. Similarly, if individual users are confident of their abilities and knowledge, they are more likely to persevere against the environmental constraints and succeed in achieving the target behavior [2]. Therefore, we hypothesize:

Hypothesis 3 (*The Individual Facilitating Conditions' Direct Effect Hypothesis*): Individual facilitating conditions have a direct effect on actual usage of a system.[2]

2.3.4 Organizational facilitating conditions

In contrast to individual facilitating conditions, organizational facilitating conditions are the environmental factors influencing usage of a system that is under the control and influence of the organization. One of the earlier explorations of this construct in the IS domain is from Thompson et al. [45], who consider facilitating conditions such as guidance and training in the hardware and software as influencing PC usage. By training users and providing assistance, some of the potential barriers to usage can be reduced or eliminated [45, 48].

Prior studies suggest that organizational facilitating conditions can affect individual usage of a system. Pare and Elam [35] found that a specific instance of a facilitating condition (organizational support) had an effect on perceived usefulness, perceived ease of use, and usage [21]. In addition, general organizational characteristics such as organization context and the amount of slack resources have been identified as impacting information technology adoption [25]. Extending these prior studies, we hypothesize:

Hypothesis 4 (*The Organizational Facilitating Conditions' Direct Effect Hypothesis*) Organizational facilitating conditions have a direct effect on actual usage of a system.

2.3.5 Multilevel direct effects and moderation

Utilizing a multilevel perspective, we further hypothesize that the group-level variable of organizational facilitating conditions will have a moderating effect on the acceptance outcomes at the individual-level. Top-down processes describe this influence of higher-level contextual factors on lower levels of the system [24]. From the top-down process perspective, for instance, it is believed that organizational-level variables shape group-level variables and in turn, group-level variables influence individual-level variables. In the context of user acceptance of technology, the group-level variable of organizational facilitating conditions, which captures the systematic differences in environmental support existing at the group-level, is expected to determine actual usage of the system to a large extent as it represents more objectively the reality of the resource availability common to a group of which the individuals are members. In addition to exerting its effect on system usage as an independent factor, the group-level variable of organizational facilitating conditions might be able to alter the significance of the relationships between the individual perceptions and actual usage of the system as higher degree of differences existing at the group-level may overshadow and limit the influences of individual perceptions on system usage. Therefore, we hypothesize:

Hypothesis 5 (*The Organizational Facilitating Conditions' Moderation Hypothesis*) Organizational facilitating conditions moderate the relationship between individual perceptions and actual usage of a system.

3 Research methodology

3.1 Overview of the two studies

The proposed hypotheses are empirically validated in two field studies using two different methodologies. In Study 1, following standard measure development procedures [10, 19], we (1) expand the original UTAUT facilitating conditions measurement items to include the organizational facilitating conditions dimension, (2) test the psychometric properties of the expanded scale, and then (3) provide a test of Hypothesis 1.

Study 2 assesses the multilevel structures of IT acceptance, as well as the effects of organizational facilitating conditions on individual acceptance outcomes by testing Hypotheses 2–5 utilizing a hierarchical linear modeling (HLM) approach. With HLM, we can assess models with parameters that vary at more than one level, such as individual-level and group-level effects. In Study 2, we test our multilevel hypotheses of organizational facilitating

[2] Note that in our conceptual model (Fig. 2), three other individual perceptions that may have a direct effect on actual usage of a system (performance expectancy, effort expectancy, and social influence) are identified. These are tested along with Hypothesis 3, but not formally hypothesized.

condition as a group-level variable (H2) that impacts actual usage through a direct effect (H4) and a moderating effect (H5), in conjunction with the direct effects of individual facilitating conditions (H3).

3.2 Introduction to HLM

In this section, we present a brief overview of HLM. Other sources [24, 37, 39] provide more complete details of HLM. HLM, also known as random coefficient modeling, is specifically designed to accommodate nested or multi-level data structures. It is frequently used in educational research, where multilevel data is common—e.g. student level, class level, school level, district level, etc. HLM is appropriate for testing questions when the data is hierarchical or nested [39]. More specifically, HLM is a regression-based approach that allows a hierarchical partitioning of variance. HLM provides a way for examining higher-level effects on lower-level relationships. HLM is typically used in models where the independent variables exist at multiple levels, and the dependent variable is at the lowest level of analysis.

Derived from Fig. 2, Fig. 3 shows a simplified example of a hierarchical relationship based on the hypotheses, where organizational facilitating conditions is hypothesized to influence system usage directly, as well as the relationship between individual-level facilitating conditions and system usage.

This is represented in terms of a Level 1 model and a Level 2 model. In the Level 1 model, we are hypothesizing a positive relationship between individual facilitating conditions and actual usage, such that stronger measures of individual facilitating conditions (e.g., individual knowledge and resources) would be associated with more usage of a system. In the Level 2 model, we are hypothesizing that actual usage may change due to the Level 2, group-level variable of organizational facilitating conditions (e.g., group-specific training). Thus, HLM enables the examination of independent variables at multiple levels of analysis. In this type of application of HLM, four research questions are typically addressed [38]:

1. Does the group-level unit in which the individual-level units reside make a difference in the dependent variable?
2. What is the impact of Level 1 variables across the Level 2 groups?
3. Are the Level 1 variables influenced by the Level 2 variables?
4. Do the Level 2 (group-level) variables modify or moderate the Level 1 (individual-level) relationships?

HLM is also used in analyzing longitudinal data, where there are repeated observations of a person over time. This is multilevel because the repeated observations (Level 1) are nested within a person (Level 2) over time. These models are also known as latent growth modeling. From the IS research perspective, Pavlou et al. [36] provide a basic overview of using HLM for latent growth modeling.

For comparing and interpreting HLM models, various estimates of model fit are used, including −2 log likelihood residual (−2LLR), Akaike's Information Criterion (AIC), and the Bayesian Information Criterion (BIC) [47]. Although smaller values for AIC and BIC are better, there is no statistical significance tests associated with the indices [37]. Therefore, hypothesis testing in HLM follows a model comparison approach in which the differences between simple models and more complex models are evaluated by examining the changes in −2LLR and the χ^2 statistic [37].

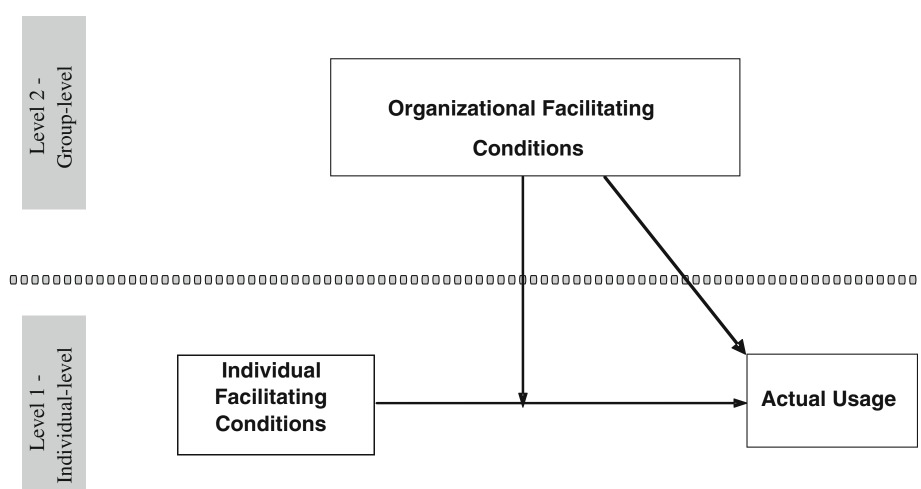

Fig. 3 Simplified HLM relationships

4 Study 1: construct development

Study 1 does not utilize HLM, but instead uses a traditional scale development methodology. The focus of Study 1 is the refinement of the facilitating conditions construct. Although Venkatesh et al. [49] demonstrated that the relationships between each of the root constructs forming the basis of facilitating conditions and intention are similar, they did not formally present evidence of the content validity and discriminant validity of the measures. This is especially important because the facilitating conditions construct incorporated ideas from the very distinct theories as presented in Table 2. To address this deficiency and to expand the scale to include the organizational facilitating conditions dimension, we followed an established paradigm for scale development [10, 19] to refine and expand the construct.

The first step in the refinement process is to generate the scale items related to the construct. Following the recommendations of Churchill [10] and Hinkin [19], we developed measures of individual-level and group-level facilitating conditions. Ten items were generated (FC1–FC10), including the four original items from the UTAUT model (FC1, FC2, FC3, FC6). The intention of these ten items was to reflect the division of individual facilitating conditions (FC1–FC5) and organizational facilitating conditions (FC6–FC10). The Q-sort technique was used to identify the items that should be grouped together [30]. Five academics and two practitioners completed the Q-sort. The responses to the items were individually examined, and where appropriate, modifications were made to more clearly reflect the target construct [12]. The final items for individual and organizational facilitating conditions are listed in Table 4, with the system context being an outdoor wireless network.

After the generation of the initial item pool, Churchill [10] recommends a pretest to purify the measure. We tested the items on 91 undergraduate students at a research university in the eastern United States. The items utilized a 7-point Likert-type scale ranging from (1) strongly disagree to (7) strongly agree. The scale purification process began with an analysis of the existing 4-item UTAUT scale to determine the unidimensionality of the UTAUT construct as defined by Venkatesh et al. [49]. A measure is considered unidimensional if it has statistical properties demonstrating that its items underlie a single construct or factor [32]. Unidimensionality is important because it is a prerequisite to reliability and validity. It is a necessary condition for internal consistency, construct validity, and theory testing [32]. Factor analysis is an appropriate technique for assessing the dimensionality of a construct [8]. Exploratory factor analysis (EFA) can be used to determine the number of common factors or latent constructs needed to account for the correlations among the variables [20]. If it can be established that only one common factor or latent construct can account for the correlations among the variables, then the item is considered unidimensional. The implicit assumption for using EFA is that the researcher generally has a limited idea with respect to the dimensionality of the construct and which items load on which factor [32]. EFA is typically conducted during the initial stage of scale development.

An EFA was first performed on the four items from Table 5 (FC1, FC2, FC3, FC6) which comprised the original UTAUT facilitating conditions construct. Figure 4 shows the eigenvalues, scree plot, and parallel analysis results using standardized data.

From Fig. 4, it appears that the data represents two factors. There are two eigenvalues greater than one, and both the scree plot and the parallel procedure indicate two factors. A two-factor solution explains 79.75% of the variance, while a one-factor solution explains only 59.36%. Combined, these results indicate that the facilitating conditions scale of the UTAUT model is not unidimensional even with the original measurement items.

Table 4 Initial measurement items

Item	Origin	Item wording
FC1	UTAUT	I have the resources necessary to use the outdoor wireless network
FC2	UTAUT	I have the knowledge necessary to use the outdoor wireless network
FC3	UTAUT	My computer is compatible with the outdoor wireless network
FC4	New	If I have a problem with the outdoor wireless network, I know where to go to get assistance
FC5	New	Given the resources, opportunities, and knowledge it takes to use the network, it would be easy for me to use the network
FC6	UTAUT	A specific group is available for assistance with difficulties associated with the outdoor wireless network
FC7	New	Enough guidance and instruction were provided for the use of the outdoor wireless network
FC8	New	The university has the infrastructure necessary to support the outdoor wireless network
FC9	New	The university provides the IT accessibility required to utilize the outdoor wireless network
FC10	New	In general, the university has supported the use of the outdoor wireless network

Table 5 Revised items of facilitating conditions

Original label	New label	Origin	Item wording
FC1	IFC1	UTAUT	I have the resources necessary to use the web-based system
FC2	IFC2	UTAUT	I have the knowledge necessary to use the web-based system
FC3	IFC3	UTAUT	The web-based system is compatible with other computer applications that I use for my coursework
FC6	OFC1	UTAUT	The instructor is available for assistance with difficulties associated with the web-based system
FC9	OFC2	New	The classroom (university) provides the IT accessibility and infrastructure required to utilize the web-based system
FC7	OFC3	New	Enough guidance and instruction were provided for the use of the web-based system

IFC individual facilitating conditions, *OFC* organizational facilitating conditions

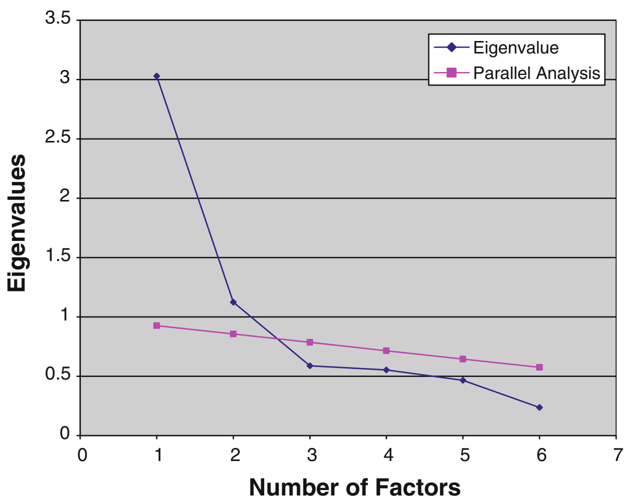

Fig. 4 Scree and parallel plots of the eigenvalues of UTAUT model

A further factor analysis of the ten items revealed problems with items FC4 and FC5 (factor loadings < 0.4) and were thus dropped from the scale [34]. FC8, FC9, and FC10 were highly correlated and therefore combined into 1 question. After the pretest, we collected additional data using the revised items. The subjects again were undergraduate business students at the same research university in the United States, but who did not participate in the pretest phase. Self-administered questionnaires with the revised items were distributed to 297 undergraduate students. In total, 218 usable surveys were returned (a 73.4% response rate). The respondents ranged in age from 18 to 37 and were 62.1% male. The respondents had diverse levels of personal computer experience ranging from 0.5 to 20 years (mean of 9.1 years). In this scale validation process, a different scenario (web-based instructional system) was used instead of the scenario used in the pretest (outdoor wireless network). The revised items are listed in Table 5. The items utilized a 7-point Likert-type scale ranging from (1) strongly disagree to (7) strongly agree.

The next step in the scale validation process is to run an EFA on the full six items to assess their dimensionality. As

Table 6 Correlation matrix

	FC1	FC2	FC3	FC6	FC9	FC7
FC1	1.000					
FC2	**0.756**	1.000				
FC3	**0.526**	**0.484**	1.000			
FC6	0.314	0.280	0.288	1.000		
FC9	0.246	0.287	0.252	**0.448**	1.000	
FC7	0.407	0.384	0.396	**0.514**	**0.450**	1.000

Note The bold numbers represent correlations between the measurement items of the same underlying construct

before, an exploratory factor analysis was performed with principal axis factoring on the correlation matrix. The first decision is to determine whether or not the data are appropriate for factor analysis. One indicator is to subjectively examine the correlation matrix visually. (See Table 6.)

High correlations among the variables indicate that the variables can be grouped into homogenous sets of variables such that each set measures the same underlying construct [18]. Table 6 indicates that the highest correlation is among FC1, FC2, and FC3 (all > 0.48). The correlations among FC6, FC9, and FC7 are not as high as the first group, but are still greater than 0.44.

Table 7 shows the factor pattern loadings of the six facilitating conditions (FC) items with varimax rotation, which is an orthogonal rotation of the underlying factor

Table 7 Rotated factor pattern loadings (varimax rotation)

	Factor 1	Factor 2
FC1	**0.887**	0.203
FC2	**0.799**	0.220
FC3	**0.526**	0.304
FC6	0.177	**0.685**
FC9	0.158	**0.603**
FC7	0.310	**0.675**

Note The bold numbers represent loading scores of the measurement items on the construct they were intended to measure axes to maximize the variance of the squared loadings of all the variables. For this rotation, we interpret factor1 and factor 2 as individual facilitating conditions (IFC) and organizational facilitating conditions (OFC).

A confirmatory factor analysis (CFA) was next performed using LISREL 8.8 on the dataset to confirm the model suggested by the EFA analysis. Figure 5 presents the measurement model.

Standardized parameter estimates are also presented with acceptable model fit: χ^2 (8) = 12.06, CFI = 0.99, NNFI = 0.97, AGFI = 0.95, RMSEA = 0.048. Content validity was assessed via two means. The Q-sort in the pretest provides basic evidence of content validity. Another way to demonstrate content validity is to perform an analysis of the inter-item correlations among scale items. Typically, these correlations should be moderate and not very high. Inter-item correlations greater than 0.8 should be avoided [23]. None of the inter-item correlations are greater than 0.80, which provides evidence supporting content validity.

Scale reliability was assessed by calculating coefficient α [13]. Reliability estimates were 0.80 for IFC and 0.72 for OFC. Both values exceed the minimum value of 0.70 recommended by Nunnaly [34]. Scale reliability can also be assessed by calculating the composite reliability estimate and the variance extracted estimate. Composite reliability is a measure of internal consistency comparable to coefficient α. Both scales demonstrate acceptable levels of composite reliability, with the coefficients exceeding 0.70. The variance extracted for both IFC and OFC exceeds 0.50, the level recommended by Fornell and Larcker [16].

In the absence of independent measures, evidence of discriminant validity can be obtained through two different procedures: (1) χ^2 difference test and (2) the variance extracted test [16]. Discriminant validity was assessed by restricting factor intercorrelations to pairwise unity and subsequently computing a chi-square difference statistic with one degree of freedom. As indicated by Table 8, the model comparison statistic is significant, providing evidence of discriminant validity.

Discriminant validity can also be assessed with a variance extracted test [16, 32]. In this test, the variance extracted estimate is compared to the squares of the correlation between two factors. Discriminant validity is demonstrated if both variance extracted estimates are greater than this square correlation. Table 9 provides the results of the variance extracted test, which provides evidence of discriminant validity. To summarize, both the χ^2 difference test and the variance extracted test show that the scale exhibits strong discriminant validity.

Convergent validity was assessed by reviewing the t tests for the factor loadings. In the CFA analysis from above (Fig. 5) all the factor loadings were significant for both IFC and OFC items. The t scores obtained for the coefficients in Table 10 range from 6.95 to 12.29, indicating that the factor loadings are significant ($p < 0.05$). This finding provides evidence supporting convergent validity of the indicators [3].

To summarize, the results of Study 1 clearly show that the revised, as well as the original, facilitating conditions construct is composed of two dimensions: individual facilitating conditions and organizational facilitating conditions, supporting H1. Following a recommended paradigm of scale development [10], we developed a new measure of facilitating conditions to augment the existing measure and explicitly add the organizational facilitating conditions dimension. In addition, we also conducted a model comparison for further establishment of two separate facilitating conditions. (See the "Appendix".) The new measure exhibited sufficiently strong psychometric properties to support valid testing of the proposed multilevel model.

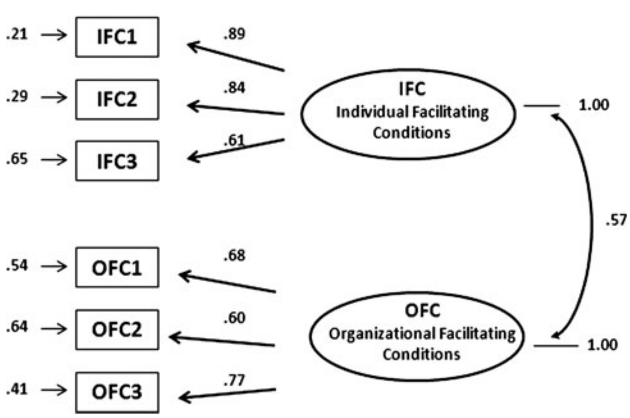

Fig. 5 CFA result for IFC and OFC

5 Study 2: multilevel model testing

Study 2 assesses the multilevel structures of IT acceptance and tests the effects of organizational facilitating conditions on individual acceptance outcomes. For Study 2, we used the facilitating conditions measure developed in Study 1 to test the multilevel research model presented in Fig. 6.

In Study 2, the subjects (college students) were nested within eight (multiple) sections of an introductory IS course. Thus, the individual-level was composed of college students, while the group-level was composed of the classes (sections) in which the students were enrolled. No student was enrolled in more than one section. The target information system was a web-based comprehensive course management system accessible via the Internet. Two methods were utilized for measuring the individual-level constructs:

Table 8 Chi-square difference test for discriminant validity

Model	χ^2	*df*	CFI	RMSEA	Model comparison		
					Difference	*df*	*p*
Comparison model (All factors covary)	12.06	8	0.99	0.048			
Correlation between IFC and OFC fixed at 1(ξ1 and ξ2)	39.84	9	0.90	0.126	27.78	1	<0.001

Table 9 Composite reliability and variance extracted estimate

Construct and indicators	Standardized loading	*T* value	Composite reliability	Variance extracted estimate
IFC			0.826	0.619
IFC1	0.890			
IFC2	0.840***	12.290		
IFC3	0.600***	8.930		
OFC			0.795	0.564
OFC1	0.680			
OFC2	0.600***	6.950		
OFC3	0.770***	7.610		

*** $p < 0.001$

Table 10 HLM model comparison sequence [37]

Step	Actions
Step 1	Determine the amount of non-independence (nesting) in the dependent variable via the intra-class correlation (ICC)
Step 2	Add the Level 1 fixed effects; Interpret the statistical significance value for these effects
Step 3	Allow the intercept to be a random effect. Compare the difference between this model to the previous model via the change in −2 LLR, AIC, and BIC
Step 4	One at a time, allow the relevant Level 1 predictor variables to become random effects. Compare the differences between models via the change in log likelihood, AIC, and BIC
Step 5	Attempt to explain the random effects via Level 2 predictors. Interpret the statistical significance value for these effects

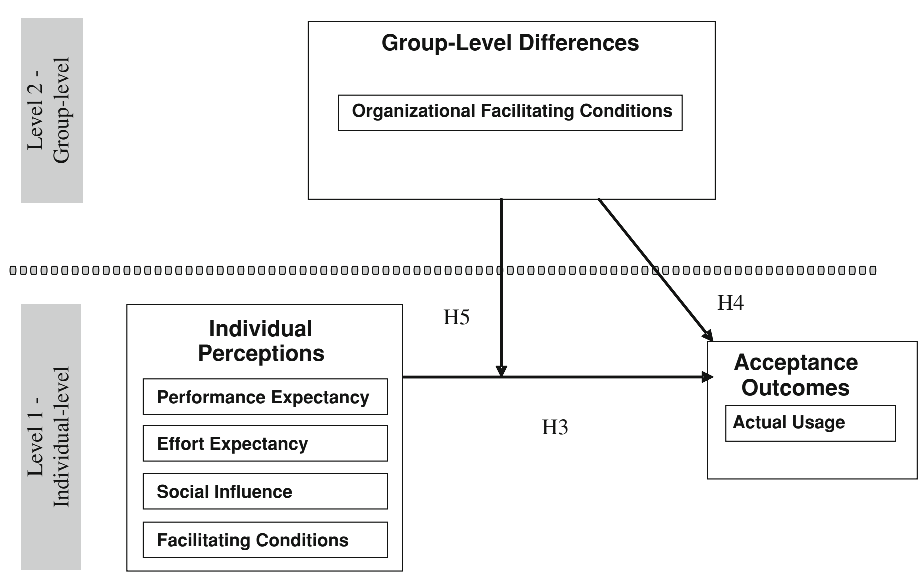

Fig. 6 Research model with hypotheses H3–H5 tested in study 2

(1) a questionnaire and (2) actual usage data over a 12-week period. In addition to the revised items for the facilitating conditions construct, the other study constructs (performance expectancy, effort expectancy, and social influence) were measured using the items from the original UTAUT model [49] via a questionnaire. For each construct, a single score measure was calculated by a weighted average approach, with the weights estimated by using the factor loadings from a confirmatory factor analysis (CFA).

The data was analyzed using hierarchical linear modeling (HLM). Because HLM is most frequently used to handle nested data structures that often correspond to hierarchical levels in an organization, we refer to Level 1 and Level 2 when discussing individual and group effects.

In Study 2, we test Hypotheses 2–5. Hypotheses 3, 4, and 5 are summarized graphically in Fig. 6. Hypothesis 2, which is not shown in Fig. 6, is to test the presence of between-class differences in system usage attributable to the group-level effects as a precondition for the testing of H4 and H5.

Figure 7 displays our research model from two perspectives—the general linear model (regression model) and the hierarchical model, following Ployhart [37].

In the regression model (Eq. 1), the regression weights are constant across the groups. This is known as a fixed effect because the weights do not vary across the units (groups). In the HLM (Eqs. 2, 3, and 4), the regression weights B_0 and B_1 are allowed to vary across the groups, with the members of the group assumed to be randomly selected from a population, hence the term "random effect." In Fig. 6, Eqs. 3 and 4 state that the between-group differences in both the intercept and the slope are explained by the group variable—organizational facilitating conditions (OFC). The intercepts and the slopes estimated with the group-level variable of OFC are further used to predict the dependent variable (actual usage) along with the individual-level variables such as performance expectancy (PE).

In Study 2, we test hypotheses H2 to H5 using a generic model comparison sequence for HLM models from Ployhart [37], which is summarized in Table 10.

Following the generic HLM model comparison sequence, the first step in testing the hypotheses 2–5 is to calculate the intra-class correlation (ICC). The ICC is a measure of the amount of variance in the individual acceptance outcome (actual usage) that is explainable by differences between the groups (classes). The ICC is calculated by taking the variance in the intercept and dividing it by the sum of the intercept variance plus residual variance. Level 1 regression assumes the ICC value to be 0. It has been suggested an ICC value greater than 0.01 to be indicative of the presence of the group-level effect in a data set [11, 22]. We calculated the ICC using SAS's PROC MIXED and running a one-way random-effects ANOVA model with the specification of the class i.d. as the independent variable and actual usage as the dependent

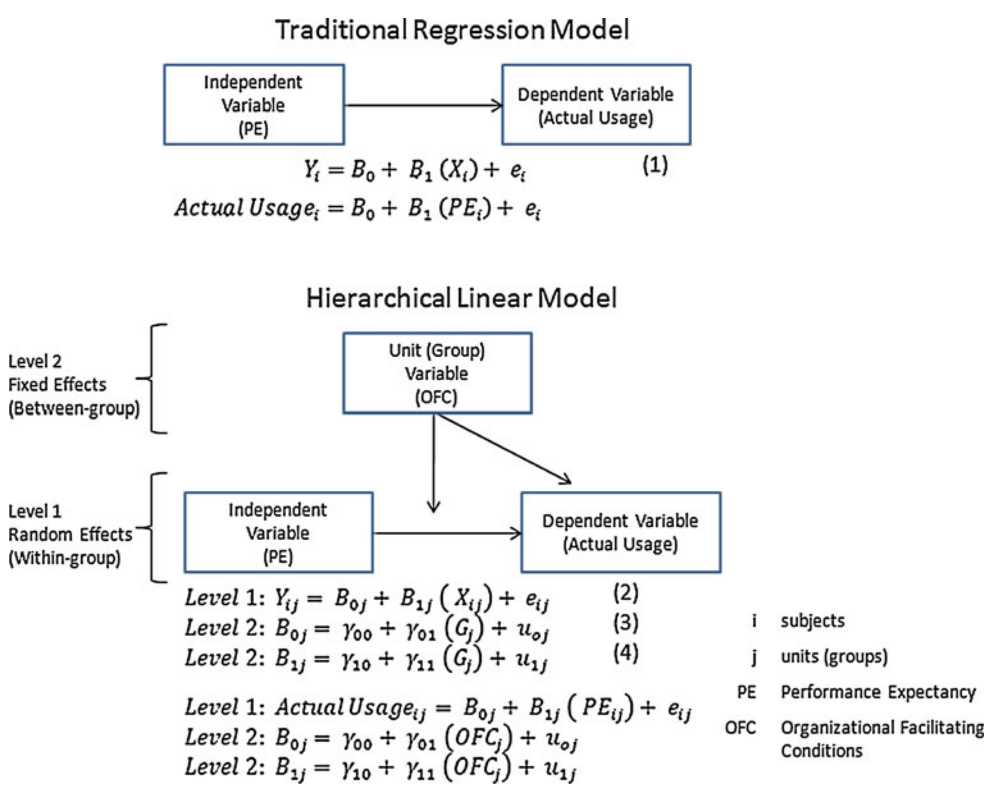

Fig. 7 Traditional regression versus HLM (adapted from [37])

Table 11 Step 1: ICC tests for actual usage

DV	Covariance parameter	Estimate	SE	Z value	ICC
Actual usage	Component UN(1,1)	2,998.82	1,837.61	1.65	0.2098
	Residual	11,294.00	1,101.83	10.25	

variable. As presented in Table 11, the model run produced a variance component of 2998.82 and residual variance of 11,294, corresponding to an ICC of 0.2098 (ICC = 2,998.82/(2,998.82 + 11,294) = 0.2098). This indicates that about 21% of the variance of actual usage can be explained by Level 2 independent variables. A χ^2 test (null model likelihood ratio test) was performed to check whether the Level 2 variance component was significant. This test produced the χ^2 statistic of 32.63 ($df = 1$) with the p value less than 0.001, indicating that the Level 2 variance component is significantly different from the null model. Therefore, H2 is supported.

Next, in Step 2 of the generic model comparison, the objective is to add the Level 1 fixed effects to create a baseline model for comparison purposes. Step 2 includes the relevant independent variables (performance expectancy, effort expectancy, social influence, and individual facilitating condition) and the intercept as fixed effects to build the Level 1 model (fixed effect only). Using SAS's PROC MIXED, we ran a fixed effects regression model, which is identical to running a simple linear regression model. Table 12a shows that effort expectancy (EE), social influence (SI), and individual facilitating conditions (IFC) are not significant. With IFC not significant, H3 is not supported. After removing IVs that are not significant, only performance expectancy (PE) remains, with the regression weight for the intercept and PE statistically significant as shown in Table 12b. We therefore continue our test of group-level effects with PE as the individual-level variable.

For proper interpretation of the intercept, we utilized the Level 1 Group-Mean/Level 2 Grand-Mean centering strategy as recommended by Ployhart [37]. In the Level 1 Group-Mean/Level 2 Grand-Mean centering, the intercept refers to the DV score (actual usage) for the average group score (PE) and average level 2 predictor score (OFC). In other words, the intercept estimate of 193.71 (shown in Table 12b) represents the average usage for an average PE score with average OFC score during the time period of the study. Steps 3 and 4 build upon the Level 1 model in Step 2 and allow random effects for the intercept (Step 3) and random effects for the relevant Level 1 predictor variables (Step 4). Step 3 is needed to determine whether there are between unit (across class) differences in the intercept. In other words, we are interested in testing whether the intercept is a random effect. Using PROC MIXED, we ran the same fixed effects regression model in Step 2, except allowing the intercept to be random.

To test the random effect of the intercept, we compared models in terms of −2 log likelihood residual (−2LLR). The −2LLR is 2,683 in step 2 and 2,650 in Step 3. (See Table 13, Steps 2 and 3.) The difference between the two −2LLR estimates is 33, which also means that the χ^2 statistic is 33. Difference in random components between the two models is 1, meaning there is 1 degree of freedom. For significance at the 0.05 level, the χ^2 should be greater than or equal to 3.84. The observed random effect of the intercept is significant with $p \leq 0.0001$, indicating that between-group variance is significant.

In Step 4, we examined whether the regression weight for PE was a random effect. After allowing the slope for PE to be random (allowing variability in the Level 1 IV of PE), we compared the fit of this model (Step 4) to the previous model of random intercept only (Step 3). We found improvement in model fit, but the effect of PE across classes (the mean of the slope of PE) was small. The difference between the two −2LLR estimates is 0.4, thus resulting in the χ^2 statistic of 0.4. Difference in random

Table 12 SAS results for Step 2 (actual usage as the DV)

Effect	Estimate	SE	*df*	*t* Value	Pr > |*t*|	Alpha	Lower	Upper
(a) Level 1 model with all IVs								
Intercept	203.38	75.523	213	2.69	0.008	0.05	54.5088	352.25
PE	15.9558	8.1178	213	1.97	0.050	0.05	0.04444	38.0656
EE	13.9855	12.4636	213	1.12	0.263	0.05	−10.5823	38.5533
SI	−2.728	11.5658	213	−0.24	0.814	0.05	−25.5262	20.0701
IFC	−16.2277	15.4288	213	−1.05	0.294	0.05	−46.6405	14.1851
(b) Level 1 model with intercept and PE								
Intercept	193.71	7.9674	216	24.31	<0.001	0.05	178.00	209.41
PE	15.9558	8.1178	216	1.97	0.050	0.05	0.04444	31.9559

PE performance expectancy, *EE* effort expectancy, *SI* social influence, *FC* facilitating conditions

Table 13 Model comparison results

Step	Model	*df*	Fixed parameter	Random parameter	AIC	BIC	−2LLR
2	Level 1 model				2,685	2689	2683
	Intercept (fixed)	216	193.71***				
	PE	216	15.96***				
	Residual			13,839***			
3	Level 1 model				2,654	2654	2650
	Intercept (random)	7	200.63***				
	PE	209	15.96***				
	Residual			11,093***			
4	Level 1 model				2655.6	2655.8	2649.6
	Intercept (random)	7	200.90*				
	PE (random)	209	16.90*				
	Residual			11,089*			
5	Level 1 and 2 model				2638.6	2638.9	2632.6
	Intercept (random)	7	305.95***				
	PE (random)	207	67.38*				
	OFC	207	24.69*				
	PE*OFC	207	10.45				
	Residual			10,955***			

AIC Akaike's information criterion, *BIC* Bayesian information criterion, *PE* Performance expectancy

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

components between the two models is 2, meaning that the degree of freedom is 2. For significance at the 0.05 level, the χ^2 should be greater than or equal to 5.99. Thus, the random effect of the PE slope was not significant, suggesting that across classes there are bigger differences in intercepts than slopes. In other words, there are relatively large differences in *group mean* of actual usage across classes but relatively small differences in the *relationship* between PE and actual usage across classes.

In Step 5, we built the Level 2 model to test the remaining hypotheses (H4 and H5). (See Fig. 8.) Table 14 shows the variance components for the intercept and slope: $U_{0j} = 3{,}410$ and $U_{1j} = 0$. The Level 2 intercept and slope were 3,410.54 and 0. This means that there are bigger (about 3,411 units) differences in intercepts than slopes across classes. In other words, there are large differences in the group mean of actual usage across groups, but small differences in the relationship between PE and actual usage across groups. We compared the fit of this model (Step 5) to the previous model (Step 4). We found the difference between the two −2LLR estimates is 17 ($\chi^2 = 17$), indicating a significant improvement in model fit with 2 degree of freedom at the 0.05 level. The results (as shown in Table 13 Step 5) also indicate that actual usage will increase about 67.4 units for every increase of PE. Actual usage will also increase about 24.7 for every increase of OFC, indicating that OFC is positively related to usage. The p values from the individual significant tests (t test) for

The model equation: $Usage_{ij} = B_{0j} + B_{1j}(PE_{ij}) + e_{ij}$ (Level 1)

$B_{0j} = \gamma_{00} + \gamma_{01}(OFC_j) + U_{0j}$ (Level 2)

$B_{1j} = \gamma_{10} + \gamma_{11}(OFC_j) + U_{1j}$ (Level 2)

Parameter estimates:

Variance

e_{ij} = Level 1 residual variance

U_{0j} = Level 2 variance in intercept

U_{1j} = Level 2 variance in slope

Fixed Effects

γ_{00} = mean of intercepts (usage) across group

γ_{10} = mean of the slope (effects of PE) across group

γ_{01} = slope (direct effects of OFC) for mean of intercept for group j

γ_{11} = slope (moderation effects of OFC) for mean of slope for group j

Random Coefficients

B_{0j} = mean for intercepts (usage) for group j

B_{1j} = mean for slope for group j

Fig. 8 Level 2 model

Table 14 Covariance parameter estimates for Step 5

Covariance parameter	Estimate	SE	*Z* value	Pr *Z*
UN(1,1)	3,410.54	2,104.73	1.62	0.0526
UN(2,1)	155.35	739.73	0.21	0.8337
UN(2,2)	0	–	–	–
Residual	10,949	1,073.43	10.2	<0.0001

Table 15 Model parameter estimates

Parameter	Description	Estimate
Γ_{00}	Mean of intercepts (usage) across group	305.95***
Γ_{10}	Mean of the slope (effects of PE) across group	67.38*
γ_{01}	Slope (direct effects of OFC) for mean of intercept for group j	24.69*
γ_{11}	Slope (moderation effects of OFC) for mean of slope for group j	10.45
U_{0j}	UN(1,1) variance for intercept	3,410.54*
U_{1j}	UN(2,2) variance for slope	0
e_{ij}	Residual (error)	10,949***

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

the PE and OFC were 0.0509 and 0.0506, which are very close to the 0.05 level. These estimates show the PE and OFC are practically significant. Therefore, H4 is supported. The moderation effects of OFC were 10.45 and were not statistically significant (p value = 0.2220). Therefore, H5 is not supported. In sum, we conclude that (1) PE is positively related to actual usage, and (2) this relationship is not moderated by OFC, but (3) there are between-class differences in usage, and (4) OFC helps explain these differences. Out of the four hypotheses tested in Study 2, H2 and H4 were supported, while H3 and H5 were not supported. Table 15 provides the final model parameter estimates.

6 Discussion

The two studies in this article have taken sequential and complementary approaches to understanding the effects of facilitating conditions on individual acceptance of technology from a multilevel perspective. In the first study, taking a traditional construct development and validation approach, we analyzed the original UTAUT facilitating conditions construct and found it to be composed of two components: (1) individual facilitating conditions and (2) organizational facilitating conditions. The original UTAUT facilitating conditions construct is a complex construct grounded in four different theories. In Study 1, we demonstrated the construct of facilitating conditions to be multi-dimensional and then improved the scale by following the scale development and refinement steps of Churchill [10] and Hinkin [9], resulting in a psychometrically strong scale. Content validity, reliability, discriminant validity, and convergent validity were all assessed and found to be satisfactory.

In the Study 2, we used a specific multilevel approach (HLM) in conjunction with our revised scale to enhance our understanding of individual technology acceptance. We found that the organizational facilitating conditions as a group-level variable explained a significant amount of variance in individual acceptance behavior (actual usage behavior). By using the HLM approach, we were able to test a multilevel model and assess the amount of variance in individual acceptance outcomes explainable by the group-level variable of organizational facilitating conditions.

Table 16 presents a summary of the findings. It should be noted that two of the five hypotheses were not supported.

First, the direct link between individual facilitating conditions and actual usage of a system (H3) was not significant. One potential factor responsible for the non-significance of H3 is the data collection time. We collected the usage data over 12 weeks. It might be possible the effect of individual facilitating conditions on usage disappeared overtime. Taylor and Todd found that perceived

Table 16 Summary of findings

Hypothesis number	Hypothesis	Results
H1	The organizational facilitating conditions construct is distinct from the individual facilitating conditions construct	Supported
H2	There are between-class differences in usage that are explained by organizational facilitating conditions	Supported
H3	Individual facilitating conditions have a direct effect on actual usage of a system	Not supported
H4	Organizational facilitating conditions have a direct effect on actual usage of a system	Supported
H5	Organizational facilitating conditions moderate the relationship between individual perceptions and actual usage of a system	Not supported

behavioral control, one of the underlying constructs of facilitating conditions, had a significant effect on usage behavior for inexperienced users, but not for experienced users [43]. Over time, it is possible that users become less sensitive to environmental conditions of resource availability as they gain experience with the system and find alternative avenues for help and support. In addition, it should be noted that Venkatesh et al. [49] also did not find a significant effect of individual facilitating conditions on usage behavior in most cases. Out of eight tests reported for the direct effect of facilitating conditions on usage behavior, the effect was only significant in two tests. One potential reason for the equivocal results could be that the measure used in their study was a combination of individual and organizational facilitating conditions. Our study separates the two dimensions and isolates the effect of organizational facilitating conditions from that of individual organizational facilitating conditions. In Study 2, the support of H2 confirms that a significant portion of system usage is attributable to organizational facilitating conditions while the comparison of the H3 and H4 testing results reveals that organizational facilitating conditions play a much more prominent role in determining system usage than individual facilitating conditions do, at least in the current study context. Without separating the two dimensions of facilitating conditions, we would never have noticed the marked differences between organizational facilitating conditions and individual facilitating conditions.

Second, the moderation effect of group-level variables (organizational facilitating conditions) on the relationship between individual perceptions (performance expectancy) and actual usage of a system (H5) was not significant. One of the possible explanations of the insignificance of H5 is that the effect of performance expectancy on actual usage was too high to be influenced by organizational facilitating conditions. For example, some extrinsic rewards (e.g., gaining high scores in tests) motivated the subjects so strongly that the subjects used the system no matter how much they were supported by the instructor or by the school. Much of IS literature also suggests the performance expectancy construct as the strongest predictor of IT acceptance [43, 44, 49]. Another possible reason for the non-significance of H5 is the small sample size. Statistically the moderation effect was tested with the sample size of 8 (the 8 groups of subjects), which might not have enough statistical power. Future studies should revisit this issue with a larger sample to examine the moderation effect.

In the context of the four research questions presented earlier (in Sect. 3.2), our results indicate the following:

1. The group-level unit (class) in which the individual-level unit (student) resides does make a difference in the dependent variable of actual usage. This is evident by the ICC calculation in Step 1 of the analysis (H2 supported).

2–3. In a multilevel nesting structure of students within classes, the Level 1 variable of individual facilitating conditions did not have a direct effect on actual usage (H3 not supported). However, the Level 2 variable of organizational facilitating conditions did have a direct effect on actual usage (H4 supported).

4. The Level 2 variable (organizational facilitating conditions) does not moderate the Level 1 relationship (H5 not supported).

7 Conclusion

Overall, the results of this research support the notion that the facilitating conditions construct is multilevel and multidimensional. The results further show that organizational facilitating conditions as a group-level variable explains a significant amount of variance over and above the main determinants of UTAUT operating at the individual-level, and that it in fact explains a larger amount of variance in individual acceptance behavior (actual usage behavior) than individual facilitating conditions. The findings suggest that the facilitating conditions operating at two different levels should be considered together for improved user acceptance of technology, and that organizational human and technical infrastructure can have more salient effects on user acceptance behavior than individual facilitating conditions. From our study findings, it can be argued that systematic differences of environmental support existing at the group-level do make a significant difference in system usage by individual users in addition to individual perceptions of IT utilities. Thus, it would be important to provide support not just at the individual-level but also at the group-level in order to reduce the variability across the groups when a new technology is introduced.

The present research demonstrates that multilevel modeling has merit over single-level modeling in illuminating complex mechanisms underlying technology adoption decision by individual users who are embedded in groups within an organization. The HLM technique utilized in the present research to assess the effects of group-level variables on individual acceptance outcomes provides a practical solution in untangling seemingly inseparable influences exerted by collective- and individual-level variables together. The present research appears to be the first study that applied the HLM technique to user acceptance of technology to empirically assess a multilevel model. As advocated by others [4, 7, 9], a multilevel analysis provides a more complete, integrative account of a complex phenomenon. Given the desirability of studying

IT implementation from a multilevel perspective [4, 7, 26, 27], multilevel modeling equipped with HLM seems well poised to become one of the essential research approaches to a deeper understanding of IT implementation in general and user acceptance of technology in particular.

From a practical standpoint, this research suggests that we should recognize the multilevel nature of IT implementation with a focus on the group-level variables (e.g., organizational facilitating conditions). One practical application of the present research is the use of the organizational facilitating conditions measure. The measure can be used to assess whether there are systematic variances in perceiving facilitating conditions between groups. This assessment can then inform managers and organizational stakeholders which groups need additional support for more effective acceptance of technology. Furthermore, the multilevel model examined in this paper suggests that in addition to individual training and support, it is important to consider group-level interventions. To facilitate technology adoption and diffusion, IS managers should consider providing group-level supports such as adding helpdesk personnel to a team, training team leaders, and offering uniform IT accessibility and infrastructure across groups. The present research shows that without including a comprehensive range of managerial interventions at both the individual-level and the group-level, IS managers cannot fully realize the expected outcomes from IT given the multilevel nature of IT acceptance.

This research is not without limitations. First, our measures of individual perceptions consisted of self-reported measures and were collected from users within a single university site. Although there is no reason to believe that the sample is not representative of a more general population, the possibility exists and the results should be interpreted with this limitation. Second, as noted earlier, the small number of groups (218 individuals nested within 8 classes) raises some concerns about the statistical power of the results. While this limitation is unlikely to negate the significant effects observed in the present research, there is the possibility that some of the non-significant effects may become significant with a larger size of groups. Future studies may want to examine the multilevel phenomenon of user acceptance within the context of additional groups. Third, there is a possibility that we may have missed some important predictors in our multilevel model. Future study should attempt to identify and test additional predictors of the model in an attempt to provide a richer understanding of IS user acceptance. For example, the social influence construct could be an additional organizational-level variable that was not tested in our model but may merit consideration in future work.

Despite the limitations, our research provides contributions to the IS literature. This research is, as far as we know, the first to refine the UTAUT model into a multilevel model. In doing so, valuable insights are gained as to how to facilitate the adoption of new ITs by improving group-level facilitating conditions. Additionally, an improved operationalization of the facilitating conditions construct with desirable psychometric properties is useful in future studies validating the UTAUT model.

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Appendix

We provide additional analyses to further establish that organizational facilitating conditions (OFC) and individual facilitating conditions (IFC) should be treated as separate constructs. We built five models for a model comparison. The first model has all final items of OFC and IFC as one comprehensive facilitating conditions construct in UTAUT. The second model has the three final items of OFC, while the third model has the three final items of IFC for representing the FC construct in UTAUT. The fourth model has the four original items of the facilitating conditions construct in UTAUT. The fifth model has all final items of OFC and IFC and two separate constructs (OFC and IFC) for representing the FC construct in UTAUT. The five models are based upon the original UTAUT with various combinations of facilitating conditions (combined OFC and IFC as one construct, OFC only, IFC only, the original UTAUT facilitating condition, OFC and IFC as two separated constructs) and were tested using LISREL 8.8. It should be noted that all other UTAUT constructs except facilitating conditions were measured with the original items from UTAUT. Model-data fit statistics for the five models are shown in Table 17. In addition, Table 17 reports total explained variances for the five alternative models.

The model fit statistics for the five models were reasonable. Although the RMSEA values were slightly outside the recommended cut-off value, these values are acceptable. According to the three fit indicators, Model 2 and Model 5 showed better model fit than others. However, the differences in model fit among the five models were found

Table 17 Model fit and explained variances comparisons

	χ^2 value	*df*	RMSEA	CFI	NFI	R^2
Model 1	753.18	288	0.10	0.94	0.91	0.70
Model 2	552.84	219	0.097	0.95	0.92	0.68
Model 3	582.36	219	0.10	0.94	0.91	0.69
Model 4	638.47	241	0.10	0.93	0.90	0.69
Model 5	705.97	283	0.096	0.95	0.92	0.74

very small (e.g., biggest difference was only at the level of 0.02). So, although it can be argued that Model 2 and 5 are a bit better representations of the data, all five models are very similar. In terms of total explained variances of two dependent variables (behavioral intention and use behavior), Model 5 showed the highest value while increasing the total explained variances by 5% from Model 4 (the original UTAUT model). That is, Model 5 with OFC and IFC as two separated constructs is the best when evaluated by explanatory and predictive power.

Additionally, we conduct more simplified model comparisons, where we have facilitating conditions as only predictor (without other independent variables) and behavioral intention as the only dependent variable. In terms of facilitating conditions, we used the same five variations: Model 1—combined OFC and IFC items as one facilitating conditions construct; Model 2—OFC only; Model 3—IFC only; Model 4—the original UTAUT facilitating condition; and Model 5—OFC and IFC as two separated constructs. The five simplified models were tested using LISREL 8.8, and the results are shown in Table 18. Model 3 showed the best model fit, but Model 5 showed highest explained variances while OFC and IFC factors were all significant and explained 38% of behavioral intentional (BI) variance. Standardized parameter estimates for the OFC-BI and IFC-BI links were 0.24 and 0.40 in Model 5.

Table 19 displays the results from the additional five simplified model tests with satisfaction as dependent variable. Satisfaction is often used as an important dependent variable in IT acceptance studies [6], and we believe it is worthy to see how the variations of facilitating conditions work with satisfaction. As the results indicate, Model 2 showed the best model fit, while Model 1 and 5 showed highest explained variances of satisfaction. Standardized parameter estimates for the OFC-BI and IFC-BI links were 0.27 and 0.49 in Model 5.

Overall, the results from the three rounds of model comparisons indicate that Model 5 with OFC and IFC as two separated constructs showed better fit indices and also explained variances more than other models. This suggests that conceptualizing facilitation conditions as two separate constructs (OFC and IFC) would provide better representations of the reality, as well as enhance our explanatory and predictive power in the IT acceptance context.

Table 18 Simplified model comparison with behavioral intention as dependent variable

	χ^2 value	*df*	RMSEA	CFI	NFI	R^2
Model 1	82.92	26	0.12	0.96	0.94	0.36
Model 2	30.06	8	0.13	0.96	0.95	0.29
Model 3	13.51	8	0.0065	0.99	0.98	0.27
Model 4	38.26	13	0.11	0.96	0.94	0.13
Model 5	51.71	24	0.085	0.98	0.96	0.38

Table 19 Simplified model comparison with satisfaction as dependent variable

	χ^2 value	*df*	RMSEA	CFI	NFI	R^2
Model 1	70.44	26	0.10	0.97	0.95	0.54
Model 2	3.67	8	0.0	0.99	0.99	0.46
Model 3	18.71	8	0.091	0.98	0.97	0.52
Model 4	40.29	13	0.11	0.97	0.95	0.37
Model 5	36.47	24	0.057	0.99	0.97	0.54

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