Fasa 1 / 2008

FINAL REPORT
FUNDAMENTAL RESEARCH GRANT SCHEME (FRGS)
Laporan Akhir Skim Geran Penyelidikan Asas (FRGS) IPT
Pindaan 1/2010

RESEARCH TITLE : **BOOTSTRAP ESTIMATION OF THE PARAMETERS OF THE SPATIAL AR(1,1) MODEL**
Tajuk Penyelidikan

PROJECT LEADER : **NORHASHIDAH AWANG**
Ketua Projek

PROJECT MEMBERS (including GRA) : 1. **PROF. MADYA DR. MAHENDRAN SHITAN**
2.
Ahli Projek

PROJECT ACHIEVEMENT *(Prestasi Projek)*

ACHIEVEMENT PERCENTAGE

Project progress according to milestones achieved up to this period	0 - 50%	51 - 75%	76 - 100%
Percentage			X

RESEARCH OUTPUT

Number of articles/ manuscripts/ books *(Please attach the First Page of Publication)*	Indexed Journal	*Non-Indexed Journal*
	-	
Conference Proceeding *(Please attach the First Page of Publication)*	**International**	*National*
	2	
Intellectual Property *(Please specify)*		

HUMAN CAPITAL DEVELOPMENT

Human Capital	Number				Others (please specify)
	On-going		Graduated		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	* Student has passed her viva, in the process of submitting the corrected thesis.
PhD Student					
Master Student	1*				
Undergraduate Student					
Total	1				

EXPENDITURE *(Perbelanjaan)*

C

Budget Approved *(Peruntukan diluluskan)* : **RM 54,250.00**
Amount Spent *(Jumlah Perbelanjaan)* : **RM 54,248.40**

Balance *(Baki)* : **RM 1.60**
Percentage of Amount Spent : 99.997 %
(Peratusan Belanja)

ADDITIONAL RESEARCH ACTIVITIES THAT CONTRIBUTE TOWARDS DEVELOPING SOFT AND HARD SKILLS
(Aktiviti Penyelidikan Sampingan yang menyumbang kepada pembangunan kemahiran insaniah)

D

International

Activity	Date (Month, Year)	Organizer
(e.g : Course/ Seminar/ Symposium/ Conference/ Workshop/ Site Visit)	a) The Tenth Islamic Countries Conference on Statistical Sciences (ICCS-X), Cairo, Egypt, 20-23 Disember 2009. b) The Asian Mathematical Conference 2009, Kuala Lumpur, 22-26 Jun 2009.	a) American University of Cairo, Egypt. b) Pusat Pengajian Sains Matematik, USM

National

Activity	Date (Month, Year)	Organizer
(e.g : Course/ Seminar/ Symposium/ Conference/ Workshop/ Site Visit)	a) Kursus Jangka Pendek "Statistical Application Training Program", 26-27 April 2010. b) Simposium Kebangsaan Sains Matematik ke-17, Melaka, 15-17 Disember 2009.	a) Graduate School of Business, USM b) Universiti Putra Malaysia dan Persatuan Sains Matematik Malaysia.

PROBLEMS / CONSTRAINTS IF ANY *(Masalah/ Kekangan sekiranya ada)*

E None

RECOMMENDATION *(Cadangan Penambahbaikan)*

F None

RESEARCH ABSTRACT – Not More Than 200 Words (*Abstrak Penyelidikan – Tidak Melebihi 200 patah perkataan*)

G

A special type of spatial models that received much attention is the first-order spatial unilateral autoregressive models denoted as AR(1,1). Several procedures are available to estimate the parameters of this model, such as the Yule-Walker method, the least squares method and the maximum likelihood method. In this research, we study the properties of these estimators for the spatial data of small to moderate grid sizes using the bootstrapping methods. Two types of bootstrapping method are considered, the bootstrapping of the residuals and the block bootstrapping. The result of both methods shows that among all estimators, the Yule-Walker estimate has smallest standard error whereas the least squares estimate has largest standard error. Details of the results have been presented at two international conferences and have been published in the proceedings (see attachments). The results also show that the method of bootstrapping the residual is more efficient than the method of block bootstrapping in terms of standard error. In conclusion, we recommend user to apply the Yule-Walker method to estimate the parameters of the spatial AR(1,1) model for small to moderate grid sizes and the efficiency of the estimator can be approximated by bootstrapping the residuals.

L : 13 Oktober 2011
Tarikh

Project Leader's Signature:
Tandatangan Ketua Projek

COMMENTS, IF ANY / ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC)
(Komen, sekiranya ada / Pengesahan oleh Pusat Pengurusan Penyelidikan)

H

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Name:
Nama:

Signature:
Tandatangan:

Date:
Tarikh:

Suppliers' Technical Capability in Co-Development Practices in Newly Established Car Industry: The Case of the Malaysian Automotive Industry

Nordin Yahaya
Stephen Courts, 132 Britannia Road, Ipswich, IP4 5JU United Kingdom

Stephen Evans
Institute for Manufacturing, 17 Charles Babbage Road, University of Cambridge, CB3 0FS United Kingdom

Marini Nurbanum Mohamad
School of Management, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, Malaysia

Abstract

Most research on co-development practices have focused on either the Japanese or US automotive industry, whilst relatively small number of research has focused on developing countries. Thus, this paper aims to present the suppliers' technical capability influence in co-development practices in the Malaysian automotive sector. The focus of this study is the co-development process of development a new product, and specifically in this case, development of a new car. This paper is based on an in depth study using qualitative research methodology. The study used an exploratory approach with the adoption of case study research strategy.

Keywords: *Co-development, supplier involvement, new product development, automotive industry*

1 Introduction

The automotive industry is continuously expanding, and has been described as the single largest industrial sector in the world economy [1]. The challenge of car companies is not simply assembling vehicles, but also orchestrating the complex set of processes involved in the manufacture of cars. The complexity is also owing to cars comprising approximately 10-15,000 individual parts, with a production run that includes approximately 500,000 units or more [2]. Developing a new vehicle involves car companies and hundreds of suppliers, and requires numerous decisions to be made by many different people. According to Thomas & Oliver [3], European vehicle manufacturers typically outsource 50-60 per cent of their parts and assembly from outside suppliers. In contrast, Japanese car makers, such as Toyota and Nissan, outsource 70-75 per cent of their components from suppliers. This evidences the needs of vehicle manufacturers to work closely with component suppliers in developing a new car. This paper aims to present the suppliers' technical capability influence in co-development practices in the Malaysian automotive sector. The focus of the study which this paper is based on looks at the co-development process of development a new product, and specifically in this case, development of a new car.

2 Literature Review

2.1 Co-development

Numerous authors have agreed that product development is an important strategy that enables firms to remain competitive in a challenging business environment [4, 5]. Clark & Fujitmoto [6] defined the product development process as being information- and knowledge-intensive work. Therefore, the product development process has a major impact on the cost, quality and timing of the launch of a product [7].

Collaboration processes provide an instrument that is used in several different industries in order to gain a competitive advantage and so reduce development costs. Collaboration can be both downstream with customers and upstream with suppliers and internal teams. Collaboration with suppliers is considered to be one of the most important strategies in NPD. Song & Benedetto [8] determined the positive impact of supplier involvement on new product performance. Supplier involvement and participation in new product development may help to reduce costs, reduce the time-to-market phase, improve quality and communication, and provide innovative technologies that ultimately can help to capture a market share and

give a return on investment [9]. Florida & Kenney [10] indicated that, in the case of the Japanese automotive industry, suppliers' components dominate 70 per cent of the car compared to 30-50 per cent in the US. Clark & Fujimoto [11] demonstrated that Japanese automakers have 12 months lead time advantage compared to the US and European vehicle manufacturers; they explained further that the Japanese advantage in lead time appears to stem from a combination of their internal organisation capability, strong supplier capability, and innovation strategy.

The term co-development has become common usage for describing very close relationships between a customer company and a supplier company when developing a new product. Co-development is a term used to describe customers and suppliers who come together to research and develop new products, thereby allowing each to take advantage of the strengths of its partners. According to EPSRC [12], co-development can be defined as "the ability of customers to design competitive products in collaboration with their first tier suppliers".

2.2 Co-development in automotive industry

In their classic study on product development in the world auto industry, Clark & Fujimoto [11] highlighted Japanese auto makers' ability to develop good quality cars with shorter lead times and fewer engineering resources in comparison to those of their US and European competitors. They highlighted that the suppliers' roles in product development in Japan might be a significant reason for the Japanese advantage; in addition, the study noted that US auto makers carried out 86 per cent of the product engineering compared to 50 per cent carried out by Japanese auto makers.

Beaume *et al.* [13] stated that, in the automotive industry, innovation management is not included in a linear process that starts with research and ends with development, but rather is found in the interplay between product development projects and knowledge activities. This interplay contains a certain richness and complexity in the process. As the automotive industry experiences a period of overcapacity, many vehicle manufacturers are moving towards mergers and acquisitions [14]. This leads to the rationalisation of product ranges and, therefore, product development activity is carried out under uncertain market conditions with high competition and new technologies. Oh & Rhee [15] classified the manufacturer-supplier collaboration within the automotive industry into five types: collaborative communication, collaboration in new car development, collaboration problems solving, strategic purchasing and supplier development. The classifications are classified according to four criteria: the purpose of, nature of, timing of and parties involved in the collaboration.

2.3 The supplier capability in product development

The supplier capability factor always arises when the customer considers the involvement of a supplier in their product development process. Wasti & Liker [16] indicated that the ability to gain unique expertise from outside suppliers has always been an important reason for outsourcing. A buyer prefers to select its most capable suppliers for a component with high technological uncertainty. Notably, the issue is whether or not a firm or its suppliers are more efficient in producing the output [17]. The supplier's ability and funding to conduct R&D, skill, competitiveness in relevant design work, the number of patents, the hardware, and other facilities become the relevant factors.

Wasti & Liker [18] indicated that OEMs mainly outsource their designs in order to tap into suppliers' capability outside their organisation. Wasti & Liker [16] further proposed that the in-house technical capabilities of the supplier and the technical uncertainty of the component are two dominant predictors of supplier involvement in product development. In addition, Petersen et al. [19] stated that supplier involvement is important when technology is complex, and buying companies do not have a high level of internal expertise. Moreover, supplier product and process knowledge are considered to be the most important elements when selecting suppliers [20].

Filippini et al. [21] suggested that in-depth knowledge product technologies and market needs will help to overcome the difficulties associated with defining the products, and will help to improve lead times. They further added that, with the high level of capabilities, development will speed-up and ensure punctuality. The literature clearly indicated that the main reason for involving suppliers in product development is technological complexity.

2.4 Research on the Malaysian automotive industry

The search for research relevant to the Malaysia automotive industry did not produce much on the topic of co-development. So far, no research has been conducted on the area of co-development within the Malaysian automotive industry. The only study on the buyer-supplier relationship within Malaysia was carried out by Abdullah et al. [22], which focused on suppliers' improvement efforts by vehicle manufacturers. Furthermore, in their study on supplier development at PROTON, Abdullah et al. found that PROTON has played a significant role in developing and extending comprehensive supports to its suppliers in addition to nurturing its long-term relationships. Their study focused on the production relationships rather than the design and development capabilities of suppliers.

3 Methodology

In order to understand the current practices of co-development within the Malaysian automotive industry from real-world perspectives, an in-depth investigation into the phenomenon was conducted. The study used an exploratory approach with the adoption of case study research strategy using a semi-structured interview approach. The interview questions were based on the findings of the pilot study and UK experts' knowledge. The data were collected through in-depth interviews involving Malaysian vehicle manufacturers, Malaysia automotive Tier-1 suppliers and overseas Tier-1 suppliers within Malaysia. Each company represents one case study. Therefore, three case studies were from the vehicle manufacturers' side and six case studies came from suppliers.

For vehicle manufacturers, both national vehicle manufacturers, PROTON and PERODUA, participated in the interviews. In addition, one overseas vehicle manufacturer transplant assistant manager agreed to participate. In terms of suppliers, Tier-1 local suppliers were selected from the PROTON Vendor Association book, the association of PROTON Tier-1 suppliers. There were 130 Tier-1 suppliers listed on PROTON Vendor Association. Out of these 130 suppliers, only 57 suppliers are Malaysian-owned without any joint ventures with overseas companies. Of the 57 Malaysian-owned suppliers, 13 of them produce standard parts, such as bolts, paints, lubricants; carpets mats and so on; these were removed as having no co-development interest due to their non-technical nature. Only six suppliers agreed to be interviewed. The respondents came from different backgrounds or departments involved in the product development process with suppliers, including purchasing, engineering, business development, and research and development. This provided the researcher with a variety of data from different perspectives with respondents that had different backgrounds.

Two interview formats were designed, one each for vehicle manufacturer and supplier groups. The interview session started with an explanation of the research, its importance, and how the respondents and Malaysian automotive industry could benefit from it. Before the interview questions were posed, the researcher explained the background of co-development in Japan and the Western world as a warm-up conversation.

The interview questions began by investigating background information of the company in general, the products, and the nationality of the company for suppliers. This also included the history of the establishment, and whether or not the company received incentives from Government; this indicated the Government policy towards the local suppliers and whether or not the suppliers had been established before the national car company was established. In order to investigate further the influence of foreign companies on Malaysian vehicle manufacturers and suppliers, interview questions concerning collaboration with foreign companies were designed. The questions included product quality, design of the product (local or parent company), who influences decision-making, and the difficulties in working with a foreign company.

The main interview questions were structured based on the themes that were identified in the literature analysis. For each theme, the questions were posed to explore the practices of the vehicle manufacturer and supplier. Near the end of the interview, the respondents were asked if they felt there were any issues important to co-development that had not been highlighted by the researcher; this gave respondents the freedom to talk about what they thought needs to be improved or what underpins the co-development practices within Malaysia. The researcher also asked respondents whether or not they would like to see any changes to co-development within the Malaysian automotive industry, and about their ideal type of co-development.

A total of 12 interviews were conducted. Six interviews were from the vehicle manufacturers group, and six from the Malaysia-based automotive suppliers. The companies' backgrounds are summarised in Table 1 below. The interview sessions lasted approximately one to one-and-a-half hours. The interviews were recorded with permission from the respondents. In total, approximately 22 hours of interviews were successfully recorded for this purpose. The interviews were transcribed and analysed using MindManager software following the themes that were identified in the literature analysis.

Table 1: Companies participated in the interview process

Company Name	Respondent's designation	Background
MVM-1	Senior Engineer, New Project Group	Malaysian vehicle manufacturer
MVM-1	Senior Executive, Group Procurement, Purchasing	Malaysian vehicle manufacturer
MVM-1	Senior Engineer, Research and Development (Power Train)	Malaysian vehicle manufacturer
MVM-1	Engineer, Research and Development, (Mirror System)	Malaysian vehicle manufacturer
MVM-2	Senior Engineer, Engine Department	Malaysian vehicle manufacturer
MVM-3	Assistant Manager, Supplier development group, Purchasing	Japanese transplant vehicle manufacturer
OSP-1	Executive, Sales Department	Joint venture company (Malaysia-Japan). Tier-1 to MVM-1
OSP-2	Manager, Business development	Europe based company within Malaysia. Tier-1 to MVM-1, MVM-3
MSP-3	Manager, Business development	Malaysian owned company. Tier-1 to MVM-1 and MVM-2
MSP-4	Executive, Business development	Malaysian owned company. Tier-1 to MVM-1
MSP-5	Head of Department, Business Development	Malaysian owned company. Tier-1 to MVM-1, MVM-3
MSP-6	Manager, Business development	Malaysian owned company. Tier-1 to MVM-1

*MVM: Malaysian vehicle manufacturer

*OSP: Overseas supplier

*MSP: Malaysian supplier

4 Findings and discussion

Supplier capability seems to be the main concern of vehicle manufacturers when selecting the appropriate supplier. The findings suggested that supplier capability is the main reason why local vehicle manufacturers' have different attitudes towards local and overseas suppliers. Overseas suppliers are involved early as the vehicle manufacturers need their know-how. In addition, overseas suppliers could influence vehicle manufacturers in product performance, shape and so on, but, on other hand, local suppliers have good manufacturing capability with competitive product prices.

The model of local suppliers' manufacturing capability within Malaysia is similar to that which has occurred in the US, where suppliers were effectively treated as a source of manufacturing capacity [6]. As most of the local suppliers have no design capability, vehicle manufacturers seem to use them as manufacturing arms.

The main finding of this study is that local vehicle manufacturers tend to involve their suppliers in developing a new car based on the suppliers' technical capability. The findings also showed that local vehicle manufacturers more comfortably ally with overseas based suppliers in developing high technological product compared to local suppliers.

Furthermore, local suppliers are only invited in the product development process after the "design freeze" stage by the vehicle manufacturers; while overseas based suppliers are involved in the new vehicle development process at the early stage.

To understand further the current co-development practices in the Malaysian automotive industry, Kamath & Liker's [23] model of supplier roles in product development can be used to describe the role of suppliers within Malaysia (Table 2).

Table 2: Four supplier roles [23]

Role	Description	Responsibilities during product development
Partner (full service provider)	Relationship between equals; supplier has technology, size, and global reach	Entire subsystem. Supplier act as an arm of the customer and participates from the pre-concept stage
Mature (full system supplier)	Customer has superior position; supplier takes major responsibility with close customer guide	Customer assembly. Customer provides specifications. Supplier may suggest alternatives
Child	Customer calls the shots and supplier responds to meet the demands	Simple assembly. Customer specifies design requirements and supplier executes it
Contractual	Supplier is used as an extension of customer's manufacturing capability	Commodity or standard part. Customer gives detailed blueprints

Overseas suppliers are categorised as a 'partner' type of supplier to vehicle manufacturers, as they have technological capability and expertise. The partner type of supplier refers to those suppliers that understand the product and process. According to Kamath & Liker [23], this type of supplier is superior to their customers (in terms of technological capabilities and expertise of the product), and they can therefore suggest solutions regarding customer performance and activities. The suppliers in this group were involved at the early stage, and intensive communication occurred throughout the cycle. All the criteria mentioned in Kamath & Liker's [23] partner supplier role match the situation with overseas suppliers within the Malaysian automotive industry.

In contrast, local suppliers within the Malaysian automotive industry play a role that falls between 'child' and 'contractual'. Suppliers under the child role have less influence on design as the customer provides the detailed specifications, whilst they have to build and test the prototypes. Some local Malaysian suppliers are categorised as playing this role. Vehicle manufacturers monitor these suppliers closely, as the product complexity is often higher than for those suppliers who take a contractual role.

The contractual type of supplier simply manufactures parts designed by the customer. They may have unique manufacturing capabilities, such as large-scale flexible automation and communication, which is less extensive than for other supplier roles. Normally, contractual role suppliers have long-term relationships with their customers [23]. As the research suggests, local Malaysian suppliers have no design capability, have long relationships with vehicle manufacturer, and can offer good manufacturing capability, and so most of them fall into this contractual role.

5 Conclusion

These findings have provided the insight to the Malaysian vehicle manufacturers and it suppliers' co-development practices; based on suppliers' technical capability. Most local Malaysian suppliers are involved after the engineering and design stage while most overseas suppliers are involved with local vehicle manufacturers at the early stages. This is clearly based on suppliers' capability, as local

vehicle manufacturers need overseas suppliers' expertise on the project. Most local suppliers act as manufacturing arms to local vehicle manufacturers and therefore they become involved after the design has been frozen. It is clear from the findings that local suppliers are not involved in the product development process or in the process co-development. Hence, the critical implication from this study is that in order for local suppliers to get involved in the vehicle development process at the early stage, local suppliers need to become more technologically competitive.

References

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11th Global Congress on Manufacturing and Management (GCMM 2012)

28-30 November 2012 AUT University, Auckland, New Zealand

www.aut.ac.nz/engineering/gcmm2012

Day1 Wednesday 28-11-2012

Time	Events												
9.00-9.30	Inauguration and Opening Address by the Vice Chancellor of AUT University												Room WE 240
9.30-10.00	Welcome Speech by the President GCMM board												
10.00-10.30	Coffee Break												
11.00-12.00	Keynote Address 1: Prof. Leszek A. Dobrzanski, Silesian Univ.of Technology, Poland; "High manganese TWIP, TRIP & TRIPLEX steels'												Room WE 240
12.00-1.00	Keynote Address 2: Prof. Zhan Chen AUT University, New Zealand; "Friction stir lap welding"												
1.00-2.00	Lunch Break												
2.00-5.30	Parallel Session 1-1 Modelling and Analysis in Manufacturing and Management Room: WE 230												
	Session 1-1 A Chair: Co-Chair:							Session 1-1 B Chair: Co-Chair:					
	2.00-2.15	2.15-2.30	2.30-2.45	2.45-3.00	3.00-3.15	3.15-3.30	3.30-4.00	4.00-4.15	4.15-4.30	4.30-4.45	4.45-5.00	5.00-5.15	5.15-5.30
	MAM 1	MAM 2	MAM 3	MAM 4	MAM 5	MAM 6	Coffee Break	MAM 7	MAM 8	MAM 9	MAM 10	MAM 11	MAM 12
2.00-5.30	Parallel Session 1-2 Machining and Machinability Studies Room: WE 240												
	Session 1-2 A Chair: Co-Chair:							Session 1-2 B Chair: Co-Chair:					
	2.00-2.15	2.15-2.30	2.30-2.45	2.45-3.00	3.00-3.15	3.15-3.30	3.30-4.00	4.00-4.15	4.15-4.30	4.30-4.45	4.45-5.00	5.00-5.15	5.15-5.30
	MMS1	MMS 2	MMS 3	MMS 4	MMS 5	MMS 6	Coffee Break	MMS 7	MMS 8	MMS 9	MMS 10	MMS 11	MMS 12

Day 2 Thursday 29-11-2012

Time	Events												
9.00-10.00	Keynote Address 3: Dr. Steven R. Schmid, University of Notre Dame USA; "Government/Industry/Academia Partnerships and Manufacturing"												Room WE 240
10.00-11.00	Keynote Address 4: Prof. Xun Xu University of Auckland New Zealand; "Cloud Manufacturing"												
11.00-11.30	Coffee Break												
11.30-12.15	Invited Paper 1: Prof. Yue Chee Yoon Nanyang Technological University Singapore;"COC Polymeric Microfluidic Chip"												Room WE 240
12.15-1.00	Invited Paper 2: Prof. Paul Gümpel Hochschule Konstanz, University of Applied Sciences Germany; "New lean alloy alternatives "												
1.00-2.00	Lunch Break												
2.00-5.30	Parallel Session 2-1 Materials Processing and Science Room: WE 230												
	Session 2-1 A Chair: Co-Chair:							Session 2-1 B Chair: Co-Chair:					
	2.00-2.15	2.15-2.30	2.30-2.45	2.45-3.00	3.00-3.15	3.15-3.30	3.30-4.00	4.00-4.15	4.15-4.30	4.30-4.45	4.45-5.00	5.00-5.15	5.15-5.30
	MPS 1	MPS 2	MPS 3	MPS 4	MPS 5	MPS 6	Coffee break	MPS 7	MPS 8	MPS 9	MPS 10	MPS 11	MPS 12
2.00-5.30	Parallel Session 2-2 Other Manufacturing Processes Room: WE 240												
	Session 2-2 A Chair: Co-Chair:							Session 2-2 B Chair: Co-Chair:					
	2.00-2.15	2.15-2.30	2.30-2.45	2.45-3.00	3.00-3.15	3.15-3.30	3.30-4.00	4.00-4.15	4.15-4.30	4.30-4.45	4.45-5.00	5.00-5.15	5.15-5.30
	OMP 1	OMP2	OMP 3	OMP 4	OMP 5	OMP 6	Coffee break	OMP 7	OMP 8	OMP 9	OMP 10	OMP 11	OMP 12
6.30-8.30	**Conference Banquet**												

Day 3 Friday 30-11-2012

Time	Events												
9.00-10.00	Keynote Address 5: Assoc. Prof. David I Wilson AUT University New Zealand; "Navigating the Wilds of Industrial Optimisation"												Room WE 240
10.00-11.00	Interactive Session on Teaching with New Technologies: Peter MacLaren, AUT University, Auckland New Zealand												
11.00-11.30	Coffee Break												
11.30-1.00	Parallel Sessions 3-1 and 3-2 Manufacturing Technology and General												
	Parallel Session 3-1 Chair: Co-Chair: Room WE 230							Parallel Session 3-2 Chair CoChair: Room WE 240					
	11.30-11.45	11.45-12.00	12.00-12.15	12.15-12.30	12.30-12.45	12.45-1.00		11.30-11.45	11.45-12.00	12.00-12.15	12.15-12.30	12.30-12.45	12.45-1.00
	MTG 1	MTG 2	MTG 3	MTG 4	MTG 5	MTG 6		MTG 7	MTG 8	MTG 9	MTG 10	MTG 11	MTG 12
1.00-2.00	Lunch Break												
2.00-6.00	**Conference Tour**												