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Two-level model of information technology adoption in local government of Bali

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Recent advance in information technology has aroused much interest among policy-makers, the business sector, the media and the academic world in developed countries. However, very little is known about the obstacles to adopting information technology in developing countries, particularly the low-income economies. This research stems from the issues described above. A variety of factors may influence the adoption of IT in local governments. Those factors range from technological and institutional to personal, social and economic factors. These factors included not only the information on variables gathered at the employee level but also on questions regarding the characteristics of each organization involved in the study. Hence the data files contain information obtained at two different levels, namely individual level and organizational level. Therefore a two-level hierarchical linear model is used to examine the relationships among variables.

information technology, adoption, local government, two-level model, Bali

INTRODUCTION

The rapid changes in IT in the developed countries have serious managerial, financial, human resource implications for information management in developing countries (Bowonder, Miyake, & Singh, 1993). The shrinking of the world into a 'global village' (Gore, 1991) makes it difficult for the developing countries to insulate themselves from the changes occurring due to developments in IT. It is thus evident that developing countries need to understand the pervasive nature of changes initiated by new IT and the consequences of not keeping pace with the changes occurring in the developed world. Therefore, the formulation and implementation of comprehensive information technology strategies have become critical for the developing countries. This is accentuated by the fact that the resources to support the operation of IT are usually scarce (Lu & Farell, 1990; Shahabudin, 1990; Kahen, 1995).

A variety of factors may influence the outcome of implementing IT in local governments. Those factors range from personal to technological, institutional, social, and economic factors. Past research in innovation highlights the importance of individual factors, technological factors, organizational factors, and the environmental factors for successful adoption of innovation (Zaltman, Duncan & Holbeck, 1973; Tornatzky & Klein, 1982). Nevertheless, most studies do not provide an in-depth discussion and examination of the factors critical to the adoption and utilization of IT in developing countries. It is important that the local conditions of potential users are considered to the same extent as the technology because of their potentially important role in the implementation process. The nature and extend of the role would appear to require further investigation.

The data in this paper come from the study that examine various potential factors that might affect information technology adoption and implementation processes in the context of Bali's local government. A four-phase conceptual model of IT adoption and implementation process is formulated for this study by synthesizing various stages of innovation adoption process proposed by previous authors (Rogers, 1962, Hage & Aiken, 1970; Rogers & Shoemaker, 1971; Zaltman et al., 1973; Huff & Munro, 1985; Panizzolo, 1998). This four-phase adoption process consists of the initiation phase, adoption phase, implementation phase, and evaluation phase. At least four types of factors (environmental, organizational, technological, and human factors) are believed to affect each phase of IT adoption process directly or through the previous phase as a mediator.

This four-phase innovation adoption process can also be observed at several levels. Possible adopters of the technology are organizations, organizational units, organizational sub units, and individuals. In the overall study, two level of adoption are considered. The first level adoption, the organizational level adoption, starts when an organization begins to realize the need for strategic change and decides to incorporate IT. It ends with acquisition of the technology. This organizational level adoption involves the first two phases of the four-phase adoption process, namely the initiation and adoption phases. The second level adoption, the individual level adoption, commences with the acquisition of the technology, and finishes when the technology is utilized. This individual level adoption involves the last two phases of the four-phase adoption process, namely the implementation and evaluation phases. This paper focuses only on the first level of adoption, and uses the perceived level adoption as the outcome variable. At level-1, human factors and technological factors are used as potential predictors, and at level-2, the aggregate of these individual level variables are used to represent the organizational climates that may affect the outcome variable. In addition, organizational characteristics are also added to the potential level-2 predictors.

In investigating the relationships among variables, it is interesting to examine the direct effects on various predictors on the outcome variable. In addition, it is also no less interesting to understand the cross-level interaction effects that occur between level-1 variables and level-2 variables. In seeking an explanation of such effects, a procedure is employed, which is called hierarchical linear modelling. The need for such techniques has been pointed out since the late 1980s. Attempts are made to model social science data that conform to a nested structure (Bryk & Raudenbush, 1992). These techniques seek to take into account the hierarchical structure of the data obtained in social science research and are therefore now commonly referred to as applications of hierarchical linear modelling, abbreviated as HLM.

Thus, the purpose of this paper is to examine various potential relationships among variables at the individual level (level-1) and at the organizational level (level-2) on adoption as the outcome variable using two-level hierarchical linear modelling (HLM) procedures. The use of these procedures makes it possible to analyse variables at different levels simultaneously in order to find out various factors that may affect the outcome variable (the dependent variable). In addition to the direct effects at different levels, this approach also provides the interaction effects between variables at the two levels. The conceptual model for the two-level HLM of adoption is shown in Figure 1.

VARIABLES USED

However, HLM does not currently allow the formation of latent variables. Hence, principal component scores are calculated for each construct involved in the models using SPSS 10. As a result, variables are in standardized forms, which allow the direct comparison of coefficients of variables within the model (Pedhazur, 1997).

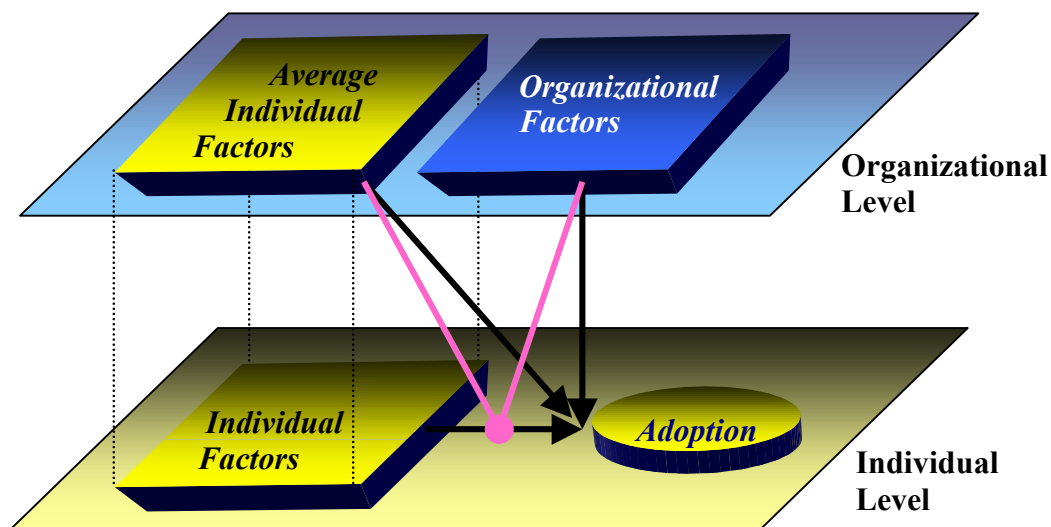


Figure 1. Two-level Model of Adoption

Table 1 lists the individual level (or level-1 or micro-level) variables as well as the organizational level (or level-2 or macro-level) variables that are examined. Darmawan (2000, 2001) elaborates the scales used to measure these variables. Where reference is made to variables used in the HLM analyses reported in this study, variable names are given in uppercase. Variables that are measured at level-1 and aggregated to the group level are assigned the suffix “_21”. The aggregated variables are used to represent the organizational and district climates that may affect the outcome variable.

Table 1. List of Variables

Individual Level	Organizational Level	Description
Organizational Factors		
	OSIZE	Organizational size
	TYPE	Organizational type
	OCOM	Organizational complexity
	CENTRAL	Level of centralisation
Individual Factors		
SEX	SEX_21	Gender of Employee
AGE	AGE_21	Age of employee
EDUC	EDUC_21	Level of Education
COMCH	COMCH_21	Communication channel
ANXTY	ANXTY_21	Computer related anxiety
ATTID	ATTID_21	Attitude toward change
RELAD	RELAD_21	Relative advantage
COMPA	COMPA_21	Compatibility
COMPL	COMPL_21	Complexity
OBSER	OBSER_21	Observability
INITI	INITI_21	Initiation
ADOPT	ADOPT_21	Adoption

DATA USED FOR THE STUDY

The data in this paper come from the study focusing on the adoption and implementation of information technology in local government of Bali-Indonesia. The total number of agencies that participated in this study was 153 agencies across all regions of Bali. Those 153 agencies employ a total of 10,034 employees. Of these, 1,427, or approximately 14 per cent, used information technology in their daily duties. They may be considered end-users. Of these end-

users, 975 employees participated in this study. The goal of this study is to examine various potential factors that might affect information technology adoption and implementation processes in the context of Bali's local government. These respondents are grouped into two categories, the initiators and the non-initiators. The initiators are those who are involved in the decision making process in adopting the technology, while the non-initiators are those who are not involved in the decision making process. For this particular analysis, the two-level HLM model of adoption, only initiators' responses are used. This sub-sample includes 465 respondents in 117 organizations.

TWO-LEVEL ADOPTION MODEL FOR INITIATORS

It should be noted that in this chapter, the term level-1, individual level, within group level, between employees, and micro-level are employed interchangeably. Likewise, the term level-2, organizational level, between group level, between organizations, and macro-level are used synonymously.

The selection of variables for the two-level HLM analysis is based on the results of the PLSPATH (Sellin, 1989), AMOS (Arbuckle & Wothke, 1999), and MPLUS (Muthen and Muthen, 1998) analyses (Darmawan, 2001). The limitations of PLSPATH and AMOS as a single level techniques are acknowledged, therefore the two-level MPLUS results are included in the model and exploratory analyses are also employed to find any other possible variables to be included in the model. However, while MPLUS provides for multilevel analysis at two levels it does not model cross-level interaction effects and does not readily provide estimates of residuals. Consequently, the HLM 5 (Raudenbush et al., 2000) and MLwiN 1.1 (Rasbash et al., 2000) analyses are employed to overcome those deficiencies that currently exist in MPLUS. Nevertheless, neither HLM nor MLwiN provide for the estimation of latent variables and in the HLM and MLwiN the latent variables have to be formed outside of these programs using principal components analyses.

Null Model

The analysis of the two level HLM model is undertaken by first running the fully unconditional model to obtain the estimates of the amount of variance available to be explained in the model using HLM 5 (Raudenbush et al., 2000). An estimate in a fully unconditional model is obtained from a model without entering into the equation any individual level or organizational level variables. This model is equivalent to one-way ANOVA with random effects (Bryk & Raudenbush, 1992).

A fully unconditional model specified in the first run of the two levels HLM analysis is given in the following equation:

$$\text{Level-1 Model: } Y_{ij} = \beta_{0j} + r_{ij} \quad [1]$$

where:

Y_{ij} is the IT adoption level according to employee i in the organization j ,

β_{0j} is the intercept for organization j (the mean adoption score for the j th organization),

r_{ij} is a random error.

In the above equation, the level of IT adoption according to employee i in the organization j is considered to be equivalent to the organization mean plus a random error. In other words, the fully unconditional model assumes no differences in the IT adoption level perception between employees within organization at level-1. It is assumed that each level-1 error, r_{ij} , is normally

distributed with a mean of zero and a constant level-1 variance, σ^2 (Bryk & Raudenbush, 1992).

$$\text{Level-2 Model: } \beta_{0j} = \gamma_{00} + u_{0j} \tag{2}$$

where:

- β_{0j} is the intercept for organization j ,
- γ_{00} is the adoption score across organizations (the grand mean outcome in the population),
- u_{0j} is the unique random effect associated with organization j .

In the level-2 equation, the IT adoption score of organization j is considered to be equivalent to the mean across all organizations plus a random error. In other words, the fully unconditional model assumes no differences in the IT adoption score between organizations at level-2. It is assumed that the random effect associated with organization j , u_{0j} , is normally distributed with the mean of zero and variance τ_{00} .

Substituting level-2 equation into level-1 equation yields the combined model

$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \tag{3}$$

According to Bryk and Raudenbush (1992), the variance of the outcome is

$$\text{VAR}(Y_{ij}) = \text{VAR}(u_{0j} + r_{ij}) = \tau_{00} + \sigma^2 \tag{4}$$

Estimating the null model is an important preliminary step in a hierarchical analysis. It produces a point estimate and confidence interval for the grand mean, γ_{00} . Furthermore, it also provides information about the variability of the outcome variable at each level. The σ^2 parameter represents the within-group (level-1) variability, and τ_{00} captures the between-group (level-2) variability (Bryk & Raudenbush, 1992). The HLM results for the null model are presented in Table 2.

Table 2. Fully Unconditional Model - Adoption for Initiators

Final estimation of fixed effects						
Fixed Effect	Coefficient	Standard Error	T-ratio	DF	Approx. P-value	
For INTRCPT1, B0						
INTRCPT2, G00	-0.032	0.08	-0.391	116	0.695	
Final estimation of variance components						
Random Effect	Reliability	Standard Deviation	Variance Component	DF	Chi-square	P-value
INTRCPT1, U0	0.822	0.8	0.64	116	848.74	0
level-1, R		0.62	0.39			
Statistics for current covariance components model						
Deviance	1102.1					
Number of estimated parameters	2					

Final Level-1 Model

The hierarchical model that is examined is based on those results of PLSPATH, AMOS and MPLUS analyses (Darmawan. 2001). The limitations of PLSPATH and AMOS as a single-level technique are acknowledged and the possibility of the misspecification of a hierarchical model based on those results cannot be ignored. However, little relevant research is available to serve as a sound theoretical and empirical basis for the specification of a hierarchical

model. Because of the complexity of the model, PLSPATH, AMOS, and MPLUS results are considered to be an appropriate basis for selecting potential predictors at both level-1 and level-2 in the HLM analyses.

In order to specify the level-1 model, variables that are found to influence the level of adoption directly at the individual level PLSPATH and AMOS analyses as well as the within model in MPLUS results are entered into the equation one by one according to the magnitude of path coefficients starting from the strongest path, but without the organizational level predictors. Bryk and Raudenbush (1992) suggest that this step is necessary to examine how much of the variance is explained by individual level predictors. Results are then examined and those coefficients that are found not to be significant are removed from the model and the next potential variable is entered into the equation. The input is altered accordingly and the data are reanalysed. These steps are repeated step by step until a final level-1 model with only significant effects is obtained. In each run, an exploratory analysis is also performed to check the possibility of each level-2 variable to be included in the model.

From this step, it is found that only one variable at the individual level, the employees' perception of IT complexity (COMPL), has a significant effect on adoption. To investigate the nature of the relationship between employees' perception of IT complexity (COMPL) and the perceived level of adoption (ADOPT), a series of exploratory analysis is undertaken using MLwiN 1.1 software (Rasbash et al., 2000).

By only entering employees' perception of IT complexity (COMPL) into the equations, MLwiN results are shown in Figure 2 and the regression line for each organization is shown in Figure 3.

$$\text{adop}_{ij} \sim N(XB, \Omega)$$

$$\text{adop}_{ij} = \beta_{0ij}\text{cons} + \beta_{1j}\text{compl}_{ij}$$

$$\beta_{0ij} = -0.042(0.081) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.112(0.045) + u_{1j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.631(0.099) & \\ -0.042(0.037) & 0.047(0.023) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.325(0.027) \end{bmatrix}$$

$$-2*\text{loglikelihood(IGLS)} = 1061.385(465 \text{ of } 465 \text{ cases in use})$$

Figure 2. MLwiN Results for Final Level-1 Model

It can be seen in MLwiN results in Figure 2 that in the final level-1 model, which only includes level-1 predictor, the mean of COMPL slope is 0.112 (0.045). However, the individual organization slopes vary about this mean with a variance of 0.047 (0.023). The intercepts of the individual organization lines also differ. Their estimated mean is -0.042 (0.081) and their estimated variance is 0.631 (0.099). In addition, there is a negative covariance between intercept and slope estimated as -0.042 (0.037). This negative covariance suggests that a higher intercept is associated with a lower slope. In other words, organizations with lower level of adoptions tend to some extent to have steeper slopes or lower impact of complexity on adoption. The variability of complexity slopes is presented in Figure 3. The individual adoption scores vary around their organizations' lines by quantities e_{0ij} , the level-1 residual, whose variance is estimated as 0.325 (0.027).

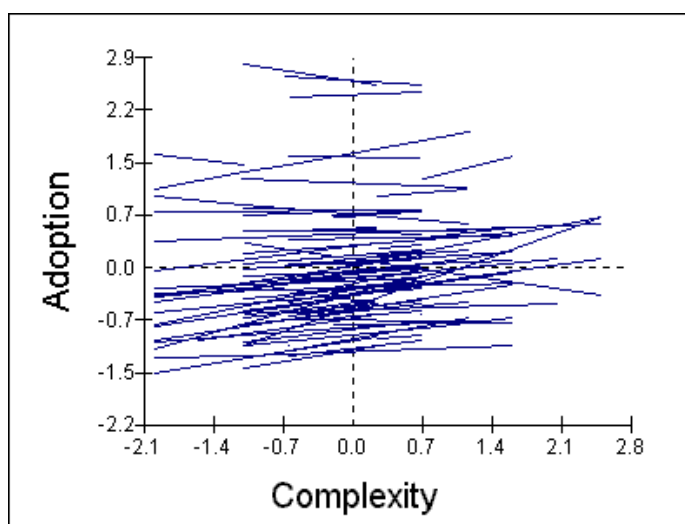


Figure 3. Regression lines for Each Organization

In order to investigate further the nature of data regarding the two variables, residual analyses are undertaken with the slope being fixed. Since 117 organizations are involved in this study, there are 117 level-2 residuals plotted in caterpillar plot, one for each organization in the data set, as presented in the first panel of Figure 4. It can be seen in the caterpillar plot that a group of around 10 organizations at each end of the plot where the confidence intervals for their residuals do not overlap zero. Remembering that these residuals represent organizations' departures from the overall average line predicted by the fixed parameter, this means that the majority of the organizations do not differ significantly from the average line at the 5 per cent level. The second and the third panels of Figure 4 present the scatter plot of adoption versus complexity and individual organizations' lines with complexity slopes being fixed respectively. In the third panel, it can also be seen the average line, the line with the largest residual, and line with the lowest residuals. These results suggest that there is a possibility of random error at the organizational level.

In order to investigate this possibility, another prediction is calculated. This time the slope is allowed to vary. The scatter plot of intercept against slope is presented in the first panel of Figure 5. The second panel of Figure 5 shows the scatter plot of adoption versus complexity. The average line and the lines with the largest and the lowest residuals are plotted in the third panel of Figure 5 along with their confidence interval.

By undertaking these exploratory analyses with MLwiN 1.1, it is confirmed that there are some possible interaction effects of variables at level-2 with the slope of complexity (COMPL). However, there is no easy way to explore the possible variable that may affect the intercept or interact with the slope in MLwiN. Particularly, when the interaction effect involves a continuous level-2 variable. MLwiN only allows categorical variables at level-2 to interact with level-1 predictors. In order to be able to explore the possible variables that may affect the intercept or interact with the slope and to allow any continuous variables at level-2 to interact with level-1 predictors, the exploratory analysis using HLM 5 is undertaken and the results are discussed in the following section.

Full Model

The next step is to run a full model that is by entering the individual level and organizational level variables into the analysis. HLM 5 is used to examine this model by using its exploratory analysis sub-routine to check for possible interaction effects. The organizational level

variables are entered one by one according to their t-values shown in the exploratory analysis results. These steps are repeated step by step until a final model with only significant effects at both levels is obtained.

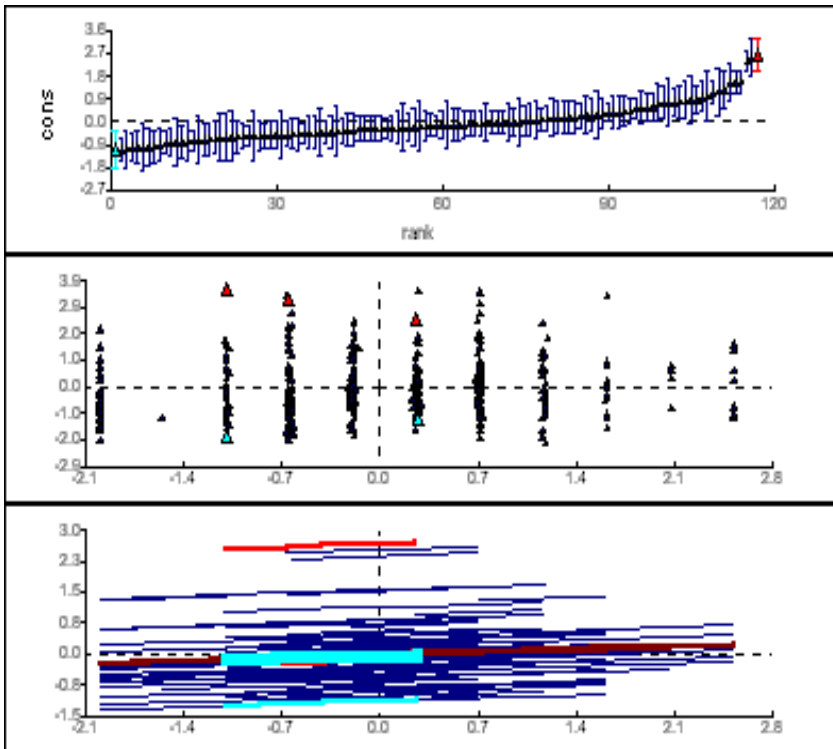


Figure 4. Exploratory Graphs with slope being fixed

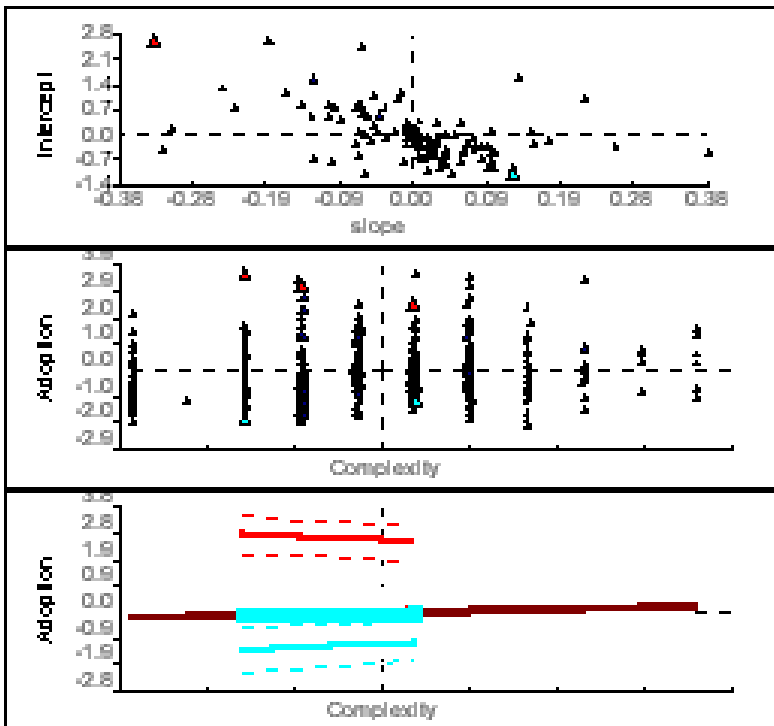


Figure 5. Exploratory Graphs with random errors at level-2

The final model is specified by the following equations:

Level-1 Model

$$Y_{ij} = \beta_{0j} + \beta_{1j} * (\text{COMPL}) + r_{ij} \quad [5]$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * (\text{TYPE}) + \gamma_{02} * (\text{OCOM}) + \gamma_{03} * (\text{COMCH_21}) + \gamma_{04} * (\text{INITI_21}) + u_{0j} \quad [6a]$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} * (\text{ANXTY_21}) + \gamma_{12} * (\text{ADOPT_21}) + u_{1j} \quad [6b]$$

By substituting level-2 equations (Equations 6a and 6b) into level-1 equation (Equation 5), the final model equation is

$$Y_{ij} = \gamma_{00} + \gamma_{10} * (\text{COMPL}) + \gamma_{01} * (\text{TYPE}) + \gamma_{02} * (\text{OCOM}) + \gamma_{03} * (\text{COMCH_21}) + \gamma_{04} * (\text{INITI_21}) + \gamma_{11} * (\text{ANXTY_21}) * (\text{COMPL}) + \gamma_{12} * (\text{ADOPT_21}) * (\text{COMPL}) + u_{0j} + u_{1j} * (\text{COMPL}) + r_{ij} \quad [7]$$

This equation illustrates that the adoption level may be viewed as a function of the overall intercept (γ_{00}), five main effects, two cross-level interaction effects, with a random error ($u_{0j} + u_{1j} * (\text{COMPL}) + r_{ij}$). The five main effects are the direct effects from IT complexity (COMPL, γ_{10}), organizational type (TYPE, γ_{01}), organizational complexity (OCOM, γ_{02}), average communication channel (COMCH_21, γ_{03}), and average initiation level (INITI_21, γ_{04}). The two cross-level interaction effects involve ANXTY_21 with COMPL (γ_{11}) and ADOPT_21 with COMPL (γ_{12}).

These so-called ‘interaction effects’ are at the core of the additional information that HLM produces as a result of the concept of ‘slope as outcome’ analysis (Bryk & Raudenbush, 1992). Table 3 shows that one level-1 variable has an effect on performance, namely COMPL, the perceived complexity of the technology. In addition, four level-2 variables influence the average adoption in each organization, namely organizational type (TYPE), organizational complexity (OCOM), average communication channel (COMCH_21), and average initiation (INITI_21). The first two variables, TYPE and OCOM, are variables at level-2 or the characteristics of the organization, whereas the last two, COMCH_21 and INITI_21, are variables aggregated from the individual level. Moreover, two level-2 variables influence the slope of perceived complexity of the technology, namely the average perceived anxiety (ANXTY_21) and the average perceived adoption level (ADOPT_21). All variables are aggregated from the individual level. These relationships are shown in Figure 6.

In general, a cross-level interaction effect relates three variables to one-another, namely, the outcome variables, its level-1 predictor, and a level-2 variable that is considered to influence the effect of the level-1 predictor on the outcome variable. In order to illustrate the interaction effect and the detail, which could be obtained from HLM output, parts of the equations for the final model involving ANXTY_21 and COMPL are presented below with the remaining terms set to zero since neither ANXTY_21 or COMPL are involved and there is no loss in generality.

$$Y_{ij} = \beta_{0j} + \gamma_{10} * (\text{COMPL}) + \gamma_{11} * (\text{ANXTY_21}) * (\text{COMPL}) + r_{ij} \quad [8]$$

where (see Table 4)

$$\begin{aligned} \beta_{0j} &= \gamma_{00} \text{ (as the average adoption across organization)} \\ &= 0.00 \text{ (since it is not significantly different from zero, } p > 0.05) \\ &\text{(This is a consequence of the use of standardized criterion variable)} \end{aligned}$$

$$\gamma_{10} = 0.10 \quad \text{and} \quad \gamma_{11} = -0.12$$

Hence :

$$Y_{ij} = 0.10 \cdot (\text{COMPL}) - 0.12 \cdot (\text{ANXTY_21}) \cdot (\text{COMPL}) + r_{ij} \quad [9]$$

Table 3. Final Model - Adoption for Initiators

Final estimation of fixed effects							
Fixed Effect		Coefficient	Standard Error	T-ratio	DF	Approx. P-value	
For INTRCPT1, B0							
	INTRCPT2, G00	0.01	0.07	0.12	112	0.902	
	TYPE, G01	0.20	0.08	2.56	112	0.011	
	OCOM, G02	0.15	0.04	3.31	112	0.001	
	COMCH_21, G03	0.27	0.09	3.00	112	0.003	
	INIT_21, G04	0.24	0.07	3.37	112	0.001	
For COMPL slope, B1							
	INTRCPT2, G10	0.10	0.05	1.99	114	0.047	
	ANXTY_21, G11	-0.10	0.06	-2.05	114	0.040	
	ADOPT_21, G12	-0.50	0.05	-10.76	114	0.000	
Final estimation of variance components:							
Random Effect		Reliability	Standard Deviation	Variance Component	DF	Chi-square	P-value
	INTRCPT1, U0	0.72	0.67	0.45	87	511.30	0.000
	COMPL slope, U1	0.42	0.40	0.16	89	212.66	0.000
	level-1, R		0.59	0.34			
Statistics for current covariance components model							
Deviance		1053.9					
Number of estimated parameters		4					

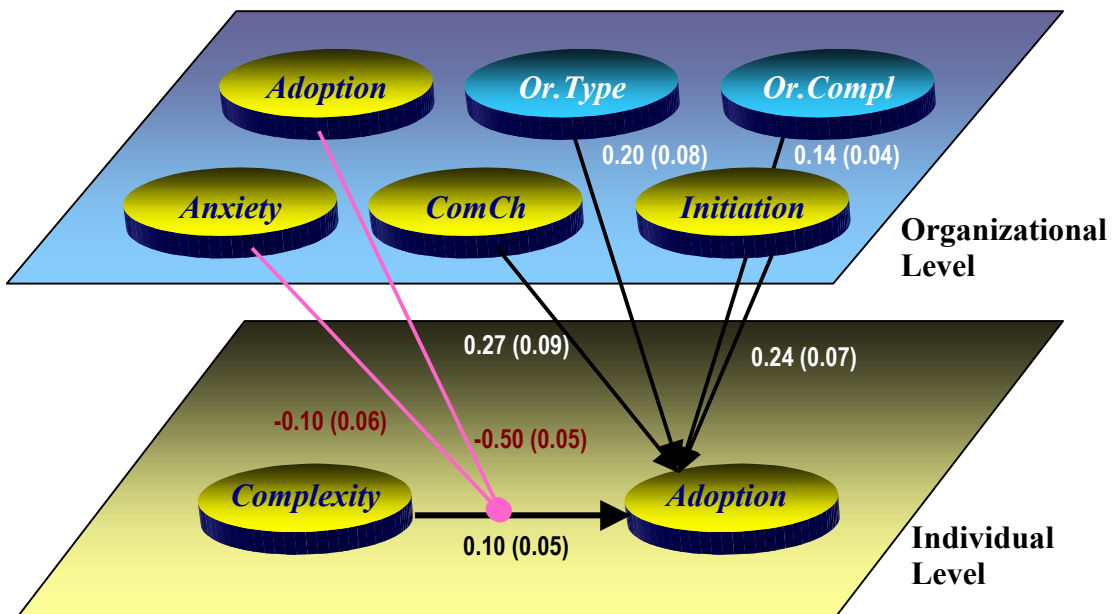


Figure 6. Two Level Model of Adoption for Initiators

In order to provide a graphical presentation of this expression, coordinates can then be calculated by substitution in equations for organizations (Equation 9) that are:

1. one standard deviation above the average on COMPL and ANXTY_21 (i),

2. one standard deviation above the average on COMPL and one standard deviation below the average on ANXTY_21 (ii),
3. one standard deviation below the average on COMPL and one standard deviation above the average on ANXTY_21 (iii),
4. one standard deviation below the average on COMPL and one standard deviation below the average on ANXTY_21 (iv),
5. average on COMPL and one standard deviation above the average on ANXTY_21 (v),
6. average on COMPL and one standard deviation below the average on ANXTY_21 (vi).

Consequently, the coordinates are:

- i. high anxiety and high IT complexity (COMPL = 1; ANXTY_21 = 1)
 $Y(\text{ADOPT}) = 0.10 * (1) - 0.12 * (1) * (1) = -0.02$
- ii. high anxiety and low IT complexity (COMPL = -1; ANXTY_21 = 1)
 $Y(\text{ADOPT}) = 0.10 * (-1) - 0.12 * (1) * (-1) = 0.02$
- iii. low anxiety and high IT complexity (COMPL = 1; ANXTY_21 = -1)
 $Y(\text{ADOPT}) = 0.10 * (1) - 0.12 * (-1) * (1) = 0.22$
- iv. low anxiety and low IT complexity (COMPL = -1; ANXTY_21 = -1)
 $Y(\text{ADOPT}) = 0.10 * (-1) - 0.12 * (-1) * (-1) = -0.22$
- v. average anxiety and high IT complexity (COMPL = 1; ANXTY_21 = 0)
 $Y(\text{ADOPT}) = 0.10 * (1) - 0.12 * (0) * (1) = 0.10$
- vi. average anxiety and low IT complexity (COMPL = -1; ANXTY_21 = 0)
 $Y(\text{ADOPT}) = 0.10 * (-1) - 0.12 * (0) * (-1) = -0.10$

These coordinates are used to generate Figure 7. It can be seen that all regression lines have their intercept at 0.00, which was the value of Y_{ij} when COMPL and ANXTY_21 were equal to zero, and hence the average intercept across all organizations. A similar technique is employed to generate Figure 8 that shows the interaction of complexity (COMPL) and organizational level of adoption (ADOPT_21) to influence the adoption by individuals as the criterion variable.

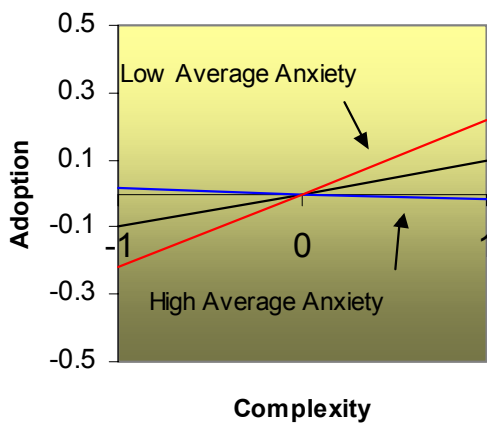


Figure 7. Effect of Average Anxiety on Complexity Slope

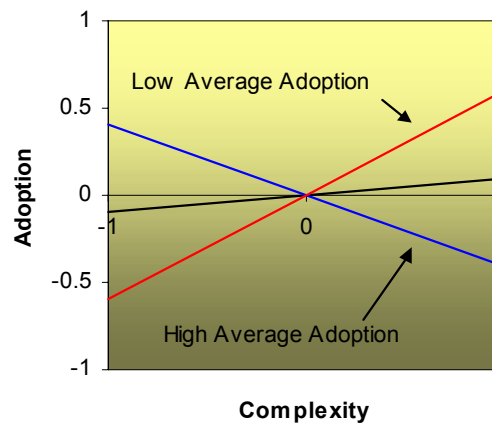


Figure 8. Effect of Average Adoption on Complexity Slope

The results reveal an interesting pattern. In general, initiators who appreciate the complexity of the technology (COMPL) tend to have higher levels of adoption (ADOPT). However, the effects of complexity on adoption for initiators in an organization are also influenced by the average levels of anxiety (ANXTY_21) and adoption (ADOPT_21) in that organization. Hence, the slope of complexity on adoption varies from organization to organization, and it depends on the average anxiety and average perception of the level of adoption in that organization. In this study, it seems that initiators in an organization where on average the initiators have a low level of anxiety tend to have a higher level of adoption. They are more motivated than those who see the technology as a source of anxiety and who therefore reject it. The former group of initiators, initiators in organizations that have low levels of average anxiety, see the technology as a challenge and consequently try to adopt it. This interaction effect is presented in Figure 7.

A high level of adoption in an organization, on the one hand, does not indicate that initiators in that organization are motivated and willing to adopt the technology despite its complexity. On the other hand, organizations that have low levels of adoption seem to be more motivated to increase that level in spite of the complexity of the technology. This result gives credence to the earlier conclusion, that complexity may spur on initiators rather than demoralise them. These interaction effects are presented in Figure 8.

Furthermore, it seems that organizational type and organizational complexity (the spread of IT skills and IT expertise in an organization) are positively correlated with adoption. Moreover, the results also suggest that the level of adoption is affected by the way it has been communicated. In addition, adoption was closely influenced by initiation as expected. That is, initiators are willing to adopt technology if they perceive it as necessary for their work. The reverse is also true.

In addition to the effects, it is also of interest to examine the variance components at both between employee (level-1) and between organization (level-2) levels. Table 4 presents this information for the fully unconditional model and the final model. In the first step, a null model is estimated. This model has no predictor at level-1 or level-2 and provides information with respect to the partitioning of variance at the two levels. Bryk and Raudenbush (1992, p.30) refer to this model as a fully unconditional model. From these values, estimates of the variance at each level were calculated according to the equations given by Bryk and Raudenbush (1992, p.63) and recorded in the second panel of Table 4. The results in Table 4 indicate that 37 per cent of the variance in the level of adoption is found between employees while 63 per cent can be attributed to differences between organizations.

Table 4. Estimation of Variance Components - Adoption for Initiators

Model	Estimation of Variance components	
	between employees (n = 459)	between organizations (n = 117)
fully unconditional model	0.39	0.67
final model	0.34	0.45
Variance at each level		
between employees	$0.39 / (0.67 + 0.39) = 37\%$	
between organizations	$0.67 / (0.67 + 0.39) = 63\%$	
Proportion of variance explained by final model		
between employee	$(0.39 - 0.34) / 0.39 = 0.13 = 13\%$	
between organization	$(0.67 - 0.45) / 0.67 = 0.33 = 33\%$	
Proportion of total available variance explained by final model		
	$(0.13 \times 0.37) + (0.33 \times 0.63) = 0.26 = 26\%$	

In the second step, estimates of variance components are computed for the final model, which has predictors at both levels. Calculations recorded in panel 3 of Table 4 provide estimates of the overall explanatory power for this model at level-1 (13%) and level-2 (33%). Overall, 26 per cent of total available variance has been explained by the final model at both levels. It can also be seen from Table 3 and Table 4 that the deviance is also reduced by 49 with an additional two degrees of freedom. Since the ratio of the decrease of deviance by the increase of degrees of freedom is greater than 1, the final model is considered to be better.

CONCLUSION

It is found in this study that the level of adoption can be viewed as a function of five main effects, two cross-level interaction effects, with a complex random error term. The five main effects are the direct effects from IT complexity (COMPL), organizational type (TYPE), organizational complexity (OCOM), average communication channel (COMCH_21), and average initiation level (INITI_21). The two cross-level interaction effects involve ANXTY_21 with COMPL (γ_{11}) and ADOPT_21 with COMPL (γ_{12}).

The results reveal an interesting pattern. In general, initiators who appreciate the complexity of the technology (COMPL) tend to have higher levels of adoption (ADOPT). However, the effects of complexity on adoption for initiators in an organization are also influenced by the average levels of anxiety (ANXTY_21) and adoption (ADOPT_21) in that organization. Furthermore, it seems that organizational type and organizational complexity (the spread of IT skills and IT expertise in an organization) are positively correlated with adoption. Moreover, the results also suggest that the level of adoption is affected by the way it has been communicated.

In addition to the effects, it is also of interest to examine the variance components at both between employees (level-1) and between organizations (level-2) levels. The results indicate that 37 per cent of the variance in the level of adoption is found between employees while 63 per cent can be attributed to differences between organizations. The overall explanatory power for this model at level-1 is 13 per cent and at level-2 is 33 per cent. Overall, 26 per cent of total available variance has been explained by the final model at both levels.

The findings of this study contribute to both the theoretical and empirical knowledge on organizational adoption of IT innovations for those governmental agencies in developing countries by adding to the case studies available the local characteristics of Bali, Indonesia. In addition, this study also provides a contribution in identifying the facilitators and inhibitors for IT adoption in local government agencies of Bali. By recognizing these factors, the Bali's government agencies are expected to be able to formulate better strategies in adopting IT in order to increase their service quality and productivity. It also provides the Indonesian government with a better understanding of local conditions in Bali for formulating their IT policy.

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