การพัฒนาโมเดลการใช้ประโยชน์วิจัยทางการศึกษา: เครื่องมือและวิธีวัดระดับการใช้ประโยชน์วิจัยและโมเดลการวัดโค้งพัฒนาการที่มีตัวแปรแฝงแบบความแปรปรวนของความคลาดเคลื่อนไม่เท่ากันวัดค่าการใช้ประโยชน์วิจัยด้วยพหุตัวบ่งชี้

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บทคัดย่อ

*การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาโมเดล วิธีและเครื่องมือวัดระดับการใช้ประโยชน์งานวิจัยทางการศึกษาในการศึกษาพัฒนาวิทยานิพนธ์ระดับบัณฑิตศึกษาด้วยการประยุกต์เทคนิคการวัดประเมินและการวิเคราะห์โค้งพัฒนาการตามหลักวิเคราะห์โมเดลสมการเชิงโครงสร้าง โดยมีวัตถุประสงค์เฉพาะของการวิจัย ดังนี้ (1) เพื่อศึกษาระดับและรูปแบบการใช้ประโยชน์วิจัยของนิสิตบัณฑิตศึกษาที่มีภูมิหลังส่วนบุคคลและเชิงบริบทแตกต่างกัน (2) เพื่อพัฒนาเครื่องมือและวิธีการวัดระดับการใช้ประโยชน์วิจัย และ (3) เพื่อพัฒนาและตรวจสอบความตรงของโมเดลการวัดการใช้ประโยชน์วิจัย 2 แบบด้วยการประยุกต์แนวคิดการวิเคราะห์โค้งพัฒนาการในการวิเคราะห์: โมเดลการวัดการใช้ประโยชน์วิจัยโดยรวม และ โมเดลการวัดการใช้ประโยชน์วิจัยโดยรวมที่เพิ่มตัวแปรแฝงการใช้ประโยชน์วิจัยจำแนกรูปแบบการใช้ 3 รูปแบบเข้าในโมเดล (การใช้ประโยชน์วิจัยโดยตรง โดยอ้อมและเชิงชักชวน) กลุ่มตัวอย่างเป็นนิสิตระดับหลักสูตรมหาบัณฑิตและดุษฎีบัณฑิต 61 กลุ่มหลักสูตรจาก 15 สาขาวิชาของสถาบันอุดมศึกษาภาครัฐจำนวน 468 คน ด้วยวิธีการเลือกกลุ่มตัวอย่างแบบหลายขั้นตอน เครื่องมือที่ใช้ในการวิจัยเป็นแบบสอบถามโครงสร้างพิเศษชนิดประเมินตนเอง 4 ตอน ตอน 1 วัดการใช้ประโยชน์วิจัยโดยรวม 1 คำถามกระตุ้นพร้อมตอบ การใช้ประโยชน์วิจัยโดยตรง-โดยอ้อมและเชิงชักชวน ตอนที่ 2 วัดการใช้ประโยชน์วิจัยโดยรวม 2 ตอนที่ 3 วัดการใช้ประโยชน์วิจัยโดยรวม 3 ตอนที่ 4 วัดการใช้ประโยชน์วิจัยโดยรวม 4 การรวบรวมข้อมูลเป็นการวัดซ้ำ 4 ครั้งตามขั้นตอนของกระบวนการวิจัย 5 ขั้น วิเคราะห์ข้อมูลโดยใช้สถิติบรรยาย การวิเคราะห์สหสัมพันธ์ การวิเคราะห์ความแปรปรวน การวิเคราะห์ความแปรปรวนตัวแปรพหุนาม การวิเคราะห์ถดถอยพหุคูณด้วยโปรแกรม **SPSS** การตรวจสอบความตรงของโมเดลด้วยโปรแกรม **LISREL** 8.72*

ผลการวิจัยที่สำคัญสรุปได้ว่า 1) นิสิตบัณฑิตศึกษามีระดับการใช้ประโยชน์วิจัยในระดับค่อนข้างสูงในการวัดค่าทั้ง 4 ครั้ง (ค่าเฉลี่ยระหว่าง 3.513 ถึง 3.657 คือนิสิตระบุว่าใช้ประโยชน์วิจัยในช่วงร้อยละ 60.00-79.99 จากความถี่ของการใช้ความรู้จากแหล่งข้อมูลทั้งหมด) โดยการใช้ประโยชน์ในแต่ละขั้นตอนการศึกษาและทำวิทยานิพนธ์มีค่าใกล้เคียงกัน มีการใช้งานวิจัยในขั้นตอนดำเนินการวิจัยและขั้นตอนกำหนดปัญหาและประเด็นหลักในการวิจัยในระดับสูงที่สุดและใช้ในขั้นตอนการเผยแพร่งานวิจัยน้อยที่สุด เมื่อจำแนกตามรูปแบบการใช้ประโยชน์ นิสิตบัณฑิตศึกษามีการใช้ประโยชน์วิจัยโดยตรงสูงที่สุด รองลงมาคือใช้ประโยชน์งานวิจัยโดยอ้อมและใช้เชิงชักชวนน้อยที่สุด 2) เครื่องมือที่วิจัยเป็นแบบสอบถามชนิดประเมินตนเอง 4 ตอนที่ผู้วิจัยพัฒนาขึ้นจากการสังเคราะห์เอกสารงานวิจัยที่เกี่ยวข้องและตรวจสอบคุณภาพตามหลักการวัดและประเมิน แบบวัดทั้งฉบับมีค่าความเที่ยงของครอนบาชและดัชนีความสอดคล้อง = .949 และ .969 วิธีการวัดค่าระดับการใช้ประโยชน์วิจัยเป็นการวัดทั้งค่าผลรวม (overall research utilization) และค่าที่เป็นการวัดจำแนกรูปแบบการใช้ (pattern of use) เป็นการวัดเชิงกระบวนการด้วยมาตรวัด 5 ระดับจากร้อยละความถี่ของการใช้ประโยชน์วิจัยจริงและเป็นการวัดซ้ำ 4 ครั้งตามขั้นตอนของกระบวนการวิจัย 5 ขั้น 3) โมเดลการวัดที่ 1: โมเดลการวัดโค้งพัฒนาการที่มีตัวแปรแฝงแบบความแปรปรวนของความคลาดเคลื่อนไม่เท่ากันวัดค่าการใช้ประโยชน์วิจัยด้วยพหุตัวบ่งชี้ มีความสอดคล้องกับข้อมูลเชิงประจักษ์ (χ^2 = 95.508; p = .001; GFI = .981; AGFI = .925) ขณะที่โมเดลการวัดที่ 2: โมเดลการวัดโค้งพัฒนาการที่มีตัวแปรแฝงแบบความแปรปรวนของความคลาดเคลื่อนไม่เท่ากันวัดค่าการใช้ประโยชน์วิจัยด้วยพหุตัวบ่งชี้ที่เพิ่มการใช้ประโยชน์วิจัยจำแนกรูปแบบการใช้ 3 รูปแบบเข้าในโมเดลไม่มีความสอดคล้องกับข้อมูลเชิงประจักษ์

คำสำคัญ

การใช้ประโยชน์วิจัย, โค้งพัฒนาการ, โมเดลการวัด, โมเดลสมการเชิงโครงสร้าง, ความแปรปรวนของความคลาดเคลื่อนไม่เท่ากัน, การวิเคราะห์องค์ประกอบ

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The Development of Research Utilization Models: Instrument, Measurement Method and Latent Growth Curve Multi-indicators Measurement Models of Research Utilization with Unequal Disturbance Variance

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ABSTRACT

The main objective of this research was to develop models, measurement methods and instruments for investigation of how to utilize research into practice for educational graduate programs by applying measurement, evaluation techniques and latent growth curve (structural equation modeling) analysis. The purposes of this research were 1) to study research utilization level and utilization pattern of graduate students with different individual, contextual and background factors; 2) to develop instruments and method for measure research utilization; 3) to develop and validate the 2 research utilization measurement models with the application of latent growth curve analysis: the measurement model of overall research utilization and the measurement model of overall research utilization adding 3 patterns of research utilization (direct, indirect and persuasive research utilization). The samples consisted of 478 graduate students selected by means of multi-stage sampling from 61 master and doctoral programs in 15 departments of two public universities in Bangkok. The research instrument is self-response questionnaire consisting of four parts of measurement; part1: first overall research utilization (RUO1), prompt question, direct, indirect and persuasive research utilization; part2: second overall research utilization (RUO2); part3: third overall research utilization (RUO3) and part4: fourth overall research utilization (RUO4). Data collection was repeated measurement for four times on five stages of research process. Descriptive statistics, correlation analysis, analysis of variance, multivariate analysis of variance and multiple regression analysis were employed for data analysis by using SPSS. Model validation was employed by using LISREL 8.72.

*The major findings were: **first,** the research utilization level of the graduate students was quite high in all four measurements (mean range of 3.513-3.657). The students indicated that 60.00-79.99 percent of total frequency in utilizing of overall knowledge was research utilization. The utilization frequencies were found approximately equal for each stage of research process. The highest one was the research operation stage, problem identification stage whereas the lowest one was the research dissemination stage. Classifying by pattern of research utilization, it was revealed that the graduate students greatly utilized research directly, then they utilized indirect utilization and persuasive utilization respectively. **Second,** the research instruments consisted of four parts self-responsive questionnaire developed based on literatures reviews with total reliability (Cronbach's alpha) and index of congruence are .949 and .969, measurement method is repeated measure implemented into process of researching (5 stages of research process) both overall and pattern utilization with five scale level identified by percentage of frequency of research-based knowledge and information using. **Third,** the first measurement model (latent growth curve multi-indicators measurement model with unequal disturbance variance) was well fitted to the empirical data (χ^2 = 95.508; p = .001; GFI = .981; AGFI = .925) whereas the second measurement model (latent growth curve multi-indicators measurement model with unequal disturbance variance adding 3 patterns of research utilization) was not fitted to the empirical data. The LGC measurement models validation gave advantage comprehension about strength and limitation of this technique. Measurement development will shed more light to understand research utilization, give enlightenment of practical process to raise quantity and quality of research using.*

Keywords

Research Utilization, Latent Growth Curve, Measurement Model, Structural Equation Modeling, Unequal Disturbance variance, factor analysis

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Origin and Rationale Background

Nearly half of century that trial of the studies concerning research utilization has been begun, The use of research or "research utilization" was discussed as important issue for decades about how to make the practice of research-based, so the evaluation and structure of research utilization were proposed. Researchers investigated the process of research utilization and divided into stages of use (Stetler and Marram, 1976; Horsley, Crane and Bingle; 1978; Rodgers, 1983, 2000, Horsley, et al, 1983, Stetler, 2003). Lasen (1980) considered research utilization as knowledge utilization comprised of complex process. In addition to the specific information or knowledge, Lasen proposed that research utilization can be categorized into instrumental and conceptual. Rich (1975, 1977 cited in Estabrooks, 1998) and Weiss (1979) also discussed the instrumental and conceptual utilization of research. Subsequently, Beyer and Trice (1982) added symbolic utilization to be the third type of use and be referred in many literatures later. Estabrooks (1998, 1999, 2003) developed conceptual structure of research utilization, she found that within a simplex-common cause model that permitted only direct effects and controlled for instrumental (direct utilization), conceptual (indirect utilization) and persuasive research utilization. The research-based evidences indicated that research utilization could be described in the form of integrated model and needed to be investigated for better understanding which be advantages for researchers and users in practising research in their works.

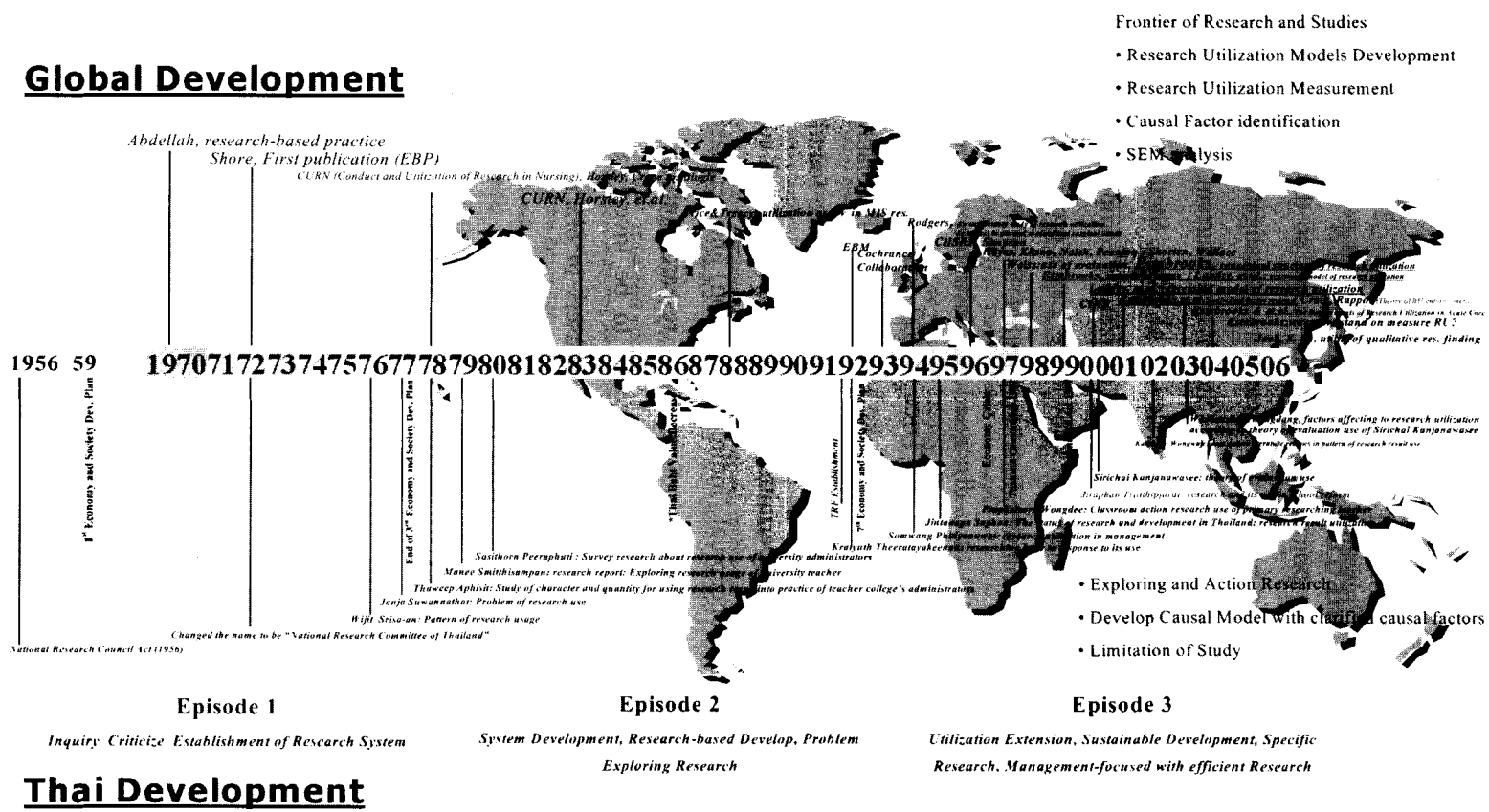

Figure 1 Comparative diagram of research utilization studies to build frontier of development in form of timeline of selected publications and events

Methodology Development

Latent Growth Curve is one of the most important analyses which has been rapidly and continuously improved for decades, it's used to analyse development, change or growth rate in any research. Initial works relied on difference evaluation that is the reason of 2 times of measurement. Then many academicians have developed the method by changing the number of measurement; based on this aspect, they have changed from 2 times of measurement to 3 or more times of measurement. The later analysis was called "growth measurement" which then developed into "growth curve analysis" by LISREL. Growth curve analysis is known as new evaluation for change which classified by its method and result of measure. At least 3 times of measurement helps the analysts to get more information for analyse, and also enable to study growth model characteristics of each unit correctly.

Growth Curve model (LGM) was firstly developed by Tuker and Rao in 1958 (cited in Wiratchai, 1999) and was improved into structural equation model by McArdle and Epstein (1987), McArdle and Aber (1990), McArdle and Hamagami (1991, 1995) then Raykov (1994 cited in Wiratchai, 1999) made the model more better with latent variable which relevant to reality of data; that was evoled into latent growth curve model in present (Wiratchai, N., 1999).

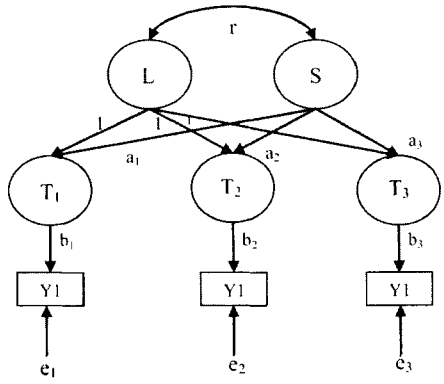

Figure 2 Latent growth curve model measured 5 times with single indicator

Latent growth Curve analysis began as figure 2 that the latent variable was measured repeatly for 3 times with single indicator or one observable variable (Y1, Y2 and Y3). The model consisted of 2 parts: latent true score (T) and specific component (e), while latent true score were affected by two important components. First component was determined as initial factor or level (L) and the second component was determined as growth rate or change factor or slope (S). Model characteristic was developed in form of second-order factor analysis that all factor loading affected to latent true score (T) from L component equal to 1 while factor loading of S component defined as a1-a3 respectively (a1 = 0 since first evaluation was no change). This prior LGM was initiatively assessed the interesting latent by single indicator.

Raykov (1994 cited in Wiratchai, 1999) applied this model to analyse the change or growth measurement. Chaiyakarn (1996) used LGM to study change score of Mathematics class in upper elementary schools under jurisdiction of Bangkok Authority with three-time measurement, he compared the analysis of one-indicator model to two-indicator model of measurement; the result indicated that two-indicators model was more efficiency than one-indicator model. Nevertheless, this longitudinal factor analysis model has a limitation because the exclusion of the intercept or average score from the model that make factor loading showed only relative effects; in addition, 2-3 times of measurement gives low reliability and validity when compares to more than 3 times measurement (Collins & Horn, 1991, 1995; McArdle & Hamagami, 1991, 1995 cited in Tangsakunruanglai, I., 1998).

From the limitation of Raycov's model along with the first development model present in three-time measurement that the first factor loading from slope component equaling zero restricts only 2 values of factor loading left to chracterize model's pattern. To solve this restriction, group of statisticians (McArdle & Epstein, 1987; Meredith & Tisak, 1990; McArdle & Hamagami, 1995 cited in Wiratchai, N., 1999) has developed better models from ordinary one in 5 ways: 1) analyse in raw score in observable measure unit adding the constant (=1) as parameter matrix for mean or intercept in LISREL model 2) use basis coefficient as parameter to characterize curve of growth feature and enabled researcher to define coeficient's value relying on evidence from theories or related research

or free the value to be calculated by LISREL program, this allows more reflexibility and variety of growth curve analysis 3) autoregressive model 4) mistake reduction when the construction of model has too many latent and observable variables using command series of reticular action model (RAM notation) which adjust model in only BE matrix 5) similar and distinct from longitudinal factor analysis as 5.1) permission eror relation between latent level and slope component 5.2) latent common factor (level and slope component) do not have to relate to error term of indicator or specific factor 5.3) path analysis of error term demonstrated by sling or span implies the assumption that each error term have no relation 5.4) error term has normal distritution. New LGM which could reveal dynamic of change, group and individual development was shown in figure 3.

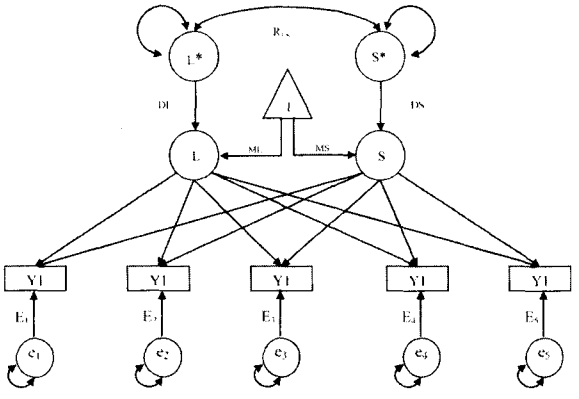

Figure 3 Latent growth curve model measured 5 times with single indicator

From the qualification of basis coefficient which is flexible to fix or free for identifying curve characteristic in LGM, McArder and Hamagami (1995) described that it is very useful to analyse growth curve diversely and could be present in 5 examples; Baseline Growth Model (BAS Model) which difines basis coefficient zero value, Linear Growth Model (LIN Model) which basis coefficient value is defined linearity, Fixed Curve Parameter Growth Model (FIC Model) which basis coefficient value is defined curvilinear, Free Parameter Growth Model (FRE Model) which frees basis coefficient value to be calculated by program and Unequal Disturbance Variance Growth Model (UDV Model), which release restriction of basis assumption from the mentioned 4 models

that variance of measure error must treat equally (similar to basis assumption of repeated mesure analysis of variance whereas the LGM, the restriction can be released). One of introduced 5 model helps researchers to analyse data and identify pattern of relevant model and the growth rate could be approximated.

Although model development is being continually employed by many researchers (Tangsakunruanglai, I., 1998, Ruajantuek, S., 1999, Chaikaew, M., 1999, Sitthikunthorn, A., 2000, Wijitwanna, S., 2000, Amatacheewin, S., 2003) but LGM models has been analysed the effect of level and slope component to indicator directly as second-order confirmatory factor analysis; and most of the models measured by single indicator.

The advancement of this research is multi-indicator measurement analysing the effect of level and slope component to research utilization as latent variable (four-times RUO was measured by 5 indicators from 5 stages of dissertation/theses process) instead of considering its direct effect on indicators. This makes the model feature a third-order factor analysis model: the first order; latent variable of level's error (L*) and slope's error (S*), the second order; latent variable of level (L) and slope (S) and the third order; the latent variable of research utilization. The first proposed measurement model is called "latent growth curve multi-indicators measurement model with unequal disturbance variance" (as shown in conceptual framework below).

One interesting point in this research is that LGC has been employed to validate model from data that measured continually in the same variable instead measured as longitudinal data because of 2 reasons: 1) applying method of longitudinal data into repeated measurement data which will provide better analysis information in the aspect that an repeateded asking will guide the respondents to reflex more correctly 2) improving the conceptual structure of research utilization (Estabrook, 1998, 2003), which analysed the data considered as chain reaction between prior RUO to next RUO (longitudinal simplex model mixed with common cause model) as shown in figure 4 whereas proposed model in figure 5-6, which not only exhibitting clarified detail but also demonstrating advantages of method that the influence of initial value (level) and change rate (slope) to 4 latent overall research utilization could be analysed.

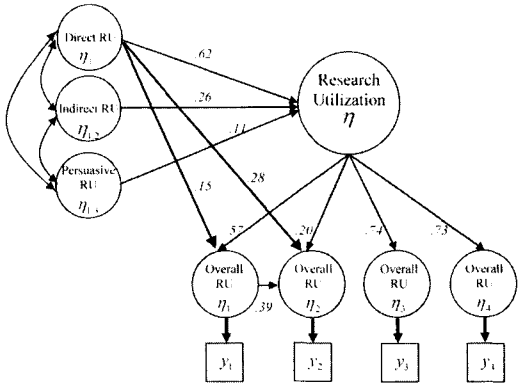

Figure 4 Conceptual structure of research utilization by Estabrooks (1998)

Objectives

The objectives of this research were 1) to study research utilization level and utilization pattern of graduate students with different individual, contextual and background factors 2) to develop instruments and method for measure research utilization 3) to develop and validate the 2 research utilization measurement models with the application of latent growth curve analysis: the measurement model of overall research utilization and the measurement model of overall research utilization adding 3 patterns of research utilization (direct, indirect and persuasive research utilization).

Conceptual Frameworks

Proposed measurement models applied LGC analysis of research utilization could be explained here in 2 structures; the measurement model of overall research utilization and the measurement model of overall research utilization adding 3 patterns of research utilization.

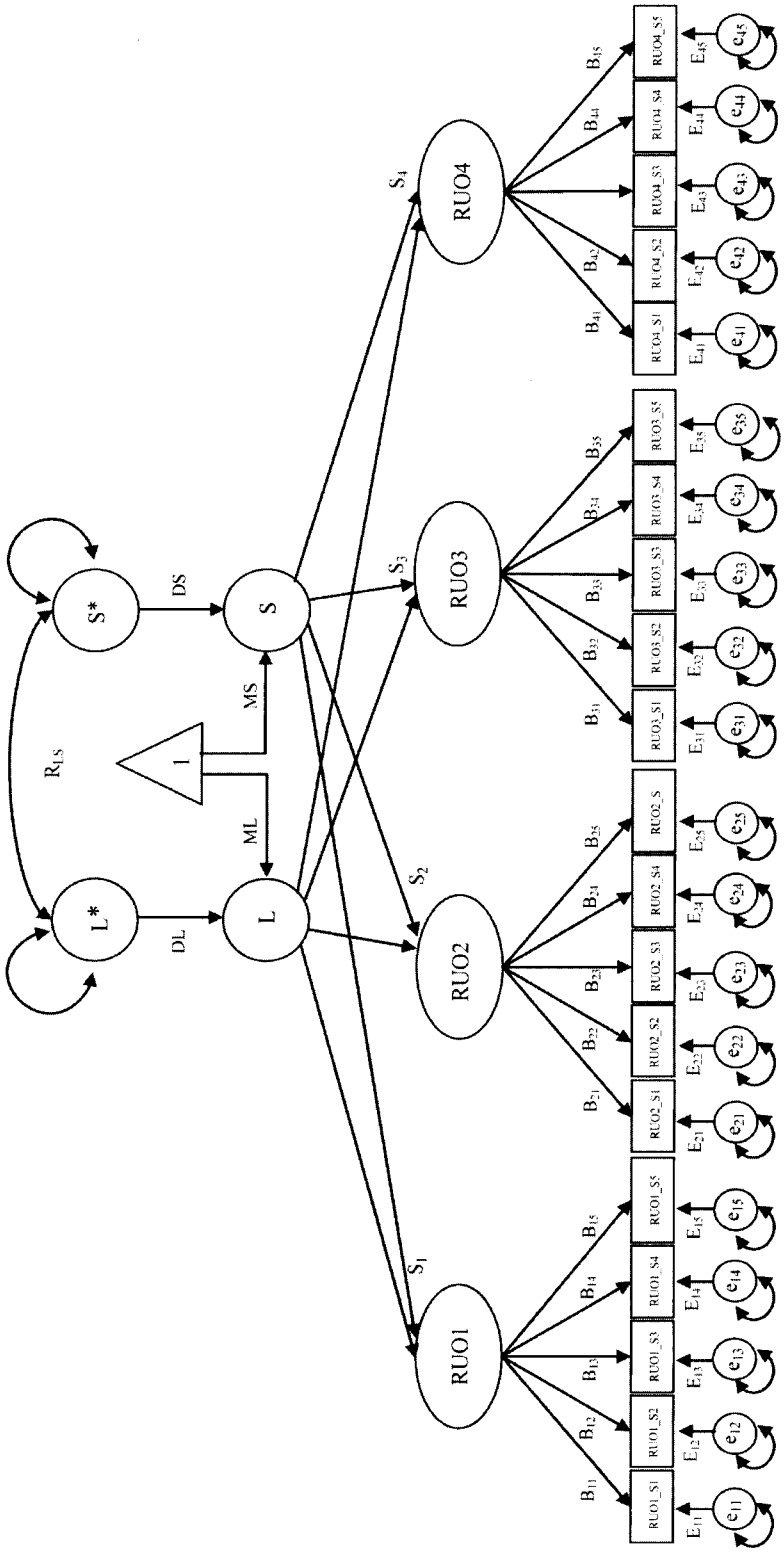

Figure 5 Latent growth curve multi-indicators measurement model of overall research utilization with unequal disturbance variance

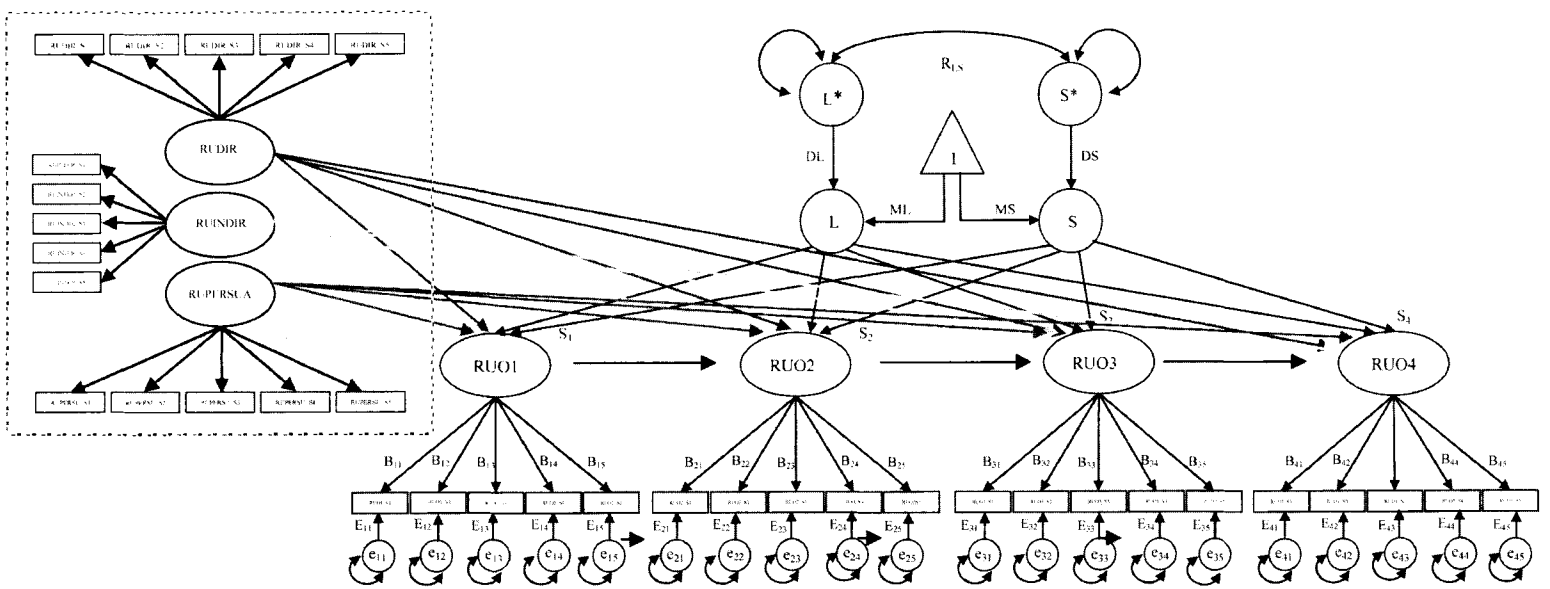

Figure 6 Latent growth curve multi-indicators measurement model of overall research utilization with unequal disturbance variance adding 3 patterns of research utilization (direct, indirect and persuasive RU)

Methods

This quantitative research of model development methodology was orderly described as follows.

Samples and Sampling Method: the samples size was 478 graduate students according to 5-20 samples per path or parameter (Hair, Tatham, Anderson & Black, 1998) selected by means of multi-stage sampling from 61 master and doctoral programs that have to conduct the research in graduate course in 15 departments of 2 governmental universities in Bangkok.

Research Instruments and Development: the developmental processes of questionnaire consisted of 3 phases. Phase 1: Instruments construction, in this phase the variables in models were theoretical and operational defined, next the specification tables were developed and then the questionnaires were constructed based on the specification tables. Phase 2: in the second phase, the questionnaires were administered to 3-5 graduate students not in the samples to check for face validity. Then , its index of congruence was checked by 7 experts in research methodology. Final phase, the questionnaires were administered with 36 graduate students excluding the samples. The result of which were analyzed to obtain Cronbach's alpha reliability and confirmatory factor analysis (CFA) in order to check construct validity.

Data Collection: the questionairres were collected by researcher and via email.

Analysis: comprised of three types of analysis. Firstly, preliminary analysis were conducted to describe the characteristic of the samples and to study the distribution of the variables in the models. Secondly, the statistical assumption testing used in this investigation were examined through scatter diagram, normality check, multicollinearity check, homoscedasticity check. Finally, CFA and SEM using LISREL program were employed to validate the two measurement models of research utilization.

Results and finding

Part 1: Level and pattern of research use of graduate student.

1.1 Ladder of research progression distribution

Analysis of samples distribution is presented in table 1 invented in the form of "ladder of research progression distribution" which shows amount of users distributed to semester in 5 stages of research process (major curriculum study, statistics and research study, problem identification, research operation and research dissemination). The amount of samples is distributed in stage 4,3,5,2 and 1 respectively; in terms of starting-ending semester and time usage of each stage, we found that stage 1 always begins at 1st semester (93.80%) and mostly ends at 3rd semester (41.03%) with time usage equals 3.02, stage 2 always begins at 1st semester (73.29%) and ends at 3rd semester (34.40%) with time usage equals 2.42, stage 3 begins at 3rd semester (37.18%) and ends at 4th semester (36.11%) with time usage equaling 2.12, stage 4 mostly begins at 4th semester (28.63%) and ends at 6th semester (25.85%) with time usage equals 2.83, stage 5 begins almost equally at 4th or 6th semester (19.44%, 20.94%) and ends at 6th or 8th semester (23.50%, 21.79%) with time usage equals 1.33.

Table 1 Frequencies of samples distribution classified by average semester when start-finish of research development stage and time usage of each stage, beginning and ending semester of all stages of research development in form of ladder of progression

Stage	Semester of stage	Frequency	Percentage	Average Usage Time		Semester 1	2	3	4	5	6	7	8	9	10	11	12
Stage 5: Research Dissemination (Amount of sample in this stage 99 person= 21.15%)	Average semester when finish stage 5 = 6.34				End				86	36	116 (23.50%)	31	102 (21.79%)	11	47	0	15
	7	2	0.46	Max=7					0	79	28	85	18	62	9	19	0
	6	1	0.23						0	1	0	0	0	0	0	0	0
	5	3	0.68					2	0	0	1	0	0	0	0	0	0
	4	3	0.68	Mode=1				1	0	2	0	0	0	0	0	0	0
	3	24	5.48					1	4	3	4	0	10	0	2	0	0
	2	99	22.60	1.33				7	8	19	6	36	2	16	0	5	0
	1	306	69.86	Min=1				0	79	28	85	18	62	9	19	0	6
	N.A.	30	-					-	-	-	-	-	-	-	-	-	-
	Average semester when start stage 5 =5.94				Begin			11	91 (19.44%)	53	98 (20.94%)	54	74	25	21	5	6
Stage 4: Research Operation (Amount of sample in this stage 170 person = 36.32%)	Average semester when finish stage 4=6.29				End			5	108	51	121 (26.86%)	52	72	19	34	6	
	7	1	0.21	Max=7				0	1	0	0	0	0	0			
	6	18	3.85					3	0	15	0	0	0	0			
	5	39	8.33	Mode=3			1	10	5	11	6	6	0	0			
	4	64	13.68			1	0	18	14	19	3	9	0	0			
	3	113	24.15	2.83		1	7	15	50	15	18	6	1	0			
	2	188	40.17			0	5	68	31	45	19	19	0	1			
	1	45	9.62	Min=1		0	0	0	33	6	4	0	2	0			
	Average semester when start stage 4 = 4.43				Begin	2	13	114	134 (28.63%)	111	50	40	3	1			
Stage 3: Problem Identification (Amount of sample in this stage 165 person = 35.26%)	Average semester when finish stage 3=4.00				End	1	31	144	169 (36.11%)	63	46	8	2	4			
	6	8	1.71	Max=6		4	0	0	0	4	0	0					
	5	11	2.35			6	5	0	0	0	0	0					
	4	36	7.69	Mode=2		24	2	8	1	1	0	0					
	3	69	14.74	2.12		20	22	14	11	1	1	0					
	2	195	41.67			10	57	83	30	14	1	0					
	1	149	31.84	Min=1		1	22	69	38	11	2	6					
	Average semester when start stage 3 = 2.87				Begin	65	108	174 (37.18%)	80	31	4	6					
Stage 4: Statistic and Research Study (Amount of sample in this stage 29 person = 6.20%)	Average semester when finish stage 2=2.75				End	51	125	161 (34.40%)	98	9	9	1					
	7	1	0.22	Max=7		0	0	0	1								
	6	6	1.32			6	0	0	0								
	5	7	1.54	Mode=2		5	2	0	0								
	4	67	14.76			66	0	1	0								
	3	138	30.40	2.42		123	15	0	0								
	2	138	30.40			91	27	16	4								
	1	97	21.37	Min=0		52	32	10	3								
	N.A.	14	-			-	-	-	-								
	Average semester when start stage 2 = 1.30				Begin	343 (73.29%)	76	27	8								
Stage 1: Major Curriculum Study (Amount of sample in this stage 5 person = 1.05%)	Average semester when finish stage 1=3.08				End	26	96	192 (41.08%)	136	4	14						
	6	13	2.78	Max=6		12	1	0	0								
	5	5	1.07			2	2	0	1								
	4	133	28.42	Mode=3		131	1	1	0								
	3	179	38.25	3.02		173	4	2	0								
	2	105	22.44			95	8	1	1								
	1	33	7.05	Min=1		26	4	1	2								
	Average semester when start stage 1 = 1.09				Begin	439 (93.80%)	20	5	4								
Semester of start-finish and usage of each stage					Semester	1	2	3	4	5	6	7	8	9	10	11	12
					Ladder of research progression												

1.2 Level of overall research utilization

By crossing tabulation between mean of research utilization level and measure time and stage of research process integrated with factor loading from CFA in table 2. It is found that samples utilized research quite high (mean range of 3.513-3.657). It is indicated that 60.00-79.99 percent of total frequency in utilizing of overall knowledge was research utilization. At 1st - 3rd measurement; the analysis shows that the highest utilization score occurred in problem identification stage (3.647, 3.821 and 3.861) while the highest factor loading of all measurement appears in research operation stage (.557, .273, .297 and .461), while the higest score at 4th measurement was in research operation stage (3.927). From grand mean comparison of all stages indicates that there was growth during the times of measurement (from 3.513 to 3.657). When considering grand mean of all measure comparison between each stage, the samples utilized research most highly in problem identification stage (3.793).

Table 2 Average score of overall research utilization in each stage of research development measured 4 times

Stage	1st measurement		2nd measurement		3rd measurement		4st measurement		Grand mean of all measure at each stage
	mean	Factor loading	mean	Factor loading	mean	Factor loading	mean	Factor loading	
1	3.618	0.441	3.692	0.216	3.705	0.262	3.707	0.406	3.681
2	3.620	0.545	3.703	0.242	3.718	0.291	3.840	0.426	3.720
3	3.647	0.508	3.821	0.236	3.861	0.276	3.842	0.410	3.793
4	3.607	0.557	3.735	0.273	3.716	0.297	3.927	0.461	3.746
5	3.075	0.367	3.130	0.209	3.092	0.236	2.968	0.330	3.066
Grand mean of all stage at each measure	3.513		3.616		3.618		3.657		3.601
	Mean =3.513		Mean =3.616		RUO3		RUO4 Mean =3.657		RU Mean =3.601
variable	Overall Research Utilization1 (RUO1)		Overall Research Utilization2 (RUO2)		Overall Research Utilization3 (RUO3)		Overall Research Utilization4 (RUO4)		Research Utilization (RU)

1.3 Level of pattern research utilization

When considering pattern of research utilization, the highest score of 3 pattern research utilization insistly appeares in the problem identification stage (3.865, 3.726 and 3.331). Mostly, graduate students used research directly, the next is using indirectly and using persuasively as the last. The factor loading of direct and indirect utilization are found the highest value in problem identification stage (.847 and .840) but persuasive utilization factor loading was highest in research operation stage (see table 3).

Table 3 Average score of overall research utilization in each stage of research development process.

Stage	Direct Research Utilization		Indirect Research Utilization		Persuasive Research Utilization	
	mean	Factor loading	mean	Factor loading	mean	Factor loading
1	3.669	0.420	3.622	0.593	3.165	0.514
2	3.769	0.710	3.652	0.810	3.263	0.904
3	3.865	0.847	3.726	0.840	3.331	0.913
4	3.833	0.752	3.620	0.784	3.306	1.000
5	3.162	0.663	3.032	0.713	2.806	0.876
Grand mean of all stage at each measure	3.660		3.530		3.174	
	RUDIR Mean =3.660		RUINDIR Mean =3.530		RUPERSUA Mean =3.174	
variable	Direct Research Utilization (RUDIR)		Indirect Research Utilization (RUINDIR)		Persuasive Research Utilization (RUPERSUA)	

Part 2: research utilization measurement instruments and method.

2.1 Special-structured questionnaire and LGC application

How to measure and evaluate exact value of research utilization? This question leads to the application of latent growth curve (LGC) concept into measuring and analysing method, special-structured questionnaire is shown in figure 7. Firstly, the respondents would be enlighted by "the meaning and example of research utilization" then, the first research utilization was asked. Secondly, respondents had to response their opinion to "prompt questions" which are series of questions that the readers have to self-reflect by answering "yes" or "no" to behavior identified as research utilization. Thirdly, it is pattern utilization measurement, followed repeatly by "the meaning and example of research utilization" and questions for measuring research utilization for 3 times. The advantage of this tool development is "revision of learning and response", this leads to the clearer concept about *"what research utilization is"* and could reflect exact value of it.

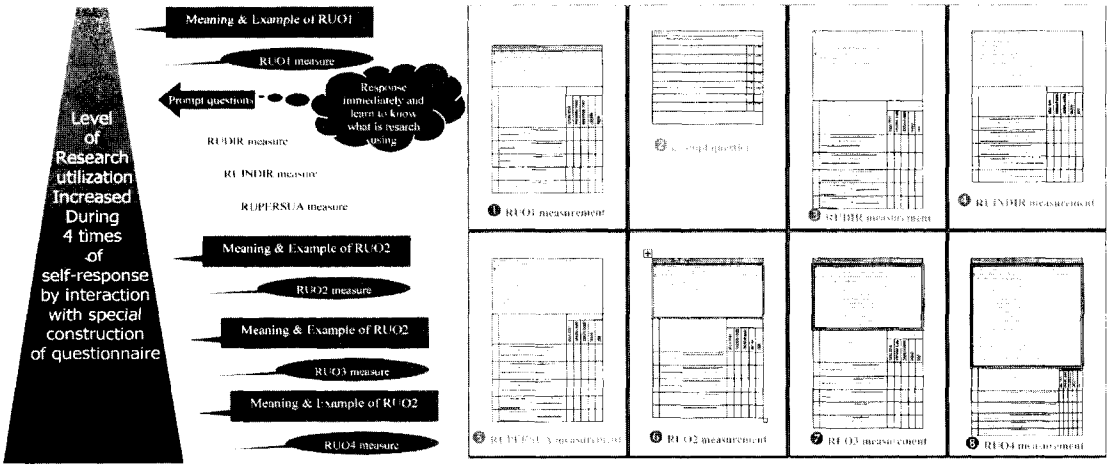

Figure 7 Explanation picture shows the mechanism of self-learning response questionnaire for measuring latent variable (research utilization)

2.2 Scale and asking question

Each item was asked to identify from research use frequency of respondents by pondering *"...in this stage, how many percent of total frequency in utilizing of overall knowledge were research utilization..."*, the answer relies on Likert's summated rating scale which is operational defined as below.

Level	Score	Frequency percentage	Meaning
1	1.000-1.499	0.00 - 19.99	scarely / never use
2	1.500-2.499	20.00 - 39.99	slightly/ sometimes use
3	2.500-3.499	40.00 - 59.99	averagely use
4	3.500-4.499	60.00 - 79.99	rather highly use
5	4.500-5.000	80.00-100.00	highly/ always/ every time use

2.3 Instrument quality check

For quality checking, researchers tried out the questionnaire with 36 students and calculated Conbrach's alpha of 35 items, sent to 9 experts to review each items to find out index of congruence (IOC). Finally, the complete questionnaire were employed to samples for gathering data. The reliability of all questionnaire displayed appropriate value (.836-.945) while indices from second-order CFA of overall research utilization were fitted well to empirical data with construct reliability varied from .210 to .797. , in addition; the CFA of 3 pattern research utilization also fitted well to empirical data with construct reliability varied from .149 to .827 as shows in table 4.

Table 4 Quality indices of questionnaire's quality

Variable	Number of items	Index of congruence	Reliability (n =36)	Reliability (n=468)	Construct validity	Construct reliability
RUO	20	1.000	0.921	0.945	χ^2=55.621, df=44, p=0.113	.210 - .797
RUDIR	5	1.000	0.714	0.836	χ^2 =7.457, df=4, p=0.114	.149 - .785
RUINDIR	5	1.000	0.873	0.837	χ^2 =7.967, df=4, p=0.093	.298 - .686
RUPERSUA	5	.925	0.878	0.897	χ^2 = 9.622, df= 4, p=.054	.245 - .827

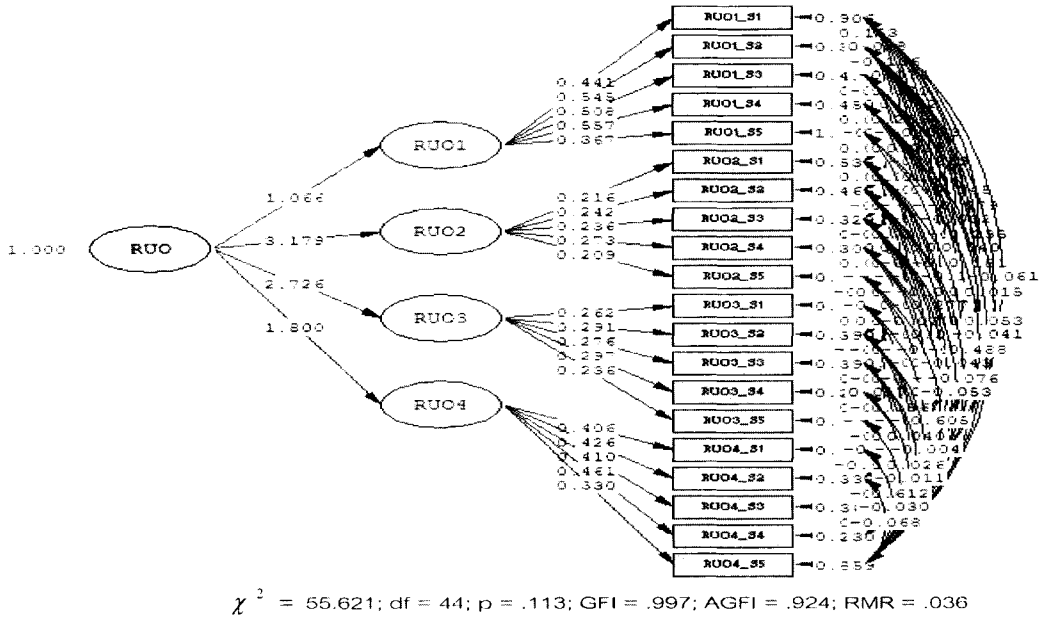

Figure 8 Fitted second-order CFA measurement model of overall research utilization

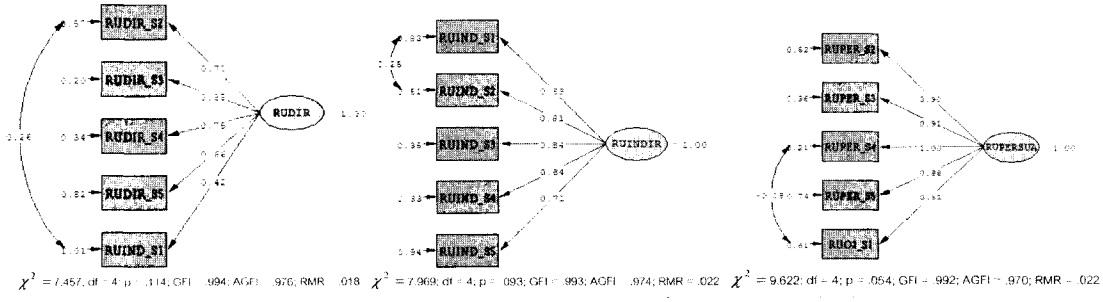

Figure 9 Fitted first-order CFA measurement models of 3 pattern research utilization

Part 3: latent growth curve measurement model measured by multi-indicators with unequal disturbance variance

This part is derived from latent growth curve measurement model with unequal disturbance variance which mentioned above, the models were progressively developed as "third-order factor analysis" as shown in figure 5 and 6. The benefits of applying LGC into measurement and analysis were: 1) measure more than 3 times 2) measured research utilization as latent variable 3) measure values with multiple indicators 4) solve the problems in longitudinal data collection.

In procedure of development, researchers conducted 5 models validation from data collected to find out what model characteristic best fitted to empirical data. Researchers studied the way that McArdle and Hamagami (1991, 1995) and Tangsakunruanglai, I.(1998) have developed; then tested the models respectively by these following procedures: 1) no slope baseline growth model (NSB model) 2) latent growth curve model with defined basis coefficient linearity (LIN mode) 3) latent growth curve model with fixed parameter (FIC model) 4) latent growth curve model with free parameter (FRE model) and finally 5) latent growth curve model with unequal disturbance variance from best fitted to empirical of 4 model above (UDV model). Lastly, added 3 pattern research utilization into best fitted model and validated again by LISREL.

The first measurement model (latent growth curve multi-indicators measurement model with unequal disturbance variance of research utilization) had 29 variables in structure with well fitted to empirical data (χ^2 = 95.508; p = .001; GFI = .981; AGFI = .925) whereas the 2nd model latent growth curve multi-indicators measurement model with unequal disturbance variance of research utilization adding 3 patterns of research utilization) was not fitted to the empirical data.

Result from model validation indicated that graduate students had highest growth between 1st and 2nd measurement (S1=.103) and the lowest growth occurred between 2nd and 3rd measurement. From parameter estimation (maximum likelihood estimation), we found RUO1 had positive relation to RUO2 with statistic significance at .01 (effect size = 25.530, standard error = 7.721) and RUO3 also had positive relation to RUO4 at

significant level of .05 (effect size= 9.702, standard error= 4.578), while there is no significant relationship between RUO2 and RUO3. The same relationship appeared at indicators level that the last indicators of 1st measurement (RUO1_S5) affected significantly to first indicator of next measurement (RUO2_S1) at significant level of .01, and also between last indicator of 3rd measurement (RUO3_S5) and 4th measurement (RUO4_S1) at significant level of .01.

When focusing on factor loading, this UDV measurement model revealed that latent research utilization could be measured well by this multiple indicator approach. Most factor loadings were found positively at significant level .01; and factor loading of indicators were found equally in same measure. 1st measurement (RUO1) had factor loading between .855-1.013 and the greatest factor loading was found in the problem identification stage (RUO1_S3). 2nd measurement (RUO2) had factor loading between .033-.041 and the greatest factor loading was found in the major curriculum study stage (RUO2_S1). The 3rd measurement (RUO3) had factor loading between .678-.853 and greatest factor loading was found in major curriculum study stage (RUO3_S1). The 4th measurement (RUO4) had factor loading between .054-.082 and the greatest factor loading was found in the problem identification stage (RUO4_S3), the research operation stage (RUO4_S4) and the research dissimination stage (RUO4_S5).

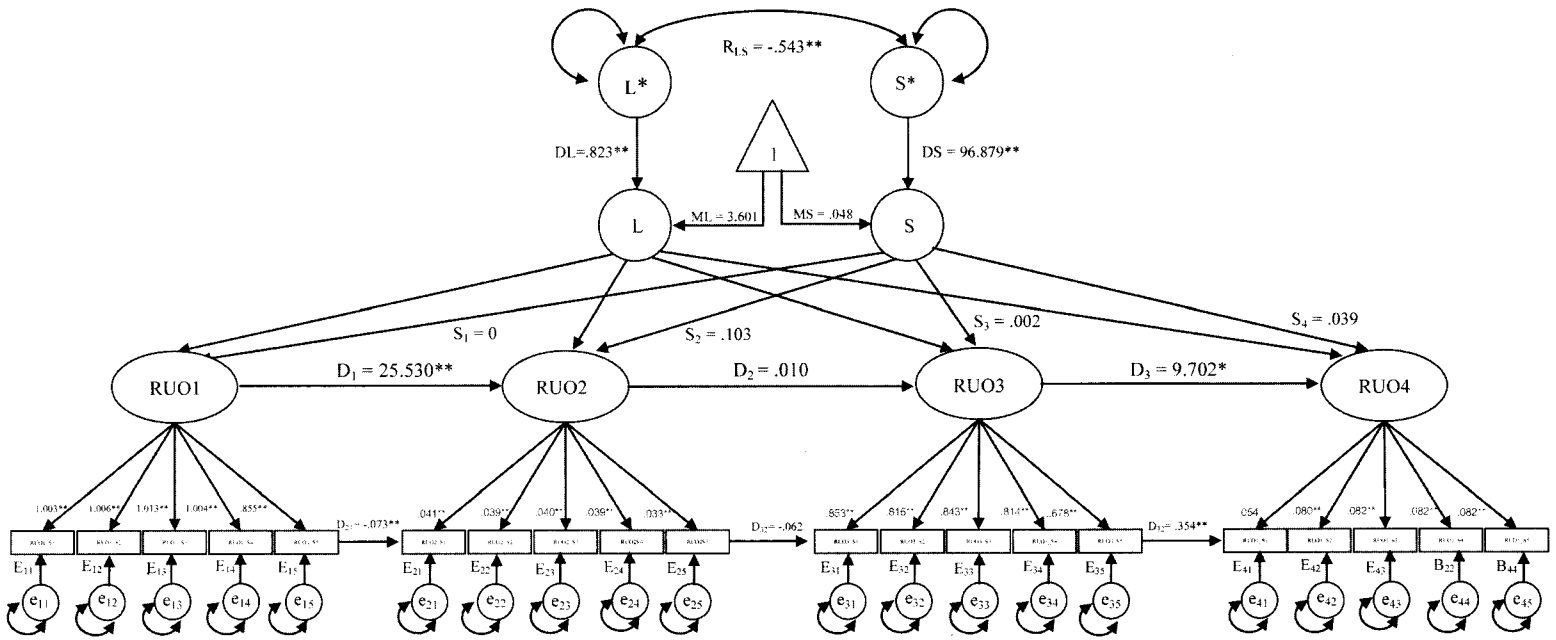

Figure 10 Fitted latent growth curve-indicators measurement with unequal distrubance variance fixed parameter growth rate by real difference of data (FIC parameter): 4 measure of overall research utilization considered chain effect between ending stage indicators to beginning to beginning state indicator

Conclusion and Discussion

First conclusion is derived from "ladder of research progression" which is useful for administrators and staffs in graduate education management to plan, make policy and consider about starting-ending and usage time of stage of thesis/dissertation process. The suitable value is now showing in table 5.

Table 5 Appropriate starting-ending and usage semester from analysis.

Stage	Starting semester		Ending semester		Appropriate usage semester	
	master	doctoral	master	doctoral	master	doctoral
1. Major curriculum study	1	1	3	3, 4	3	3-4
2. Research and Statistics study	1	1	3	3	2-3	3
3. Problem Identification	3	3	3	3, 4	1	1-2
4. Research operation	3	3,4	4	6	1-2	3-4
5. Research dissemination	4	6	4	6	1	1

** **Notice: this suggestion relies on samples from 2 semester annual year (1 vacation semester) curriculum.**

Second point of conclusion is about level and pattern of research utilization; although graduate students utilized research at quite a great level when computed all stages but when scruntinized into the detail, we found that graduate students identified highest level of using in stage 3 and 4 but lowest in stage 5. This finding guides the learners and concerning teachers that they should concentrate more at these 2 stages and spend more time to seek and search research information. In addition, at the stage of lowest research utilization (research dissemination); they have to raise the quantity and quality of research using too.These finding push duty on shoulders of responsive stakeholders to "focus on relevant reseach in the right time and duration.

Next advancement is the instrument of measurement, question, scale, structure and method development. The multi-indicators of 4-times measurement questionnaire can be used widely with other samples and contexts, the repeated measure (came from

LGC application) also gives more valid value of research utilization. Development and measurement approach would be advantage to future developers.

Finding from model validation gives useful information to prove the strength and limitation of UDV model as 1) LGM is better fit to empirical data compare to simplex-common cause model 2) analysis from multiple indicators instead of single indicators displays brighter information because a more number of indicators and the analysis could be considered at both latent variable level and indicator level 3) RAM notation command adjustment enables the researcher to validate model easily, reduce the confusion if adjusting in other commands. But this application also has limitation because of number of BETA matrix dimension will increase rapidly from a more number of indicators; when the number of variables in model is too many, it will lead to higher chi-square that makes this such a model does not fit to empirical data.

Academic advancement and methodology development in this research

1) Variables measurement, instrument and method developed by applying latent growth curve analysis. The evaluator will get better relevant value and reliability of variable. This aspect can be applied to make higher learning in other science and context.

2) Quantitative measure technique development of research utilization in many aspects. Measurements in this research are overall measurement, measure classified by pattern of use and by special structure of questionnaire (be enlighten during response). This approach builds clearer comprehension along the assessment process (giving definition, example of use, defining level from frequency of use in 5 stage of research process).

3) Latent growth curve measurement model measured by multi-indicators with unequsl disturbance variance. The model is advantageous to analyse thoroughly both latent and observable variable level. This quality makes it to be potential technique to better inspect relationship between variables, analyse clearer of growth rate and initial value effect.

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