SECOND MALAYSIAN POSTGRADUATE CONFERENCE (MPC) 2012

Date: July 7-9, 2012

Venue: Bond University
Gold Coast, Queensland,
Australia

Organized by

EMA, Sydney
MyPSA, New South Wales
PPMQ, Queensland
MASCA, Queensland

Australia

In conjunction with

MALAYSIAN AUSTRALIA -
NATIONAL CONFERENCE AND GAMES (NCG) 2012
(7-12 July 2012)

SECOND MALAYSIAN POSTGRADUATE CONFERENCE

MPC 2012

7 - 9th July, Bond University, Gold Coast, Queensland, Australia. MPC is a conference of intellectual gathering for the Malaysian Postgraduate students in Australia to gather and to promote the sharing of ideas and knowledge among the MyPSA members.

SECOND MALAYSIAN POSTGRADUATE CONFERENCE (MPC 2012)

CONFERENCE CHAIRMAN'S PREFACE

The year 2012 represents a significant milestone in the history of MyPSA-NSW, PPMQ and EMAS with the organization of the Second Malaysian Postgraduate Conference at the Bond University, Gold Coast on 7~9 July 2012, concurrent with National Conference and Games NCG 2012. A number of delegates from different premier academic and research institutions in Australia have participated and shared their research experiences at the conference. In all 25 contributed and presentations are presented at the conference. The topics covered range of all aspect study from engineering, medical, humanitarian, art, social sciences, technology, finance and management.

The conference has helped in bridging researchers working at different institutions in Australia to share their knowledge and helped in motivating young researchers working for their doctoral program. This has also given some clear directions for further research from the deliberations of the conference.

Several people have contributed in different ways for the success of the conference. We thank all the authors of the contributed papers, for the cooperation rendered to us in the publication of the conference proceedings. In particular, we would like to place on record, the expert reviewers who have spared their time for reviewing the papers. We also highly appreciate the assistance offered by many volunteers in organising the conference and the preparation of the conference proceedings.

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Chairman
MPC 2012

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GENERAL INFORMATION

DATE : 7 ~ 9 July 2012 (Saturday - Monday)
VENUE : Bond University, Gold Coast Queensland
ACCOMODATION : Marrakesh Apartments, Surfers Paradise, QLD, Australia.

PAPER PRESENTATION GUIDELINES

1. Paper presentation will be 15 minutes followed by 5 minutes Q&A.
2. Proceedings will be prepared after the colloquium.

SATURDAY, 7TH JULY 2012

10.00am -Check –in Marrakesh Apartment
12.30pm -Bus trip to Bond University
1.00pm -Registration at Bond University
2.00pm -Opening Ceremony
2.30pm -Keynote Address
3.30pm -Tea Break / Asar
4.00pm -Session 1
5.30pm -Day 1 Ends / Maghrib /Bus trip to Marrakesh Apartment
*Evening-Light & Easy

SUNDAY, 8TH JULY 2012

07.15am -Breakfast
08.00am -Bus trip to Bond University
09.00am -Plenary / Session 2
10.30am -Tea Break
11.00am -Session 3
01.00pm -Lunch / Zuhur
02.00pm -Session 4
04.00pm -Tea Break / Asar
04.30pm -Closing ceremony
05.30pm -Day 2 Ends / Maghrib / Bus trip to Marakesh Apartment
*Evening-Light & Easy

MONDAY, 9TH JULY 2012

10.00am -Check out

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2nd Malaysian Postgraduate Conference (MPC2012)
7-9 July, Bond University, Gold Coast, Queensland, Australia
Editors: M.M. Noor, M.M. Rahman and J. Ismail

LEVEL OF COMMUNICATION, LEADERSHIP AND TEAMWORK SKILLS AMONG HIGHER EDUCATION STUDENTS

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ABSTRACT

A holistic view of education suggested that generic skills besides knowledge are important outcomes of university education. All Malaysian universities need to be more sensitive to generic skills because these skills are essential based on Malaysian Qualification Frameworks (MQF) 2006. The purpose of the study is to determine the validity and reliability of Malaysian Generic Skills Instrument (MyGSI) and the levels of communication, leadership and teamwork skills among higher education students. The population of the study is all Universiti Kebangsaan Malaysia (UKM) undergraduate students. The sample was clustered according to faculties. There were 635 samples in the study. The respondents age ranged from 20 to 35 years old. The data were analysed using Winsteps version 3.64.2, a Rasch-based item analysis program. The study used MyGSI which consists of 149 items. Mean, standard deviations, t-test and ANOVA were used in the data analysis. The findings showed that the levels of communications, leadership and teamwork skills were higher among non-science students as compared to science students. The study also showed that the levels of communication, leadership and teamwork skills were differed based on gender, race and group. The study implied that lecturers need to be more sensitive to the needs of upgrading students' generic skills to prepare them to be more competent in employment skills.

Keywords: Generic skills, communication, leadership, teamwork skills, student of higher education.

INTRODUCTION

Our graduates are our future leaders. Leaders of tomorrow require generic skills that will enable them to function effectively in the workplace. The generic skills are the skills that students need to become more successful learners and successful practitioners in their field of study, work and other aspects of their life are an important outcome of university education (Havard et al., 1998; Bennett et al., 2000; Biggs, 2003; Lublin, 2003; Lizzio and Wilson, 2004; Jager and Nassimbeni, 2005; Ballantine and Larres, 2007; Allan and Clarke, 2007). MQF (2006) has listed eight generic skills that are needed by all individuals: (i) knowledge of discipline areas (ii) practical skills (iii) social skills and responsibilities (iv) value, attitudes and professionalism (v) communication, leadership and teamwork skills (vi) critical thinking, problem solving

and scientific skills (vii) information management and lifelong learning skills (viii) managerial and entrepreneurial skills.

Biggs (2003) posited three levels of skills that are required for students to become independent learners: generic skills related to specific content and metacognitive learning skills. He defined generic skills as "ways of managing time and space" (Biggs, 2003). A holistic view of education suggested that generic skills such as communication, leadership and teamwork skills besides knowledge are important outcomes of university education. These holistic skills are often common and unique to all courses irrespective of their subject domain. These are often referred to as generic or key skills (Oliver et al., 2000). Students needed the generic skills to be successful practitioners in their fields (Owen, 2002; Lublin, 2003; Lizzio and Wilson, 2004; Joger and Nassimbeni, 2005; Canning, 2007). Why are the local public university graduates unable to get jobs in private companies? The question which appeared in the New Straits Times (Malaysian local newspaper) on 20th of April 2005 was supported by the Star on 26th of March 2005 through the following statement "Graduates failed during interview session due to poor communication in English". According to *Utusan Malaysia* (24th of March 2005), 80,000 unemployed graduates need extra training to be employable". On the 7th of March 2005, *Harian Metro* suggested that graduates need to have communication skills in order to be marketable". Times, London, England reported on 7th of February 2006 that unemployed graduates are poor in their social and generic skills. The purpose of the study is to determine the validity and reliability of MyGSI and the levels of communication, leadership and teamwork skills among UKM undergraduate students. The study will also provide the University with an overview of the undergraduates' levels of generic skills.

METHODOLOGY

The study was conducted using quantitative survey approach. The population of the study is all UKM undergraduate students. The sample was clustered according to faculties. There were 635 samples (158 males and 477 females' students) in the study. The respondents' age ranged from 20 to 35 years old. The data was analyzed using Winsteps version 3.64.2, a Rasch-based item analysis program. The study used MyGSI which consists of 149 items which was certified by a panel of experts. The items consist of 66 communication items, 42 leadership items and 41 teamwork items. Mean, standard deviations, t-test and ANOVA were used in the data analysis.

RESULTS

The data was analyzed using Winsteps version 3.64.2 to determine the validity and reliability of the MyGSI. Rasch Model analysis provided item reliability and construct validity as shown in Table 1 to 3. The item reliability index is range 0 to 1 whereby 0.8 and above is strongly acceptable (Bond and Fox, 2001). A construct with a set of unidimentional items should display a positive *PTMEA Corr* value which means that the items are working together to measure a single underlying construct. This is the basic step in measuring the construct validity (Bond and Fox, 2001). Table 1 shows that the item reliability of communication skills is 0.99. Table 2 shows that the item reliability of leadership skills is 0.99, whereas the item reliability of teamwork skills in Table 3 is 0.98.

Table 1. Item reliability: Communication skills

	RAW SCORE	COUNT	MEASURE	MODEL EROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	2320.3	635.0	.00	.06	1.00	-.2	1.02	.0
S.D	285.9	.0	.80	.01	.25	4.1	.30	4.4
MAX	2699.0	635.0	3.03	.70	1.72	9.9	2.04	9.9
MIN	1078.0	635.0	-1.40	.05	.58	-7.6	.57	-7.9
REAL RMSE .06			SEPARATION 13.14		ITEM RELIABILITY .99			
MODEL RMSE .06			SEPARATION 13.68		ITEM RELIABILITY .99			
S.E. OF student MEAN = .10								

Summary of 66 Measured Items

Table 2. Item reliability: Leadership skills

	RAW SCORE	COUNT	MEASURE	MODEL EROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	2527.6	635.0	.00	.07	1.01	-.4	1.03	-.4
S.D	153.0	.0	.64	.00	.30	3.9	.39	4.1
MAX	2738.0	635.0	-1.05	.05	.66	-6.1	.64	-6.7
MIN	1939.0	635.0	-1.05	.05	.66	-6.1	.64	-6.7
REAL RMSE .07			SEPARATION 8.83		ITEM RELIABILITY .99			
MODEL RMSE .07			SEPARATION 9.20		ITEM RELIABILITY .99			
S.E. OF student MEAN = .18								

Summary of 42 Measured Items

Table 3. Item reliability: Teamwork skills

	RAW SCORE	COUNT	MEASURE	MODEL EROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	2469.8	633.0	.00	.07	1.00	-.1	1.01	.1
S.D	113.5	.0	.52	.00	.17	2.7	.20	3.0
MAX	2705.0	633.0	1.16	.07	1.37	5.2	1.54	7.2
MIN	2189.0	633.0	-1.18	.06	.70	-5.0	.70	-5.2
REAL RMSE .07			SEPARATION 7.32		ITEM RELIABILITY .98			
MODEL RMSE .07			SEPARATION 7.57		ITEM RELIABILITY .99			
S.E. OF student MEAN = .08								

Summary of 41 Measured Items

Table 4 shows the responses from each cluster: gender, race, stream, and group. The number of female respondents is 477 (75%) whereas males is 158 (24.9%). The total of Malay students is 541 (71%), Chinese 152 (23.9%), Indian 19 (3%) and others 13 (2%). Both science and non-science students are respondents in this study. The number of Social Science students is 424 (66.8%) whereas science students 211 (33.2%). They were three groups of students in the study: Health Science 92 (14.5%), Science 119 (18.7%) and Social Science 424 (66.8%).

Table 4. Profile of respondents

Demography Factor	N	Factor	Frequency	Percentage
Gender	635	Male	158	24.9
		Female	477	75.1
Race	635	Malay	451	71.0
		Chinese	152	23.9
		Indian	19	3.0
		Others	13	2.0
Streams	635	Science	211	33.2
		Non Science	424	66.8
Group	635	Health Science	92	14.5
		Science	119	18.7
		Social Science	424	66.8

Table 5. Mean percentage and standard deviation of MyGSI according to demography factor

Demography	Factor	Generic Skills							
		Communication		Leadership		Teamwork		Overall	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gender	Male	72.78	6.25	78.50	7.65	77.76	7.34	75.73	6.31
	Female	73.18	5.48	79.97	7.10	78.21	7.13	76.48	5.71
Race	Malay	73.47	5.04	80.81	6.45	79.32	6.16	77.37	5.06
	Chinese	70.48	6.38	76.06	7.69	74.34	7.65	73.11	6.27
	Indian	73.34	8.14	79.62	12.56	78.79	13.94	76.17	10.71
	Others	73.72	4.72	79.41	5.61	78.69	5.97	76.19	4.85
Stream	Science	73.34	5.73	78.00	7.24	76.17	7.11	75.02	5.93
	Non Science	73.44	5.62	80.35	7.16	79.06	7.03	76.94	5.74
Group	Health Science	73.08	5.72	78.71	6.21	75.89	5.72	75.44	5.25
	Science	71.77	5.70	77.64	7.94	76.39	8.04	74.69	6.41
	Social Science	73.45	5.62	80.36	7.16	79.06	7.03	76.94	5.74

Table 5 shows that the mean percentage and standard deviation are according to demographic factor. The data showed that female scores were higher in all constructs (communication, leadership and teamwork skills) compared to male students (mean percentage =76.48, 75.73). The mean percentage according to race showed that Malay students are higher in generic skills compared to Chinese, Indian and others (mean percentage=77.37, 73.11, 76.19, 76.19). Furthermore, the mean percentage for students from non-science is higher compared to science students (mean percentage=76.94, 75.02) and mean percentage for students from social science is higher compared to health science and science students (mean percentage=76.94, 75.44, 74.69). The summary table of the t-test which compares the means percentage according to stream is shown as Table 6. The t-test of all the constructs showed the mean percentage for students from non-science stream were higher compared to students from science stream and the difference was significant: communication skills ($p<0.05$), leadership ($p<0.001$)

and teamwork skills ($p<0.001$). The summary table of t-test which compares the means percentage according to gender is shown as in Table 7. Only the leadership skills construct was significant ($p<0.05$) according to gender.

Table 6. t-test to compare mean percentage according to stream

Construct	Factor	Mean	SD	t	Sig
Communication	Science	73.72	5.73	-2.313	.021
	Non-Science	73.34	5.62		
Leadership	Science	78.00	7.24	-3.720	.000
	Non-Science	80.35	7.16		
Teamwork	Science	76.17	7.11	-4.859	.000
	Non-Science	79.06	7.03		

Table 7: t-test to compare mean percentage according to gender

Construct	Factor	Mean	SD	t	Sig
Communication	Male	72.78	6.25	-.778	.444
	Female	73.18	5.48		
Leadership	Male	78.50	7.65	-2.209	.028
	Female	79.97	7.10		
Teamwork	Male	77.76	7.34	-.676	.499
	Female	78.21	7.13		

Table 8 shows the One-Way Analysis of Variance (ANOVA) according to race. The ANOVA test revealed that there was a significant difference for all constructs of all difference races. There was significant difference for communication ($F=15.444$, $p<0.001$), leadership ($F=17.488$, $p<0.0001$) and teamwork skills construct ($F=19.904$, $p<0.0001$). The Scheffe test (Table 9) shows the pairs of means that are significantly different were for Malay and Chinese students. Table 10 shows the One-Way Analysis of Variance (ANOVA) according to groups. The ANOVA test revealed that there was a significant difference for all constructs of all difference groups. There was significant difference for communication ($F=4.086$, $p<0.05$), leadership ($F=7.499$, $p<0.001$) and teamwork skills construct ($F=11.923$, $p<0.0001$). The Scheffe test (Table 11) shows the pairs of means that are significantly different were for social science and science students in communication and leadership skills, but the pairs of means that are significantly different between Health Science and Science students, Science and Social Science students was in teamwork skills.

Table 8. Analysis of one-way ANOVA according to race

Construct		Sum of Squares	df	Mean Square	F	Sig.
Communication	Between Groups	1398.821	3	466.274	15.444	.000
	Within Groups	19051.283	631	30.192		
Leadership	Between Groups	2565.448	3	855.149	17.488	.000
	Within Groups	30854.690	631	48.898		
Teamwork	Between Groups	2826.073	3	942.024	19.904	.000
	Within Groups	29864.536	631	47.329		

Table 9. Mean comparison between the races using ANOVA

Race	Construct		
	Communication	Leadership	Teamwork
Malay (A) (n=451) Chinese (B) (n=152) Indian (C) (n=19) Others (D) (n=13)	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: A and B	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: A and B	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: A and B

Table 10. Analysis one-way ANOVA according to group

Construct		Sum of Squares	df	Mean Square	F	Sig.
Communication	Between Groups	261.031	2	130.516	4.086	.017
	Within Groups	20189.073	632	31.945		
Leadership	Between Groups	774.706	2	387.353	7.499	.001
	Within Groups	32645.432	632	51.654		
Teamwork	Between Groups	1188.566	2	594.283	11.923	.000
	Within Groups	31502.043	632	49.845		

Table 11. Mean comparison between the group using ANOVA

Student Group	Construct		
	Communication	Leadership	Teamwork
Health Science (A) (n=92) Science (B) (n=119) Social Science (C) (n=424)	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: B and C	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: B and C	ANOVA: significance at 5% level Scheffe: Pairs of means that are significantly different: A and B, B and C

DISCUSSION

The findings of the study showed that the level of communication, leadership and teamwork skills were higher among female students as compared to male students. Previous studies had shown that male and female students are inclined toward different fields of study (David et al., 2000; Maccoby and Jacklin, 1974; Mau and Lynn, 2001). Others studies also found that females had better performance in multiple choice tests (Bellar and Gafini 1995; Wester and Henriksson, 2000) and in test that require writing ability (Kleinfeld 1998). Males show better performance in items concerning science, sports, and mechanics (Lawrence and Curley, 1989; Wild and Mc Peek, 1986), whereas females perform better in items related to social science, humanities, philosophy and human relationships (Wild and Peek, 1986; O'Neil et al. 1989). It is also possible that gender may play a role in the evaluation of students' generic skills. It might be argued that, consistent with a traditional gender role perspective (Berger and Williams, 1991), female students would place greater value on communal or interpersonally related skills, and male students on agentic or problem-solving skills ((Lizzio et al., 2004). In leadership skills, other studies found that female students tend to be more transformational than male student. Males had a tendency to portray transactional leadership skills (Rosenbusch and Townsend, 2004). Therefore application of generic skills in discipline subject must emphasize on expertise and ability aspects based on student ability level. The findings of the study showed that the level of communications, leadership and teamwork skills were higher among non-science (social science) students compared to science (health science and science students). Discipline curriculum of social science subjects emphasize more on interaction with other individual, which involves a lot interpersonal skill. This resulted in communication skills being inscribed directly or indirectly in the subject discipline. This situation can influence and enhance the three related skills. Previous studies at the School of Education, University of Nottingham by Murphy (2001) have shown the auditing of communication skills is linked to a reflective writing task carried out while the students undertake a one week placement in a Primary School just prior to the beginning of their course. Each student completes this task and is provided with feedback on their expression, analysis, reflection, ability to summarize, overall presentation and organization. This exercise also covers some communication skills such as spelling, grammar, punctuation and handwriting. Previous studies had shown that the students in social science-related disciplines might regard interpersonal skills as more relevant to their current study and

future professional work. Similarly, management students may appraise teamwork skills as more relevant than student from other streams and group (Lizzio and Wilson, 2004).

Subject discipline of science student is more focused on natural fauna, concrete material, laboratorial experiment, animal, plant, chemical, electric and others. They interact less with other group. Their interaction is confined to their own group. This situation is a contributing factor to the level of their communication skill compared to the social science students. Therefore assignments that are administered in subject discipline must stress on related generic skills so that their level of generic skills can be upgraded. The study is suitable as suggested by Bennett et al. (2000) in his paper, "Skills Development in Higher Education and Employment" which states: "A model of generic skills is of limited use in the higher education context unless these skills can be clearly differentiated from disciplinary generic skills and knowledge. This was achieved through an analysis of theories of learning and skills development. Cotterell's (2001); Biggs (2003); Casey (2007) and Canning (2007) suggest that all skills learning or generic skills should be delivered within subjects. In this way learners can relate strategies to the program outcomes and to specific subject learning tasks. This is a perspective that is reflected widely in extant literature (Chalmers and Fuller, 1996; Hadwin and Winne, 1996; Norton and Crowley, 1995; Ramsden, 2003; Ramsden, Beswick and Bowden, 1986; Wade and Reynolds, 1989). Within-subject skill development has been interpreted variously as incorporating study skills as a discrete module into a subject program, integrating them loosely within subject modules, and embedding skills fully into modules to the extent that all lecturers in Higher Education accept and exercise a responsibility to help students to improve their generic skills (Casey 2007; Canning 2007). The findings of the study showed that the level of communications, leadership and teamwork skills were higher among Malay students compared to other students. This situation shows that background factor and family setting (race, socio-economic status, parent education level and origin and accommodation environment), teaching style and assessment form shall require those factors (David et al., 2000; Jackson 2002; Vezeau et al., 2000). Implementation generic skills among the higher education students must take into account all background factors.

CONCLUSION AND RECOMMENDATIONS

The study implied that lecturers need to be more sensitive to the needs of upgrading students' generic skills to prepare them to be more competent in employment skills. In order for all students to achieve a high level of competency there needs to be more opportunities for the development of generic skills (Allan and Clarke, 2007). The dislocation between the development of these skills and the context in which they are applied appears to preclude their effective development; suggesting that the embedding of these generic skills within subject discipline and modules might be efficacious (Robley et al., 2005). The development of generic skills has been motivated by the belief that there are skills which all graduates should possess, and which would be applicable to a wide range of tasks and contexts beyond the university setting (Moore 2004; Moore et al., 2004; Bennett et al., 2004; Crebert et al., 2004; Bath et al., 2004). Generic skills needs to be applied in each teaching of subject and it must be exposed during early intake from the first semester. Lecturers need to be more sensitive towards strengths and weaknesses of their students so that teaching and learning strategy would

be emphasized on generic skills. Lecturers need to understand which generic skills that require emphasis and always be more creative and innovative in intermingling generic skills in education and learning. Lublin (2003) found that by their nature the generic skills need a context - you don't just communicate, you communicate something to someone, so there is a good case for saying that they must be embedded in the subject.

All Malaysian universities need to be more sensitive to generic skills because these skills are essential based on MQF 2006. Enough exposure must be given to every student in relation to generic skills according to the qualification framework which has been stipulated in MQF 2006 to qualify student based on standard set by Malaysian Accreditation Board (LAN). Other studies have also found that assessment of the generic skills of students at the point of entry to the University was necessary (Murphy 2001; Biggs 2003; Lizzo and Wilson, 2004; Allan and Clarke, 2007). The study is an important input for UKM because it gives an overview of the level of generic skills among UKM students. The students' ability in the eight generic skills is comprised of different levels. If students' generic skills level is satisfactory for communication, leadership and teamwork skills then they can concentrate on other generic skills required by MQF 2006. This situation will enable the university, especially the 11 faculties in UKM to plan intervention programs for students who have minimum levels of generic skills. Therefore the intervention program could be implemented orderly and organized systematically.

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NATIONAL HPV VACCINE: THE AUSTRALIAN DEBATE

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ABSTRACT

The purpose of this paper is to analyse the public health policy with regards to the Human Papilloma Virus (HPV) Vaccination Programme in Australia. A case study based on media reports and journal articles was used to examine the public health policy which evolves around the framework of policy triangle. The environmental factors influencing the policy context; PBAC, politicians, health professionals, pharmaceutical industries, consumer groups, individuals and the media that leads to the variation in policy. Several actors with authority and external forces were identified to have direct and indirect impact on the HPV vaccine policies which intervene with the cost-effectiveness assessments, the independence of the process and political intervention in the decision making. It involves a complex process influenced by multiple factors such as politics, socio-economic and other environmental factors that are elaborated based on context, process and content. In spite of having a well defined process, there are some weaknesses in the decision making process that is not well understood by the affected stakeholders thus posing a threat to the independence of the system.

Keyword: Public health, HPV, Vaccine policy

INTRODUCTION

Public health policy evolves around the framework of policy triangle (Kent et al., 2005) which involves a complex process influenced by multiple factors such as politics, socio-economic and other environmental factors. The environmental factors influence the policy context that leads to the variation in policy which has profound impact in our Human Papilloma Virus (HPV) case study in Australia. Several actors with authority and external forces were identified to have direct and indirect impact on the HPV vaccine policy which will be discussed based on the context, process and content.

CONTEXTUAL FACTORS THAT INFLUENCE THE HPV VACCINE POLICY

Situational Factors

Strong political statement was made by the then Prime Minister (John Howard) on Australia Day, the 26th January 2006, when awarding Ian Frazer the Australian of the Year. Roughead and Gilbert (2008) made a public statement that the vaccine would be made available to young women across Australia. The statement was made prior to consultation with the Federal Health Minister (Tony Abbott). This is seen as a political mileage for the ruling party as it spurs opportunity for the general public to participate in policy discussion and decision as the federal elections was just around the corner.

Structural factors

Media in Australia play a big role in influencing the general public. Within a short period after the vaccine was launched, media coverage of the new vaccine portrayed the vaccine as a medical miracle, a life saver and framed as social good. This stimulated public debate and expert opinions were reported in favour of the vaccine to be made available to the public free of charge. Experts such as Associate Professor Margaret Davy who is the Royal Adelaide Hospital's Director of gynaecological oncology was quoted as saying that the government appeared to be saying that it was not worth to spend AUD450 on women. Statement by not so independent expert, Dr Gerry Wain who was not only the Westmead Hospital gynaecology director but also NSW cervical screening program scientific director, pointed out that the government does not value the life of Australian women especially young, poor women who cannot afford to buy the vaccine but needed it most. These comments cemented the pressure on the government to reverse the initial decision by the Pharmaceutical Benefits Advisory Committee (PBAC). There were also disappointment expressed by non-governmental organization, Cancer Council, consumers and doctors' groups when PBAC rejected the vaccine application. These parties form a strong voice in advocating for the HPV vaccine approval.

Cultural factors

As the vaccine was to be given to young girls aged 12-13 years, it caused a strong feeling of anxiety among conservative religious groups (Colgrove, 2006) in the society as it was seen as encouraging the girls to have sex at a younger age as they were deemed "protected". The idea that it may spread wrong message that vaccinated girls were "protected" from sexual transmitted diseases also arose. Mr Tony Abbott was also criticised for his defence of PBAC rejecting the HPV vaccine on the basis that his Christian values were limiting his ability to make the vaccine readily available to all women. However, these issues were short-lived as the Federal Government went ahead in making the HPV vaccination a school based vaccination programme. It was also made available through local GPs in community base catch-up programmes where older women up to 26 years of age can also receive the vaccine.

International factors

Ian Fraser being awarded Australian of the Year accolade was a gesture of national pride. It proves that Australia is in the forefront of medical advancement as it was the first of its kind and by implementing the HPV vaccination programme would make Australia be seen as "leading the world" and promoting international recognition.

PROCESSES THAT INFLUENCE THE HPV VACCINE POLICY

Problem Identification

The prevalence of HPV among cervical cancers was around 75% and the breakthrough in having a vaccine was welcome news for many parties. In 2005, press articles reported HPV vaccine was termed as the world's biggest vaccine following reports that results

from phase III clinical trial: "Medical miracles Aussie doctors unveil cervical cancer lifesaver". Therefore, it was worth making HPV vaccine a national priority by the Federal Government as it coincides with the upcoming general elections.

Policy Formulation

PBAC plays a role in providing evidence based on several criteria. They also make recommendations which were supposed to be independent of external pressure. However, the process was interrupted by political intervention. Pressure was also mounted from CSL as they try to push for the highest profit before a rival product was ready. Pressure from the Prime Minister and women health groups forced PBAC to call for an Extraordinary Meeting and subsequently in less than a week, the HPV vaccine was made available via government funding.

Policy Implementation

Once the HPV vaccine was approved, the government implemented a school based programme where school girls' age 12-13 years will receive the full three doses. Parental consent was required for each student and injections were carried out in schools. The HPV vaccinations also include a catch-up programme that aimed at targeting school girls from the age of 14-18 years at the end of 2008. Community based catch-up programme also included older women up to 26 years old to be taken at their local GP.

Policy Evaluation

Monitoring and evaluation of the programme was conducted in the same setting at the state and national level covering the schools as well as GP/community based programmes.

CONTENT THAT INFLUENCES THE HPV VACCINE POLICY

Although there was not enough epidemiological data on HPV prevalence/vaccination in Australia, the programme was carried out with the assumptions that international data can be generalized to the Australian population. Its safety and the need for a booster dose remain questionable. Despite all of these, the vaccine was still approved to be used in both boys and girls before sexual onset in an effort to reduce the rate of cervical cancer. The HPV vaccination programme was given only to girls' aged 12-13 years with the assumption that they have not had sexual contact. The cost effectiveness of the programme remains unclear as the length of immunity offered was not actually known. Nevertheless, the issue of cost was silenced as the bigger picture of "saving lives" was paramount in the society at large coupled with frenzied positive media reports.

CONCLUSIONS

In spite of having a well-defined process, the HPV vaccination programme in Australia was implemented in haste. There were flaws in the decision making process that was not well understood by the affected stakeholders. Threats to the independence of

decision making process need to be outlined and mitigated as part of efforts for better communication among the stakeholders, and thus results in better policies.

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POSTGRADUATE JOURNEY OF MALAYSIAN STUDENTS IN AUSTRALIA

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ABSTRACT

Postgraduate studies are a topic of interest for all participants attending our Malaysian Postgraduate Colloquium 2012, which is only the second colloquium session. The colloquium was introduced in 2011 as a platform for our Malaysian postgraduate students to share their field of research with fellow academicians who are currently pursuing their doctoral studies in the Australian universities and at the same time creating and raising awareness with the relevant authority, be it in the local Australian universities as well as the Ministry of Higher Education of their Different PhD pathway or journey that has always been understood as similar to those pursuing in UK or USA. From the discussions that had taken place during the sessions, it is found that there are a lot of differences which occurred as Cultural Mismatches in aspects such as Supervision, Expectations, Familiarity of Australian English, Approaches, Understanding of Subject Matter and Writing Styles. These have been the areas of concerns as they become the obstacles for students in their doctoral journey and all the while have not been addressed properly which led to the casualty rate of our Malaysian candidates.

Keywords: Postgraduate Journey, Malaysia, Australia

INTRODUCTION

In this paper, as the current Director of Education Malaysia Australia who is also an alumni of an Australian university, there are observations made throughout my years as Doctoral student specializing in the inter and cross-cultural aspects between Malaysian and Australian approaches in negotiation as well as heading Education Malaysia Australia which can be considered as useful 'tips' for those who are currently pursuing your postgraduate studies. These include the following areas:

1) Self Preparation
2) Proper Documentation
3) Supervision
4) Motivation
5) Handling Challenges

SELF PREPARATION

One has to be both mentally and physically prepared when decided to embark on a PhD journey. This is merely emphasizing on 'Knowing what to do!' which in Australia, it is wise to have postgraduate discussion group on a fortnightly or monthly basis. This does not only provide a sharing of experiences amongst postgraduates but also it is a learning

and discovery session for students to draw up a checklist for themselves. In the process of learning the unknown journey, the sharing will develop students in finding a system to get them organized, building their self confidence and self esteem, learning to design their own short term and long term time line, becoming a knowledge seeker by finding more of the support system from both the graduate school and faculty and to be aware of students' counselors that have been provided to assist them. The process of adjustment to new demands require a lot of hard work and pressure (Lin and Yi, 1997; Ryan and Twibell, 2000). It is also very important that students should have passion in their field of research interest. In order to start the journey, it is wise to firstly check the area of studies, bearing in mind that a doctoral study has to be a new contribution to the discipline. This definitely should be a priority list.

PROPER DOCUMENTATION

Tabulation of work schedules in weeks or months for a semester is the initial task for students to have some kind of documentation or monitoring of their progress. The table will include tasks need to be accomplished and actual tasks done, together with dates of submission of work to supervisor. Dates of meetings with supervisor should be included in order tracking can be done in future. In addition, Feedback dates received from respective supervisor or co-supervisor for each task submitted are important. The purpose of proper documentation from the first year of candidature will alert students to be on track with their work and it will help in providing relevant information for students' annual progress report. It is important that the Sponsor and Dean of Faculty in Malaysia to know that students are serious in their work and from the documentation the sponsor will be able to gauge on work progress for the purpose of extension.

SUPERVISION

Firstly, Malaysian students understand that a supervisor is expected to be an expert in the field of study whereas in Australia, a supervisor is someone who could lead or supervise a candidate to be the expert of his own study or research. A student demonstrates different roles during supervision as the degree of student's contribution towards his own study varies from year to year. The expectation of a Malaysian student is normally to be guided fully by their supervisor. On the other hand, a supervisor expects students to be independent in a shorter time and therefore, students will have to explore as much in building their research skills. The supervision should be developmental in nature, featured by consistency, continuity, intellectual dialogues, modeling, coaching, and two-way interactions (Race, 2005; Kumar and Stracke, 2007; Caffarella and Barnett, 2010; Kumar and Stracke, 2010). Therefore, students are encouraged to record their discussion with their supervisors in order to fully understand the instructions or advices given. More frequently, students are not able to grasp the key discussion topics due to probability of language barrier and familiarity of the Australian accent and dictions. The effective approach to overcome this difficulty and to ensure the correct instructions to be followed, the recorded discussion will then be produced as written instructions understood and reconfirmed by their supervisors before working on the assigned task. All the discussions during the candidature will then be compiled in folders and kept as references. It has been reported that there’s a mismatch between the students’ earlier expectations and current realities in terms of supervision experience (Ismail and Wahiza, 2012).

It is therefore important to note that peer learning also plays a significant role in determining the success rate of a doctoral student besides supervision. Peer learning is highlighted by Boud (2001) as a "two-way, reciprocal learning activity" (p.3) and "refers to networks of learning relationships, among students and significant others" (Boud and Lee, 2005, p.503). It would be more encouraging if students are able to work towards a "desired partner-like relationship" with their respective supervisors as described by Stracke (2010) and to develop into a more enhanced communication for a better understanding between them.

MOTIVATION

Motivation is an element to elevate one's spirit to be focused on their endeavor to complete the study. In order to keep up the interest in the study, students will have to be more organized in managing their work. Both motivation and experience are significantly important for students to have, as they will be facing a highly challenging and rigorous experience journey (Hitt, 2009). For example, it is advisable to find the best software's to keep their work or data more manageable, besides having endnotes software to keep track of their readings and notations. Being consistent in writing up their thoughts from a very early stage of study would definitely help to develop students' thinking skills. To have the habit of writing one's thoughts will lead students to another level, the art of critical thinking. Learning to be critical and analytical about any reading that has been done is a good practice towards writing a good literature review chapter, which has always been a stumbling block for most Malaysian students in order to progress well in their thesis. Finally, it is motivating when writing is done on a template of a university's thesis. In writing consistently and systematically, it encourages students to write more? Students will have to develop a system where plagiarism can be avoided and not carelessly done. One of the ways is to identify original writer or author's words to be differentiated with colored fonts. In addition, students will have to work extremely hard to build on their research capabilities. Mentally they have to be prepared to learn and build tacit knowledge on how to do research (Hitt, 2009).

HANDLING CHALLENGES

PhD journey is the journey of the unknown. One will not know what to expect but to be brave enough to face and to handle the challenges as they come. How does one manage or overcome this? Students are found to be struggling half way through their candidature as they realize that there is a mismatch between expectation and reality at the intermediate stage of their studies (Ismail and Wahiza, 2012). Challenges come in various forms, they may come from students' own family, students' lacking the research skills, not proficient enough in the language, inadequate writing skills and not critical enough in thinking. For instance, the candidature in Australia universities will not have a viva after the submission of a completed thesis for examination. Therefore, candidates are expected to be strong in their writing skills by the final year. This has been a great concern of the Malaysian or even international doctoral candidates. Most international students may need to get themselves to be doing collaborated work by getting organized into sessions or groups for the purpose of sharing research, sharing the research process, and sharing knowledge about practical matters (Stracke, 2010). This will not only get them to gain moral support but they will have an opportunity to gain more insights into their PhD journey.

Perhaps, a diary or journal writing would be best for self reflection. This could be a channel for students to detach themselves from unstable emotions fast. A great relief when one has written a reflection of one's thoughts especially when they are more negatively inclined. The feeling of ' freedom' will be experienced and it is a way to get them out of the system. The result is that one will experience having a clearer mind after getting into a 'PIT' or a severe problem. This could be recommended as a self managing emotion technique.

CONCLUSION

In conclusion, a PhD study experience is an invaluable process of self development. The journey teaches us to identify and strengthen our positive attributes and at the same time recognize our weaknesses and learn to manage them more successfully. Being an expert in one's discipline is an achievement but the ability to become a person with a 'Towering Personality' is the best 'GIFT' that comes with the journey's package. All candidates should never ever learn the word 'QUIT' because the journey is worthwhile to experience.

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DESIGN OF SMART STRUCTURES FOR WIND TURBINE BLADES

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ABSTRACT

The wind turbine blade is a very important part of the rotor. Extraction of energy from wind depends on the design of the blade.The advancement of fibre composite materials have provided the best solutions to overcome inefficiencies caused by traditional materials used in wind turbine construction. At present, the majority of wind turbine blades are constructed with glass fibre reinforced plastic (GFRP). The use of composite materials eventually have solved some of the problems associated with efficient operation of horizontal axis wind turbines (HAWTs) such as gravitational forces due to weight but there are other unresolved problems such as long term material property degradation, local shape deformation of the profile of the wind turbine blades etc. This project aims to address the adverse structural response of the blade profile with the variation of operational parameters such as wind velocity and material properties on blade's performances. For this reason, the shape memory alloy (SMA), which is Nitinol (NiTi) has been embedded in the blade to alleviate the load. A parametric blade model utilising the Abaqus finite element program has been developed to efficiently predict the deflection of the blade. Result obtained from Abaqus is compared with the current experimental work. It was found that the numerical model developed in FEA agreed relatively well with the experimental work, thus validating underlying assumptions.

Keywords**:** GFRP**,** SMA, FEA,NiTi

INTRODUCTION

The utilization of wind energy is not a new technology but has caught attention due to the rediscovery of a conventional wind power technology. It has been proven in the past as that it was used to capture the wind as much as possible in order to generate power(Erich, 2009). In 2007, the government has committed to ensure that 20 per cent of Australia's electricity supply would come from renewable energy sources by 2020 by establishing the expanded national Renewable Energy Target (RET) scheme. The enhanced RET scheme commenced on 1 January 2010 and is projected to deliver more than 45,000 gigawatt hours of electricity in 2020. It is expected to unlock more than $AUS20 billion in investment over the next decade (ACEC, 2012).

Rapid development in material technology has given influential impact on some variation structure of the wind turbine. The variation mainly depends on positive reaction for lowering the prices of wind turbine construction and operational cost. As known, there are a lot of materials such as composite materials to be used in wind turbine structures such as for tower, blade hub and nacelle. The focal point in the system where the wind is converted into useable energy is the wind turbine blade. Around more than 10,000 blades have been supplied over 10 years to the strictest quality standards which near to aerospace quality at industrial cost. The blades have been customized designed which tailored to customer's turbine specification (Nolet, 2011). The blade, as part of the prime mechanical wind turbine rotor, is a key element within the wind turbine system and as such research aimed at improving blade performance is of great importance(Glauert, 1983). It is definitely an influential component for system efficiency. In the evolution era, dimensions and number of component vary on the basis of turbine strength. Its development in the past varied from canvas to wood and sheet metal. But, in recent modern era, composite has been implemented by all turbine manufacturer (Eker et al., 2006). The anatomy of the modern wind turbine is illustrated in Figure 1.

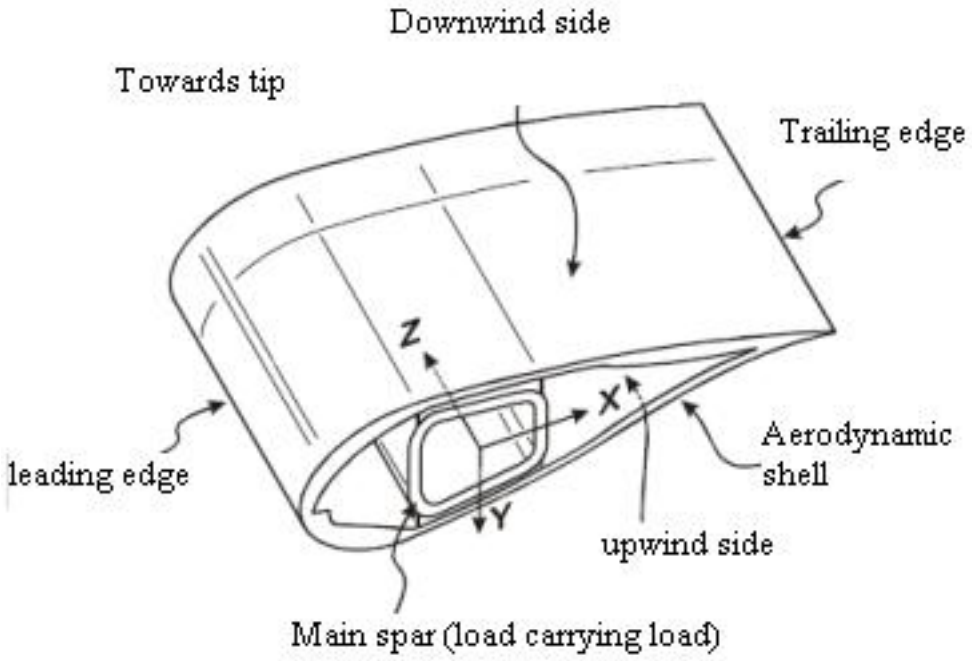

Figure 1. Typical cross sections of wind turbine blade (Sorensen et al., 2004)

Wind turbine blades are required to preserve an optimum cross section for aerodynamic efficiency by optimizing the lift to generate the maximum torque to drive the generators. Figure 2 shows aerodynamic mechanism of the wind blade when there is wind flow. However, several factors such as static and dynamic loading, fatigue resistance, rigidity, weight, sound emission and appearance have adverse impact on a wind turbine (Epaarachchi and Clausen, 2006), (Spera, 2009), (Wood, 1991).

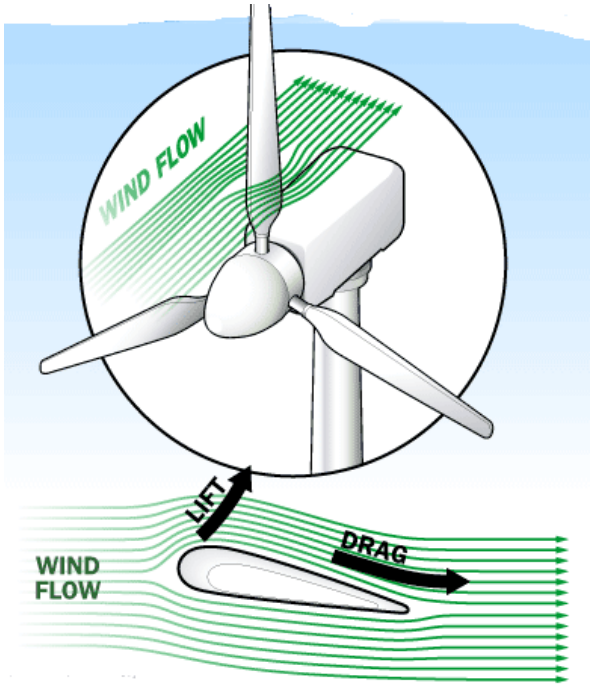

Figure 2. Aerodynamic of the wind turbine blade (Eggleston and Stoddard, 1987)

BLADE LOADING

Aerodynamic Forces

An aerodynamic force is complicated in nature and hard to investigate. These forces can be unsteady and vary in a non-linear way along the axis of blade, also made complex by the random condition of the atmosphere. In studying them, stochastic or statistical testing must be relied on rather than more direct deterministic testing like through wind tunnel testing. The aerodynamic forces acting on a blade at steady state are shown in Figure 3. Due to the aerodynamic pressure acting on the blade's surface, the resultant lift force L_A acts perpendicular to the resultant wind velocity, W_A and also the drag force D_A, act parallel to the resultant wind velocity.

The resultant velocity $W_A = \sqrt{(r\Omega + W_A)^2 + U_0^2}$ (1)

$$= U_0\sqrt{(\lambda + \frac{W_A}{U_0})^2 + 1} \quad (2)$$

The aerodynamic forces on the blade section simply can be expressed as

$$L_A = \frac{1}{2}\rho C_P W_A^2 \Delta A \quad (3)$$

or

$$L_A = \frac{1}{2}\rho C_P U_0^2 [(\lambda + \frac{W_A}{U_0})^2 + 1]\Delta A \quad (4)$$

where $\lambda = \frac{\Omega r}{U_0}$, tip speed ratio, with Ω is the rotational speed of the turbine, r is the radius of the blade section considered, ρ is the density of the air and ΔA is the considered small area of a wind turbine blade. As a consequence, aerodynamic force on the blade at wind velocity V can be easily determined by multiplying aerodynamic forces at wind velocity U by factor of $\frac{V^2}{U^2}$, as long as C_P is constant. (Note:W_A is considerably smaller than $r\Omega$).

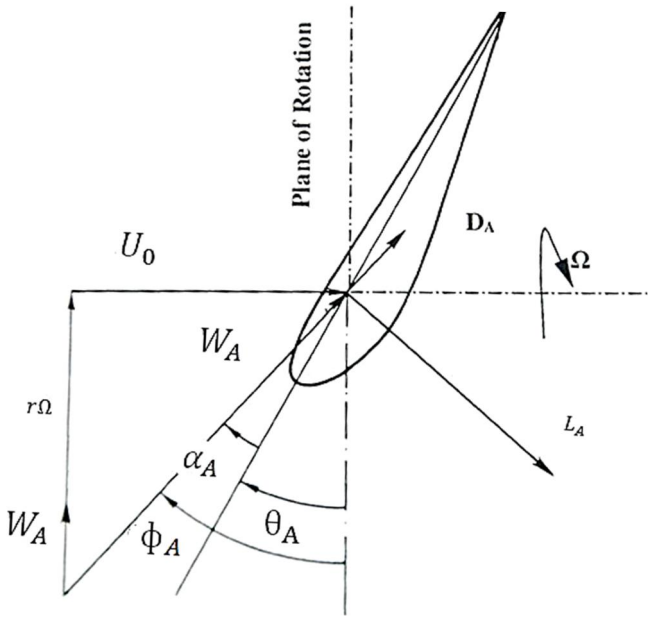

Figure 3. View of aerofoil section at the radius r along the blade, relative to the hub blade(Eggleston and Stoddard, 1987)

Analysis of aerodynamic pressure along the blade is a complex task. Wood (1991) used a panel code to overcome some of the deficiencies found in the blade element theory (BET). In the panel code, a blade is divided into 40 strips along the blade axis and 10 pressure centers along the chord. Wood has shown that by using full – three dimensional analysis, the blade surface pressure in steady wind can be estimated more accurately than with BET. The panel code determines the normal pressures acting on the blade surface and so estimates the drag forces, D_A. As such the predicted performance of wind turbine blade will be overestimated.

Inertial, Gravity and Structural Forces Blade Design and Structural Analysis

These forces arise as a result the blade mass, blade rotation and gravity and contribute to the total forces acting on a wind turbine. A combination of aerodynamic, gravitational and inertial forces lead to two significant blade motion whilst rotating: blade flapping and blade lead-lag as illustrated in Figure 4. Blade flapping, motion of the blade out of its plane rotation, is fundamentally caused by variation in wind flow. Blade lead-lag is essentially caused by the operating blade rotating, in gravitational field. The centrifugal force acting on the blade creates a counter acting moment to that induced by the

aerodynamic pressure. As such, centrifugal force reduces the deflection, *d* on aerodynamically loaded blade.

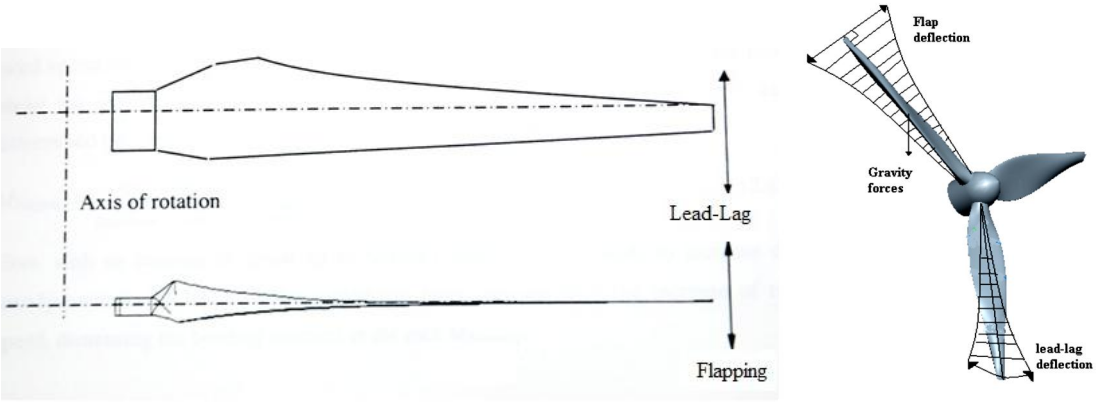

Figure 4. Lead-lag and flapping moment (schematic view)

Figure 5 shows the blade motion, let the resultant aerodynamic force be δF acting on a blade surface of δA at radius in the direction *Y*(Note: gravity forces and in-plane component of the aerodynamic pressure are perpendicular to the flapping plane) on a blade in steady operation at rotational speed Ω (< rated operational speed). At this particular instant the total bending moment at the root end about the axis perpendicular the blade's rotational axis (Flapping moment) can be determined by:

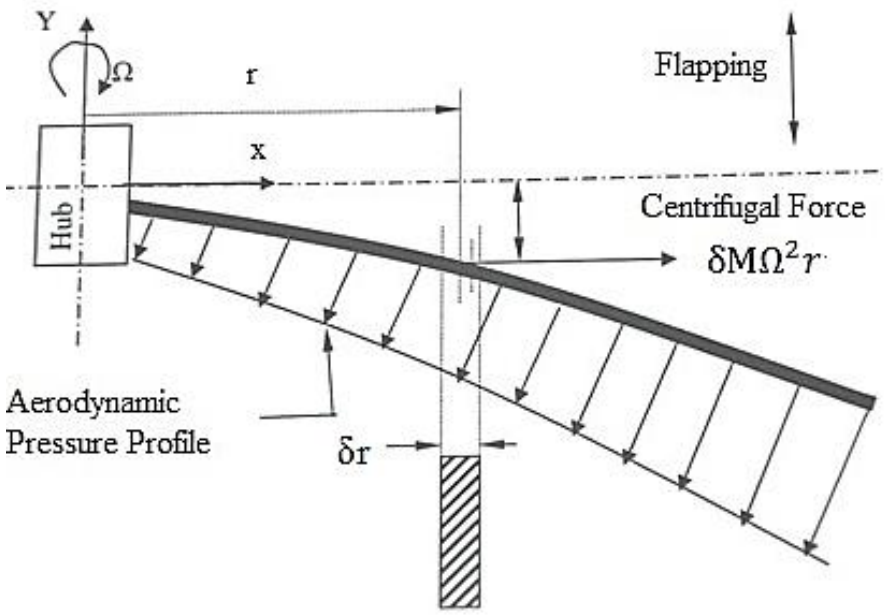

Figure 5. Inertial forces acting on a wind turbine blade before steady operation at constant speed of Ω (schematic view)

$$M_{Flapping} = \sum_{Blade\ length}(\sum_{chord} \delta Fr - \sum_{chord} \delta M\Omega^2 rd) \quad (5)$$

Here, with an increase in speed up to turbine's rated speed, *d* deflection tends to increase due to aerodynamic pressure load. However, the centrifugal force increase with

the increase of turbine speed, decrease the bending moment at the root $M_{Flapping}$ (Epaarachchi, 2002).

NACA 4-Digit Airfoil Selection

The development of efficient (low-drag) airfoils was the subject of deep experimental investigations in the 1930s. These airfoils were standardized by the National Advisory Committee for Aeronautics (NACA), and extensive lists of data on lift coefficients were reported(Manwell et al., 2009). The comparative study has been taken in order to develop NACA 4412 blade profile. Figure 6 shows variation of the optimum power coefficient with the design tip-speed ratio for a blade made of NACA 4-digit airfoil families. It is seen that C_p increases rapidly with TSR up to its optimum value after which it decreases gradually with a slower rate. The optimum range of the TSR is observed to lie between 6 and 11, depending on the type of airfoil. The effect of wind shear and tower shadow resulted in a reduction of the power coefficient by about 16%. The value of the design TSR at which $C_p$max occurs is also reduced by about 9%. It is also observed that blades with NACA 4412 produces higher power output as compared with other airfoil types.

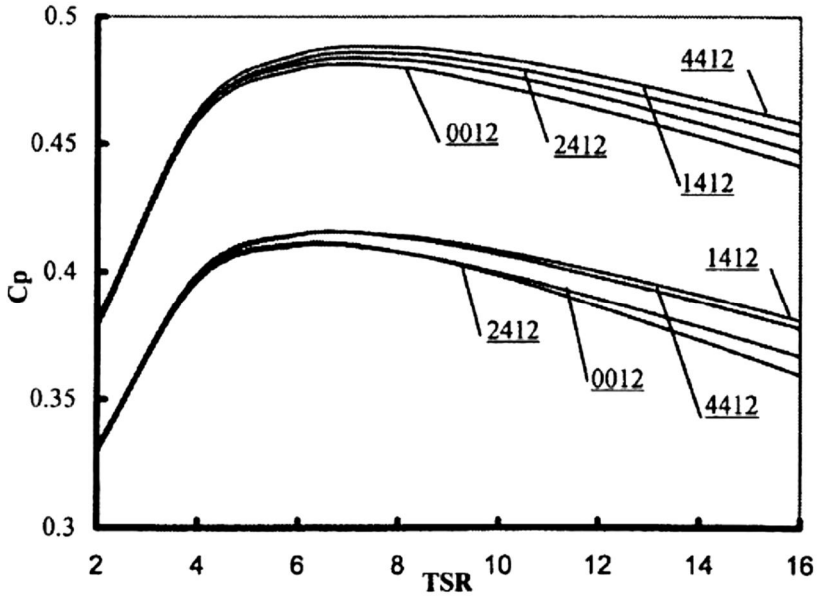

Figure 6. Variation of the optimum power coefficient with TSR for a three bladed rotor of NACA 4-digit airfoil(Malawi, 2010)

Smart Structures Application

Shape memory alloys (SMAs) have been defined by several researchers as smart material with all the various definitions pointing to the unique properties associated with SMAs. SMA as a metal alloy can memorize and revert to a specific shape after considerable deformation. Patoor et al. (2006) defined SMAs as metallic alloys that can undergo martensitic phase transformations as a result of applied thermo-mechanical loads and are capable of recovering permanent strains when heated above a certain transformation temperature(Patoor et al., 2006). SMAs are defined by their remarkable ability to sustain and then recover large super elastic strains by stress and temperature

dependent crystallographic transformations (Srinivasan and McFarland, 2001) (Armstrong and Lilholt, 2000). SMAs possess sensing and actuating functions and have the potential to control the mechanical properties and responses of their hosts due to their inherent unique characteristics of SME and super elastic. When integrated into structural components, SMAs perform sensing, diagnosing, actuating and repair or healing functions, thereby enhancing improved performance characteristics of their hosts (Zhang et al., 2007)(Lau et al., 2002a). In the literature, SMA actuators have been proposed for use in many engineering structures. Many studies have suggested SMA wires can be embedded in a composite(Lagoudas and Bo, 1994)(Zhou and Lloyd, 2009). The embedding approaches have been investigated by Yongsheng et al. who studied the behavior of SMA strips that have been thermally trained to memorize a bent shape, pre-strained to a circumferential shape(Yongsheng et al., 2009)(Lau et al., 2002b).

On heating, the strips tend to recover the memorized shape and the plate is forced to bend. As in-plane displacements of the strips relative to the plate are allowed in this design, de-bonding and rapid ageing are prevented during multi-cycle actuation. Rizzoni et al. studied the actuation characteristics of NiTistrips/ribbon working in bending and fixed to the surface of a polymeric plate. The preliminary experimental assessment of the heat treatment parameters that are needed to memorize a bent shape has been presented. Typical application of such composite is the control of the geometry of blades to increase the performance of cooling fans in earth-moving engines (Rizzoni et al., 2011). Nowadays, fibre reinforced composites have already gained large interest and increased application in diverse fields. This is mainly due to their inherent high stiffness-to-weight ratio, corrosion resistance and controlled anisotropic properties. Shape memory alloys (SMA) are commercially used in a variety of actuator, clamping and fixing devices (Zhou and Lloyd, 2009).

Smart Wind Blade Concept

The series investigations of the graded sandwich panel will be tested based on the cantilever beam are focused on implementation and testing of the embedded SMA under static loading. Parameters such as time response for actuation, temperature surface, current applied will be measured during the test.FEA will be used to simulate the deflection and optimize the experimental work analysis.

Modeling Process and FEA

Before plotting in 3D, predefined coordinates have been precisely generated in the Matlab and all the respective points have been imported into the coordinate system (CSYS) in Pro E(USQ, 2009). After activating the coordinate system, cross sectional area of chord has been generated using surface blending and swept protrusion. For simulation of static loading, a design blade was plotted in Pro E which is shown in Figure 7. The specification of the profile is illustrated in Table 1. Then, the three parts were properly assembled into the blade assembly and saved into Initial Graphics Exchange Specification (IGES) format. In Abaqus 6.11, the drawing will be imported to test the static loading as shown in Figure 8(Abaqus, 2011)(Yushu and Chuanguo, 2010).

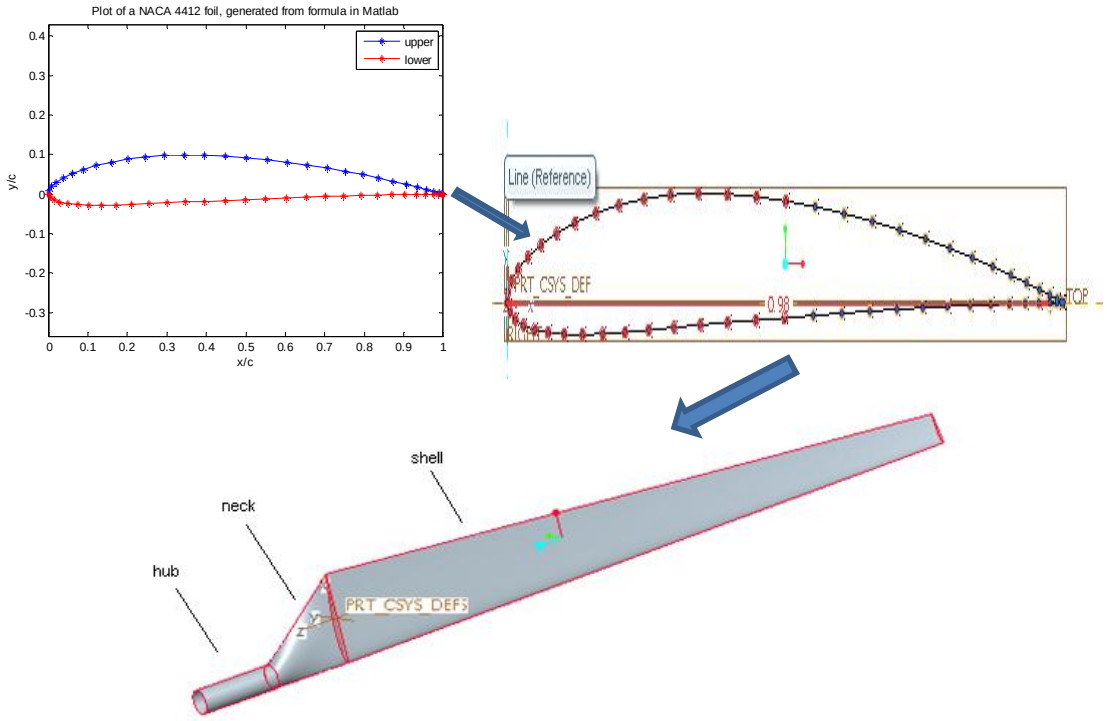

Figure 7. The coordinate points for NACA 4412 into Pro E for blending surface

Table 1. Geometric details of NACA 4412 (Selwin et al., 2008)

Particular of blade geometry	
power	5kW
root chord length	330 mm
tip chord length	130 mm
blade length	2500 mm
hub diameter	67.5 mm
hub blade to neck length	300 mm
twist from the root to tip	18°

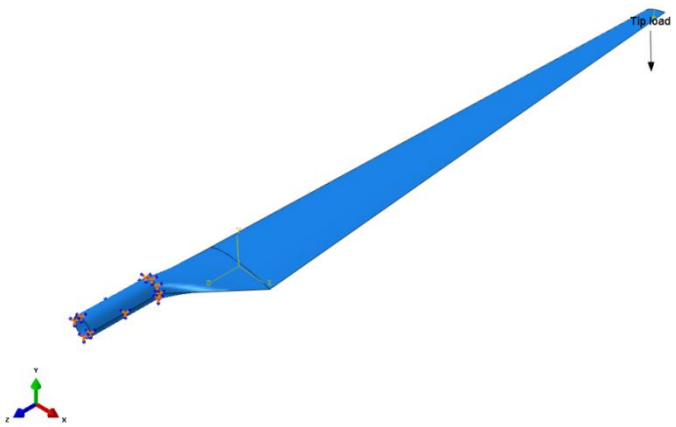

Figure 8. Boundary condition, load applied at the tip and meshing process

Figure 9 illustrates the displacement along the blade. At the free end there are no boundary conditions and therefore the displacement is much larger at the tip and displacement is constrained at the hub as there is restriction point. Figure 10 shows the strain pattern concentration simulated using Abaqus. Higher strain values are predicted at the root rather than at the tip section. This was also proven by Grujicic et al. (2010) where simulation was carried out using Ansys. Figure 11 depicts the fabrication of the ply configuration has been simulated at $[0^0/90^0/-45^0/+45^0]$**.** Similarly**,** higher contribution of the stress at the root rather than at the tip is observed.

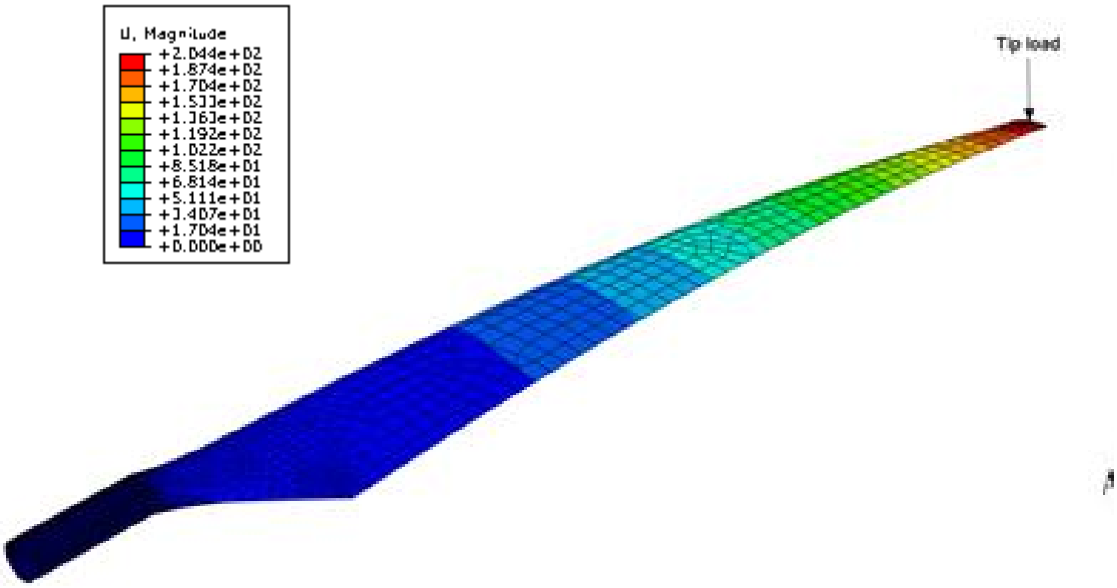

Figure 9. Displacement profile along the blade at isoview angle

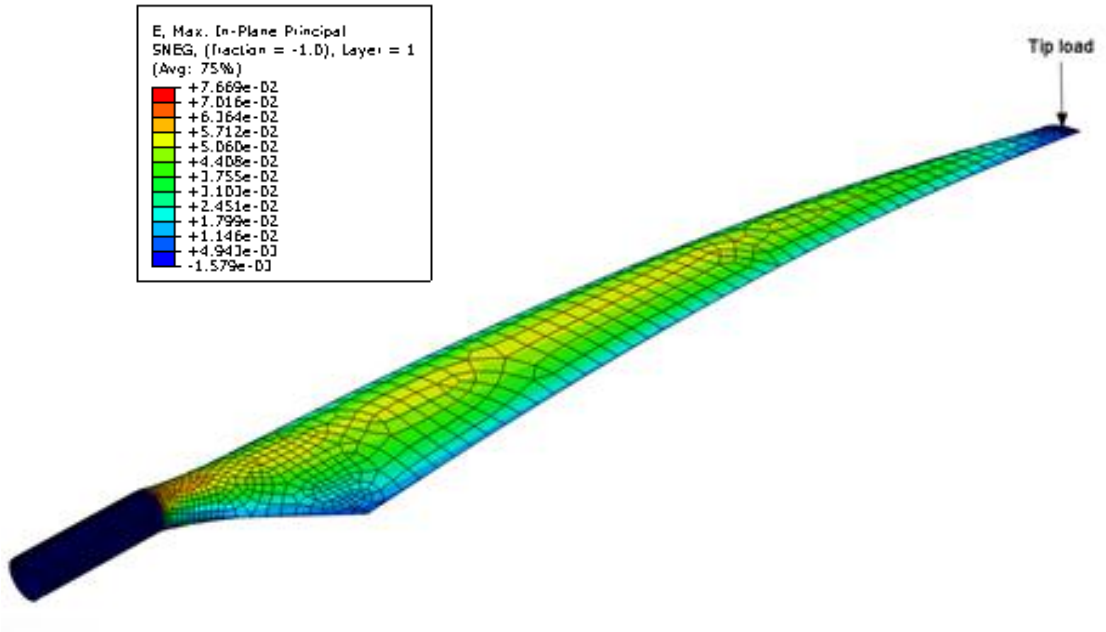

Figure 10. Strain pattern at isoview angle

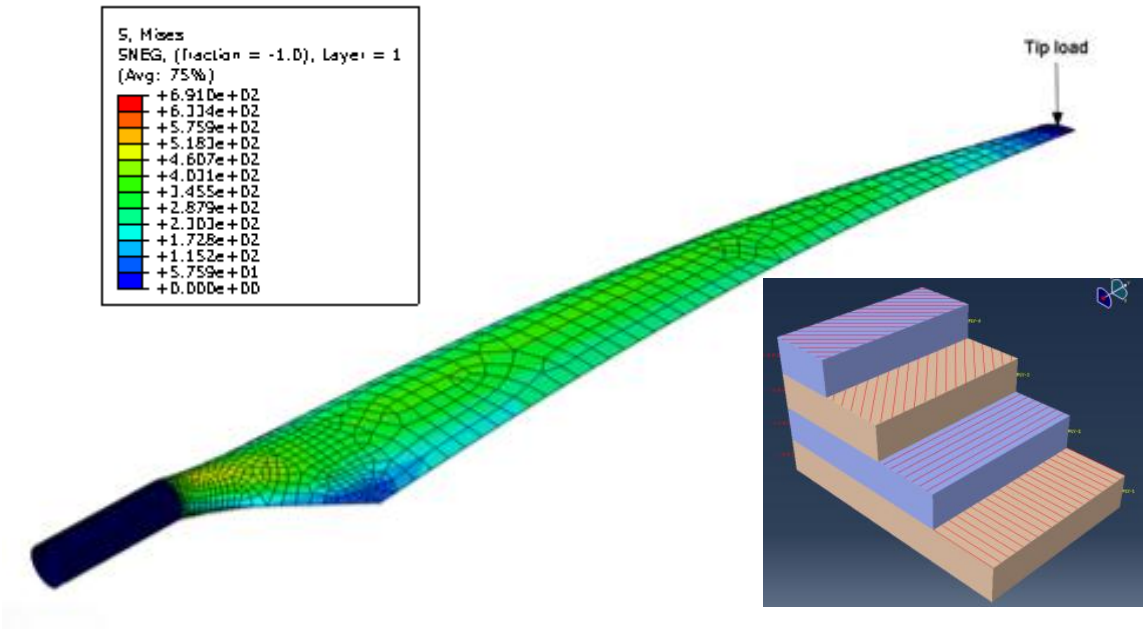

Figure 11. Stress pattern at isoview angle

NUMERICAL MODEL

A numerical model has been developed to analyse the deflection behavior of the graded GFRP (glass fibre reinforced plastic) beam, using Abaqus/Explicit 6.11code. The graded beam with the element type SC8R was modeled geometrically using the mechanical properties (Table 2) for the static loading as shown in Figure 12. Then the numerical modeling has been experimentally validated based on the cantilever beam as shown in Figure 13.

Table 2. Mechanical properties of GFRP

Glass Fibre Epoxy	**E-glass UD Kinetix R246TX**
E_1 (MPa)	34412
E_2 (MPa)	6531
V_{12} (MPa)	0.217
G_{12} (MPa)	2433
G_{13} (MPa)	1698
G_{23} (MPa)	2433
$\rho(kg/m^3)$	2000

In order to validate the result given by Abaqus, comparison on the tip deflection is made with Strand 7. Table 3 shows the comparison made on the tip deflection between Abaqusand Strand 7 deflection at the tip are 40.174mm and 41.271 mm respectively.About 2 % of percentage difference was discovered. However, in Figure 13 Abaqus was able to simulate nonlinear contour pattern variation particularly at the tip where the concentrated load is applied.

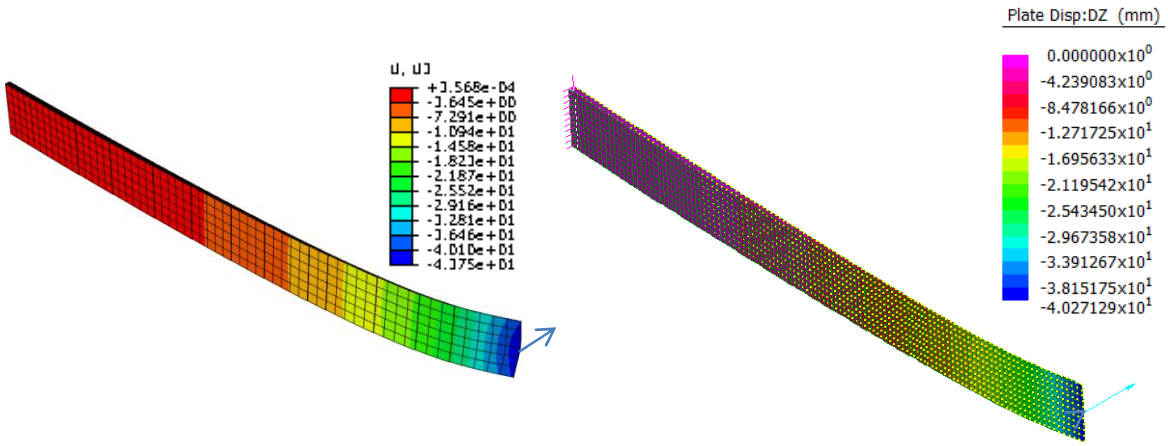

Figure 12. Deflection pattern using Abaqus (left) and Strand 7 (right)

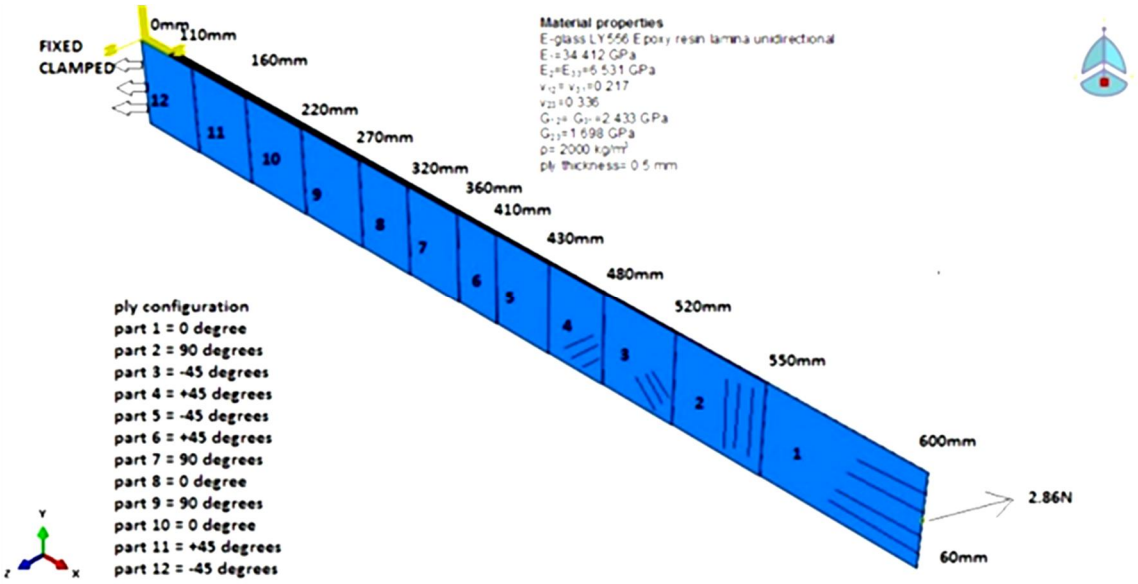

Figure 13. Graded GFRP beam model layout diagram

Table 3. Comparison of FEA

Simulation	Abaqus	Strand 7
Tip deflection (mm)	40.174	41.271

EXPERIMENTAL DESIGN

Specimens for Smart Structure Testing

The graded GFRP beam was fabricated in the CEEFC laboratory. Five samples have been experimentally tested in the cantilever beam and designated test rig has been used for deflection test as shown in Figure 14. The graded thin shell was fabricated using hand lay-up that consisted of a unidirectional E-glass fiber/epoxy composite laminated with the configuration lay-up of $[0^0/90^0/-45^0/+45^0/-45^0/+45^0/90^0/0^0/90^0/0^0/+45^0/-45^0]$ respectively with the lamina elastic material properties. In order to reduce shear load

bearing strength, the inner foam such as expanded polystyrene (EPS) has been tied constraint to GFRP laminate. Before experimental work is carried out the simulation was madeto predict the deflection of the panel. Figure 15 shows the model used in simulation is in agreement with the experimental work. Reasonable agreement was achieved between both methods. The current findings shows that by using EPS the blade deflection could be minimized by about 35 % in experimental whilst 39 % in FEA. To develop the SMA wire displacement, a test on the relationship of deformation with load applied with hot and cold wire has been experimentally carried out. The DC power supply model GW Instek GPC 1850D has been used to drive the current flow in SMA wire.

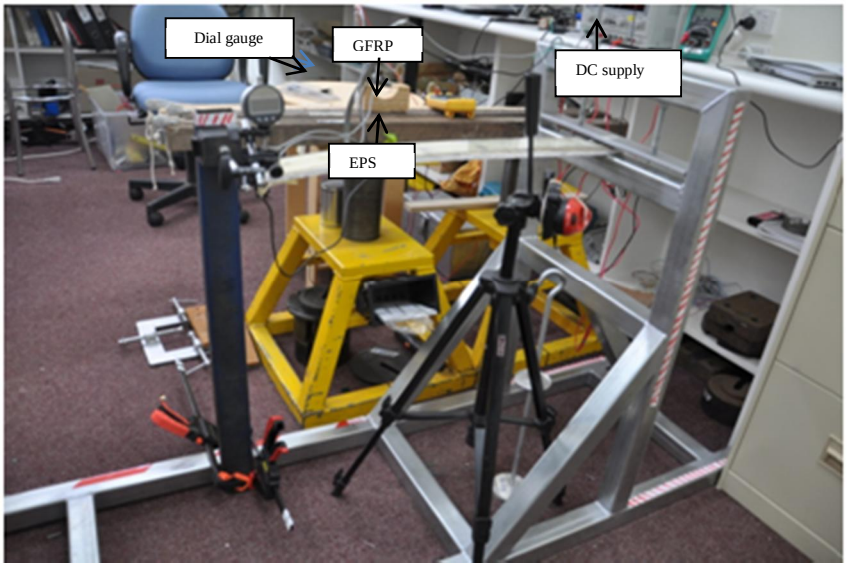

Figure 14. Experimental test rig

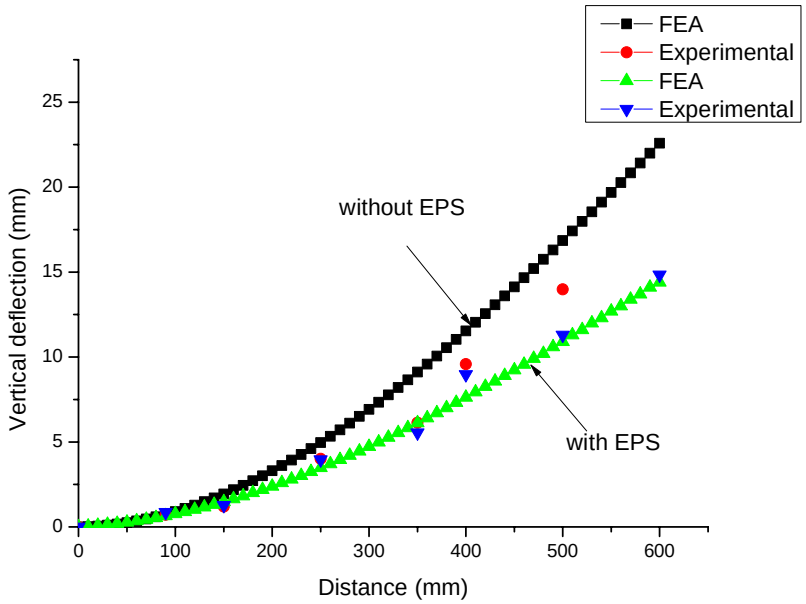

Figure 15. Comparison of vertical deflection between FEA and Experiment (with EPS/without EPS)

Figure 16 presents the experimental setup for the load test. The FlexinolSMA wire with diameter of 0.51 mm has been used for this purpose. It is expected that the deflection will be reduced as well as the SMA wire is embedded in the composite blade. At the early stage, load test has been carried out with the voltage supplied from the constant DC power supply unit at 5.50 V with current 2.2. Assuming the pulley is light, the rotational inertia is negligible. Moreover, no force is required to turn the frictionless pulley, so it can be assumed that the bearing of pulley is frictionless. Figure 17 shows the comparison of the load test wire with and without current being applied. It was estimated 2 mm of pulling force existed at different loads.

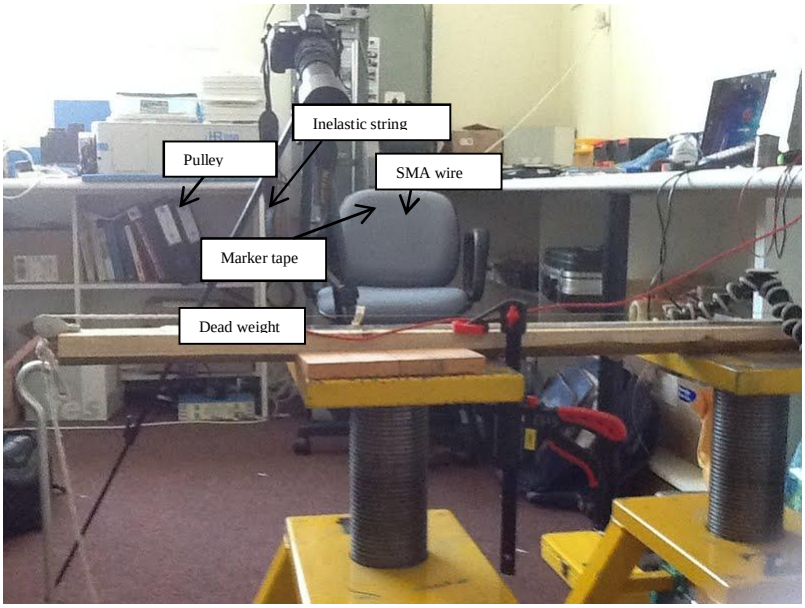

Figure 16. Experimental setup for the load test

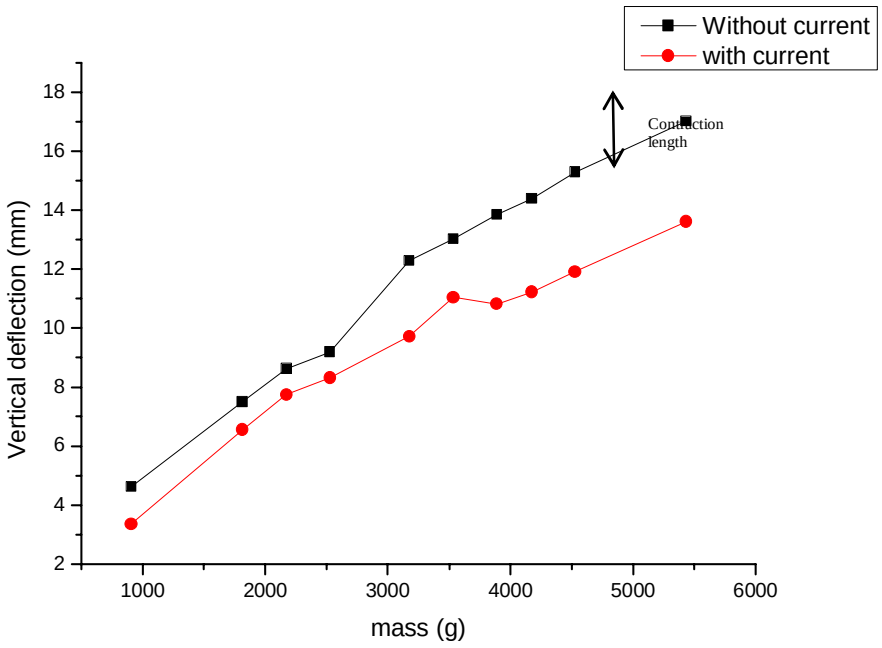

Figure 17. Load test of SMA wire

Table 4 shows the result of the pulling force of the SMA when current is applied. It has been observed in this test, the relationship of the current is proportional to the heat generated in the wire as well. Figure 18 shows the temperature relationship with the voltage applied. Temperature parameter is used to monitor the transformation and temperature lies in the range martensitic region. To determine the transformation temperature of the SMA, the DSC (direct scanning calorimeter) has been used as depicted in Figure 19. In this test, the critical deformation and shape recovery are explained according to the lattice parameters changes through a phase transformation between austenite and martensite and the characteristics of the crystal structure.

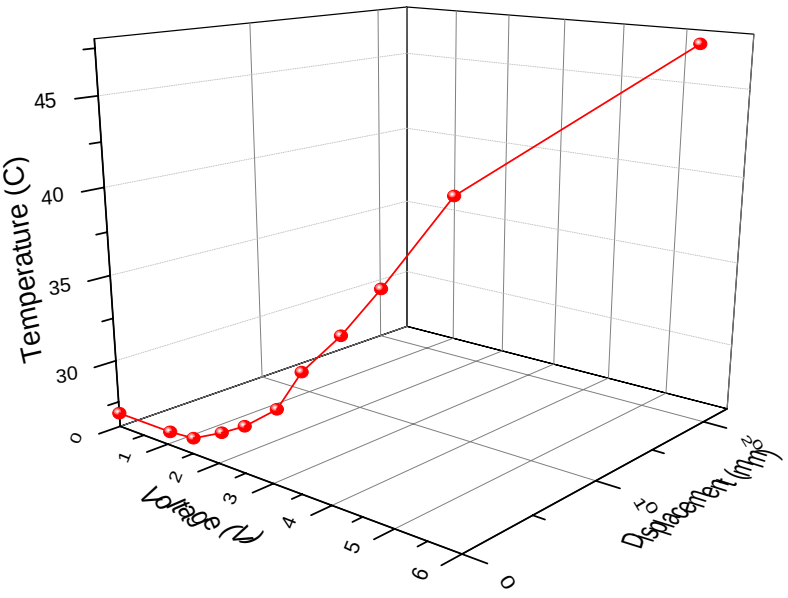

Figure 18. Relationship between the voltage, surface temperature and displacement

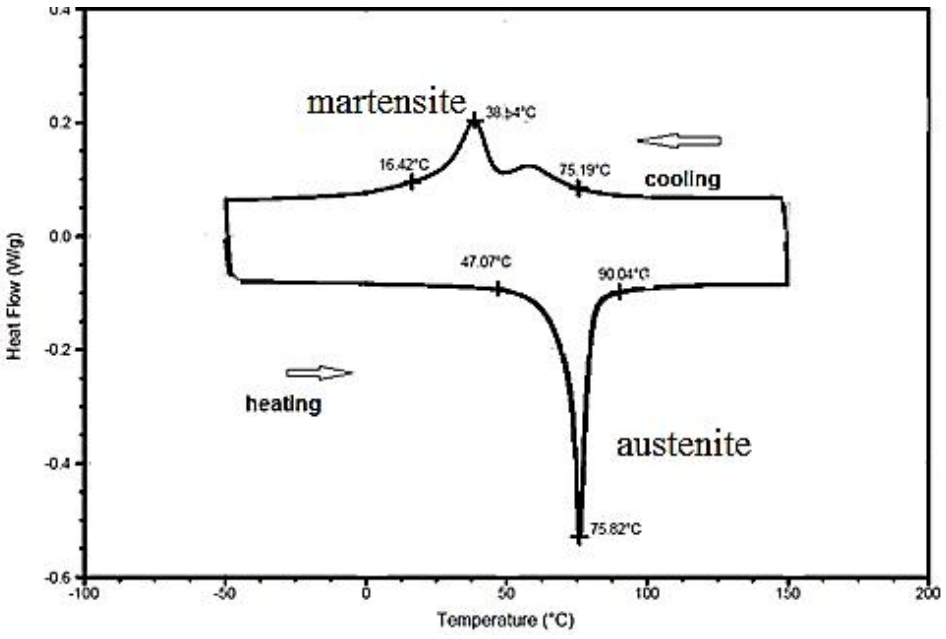

Figure 19. Transformation temperature of the SMA

Table 4. Pulling test load of 907g

Voltage (V)	Initial displacement (mm)	Final displacement (mm)	Distance change (mm)
1	15.99	15.99	0.00
2	15.99	15.90	0.09
3	15.99	15.53	0.46
4	15.99	14.36	1.63

Problem Encountered During Experiment

The NiTi will be embedded between the EPS and the FGRP composite panel which is parallel to neutral axis. The fabrication of the panel is illustrated in the Figure 20. Currently, the fabrication of SMA embedded on the sandwich panel has been ongoing. However, there is difficulty particularly in embedding the pre strain wire although the clamping device has been used. The turn buckle is used to pull the wire up to 4 percent pre-strain. In this arrangement, the NiTi embedded in fibres are free to move during the phase transformation process and also must resist degrading and destructing the graded composite blade when the actuation process takes place.

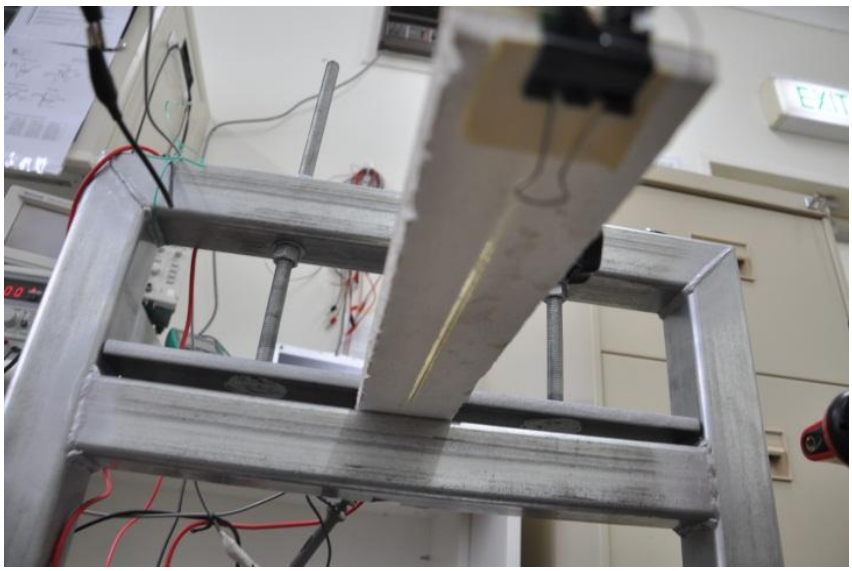

Figure 20. SMA fabrication with the burn EPS

CONCLUSION

The investigation of the deflection of the graded GFRP laminated with adhesively epoxy resin under concentrated loading is presented. Current findings and results of the numerical simulation and its correlation with experimental results have been discussed. Finite element analysis using Abaqus is able to predict satisfactorily deflection compared with the experimental works. Future works and problem encountered are also discussed. The SMA which is embedded in composite is expected to alleviate the deflection.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATION

GFRP : Glass fibre reinforced plastic
SMA : Shape memory alloy
FEA : Finite element analysis
NiTi : Nitinol
CEEFC: Centre of Excellence in Engineered Fibre Composites
UPM : Universiti Putra Malaysia
MOHE: Ministry of Higher Education
NACA : National Advisory Committee for Aeronautics
TSR : Tip speed ratio
C_p : Coefficient of power
EPS : Expanded polystyrene

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Editors: M.M. Noor, M.M. Rahman and J. Ismail

IMPROVED HYDROGEN STORAGE PERFORMANCE IN MGH_2 WITH CARBON NANOTUBES COMPOSITES

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ABSTRACT

Mg (MgH_2)-based composites using purified carbon nanotubes (CNTs) as catalysts were prepared by a high energy ball milling technique. The synthesized composites showed improved kinetics and thermodynamics in hydrogen storage performance, e.g. a significant increase of sorption rate and decrease in desorption temperature. The structure and morphology analysis provides the characteristics of the composites thus supporting the enhanced performance. The synthesized composites can absorb almost 6.0 wt% of hydrogen within 2 minutes at 200°C and desorb 6.5 wt% hydrogen in 20 minutes at 300°C. From the microstructural analysis it was found that the grain size effect is not responsible for the enhanced sorption property of the composites. The influence of CNTs on desorption temperature was also investigated by using temperature programmed desorption (TPD). The TPD results reveal that the peak desorption temperature and the onset temperature can be lowered by 58°C and 121°C respectively, compared to the non-catalyzed MgH_2. The enthalpy and entropy of hydrogen desorption for the synthesized MgH_2-based composites are calculated by the van't Hoff analysis and found to be 73.0 kJ/mol H_2 and 130.0 J/mol H_2·K, respectively.

Keywords: Hydrogen storage, magnesium hydride, carbon nanotubes, mechanical milling.

INTRODUCTION

The most efficient and safe mode of hydrogen storage for vehicular application is by making use of solid materials in hydrides form. In particular magnesium hydride (MgH_2 system) is the most promising storage material that possesses both high gravimetric (7.6 wt% of hydrogen) and volumetric (110 kg/m^3) densities besides its excellent reversibility as well as low cost completes the selections. However the major drawback in the practical application of such material is due to its sluggish hydrogenation /dehydrogenation kinetics as well as high operational temperature. This is attributed to the fact that magnesium has a very strong affinity to hydrogen and the decomposition enthalpy of bulk MgH_2 of about 75 kJ/mol H_2, which corresponds to a dehydriding temperature of 300°C at 1 bar (Stampfer et al., 1960)

Numerous works have been done to overcome the poor kinetics by introducing various additives to the magnesium hydride system. Utilizing carbon materials in hydrogen storage material has drawn interest amongst research groups and this topic

was recently reviewed in detail (Adelhelm & de Jongh, 2011; Wu & Cheng, 2010). The positive traits of single-walled carbon nanotubes (CNTs) in MgH_2 system are said not to alter the microstructure, instead it acts as a surface dispersant and/or 'hydrogen pumps' in the composites (Babak Shalchi et al., 2009). In this work the effect of incorporating CNTs as catalyst in the MgH_2 system was investigated specifically with different CNTs milling time.

EXPERIMENTAL

The MgH_2 solid storage material was prepared by employing Magnesium hydride (MgH_2, hydrogen storage grade-purchased from Sigma-Aldrich) and CNTs (prepared and purified in our lab). Ball milling of MgH_2 (M5) and MgH_2 + CNTs (Mcnt5) was performed by mechanically milling in a high energy SPEX 8000 vibration ball mill for 5 hours under argon atmosphere. A similar preparation method was conducted for shorter CNTs milling time (M3cnt2) in which CNTs was introduced in the last 2 hours to complete 5 hours of total milling time. The amount of the additives introduced to MgH_2 is 5wt% each and the ball to powder ratio was kept at 40:1 in all samples. All the sample handlings for all samples were performed in an Argon-filled glove box (MBraun) in which the water and oxygen levels were kept below 1 ppm.

The structure and morphology of the samples were characterized by X-ray diffraction (XRD, Rigaku) with Co Kα radiation at a scanning rate of 2°/min. Raman analysis was carried out using Nicolet Almega™ Visible Raman Spec equipped with a charge-coupled device (CCD) detector using a red laser with an excitation wavelength of 633 nm. All hydrogenation measurements of the milled powders were evaluated by using an automated Sieverts apparatus (Suzuki Shokan PCT H_2 Absorption Rig). Absorption and desorption tests were performed under an initial pressure of 2.0 MPa and 1 KPa at various temperatures respectively. Non isothermal hydrogen desorption of the re-hydrogenated samples was investigated by temperature programmed desorption (TPD) equipped with a thermal conduction detector. Argon was used as the carrier gas and all samples were subjected to a 5°C/min heating rate with 50 ml/min flow rate during the analysis.

RESULTS AND DISCUSSION

Structural Characterization

Figure 1 illustrates the XRD patterns of as-milled M5, M3cnt2 and Mcnt5. It is shown that no peak of CNTs can be observed in M3cnt2 and Mcnt5 and this clearly shows that CNTs are well incorporated in the prepared composites. All patterns show similar peaks with the main peaks matching β-MgH_2 (JCPDS-12-0697), and other peaks correspond to α- MgH_2 (JCPDS-35-1184) and MgO (JCPDS-65-0476). The presence of the orthorhombic α-phase is due to the alteration in the microstructure caused by the high energy ball milling (Schulz et al., 1999). The crystallite sizes of β-MgH_2 were estimated by the Scherrer equation according to the diffraction pattern, the results of which are tabulated in Table 1. It is shown that the grain sizes of β-MgH_2 for all samples are close to one another except for M5 having a grain size of 11.0 nm instead. This microscopic analysis shows that CNTs milling time did not affect the grain size of the composites and was thus not responsible for the different performances between them.

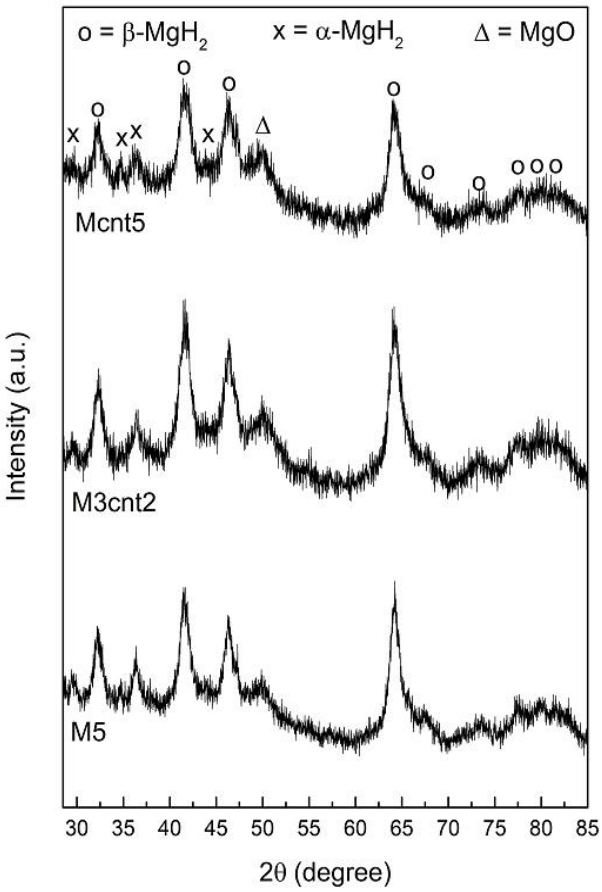

Figure 1. XRD pattern of Mcnt5, M3cnt2 and M5

Table 1. Grain size of β-MgH_2 in as-milled samples

Sample	β-MgH_2 grain size (nm)
M5	11.0
M3cnt2	10.0
Mcnt5	9.8

The Raman spectroscopy is an alternative method for analyzing the degree of damage of CNTs. There are two particularly important peaks in the range of 1300 to 1700 cm^{-1} of the spectrum which provides the finger print of carbon species. The peak located at around 1590 cm^{-1} corresponds to the tangential C-C stretching mode known as G band which is characteristic of graphitic structure in CNTs whereas the other peak around 1350 cm^{-1} designated as D band is assigned to the residual ill-organized graphite which is caused by impurities and defects on CNTs (Pierard et al., 2004). The relative intensity ratio of the D to the G bands , I_D/I_B, can be related to the structural characteristics of the carbon (Kastner et al., 1994). The ratio can provide information of CNTs structural defects. As the ratio increases it reflects the increase of the CNTs defect structure and the reduction degree of graphitization that occurred (Wang et al., 2004). Figure 2 presents the Raman spectra of magnesium hydride composites and CNTs. All samples containing CNTs show both G and D bands.

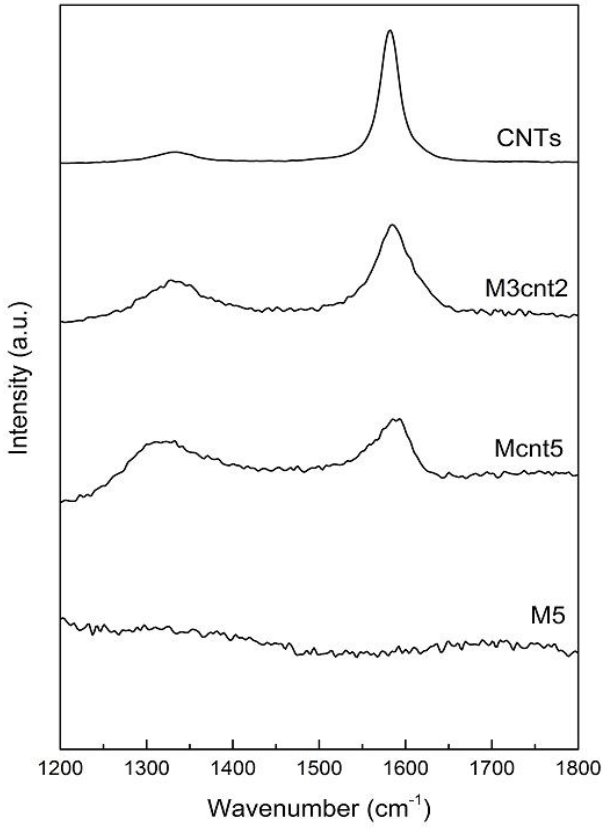

Figure 2. Raman spectra of CNTs and as-milled samples

Table 2 shows that I_D/I_B for M3cnt2 is less than Mcnt5 with a ratio of 0.79 and 0.92 respectively. It is clearly shown that milling the CNTs in 5 hours caused more damage in CNTs structure than the 2 hours milling time. Several reports have been published on the effect of ball milling on CNTs which also demonstrate that the planar structure is severely damaged during long periods of milling [6, 9, 10].

Table 2. I_D/I_G values of ball milled MgH_2 composites

Sample	**I_D/I_G**
M3cnt2	0.79
Mcnt5	0.92

Hydrogenation Performance

Figure 3 shows the absorption profile at 200°C for M5, M3cnt2 and Mcnt5. It clearly shows that CNT has provided a significant catalytic effect in hydrogenation compared to the non-catalyzed sample (M5). It is also shown that a shorter CNTs milling time enhanced the absorption of hydrogen in MgH_2. M3cnt2 absorbed 6.0 wt% of hydrogen in 2 minutes compared to 5.5 wt% by Mcnt5. This shows that the relatively more CNTs structure in M3cnt2 assisted the absorption of hydrogen thus improving the hydrogenation performance. Even at a lower absorption temperature of 150°C M3cnt2 it shows superior absorption performance similar to that at 200°C (Figure 4). It should be pointed out that the absorption performance was directly measured after an initial

desorption at 350°C without any pre-activation process. This excellent hydriding kinetics and high capacity are important for practical magnesium based hydrogen storage system. It is generally accepted that hydrogen diffusion in the magnesium hydride layer is rather sluggish, thus contributing to the slow hydrogenation rate. It was reported that CNTs provided additional diffusion channels for the diffusion of hydrogen atoms (Wu et al., 2005), as well as decreased the hydrogen diffusion barrier through C-Mg interaction (Du et al., 2006).

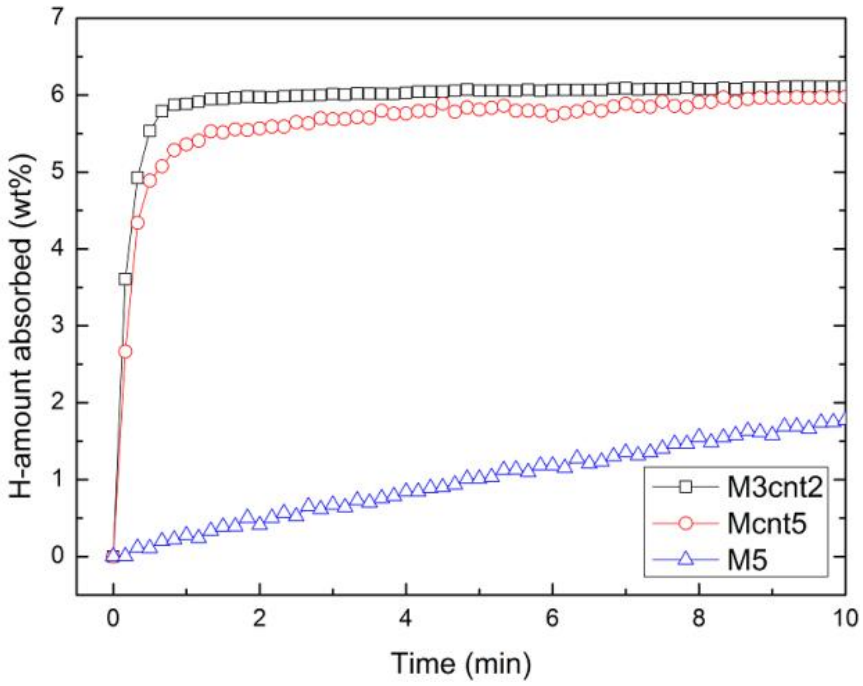

Figure 3. Hydrogen absorption as-milled samples at 200°C

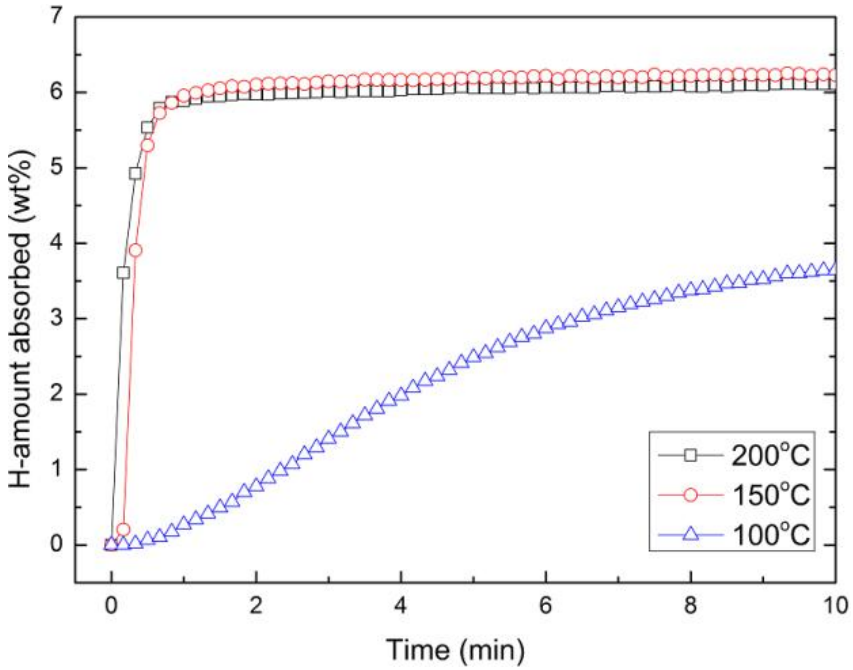

Figure 4. Hydrogen absorption of M3cnt2

Dehydrogenation Performance

Non-isothermal hydrogen desorption was investigated with TPD having argon as the carrier gas. Figure 5 illustrates the TPD profile of M5, M3cnt2 and Mcnt5. M5 exhibits the highest desorption peak temperature of 377°C, followed by M3cnt2 and Mcnt5 with peak temperatures of 319°C and 300°C respectively. It is also shown that adding CNTs may reduce the onset temperature of Mcnt5 and M3cnt2 to 180°C and 207°C respectively. Mcnt5 shows a broader peak compared to M3cnt2, implying that the availability of more CNTs structure in M3cnt2 assists the hydrogen desorption better than Mcnt5. To elucidate this observation, dehydrogenation rate measurements of these samples were characterized at 300°C and are shown in Figure 6. Both CNTs contained samples showing better desorption rates than non-catalyzed MgH_2. On top of that it is clearly illustrated that having a short 2 hours CNTs milling time, enhanced the desorption kinetics compared to a longer 5 hours CNTs milling time. This provides a direct relationship between CNTs structure availability and desorption performance.

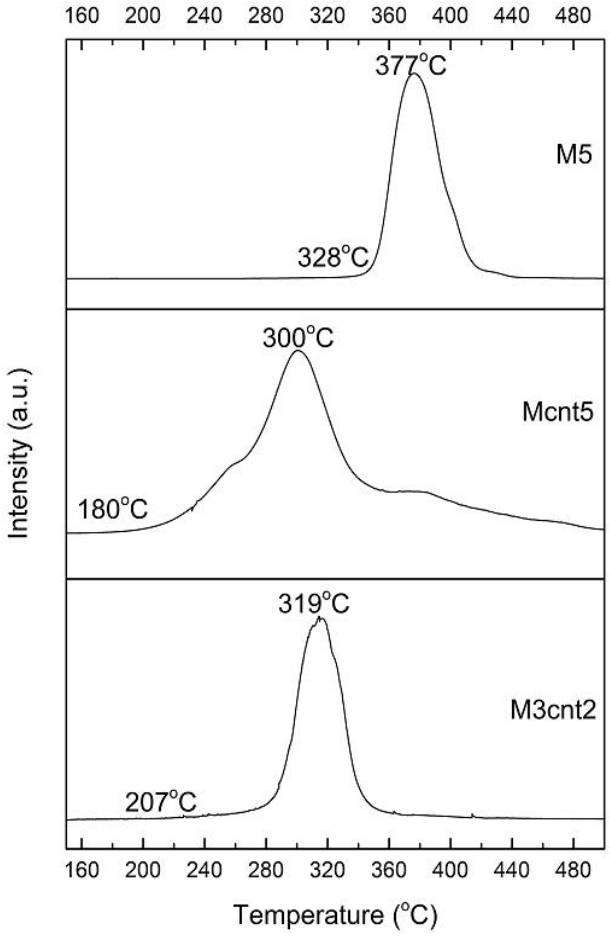

Figure 5. TPD profile of re-hydrogenated samples

A thermodynamic investigation was carried out to further clarify the outstanding observation in the TPD results. A similar technique adopted from Paskevicius et al. (2010) was used to find the equilibrium desorption pressure at 280°C, 260°C and 240°C for all samples. A van't Hoff plot was constructed by using the equilibrium data obtained and is shown in Figure 7. The decomposition enthalpy (ΔH) and entropy (ΔS)

are listed in Table 3. The effect of CNTs towards thermodynamic stability can be observed by the reduction of both enthalpy and entropy of M3cnt2 and Mcnt5 given as 72.9 kJ/mol H_2 and 130.0 J/K·mol H_2 and 73.0 kJ/mol H_2 and 130.3 J/K·mol H_2 respectively.

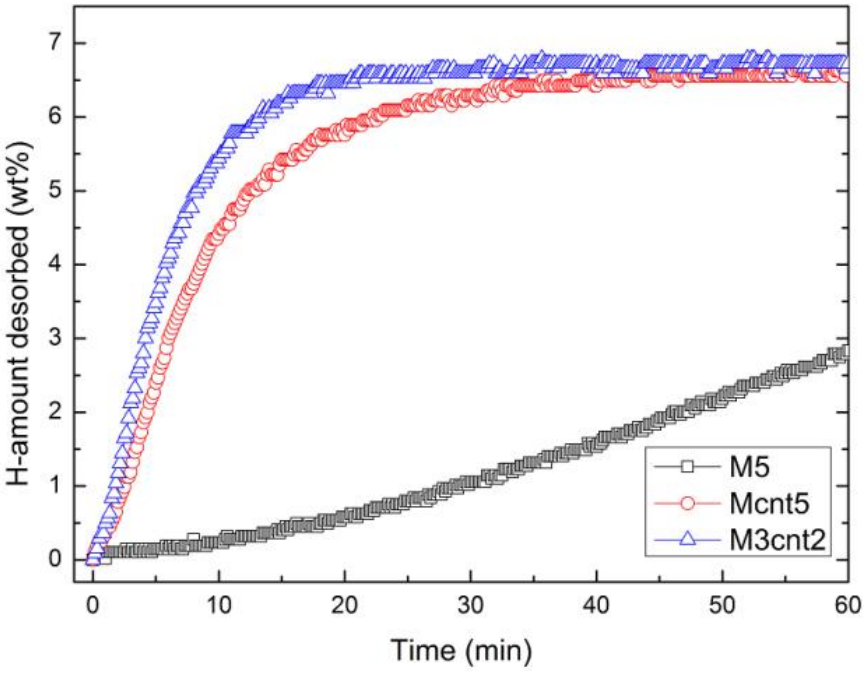

Figure 6. Hydrogen desorption of M5, Mcnt5 and M3cnt2 at 300°C

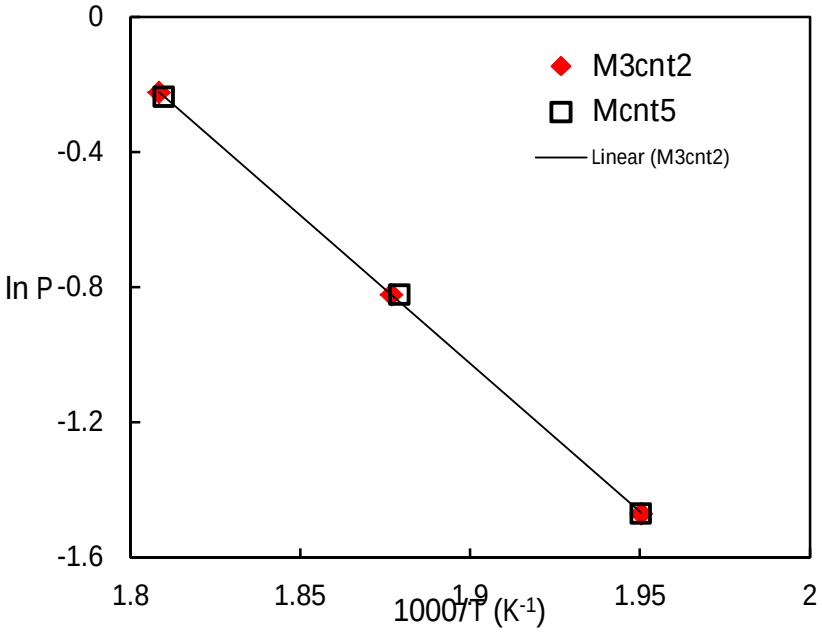

Figure 7. van't Hoff plot of M3cnt2 and Mcnt5

Table 3. Thermodynamic properties of MgH_2 composites

Sample	Desorption enthalpy (ΔH, kJ/mol H_2)	Desorption entropy (ΔS, J/K·mol H_2)
MgH_2[13]	78.5	140.0
Mcnt5	73.0	130.3
M3cnt2	72.9	130.0

It was reported that co-milling MgH_2 with CNTs will not alter the enthalpy of desorption (Amirkhiz et al., 2010). However in this study it was found that adding CNTs to MgH_2 reduces ΔH and ΔS further as low as 5.6 kJ/mol H_2 and 10 J/ K·mol H_2 respectively compared to commercial MgH2 (Shao et al., 2011). It should be noted that the different type of milling conditions (type of equipment used and milling time) may cause the difference in sample properties. As for CNTs milling time effect, it is observed that both samples give similar thermodynamic properties, thus implying that CNTs structure availability only improves the dehydrogenation kinetics rather than thermodynamics properties of the composites.

CONCLUSION

In this work, the effects of incorporating CNTs in magnesium hydride system by varying CNTs milling time were investigated. The sorption performance of the magnesium hydride system was further enhanced when CNTs were introduced to the system. With shorter CNTs milling time a remarkable effect was observed with a hydrogen absorption amount of 6.0 wt% in 2 minutes at 200^{o}C and a similar observation was found for a lower absorption temperature of 150°C. The dehydrogenation rate was also improved by a shorter CNTs milling time where 6.5 wt% of hydrogen was released in 20 minutes at 300°C. However CNTs milling time did not alter the thermodynamics properties of the composites. The grain size is not the primary factor in improving the sorption performance, instead the CNTs play a key role in enhancing the hydrogen sorption properties of the synthesized Mg-base composites by providing more diffusion channels for the hydrogenation /dehydrogenation process

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NOMENCLATURE

CNTs	carbon nanotubes
I_D/I_B	relative intensity ratio of the D to the G bands
TPD	temperature programmed desorption
ppm	part per million
ΔH	enthalpy, kJ/mol H_2
ΔS	entropy, J/K·mol H_2

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A PRELIMINARY STUDY OF CONTROL PARAMETERS FOR OPEN FURNACE MILD COMBUSTION USING CFD

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ABSTRACT

Pollution regulation and demand for efficient energy have driven the combustion community to work on combustion improvement. Moderate or Intense Low oxygen Dilution (MILD) combustion is one of the best alternative new technologies for clean and efficient combustion. MILD is proven to be a promising combustion technology for industrial applications. This paper studies the design stage for an open furnace with exhaust gas recirculation (EGR) captured from the flue gas. This study uses ANSYS Fluent to simulate and predict the parameters. The study started with 3D furnace with two EGR. Due to incorrect flow, modifications have been made to the EGR inlet and outlet. Finally 3D model with four EGR was developed and was successful in producing the desired flow in the EGR.

Keywords: MILD combustion, computational fluid dynamics, exhaust gas recirculation, turbulent, open furnace

INTRODUCTION

Energy supply for heating, cooking, transportation is one of the basic needs for mankind. Combustion of fossil fuel up to 2030 is projected to fulfil about 80% of world energy needs (Maczulak, 2010). Demand for reliable, efficient and clean energy is increasingly important with concerns over climate change and the reduction of pollution emissions from human activities (IEA, 2002, Jonathan, 2006, Pacala and Socolow, 2004, IPCC, 2007, Ghoniem, 2011). Climate change is the effect of rising concentrations of greenhouse gases. Carbon dioxide, nitrous oxide, chlorofluorocarbons and aerosols are the main greenhouse gases produced by human activities. Environmental issue and concerns are motivating factors for innovation in combustion technology employed in transportation and stationary power-generation applications.

Among fossil fuel, natural gas combustion is the most attractive since it produces less harm to the environment because it releases less carbon dioxide, nitrogen oxide, sulphur dioxide, particulate and mercury per unit energy compared to oil and coal (EIA, 1999). In 2009, the estimated natural gas reserves is 187.5 trillion cubic meters, which can supply up to $7x10^{15}$ MJ of energy, and the petroleum reserves can supply up to 1383 billion barrel which can supply $8.4x10^{15}$ MJ of energy [BP, 2010, 2011]. Table 1 show the comparison of pollutants for natural gas, oil and coal. The use of natural gas will reduce the impact of fossil fuel combustion on climate change. In order to reduce further on NO_x and other harmful pollutant, lean mixture will reduce the combustion temperature and reduce the formation of NO_x. Beside fuel NO_x and prompt NO_x, the thermal NO_x is the main NO_x formation will increase rapidly after the combustion temperature reach 1573 K (EPA, 1999) and 1810 K (AET, 2012). Figure 1 shows the formation of NO_x. In order to achieve the low NO_x emission and high thermal efficiency combustion, MILD combustion technology is the proper selection which will give low NO_x emission and high thermal efficiency combustion.

Table 1. Pollutant from fossil fuel (EIA, 1999)

No.	Pollutant	Gas	Oil	Coal
		(kg of pollutant per 109 kJ of energy input)		
1.	Carbon dioxide	273,780	383,760	486,720
2.	Carbon monoxide	94	77	487
3.	Nitrogen oxide	215	1,048	1,069
4.	Sulphur dioxide	2.34	2,625	6,063
5.	Particulate	16.4	197	6,420
6.	Mercury	0.00	0.016	0.037

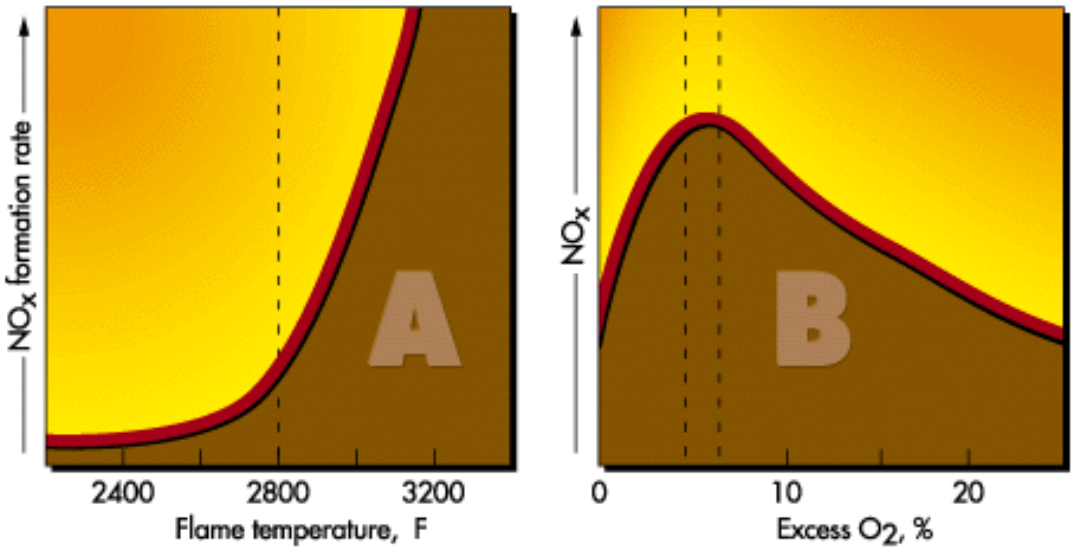

Figure 1. The rate of NO_x formation, (a) flame temperature in Fahrenheit (2800 F is equal to 1810 K) (b) percentage of oxygen level in the oxidiser (AET, 2012).

MILD combustion technology comes from the concept of excess enthalpy combustion (Hardestry and Weinberg, 1974). This combustion is also called flameless oxidation or FLOX (Wünning, 1991, 1996, Wünning and Wünning, 1997 and Milani and Wünning, 2007), low NOx injection (Orsino et al., 2001), Moderate or Intense Low-oxygen Dilution (MILD) combustion (Dally et al., 2002, Cavaliere and de Joannon, 2004, Christo and Dally, 2004) and high-temperature air combustion (HiTAC) (Katsuki and Hasegawa, 1998 and Tsuji et al., 2003). MILD combustion technology utilizes the heat and exhaust gas recirculation (EGR) or flue gas recirculation (FGR) to achieve stable low temperature combustion under a hot oxidant diluted condition. MILD combustion has been achieved experimentally (Dally et al., 2008, Li and Mi, 2010, Mi et al., 2010 and Li et al., 2010a, 2010b) and numerically (Scharler R and Obernberger, 2000, Giammartini et al., 2000, Awosope et al., 2006, Galletti et al., 2007, 2008, 2009, Mollica et al., 2009 and Szegö et al., 2003, 2009, 2010) in premixed and non-premixed combustion modes.

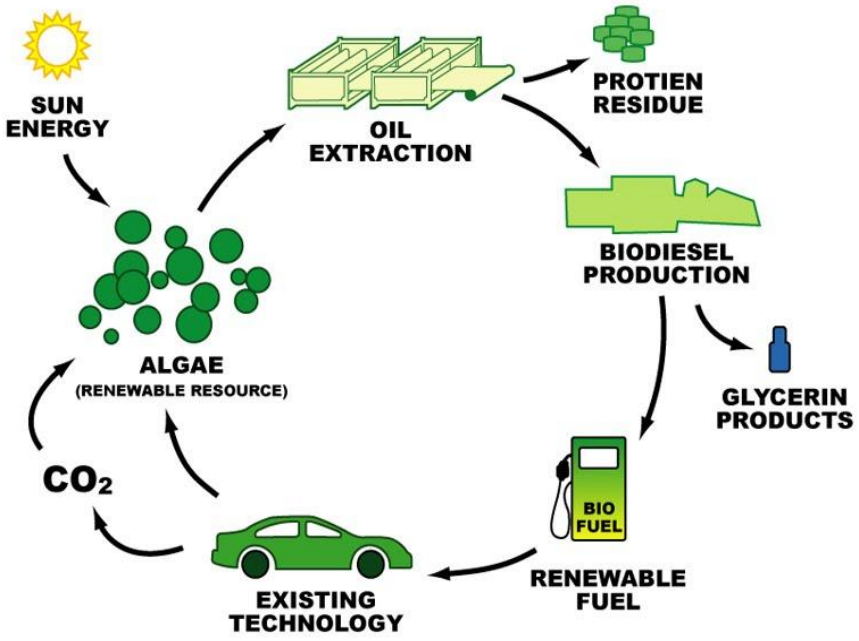

Figure 2. Carbon dioxide close cycle for biofuels (www.knol.google.com)

Beside NO_x emission and efficiency issue, another important issue in combustion is CO_2 emission which will also impact on greenhouse gasses (GHG) (Volk, 2008). Energy Information Administration (EIA, 2002, 2007 and 2011) reported that CO_2 emissions from combustion account for about 80% of anthropogenic GHG. In order to reduce CO_2 emissions, biogas will be the best alternative since biogas produced from biomass uses CO_2 in the photosynthesis stage; hence this will reduce the CO_2 in the atmosphere (Figure 2). The production of biofuels is normally based upon locally-available feedstocks including soybean, rapeseed, jatropha seed, palm oil, sunflower, cottonseed, tallow (animal fat) or even waste cooking oil. In the Australia and US, most

biofuels are derived from soy beans while in Europe rapeseed is the largest source. Biogas normally consist of about 50% methane with the heating value of 21MJ/Nm^3, the density is 1.22 kg/m^3, which is similar to air: 1.29 kg/m^3 (Al-Seadi et al. 2008). Biogas also suitable for the internal combustion engine (ICE) used. Huang and Crookes (1998) and Borjesson and Mattiasson (2008) studied the efficiency of biogas for ICE, Caresana et al. (2011) used it for energy production, Colorado et al (2010) and Effuggi et al. (2008) use for MILD furnace combustion. The computational work was carried out using Fluent 13.0 (ANSYS 2010) in a preliminary study of the control parameters for open furnace combustion. The parameters involved are air and fuel velocity injected, nozzle design, chamber design, EGR design and exhaust design. The purpose of the study is to analyse and optimise the parameters and predict the flame behaviour.

GOVERNING EQUATIONS

Fluid flow governing equations consists of continuity equation, density, enthalpy, temperature, species mass fraction, turbulent kinetic energy (k), turbulent dissipation rate (ε). For the axisymmetric flow in low Mach number (M < 0.3) (Rehm and Baum, 1978 and Majda and Sethian, 1985), the transport equations are: mass (the continuity equation)

$$\frac{\partial \rho}{\partial t} + \nabla . \rho U = 0 \tag{1}$$

Velocity

$$\frac{\partial \rho (u,u,w)^T}{\partial t} + (\nabla . \rho U u, \nabla . \rho U v, \nabla . \rho U w)^T + (-\frac{\rho w^2}{r}, \rho g, \frac{\rho u w}{r})^T = -\nabla \pi + \nabla . \tau \tag{2}$$

Enthalpy

$$\frac{\partial \rho h}{\partial t} + \nabla . \rho U = \nabla . \lambda_e \nabla T - \nabla . q_{rad} + \nabla . \sum_l \rho h_l(T) D_e \nabla m_l \tag{3}$$

Temperature

$$\rho c_\rho \frac{DT}{Dt} = \nabla . \lambda_e \nabla T - \nabla . \sum_l \rho h_l(T) D_e \nabla m_l - \rho \sum_l \frac{Dm_l}{Dt} h_l(T) \tag{4}$$

Species mass fraction

$$\frac{\partial \rho m_l}{\partial t} + \nabla . \rho U m_l = \nabla . D_e \rho \nabla m_l - R_l \tag{5}$$

The most common turbulent model is k-ε model (Jones and Launder, 1972, Launder and Sharma, 1974, Bardina et al., 1997 and Wilcox, 1998). The equation for turbulent kinetic energy (k) is (6) and turbulent dissipation rate (ε) is (7).

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_i}(\rho k u_i) = \frac{\partial}{\partial x_j}\left[(\mu + \frac{\mu_t}{\sigma_k})\frac{\partial k}{\partial x_j}\right] + P_k + P_b - \rho\epsilon - Y_M + S_k \quad (6)$$

$$\frac{\partial}{\partial t}(\rho \epsilon) + \frac{\partial}{\partial x_i}(\rho \epsilon u_i) = \frac{\partial}{\partial x_j}\left[(\mu + \frac{\mu_t}{\sigma_\epsilon})\frac{\partial \epsilon}{\partial x_j}\right] + C_{1\epsilon}\frac{\epsilon}{k}(P_k + C_{3\epsilon}P_b) - \rho C_{2\epsilon}\frac{\epsilon^2}{k} + S_\epsilon \quad (7)$$

where turbulent viscosity, $\mu_t = \rho C_\mu \frac{k^2}{\epsilon}$, production of k, $P_k = -\overline{\rho u_i' u_j'}\frac{\partial u_j}{\partial x_i}$, effect of buoyancy, $P_b = \beta g_i \frac{\mu_t}{Pr_t}\frac{\partial T}{\partial x_i}$ and $\beta = -\frac{1}{\rho}(\frac{\partial \rho}{\partial T})_p$. In the effect of buoyancy, g_i is the component of the gravitational vector in the ith direction and Pr is turbulent Prandtl number. Pr is 0.85 for the standard and realizable k-epsilon model. Other model constants are $C_{1\epsilon}, C_{2\epsilon}, C_{3\epsilon}, C_\mu, \sigma_k$and σ_ϵ.

The computational and simulation method to improve combustion process has been rapidly expanding over the last decade. Computational fluid dynamics (CFD) is an important tool to simulate and predict the behaviour of flame and all the parameters before the experimental work take place. CFD work will reduce the massive experimental cost especially during the beginning stage. Galletti et al. (2007) reported that recently the combustion and furnace industry shows the interest on CFD modeling. CFD may help in optimizing burners' performances such as injection nozzles and flue gas recirculation. CFD results must be validated with experimental work. Different scale of MILD combustion setups has been simulated using CFD software over the last decades (Danon, 2011). Turbulent flow is one of the important points in this study. Turbulent flow is needed for the oxidiser and fuel to mix before the combustion take place. Turbulent flow occurs at high Reynolds numbers and is a very complex process: even more complex when involved with combustion reaction or other chemical reaction. Tennekes and Lumley (1972) characterised the nature of the turbulence as irregularity, large Reynolds numbers, diffusivity, three-dimensional vorticity fluctuations and continuum phenomenon. Sensitivity to turbulence k-ε model (Jones and Launder, 1972, Launder and Sharma, 1974, Bardina et al. 1997 and Wilcox, 1998) was investigated but not reported in this paper. The model was initialised as follows, reference frame is relative to cell zone, gauge pressure is 0 Pa, x, y and z velocity are 0 m/s, turbulent kinetic energy is 16.8 m^2/s^2, turbulent dissipation rate is 40,751 m^2/s^3, pollutant NO, N_2O and HCN mass fraction is 0, Temperature is 600K, mean mass fraction is 0.5 and mixture fraction variance is 0.

RADIATION MODEL

The radiation model used in this work is Discrete Ordinate (DO) model (Chui and Raithby, 1993). Discrete ordinate model is applicable to a wide range of optical thicknesses. The optical thickness for MILD flames is not well defined or well known, making DO model seems like a good selection. The model solves a radiative transfer equation. The absorption coefficient used is weighted sum of gray gas model (WSGGM) which was conceptually developed by Hottel and Sarofim (1967) and used for spray combustion (Choi and Baek, 1996) and gas furnace (Liu et al. 1998). The

WSGGM is selected due to the reasonable compromise between the oversimplified gray gas model and a complete model.

CHEMICAL REACTION

The mass ratio of fuel and air was estimated by using the general equation of combustion (Equation 8). Assuming the combustion is using pure methane (CH_4) and air ($0.21O_2$ and $0.79N_2$), the general equation for hydrocarbon and air stoichiometric combustion is shown in equation (8) and the equation for methane and air combustion is shown in equation (9). From equation (9), the fuel to air ratio is 1:9.5. This ratio was used in early design stage for the air and fuel inlet and nozzle size (Table 2).

$$C_n H_m + \left(n + \frac{m}{4}\right)(O_2 + 3.76N_2) \rightarrow nCO_2 + \frac{m}{2}H_2O + 3.76\left(n + \frac{m}{4}\right)N_2 \quad (8)$$

$$CH_4 + (2)(O_2 + 3.76N_2) \rightarrow CO_2 + 2H_2O + 7.52N_2 \quad (9)$$

For more detailed stoichiometric combustion, equation for low calorific value (LCV) gas consists of 50% methane, 20% hydrogen and 30% carbon dioxide by mass fractions and EGR ratio is 50% is shown in equation (10) and (11).

$$(0.5CH_4 + 0.2H_2 + 0.3CO_2) + (1.1O_2 + 4.1N_2) + 1.0(0.8CO_2 + 1.2H_2O + 4.1N_4) \rightarrow 2.0(0.8CO_2 + 1.2H_2O + 4.1N_4) \quad (10)$$

$$(0.5CH_4 + 0.2H_2 + 0.3CO_2) + (1.1O_2 + 4.1N_2) + (0.8CO_2 + 1.2H_2O + 4.1N_4) \rightarrow (1.6CO_2 + 2.4H_2O + 8.2N_4) \quad (11)$$

RESULTS AND DISCUSSION

The computational work begin with normal combustion without EGR to check the combustion of LCV gas (biogas) consisting of 50% methane, 20% hydrogen and 30% carbon dioxide by mass fractions (Figure 3(a)). The gas enters the combustion chamber through 20 mm diameter fuel inlet at 40 m/s to 50 m/s into the combustion chamber. Air was injected at 80 to 100 m/s through an annulus gas inlet at the bottom of the chamber. The exhaust on the top of the combustion chamber is called stack. The stack consisting of damper acts as a stopper for the flue gas flow. If the damper was totally closed, the flue gas will not flow out of the chamber thru the stack. The damper can be adjusted to control the volume of flue gas flowing out from the chamber and flowing through into EGR pipe. A more detailed burner and chamber specification is shown in table 2. Once the combustion was stable, then two EGR pipes were added to the system to test the combustion with oxidiser diluted by flue gas through EGR (Figure 3(b) and 3(c)). At the beginning of the simulation, the EGR pipe was connected perpendicular and straight to the air inlet and exhaust outlet. Then a problem was encountered in the fluent, the fluid did not smoothly flow into the EGR pipe and out from the EGR pipe (Figure 3(b)). This is due to the hot flue gas flowing straight to the exhaust on the top of the chamber and

also the opening of the exhaust being very small. Improvement was made to the input of the EGR. The smooth corner to help the fluid flow into the EGR pipe was added (Figure 3(c)). The result was encouraging with the flow showing significant improvement. This method was then implemented at the EGR outlet at the bottom of the burner figure 4(b).

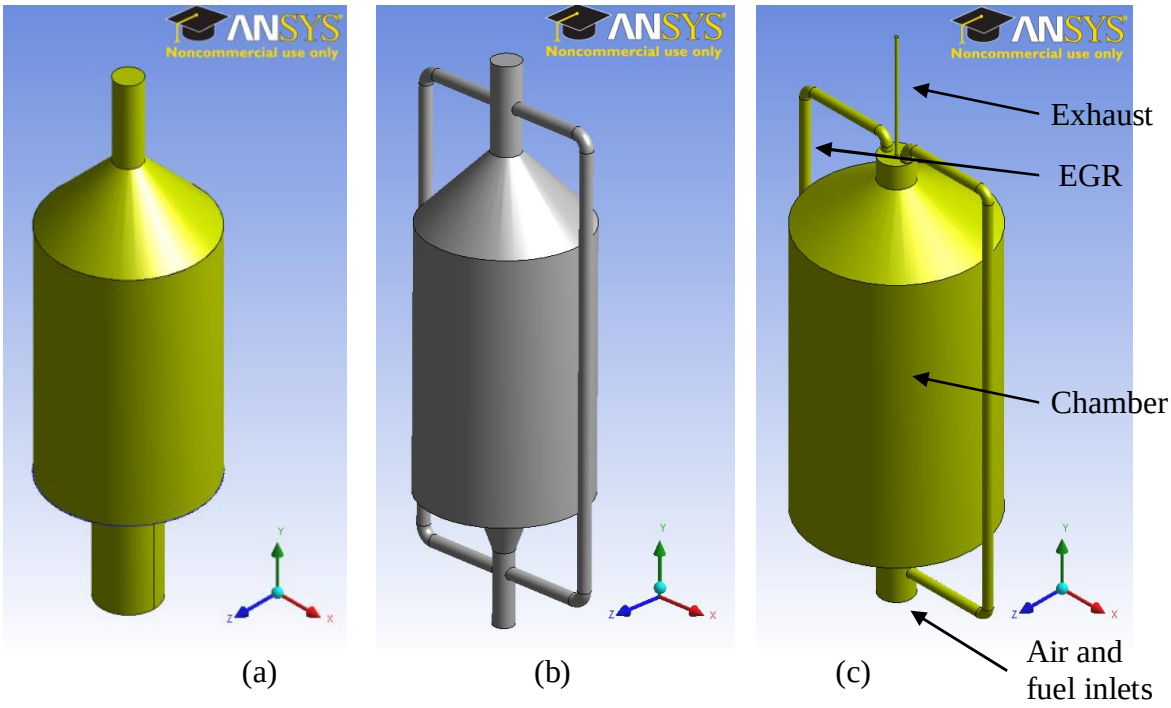

Figure 3. First combustion chamber model (a) No EGR (b) with 2 EGR pipe (c) with 2 EGR pipe and EGR inlet modified

Table 2. Typical data for furnace and burner in Figure 3(c)

Item	Data
Fuel	$0.5CH_4 + 0.2H_2 + 0.3CO_2$
Oxidiser	Atmospheric air, heated to 800 K
Fuel inlet	Round 1,256 mm^2, 40~50 m/s each
Air inlet	Annulus 5,140 mm^2, 80~100 m/s each
Chamber size	Diameter 375mm, Height 650mm
EGR	2 EGR with 386.9 mm^2 each inlet
Mesh method	Tetrahedrons (Patch conforming method) with 92,034 nodes and 421,172 elements
Radiation model	Discrete Ordinate (DO) model. Absorption coefficient: Weighted Sum of Gray Gas (WSGGM) model.

The next improvement was the addition of two more EGR pipes to become four. This new design can be seen in Figure 4. The gas entered the combustion chamber through four fuel inlet small pipes; each of them was 5 mm in diameter at 20 m/s to 40

m/s depending on the need for lean or rich combustion. The gas then flew through to the centre of the bluff body burner and jetted in through the bluff body burner with the annulus opening of 24.3 mm^2. Fresh air was injected at 80 to 100 m/s through 5 mm diameter at the side of each EGR pipe to induct the EGR to flow downward. The injected fresh air then mixed with the EGR gas. A more detailed burner and chamber specification is shown in Table 3.

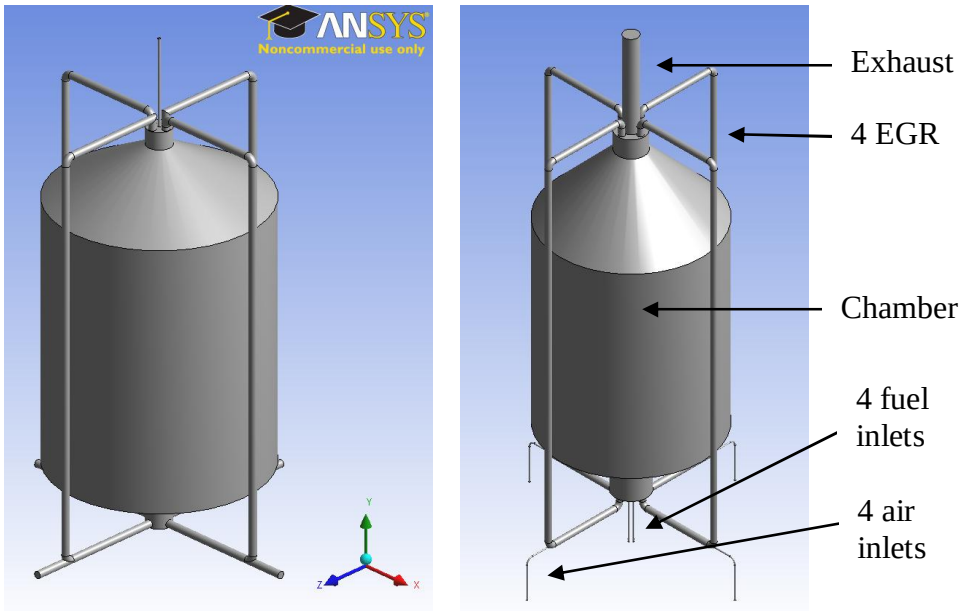

Figure 4. Final model with 4 EGR, (a) Air inlet internal diameter is 22 mm, (b) Air inlet internal diameter is 5 mm

Table 3. Typical data for furnace and burner in Figure 4(b)

Item	Data
Fuel	$0.5CH_4 + 0.2H_2 + 0.3CO_2$
Oxidiser	Atmospheric air, heated to 800 K
Fuel Inlet	4 x 19.6 mm^2, 20 m/s each
Air Inlet	4 x 19.6 mm^2, 80 m/s each
Chamber size	Diameter 600mm, Height 860mm
EGR	4 EGR with 386.9 mm^2 each inlet
Mesh method	Tetrahedrons (Patch conforming method) with 111,975 nodes and 501,831elements
Radiation model	Discrete Ordinate (DO) model. Absorption coefficient: Weighted Sum of Gray Gas (WSGGM) model.

After the computational testing and analysis, the bluff body burner with 24.3 mm^2 fuel inlet and 97.3 mm^2 oxidiser inlets was chosen. The maximum

temperature of the combustion is 1,540 K which is below the limit of the temperature for the rapid formation of NO_x. The temperature of the combustion zone is 1200 to 1540K (Figure 5). The inside wall temperature is about 750 to 800 K and the EGR flow is about 700 to 750 K. The flow for EGR is below 5 m/s since the opening for the chamber outlet is 176.6 mm^2. This opening is relatively big in size compared to the total inlet size of 486.8 mm^2. The ratio of inlet to outlet is 2.8. In order to increase this EGR flow, this opening can be reduced by increasing the EGR ratio. EGR ratio of 50% means half of the flue gas will flow back to the combustion chamber.

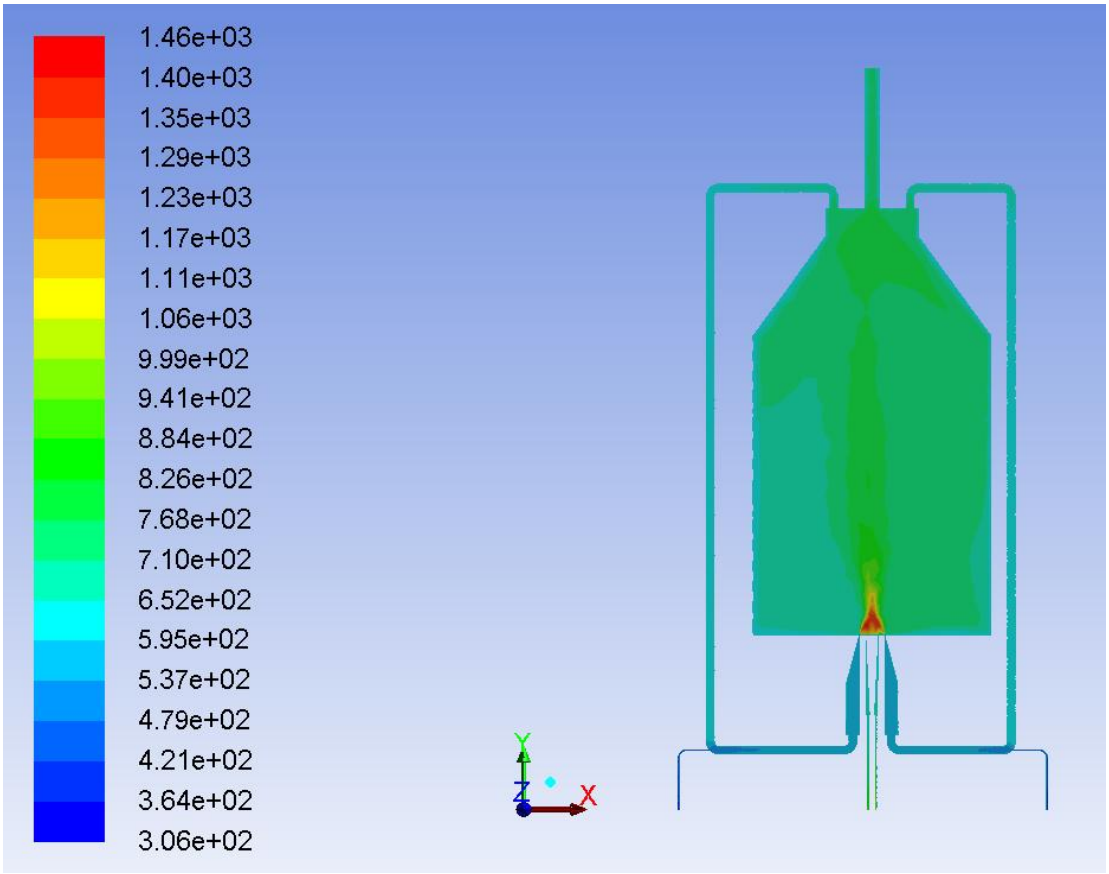

Figure 5. Combustion temperature in the chamber for Figure 4(b)

EGR flow is very important to achieve MILD combustion. Flue gas from the EGR will preheat the reactant and dilute the oxygen in the fresh air (Tsuji et al., 2003). The oxygen content in the oxidiser will be reduced from 21% to the required level. Figure 6 shows the velocity magnitude only showing the range of between -5.0 m/s to 5.0 m/s. The flow magnitudes are the highest at the centre of the chamber and dramatically reduce to very low speed far from the centre of the chamber.

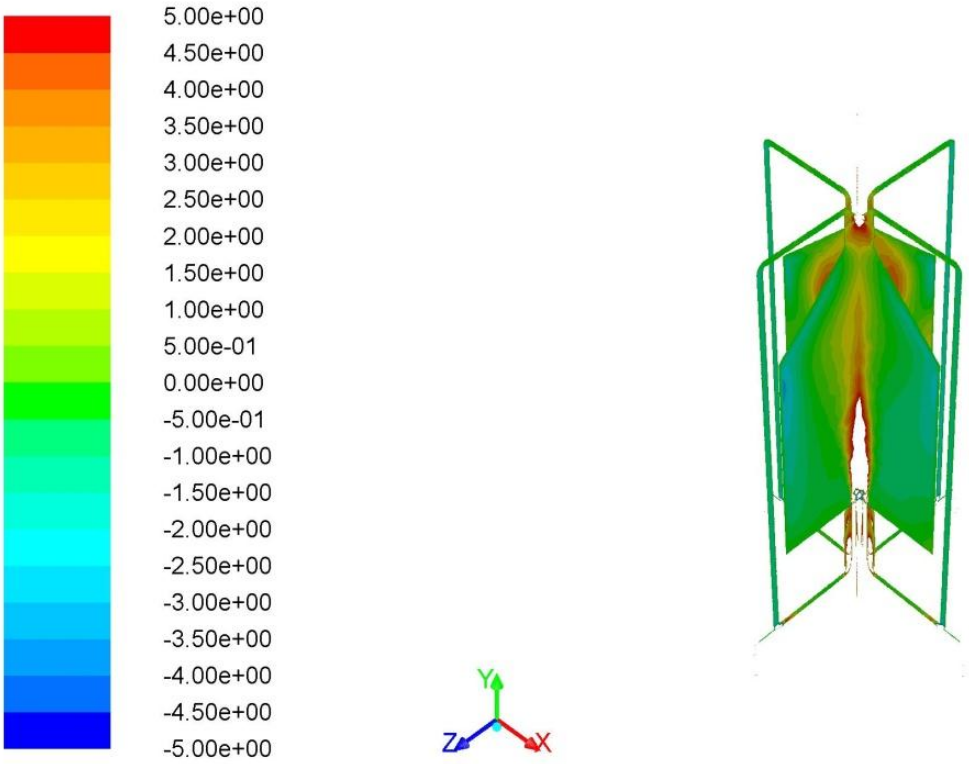

Figure 6. Velocity magnitude between -5.0 m/s to 5.0 m/s for figure 4(b) with gas inlet at 20 m/s and air inlet at 80 m/s.

There are four air inlets, one at each EGR. Every air inlet diameter is 5 mm with 100 m/s air velocity input. The total volume flow rate for the air is 7850 cm^3/s. If air is injected at 100 m/s and inlet diameter bigger than 5 mm, then EGR will flow in the reverse direction. The increase of inlet diameter or air velocity injected will increase the volume flow rate. If volume flow rate for the air inlet is higher than 7850 cm^3/s, EGR will flow upward instead of flowing downward. This is because the volume flow rate is higher than the allowed volume for the air nozzle at the combustion chamber. The air flow will reverse at the EGR pipe and this is an unwanted condition. Figure 7 shows the EGR flow in reverse direction. EGR should flow from top to bottom but the setting made the EGR flow in the reverse direction. Positive flow rate in Y direction means the flow is upward. Each EGR inlet is 379.9 mm^2 and the total for four EGR is 1519.8 mm^2. EGR should be flowing from top to bottom and mixed up with fresh air before combusting in the chamber. Figure 8 shows the correct flow of EGR. Negative flow rate in Y direction means the flow is downward. This flow can be achieved when the air inlet is control below 100 m/s for 5 mm air inlet.

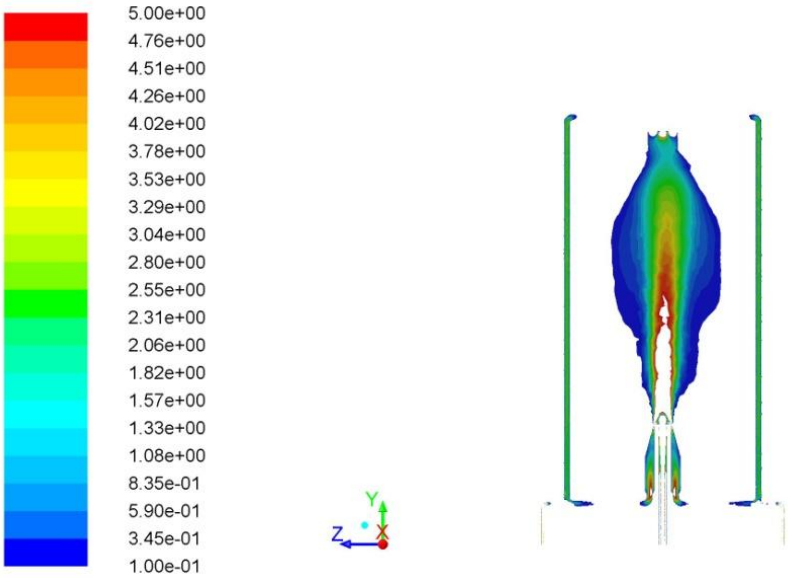

Figure 7. Velocity in Y direction between 5.0 m/s to 0.1 m/s for figure 4(b) with gas inlet at 40 m/s and air inlet at 120 m/s and EGR is reverse flow.

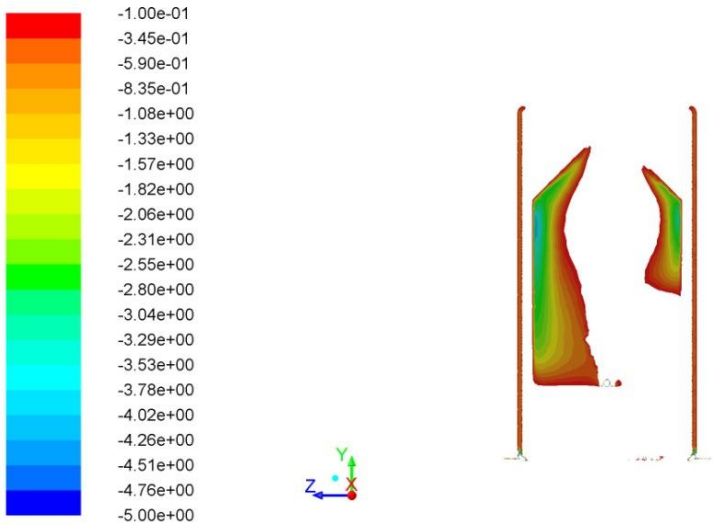

Figure 8. Velocity in Y direction between -0.1 m/s to -5.0 m/s for figure 4(b) with gas inlet at 20 m/s and air inlet at 80 m/s and EGR is correct flow.

CONCLUSION

The open furnace model was developed and numerically studied using FLUENT 13.0 to optimise parameters toward achieving MILD combustion in the chamber. The chamber design was finalised with four EGR pipes and the downward flow for flue gas was achieved. The LCV gas consisting of 50% methane, 20% hydrogen and 30% carbon dioxide by mass fractions was used in the study. The bluff body burner with 24.3 mm^2

fuel inlet and 97.3 mm^2 oxidiser inlet was chosen. From the CFD result, the temperature of the combustion zone is 1200 to 1500K and the temperature inside the wall chamber and EGR pipe flow is about 750 to 800 K. The flow for EGR is below 5 m/s since the opening for the chamber outlet is relatively big: 15 mm in diameter. This EGR flow rate can be increased by reducing the exhaust flow rate.

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NOMENCLATURE

CCS	Carbon capture and storage
CFD	Computational fluid dynamics
CO	Carbon monoxide
CO_2	Carbon dioxide
EGR	Exhaust gas recirculation
FGR	Flue gas recirculation
GHG	Greenhouse-gas
H_2O_2	Hydrogen peroxide
HC	Hydrocarbon
HTOC	High temperature combustion
IEA	International Energy Agency
LCV	Low calorific value
NO_x	Nitrogen oxides
OH	Hydroxyl
SO_x	Sulphur oxides
UHC	Unburned hydrocarbons

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MODAL ANALYSIS OF HIGH FREQUENCY ACOUSTIC SIGNAL APPROACH FOR PROGRESSIVE FAILURE MONITORING IN THIN COMPOSITE PLATES

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ABSTRACT

During the past few decades, many successful research works have evidently shown remarkable capability of Acoustic Emission (AE) for early damage detection of composite materials. Modal Analysis of AE signals or Modal Acoustic Emission (MAE) offers a better theoretical background for acoustic emission analysis which is necessary to get more qualitative and quantitative result. In this paper, the application of MAE concept in a single channel AE source location detection method for failure characterization and monitoring in thin composite plates was presented. Single channel AE source location is one of the recent studies for composite early damage localization, owing to the growing interest and knowledge of modal analysis of AE wave. A tensile test was conducted for glass fiber epoxy resin specimen with small notch. A single channel of AE system was used to determine the AE source location on specimen under testing. The results revealed that AE single channel source location provides reasonable accuracy for glass fiber laminate which was tested.

***Keywords*:** Modal acoustic emission, time frequency analysis, composite plates.

INTRODUCTION

Acoustic emission (AE), one of the non-destructive testing techniques, is increasingly popular in the last few decades, especially in the health monitoring of structures such as buildings, bridges, wind turbines and transport vehicles. This technique is established today owing to its ability to reveal in advance of any impending failure of a building structure, but more than that, this non destructive method can be done online or offline. AE can be defined as a high frequency acoustic signals that are released when material is under stress or strained (Shull, 2002). In general, AE technique performs well and is able to give accurate and consistent result for metallic structures. However, in composites, the challenge for a reliable AE results is huge due to the anisotropic behavior of the materials. Several studies have been done to investigate the potential of AE technique for health monitoring of composite structures and are becoming more quantitative leading to more general result instead of case specific (Scholey et al., 2010).

Accurate source location determination in composite plates is still a major issue due to its complex structure and wave propagation behavior. Location detection is very

important especially when monitoring the progressive failure inside the composite laminates. Accurate location observing can give the precise information on the crack velocity, size of delamination and its orientation and many more. For this purpose, the calculation of effective wave propagation velocity is critical since it will affect the accuracy of arrival time determination at each AE sensors. In commercial application, effective wave velocity is calculated manually using standard Hsu-Nielsen source location test with a known distance. This step though suitable for isotropic materials, can be eliminated with the calculation of effective group velocity in modal analysis of acoustic emission signals (Jing-Pin et al., 2006; Oskouei and Ahmadi, 2008).

Nowadays, owing to the recent advances in signal processing algorithms and assimilation of AE theory for plate-like structures (Morscher, 1999; Wevers, 1999) modal analysis of AE signals or Modal Acoustic Emission (MAE) offers a better theoretical background for acoustic emission analysis. The MAE treats the AE signals as the mechanical waves which propagate through a structure in a variety of modes and have the characteristics of dispersion and attenuation. Analyzing these different modes of AE signals will give more accurate result of source location detection (Jing-Pin et al., 2006; Jing-pin et al., 2008). Accurate wave group velocity value can be easily calculated through dispersion curve and can be used in AE source location detection algorithm (Jing-pin et al., 2004; Oskouei and Ahmadi, 2008). Also, with the appropriate time frequency analysis such as wavelet transform or short time Fourier transform the source location can be done will lesser number of sensors (Jing-Pin et al., 2004). The dispersion curves are derived from Lamb's characteristic equation (Lam et al., 2009),

$$\frac{\tan(\beta d/2)}{\tan(\alpha d/2)} = -\frac{4\alpha\beta k^2}{(k^2-\beta^2)^2} \quad \text{for symmetric modes} \qquad (1)$$

and

$$\frac{\tan(\beta d/2)}{\tan(\alpha d/2)} = -\frac{(k^2-\beta^2)^2}{4\alpha\beta k^2} \quad \text{for asymmetric modes} \qquad (2)$$

where $\alpha = \sqrt{\frac{\omega^2}{c_L^2} - k^2}$, $\beta = \sqrt{\frac{\omega^2}{c_T^2} - k^2}$ and $k = \omega/c_p$. The parameters d, ω, k, c_p, c_l and c_t are the plate thickness, angular frequency, wave number, phase velocity, longitudinal wave velocity and transverse wave velocity respectively. The relation between the group velocity (c_g) and phase velocity (c_p) is (Wevers, 1999),

$$c_g = \frac{dkc_p}{dk} = c_p + k\frac{dc_p}{dk} \qquad (3)$$

Figure 1 and Figure 2 show the dispersion curves generated for 28.7 cm × 2.5 cm fiberglass epoxy resin plate with density value 1559 kg/m^3 and thickness 2.64 mm. It is observed that, when frequency excited is smaller than 400 kHz, only fundamental modes; S_o (Symmetric) and A_o (Asymmetric) are exist. This article reports the use of modal analysis of AE theory for thin composite plates, in particular for location detection purpose. Instead of pencil break test, a tensile test was used in this study to produce similar AE signal as in real application.

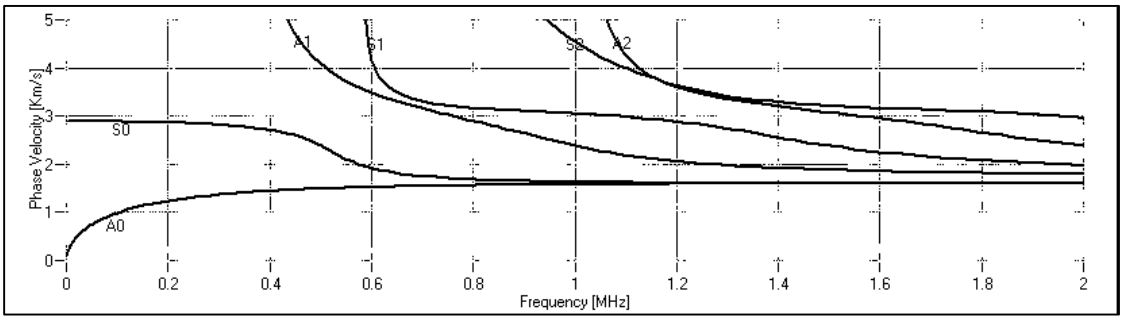

Figure 1. Phase velocity dispersion curves

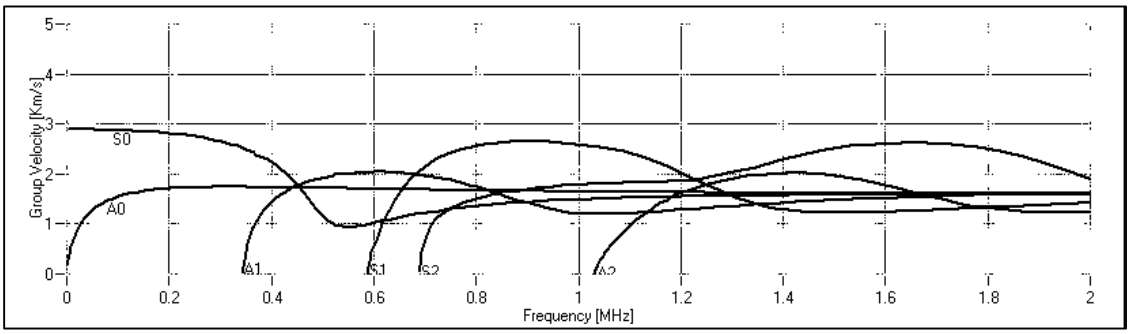

Figure 2. Group velocity dispersion curves

EXPERIMENTATION

A standard tensile test (ASTM, D3039/D3039M) was carried out on a 28.7 cm × 2.5 cm fiberglass epoxy resin plate and thickness 2.64 mm. The unidirectional laminate with stacking sequence [0º] was fabricated using the hand lay-up method. An artificial notch with approximately 3 mm length was created and located 7.5 cm from sensor to initiate crack and AE activity. The experimental set-up was as shown in Figure 3. Two piezoelectric sensors were coupled to the surface of the plate which were placed 15 cm apart from each other. The sensors were individually connected to two PAC AE Node Systems (data acquisition from Physical Acoustic Corporation) for waveform acquisition and were synchronized with the help of *AE Win* software. All the acquired signals were analogue filtered to the range of 20 kHz – 200 kHz. The sampling rate for acquisition was set to 5 Mega sample per second and threshold was set to 45 dB. In the *AE Win* software, the first time threshold crossing (FTC) was chosen for the source location detection. All acquired waveforms were stored in computer for further analysis.

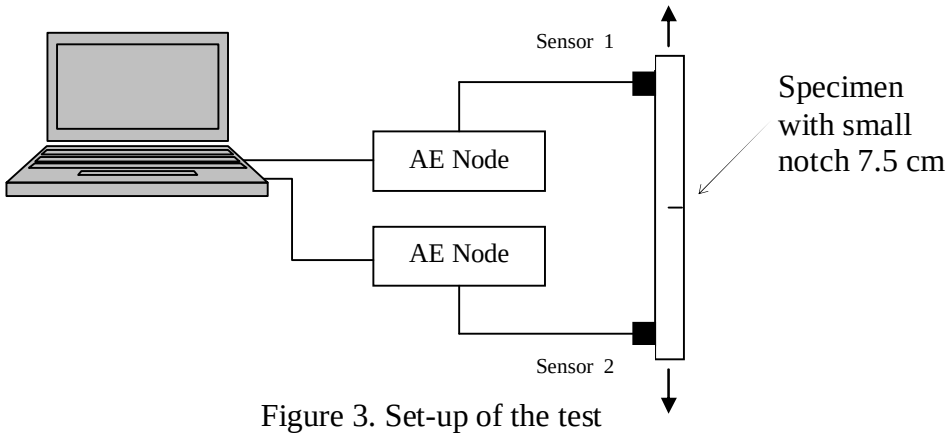

Figure 3. Set-up of the test

RESULTS AND DISCUSSION

AE system successfully captured a few very powerful AE signals at the beginning of cracking process at notch area, during 30 percent of strain (approximate). A lot of AE signals appeared later of more than 70 dB and located scatter around the notch area as shown in Figure 4. Figure 5 and Figure 6 show the typical AE waveform and its amplitude spectrums at the source point. Two peak frequencies appeared indicating the existent of two modes of wave, extensional and flexural wave modes. The different arrival time of both wave modes can be used for single channel location detection.

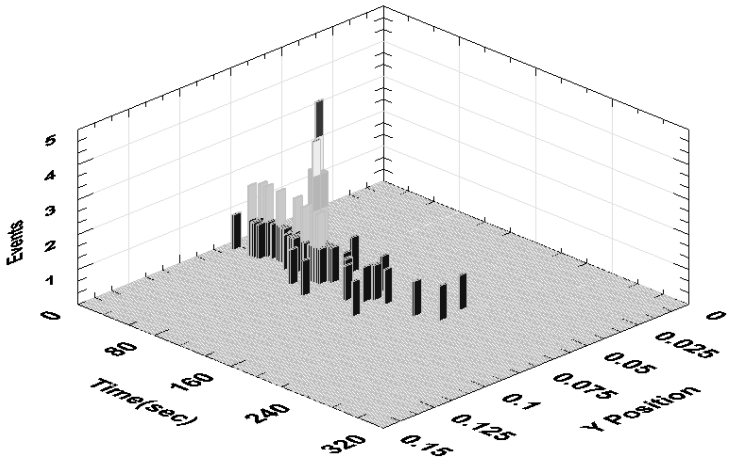

Figure 4. AE events at crack location; near notch.

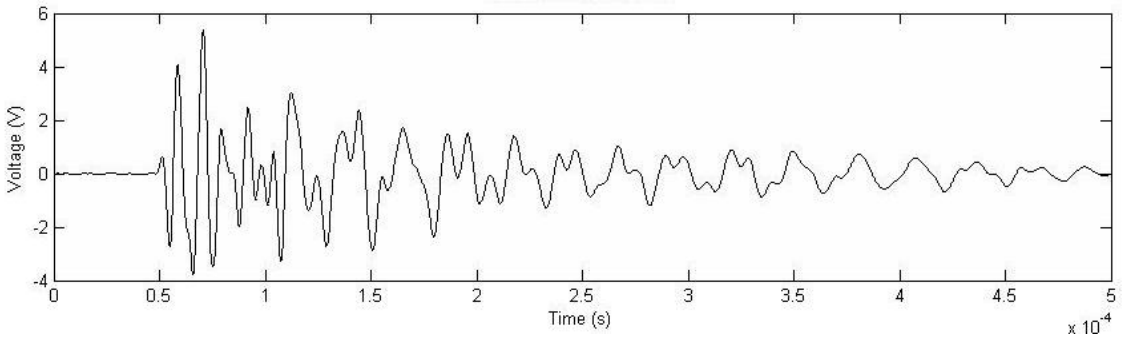

Figure 5. Waveform from sensor 2

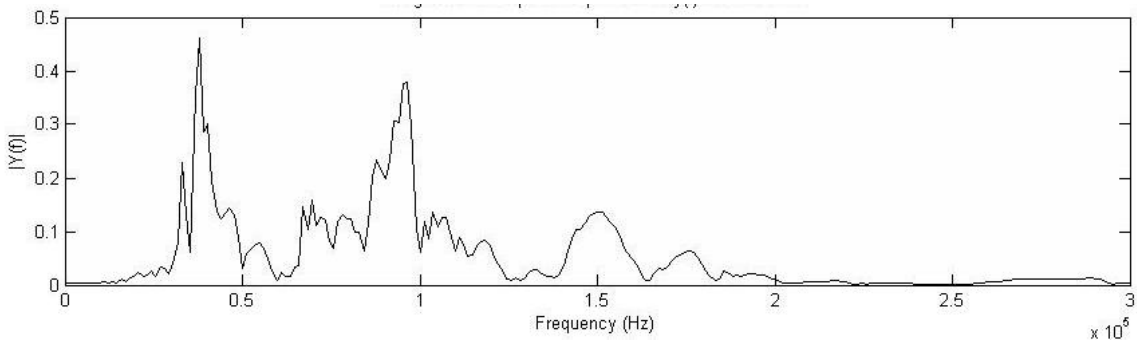

Figure 6. Amplitude spectrum of AE signal in Figure 5 (above)

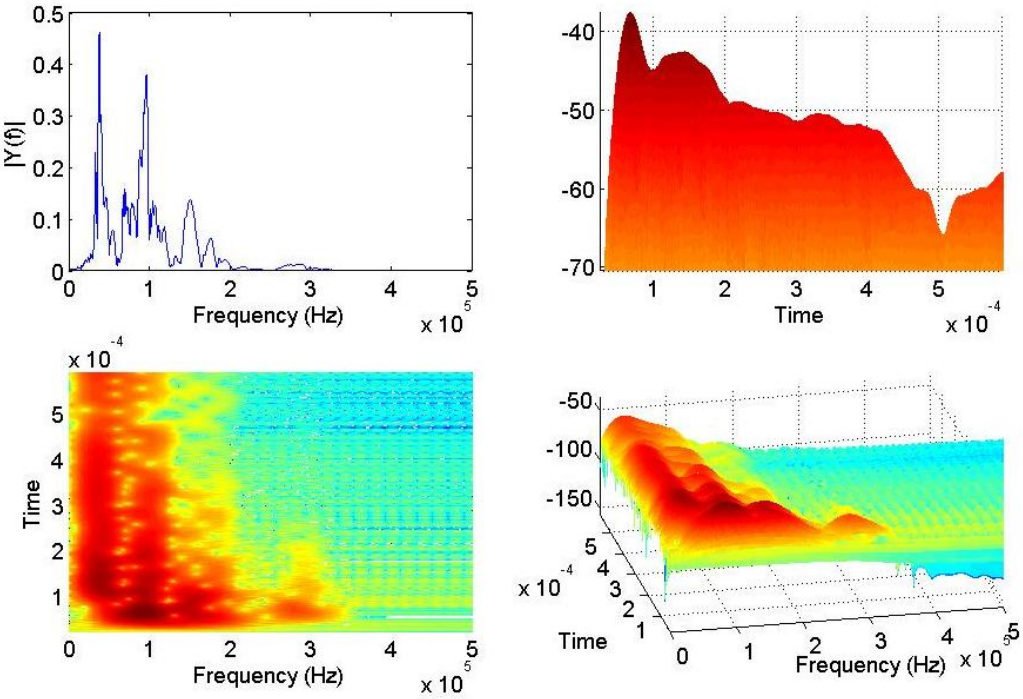

Figure 7. STFT analysis

Further analysis using Short Time Fourier Transform (STFT) was done for the waveform acquired from Sensor 2 (Figure 5). STFT successfully displayed the arrival time of each frequency band in the waveform spectrum as shown in Figure 7. By calculating the time arrival of two peak frequency from dispersion curve (Figure 2); 37 kHz (flexural wave, A_o) and 100 kHz (extensional wave, S_o) and each corresponding group velocities, the location of AE source can be predicted. According to Jing-pin et al. (2004) the distance from AE source to Sensor 2, l_2 can be calculated as,

$$l_2 = \frac{t(f_A) - t(f_S)}{[c_g(f_A)]^{-1} - [c_g(f_S)]^{-1}} \tag{4}$$

where $c_g(f_A)$ and $c_g(f_S)$ are the group velocities of frequency at A_o and S_o modes and $t(f_A)$ and $t(f_S)$ are the arrival time of frequency at A_o and S_o modes to Sensor 2.

From STFT analysis, the arrival time for A_o and S_o wave modes were 0.1136 ms and 0.0688 ms, respectively. Meanwhile, based on the group velocity dispersion curve, the wave velocity for A_o and S_o wave modes were 1160 ms^{-1} and 2870 ms^{-1}, respectively. Therefore the distance between source location and Sensor 2 can be determined using Eq. (4). The result is 8.7 cm; 12 % or 1.2 cm error compared to actual location (7.5 cm). Note that the error can be decreased if Continuous Wavelet Transform (CWT) analysis was used instead of STFT. CWT performs better time and frequency resolution compared to STFT thus can lead to more accurate result (Hamstad et al., 2002).

CONCLUSION

The experimental evaluation of modal analysis of acoustic emission has been presented. Instead of performing standard pencil break test of the composite plate as artificial source for AE signals, this study used the tensile test for specimen with small notch which closer to replicate the real application. The application of single channel source location detection was presented. A random sample of waveform was chosen for time-frequency analysis and has performed promising result. Although the error was more than 10%, it is believed that if using the Wavelet analysis, the result will be more accurate. It can be concluded that the MAE is an effective tool for source location prediction. As mentioned earlier, an accurate source location method can be a very good tool for progressive failure monitoring in composite structure. Further investigation will lead for better quality of structure health monitoring of composites.

ACKNOWLEDGEMENT

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PRELIMINARY STUDY FOR MULTIPLE OBJECT ORIENTED APPROACHES TOWARDS AUTOMATED SEGMENTATION, 3DVISUALISATION OF CELL TOMOGRAPHY

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ABSTRACT

The aim of this project is to improve the semi-automated segmentation of mammalian cell tomograms while maintaining a high level of accuracy. To achieve this, we focus on the development and application of new approaches for the high-fidelity, semi-automated segmentation, meshing and visualization of cellular compartments and organelles within large cellular volumes reconstructed in 3D at high (i.e. 4-5 nm) resolution by Electron Tomography (ET). We have observed that by categorizing the 'complexity level' of key organelles and testing combinations of promising filtration and segmentation algorithms, results in different optimal parameter settings depending on the complexity level of cell compartments. Cellular tomograms of insulin-secreting pancreatic beta cells are used as primary 'proof-of-concept' datasets for this project. Tomograms collected by dual-axis ET of thick (300-400 nm) plastic sections cut from high-pressure frozen, freeze-substituted and plastic-embedded islets of Langerhans isolated intact from adult mouse pancreas and imaged at 300 keV using a Tecnai F30 electron microscope (EM).

Keywords: electron tomography, cell tomography, noise reduction, segmentation.

INTRODUCTION

Next to specimen preparation itself, the single most time-consuming step in electron tomographic (ET) studies of mammalian cell structure these days of improved instrumentation and automated image acquisition is that of modelling or 'segmenting' the compartments and other structures of interest within the tomograms. As such, informed mathematical approaches that expedite the delineation of compartment boundaries as well as compartment/organelle identification will play a crucial role in overcoming the bottleneck that remains at the level of detailed image data analysis which follows the three-dimensional (3D) reconstruction of the tomographic volume from sets of aligned two-dimensional (2D) images. Extracting useful functional information from such 3D structural and/or anatomical data in an intuitive and expeditious manner has been hampered primarily by a lack of dedicated bioinformatics resources and expertise related to image processing, segmentation/meshing and object identification/annotation. Here, we aim to develop a comprehensive set of tools for segmenting, annotating and visualising 3D cell structure data generated by ET.

Although a number of promising new algorithmic approaches for analysing and defining 3D cellular data in an automated (or at least semi-automated/iterative) manner are beginning to emerge, considerable work still remains to be done before these more advanced approaches are likely to be incorporated as a routine part of tomogram analysis. Typically, these algorithms are designed to recognise particular structures (e.g. particles, filaments) based on their size and/or shape (sometimes relying on a set of 3D 'templates' to guide extensive object searches within tomographic volumes), or to partition membrane-bound compartments using different mathematical approaches that include edge detection, thresholding and closed-ness based on features such as pixel intensity or texture (Noske et al., 2008). Generally, additional pre- and/or post-processing steps need to be applied to tomographic images prior to running such algorithms to enhance the 'signal' of interest (e.g. compartment membranes, cytoskeletal filaments) versus background 'noise' (i.e. cytoplasmic density in the case of cellular tomograms) (van der Heide et al., 2007). In an algorithmic context, such background noise reduces or interferes with the ability of an algorithm to accurately define structures.

The focus of this paper is on developing and applying new approaches for the high-fidelity, semi-automated segmentation, meshing and visualisation of cellular compartments and organelles within large cellular volumes reconstructed in 3D at high (i.e. 4-5 nm) resolution by ET. Cellular tomogram dataset for this project was provided by my colleague, Mr Peter van der Heide, in the Marsh Group that represents ~2% of the total volume of insulin-secreting pancreatic beta cells will serve as the primary 'proof-of-concept' datasets for this project. These images were generated by dual-axis ET of thick (300-400 nm) plastic sections cut from high-pressure frozen, freeze-substituted and plastic-embedded islets of Langerhans isolated intact from adult mouse pancreas and imaged at 300 keV using a Tecnai F30 electron microscope (EM). Effectively, this volume equates to a so-called 'high-resolution supermontage' encompassing an entire cell in cross-section (together with adjacent cells) within an area spanning ~17x17 μm in X and Y. Specifically, my project aims to test, evaluate and implement multiple algorithmic approaches to enable the semi-automated analysis of complex 3D cell image volumes. The work undertaken in this project will underpin the development of software to serve as a data-processing pipeline for large cellular tomograms reconstructed at high (≤5 nm) resolution in 3D in future.

MATERIALS AND METHODS

Preparation, Imaging and ET Reconstruction of Mammalian (insulin-secreting) cells

The procedure used to prepare cells from mouse pancreas for imaging and subsequent 3D reconstruction using a dual-axis tomography approach has been described elsewhere in detail (Marsh 2007, Marsh et al. 2001a, Marsh et al. 2004, Mastronarde 1997). Briefly, a thick (~250-400 nm) section cut from plastic-embedded tissue was serially tilted by small (e.g. 1° or 1.5°) increments over an angular tilt range of ±60-70°, which then sets of 2D images were digitally acquired to a CCD. Two single-axis tomograms were computed and brought into register in 3D space and computationally combined to produce a dual-axis tomogram demonstrating improved symmetry and resolution 3D (Mastronarde 1997, Penczek et al,. 1995, Taylor et al. 1984). All of these outlined

procedures were performed using the IMOD software package developed and maintained by the Boulder Laboratory for 3D Electron Microscopy of Cells (Kremer et al. 1996).

Classifying Cell Compartments According to Its Similarities

Accurately tracing (e.g. manual segmentation) through the centre of the membrane bilayer in a cellular organelle is not an easy task, especially when the organelle's exact morphology is unknown beforehand and the staining of the membrane may vary in texture and intensity. Such things as overcrowded cytoplasm, image noise and distortion may also hinder accurate manual segmentation. Much of the previous research in automated ET segmentation has been in the development and application of tools for quantitative analysis and interpretations are mainly based on ET volumes with low SNR (Frangakis and Forster, 2004; Narasimha et al., 2008; Winkler, 2007). Sanberg (2007) has also shown that using orientation information can assist in the automatic segmentation of microtubules or other fiber-like structures and that image information alone (such as intensity and texture, which are nonuniform along the microtubule) is not sufficient.

Consequently, the shape and 'complexity' of the organelle is perhaps the most significant information in obtaining the best segmentation result. This study will show that by categorising the 'complexity' (and therefore segmentation difficulty) of each compartment based on its shape (and eventually extending to other features such as texture), we will improve the precision of the process of segmenting ET volumes. To achieve this aim, a background study has been undertaken, that summarises the primary morphology and degree of complexity of three significant compartments/organelles found in the ET volumes of pancreatic beta cells that we intend to segment in the course of our group's biological investigations of beta cell biology: the Golgi apparatus, mitochondria and insulin granules.

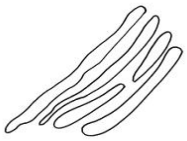
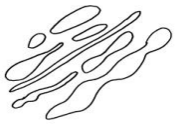
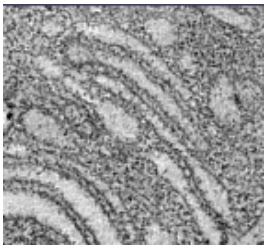
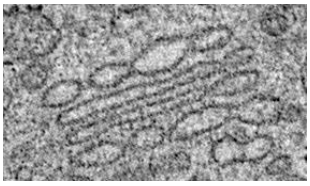
The Golgi Apparatus

The Golgi apparatus is a key organelle found in all eukaryotic cells whose primary function is to further modify macromolecules (e.g. lipids, proteins) from the endoplasmic reticulum (ER). This processing is particularly important for proteins to achieve their final functionality for a number of fundamental cell processes, such as secretion. The Golgi apparatus consists of a number of discrete stacks of fenestrated, flattened membranous compartments called cisternae, which are laterally inter-connected to form a ribbon-like structure (Marsh et al., 2001; Marsh and Howell, 2002; Noske et al., 2008). In prior ET studies of the beta cell, the Golgi typically consists of 5 to 7 individual cisternae and is somewhat analogous to a stack of pancakes; this morphology contributes to a high surface-to-volume ratio. The Golgi can be divided into a series of different spatial and functional regions, termed the cis-, medial-, and trans-cisternae, each distinguished by different enzymes which selectively modify the different types of molecules as they progress through these regions along the cis-trans axis. From the ER, membrane transport vesicles and tubules carrying newly synthesised proteins fuse with cis-Golgi cisternae. Their protein cargo then progressively transits across the stack to the trans-Golgi cisternae, where proteins are then sorted and

packaged for shipment to the required destination either within the cell or for release to the extracellular space.

In some cases, tubular connections between non-adjacent (and more rarely, adjacent) cisternae have been observed; this, in conjunction with functional stratification of the different regions of the stack, mean that the organisation of Golgi cisternae shape can be divided into three levels of morphological complexity for the purposes of this study (presented as Case 1, Case 2 and Case 3 in Table 1, below). Each has been simplified as a cartoon image to more clearly illustrate the basic morphological/shape complexity variations that exist, as determined from evaluating existing ET datasets produced by our group to date.

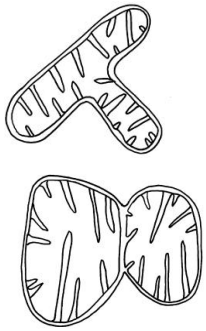
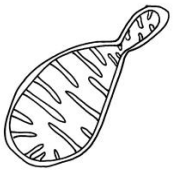
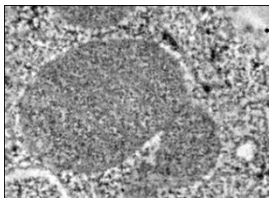
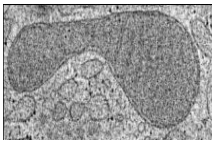
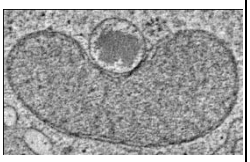
Table 1. Illustrative schematic images and example of real dataset to highlight different levels of shape complexity for the Golgi apparatus with respect to segmentation.

Case 1	Case 2	Case 3
		
Real dataset	Real dataset	Real dataset
		
Each cisterna is an individual ‘pancake’ layer, relatively uniform in length, with only slight variations in shape and size.	The cisternae appear to have differences in shape, length and width, but are still clearly separated. Some examples of variations in shape include a long tubular profile, wide/roundish or 'distended' cisternae and elliptical membranes.	Trans- or cis-Golgi often have vesicles budding off, but still attached and are typically segmented as the same surface as the attached cisternae. These shape anomalies, as well as variations in staining density usually associated with these buds, can cause difficulties using a smooth segmentation algorithm.

Mitochondria

Mitochondria comprising multiple subregions that carry out specialised functions are ultimately bound by an outer membrane layer, together with a small inter-membrane space followed by an inner membrane layer that is organised into cristae and the matrix (the space within the cristae). Mitochondria work as a generators in the cell that supply chemical energy in the form of adenosine triphosphate (ATP), necessary to carry out basic cellular activities. They tend to have a heavy/dark staining density. Morphologically, this organelle can be quite complex, as they often branched and forming irregular shapes presumably due to fission or fusion events determined by the energy state/needs of the cell prior to freeze-fixation of the cells.

Table 2. Illustrative schematic images and example of real dataset to highlight different levels of shape complexity for mitochondria with respect to segmentation.

Case 1	Case 2	Case 3	Case 4
			
Real dataset	Real dataset	Real dataset	Real dataset
			
Singular and free in cytoplasm: e.g. the outer membrane is clearly separated from that of other organelles/compartments and significantly denser than the surrounding cytoplasm.	Singular/free in the cytoplasm. Branched or proximal to a branch. An artifact (or limitation) of ET is seen as the membrane surface curves away from being in perfect cross-section, it becomes less distinct (e.g. blurry or cloudy) and therefore harder to segment.	Singular/free in the cytoplasm. Not necessarily branched, but mitochondria appear to have two distinct shapes (slender shape)	Proximal to, or in (apparent) contact with other organelles or compartments.

In this study, we will only be considering the gross surface morphology of mitochondria as delineated by the outer membrane. We have assigned four levels of complexity to the overall morphology of mitochondria in beta cells. Case 1 is the most simple, with only non-branched mitochondria, which display a relatively consistent shape from one Z-slice to the next (usually tubular or pancake-like) and exist as 'singular' spatially discrete objects in the cytoplasm (meaning that their outer membrane does not contact any other mitochondrion or other organelles/compartments). We have also observed, in accordance with other studies, that mitochondria can be branched in some regions. Branched mitochondria that remain spatially discrete within the cytoplasm constitute the second level of complexity (Case 2). It should be noted that it is a subject of debate whether these branched mitochondria should be considered one mitochondrion, two mitochondria in the process of fusion (or fission), or three separate mitochondria (Chen and Chan, 2005; Frazier et. al., 2006; Karbowski and Youle, 2003; Okamoto and Shaw, 2005; Perkins and Frey, 2000). Case 3, is similar to Case 2, but rather than being branched, each mitochondrion appears to have two distinct shapes. Case 4, the most difficult to segment, has more to do with the proximity of other organelles/compartments to our mitochondria of interest. In this case, it is hard for computational tools to assign a membrane/edge to the correct organelle, as they are similar in density and grey value. Table 2 illustrates these four cases of mitochondrial complexity.

Secretory (insulin) granules

Insulin granules are typically spherical and computationally easy to segment if the membrane is intact. In beta cells, there are predominantly two types of insulin granules: mature and immature. In this study, we have ignored this distinction, limiting our focus to the granule's general shape, as the insulin core is not to be segmented. That being said, the position of the insulin core or crystal (relative to the granule membrane) plays a crucial rule in determining the level of complexity, illustrated in Table 3.

a) Mature Granules

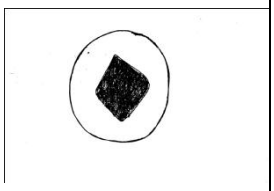
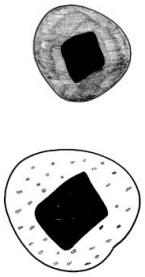
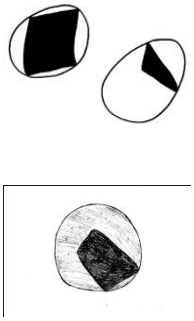
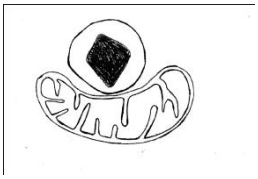
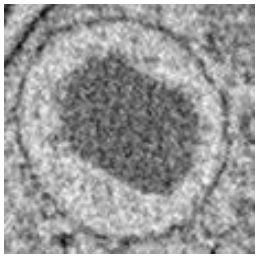
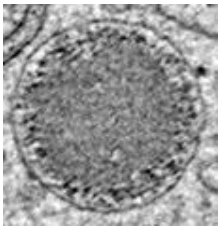
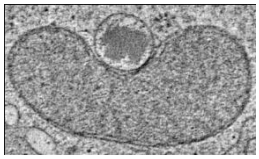
Mature granules in beta cells isolated from normal mice have an average diameter of approximately 300nm and are roughly spherical in shape. Granules often appear to have an empty lumen with a more densely stained insulin core. This staining pattern in combination with an insulin crystal that does not come into contact with the granule membrane is the simplest condition for segmentation (Case 1). We have also regularly observed a densely stained lumen with a less stained crystalline core, which is slightly more difficult to segment (Case 2, when the crystal does not contact the membrane). When the insulin crystal contacts (or comes very close to) the membrane, segmentation is considerably more difficult, giving us Case 3. In this category, existing segmentation algorithms often combine the crystal and membrane into one surface, or even fail to segment the membrane altogether and erroneously segment the insulin crystal itself.

b) Immature Granules

Immature granules can be either considerably larger as well as similar in size to mature granules but lack the well-defined insulin crystal core; instead, their uncleaved proinsulin cargo can be visualised as small punctate stain density of relatively uniform

size and distribution within the granule lumen. Due to the fact that they appear less dense since the protein has not yet condensed in the granule core, immature granules are often called 'pale granules' in morphological studies due to this difference in stain density and can also exhibit more irregular shapes.

Table 3. Illustrative schematic images and example of real dataset to highlight different levels of shape complexity for insulin granules with respect to segmentation.

Case 1	Case 2	Case 3	Case 4
			
Real dataset	Real dataset	Real dataset	Real dataset
			
Singular/free in the cytoplasm. Throughout the reconstruction, empty lumen space separates the insulin core from the granule membrane, allowing for easy segmentation.	Singular/free in the cytoplasm. Morphologically the same as Case 1, with one distinction: the granule lumen has varying degrees of staining density.	Singular/free in the cytoplasm. The insulin crystal contacting (or appearing to contact) the granule membrane. Because these often have a similar density, segmentation algorithms tend to fail, irrespectively of the density (or lack of density) of the remaining lumen.	Proximal to, or in (apparent) contact with other organelles/compartments

Basic Measurements For Each Volume Extract Of Cell Compartments

The main reason of doing this is to record the dimension of every individual Golgi compact region in each of the islet beta-cell tomogram, by measuring each in the longest direction to determine most practical uniform dimensions for sub volumes extraction that will work across every tomogram we intend to extract from. The dimensions and measurements of each region were recorded in a spreadsheet document, i.e. voxel size, volume size, and density information (maximum, minimum, mean). Based on this information, *boxstartend* function in IMOD can be used to quickly extract many sub-volumes with same volume size simultaneously.

Manual Segmentation of Cell Tomography

Manual tracing is proved to be the best segmentation method especially for noisy datasets. This is mainly because biologist's trained eye could clearly know how to distinguish between the real membrane line/s (contour/s) of membrane bound cell compartments and background noise in cytoplasm, thus could trace this membrane boundary nicely. In this project, IMOD software is used for manual tracing and 3D visualisation of the segmentation results. The results were recorded in a spreadsheet and used for validation process. The average time consumed to manually trace each volume extract is between 5 to 30 minutes (depending on volume size and number of contour).

Automated Segmentation of Cell Tomography (parameter experiments)

Filters that have been successfully applied on various kinds of images are believed to have promising results on Electron Tomography (ET) datasets, for example median filter, bilateral filter, diffusion-based filters and mean-shift filter, which are also grouped as Edge and Corner Preserving Smoothers (ECPS) (Pappari et.al 2007).

Table 4. Proposed noise reduction and segmentation algorithms for this project

Noise reduction algorithms		Package	Language	Dimensions
1.	Median filter 2D	ImageJ (13)	Java	2D
2.	Median filter 3D	CoAn (14)	C++/Fortran	3D
3.	Gaussian filter	ImageJ (13)	Java	2D
4.	Mean shift filter	ImageJ (13)	Java	2D
5.	NAD filter	IMOD (15)	C++	3D
6.	Bilateral filter	BSoft (16)	C++	3D
7.	Kuwahara filter	ImageJ (13)	Java	2D
8.	Minimum filter	ImageJ (13)	Java	2D
9.	Maximum filter	ImageJ (13)	Java	2D
Segmentation algorithms		Package	Language	Dimensions
1.	Watershed segmentation 3D	CoAn (14)	C++/Fotron	3D

In this project, we divided these filters into three significant sub classes; 1) Rank filters that consist of minimum and maximum filters, median filter and Kuwahara filter (kuwahara et al. 1976); 2) Heat equation-based methods such as non-linear anisotropic diffusion (NAD) filter (Frangakis and Hegerl 1999), and 3) Bilateral filter (Tomasi and

Maduchi 1998). Whilst several segmentation algorithms show potential, 3D watershed transform (Volkmann 2002), is chosen as the best for segmenting the filtered Golgi volumes. Other organelles with a simpler shape such as granules may be segmented better with other algorithms like Active Contours (Bartesaghi et al. 2005). The 10 algorithms used in this project, which have all been used successfully on tomograms are: Median filter 2D, Median filter 3D, Gaussian filter, Mean shift filter, Non-linear Anisotropic Diffusion (NAD) filter, Bilateral filter, Kuwahara filter, Minimum filter, Maximum filter and Watershed segmentation. Below is the list of the 10 algorithms currently usedwhich have all been used successfully on electron tomogram. Below shows our proposed steps in automated segmentation process and 3D visualization of cell tomography using several tools provided in IMOD software and other software (for noise reduction step)

Complete Segmentation and 3D Visualisation Process:

1. Prepare nine same sets of the area of interest.
2. For 2D noise reduction, convert six volumes into stacks of *.tif* files (e.g. extract001_slice0001.tif) by using *mrc2tif* (IMOD) to number the files in sequence during conversion.
3. For 3D noise reduction, convert three volumes into normalised 32-bit floating point format by using *maptool* (CoAn), save as a *.map* volume *extract001.map*.
4. Filtering process: image sequence *.tif* files are filtered by each 2D filter and saved as *extract001_slice0001_filtered.tif,* whilst the 3 *.map* volumes are filtered by each 3D algorithm and saved as *extract001_filtered.map*.
5. Convert filtered 2D *.tif* stacks into *.mrc* volumes by using *tif2mrc* function (IMOD), then convert to normalized 32-bit floating point *.map* files as in step 3. Restore volume origin and voxel size based on original extracts.
6. Segmentation process: All filtered volumes are then passed to watershed for 3D segmentation (*mapcarv* from CoAn), producing "label maps" of objects.
7. Remove small objects and noise from label maps using *maplpick* (CoAn).
8. Apply closing-opening function for some morphological correction/smoothing on label maps by using *maplmorph* (CoAn).
9. Make model file by using *imodauto* (IMOD) and save image result as model (*.mod*) file.

Validation For The Best Result Of Parameter Experiments

Manual segmentation vs. automated segmentation

Tedious and time consuming are two main drawbacks for manual segmentation although this technique is undoubtedly the best technique for segmenting multiple/numerous morphology; where different organelles in different slices (3D) consist/composed of various shape, size, as well as its background density. An acceptable standard is set for a fair comparison between manual and automated segmentation.

'Scoring system' for different organelle types and complexity levels

'Scoring system' is developed in this project purposely to serve for comparison standard; used to carry out the segmentation accuracy. Information retrieved from 3D generated such as total contour volume (TCV) and total mesh surface area (TMS) are used for scoring system. More information about TCV and TMS can be found in IMOD website. The difference (D) between TCV:TMS of manual segmentation and automated segmentation is calculated and recorded. Different scoring system for different 'complexity level' of each membrane-bound organelle is proposed for the best segmentation results. The three best scores of parameter settings for each organelle and complexity level were recorded.

RESULTS

In this paper a survey on 'complexity level' for three keys membrane-bound organelles has been conducted. For the Golgi apparatus, there are three categories recorded, while four categories are recorded for mitochondria as well as insulin granules. A survey on filtration and segmentation algorithms also has been carried out and a combination strategy has been used for nine potential image filters and one powerful segmentation method. This great combination has shown their great potential in segmenting those organelles almost perfectly and has proved there are possibilities to achieve a fully automated segmentation for the whole electron tomograms (including other cell compartments that have not stated in this project) that comprise highly noisy datasets. Another result achieved in this paper is 'scoring system' for each different organelles and 'complexity level'. These new finding of accuracy standard is proved to be applicable for specific category of an organelle focused in this paper.

CONCLUSION AND DISCUSSION

In order to overcome problems of difficulties in the segmentation of membrane bound organelles caused by noise and organelle overcrowding, pre-processing techniques such as noise reduction methods or image filter algorithms are highly needed to reduce the level of interfering background noise in images. Care must be taken to remove as much high-frequency noise as possible while preserving the object signal i.e. organelle membranes. Categorisation of the shape and complexity of organelles is a promising way in identifying the best parameter settings of both noise reduction and segmentation algorithms in combination for better visualisation and annotation of cellular tomograms at high resolution. Thus, a serious survey is needed to test the parameters of various filtration and segmentation methods for the segmentation of key organelles that differ in complexity (e.g. the Golgi, mitochondria and granules) to lead in future development of a software/program for fully automated segmentation of the whole electron tomography.

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MILD COMBUSTION: A TECHNICAL REVIEW TOWARDS OPEN FURNACE COMBUSTION

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ABSTRACT

Moderate or Intense Low oxygen Dilution (MILD) combustion is one of the best alternative new technologies for clean and efficient combustion. MILD combustion has been proven to be a promising combustion technology for industrial applications with decreased energy consumption due to the uniformity of temperature distribution, also producing low NO_x and CO emissions. This article provides a review and discussion of the recent research and development in MILD. Furthermore, the problems and focuses are summarized with some suggestions and therefore presented on upgrading an application of MILD in the future. Currently MILD combustion has been applied in closed furnace. For closed furnace, the preheating supply air is no longer required since the recirculation inside the enclosed furnace will self preheats the supply air and self dilutes the oxygen in the combustion chamber. The possibility of using open furnace MILD combustion was discussed and reviewed.

Keywords: MILD combustion, turbulent combustion, open furnace

INTRODUCTION

Chemical reaction through combustion still contributes to most of the energy needs. The demand of energy is dramatically increasing due to the growth of the world's population and substantial economic development in countries such as China and India. Some of the major challenges are to provide efficient energy and limit greenhouse-gas (GHG) emissions. Combustion of fossil fuel is projected to fulfil about 80% of these energy needs (IEA, 2009 and Maczulak, 2010). The pollution resulting from conventional combustion processes is linked with global warming and other associated changes such as abnormal weather patterns, rise in ocean levels and melting of ice the North and South Poles. The more efficient use of fuel with low GHGs emission as well as carbon capture and storage (CCS) might be effective ways to gradually reduce the GHG emissions (IEA, 2006, 2009 and Orr, 2005). IEA/OECD (2002) and Jonathan (2006) reported that CO_2 contributed 77% of the greenhouse gas emissions with combustion accounting for 27%, making it a major contributor to global climate change. To counter this issue, the improvement of combustion efficiency with lower emissions has led researchers to have more interest in new combustion technology and combustion modeling (Smith and Fox, 2007 and Merci et al., 2007). One of the methods to improve the combustion efficiency is to preheat the reactant by the hot flue gas. However, preheating the combustion air generally increases the flame temperature which results in

more formation of thermal NO_x. A new combustion technology has been suggested that is able to solve this issue: Moderate or Intense Low Oxygen Dilution (MILD) combustion produces high combustion efficiencies with very low emissions.

Combustion processes require three basic elements which are fuel, oxidiser and heat or an ignition source. Fuel and oxidiser need to be mixed at the molecular level via a turbulent mixing process. In 1989, Wünning (1991) observed a surprising phenomenon during experiments with a self-recuperative burner. At furnace temperatures of 1273K and about 923K air preheat temperature, no flame could be seen and no UV-signal could be detected. The fuel was completely burnt and the CO was below 1ppm in the exhaust. The NO_x emissions were almost zero with smooth and stable combustion. Wünning (1991) called that condition "flameless oxidation" or FLOX (Wünning, 1996, Wünning and Wünning, 1997 and Milani and Wünning, 2007). This new combustion technology was also labelled as Moderate or Intense Low-oxygen Dilution (MILD) combustion (Dally et al., 2002, Cavaliere and de Joannon, 2004). Katsuki and Hasegawa (1998) and Tsuji et al., (2003) found that high-temperature air combustion (HiTAC) is nearly the same as MILD combustion, besides operating at higher temperatures. MILD combustion has many beneficial features, especially on producing uniform temperature distribution, excellent combustion stability, very high efficiency and extremely low emissions of NO_x. The early research and development of MILD combustion came from Germany (Wünning and Wünning, 1997, Plessing et al., 1998, Mancini et al., 2002, 2007, Kim et al., 2008 and Zieba et al., 2010) and Japan (Katsuki and Hasegawa, 1998, Yuan and Naruse, 1999 and Tsuji et al., 2003). However all the combustion was studied for closed chamber or closed furnace.

Currently there is no record of studies for MILD combustion in open furnace. More understanding on flame structures are necessary to increase the application range of the MILD combustion (Medwell, 2007) especially on open furnace. Some histories, recent trends and researches on MILD were reviewed. The key topics discussed include MILD combustion regime, flame characteristics and properties, NO_X emissions. Some early results on the modelling of open furnace of MILD combustion were discussed at the end of this paper.

COMBUSTION REGIME

MILD combustion is greatly different from normal combustion mainly because of the low oxygen concentration and mixture temperature higher than the fuel autoignition point (Li et al., 2011b). Figure 1 indicates that the MILD combustion range for oxygen dilution is about 3-13% and the reactant temperature is above the auto ignition temperature.

The recirculation of hot flue gas to preheat the reactants and simultaneously diluted the oxygen was a key concept of MILD combustion (Tsuji et al., 2003). The maximum temperature increase due to the combustion is lower than the mixture self-ignition temperature (Cavaliere and de Joannon, 2004). Recent applications of MILD combustion have been into research and development of gas turbines (Duwig et al., 2008, Arghode and Gupta 2009, 2010a, 2010b, 2011a, 2011b) and gasification systems (Tang et al., 2010, 2011). This combustion mode can be very interesting in gas turbine applications due to low maximum temperatures (very close to the ones at the inlet of a

gas turbine), noiseless characteristics, good flame stability and effectiveness in reducing pollution emissions. In contrast, the problems related to large scale application of MILD gas turbines are the characteristic time related to the chemical process (the ignition delay time) and the preheating of the fresh reactants (ultralean, superdiluted, highly preheated). Based on the study and compilation by Li et al. (2011b), common MILD combustion appears to be summarised as:

i. High temperature pre-heat of air and high-speed injections of air and fuel are the main requirements of achieving MILD combustion;
ii. Strong entrainments of high-temperature exhaust gases, which dilute fuel and air jets, are the key technology of maintaining MILD combustion;
iii. Important environmental conditions for the establishment of MILD combustion: local oxygen concentration is less than 5%-10% while local temperature is greater than that for fuel self-ignition in the reaction zone. These must be achieved by strong dilution of reactants with the flue gas (N_2 and CO_2-rich exhaust gas);
iv. When using the regenerator to recycle the waste heat of flue gases, the thermal efficiency of MILD combustion can increase by 30%, while reducing NO_x emissions by 50% (Tsuji et al., 2003).

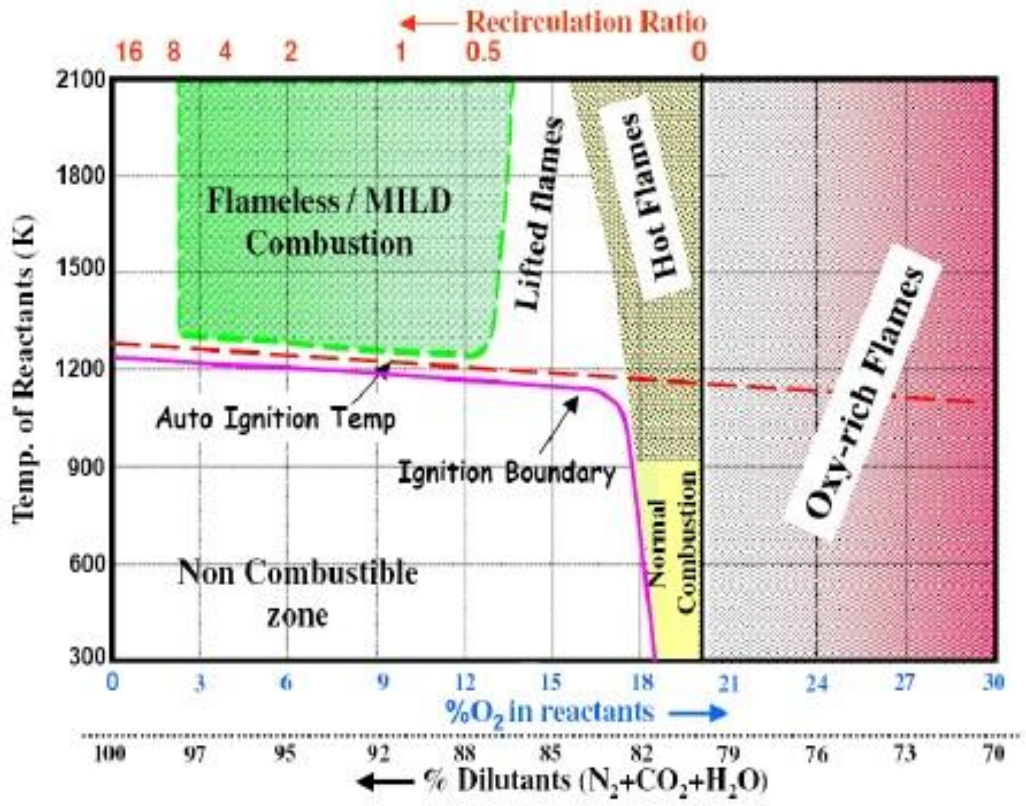


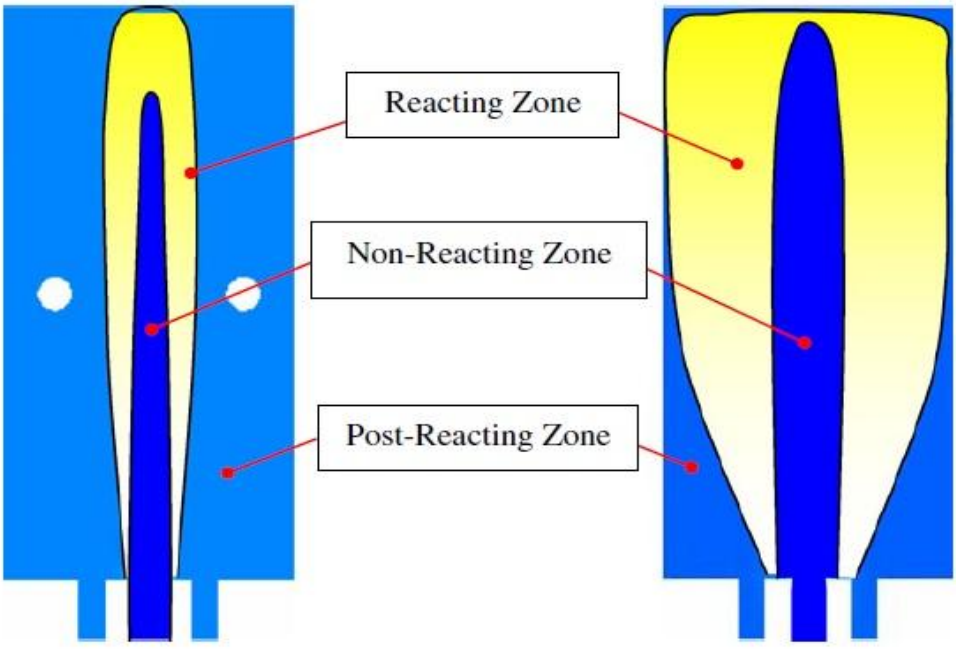
Figure 1. Schematic regime diagram for methane-air JHC flames (Rao, 2010).

The supply air needs to be heated by using a recuperator or regenerator to absorb waste heat from the flue gas. A recuperator can preheat the air to 1000K while the regenerator can heat the combustion air to about 1600K (Tsuji et al., 2003). It shows that there are four main regimes: a clean MILD combustion region, where MILD is

easily sustained without any significant emissions; an unstable flame region, where low-emission MILD conditions can be achieved by suitably selecting some key operating parameters, such as the combustion air temperature; a conventional (normal) flame combustion region and a no-combustion or extinction zone. The more usual representations (Cavigiolo et al., 2003 and Wünning and Wünning, 1997) identify different regimes of stable and unstable flame combustion and a flameless oxidation region. The oxygen concentration and the temperature of the air preheated will affect the MILD flame colour as shown in figure 2. The flame became green and generally less visible when the oxygen level decreased to 2%, (Gupta et al., 1999). When MILD combustion started, the furnace was bright and transparent (Wünning and Wünning, 1997, Tsuji et al., 2003 and Cavaliere and de Joannon, 2004).

(a) 21% (b) 8% (c) 2%

Figure 2. Combustion air temperature of 1100 °C and percentage of O_2 concentration (Gupta et al., 1999)



(a) (b)

Figure 3. Closed furnace reacting zone for (a) conventional and (b) MILD combustion (Li and Mi, 2011)

Recently Parente et al. (2009, 2011b) studied the MILD combustion regime using a novel methodology based on Principal Component Analysis (PCA), investigates the main features for the characterisation. PCA can effectively identify low dimensional representations of the CH_4 / H_2 experimental dataset. Figure 3 illustrates the flame region for MILD and conventional combustion based on the [OH] contours. Significantly, both the reacting and non-reacting zones for the MILD case are bigger compared to the conventional case. The best combustion process is lean combustion. This is due to lean combustion use of less fuel and the impact is less cost of combustion. MILD lean combustion means that the combustion with less fuel and less oxygen level. In between the ratio of oxygen from 3 to 13%, auto ignition temperature is reducing with the increase of oxygen level.

COMBUSTION EFFICIENCY

Combustion efficiency is the ratio of the heat received by the target material to be heated (useful output) to the supply heat provided to the combustor (in the form of fuel or electricity supply). Industrial burners need a stable and efficient flame for an economical and safe heating process. In the industrial scale, diffusion or non-premixed combustion is commonly used due to its controllability and safety (Peters, 2000 and Tsuji et al., 2003). Bluff-body burners can offer a stable burner as required. There are many different shapes and geometries such as cone, cylinder, vee gutter, disk and sphere. The geometry will affect the recirculation zone (flame bluffing zone). Furnace lean and clean operation is very critical since two thirds of the plant's energy budget is allocated for the fuel cost (Thomas, 2011). Combustion thermal efficiency in the furnace can be improved by recycling the exhaust gases (Li et al. 2011a, 2011b).

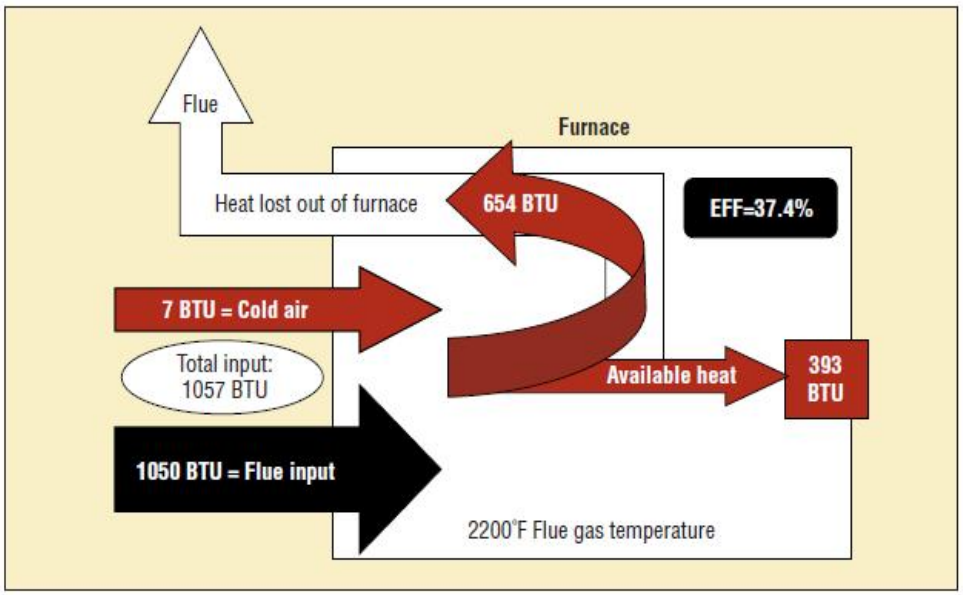


Figure 4. Efficiency of the heating system without EGR (Kraus and Barraclough, 2012).

MILD combustion has proved to produce clean and efficient combustion. Recent studies by Colorado et al. (2009) and Danon et al., (2010) on low calorific value fuels used in MILD combustion show that low NO_x emissions were achieved. The

fundamental parameters of MILD combustion are the average combustion chamber temperature (T_c), dilution ratio (K_V), and jet velocity (Derudi et al., 2007a). K_V is a key parameter for the MILD combustion operating conditions. Several other researchers (Wünning and Wünning, 1997, Katsuki and Hasegawa, 1998, Cavigiolo et al., 2003, Dally et al., 2008 and Galletti et al., 2009) defined K_V as the ratio between the recycled exhausts and the incoming air and fuel flow rates. MILD combustion has many advantages, such as producing very high thermal efficiencies and low emissions of NO_x. It produces a uniform temperature distribution, excellent combustion stability and has been considered as one of the new-generation, clean and efficient combustion technologies. It has great potential to be implemented in many industrial applications.

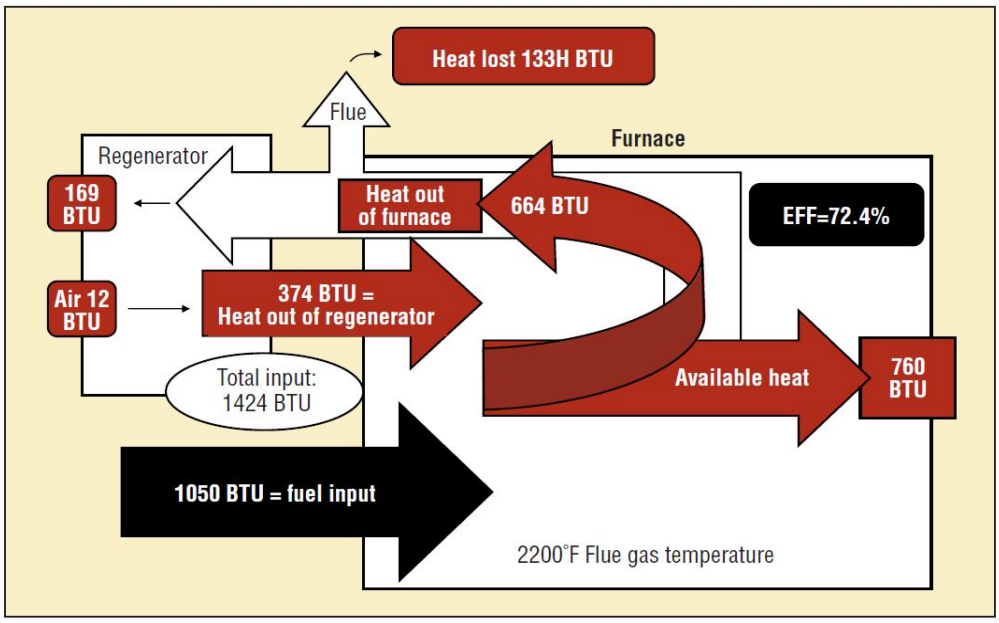


Figure 5. Efficiency of the heating system with EGR (Kraus and Barraclough, 2012).

The advantages of MILD combustion are implemented by the heating industries. Danon (2011) reported an increase in demand for expertise on the implementation of MILD combustion, especially for large-scale furnaces equipped with multiple burners. MILD combustion was achieved experimentally (Yuan and Naruse, 1999, Ertesvag and Magnussen, 2000, Weber et al., 2000, Özdemir and Peters, 2001, Hasegawa et al., 2002, Cabra et al., 2003, 2005, Rafidi and Blasiak, 2006, Sabia et al., 2007, Derudi et al., 2007a, 2007b, 2007c, Mörtberg et al., 2007, Kumar et al., 2007, Dally et al., 2008, Li and Mi, 2010, Mi et al., 2010, Zhenjun et al., 2010, Li et al., 2010a, 2010b, Oldenhof et al., 2010, 2011, Derudi and Rota, 2011 and Kraus and Barraclough, 2012) and numerically (Ertesvag and Magnussen, 2000, Coelho and Peters, 2001, Park et al., 2003, Cabra et al., 2003, 2005, Kim et al., 2005, Awosope et al., 2006, Kumar et al., 2007, Galletti et al., 2009, De et al., 2010, Frassoldati et al., 2010, Oldenhof et al., 2010, Zhenjun et al., 2010, Szegö, 2010, Parente et al, 2011a, 2011b and Kraus and Barraclough, 2012) in premixed, partially-premixed and non-premixed combustion modes. For the furnace combustion, simultaneous increase in radiant heat transfer and reduced NO_x emissions are possible with careful control of the fuel and air mixing (Mulliger and Jenkin, 2008). Nakamura et al. (1993) and Webber (2001) experimentally studied several pilot-scale furnaces equipped with heat exchangers. They demonstrated

that the port angles and locations will affect the heat transfer behaviour. The comparison of combustion with and without EGR can be seen in Figure 4 and 5. The furnace in Figure 4 is running without regenerator (EGR) and 654 BTU of heat lost through flue gas. The difference for Figure 5 is the furnace running with the regenerator (EGR) and from 654 BTU of heat in the flue gas; only 133 BTU is lost through flue gas to the atmosphere. Some 521 BTU of the heat is returned back to the system via the regenerator. The efficiency is 37.4% for the system without EGR and 72.4% for the system with EGR.

MILD RECENT TREND

The concept of MILD combustion has been extensively studied experimentally and numerically. However the challenge still remains to accurately model the MILD combustion regime due to the homogeneous mixing field effect by turbulence mixing and slower chemical reaction rates. MILD combustion is characterised by a strong relation between turbulence and chemistry, occurred at similar timescales (Plessing et al., 1998 and Galletti et al., 2007). The turbulence chemistry interactions should be treated with finite rate approaches. The non-premixed mode occurred when the fuel and preheated air are injected to the enclosure furnace through different ports and mixing and combustion proceed inside the chamber. Nathan et al. (1992) and Parham et al. (2000) reported that by controlling the mixing through their precessing gas jet, a simultaneous reduction in NO_x emissions by 30–50% and an increase in heat transfer by 2–10% were achieved. Szegö et al. (2008) used a furnace with 20kW supplied by the fuel and 3.3kW from the pre-heated air. This closed furnace used parallel air and fuel jets with one central air nozzle, four fuel jets and four exhausts. All the nozzles and exhausts were at the bottom of the furnace. This MILD combustion setup has produced data on various experiments including fuel tests, flame tests, NO_x tests, and heat exchanger tests (Maruta et al., 2000, Flamme, 2004, Park et al. (2004), Christo and Dally, 2004, 2005, Medwell et al., 2007, 2008, Mörtberg et al., 2006, Stankovic, 2006, Lou et al., 2007, Dally et al., 2002, 2004, 2008, 2010, Colorado et al., 2009, Mi et al., 2009, de Joannon et al. 2009, 2010, Li et al., 2011b, Oryani et al., 2011).

MILD combustion technology is still not fully commercialized and well adopted in furnace industry, thus it is very important to conduct substantial fundamental and applied research (Cavaliere et al., 2008, Li et al., 2011b, Parente et al., 2011a, 2011b and Danon, 2011). The fuel-air mixing in MILD combustion has become one of the interests of studies (Tsuji et al., 2003). Precise prediction of turbulent mixing is important in modelling turbulent combustion because it has a large effect on the flow field and turbulence–chemistry interaction (Shabanian et al., 2011). Galletti et al. (2007) claimed that the reactants' jet velocity and their angles are the main parameters affecting the quality of the air-fuel mixture. The characteristic of MILD combustion is strong coupling between turbulence and chemistry (Parente et al., 2008), occurring at similar timescales (Plessing et al., 1998 and Galletti et al., 2007) thus the turbulence-chemistry interactions should be treated with finite-rate approaches. The level of homogeneity of the mixing field (de Joannon et al., 2010) and slower reaction rates make the accurate modeling of this combustion regime challenging (Aminian et al., 2011), especially for the heat release rate and NO_x and soot formation, thus a fundamental study on the mixing quality is required. To achieve MILD combustion, the air supply has to be preheated (Wünning and Wünning, 1997). Many researchers claim

that regenerative heating or preheating is an important element in MILD combustion applications, which may add some complexity when retrofitting systems. However, a recent study by Li et al. (2011a, 2011b) showed that preheating is not required in the case of a closed furnace. The use of an open furnace operating in MILD combustion mode was investigated. Generally, the setup for open furnace is simpler and cheaper than closed furnace because the latter needs a thick and solid wall. However, open furnaces have additional complexity because of their requirement for preheating of the reactants. Oldenhof et al. (2011) claimed that studying flameless combustion in an open and unconfined setup might give valuable insights. The combination of open furnace and preheating as well as the effect of air-fuel mixing (Oldenhof et al., 2011) need to be fully addressed. It is believed that there is no reported data about MILD combustion in open furnace applications.

Biogas is an attractive alternative to replace the dependency on fossil fuels. Recently Colorado et al. (2009) studied MILD combustion using biogas (methane diluted with inert gases) and reported that NO_x and soot emissions were reduced but CO emission was increased. This was possibly due to the high fuel dilution and low coflow oxygen level. NO_x emission could be reduced effectively by means of low-oxygen concentration combustion (Suzukawa et al., 1997, Gupta, 2000 and Fuse et al., 2002). NO_x strongly depends on the mixing processes between fuel and air. The recirculation flue gases are entrained with combustion air and fuel before combustion occurs to depress higher peak temperature. As a result, thermal NO_x is suppressed. There are parameters to be measured to achieve the desired MILD combustion which are dilution ratio (K_v) and temperature inside the combustion chamber. The minimum dilution ratio to achieve MILD combustion is 2.5 (Wünning and Wünning, 1997). The MILD combustion key control strategies are the heating requirement by the furnace. Based on the heating requirement, the dilution ratio and fresh air supply was controlled by. EGR, fresh air and fuel supply are controlled based on the dilution ratio required. Fuel consumption is the key to measure the efficiency of the system. Thermocouples are used to measure the heat produced by the flame.

EXHAUST GAS RECIRCULATION

Thermal efficiency of furnace and other heating equipment, such as kilns, ovens and heaters are very critical issue. Large amount of the heat is wasted in the form of flue gases and small amount of wall loss, opening loss, store heat and cooling water loss. Exhaust gas recirculation (EGR) is one of the methods to recover these losses. EGR behaves differently to heat regenerators. EGR works by recirculating a portion of the exhaust gas back to the combustion chamber. The main purpose of EGR is that the oxygen in the combustion chamber will be diluted by the hot flue gas and the mixture heated directly. The volume of hot flue gas to be injected back into the system depends on the level of oxygen dilution needed. EGR with MILD combustion was used by Wünning and Wünning (1997), Katsuki and Hasegawa (1998) and Cavaliere and de Joannon, (2004) as a solution to avoid NO_x and soot formation. Wünning and Wünning (1997) calculated the dilution ratio K_V with EGR as:

$$K_V = \frac{M_E}{(M_F + M_A)} = \frac{(M_T - M_F - M_A)}{(M_F + M_A)} \quad (1)$$

The total mass flow rate (M_T) is calculated by adding up the EGR mass flow rate (M_E), fuel mass flow rate (M_F) and fresh air mass flow rate (M_A). The dilution ratio (K_v) and temperature inside the combustion chamber are to be measured when combustion achieve steady state. The minimum dilution ratio is 2.5 (Wünning and Wünning, 1997). The control strategy is the heating required by the furnace which will determine the required dilution ratio. The damper blade will act as a control valve at the furnace stack. The damper blade will use to control the outflow from the furnace and the percentage of the opening size will determine the percentage of the exhaust gas recirculation (EGR). The EGR and the fresh air mixing will determine the dilution ratio of the system. The total flue gas out of the system must be equal to the quantity of the fresh air and fuel supply. The research on utilising EGR to reduce the emission and increase the efficiency of the combustion extensively progress. EGR was reported giving effect on the reduction of the emission for the internal combustion engine (Abdullah et al., 2009, Mamat et al., 2009 and Yasin et al., 2011).

BIOGAS: LOW CALORIFIC VALUE GAS

Considering biogas with the standard methane content of 50%, the heating value is 21 MJ/Nm³, the density is 1.22 kg/Nm³ and the mass is similar to air at 1.29 kg/Nm³ (Al-Seadi et al., 2008). The use of gas is predicted to continue to replace coal for electricity generation as it is a cleaner fuel producing lower greenhouse gases. Coal usage is predicted to increase by 50%, whereas gas is expected to increase by 88% (Scragg, 2009). Biogas can be produced from the biodegradation of organic materials of biological origin (biomass) in anoxic environments, such as swamps, wetlands, sediments, and in the rumen of ruminant animals. Methane production in engineered anaerobic digestion (AD) systems has been employed for more than a century to treat municipal sludge generated by municipal wastewater treatment plants (WWTPs), beside renewable resources and reduce greenhouse gas emissions, biogas also benefit to the farmers. It will reduce biomass waste and digestate is an excellent fertiliser since its rich of nitrogen, phosphorus and potassium. Besides many advantages of biofuel and biogas, currently there are some debates on the sustainability of biofuel resources (RACQ, 2008) including the risk of food supply and shortage of biomass due to floods and other circumstances.

Methane is the main component of natural gas and biogas and is the most abundant organic compound on earth. Natural gas is a promising alternative fuel to meet strict combustion emission regulations in many countries. The combustion run on natural gas can operate at lean burn and stoichiometric conditions with different combustion and emission characteristics. Table 1 shows the differences in natural gas composition between some countries compiled by Hairuddin et al. (2010). Natural gas, methane or hydrogen is commonly used for industrial burners. Hydrogen is the most clean and very low emission in combustion. Hydrogen's low density giving a challenging medium for the storage (requires very high pressures tank). By adding hydrogen to the fuel blend, the influence of molecular diffusion will increase with increasing hydrogen (Mardani et al. 2010b). Recently Mardani et al. (2010a, 2010b) and Wang et al. (2011) investigated the effects of hydrogen addition and found that MILD combustion occurred more easily. Yu et al. (2010) found that pure hydrogen could not reduce thermal NO_x emission in the flameless combustion regime. Hydrogen properties show a lot of advantages over fossil fuels. Hydrogen is produced mainly from fossil fuel

resources and only 4% generated by electrolysis (Stoots, 2011). In the future, when fossil fuel depleted, the raw material will be changed to water and biomass (Hollinger and Bose, 2008). The purpose of the fuselage (enclosure) is to capture the flue gas to use as EGR. This configuration is not fully enclosed due to there being an opening at the top of the furnace. Therefore this setup is considered an open furnace.

Table 1. The difference in natural gas composition between some countries (Jonathan 2006, Kong & Reitz 2002, Olsson et al. 2002, Papagiannakis and Hountalas 2004).

Components	**Volume (%)**			
	Australia	**Greece**	**Sweden**	**USA**
Methane (CH_4)	90.0	98.0	87.58	91.1
Ethane (C_2H_6)	4.0	0.6	6.54	4.7
Propane (C_3H_8)	1.7	0.2	3.12	1.7
Butane (C_4H_{10})	0.4	0.2	1.04	1.4
Pentane (C_5H_{12})	0.11	0.1	0.17	-
Hexane (C_6H_{14})	0.08	-	0.02	-
Heptane (C_7H_{16})	0.01	-	-	-
Carbon Dioxide (CO_2)	2.7	0.1	0.31	0.5
Nitrogen (N_2)	1.0	0.8	1.22	0.6

CFD MODELLING

The application of computer simulation techniques to improve combustion process has been rapidly expanding over the last decade. These techniques offer reliable predictions on the effect of various parameters on combustion performance. Moreover, the computational simulation frequently presents information on physical quantities that are quite difficult to measure. CFD is the tool to model the fluid flow problems numerically and reduce the excessive cost of experimental work. Galletti et al. (2007) reported that beside the experimental characterization of MILD combustion burners, the industry also shows the interest on CFD modeling. CFD may help in optimizing burners' performances such as injection nozzles and flue gas recirculation.

CFD alone is not fundamentally strong without validation of their result with the experimental work. MILD combustion in setups on many different scales has been extensively simulated using CFD software over the last decades (Danon, 2011). The configuration of reactants and exhaust ports was optimized using a CFD modeling study (Szegö, 2003). Mollica et al. (2009) using CFD to study the effect of preheating, further dilution provided by inner recirculation and of radiation model for a hydrogen-air MILD burner. Oryani et al, (2011) numerically analyse and comparing the flue gas recirculation (FGR) and fuel induced recirculation (FIR) conditions in the case of N_2, CO_2 and H_2O dilution and found that with small amounts of dilution, FIR is more effective in NOx reduction. The established turbulent model in fluent was utilised. The continuous fluid flow and chemical reactions are simulated in a discretization mode. A mesh or numerical grid of the physical geometry for burner head and boundary wall are generated. The fluid flow and heat transfer transport equations, which are conservation of mass, momentum, heat and species, are solved. Recently Szegö et al (2011) using CFD to model MILD combustion in furnace and found that there is a strong coupling between the furnace aerodynamics and the reaction zone. CFD modelling is useful to

pre-determine the control parameters. Sensitivity to turbulence model (e.g. standard *k-ε* model (Launder and Sharma, 1974)) normally was investigated. The control parameters for the modelling works are temperature, velocity and the angle of the supply air; temperature, velocity and the angle of the fuel; percentage of EGR; location of the EGR input to supply air; burner head design and fuel properties.

Turbulent flow occurs at high Reynolds numbers and very complex process and even more complex when involve with combustion reaction or other chemical reaction. Tennekes and Lumley (1972) characterised the nature of the turbulence as irregularity, large Reynolds numbers, diffusivity, three-dimensional vorticity fluctuations and continuum phenomenon. In the combustion process, particle interactions are very important in the fuel and air mixing process: usage of mixing models is required to close the molecular diffusion term in the probability density function (PDF) transport (Pope, 1985):

$$\frac{\partial \rho P}{\partial t} + \frac{\partial \rho u_i P}{\partial x_i} + \frac{\partial \rho S_k P}{\partial \psi_k} = -\frac{\partial}{\partial x_i}\left[\rho \langle u_i^{"} | \psi \rangle P\right] + \frac{\partial}{\partial \psi_k}\left[\frac{1}{\rho}\langle \frac{\partial J_{i,k}}{\partial x_i} | \psi \rangle P\right] \quad (2)$$

Particle mixing is becoming more important to study for the mixing process. Recently Wandel (2011) has proposed a new turbulent mixing model which randomizes the interaction of the particles in a local manner. The proposed model was called SPDL or Stochastic Particle Diffusion Length (Wandel, 2011) model, which is based upon the practical localness of the random inter-particle distance (Noor et al, 2011). The configuration of reactants and exhaust ports was optimized using a CFD modelling study (Szegö et al., 2003, Khoshhal et al., 2011, Noor et al, 2012a, 2012b). Mollica et al. (2009) used CFD to study the hydrogen-air MILD burner. They reported about the effect of preheating, further dilution provided by inner recirculation and radiation model. Numerical method was utilised on the flue gas recirculation (FGR) and fuel induced recirculation (FIR) analysis (Oryani et al., 2011). In the small amounts of N_2, CO_2 and H_2O dilution, FIR is more effective in NO_x reduction. Recently Szegö et al. (2011) used CFD to model MILD combustion in furnace and found that there is a strong coupling between the furnace aerodynamics and the reaction zone.

OPEN FURNACE

MILD Combustion in closed furnace was established for many years; however, many fundamentals still need further study and resolution. Open furnace combustion for MILD is still a new approach. Open furnace combustion needs the enclosed chamber to collect the flue gas and use it as EGR. The oxygen in the fresh air supply needs to be diluted and EGR must be used for this purpose. The concept of open furnace is due to the opening at the top of the furnace and the flue gas that is not used for EGR was released from this top opening. Figure 6 shows the open furnace (Noor et al, 2012a, 2012b) used to numerically study the MILD combustion. The opening on the top of the furnace chamber can be controlled and adjusted in order to control the amount of EGR and dilution ratio. The dilution ratio was controlled by the opening of the damper. The damper at the furnace stack was used to control the outflow from the furnace and the percentage of the opening size was determined by the percentage of the exhaust gas recirculate (EGR). The main purpose of EGR is to dilute fresh air with exhaust gas; and therefore will reduce the peak combustion temperature and pressure which will consequently reduce the amount of NO_x (Santoh et al., 1997, Abd-All et al., 2001,

Agarwal et al., 2006, Hountalas et al., 2008). The EGR and the fresh air mixing will determine the dilution ratio of the system.

The total flue gas emitted from the system must be equal to the quantity of fresh air supply. In order to capture the combustion image and the flame propagation, high speed camera was utilised in the early state of the combustion and establishment phase. When the flame reaches a steady state and invisible to the naked eye, the high speed camera will capture the flame luminescence (Oldenhof, et al., 2010, 2011). This process is important for the MILD combustion non premixed lifted flame. In normal jet flames, the lift-off height is the axial height of the sharp flame interface. To determine lift-off height, a certain threshold level for an averaged quantity is defined. Example using the quantities like temperature (Kumar et al., 2007), OH concentration (Cabra et al., 2003 and Ertesvag and Magnussen, 2000) or luminescence (Cabra et al., 2005) was proposed.

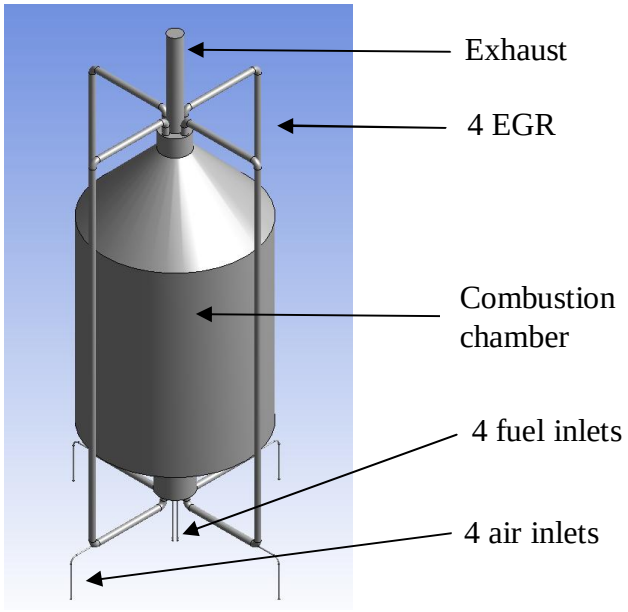


Figure 6. Open furnace with 4 EGR and top chamber opening.

Open furnace through the combination of the study parameters: preheating the reactants using EGR to dilute the oxygen in air supply, high reactant jet velocity, hydrogen additive to the biogas to reduce the mixture self ignition temperature and turbulent mixing of the reactant, optimisation of MILD combustion in an open furnace can be achieved. CFD was utilised to simulate the combustion with low calorific value gas call biogas. In this simulation, 50% of methane was mixed with 20% of hydrogen and 30% of carbon dioxide to form the low calorific value gas. The result for the combustion temperature and combustion radiation zone is shown in figure 7 and 8. The result from the simulation shows that MILD combustion can be achieved using an open furnace combustion with the enclosed chamber to capture and utilised flue gas as EGR.

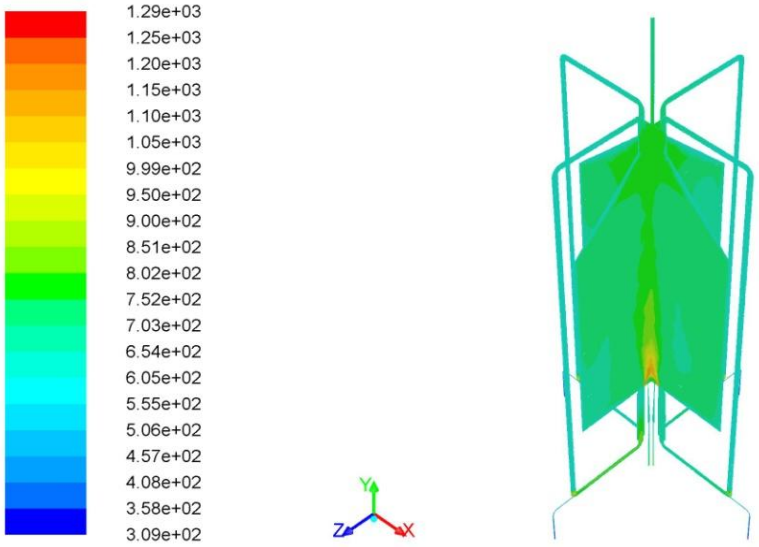


Figure 7. Combustion temperatures for low calorific value gas.

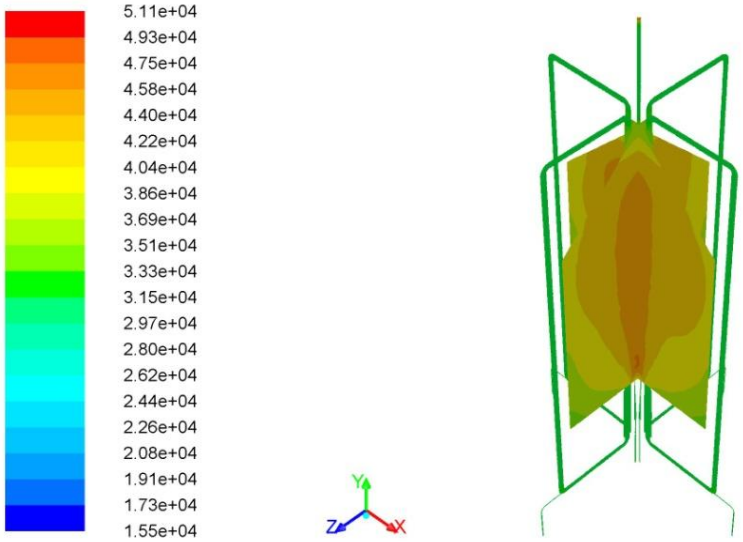


Figure 8. Combustion radiation zone.

CONCLUSION

The review of MILD combustion toward open furnace was discussed. MILD or flameless combustion produces higher efficiency with lower emissions. The MILD combustion provides many benefits to the furnace and burners in heating industries. Despite the benefits, the fundamental of the combustion is not properly well established and needs further research especially on the control parameters, combustion behaviour, combustion characteristics, exhaust gas recirculation and dilution required. Heating industries are still in early stages to adopt MILD or flameless technology to their burners. Most of the burners are still using conventional combustion technology since it is fundamentally stable, strong knowhow and relatively high experience. In January 2012 issue of Industrial Heating journal, Kraus and Barraclough discussed about the

utilisation of thermal regeneration for the industrial furnace is a must in order to increase the thermal efficiency of the burners. Biogas is one of the best alternatives for the fuel depletion issue. Fuel from bio resources is very environmental friendly since the cycle of CO_2 is properly closed. Hence the biogas with MILD combustion is the one of the best combustion for future energy and heating industries. CFD are good tools to simulate and predict the parameter before the experimental work take place. Simulations were the best option to reduce the experimental cost. Recent trend shows that MILD can be achieved by closed furnace. The dilution and preheating process happened internally in the closed combustion chamber. This will make the constructions of the combustion chamber simpler without external EGR needed but still closed furnace need thick wall. At this stage, there are no results of experimental or numerical records for open furnace MILD combustion. In this study, the open furnace with EGR to dilute and pre-heat the oxidant was numerically studied. MILD combustion was achieved for open MILD combustion. This result needs to be validated by an experimental technique.

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Nomenclature

CCS	Carbon capture and storage
CFD	Computational fluid dynamics
CMC	Conditional moment closure
CO	Carbon monoxide
CO_2	Carbon dioxide
FGR	Flue gas recirculation
GHG	Greenhouse-gas
HC	Hydrocarbon
HiTAC	High temperature air combustion
HTOC	High temperature combustion
JHC	Jet in hot coflow
LCV	Low calorific value
MILD	Moderate or intense low O_2 dilution
NO_x	Nitrogen Oxides
OH	Hydroxyl
PDF	Probability density function
SO_x	Sulphur Oxides
SPDL	Stochastic particle diffusion length
UHC	Unburned hydrocarbons

Symbols

B	Diffusion coefficient
K_T	Total number of particles
$\overline{W}$	Mean molecular weight of mixture
W_I	Molecular weight of species I
$\dot{q}$	Heat release rate
N	Total number of species
P	Favre joint PDF of composition
P_b	Position of particle
R	Gas constant
R_d	Internal dilution ratio
T	Temperature
T_c	Chamber temperature
V	Volume
K_v	Dilution ratio
Y	Mass fraction
Z	Mixture fraction
d	Constant
k	Turbulence kinetic energy
m_{in}	Mass flow rate
t	Time
u	Velocity
v	Specific volume
w	Importance weight

Greek Symbols

u_i	Favre mean fluid velocity vector
δt	Time interval
S_k	Reaction rate for species k
ε	Dissipation rate
ψ_k	Composition space vector for specie k
u_i''	Fluid velocity fluctuation vector
$J_{i,k}$	Molecular diffusion flux vector
ν	Kinematic viscosity
ξ	Reference variable
ρ	Density or mean fluid density
$\emptyset$	Composition of particle
$\dot{\omega}$	Chemical reaction rate
β	Index of composition variable
α	Model parameter

INVESTIGATING INTERCULTURAL COMMUNICATION ACROSS ETHNIC DIVERSITY: A PRELIMINARY STUDY AT UNIVERSITY MALAYSIA TERENGGANU

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ABSTRACT

The Malaysian context is diverse in that there are three main ethnic and religious groups: Muslim Malay, Chinese Buddhist and Indian Hindus. These ethnic and religious groups are reflected in the staff composition at the University Malaysia Terengganu (UMT), a university on the East Coast of Malaysia. The site has been selected because, given the ethnic mix, there is potential for intercultural communication problems to surface among the staff which includes the three ethnic groups. The objective is to ascertain whether these communication patterns generate problems and conflict which may, in turn, affect the university's productivity.

Keywords: intercultural communication, ethnic diversity, Malaysian university

INTRODUCTION AND BACKGROUND

This paper examines the potential for the development of intercultural communication problems between the different ethnic groups employed at University Malaysia Terengganu (UMT). Differences in cultural background may lead to communication difficulties between the administrative staff which could, in turn, affect the university's productivity. This paper will address this hypothesis by first explaining the Malaysian context, in terms of its socio-cultural, language, educational and political nuances. The paper will then outline the perspectives provided by cross-cultural, communication and conflict theories to theoretically contextualise the study. The research design and methodologies will be next described. Lastly, the paper will explore the results before outlining the preliminary findings produced by the study.

The Malaysian Context

The Socio-Cultural Impetus

Malaysia is a multicultural country consisting of people from different racial origins and ethnic groups. Demographically, Malays are the dominant race or Bumiputra, and constitute 65% of the population, along with the Chinese, 26%, and Indians 8%. The Chinese and Indians migrated to Malaysia (then called Tanah Melayu or Malaya) in the 16th century (Demographics of Malaysia, 2010). The national religion is Islam (60%) but other religions such as Buddhism (19%), Christianity (9%), Hinduism (6%),

Sikhism, Daoism, Confucianism/Taoism/other traditional Chinese religion (3%) and other religion (2%) are free to practise their own beliefs (Demographics of Malaysia, 2010). Malaysian Malays generally are Muslims. However Chinese Malaysians follow several religious beliefs such as Christianity, Buddhism, Chinese religion, Bahai, Sai Baba and Islam (see Carstens, 2006, Lee & Tan, 1999). Malaysian Indians practise different faiths such as Hinduism, Christianity and Islam. Terengganu is a multicultural state on the east coast of Malaysia (see Figure 1), with ethnic Malays the most dominant group. Minority groups include ethnic Chinese, Indians and Thais [Terengganuswadee.com, 2004).

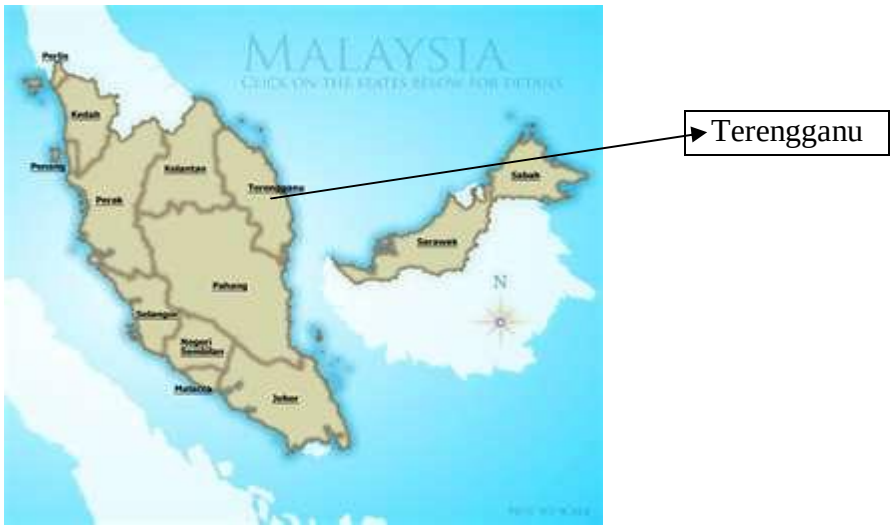


Figure 1. Malaysia map

In the 2010 census, the Terengganu population was 1,015,776. The majority were Muslim (96.9%) followed by Buddhists (2.5%), Hindus (0.2%), Christian (0.2%) and finally followers of other religions or non-religious groups (0.2%) [see Figure 2] (Terengganu, 2012).

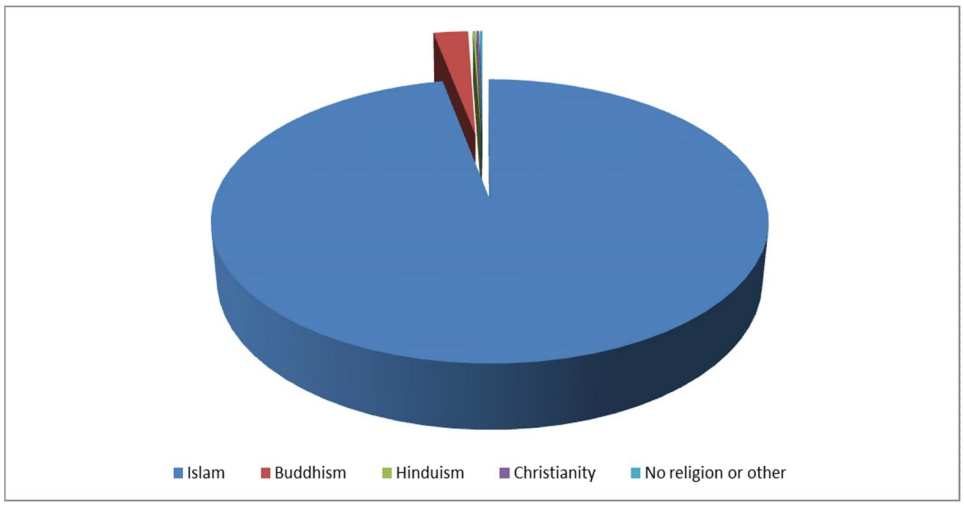


Figure 2. Religious population of Terengganu

The ratio of the ethnic groups differs from that the regions on the west coast of Peninsular Malaysia such as Johor, Negeri Sembilan, Penang, Perak, Selangor and Kuala Lumpur (see Table 1). The Malay ethnic is seen dominant on east coast of Peninsular Malaysia while other ethnic group is seen distributed evenly on west coast of Peninsular Malaysia even though Malay is still the majority ethnic yet the differences are small.

Table 1. Population distribution by states

State	Bumiputera (%)	Chinese (%)	Indian (%)
Johor	57.1	35.4	6.9
Negeri Sembilan	57.9	25.6	16.0
Penang	48.5	40.9	10.6
Perak	55.87	31.35	20
Selangor	58.9	27.8	13.3
Kuala Lumpur	38.6	46.5	13.4

(Source: National Census 2000, Department of Statistics Malaysia as cited in Demographics of Malaysia, 2012)

The Language

The national language has been the Malay language since 1967. English is the second language. For Malaysian government official matters, the Malay language is widely used. English is used in service industries, schools and private institutions as well as in dealing with international counterparts and international relations. Malaysia has over a hundred languages and dialects being spoken daily (Lim, 1998). Apart from the formal Malay language and English, Malaysians also use other languages and dialects in their conversation, for example Cantonese, Hokkien, Mandarin and Tamil (Languages of Malaysia, 2010).

The Educational Impetus

Malays are generally educated through the Malay-medium school system in daily, vocational or religious schools which only for Malay Muslim. Some of the older generations (during the British colonial times) were educated in English medium-schools. In general, the Malays in Terengganu also possess the same educational background as most of the Malays in Malaysia. Chinese Malaysians experience a range of educational backgrounds. Some were educated in the English medium especially before the Second World War, during the British presence (Lee & Tan, 2000). Typically, this category refers to older generations, however, new generations of Chinese Malaysians are commonly educated in vernacular schools (schools using Mandarin as the medium of teaching) and Malay-medium schools [school using the national language, Malay, as a medium of teaching] (Lee & Tan, 2000). Malaysian Indians come from various educational backgrounds, mainly from Malay-medium schools and vernacular schools (Tamil as a medium of teaching).

Malaysia is therefore not a homogenous culture; in fact it is multicultural in many aspects such as in language systems, communication symbols, educational systems and religion. Yet in educational institutions, the three groups need to work together, to understand and respect each other's' cultural beliefs, and together, they shape Malaysian culture with its many different values and cultures. These different educational systems could affect intracultural and intercultural communication in the work place. Several studies have been conducted (see Lailawati, 2005; Fontaine & Richardson, 2003; Hofstede, 1991 & 2001) but they have neglected this issue and portrayed an image of Malaysians as a homogenous group. Nevertheless, recognizing the impact of such differences is important in a study which explores intercultural communication at a university as a workplace.

The Political Impetus

Politically, Malaysia practises as a federal constitutional monarchy, where the Yang di-Pertuan Agong is the Head of State and the Prime Minister of Malaysia is the Head of Government. Malaysia has three power bases: executive power which is exercised by the federal government and the 13 state governments; legislative power which is vested in the Federal Parliament and the 13 state assemblies; and the judiciary, which is more independent of the executive and the legislature, though the executive maintains a level of influence in the appointment of judges to the courts (Politics of Malaysia, 2010). A recent political impetus that is influencing Malaysian sensitivities towards multicultural affairs in the country, is the role played by the current Malaysian Prime Minister, Dato Seri Najib Tun Razak. The Prime Minister has chosen a 'One Malaysia' vision as his main focus. This vision promotes unity in diversity. The purpose is to build the country's strength though sharing a goal to retain respect, friendship and understanding and to form a better future for all Malaysians despite their differences (Prime Minister, Dato Seri Najib Tun Razak cited in Welcome to One Malaysia, 2010). The Prime Minister feels that Malaysia is experiencing many episodes of ethnic tension alongside the efforts to maintain unity; that Malaysia should value differences to boost the economy; that differences should not be seen as an adversity or neglected by the community; that a multicultural society should be seen as a virtue to be celebrated , shared and appreciated; and that the spirit of One Malaysia can be embedded through respecting each other regardless of the ethnicity or religiosity (Welcome to One Malaysia, 2010).

THE ISSUES

Malaysia

Malaysia has the potential for conflict arising between different ethnic groups and has long been trying to maintain harmonious ethnic relationships. This is crucial in the Malaysian setting where society is becoming more aware of differences in ethnicity (Guan, 2000). Culture, religion and ethnicity differences are easily triggered if intercultural communication skills are ignored. The recent issues of religious beliefs being used by some politicians in Malaysia can quickly disrupt ethnic collaboration (see Fuller, 2006). Current issues such as churches being bombed by ethnic Malays or mosques being desecrated with pig's head can also worsen ethnic relationships (see Mydans, 2010, Asia News, 2010, Staff Berita semasa, 2010). In 2006, Malaysia's

previous Prime Minister, Tun Abdullah Ahmad Badawi, was worried about the level of ethnic tensions caused by religious and racial issues (see Fuller, 2006). If these potential confrontations are ignored and the uniqueness of the ethnicity mixture is overlooked, it is predicted that a large number of talented non-Malays may migrate to other countries. Malaysia should take the opportunity to value each and every ethnic group in the environment. The differences should be taken as advantages not as threats. There is a shortage of research about the issues of intercultural communication among the personnel who are actually working in universities. While there are studies which focus on intercultural communication issues these settings are not in the university context. They are based on local or multinational companies (see Hofstede, 1999, Renaldo, Christopher & Rao, 2007). In addition, most of the intercultural communication studies conducted by Malaysian researchers depend on quantitative methods (see Renaldo et al., 2007) rather than qualitative methods. The limited study that focused on qualitative methods did so, however, only in relation to the international students' adaptation (see Latifah, 2000). Such research also focuses on the West Coast, Peninsular Malaysia, where the composition of the various ethnic groups is more evenly distributed and language usage is not so challenging (see Pandian, 2008).

University Malaysia Terengganu

Diverse ethnic and religious groups, mainly Muslim Malay, Chinese Buddhist and Indian Hindus, are reflected in the staff composition at the University Malaysia Terengganu (UMT), a university on the East Coast of Malaysia. UMT has been selected as the place of study because of the unique composition of the ethnic minorities. Most public universities in Malaysia have an equal balance of ethnic minority groups in their organizational levels, however the majority of personnel at this university are local Malay (local born) instead of non-local Malays (non-Terengganu born) and other ethnic minorities. The site has been selected because, given the ethnic mix, there is potential for intercultural communication problems to surface between local and non-local Malay personnel as well as between other personnel from different ethnic groups. For example differences in ethnicity and religion may have the potential to initiate communication difficulties between the personnel which could affect the university's productivity and, in turn, students' experiences at university.

UMT's work environment is also different from other universities as UMT is situated in the northern region, has a typical Islamic lifestyle and has not been as influenced by the West during colonization (History of Malaysia, 2010). For example, during 1888 to 1948, the Terengganu state government appointed several Muslim scholars as the Chief Minister, Minister, Mufti (a Muslim jurist expert in Islamic law) and officers in the administration of the Terengganu Sultanate to confront the threat of foreign powers such as Siamese and British influences. They were given the responsibility to be as advisers to the Sultan in administration affairs, social development, laws, jurisdictions and international relations (Berhanuddin, 2010). This indicates that Islamic influences are reflected in the workplace where the study is conducted.

Research Purpose

The purpose of the study is to investigate the intercultural communication patterns across ethnic diversity demonstrating personnel employed at UMT. The study aims to:

i) analyse the cultural values held by the UMT personnel include power distance, uncertainty avoidance and long-term orientation.
ii) investigate the verbal communication as in language use by the personnel,
iii) explore nonverbal communication, including their use of proxemics, haptic and silence;
iv) delve into how conflict arises and is mitigated as a consequence of differences in the cultural values, verbal and nonverbal communication.

The influences of religion and dialect (which is distinct from other non-local Malay languages and the formal Malay) thus contribute to a case study.

THEORETICAL PERSPECTIVES

These section overviews the definition and theoretical framework used in the study. The study uses a theoretical framework including the theory of cultural value dimensions (Hofstede, 1991; 2001), verbal and nonverbal communication theory (Hall, 1959; 1966; Knapp & Hall, 2006) and culture-based situational conflict theory (Ting-Toomey & Oetzel, 2001).

Intercultural Communication (IC): The Definition

The term first originated in the United States in 1946 with the establishment of Foreign Service Institute. It arose in response to the need to train foreign diplomats in the language and anthropological cultural understanding of different cultural groups. The term became widespread and was associated with Hall's 'The Silent Language' in 1959, where he applied abstract anthropological concepts to the real world and later extended the anthropological view of culture to include communication (Jandt, 1998). Since then, culture and communication are associated in the literature investigating different cultures. IC can be defined as the 'art of understanding, and being understood by, the audience of another culture' and 'the audience could be one person or more and not necessarily a large group' (Sitaram, 1980, p.92). Therefore, 'IC occurs whenever a person from one culture sends a message to be processed by a person from a different culture' (Samovar, Porter & McDaniel, 2009, p.7). This definition needs to be understood in order to obtain a clear idea about intercultural communication. For the purpose of this study, then IC is defined as an interaction between individuals or groups from different cultural, religious and ethnic background, which very much different in shared meaning, behaviors, concepts and interpretations.

Cultural Values

Cultural values a core component in the study, will be analysed the cultural values in the respondents. As Ferraro (2002, p.26) explains, values are 'those things found in all cultures that are expected or hoped for, they involve embedded assumptions about what is right or wrong, good or bad; and they involve a set of standards by which behavior is

evaluated'. That is because differences in cultural values can point to confusion and uncomfortable feelings in business relationship (Ferraro, 2002).

The literature agrees that values are linked with culture. Most researchers can see that cultures may possess different values from other cultures. Hofstede (1991 & 2001), for instance, developed values dimensions and formulated a model that identifies value dimensions. Brew and Cairns (1993) contrast values from individualist and collectivist cultures. For example, an individual from an individualist culture values direct and explicit communication in contrast to a person from a collectivist culture may value indirect and appreciate context in communication strategies (Brew & Cairns, 1993). Ferraro (2002) notes that values and culture interlock and thus may determine the behaviors of others towards other cultures. Values are used to learn, to understand, to identify and to prevent diverse cultural traits and also create a cultural awareness in order to avoid miscommunication in intercultural communication (Ferraro, 2002).

Dimensions Of Cultural Values

Different cultures thus demonstrate different values in their community. Scholars such as Hofstede (1991 & 2001), Ferraro (2002), Hall (2005), Mircea (2008) and Samovar et al (2009) present these as cultural dimensions. Hofstede is the most prominent scholar in intercultural communication, developing values dimensions based on his study of how values in the workplace are influenced by culture. Hofstede formulated a model that identifies four primary value dimensions to assist in differentiating cultures: Power Distance (PDI), Individualism (IDV), Masculinity (MAS), Uncertainty Avoidance (UAI) and Long-term orientation (LTO). Hofstede's (1991 & 2001) value dimensions foreshadowed those of Gudykunst (1998), Samovar et al (2009), Ferraro (2002) and Mircea (2008). Gudykunst's value dimensions (1998) verify five cultural dimensions similar to Hofstede's (1991 & 2001) such as individualism-collectivism and low-high-context culture. Samovar et al (2009) discusses nine dimensions of cultural values and called this a 'cultural syndrome'. Ferraro (2002) identified ten cultural dimensions which are applicable to global business as well as intercultural communication. Some scholars critique Hofstede's efforts, for example McSweeney (2002) in his classification of national cultures. Despite his critics, Hofstede's dimensions provide a point of reference when analyzing intercultural communication problems across cultures (Kim, 2005). National identities are seen then as a viable means that can be used to identify and measure cultural differences (Hofstede, 1998).

Understanding cultural values dimensions is important in avoiding misunderstandings and miscommunication especially when the communication occurs within different cultural backgrounds. This is because not every culture holds the same value of cultural dimensions. Cultural values such as collectivism vs. individualism were investigated by Parkes, Bochner and Schneider (2001) in a study about national culture dimensions affecting organizational values in Australia and Asian organizations. This study discovered that Australian employees were more individualistic and less committed in the organization (since the sense of collectivist responsibility were lower) compared with Asian cultural values (Parkes, Bochner & Schneider, 2001). This study suggests that feelings of uneasiness, misunderstanding and miscommunication can arise between different cultures. There has been research in Malaysian cultural values (see Dahlan, 1990, Hofstede, 1991 & 2001, Lailawati, 2005, Latifah, 2000, Lim, 1998,

Pandian, 2008 & Tamam, 2009a & 2009b) but these have generally overlooked differences in the ethnic cultural dimensions. Hence, this study is interested to investigate ethnic cultural value orientations of personnel at UMT. It will focus on power distance, uncertainty avoidance and long-term orientation.

Verbal Communication

Verbal communication is generally understood to be communication in the form of words which are spoken or written. Table 2 synthesizes several definitions of verbal communication. Differences in context, patterns of communication and the different assumptions underpinning the use of verbal communication can cause miscommunication especially in the workplace (Inon et al, 2009). Our culture educates us about how to use verbal messages in appropriate ways. For example, some cultures do not address their teachers by the teacher's first name which others are far more formal (see Hall, 2005). Our gender too, influences our verbal communication. Several studies show that women's speech tends to be more polite than men's speech, as well as in telephone conversations (Brown, 1980; Wetzel, 1988; Holmes, 1995; Smoreda & Licoppe, 2000 as cited in Devito, 2009). In this study, verbal communication refers to the words themselves (the way words are spoken is nonverbal). The study is not concerned with the grammatical structure of the language; rather it seeks to concentrate on the verbal communication in terms of word usage among the staff. Since the language at this institution is varied, where the respondents possibly use Terengganu dialect and formal Malay language, thus the word usage is important. This word usage is predicted to be confusing and may create problems for personnel who are not local.

Table 2. Definitions of verbal communication in the literature

Scholars	Definitions
Devito (2009)	Verbal message is the message that you sent using words, the word *verbal* also refers to words, not orality, where verbal message include oral and written word.
Mircea (2008)	Language refers to social interactions where language is an outstanding factor establishing understanding and conditions for dialogue.
Hall (2005)	Verbal communication is connected to context, where we may decide 'to use our words, written or spoken' (Hall, 2005, p.139) which is always associated with frames plus become parts of the whole issues of understanding the context.
Ferraro, (2002)	Language can be described as a symbolic system of sounds when combine together will give meanings to the speakers
Ting –Toomey (1999, p.85)	Language as 'an arbitrary, symbolic systems that names ideas, feelings, experiences, events, people and other phenomena and that is governed by the multilayered rules developed by members of a particular speech community'.
Jandt (1998, p.121)	Language is 'a set of symbols shared by a community to communicate meaning and experience'.

Nonverbal communication

Nonverbal communication has several definitions. Table 3 outlines these definitions.

Table 3. Definitions of nonverbal communication in the literature

Scholars	Definitions
Jandt (2010, p.107, 1998, p.99)	Describe nonverbal communication as an 'intentional uses as in using a non-spoken symbol to communicate a specific message...and nonverbal communication refers to a source's of actions and attributes that are not purely verbal'.
Tyler et al. (2005)	Nonverbal behaviour literally means communication not using any words, which can be used in a certain context, to interpret the act into a meaning, where this action can either be alone or associated with verbal behaviours.
Gudykunst (1998)	Non-verbal is very distinct and invented in a basis of agreement among the members of a group which using the non-verbal, they are arbitrary like symbols and do not involve displacement.
Burgoon et al. (1988, as cited in Jandt, 1998, p.99)	Characterize nonverbal communication ' as those actions and attributes of human that have socially shared meaning, are intentionally sent or interpreted as intentional, are consciously sent or consciously received, and have the potential for feedback from the receiver'.

After considering these definitions, this study defines nonverbal communication as communication by all the means using symbols and body language to communicate the message to a receiver, except for the actual words themselves. The way words are spoken or written is therefore related to nonverbal communication.

Types of Nonverbal Communication

There are several types of nonverbal communication discussed by the communication scholars including kinesics, proxemics, chronemics, paralinguistic and semiotics (see Tyler et al., 2002). Others categories include silence, haptics, clothing and physical appearance, olfactory and oculesis (see Jandt, 1998 & Devito, 2009). Knapp and Hall (2006) suggest that theoretical writings and research on nonverbal communication can be broken down into the following three areas: the communication environment (physical and spatial), the communicator's physical characteristics and body movement and position (gestures, posture, touching, facial expressions, eye behaviour and vocal behaviour). Given that nonverbal communication is very wide and varied, this study limits its focus to three area of nonverbal communication. As suggested by Knapp and Hall (2006), this study feels that proxemics, touch and the use of silence are significant to the study.

Proxemics

The study about the use of space was pioneered by Edward T. Hall back in 1959. Proxemics can be divided into two categories: distances and territoriality (Devito, 2009). Proxemics distances can be categorized into four types: intimate relationship, personal relationship, social relationship and public relationship (see Devito, 2009). The four types of distance allow us to determine our relationship with others: whom we keep our distance from, and whom we may not keep our distance from. Our use of distance is influenced by gender, personality (extrovert or introvert), age and familiarity [stranger and the people we familiar with] (Burgoon et al, 1996; Burgoon & Bacue, 2003 as cited in Devito, 2009). Territoriality refers to 'a possessive or ownership reaction to an area of space or to particular objects' (Devito, 2009, p.133) and is divided into two types: territory types and territorial markers. There are three types of territories described by Altman (1975, as cited in Devito, 2009): primary, secondary and public territory. There are also three types of territorial markers: central markers, boundary markers and earmarkers [see Table 4] (Devito, 2009). Proxemics can be viewed differently by the individual based on their cultural background. Hence, this type of nonverbal is important in reflecting respondents' variations.

Table 4, Types of territorial markers

Marker types	Explanation
Central markers	Refers to an item that you put in a territory to reserve it such as a drink in a canteen table or books in library table.
Boundary markers	Refers to a boundary that separates your place and the others such as in a bus seats which separates by your bag in a centre or the moulded plastic seats.
Earmakers	Refers to identifying makers that show your ownership of the territory or object such as a nameplates, student cards or initials on a shirt. These earmarkers indicate that you belong to a certain group or territory such as a corporation or institution.

(Adapted from Devito, 2009)

Touch Communication

Touch also has a plethora of meanings. There are five types of messages which illustrate the meaning of touch (Devito, 2009). First, touch can convey positive feelings to others when we touch people to give them support or appreciation. Secondly, touch conveys our intention to play affectionately or aggressively. Thirdly, we use touch to control the behaviours, attitudes or feelings of others. Touch is also used to gain attention and finally includes ritualistic touching such as when greeting people, either by shaking hands, hugging or kissing (Devito, 2009). Even though touching is part of communication, some people avoid touching. This is called touch avoidance. Touch is subject to cultural differences as every culture has rules about touching. Some cultures may comfortable with lots of touching and some may be a touch avoidance society. People from cultures that value lots of touching are labeled as contact cultures, and those who are from touch avoidance cultures are labeled as noncontact cultures. Japan is a noncontact culture and northern Europe is a contact culture (Devito, 2009). Touch can

thus vary depending on the individual's cultural background. This study will explore the use of touch among the respondents in order to clarify differences between ethnic groups and any problems that may arise related to the use of touch.

Use of Silence

There are six functions of silence: silence allows speaker time to think, functions as a weapon, displays a 'response to personal anxiety', prevents communication, communicates emotional responses and says nothing (Devito, 2009). Speakers also use silence as a time to arrange and prepare their conversation or sometimes it is used to hurt someone's feelings (Devito, 2009). In a time of conflict, some couples remain silent to show their heated emotions which suggests that silence also works as a punishment. Silence is also used to respond to a new environment, where you choose to be silent because you are new to the environment or to avoid rejection. In a conflict situation, silence can be used to prevent an unfavorable topic from arising. Silence too may be applied to buy time to cool off when conflicts arise. Silence can indicate and communicate emotional responses, for example refusal to become involved in verbal communication (Ehrenhaus, 1988, as cited in Devito, 2009) or when you want to avoid any 'responsibility for any wrongdoing' (Beach, 1990-91, as cited in Devito, 2009, p.140). Silence may give positive meanings in some cultures such as modesty, shyness (in positive way) and self-consciousness or negative meanings such as insensitivity, disinterest or lack of understanding. Silence is also subject to cultural differences, for instance in United States, silence is seen as a negative expression while in Japan silence is believed to be an appropriate way of behaving (Devito, 2009). The use of silence is important to the study in order to ascertain how the ethnic groups use this as a strategy in conflict, the variances between ethnic groups and the use of silence in respondents' communication patterns**.**

Conflict

Hall (2005, p.233) sees conflict as:

> An expressed struggle between at least two parties who perceive incompatible goals and/or potential interference from the other party in achieving the desired goal. This conflict condition can turn into intercultural conflict when 'the incompatibility must be generated, where differences in meaning may emerge and understood differently.

Intercultural conflict can be defined as a 'study of conflict that evolves, at least in part, because of cultural group membership differences' (Ting-Toomey & Oetzel, 2001, p.2). It is the experience of emotional frustration in conjunction with perceived incompatibility of values, norms, face orientations, goals, scarce resources, processes, and/or outcomes between a minimum of two parties from two different cultural communities in an interactive situation (Ting-Toomey & Oetzel, 2001, p.17). There are several reasons, according to Ting-Toomey & Oetzel (2001, p.3), why intercultural conflict needs to be managed in a constructive and creative way. One reason is that a different viewpoint which may offer various ways to solve problems. Secondly, diversity in a workplace should not be neglected, as this may result in:

> Low morale because of culture clash, high absenteeism because of physiological stress, money have to be spend to retrain individual because of high employee turnover, time waste because miscommunication between diverse employees and the enormous amount of personal energy expended in defensive resistant to inevitable change (Loden & Rosener, 1991 as cited in Ting-Toomey & Oetzel, 2001, p.8).

A diverse workforce, too, has advantages such as:

> Full use of the organization's human capital, increased knowledge, enhance mutual respect among diverse employees, increased commitment among diverse employees at all level of organizational and across all functions, greater innovation and flexibility as others participate more constructively in problem-solving teams and improved productivity as more employee effort is directed at achieving the system's goal and less energy is expended in dealing with cultural miscommunication issues (Loden, 1996 as cited in Ting-Toomey & Oetzel, 2001, p.8, Loden & Rosener, 1991 as cited in Ting-Toomey & Oetzel, 2001, p.8).

This study focuses on culture-based situational conflicts (see Ting-Toomey & Oetzel, 2001) and believes that investigating conflict along a cultural variability perspective serves not only to understand conflict variations among different clusters of cultures but also the differences in value dimension and how they influence conflict management processes (Ting-Toomey & Oetzel, 2001). This definition of conflict provides a better barometer to the study in exploring how conflict can arise interculturally.

Types of Intercultural Conflict

There are three types of intercultural conflict: object, relationship and priority conflicts (Hall, 2005). Object conflicts refer to 'conscious or unconscious disagreement and misunderstanding about something' (Hall, 2005, p.233). O*bject* in a very broad sense refer to anything that 'may be perceived intellectually be it physical or abstract' (Hall, 2005, p.233). Here, the discussion is important for both cultures and has:

> a strong relation to the issues either positively or negatively but the term or concept may be found in a variety of contexts and is often surrounded by greater cultural elaboration and restrictions, it provides and explanatory bridge between other concepts and finally the meanings associated with it are discrepant across particular cultural communities (Hall, 2005, p. 235).

Relationship conflict refers to the relationship between two or more people which normally 'deals with how these identities affect and link each other together in actual, specific relationships' and 'often highlight the implications of human actions relative to one another'(Hall, 2005, p.236). Relationship conflict links with the issue, the relationship and the effect on the relationship. Priority conflict 'involves a judgment of the relative moral worth of certain actions' (Hall, 2005, p.238). Often priority conflict links with the emotional state of the person and exposes people's values and communities to different kinds of people and the different actions taken.

Cultural Approaches To Conflict

Essentially, there are five styles of handling the interpersonal conflict described above: avoiding, accommodating (obliging), competing (dominating/controlling), compromising and collaborating [integrating] (Hall, 2005). An avoiding style is used to avoid the conflict topic (do not want to discuss) or avoiding the individual or the conflict situation. An accommodating (obliging) style puts a 'high concern for the other person's conflict interest above and beyond one's own conflict interest' (Ting-Toomey & Oetzel, 2001, p.46). A compromising style requires give-and-take in order to achieve an agreement in the conflict and a collaborating (integrating) style 'reflects a need for solution closure in conflict and involves a high concern for self and high concern for others in conflict substantive negotiations. This five styles reflect a western approach: 'it should be noted that 'obliging and avoiding conflict styles often take on a Western slant of being negatively disengage' (Ting-Toomey & Oetzel, 2001, p.46). In a collectivist culture, this conflict style helps 'to maintain mutual-face interest and relational network interest' (Ting-Toomey, 1988 as cited in Ting-Toomey & Oetzel, 2001, p.46). A cultural approach to conflict adds an important element to the study. The study investigates the respondents' approaches towards the conflict and is related to other aspects of the study: cultural values, verbal and nonverbal communication patterns.

METHODS

Research Design

The primary approach for this research study is ethnography. Ethnography can be defined as 'the direct observation, reporting and evaluation of the customary behaviour of a culture' (Jandt, 1998, p. 49). This technique requires unlimited period of residence, knowing the language of the group, participating in the group activities, and using a variety of observational and recording techniques. The researcher is familiar with the local dialect and the Malay language. A limitation for the author is however that the author is not fluent in Mandarin, or its dialects such as Cantonese or Hokkien, or the language spoken by the Indian population, Tamil. The study will apply key methods of ethnography: participant observation and informal interviewing of respondents as proposed by Agar (1980, pp.6 as cited in Cousin, 2009) for 'the purpose of learning from their ways of doing things and viewing reality'.

Mixed-Method Approach

This study used a survey, followed by one-on-one interviews or e-interviews (depending on the personal preferences of the respondents). The use of quantitative method in this study will be complementary to the qualitative methods in that this data summarize the demographic characteristics of the respondents. Quantitative methods 'employ meaningful numerical indicators to ascertain the relative amount of something' while qualitative methods 'employ symbols (words, diagrams and non-meaningful numbers [to indicate the meaning] other than relative amounts) people have something' (Frey et al., 2000, p.83). While ethnography ideally requires observation in natural setting (Jandt, 1998, p.49) this study applied this method in collecting demographic information and measuring instances of intercultural issues that may exist in the work place from the

three ethnic groups' viewpoints. The qualitative approach is selected in order to provide an in-depth perspective regarding the personnel experiences that cannot be measured through a straight quantitative approach.

Participants

The respondents comprised administrative personnel from three administrative levels: the upper, middle and lower levels including academic staff at University Malaysia Terengganu, Terengganu, East Cost of Malaysia. Eighty nine respondents were involved in the survey across three managerial levels. Twenty respondents were selected for the interviews.

Research Methods

Quantitative Methods

The survey was designed and administered using Survey Monkey, a web-based survey software available at http://www.surveymonkey.com. Around 120 surveys were distributed across three organizational levels: the upper, middle and lower management, with approximately forty respondents for each level. The respondents for surveys are chosen through a purposive sampling technique to ensure a range of ethnicity, religion and years of service are represented. Purposive sampling involves 'recruiting people on the basis of shared characteristic which will help you in your inquiry' (Cousin, 2009, p.79). The survey questions consisted of two parts: demographic data and respondents' knowledge of intercultural communication. In the second section respondents were asked 'Yes' and 'No' questions. They consisted of general questions about culture, cultural values (power distance, uncertainty avoidance and long-term orientation), verbal communication (language use) and nonverbal communication (proxemics, haptic and the use of silence).

Qualitative Methods

Interview questions then developed after analysing the survey data. In general, the interview questions were elaborated from those on the survey then used in semi-structured interviews. The respondents were given a choice of interviews: one-on-one semi-structured interviews and e-interviews. E-interviews are used as an alternative method in collecting data. The e-interview will be offered because the topics may be too sensitive for religious, linguistic or cultural reasons (Bampton & Cowton, 2002). E-interviews can generate feelings of comfort for interviewees and make it easier for them to discuss these issues without feeling embarrassed or discomforted by the presence of the interviewer. This method also 'suitable for research students who wish to conduct research on their home countries while studying abroad and so that they would labor under no cultural or linguistic difficulties…' (Bampton & Cowton, 2002, p.6). The study also used e-interviews if there are any matters which arose with regards to the e-interview questions and required follow ups from abroad, especially after the end of data collection period (which only occurred for three months in the home country). Twenty respondents were selected using purposive sampling, in order to access a particular subset of respondents based on religion, ethnicity, years of service and gender. By selecting the respondents this way, 'the interviewer is in fact selecting what

she thinks is a key source of variation to add to the depth and plausibility of her analysis' (Cousin, 2009). To investigate respondents' lived experiences in relation to their intercultural communication, a semi-structured interview was used. Semi-structured interviews are the main, preferred data collection method because respondents are able to freely discuss their experience as to how they deal with intercultural communication problems at their workplace. Semi-structured interviews allow researchers to explore in-depth the experiences and perceptions of the individuals, which also mean 'the description of groups' (Cousin, 2009, p.109). This type of interview can be described as having a 'structured set themes which serve as guide to facilitate interview talk' (Cousin, 2009, p.109). Therefore, the interviewer should adapt, modify and add whenever possible in the prepared questions accordingly to the interview talk (Cousin, 2009). Through semi-structured interviews, the interviewer applied 'a set of basic questions on the interview schedule, but they are free to ask probing follow-up question...' (Frey et al., 2000, p.101) in order to obtain details.

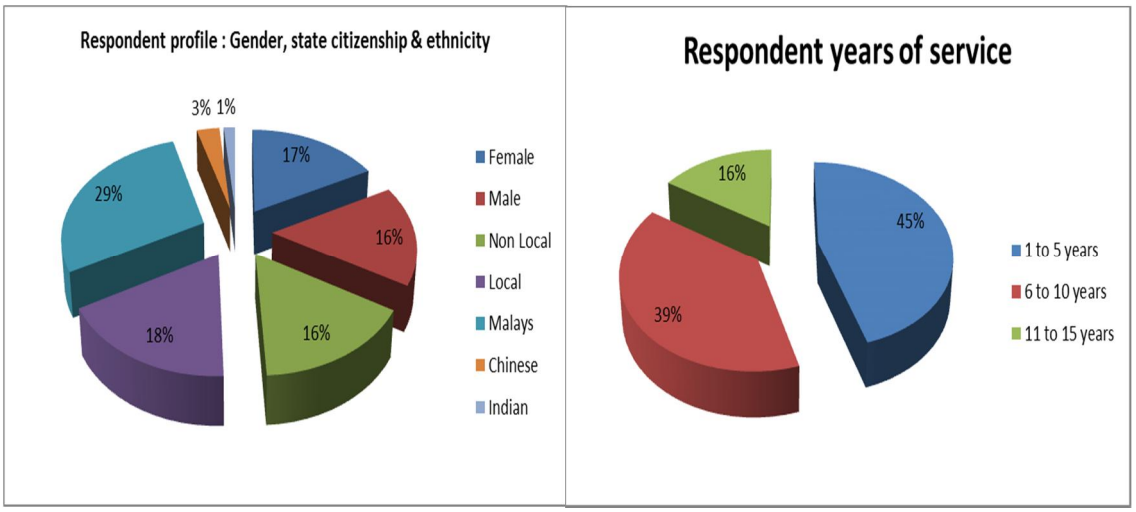
Interviews are 'exchanges in which people provide information orally' (Frey et al., 2000, p.99). These methods 'are self-report measures that ask respondents to provide information about their own and/or other people's belief, attitudes and behaviours (Frey et al., 2000, p.100). This study employed two question formats in the interview sessions. First, the funnel format is where 'open questions are used to introduce the question, followed by narrower, closed question to seek more specific information. Second, is the inverted funnel format, 'which begins with narrow, closed questions and build to broader, open questions' (Frey et al., 2000, p.101). The venues for the interview were chosen by the respondents: their most comfortable available place away from distractions and where they were able to speak about their intercultural experiences (Cousins, 2009). The researcher asked their permission to tape record the sessions every time before the interview started. The researcher also briefed the interviewees so that they understand the flow of the interview (Frey et al., 2000). If a question may address a taboo or personal topics, the researcher used an inverted funnel format 'because one can pose low-risk, closed, fixed-choice questions first and, after respondents are comfortable with the topic, move on to more probing, open question' (Frey et al., 2000, p.102).

Data analysis

Quantitative data were analyzed using explanatory data analysis which includes data from the survey and the interview. Data from the survey use SPSS to summarize demographic data and gather intercultural issues and awareness. The qualitative interviews were transcribed in verbatim and translated. In transcribing, researcher tried to minimize and corrected the grammatical error of the direct quotations to ensure that the meaning is not lost during the transcription process so to preserve the respondents' 'voices' in the text (see Colic-Peisker & Walker 2003; Ebbeck & Dela Cerna 2006). Those passages which did not have exact equivalent to English will also be stated in original language. The qualitative data has been grouped into thematic concerns and pseudonyms used to address respondents.

RESULTS

Demographic Survey Data: The majority of the respondents who participated in the survey aged from 31 to 35 years old. Non-local belongs to other 12 state such as Perak, Kelantan etc. as well as from East Malaysia such as Sarawak. The majority of respondent are Malay Muslim (n=78), 7% (n=6) Buddhist, 5% (n=4) Hindus and 1% (n=1) is Christian. The majority Malays worked at three levels of the organization, mostly at middle level (n=47) while the Chinese (n=7) and Indian (n=4) respondents mainly worked at the middle level, with only one Chinese working at the upper level and none at all at the support levels.



Figures 3 and 4: Respondent profile: Gender, state citizenship, ethnicity and years of service.

Survey and Interview Data: In a survey a general question was asked: *I know a lot about my colleague's culture*. The majority Malays (n=40) answered 'No' which illustrates that majority of the Malay in this study have limited knowledge about their colleagues from different cultural background. This result was reinforced through interview data, with respondents sharing their views concerning their lack of knowledge of their colleagues from minority groups:

> *I may know Mr Lingam, only as a colleague. I may talk to him, chatting, but I do not know in detail about him if compare to my Malay friends, which is I closed too. I know what is and what not. (Khadijah, Malay academician)*

> *I'm not comfortable to admit that I really know a lot about other ethnic cultures. But I did know their cultures a lot more than they know about my culture. (Liang, Chinese academician)*

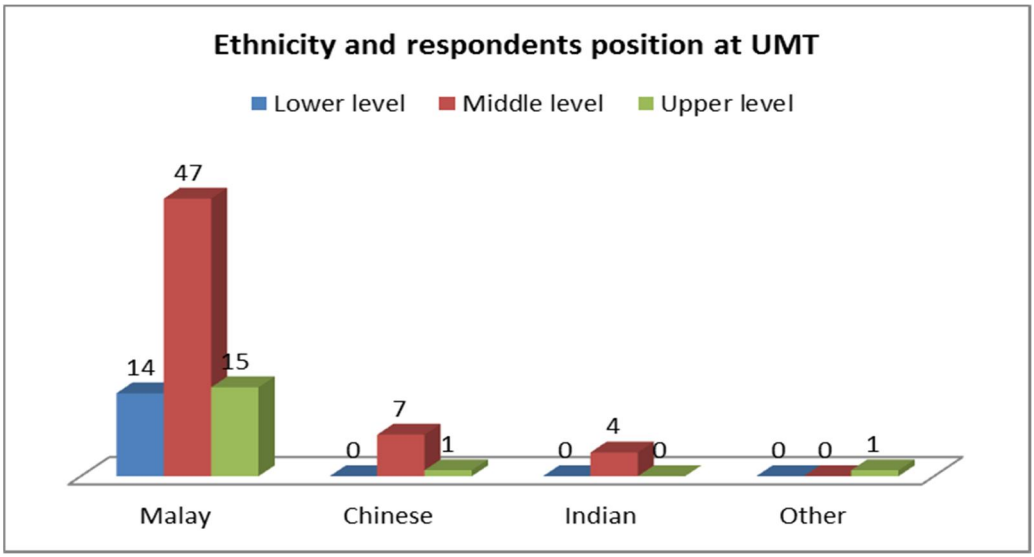


Figure 5. Ethnicity and respondents position at UMT

Cultural values: This study focuses into three cultural values: power distance, uncertainty avoidance and long-term orientation. These cultural values were selected based on Hofstede dimensions.

Power Distance (PD): The survey data in relation to cultural values however shows that there is very little difference between the ethnic groups. For example, Question Cul6 indicates that majority of the respondents regardless of their ethnicity value high power distance as well as question Cul8. These findings suggest that all groups are hierarchical and perceive power distance as an important value. On the other hand, question Cul10 indicates that the majority of the respondents, in spite of their ethnicity, value low power distance. This reveals that despite being high in power distance, in some other aspects they are likely to choose to not exercise power distance. Question Cul19 suggests that the majority of respondents, regardless of ethnicity, value high uncertainty avoidance. They prefer to have a well-defined rules and regulations at their workplace to avoid uncertainty. However question Cul21 shows that the majority of respondents, regardless of ethnicity, value low uncertainty avoidance which signifies that they are not afraid of any transformation in the institution. Questions Cul29 and Cul34 both signify the long-term orientation of the majority of respondents irrespective of their ethnicity towards their future achievement in the organization.

However the interview data does suggest that there are differences between the ethnic groups in the areas of power distance, uncertainty avoidance and long term vs. short term orientation. In relation to power distance:

> *Yeah, I'm not comfortable… I'm afraid that if I'm not using the right salutation for the right designation, when I know later on, it will make feel guiltier... (Yusof, Malay upper level)*

> *I should address them correctly; it is recognition for their achievement... (Aditya, Indian academician)*

In relation to uncertainty avoidance:

> *Basically, when we were reshuffled to other department, normally we asked for it, which we really love to do, it will be no problem to me. (Khadijah, Malay academician)*

In relation to long term vs. short term orientation:

> *… it is not a wise choice to let fate to control all. … I believe, everything should be plans accordingly…I consider with focus and effort, I will get what I deserves for. (Steven, Chinese academician)*

Amina (Malay academician) showed a different perspective, however, with regard to uncertainty avoidance:

> *If the changes that had been made are inappropriate, I reject them. For example I feel uncomfortable if the punch cards need to be punched twice. This actually does not fit to my flexi hours of working.*

One respondent described the power distance with regard of the job position and superiority which suggest the dominant position held by and understood by both ethnic groups:

> *Well, it just when my superior is around, I cannot mingle with them like I mingle with my colleague, surely there is a gap; I cannot simply make jokes… (Aishah, Malay support staff)*

Apart from respondents being high in power distance, there was a respondent who did not prefer their colleague to use their title or proper salutation as mention by Mek Na (Malay academician) who is both female and younger and may reflect a changing pattern of communication:

> *I prefer they use my name…I'm not comfortable and I think that's too formal for me.*

Table 5. Survey and feedback from respondents

Power Distance (PD): Survey	**Yes**	**No**
Cul6: Uncomfortable addressing their superior by name	97%	3%
Cul8: Always say 'Yes' even though disagree	87%	13%
Cul10: Cannot give their colleagues equal treatment; they need to consider their colleague's age and seniority in services, even though they are in a high level of management than theirs.	24%	76%
Uncertainty avoidance (UA): Survey		
Cul19: I am uneasy in situations where there are no clear rules in my workplace.	92%	8%
Cul21: I don't like changes or being transferred to other department.	19%	81%
Long-term vs. Short-term orientation (LTO vs. STO) : Survey		
Cul29: I will try my best to achieve the most excellent awards in my organization.	92%	8%
Cul34: I will let fate to control in order to achieve the most excellent awards in my organization.	27%	73%

Verbal Communication: Use of language

Figure 6 illustrates fifty Malay respondents who can converse in two languages: Malay and English. Seven Malay respondents can speak more than two languages, such as Malay, English and Arabic. Six of the Malay respondents can also converse in Mandarin and Japanese apart from Malay and English. Only twelve Malay respondents are bilingual either in Malay or in English. The majority Chinese respondents do speak three languages: mainly Malay, English and Mandarin. Only one Chinese can speak two languages namely Malay and English. All of Indian respondents (n=4) can converse in three languages: Malay, English and Tamil. The findings indicate that majority of the respondents either Malay or minority ethnics normally use Malay and English as a verbal language at this institution. A few Malay respondents were also capable of speaking several other languages such a Japanese, French and Arabic. This was usually their personal choice. While Chinese and Indian respondents generally able to speak more than two languages which include their mother tongue either a Mandarin or Tamil. During the interview, the respondents were asked which language that they use most in day to day interaction. Table 6, question Lan2, indicates that majority of respondents use Malay language in their daily communication at the institution.

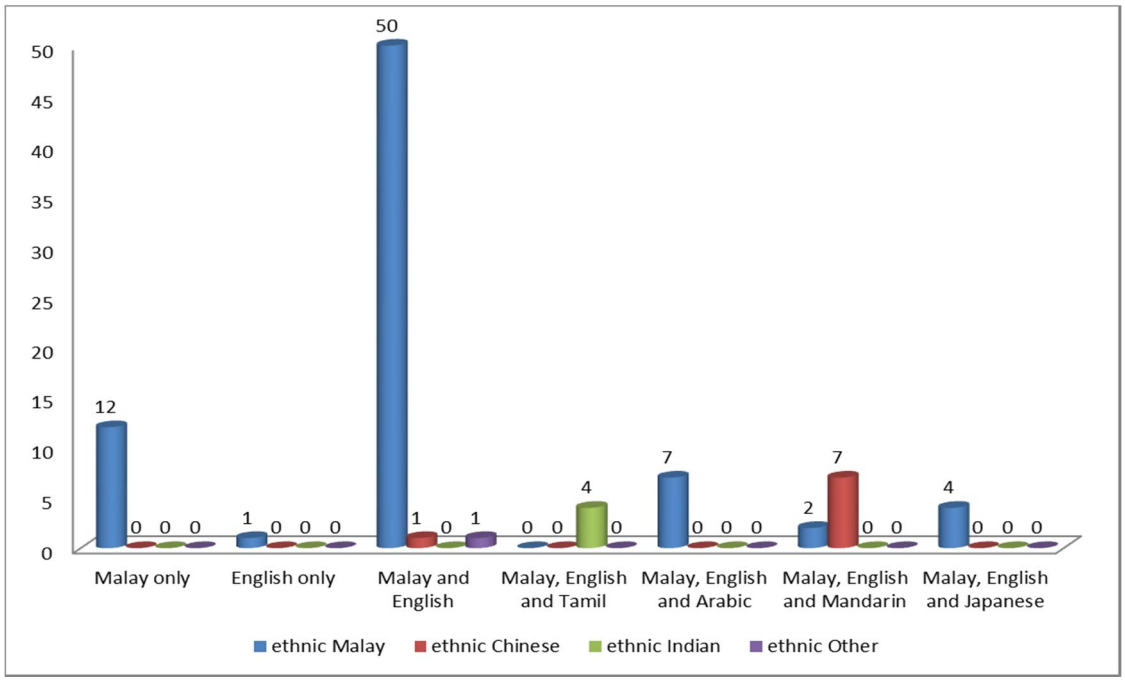


Figure 6: Variety of language that the respondent able to speak

Table 6. Survey and feedback from respondents

Verbal communication: Use of language - Survey	**Yes**	**No**
*Lan2: Do you use Malaysian/Malay language (formal) in your daily conversation at UMT***?**	97%	3%
Lan4: Do you use Terengganu dialect in your daily conversation at UMT?	71%	29%
Lan8: Do you experience any misunderstandings in relations to the usage of words in Terengganu dialect?	40%	60%
Lan10: Do you choose your topic or words carefully when communicating with the other ethnic groups?	98%	2%
Lan11: Are you aware that some objects or animals should not be mentioned in front of other ethnics (such as pigs to Muslim)?	90%	10%

Yusuf (Malay upper level), Yahya (Malay middle level), Mek Na (Malay academician) and Lei Hua (Chinese upper level) share their views in relation to language use at UMT:

Interview 1	
Researcher	*: Do you use Malay language in daily conversation?*
Yusuf	*: Yup…mostly in Malay language.*
Interview 2	
Researcher	*: Normally when and with whom that you use English in your daily conversation?*
Yahya	*: Usually when there is an overseas visitor, for instance last week we did entertained two visitors from Australia, this actually a last minute duty assigns by International center to our department. I was designated to take them touring the campus. So I need to communicate in English.*
Interview 3	
Researcher	*: Do you use Malay language and mixed with Terengganu dialect?*
Mek Na	*: Aaa…it really depends with whom I communicate, what situation and the context as well.*
Interview 4	
Lei Hua (LH)	*: I will speak Chinese with my Chinese friend, a Mandarin.*
Researcher (R)	*: What is your mother tongue?*
LH	*: I consider my mother tongue is Teo chew. Normally with my school friend I prefer to use Mandarin.*
R	*: So, that means you will use Mandarin if you converse with your Chinese colleague as well?*
LH	*: Mandarin, unless he/she cannot speak Mandarin.*
R	*: What language do you use if they cannot understand Mandarin?*
LH	*: I will use English, such as Mr L (which is a Chinese guy), he cannot speak Mandarin. Automatically I will use English, if not he may not understand me.*
R	*: When and where that you normally use Malay language at UMT?*
LH	*: Anytime and anywhere*
R	*: Meaning that you will use Malay language with support staffs as well as with your superior?*

LH	*: Yup*
R	*: With whom, where and when that you normally use English?*
LH	*: I use English during my lecture, sometimes I will mix with Malay language if my students seems didn't get the point. Also it depends on the individual, sometimes certain individual prefers English, and then I use English.*

Interview 5
I normally uses Malay and English language, a part from that I also speak other Chinese dialect such as Hakka, Mandarin and Cantonese…I also uses Terengganu dialect whenever I need to speaks with my subordinate but not as fluent as local…(Liang, Chinese academician)

These data indicate that intercultural communication between Malay and others exists, but the language of inter-ethnic communication is the Malay language. Apart from Malay language, the personnel apparently use English and the Terengganu dialect as a medium of conversation among themselves. English is normally used whenever there was a visitor from overseas or in the classroom (as explain by respondent in interview 2 and 4). While the use of the Terengganu dialect really depends on the context and the individual that they are communicating with (as described in interview 3 and 5). Survey Question Lan8 shows that the majority of respondents did not experience misunderstandings in relation to the usage of words in the Terengganu dialect; however 40% of the respondent had experienced some misunderstanding. Yusuf (Malay upper level) explained during the interview:

Researcher (R): Encik Yusuf ever experiences any misunderstandings in relations to the usage of words in Terengganu dialect?	
Yusuf (Y)	*: Yes..it is…I mispronounce the words.*
R	*: what is the word?*
Y	*: I mispronounced and the staffs did not understand what I mean, it seems like* **idgham** *is not right, I'm sure it's a word.*
R	*: what is that word?*
Y	*: Oh…I couldn't remember…it sound like…*
R	*: is it* **sokmo**…**lallu***?*
Y	*: Not* **sokmo**, *I mispronounced and the sound is not right…I used to use the words, eventually in one morning while having a meeting, when I pronounce it, my staff point out.*
R	*: Is it because the word is not appropriate?*
Y	*: No, it's the way I pronounced it.* **Dengung *i***s *not right.*

Idgham and *dengung* are mentioned in this conversation referring to the right pronunciation when reading Al-quran (*Tajweed*). While *sokmo* is a Terengganu dialect referring to always/every time and *lallu* means now/ instantly/ promptly which is different from *selalu* in formal Malay language which normally refer as always/every time. This proved to be confusing for the first timer who had started at the institution.

> *Yup…at first…when my colleague said* **sokmo***…it's a dialect that require more time to learn, so I will asked around, what is that thing means, sometime my students teach me instead….at one time I thought* **sokmo** *means as* ***semua** *(everything/the whole thing). (Steven, academician)*

***Semua** (everything/the whole thing) in formal Malay represents a different meaning from the word **sokmo** (always).

Findings indicate that the majority of respondents, regardless of ethnicity, are aware that they need to be selective in terms of topics while communicating with other ethnic groups. They were also aware that there is a taboo for some ethnic groups with regards to the object or animals being mention in front of the ethnic group which can then spark misunderstandings. This has been highlighted by Liang (Chinese academician).

> *…But I felt that Terengganu dialect is difficult to understand because the accent is different and there are possible words that have different meaning to what I generally know. I know several taboo words which should not be cited in front of other ethnic group such as* **Bodoh, biadap, lembu, anjing, babi, Keling, syaitan** *(stupid,rude,cow,dog,swine/pig,Keling and demon).*

The words such as stupid, rude, cow, dog, swine, etc. are a taboo to some of the ethnic groups and have prejudicial cultural meanings. *Keling* is a rude term used to refer to Indians (Malaysian Indians stuck with dictionary's ethnic slur, 2009 & Sabri,2012), the meaning is quite similar to the word 'nigger' used for African American or the word 'Boong, Abo and Coon' for the Aborigines of Australia (List of ethnic slurs, 2012).

Nonverbal communication: Proxemics, haptic and use of silence

Table 7. Survey questions and feedback from respondents

Proxemics	**Yes**	**No**
NV1: *I'm aware that every ethnic and religious group in UMT have their own interpretation of the use of space.*	60%	40%
NV2: *I feel uneasy if my male colleague gets too close to my working space/area (desk or your chair.)*	92%	8%
NV3: *I feel uncomfortable if someone of the opposite gender stands too close to me at my work place.*	70%	30%
Haptic		
NV25: I'm aware that certain ethnic groups may have a taboo in touching practices.	87%	13%
NV26: I'm aware that some ethnic group do not like to be touched in some areas of their body because of their cultural and religious beliefs.	78%	22%
Use of silence		
NV33: I will normally use silence as a defensive strategy when in conflict with my colleagues from the same gender, ethnicity and religion.	56%	44%
NV34: I will normally use silence as a defensive strategy when in conflict with my colleagues from different gender, ethnicity and religion.	54%	46%

Question NV1 indicates a high awareness by survey respondents with regard of the use of space by diverse ethnic groups. Furthermore, question NV2 and NV3 show that the ways in which space is used and interpreted are cultural. Questions NV25 and NV26 reveal a high level of awareness among the respondents about the taboo of touching and which ethnic groups that disapproves of touching in relation to religious and cultural beliefs. Besides, questions NV33 and NV34 suggest that silence in a particular situation may mean an acceptance, agreement and, in certain other cases, indifference, apathy or even anger. In some ways silence is used and interpreted as cultural practices.

Lei Hua (Chinese upper level) highlights the issue of proxemics during the interview:

> *I feel okay if my colleague from different gender gets too close to my working area. I don't mind to be just two of us in my room, but I may concerns that other ethnic may not feel comfortable…*

With regard to haptic issues, however some respondents could explain this in detail, while others couldn't.

> *I do not know any of the taboo that practice by other ethnic group. (Hawa, Malay upper level)*

> *In my culture, they do not practice touch… Also they used to touch whenever they need to greet someone by shaking hands. While touching is permissible and permissible in my culture...I knew that ethnic Malay do have taboo in touching practices, especially Malay women, which I believe are more sensitive to the use of touch due to religious and cultural beliefs … (Liang, Chinese academician)*

Further, in discussing the issues of silence, Indian respondents appear to be more vocal. Aditya (Indian academician) explains this in an e-interview:

> *I will not keep silence whenever I feel annoyed by my colleagues; I think this will create more tension. I disagree that silence can solve conflict, to me; I should voice out and try to resolve the conflict. Whenever I face disagreement with my colleague from the same gender, ethnicity and religion, I will express my stand and discuss the issues, I believe this is more practical. Whenever I encounter a conflict with colleague from different ethnicity, I will speak up and will try to point out his stand. I feel this ways is more professional.*

Conflicts Resolutions

The respondents were given a situation and type of conflict resolution that they may choose. Essentially, there are five styles of handling interpersonal conflict: avoiding, accommodating, competing, compromising and collaborating.

Table 8. Survey question and feedback from respondents

Conflicts resolutions that they choose to use in the situation given	**By ethnic**	**No. of respondent**	**Chosen Solution**
CF10: When there is a conflict between my colleague from the different ethnicity, religion and cultural background, I will…	Malay	40	Collaborate to solve conflict until a mutually agreeable solution is found
	Chinese	6	collaborate to solve conflict until a mutually agreeable solution is found'
		2	compromise whenever a conflict arise'
	Indian	3	collaborate to solve conflict until a mutually agreeable solution is found'
		1	gunny sacking

The survey question above provided fourteen alternatives for respondents to choose from. Yet, fifty five respondents selected 'collaborate to solve conflict until a mutually agreeable solution is found 'as a solution. Majority respondents prefers to collaborate whenever conflict arises, on the other hand two Chinese respondent prefers to compromise and one Indian select to avoid the conflict (gunny sacking).

This could imply that harmony and long lasting relationship is a priority. In terms of cultural differences, apparently the three ethnic groups prefer to avoid controversial solution and try their best to maintain good relationships. There are only a small number of Chinese and Indian respondents who prefer to avoid or choose compromise in relation to conflict. At hand no obvious difference from the three ethnic groups in choosing the solution.

Interview respondents provided interesting insights into the issue of conflict and its resolutions. Whenever conflict arose:

> *I choose to be silent whenever there is a conflict especially with a colleague from different background because I do not know in detail their restrictions. (Liang, Chinese academician)*
> *Whenever there is a conflict, I will focus to the issues that we discuss, I certainly not depend on the ethnic, either you are Malay or Chinese, there is no differences in terms of resolution. (Lei Hua, Chinese upper level)*
>
> *I believe that the culture here may not accept an individual who are outspoken, that is the reason why I choose to be silent whenever there is a conflict between my colleague from different ethnicity, religion and cultural background. (Fatimah, Malay support staff)*

Fatimah seems to avoid conflict by using a silence strategy as they assume that the culture of the workplace may not permit the individual to be open. Liang however says that not knowing the culture of the individual that they had a conflict with prevents a more pro-active strategy. Lei Hua indicates that it is the issue of the conflict should be

addressed not the cultural background of the individual. Considering Fatimah is from support level, this could be criteria where the subordinate would prefer to avoid the conflict and perceive their leader as a mentor or more superior. This is significant in the collectivist culture, where there is a need 'to maintain mutual-face interest and relational network interest' (Ting-Toomey, 1988 as cited in Ting-Toomey & Oetzel, 2001, p.46). Lei Hua may not feel as restricted as Fatimah in dealing with the conflict considering she is at the upper level of the management where the leader may need to be seen as a reliable and respected individual.

DISCUSSION

The findings reveal that the majority of respondents for both the survey and the interviews were Malay. This could be seen to be a limitation for the study. However it is theorised that this context would highlight the cultural influence of the Malays on the minority groups. Malays are the majority ethnic group and is the group present at the middle and upper levels of management. The majority of Malays in this study are local (53%). A general question about culture revealed by the survey data was that the Malay personnel have less knowledge about their colleagues from different cultural backgrounds. Given that the local Terengganu population has less minority ethnic groups than other Malay provinces this finding needs investigation. This is confirmed by the interview respondents, for example see the Khadijah interview. The interview findings reveal that the minority groups feel there is inequality in terms of the cultural knowledge Malays possess about their minority culture. The evidence shows that cultural values such as power distance have been embraced by the majority of the respondents, regardless of ethnicity. For example, the survey and the interviews both confirm that power distance differences are understood and valued in the institution. Yet there were a minority of interview respondents who disclosed that they valued others' power distance practices in minimal way only. The survey and the interview respondents also showed that they understood and valued differences about uncertainty practices. Some interviewees explained that there was a minority of respondents who saw uncertainty as a threat (for example Amina).The survey and interview data confirmed that majority of the respondents did value long term orientation prevalent among respondents at their workplace.

Verbal communication is seen as one way of integrating personnel from diverse backgrounds. The use of formal Malay in their daily conversation helps personnel to overcome differences in the variety of language that they normally use outside the workplace. The Terengganu dialect however was perceived to be difficult by some of the respondents and sometimes leads to misunderstanding, especially for personnel who are not local (as explained by the interview respondents Yusuf, Steven and Liang). Further, regardless of ethnicity, the survey and interview respondents demonstrated their awareness that every ethnic group should be sensitive in dealing with the taboo words in front of other ethnic groups. They were aware that this can lead to misinterpretation and conflict. The findings also reveal that there are differences in the use of nonverbal communication. The use of proxemics is varied according to ethnicity, as reveals by Lei Hua, a Chinese respondent with a PhD. On the other hand, other ethnic groups are concerned about the importance of proxemics exhibited by Malay Muslim colleagues. Whilst the survey shows the use of haptics is taken seriously, the interview reveals that Malay respondents seem to be unaware about the issues compared to non-Malay

respondents (see for example Liang). Moreover the use of silence is seen as a strategy to avoid conflict. Some respondents however do not prefer this way and choose to be vocal (see for example Aditya). The interviews confirm this more than the survey results. Additionally, the findings show that collaborating and compromising is the most popular conflict resolution strategy chosen by the respondents in the survey. Nonetheless, the interview also provides evidence that some respondents also choose avoiding and accommodating as a means to resolve conflict.

Overall the findings conclude that personnel ethnicity, religion and managerial position can influence respondents' actions towards several issues of intercultural communication at their workplace. The study provides insights that different ethnic groups take their peers 'for granted' from either the view point of a dominant or marginalized cultural perspective. The dominant group often assumes that their view is acceptable to the entire minority. In an ideal world, cultural diversity should be seen as an advantage not vice versa. Differences are supposed to be valued and respected and it is important not to underestimate variances. Every individual in the institution deserves to be appreciated regardless of their ethnicity, religion or cultural background and this eventually will reduce mistreatment to minority. To help respondents appreciate this view, the study recommends a process of creating awareness. It recommends the use of a conceptual model introduced by Lawrence (2009) in order to create and sustain more positive communication and connections among the personnel at this particular institution.

CONCLUSION

The differences in intercultural communication patterns depicted by the respondents may not be representative to the whole population of the University Malaysia Terengganu or Malaysian ethnicity as a whole. The results though are specially derived from the respective purposive sampling. While the findings of this study were not necessarily definitive due to the small sample and single location, it is nevertheless hoped that higher education institutions understand the importance of intercultural communication to the personnel working at the university level. This will contribute not only to the well-being of personnel and the students but also enhance the communication and promote ethnic integration among the personnel at Malaysian higher education alongside the ethnic integration of the students.

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LESS IS MORE - PARTIAL THIOLATION OF POROUS CHITOSAN BEADS TO ENHANCE CU(II) ADSORPTION

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ABSTRACT

Chitosan gel beads have a high Cu(II) uptake due to its high affinity to Cu(II) ion. However, its use as an absorbent in flow column is affected by swelling and low stability in acidic conditions. Even though crosslinking of chitosan beads increases resistance to acid attack, it also decreases their sorption capacity. In this study, modified chitosan beads (ETB) with dithiocarbamate derivatives were thermally decomposed to form thiourea and disulfide crosslinks to enhance stability in acidic condition. The Cu(II) ions were adsorbed to amine, thiol and sulfonate groups of ETB. The coordinated Cu(II) ion was reduced to Cu(I) ion and oxidized thiol to sulfonate groups. The Cu(II) uptake of partially modified ETB was greater than highly modified ETB. The Cu(II) uptake (mmol/g) was inversely proportional to total sulfur of ETB with a linear correlation coefficient of 0.8835 (ETB/solution ratio: 20 beads / 30 mL). Greater formation of crosslinks in highly modified ETB may have decreased the number of amine binding site for Cu(II). The Cu(II) uptake of partially modified ETB was similar to pristine chitosan beads with greater stability in acid.

***Keywords**:* chitosan, copper, crosslink, thiolation, beads

INTRODUCTION

Copper element is used in numerous applications, such as wiring in electronics and agricultural fungicide (Wightwick et al. 2008). The low level contamination of Cu(II) ion in ground water is of great concern due to the accumulative nature of heavy metals in the human body (Srivastava & Goyal, 2010). However, conventional remediation technologies (e.g. membrane filtration and chemical precipitation) of this wastewater may not be cost effective as compared to adsorption using waste derivatives (Zhou & Haynesa, 2010). Chitosan which is derived from the exoskeleton of crab and prawn is used as adsorbent for both organic and inorganic pollutants in wastewater (Renault et al. 2009). The extensive network of C_2 amine groups (-NH_2) and C_6 hydroxyl groups (-OH) in chitosan accounts for their ability to remove metal, either by chemisorption or physisorption (Juang & Shao 2002). However, the solubility of chitosan in acidic solution has affected its application in acidic wastewater. Thus, the introduction of

chemical crosslink to chitosan is necessary to enhance its resistance to acid attack (Rorrer, Hsien & Way, 1993). Glutaraldehyde has been used to crosslink chitosan with adverse effects on the Cu(II) uptake capacity (Koyama & Taniguchi, 1986). Thus, the crosslinking of chitosan is usually conducted together with chemical grafting that introduces new functional groups to improve metal uptake (Merrifield et al. 2004; Kannamba, Reddy & AppaRao, 2010). The dithiocarbamate derivative of chitosan which has the ionic >N-CS_2^- group has been reported to have high affinity with Cu(II) ion (Muzzarelli et al. 1982). The potential formation of disulfide and thiourea crosslinks from decomposition of dithiocarbamate may improve the stability of chitosan beads (Erve et al. 1998). In this study, chitosan beads were simultaneously crosslinked and functionalised with thiol/thione groups to reduce the consumption of chemical reagents in chitosan modification. The modified chitosan with varying degrees of thiolation were synthesised, characterised and investigated for their Cu(II) uptake capacity and their sorption mechanism.

METHOD

Synthesis of ETB

Chitosan (degree of deacetylation = 88 %), carbon disulfide (CS_2) and sodium hydroxide (NaOH) were purchased from Qingdao Yuanrun Chemical Company Limited, Sharlau and Labserv, respectively. All chemicals were used without purification. Chitosan acetate solution was prepared by dissolving 2 g of chitosan in 50 mL 0.2 M acetic acid. The method for the preparation of chitosan gel beads was adapted from Wan Ngah et al. (2008), where chitosan acetate solution were added dropwise into 0.5 M NaOH bath, then thoroughly rinsed with MilliQ water prior to modification (Wan Ngah, Hanafiah & Yong, 2008). The average dry weight of chitosan bead was 1.9 ± 0.1 mg. Chitosan beads with varying degrees of thiolation were prepared by heating 4000 wet chitosan beads (7.6 g dry weight) with various amounts of CS_2 (0.8, 1.6, 2.4, 3.2, 6.4 and 16 g) and 100 mL ethanol at 60 °C for 2 hours. The modified beads (ETB) were rinsed with 5 aliquots of 250 mL ethanol and another 10 aliquots of 500 mL MilliQ water. Wet ETB samples were kept in air-tight reagent bottles filled with MilliQ water.

Characterisation of ETB

The total sulfur content of ground ETB was determined by Amdel Bureau Veritas Australia using the LECO sulfur elemental analyser. Quantification of thiol groups in ground ETB was conducted with Ellmans experiment using 5,5'-dithiobis-(2-nitrobenzoic acid) (DTNB), supplied by Sigma Aldrich. The 1 M phosphate buffer with pH 8 was prepared, bubbled with nitrogen gas for 30 minutes and sealed in a dark reagent bottle. DTNB and cysteine stock solution were prepared in 5 mM of concentration. The cysteine standards were prepared by diluting cysteine stock solution with phosphate buffer. All reagents were bubbled with nitrogen gas for 30 minutes and sealed in a dark reagent bottle. DTNB reagent was added to both cysteine standards and 3 mg ground ETB, shaken for 30 minutes and their absorbance was measured at 412 nm using Uv-vis spectrophotometer. The calibration line has a high fitness with a correlation coefficient, R^2 of 0.984. The molar extinction coefficient of 14100 is similar to those reported in literature (14140) (Dynon et al. 1972). The solubility of ETB was examined by immersing 20 beads in 50 mL nitric acid at pH 2. The Fourier Transform Infrared spectra (FTIR) were recorded from 1 w/w % KBr disc (2 mg ground ETB to

200 mg KBr) using the Agilent 660-IR spectrometer. A total of 64 scans was conducted on background and samples with a wavenumber range of 4500 to 400 cm^{-1}. The solid state ^{13}C nuclear magnetic resonance (NMR) spectrum of ground ETB was obtained using a cross polarization total sideband suppression program (CPTOSS). The NMR instrument used is the Avance II Bruker BioSpin 300 MHz. About 0.5 g of ground ETB was placed into a 4 mm diameter zirconia rotor and spun at 10 kHz during the analysis. The parameters of NMR analysis are summarised in Table 1. The analysis of x-ray photoelectron spectroscopy (XPS) was conducted on wet ETB and Cu-ETB beads (sulphur content: 6.9 mmol/g) with a Kratos Axis-Ultra spectrometer, using a monochromatic Al Kα source.

Table 1. Parameters for solid state ^{13}C nuclear magnetic resonance (NMR) spectroscopy

Description	Value
Number of scans used	18000
Sweep width (Hz)	22058
Acquisition time (s)	0.023
Receiver gain	2050
Pre-scan delay (μs)	6
Recycle (relaxation) delay (s)	5

Cu(II) adsorption

The batch adsorption of Cu(II) was conducted using 1 mM copper nitrate solution at pH 4.5 and room temperature (25 °C). ETB wet beads were shaken with 30 mL copper nitrate solution for 48 hours in two sorbent/solution ratio (5 and 20 beads / 30 mL). Equilibrium concentration of Cu(II) was analysed using a Perkin-Elmer Optima 3000DV inductively coupled plasma optical emission spectrometer (ICP-OES). The uptake of Cu(II), q_e (mmol/g) was calculated based on Eq. (1).

$$q_e = \frac{C_o - C_e}{m_{ETB} \times N_{Cu}} \times V \quad (1)$$

where C_o and C_e are Cu(II) concentrations (mg/L) before and after treatment with ETB; V is the volume of Cu(II) wastewater (L); m_{ETB} is the mass of ETB sorbent (g) and N_{Cu} is the atomic mass of elemental copper (g/mol).

RESULTS AND DISCUSSION

Degree of Thiolation

All ETB were not soluble in 50 mL nitric acid at pH 2. The total sulfur and thiol content of ETB prepared with different CS_2/chitosan ratio is shown in Figure 1. In general, total sulfur was higher when chitosan beads were modified with greater CS_2/chitosan ratio. Total sulfur increased proportionally with increasing CS_2/chitosan ratio and reached a plateau when the CS_2/chitosan ratio was at 2. The increase of ETB thiol content with greater CS_2/chitosan ratio was small but similar to the pattern of total sulfur.

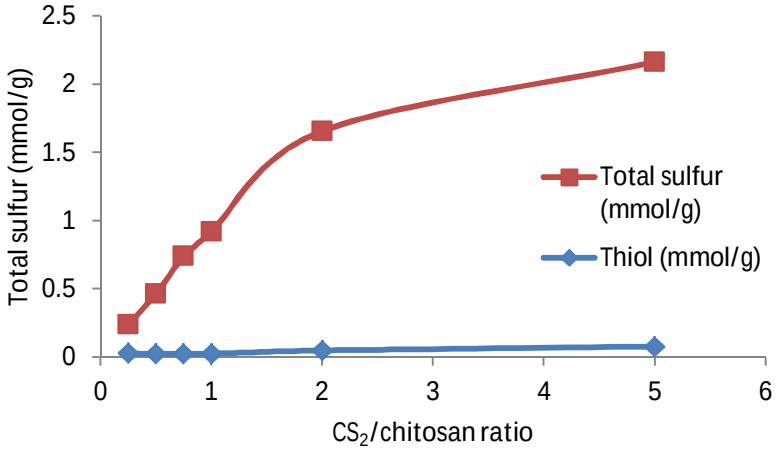


Figure 1. Total sulfur and thiol content of ETB (mmol/g) as a function of CS_2/chitosan reagent ratio

FTIR spectra analysis

The stacked FTIR spectra of freeze dried chitosan beads, ETB and Cu-ETB are shown in Figure 2. The shoulder at 1621 cm^{-1} was assigned to thiocarbonyl group (Gavilan et al. 2009). The strong amide I band was at 1645 cm^{-1}.The thioureide band of dithiocarbamate (>N=CS_2^-) at 1480 cm^{-1} (Muzzarelli et al. 1982; Humeres et al. 2002), dithioester band of xanthate (-O-CS_2^-) between 1215 – 1175 cm^{-1} (Sankararamakrishnan et al. 2006) and thiol group (-SH) at 2550 cm^{-1} (Sousa, Silva Filho & Airoldi, 2009) are not visible in all ETB spectra, possibly due to superposition with strong amide bands. The disappearance of a shoulder at around 1600 cm^{-1} in the chitosan bead spectra indicated a decrease in amine group.

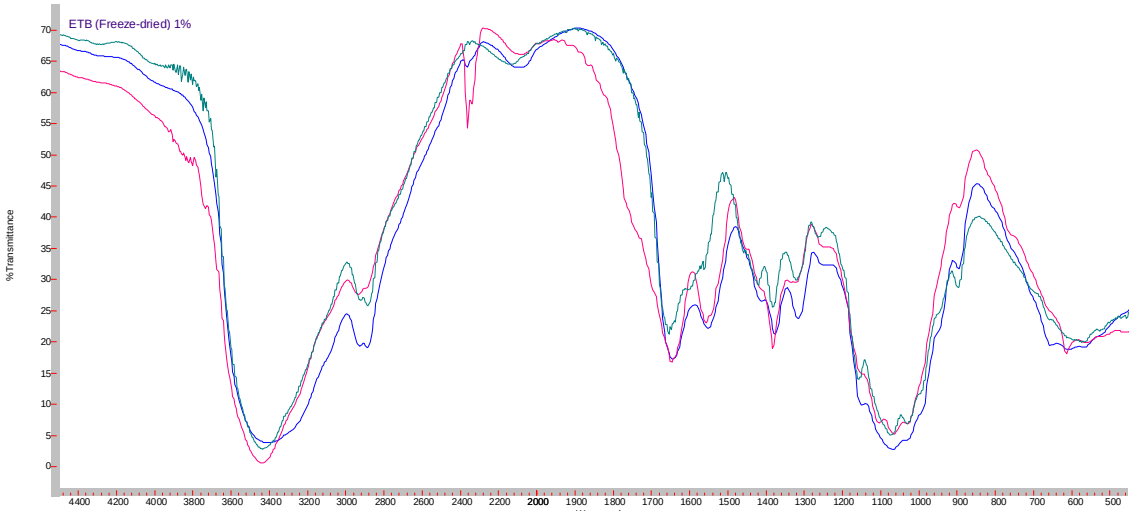


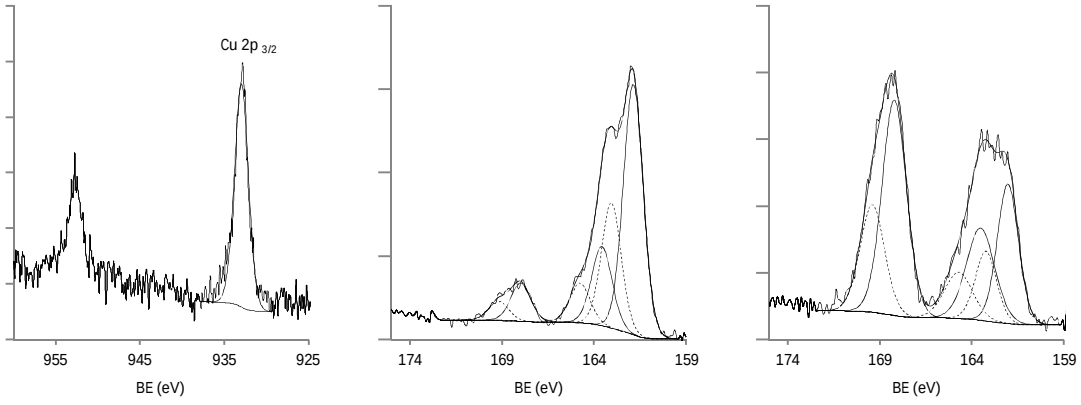
Figure 2. FTIR spectra of pristine chitosan (Green), ETB (blue) and Cu-ETB (Red)

Apart from that, enhanced band intensity for C-N vibration at 1454 cm^{-1} and 1374 cm^{-1} indicated the presence of new thioamide I and II bands (Reddy et al. 2011), possibly from the formation of new thiourea or dithiocarbamate groups. Amide I and II

bands shifted to a higher wavenumber when treated with Cu(II) ions, indicating metal coordination between amide with Cu(II) ions (Kagaya et al. 2010). Overall, Cu(II) ions were fixed at amide and/or thiomide groups in ETB. Shifting of ν(HNC=S) bands to a higher wavenumber value indicated interaction of amide with Cu(II) ions (Huang et al. 2001; Cárdenas et al. 2009; Kagaya et al. 2010). The wavenumber of a strong amide I was shifted from 1553 to 1558 cm^{-1}; the weak amide II band from 1378 to 1384 cm^{-1} and another weak amide II band from 1240 to 1248 cm^{-1}. The stretching band for hydroxyl group was shifted to lower wavenumber value in Cu-ETB, indicating formation of metal-oxygen interaction.

Analysis of solid state ^{13}C TOSS NMR and XPS spectra

A broad peak at 186 ppm in ^{13}C TOSS NMR spectra (data not reported) indicated the presence of thione group in ETB. This value is within the reported chemical shift of thiourea derivatives at 182.7 ppm (Humeres et al. 2002) and 185 ppm (Gavilan et al. 2009). The XPS spectra of ETB and Cu-ETB are shown in Figure 3. An analysis of S 2p XPS spectra (B) found three sulfur species in ETB. Two major doublets were detected at 161.9 and 163.6 eV with a minor doublet at 168.0 eV. These peaks were assigned to S(-II) in thiol group (-SH), S(-I) in disulfide crosslink (-S-S-) and S(IV) of sulfonate group ($-SO_3^-$) (Castner, Hinds & Grainger 1996) with atomic percentage of 1.6, 0.5 and 0.3 % respectively. The thiol and thiolate ($-S^-$) groups were present along with the thione group (>C=S) as tautomers in ETB (Atia 2005). Disulfide crosslink were formed due to oxidation of thiol groups. The prolonged heating during synthesis of ETB had further oxidised sulfur to form sulfonate group (Goubert-Renaudin et al. 2009).



(a) (b) (c)

Figure 3. Core level XPS spectra: (A) Cu 2p of Cu-ETB; (B) S 2p of ETB; (C) S 2p of Cu-ETB

The comparison of XPS spectra of ETB and Cu-ETB is shown in Table 2. The partial conversion on ETB was indicated by the presence of amine group ($-NH_2$) at 399.9 and protonated amine group ($-NH_3^+$) at 402.0 eV. The binding energy for $-NH_2$ increased by 0.1 eV, indicating coordination of lone pair electrons with Cu(II) ion (Dambies et al. 2000). Peak shifts of thiol ($-S^-$) and sulfonate ($-SO_3^-$) groups to a higher binding energy showed interactions of the corresponding groups with Cu(II) ion (Atzei et al. 1995). The appearance of new Cu $2p_{3/2}$ peak at 933.0 eV showed a predominant presence of Cu(I) (Vieira et al. 2011). The reduction of Cu(II) ion coincided with a

significant increase of sulfonate's peak area as well as a decrease of thiol's peak area. The coordination of Cu(II) ion with thiol/thione groups on ETB surface had also enhanced the oxidation of thiol/thione groups to a sulfonate group (Gong, Yin & Liu 2003).

Table 2. XPS binding energies of thiolated chitosan beads (ETB) and Cu-ETB

SAMPLES	Binding energy (eV)					
	S $2p_{3/2}$			N 1s		Cu $2p_{3/2}$
	S(IV) ($-SO_3^-$)	S (-II) ($-S^-$)	S(-I) (-S-S-)	$-NH_2$	$-NH_3^+$	Cu(I)
ETB	168.0	161.9	163.6	399.9	402.0	-
	0.3	*1.6*	*0.5*	*6.2*	*0.6*	
Cu-ETB	168.2	162.1	163.5	400.0	402.0	933.0
	1.0	*0.6*	*0.5*	*5.4*	*1.1*	*0.2*

Legend: Italic numbers are atomic percentages of elemental species

Cu(II) Adsorption

The colour of ETB beads adsorbed with Cu(II) was generally blue, with an increasing brown colour as total sulfur of ETB increased. The Cu(II) uptake, q_e (mmol/g) as a function to ETB total sulfur (mmol/g) is shown in Figure 4. In general, the Cu(II) uptake was greater when chitosan was partially modified. The Cu(II) uptake was inversely proportional to ETB total sulfur with reasonably high fitness. The linear correlation coefficients, R^2 at 5 and 20 beads / 30 mL were 0.738 and 0.8835 respectively. This result may be explained by the excessive formation of thiourea or disulfide crosslinks in highly modified ETB (Figure 5). The formation of one crosslink consumed two dithiocarbamate groups. Thus, the number of $-NH_2$ group decreased with a greater degree of thiolation. Similar observations were also reported on glutaraldehyde-crosslinked chitosan gel particles where the Cu(II) uptake decreased with a higher degree of crosslink (Koyama & Taniguchi 1986; Sun, Wang & Wang 2006). This result supported the hypothesis of exhaustion of C_2 amine ($-NH_2$) of modified chitosan (Navarro et al. 2003).

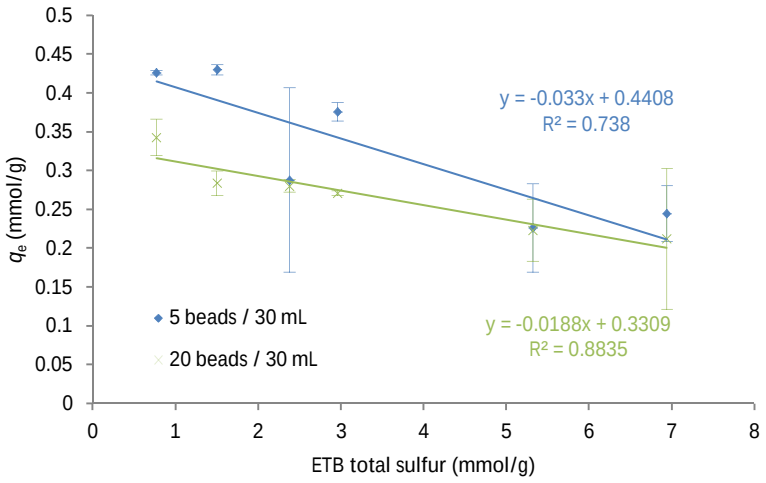


Figure 4. Cu(II) uptake (mmol/g) as a function of ETB total sulfur (mmol/g) at 5 and 20 beads / 30 mL sorbent dosage

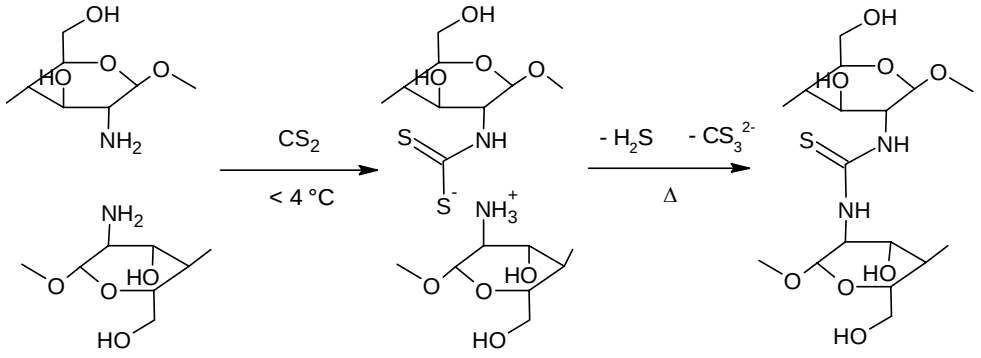


Figure 5. Proposed mechanisms for the formation of dithiocarbamate and subsequent decomposition to thiourea in ETB

CONCLUSION

Thiolation has enhanced durability of chitosan beads in acidic conditions by introducing thiourea or disulfide crosslinks. However, a higher degree of thiolation decreased Cu(II) uptake due to exhaustion of the amine group. The outcome of this study showed that moderate thiolation was adequate to boost bead stability in acid, and potentially prevents excessive use of carbon disulfide. The partially thiolated beads can be stably used as resins in the flow reactor to remediate acidic wastewater and regenerated using acidic eluent.

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ISLAMIC MUTUAL FUNDS PERFORMANCE: A PANEL ANALYSIS

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ABSTRACT

The tremendous growth of the Islamic mutual funds worldwide has increased demand among investors to include the funds in their portfolio investments. The growth of the fund domicile in Malaysia for example, is the largest in 2011, represents 29 per cent of the clients worldwide. Therefore, this paper aims to investigate returns performance of the funds relative to the respective market benchmark using panel data analysis from January 1990 to April 2009. Consistent with previous studies, on average, the result reveals that there is statistically insignificant difference in return performance of the Islamic funds relative to the single and multiple benchmarks. The result also reveals that there is a superior fund selectivity skill but inferior market timing expertise among the Islamic fund manager within the period of the study. On the contrary, results denote that returns performance of Islamic funds is comparable to the market benchmark. Hence, the outcome of this study would benefit potential investor and market players towards participating in mutual fund industry, particularly in Malaysia. Additionally, the study will add knowledge on Islamic mutual funds performance in the finance literatures.

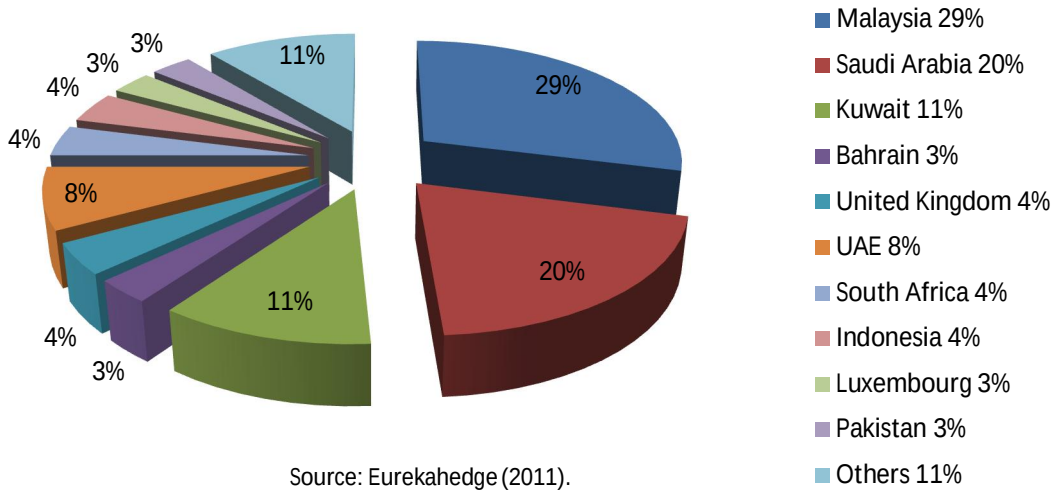
***Keywords**:* Islamic mutual fund; Islamic unit trust; performance evaluation, panel data

INTRODUCTION

The Islamic mutual fund or Shariah-based fund is steadily increasing as an important selection in a portfolio management and plays a major role in the development of the overall Islamic financial system worldwide. The Islamic mutual funds have grown tremendously throughout the past three decades and the interest of the investors towards Islamic investment funds is expected to increase in the near future. The Islamic mutual funds industry worldwide is also the fastest growth industry in the Islamic financial system that can be hypothesized that the industry could give a direct impact to the returns performance of the Islamic mutual funds. However, it has also been argued that imposing the limitation of the Islamic investments to the Shariah-compliance products will lead to the inferior performance of the portfolio due to limitation of the Shariah-compliance products in the global market. At the same time, the Islamic investments are required to meet Shariah screening criteria, in which the similar criteria were not imposed to the conventional counterparts. This requirement is argued to give an adverse impact to the returns performance of the Islamic funds. Therefore, this paper aims to investigate if there is any difference in returns performance of the Islamic funds in relation to the Islamic and conventional benchmarks. This paper also aims to examine the fund selectivity skill and market timing expertise of Islamic fund manager. In order

to achieve the objective, the paper employs sophisticated and recent econometric method of panel data analysis based on single and multifactor CAPM regression in evaluating returns performance of the funds.

In this paper, the study focuses on the Malaysian Islamic mutual fund market, which comprises of local and also global funds and constitutes about one third of the Islamic funds in the market worldwide. Since the growth of the Islamic mutual funds has increased faster than the conventional mutual funds, we hypothesize a difference returns performance of Islamic funds using difference benchmark. Therefore, the study is important as it gives recent evidence on Islamic mutual funds performance in relation to the conventional counterparts using more extensive and more recent data. In Malaysia, the Islamic fund was already established since 1970s with the introduction of Dana Amanah Bakti by Asia Unit Trust Berhad in 1971 although the IMFs industry has recently developed in 1990s. With the higher demand of the funds in the country, therefore, it is not surprising that Malaysia holds the largest percentage of IMFs clientele in the world market. Malaysia holds about 24 per cent of funds by domicile of clients in 2007 and now the holding percentage is increasing to 29 per cent as in year 2011 (See Figure 1).



Source: Eurekahedge (2011).

Figure 1. Islamic Funds by Domicile of Clients, 2011

Malaysia is chosen as a case due to its tremendous growth in Islamic mutual funds. The number has increasing from 2 funds in 1992 to 13 funds in 1999 and to 149 funds as at December 2008. The net asset values of these funds increased to RM22.08 billion, out of the total NAV RM191.71 billion as at December 2009, with units in circulation amounting to 56.85 billion units. Currently, more than 700 Islamic mutual funds are offered, which specialize in various categories like equity, bond and so forth (Hoepner, Rammal and Rezec 2011). In Malaysia for instance, the growth of the industry has increased significantly in relation to the global market. As at February 2012, about 167 IMFs are available in the Malaysian market according to the SC. With regard to asset values, the percentage of the NAV of the IMFs towards total industry is about 10.95 per cent (with units in circulation amounting to 61.96 billion units) relatively to 89.05 per cent of the CMFs counterparts. In relation to the KLSE market capitalization, the IMFs portfolio contributes 2.17 per cent. The rest of the chapter is

structured as follows: Section 2 briefly explains the relevant literatures. Section 3 explains the data and methodology employed in this study. Section 4 proceeds with the results and discussion on the performance analysis and finally, Section 5 is a conclusion.

LITERATURE REVIEW

Studies on mutual fund performance were being discussed thoroughly worldwide. In Malaysia for instance, on overall perspectives, the performance of mutual funds industry denoted that in average aggregate, mutual funds industry in Malaysia performed worse than its market portfolio (Shamsher & Annuar 1995; Tan 1995; Leong & Aw 1997; Low 2007; and (Taib and Isa 2007); Abdullah et al. (2007). The study by Taib and Isa (2007) showed on average the Malaysian mutual funds industry not only underperformed its market benchmark but also the risk-free asset returns. Low (2007) also indicated that mutual funds in Malaysia provided negative performance in relation to its market benchmark either the KLCI or the EMAS index. However, only few studies concentrated on comparative performances between the Islamic mutual funds (IMFs). Among the studies included the works of (Abderrezak 2008, Nathie 2008, Elfakhani et al. 2005a, Elfakhani and Hassan 2007, Elfakhani and Hassan 2005, Fikriyah et al. 2007, Girard and Hassan 2005, Ismail and Shakrani 2003, DeLorenzo 2000). DeLorenzo (2000) for example, emphasized the important of the existence of a Shariah Supervisory Board. This is to ensure fund management companies in particular follow the Shariah screening criteria, therefore requires constant attention and supervision. Thus, the primary mission of this board is to ensure that stocks selected are *halal* and remain so.

Ismail and Shakrani (2003) on the hand empirically studied on the weekly price data for 12 Islamic mutual funds in Malaysia for the period of 1 May 1999 until 31 July 2001. They found that the adjusted-R^2 and standard error of the conditional relationship is higher in down-markets than in up-markets, suggesting that the beta could be used as a tool in explaining cross-sectional differences in Islamic fund returns and as a measure of market risk. This is in line with the risk-return paradigm; however it does not address the issue of lower or higher returns. Elfakhani et al. (2005) use 46 Islamic funds across the world. They found no statistical difference in the performance of the studied funds compared to returns of respective indices. They concluded that the performance of funds is improving over time as the fund managers were gaining more experience and gain a sense of the market. Elfakhani and Hassan (2007) suggest that the funds do not differ substantially from that of other conventional funds although the Islamic funds appear to be slightly higher in performance. Therefore, they suggested that there is not any statistically significant risk-adjusted abnormal reward or penalty associated with investing in Islamic funds. Abdullah et al. (2007) contradicts this finding by showing that conventional funds perform better than Islamic funds during good economic periods and vice-versa during bad economic periods. Krauessl and Hayat (2011) estimate the performance of 59 internationally-traded Islamic equity funds over a 5-year period. They find 31 funds significantly underperformed the respective market benchmark. Hence there is a controversy here that requires a re-examination.

Girard and Hassan (2005) revealed that there was also no difference between Islamic and non-Islamic indices. They found the Islamic indices outperform from 1996 to 2000 and underperform from 2001 to 2005 their conventional counterparts

thus suggesting thhe similar reward to risk and diversification benefits exist for both Islamic and conventional indices. Abderrezak (2008) also demonstrated the similar abilities performance of Islamic and ethical funds market using Fama's performance measures and both portfolios did not outperformed the S&P 500, a proxy for the market performance. Hassan et al. (2010) and Hoepner et al. (2011) study the Malaysian markets. One suggests that there is no difference in performance of the Islamic and conventional funds. The other finds that Islamic funds display a tilt towards growth and small cap stocks, so the performance is allegedly higher because of the composition of the portfolio. Saad et al (2010) found that the Islamic unit trust companies in Malaysia are comparable with conventional counterparts. By using data envelope analysis (DEA) approach, they found that some of the Islamic unit trust companies are above average in total factor productivity (TFP) performance. Again, this poses a challenge as these results are contradictory and these studies did not examine market timing or fee impact.

With regards to the market timing strategy, it is becoming a common phenomenon in the global market, with some MFs providing evidence of negative market-timing ability as reported by (Chang & Lewellen, 1984; Chen, et al., 1992; Henriksson, 1984; Kon, 1983), and some revealing positive market-timing (Bello & Janjigian, 1997; Lee & Rahman, 1990; Lehmann & Modest, 1987). For example, Bello and Janjigian (1997) documented positive and significant market timing abilities and security selection abilities for 633 MFs within the most recent period of 1984 to 1994. They used the extended TM model by controlling the effects of non S&P 500 assets held in MF portfolios. The evidence from the original TM model, however, failed to reveal a positive market timing ability. In Malaysia, Annuar et al.(1997) found that the Malaysian MFs during the time period of 1990 to 1995 appeared to posses no market timing ability, but superior selection ability skills. Abdullah et al. (2007) detected poor selectivity performance of stock selection ability skills and market timing ability of the Islamic and Conventional fund managers in Malaysia, for the period of January 1992 to December 2001. Elfakhani et al. (2005) also indicated similar results during the period of January 1997 to August 2002, whilst Ahmed (2007) in general observed that fund managers performed poorly in security selection and market timing ability. He tested 60 individual funds within the period of 1998 to 2004 and fo und that only two funds were superior in their timing ability.

METHODOLOGY AND THE DATA

The Data

The study employs the monthly returns data of 129 Malaysian IMFs from various categories, namely allocation, alternative, equity, fixed income and money market, obtained from Morningstar database over the period of January 1990 to April 2009. The data is based on historical performance of the selected fund and is arranged in panel regression analysis, with the beginning and ending of each of an individual fund varies from one to each others. The beginning is based on inception date and the ending date is at the end of April 2009. These monthly returns are net from all expenses, but excluding the front and exit fees. This total sample is after process of selecting the funds that have a minimum of 12-month returns thus excluding 14 funds to be a final sample of 129

funds. The selection is made based on a personnel judgement sampling method, followed Bertin and Prather (2009). Despite the restriction, the data in this study includes the largest number of mutual funds in Malaysia so far. According to Elfakhani et al. (2005b), the 68 months sampling period was appropriated to observe returns, as the sample was allowed to cover two distinctive market cycles. Yet, longer historical performance data may lead to more robust and conclusive results. This study provides more extensive data as it covers at least two complete market cycles including three expansions and three troughs over the duration of the study.

The study employs the Kuala Lumpur Composite Index (KLCI) as a market benchmark. Since the Islamic benchmark has recently been launched in July 1999, therefore investigation return performance of the funds based on KLCI is appropriate to capture longer period of the study. Moreover, the Malaysian market is unique as the most of the stocks listed in the Bursa Malaysia Kuala Lumpur Stock Exchange (KLSE) are under Shariah-compliant list. As on October 2003, the number of Shariah-compliant securities in Malaysia grew to 722 securities or 81% of the total listed securities on the KLSE as compared to 684 securities of 80% of the total listed securities in 2002 (SC 2003). The most recent, about 88% of stocks listing in the KLSE are Shariah-compliance and represent two-thirds of the Malaysia's market capitalization (Bursa_Malaysia 2010). Therefore, the index is regard as fit to be a proxy for the market benchmark for the Islamic funds.

Methodology and The Model

The independent variables in this paper can be divided into two main categories, namely single benchmark and multiple benchmarks. The single benchmarks consist of the KLCI index market return and KLSYA index. For the multiple benchmarks, this study extends the independent variables in single benchmarks to include other benchmarks, namely MSCI World index, DJIM index, KLSE Malaysian small-cap index, the Malaysian fixed deposit rate for bond index and KLIBOR for money market index. All the indices are converted into monthly average rate of return to suit the monthly return data of the IMFs, the dependent variable. The calculations of a market return for each of the market indices employed in this thesis using the formula as the following:

$$\overline{r}_{Mt} = \ln(Pi_{Mit}/Pi_{Mit-1}) * 100 \text{ or equivalently,}$$
$$\overline{r}_{Mt} = \ln(Pi_{Mit}) - \ln(Pi_{Mit-1}) * 100 \quad (1)$$

where $Ri_{Mit}$the average return of a market return is is computed based on log price index Pi_{Mit} for time t minus log price index of Pi_{Mit} for a time t-1. In this thesis, all the mutual fund returns are in percentage; hence the market return is also calculated in percentage.

Since the objective of this paper is to examine any difference in return performance of IMFs in relation to the market return benchmark, single and multiple benchmarks, the study employs panel data regression analysis, which allows for the series in the cross section and time to run together in a regression rather than run separately in each of the series variable. As a result, the observation of the study is largely increasing rather than using time series based on the same data. The study conjectures that there is a difference in returns performance of the funds, thus allowing

for null hypothesis to be rejected. Otherwise the null hypothesis is accepted if the results show no difference in returns performance of the funds in relation to the market benchmark. The panel data regression method also able to remove econometric problems associated with the normal regression analysis, for example, the variation results before and after adjusted for the heteroskedasticity and serial correlation problems. Furthermore, the panel data analysis can also be incorporated each of the funds in the portfolios without necessarily calculating the average of the portfolio total return. Therefore, the results obtained from the analysis shall be more rigorous. Follow Baltagi (2005), the panel ordinary least square (OLS) estimation, assuming one-way error component model for the error term, is calculated based on this formula:

$$y_{it} = \alpha + \beta_{it} X_{it} + v_{it} \quad (2)$$

where v_{it} is a time-varying error term that can be written as $v_{it} = a_i + u_{it}$. Therefore, the eq. 1 further derives as the following:

$$y_{it} = \alpha + \beta_{it} X_{it} + a_i + u_{it} \quad (3)$$

The a_i denotes the unobservable factors that change over time or individual unobservable effects of the individual mutual funds, and u_{it} is the remainder disturbance with usual assumption that it is not correlated to the dependent variable. These unobservable managerial skills of the fund managers can also be represented byu_{it}. In the case, the unobserved effects a_i are correlated with the explanatory variables X_{it}; the fixed effects panel data is used or if it is proven that all explanatory variables are truly random, then use random effects.

The study adopts unbalanced panel data regression assuming random effects, due to element benchmark and market timing are not correlated to each other. The problems of serial correlation and heteroskedasticity have been corrected using white cross-section standard error and covariance test. The study then employs the panel OLS estimation into CAPM model. The $y_{it} = \overline{r}_{pt}$ and the $X_{it} = \overline{r}_{Mt} - \overline{r}_{ft}$. The v_{it} is equal to ε_{pt}. The formula is written as the following:

$$\overline{r}_{pt} = \alpha_{it} + \beta_{pt} \left(\overline{r}_{Mt} - \overline{r}_{ft}\right) + \varepsilon_{pt} \quad (4)$$

This $\overline{r}_{pt}$ means a mean excess or risk-adjusted return of the portfolio, calculated from the $\overline{r}_{it} - \overline{r}_{ft}$. It represent as a dependent variable in the regression model. $\overline{r}_{Mt} - \overline{r}_{ft}$ is the excess return of market at time *t*, and α_{it} and β_{pt} are coefficient estimates denoting return performance and systematic risk, respectively. $\overline{r}_{ft}$ is based on Malaysian t-bills is used as a proxy for the risk free rate[1]. ε_{it} is an error term. $\overline{r}_{Mt}$ is an average market return portfolio.

The study also incorporated the multi factor version of CAPM to evaluate the performance of the mutual funds. The factors included the large capitalization stock indexes (KLCI); small capitalization stock indexes (KLCI Small Caps); a foreign stock index (MSCI world); and a bond index. The choice of multi benchmarks is important to

[1] The study follows the calculation of the monthly risk free rate is as follows; $R_{ft} = (1+R)^{1/12} - 1$.

enable the model captures the impact of the fund's differential holdings of large-cap, small-cap, foreign and bond investments (Bertin and Prather, 2009, p.1366). Therefore, for the variable $\overline{r}_{Ft}$, it further derived to $\overline{r}_{Ft}1$ to refer to conventional foreign benchmark, the MSCI world index and $\overline{r}_{Ft}2$ to refer to Islamic foreign benchmark, the DJIM index. The modified multi factor CAPM model is developed as follows:

$$\overline{r}_{pt} = \alpha_{it} + \beta_{pL}(\overline{r}_{Lt} - \overline{r}_{ft}) + \beta_{pS}(\overline{r}_{St} - \overline{r}_{ft}) + \beta_{pF}(\overline{r}_{Ft} - \overline{r}_{ft}) + \beta_{pB}(\overline{r}_{Bt} - \overline{r}_{ft}) + \varepsilon_{pt} \quad (5)$$

Finally, the study extends the work of Bertin and Prather (2009) to include one more market benchmark, namely KLIBOR rate as a proxy for the money market index. The equation is as follow:

$$\overline{r}_{pt} = \alpha_{it} + \beta_{pL}(\overline{r}_{Lt} - \overline{r}_{ft}) + \beta_{pS}(\overline{r}_{St} - \overline{r}_{ft}) + \beta_{pF}(\overline{r}_{Ft} - \overline{r}_{ft}) \quad (6)$$

In order to evaluate performance of market timing ability and fund selectivity skill of the Islamic and also the conventional fund managers, the study adopts Treynor Mazuy Model (TM Model) developed by Treynor and Mazuy (1966). The model is based on exponential of the market benchmark in CAPM model using quadratic regression. The regression model is also applied to the time series and also panel data analysis. According to Admatti et al. (1986), the TM model provides a valid measure of market-timing performance ability. The positive values of α and β are indicative of security selection skill and market-timing skill for Islamic mutual funds managers. The model equation is as following:

$$\overline{r}_{pt} = \alpha_{pt} + \beta_{pt}(\overline{r}_{Mt} - \overline{r}_{ft}) + \theta_{pt}(\bar{r}_{Mt} - \bar{r}_{ft})^2 + \varepsilon_{pt} \quad (7)$$

where $\boldsymbol{\alpha_{pt}}$ denotes the ability of portfolio fund managers to make effective skill on stock selection and $\boldsymbol{\theta_{pt}}$ denotes the market timing expertise of each of the fund managers. If they are positive, there exists a superior in selectivity skill and market timing expertise among the fund managers and otherwise, if negative. The other variables are defined as previously mentioned. If the $\boldsymbol{\beta_{pt}}$ for all the funds value lesser than 1, it implies that the fluctuation in the stock market does not infinitely influence any specific fund per se. In other words, the higher the beta of a fund portfolio, the high volatile of a fund comparatively to the market.

The TM Model also is developed to be new model called the Extended TM Model by adding the multiple benchmarks into the original TM Model follow Bello and Janjigian (1997). The Extended TM Model is like the following:

$$\overline{r}_{pt} = \alpha_{it} + \beta_{pL}(\overline{r}_{Lt} - \overline{r}_{ft}) + \beta_{pS}(\overline{r}_{St} - \overline{r}_{ft}) + \beta_{pF}(\overline{r}_{Ft} - \overline{r}_{ft}) + \beta_{pB}(\overline{r}_{Bt} - \overline{r}_{ft}) + \beta_{pm}(\overline{r}_{mt} - \overline{r}_{ft}) + \theta_{pt}(\bar{r}_{Mt} - \bar{r}_{ft})^2 + \varepsilon_{pt} \quad (8)$$

RESULTS AND DISCUSSION

Single CAPM Performance

Table 1 exhibits results of the single factor CAPM panel data regression for the IMFs that show that the alpha estimate of the portfolio is positive and significantly different from zero at one percent level, indicating that on average the group outperforms the

market benchmark. On average, the IMFs portfolio outperforms the conventional market benchmark by 2.51 percent per annum over the period 1990-2009. However, the results also show that the IMFs is insignificantly outperforms the market whilst using Islamic benchmark by 0.144 percent per annum within 10-year period from 1999-2009. The KLSYA serves as a proxy for the Islamic benchmark in Malaysia has been recently launched in August 1999. The result of outperformance but statistically insignificant of the IMFs is generally consistent with evidence of Hayat and Kraeussl (2011). Hayat and Kraeussl found that the average of 51 Islamic equity funds in Malaysia outperform the KLSYA by 0.73 per cent per annum over the period 2000-2009.

With regards to the systematic risk, estimated by the beta in the regression, it seems that IMFs portfolio has the highest beta, the average beta of 0.54 out of 129 funds in the sample. The beta estimate is relatively smaller in our study compare to the beta estimate in the study of Hayat and Kraeussl (2011) which was the average of 0.75. However, they limit to the Malaysian Islamic equity funds in their sample. On overall basis, the beta of IMFs and CMFs is less volatile and less risky compared to the market return. On average, the results denote there is no statistically difference of alpha from zero, implying there is no difference in return performance of IMFs in relation to the market benchmark. However, the systematic risk of the IMFs indicates a strongly significant difference indicating that the risk of the fund is on average lower than the market risk. The finding is somewhat consistent with the previous studies in term of return but not the risk. The previous studies indicate there is no difference in risk and return characteristic of IMFs and CMFs (Elfakhani et al. 2005a, Hassan et al. 2010). The evidence of difference in risk could support the ideas that Islamic funds associated with some specific risks that not present in the conventional counterparts like the risk of inconsistency in Shariah scholars' judgements, the lack of track record and high exposure to companies with sub-optimally leveraged and low in working capital (Hayat and Kraeussl 2011).

Table presents results of mean excess returns performance of IMFs against market benchmark using panel data regression. The table also presents returns performance of IMFs according to the fund asset classes. The results reported after correction for heteroskedasticity standard errors and covariance using White (1980). All returns are in percentage and net of all expenses. The returns are adjusted for the market risk free rate using one month Malaysian t-bills. The overall sample period is based on monthly data from January 1990 to April 2009 and the total numbers of funds (*N*) and the duration period varies depending on the availability of the data in each of the categories. Standard errors based on the cross-section of the estimated coefficients are reported in parentheses.

Table 1. Single-factor CAPM Performance Analysis

Category	KLCI as market benchmark			
IMFs	α	β	Adj_R^2	*N* (Obs)
Overall	0.209*	0.540***	0.41	129 (8,403)

	(0.124)	(0.037)		
Allocation	0.095	0.543***	0.56	32 (1800)
	(0.136)	(0.027)		
Alternative	-0.069	0.031	0.06	8
	(0.096)	(0.019)		(206)
Equity	0.210	0.624***	0.49	58 (4720)
	(0.188)	(0.056)		
Fixed income	0.053	0.018	0.01	17 (1017)
	(0.065)	(0.018)		
Money market	0.765***	0.327***	0.12	14
	(0.280)	(0.063)		(635)

Notes: Obs is the number of observations. The asterisks ***, **, and * indicate significant level at 1%, 5% and 10%, respectively.

Table 1 also reports single factor CAPM performance analysis based on various asset classes in relation to market benchmark. The results denote that all the asset classes except alternative outperform the market benchmark, with the alpha of money market is statistically significant from zero, suggesting the mutual funds in money market category outperform the market benchmark. The betas of all the portfolios are statistically significant which implies that the systematic risk of the funds is less volatile rather than the market risk.

CAPM Performance based on Multiple Benchmarks

The study extends the analysis on multiple benchmarks via panel data regression. This analysis aims to control the asset class performance differences by estimating alpha using multifactor CAPM Model. Table 2 presents the results of the panel regression which include four different models in a fund portfolio. On overall performance, the results in Table 2 denote that all the models have positively alpha estimates but insignificant, implying that the excess return performance of the IMFs are comparable in relation to the multifactor CAPM model. This table presents coefficient estimates using full sample (AMFs), IMFs and CMFs monthly average return net of all expenses as the dependent variable. The sample period is from 1995M12 to 2009M04 for the models 1 and 3, and from 1996M01 to 2009M04 for the models 2 and 4. The heteroskedasticity problems are corrected by using White (1980). Standard errors based on White (1980) are given in parentheses. Variance inflation factor (VIF) to detect multicollinearity problems for each of the variables is also presented. With regard to the findings based on multiple benchmark models, suggesting that the difference in alpha performance of the fund portfolios in relation to the single benchmark. The coefficient estimate for the betas of the multi benchmark models show consistent result to the single CAPM benchmark, that the large stock index indicates strong relationship with the fund alpha when the result shows that the coefficient estimate of the large stock, βpL is significantly difference from zero, suggesting that the benchmark strongly influence the performance of the funds.

Table 2. Multi-factor CAPM Performance Analysis

Variable	**IMFs**			
	Model 1	**Model 2**	**Model 3**	**Model 4**
α	0.147	0.122	0.101	0.075
	(0.142)	(0.138)	(0.145)	(0.141)
VIF	*0.000*	*0.000*	*0.000*	*0.000*
βpL	0.519***	0.529***	0.518***	0.529***
	(0.044)	(0.042)	(0.043)	(0.041)
VIF	*2.300*	*1.901*	*2.396*	*1.884*
βpS	-0.007	-0.005	-0.007	-0.004
	(0.025)	(0.025)	(0.024)	(0.024)
VIF	*2.800*	*2.364*	*2.692*	*2.322*
BpFMSCI	0.032	-	0.034	-
	(0.031)	-	(0.030	-
VIF	*2.590*	-	*2.566*	-
BpFDJIM	-	0.011	-	0.009
	-	(0.035)	-	(0.034)
VIF	-	*1.596*	-	*1.659*
BpB	1.324	1.970	-2.506	-1.649
	(5.014)	(4.751)	(4.936)	(4.680)
VIF	*1.470*	*1.250*	*1.504*	*1.302*
BpM	-	-	7.792	7.556
	-	-	(5.294)	(5.377)
VIF	-	-	*1.583*	*1.572*
Adj R2	0.44	0.44	0.44	0.44
N	129	129	129	129
(Obs)	(8,024)	(8,013)	(8,024)	(8,013)

Notes: Obs is the number of observations. The asterisks ***, **, and * indicate significant level at 1%, 5% and 10%, respectively.

Market Timing Performance Analysis

This section examines the performance of market timing and fund selectivity skill of IMFs using TM Model which denotes that any significant positive of alpha and beta provide evidence of superior market timing expertise and fund selectivity skill among fund managers of the fund portfolios. The results are reported in Table 3. The table presents market timing expertise and stock selectivity skill of IMFs fund managers based on TM Model and also the Extended TM Model after correction for heteroskedasticity standard errors and consistent covariance estimator using the method of White (1980). The dependent variable in each regression is the fund's mean excess monthly return. All returns are in percentage and net of all expenses. The returns are adjusted for the market risk free rate using one month Malaysian t-bills as a proxy for risk free rate of return. The overall sample period is based on monthly data from January 1990 to April 2009. However, for the extended model sample period is reduced to December 1995-April 2009, due to small-cap benchmark is recently launched end of year 1995. The foreign benchmark is MSCI for the all funds and CMFs portfolios, whereas for the IMFs portfolio, the DJIM is employed. For the regression with DJIM, the beginning starts in January 1996 but similar with the ending. Standard errors based

on the cross-section of the estimated coefficients are reported in parentheses. VIF is also presented indicating that there is no multicollinearity in the regression conducted when the VIF is below than 5.

Table 3. Market Timing Analyses for TM and Extended TM Models

Variable	**TM Model**		**Extended TM Model**	
	IMFs		**IMFs**	
	Coefficient	VIF	Coefficient	VIF
α	0.103 (0.145)	0.000	0.041 (0.150)	0.000
β	0.549 (0.034)***	1.029	0.520 (0.042)***	2.073
θ	0.003 (0.003)	1.065	0.003 (0.003)	1.106
$B_P S$	-	-	-0.015 (0.018)	1.570
$B_P F$	-	-	0.051 (0.030)*	2.214
$B_P B$	-	-	-5.131 (4.682)	1.738
$B_P m$	-	-	6.582 (4.682)	1.672
Mean var.	0.129		0.061	
Residual	5.143		4.847	
Adj_R^2	0.42		0.45	
N (Obs)	129 (8,267)		129 (8024)	

Notes: Obs is the number of observations. The asterisks ***, **, and * indicate significant level at 1%, 5% and 10%, respectively.

Table 3 reveals the coefficient estimates of the alphas are not significant either using TM or Extended TM Models, implying insignificant superior fund selectivity skill of IMFs fund manager. The results show that the IMFs fund selectivity skill is more superior using TM Model rather than the Extended TM Model counterparts. Results also show the coefficient estimates of theta θ are not significant in a portfolio across the models, suggesting that there is inferior market timing expertise among the Islamic fund managers over the period of the study. Furthermore, the systematic risk in both models also consistent with the previous findings that denote beta of the IMFs is below than 1, suggesting that the portfolio associated with low risk and less volatile relative to the KLCI, a a proxy for the market benchmark. The analysis is then extended to investigate the performance of market timing and fund selectivity by the asset classes of the fund via the two models as shown in Table 4. The results indicate the equity fund and fixed income categories are insignificantly superior performance in fund selectivity skills. The alternative fund is underperformed the market benchmark in all the portfolios. The table presents the results of market timing and fund selectivity performance by the asset classes. The dependent variable in each regression is the fund's mean excess monthly return (in percentage) in each of the investment type categories. The duration period varies depending on the establishment of the fund category and the market benchmark. For allocation, it starts from 1995M12 to 2009M04; for the alternative, the sample starts from 2004M09 to 2009M04; for equity and money market, the period is from 1996M01 to 2009M04; and for fixed income, the duration is from 1995M12 to 2009M04. However, results in Table 4 show only the alternative fund of the IMFs is statistically significant, suggesting that the fund category underperforms the market return by 2.62 per cent per annum. The result also indicates a superior money market fund using the TM Model. The systematic risk of a fund based on beta value remains significant for all except for the alternative and fixed income fund categories of the IMFs portfolio.

Table 4. Market Timing Analyses by Asset Classes for TM and Extended TM Models

Variable	**Investment or Asset Classes**				
	Allocation	Alternative	Equity	Fixed income	Money market
Panel A: TM Model					
α	0.058	-0.001	0.055	0.050	0.657**
	(0.146)	(0.106)	(0.212)	(0.060)	(0.274)
β	0.546***	0.029	0.632***	0.018	0.332***
	(0.027)	(0.018)	(0.051)	(0.018)	(0.063)
θ	0.002	-0.002	0.003	0.000	0.003
	(0.002)	(0.002)	(0.004)	(0.002)	(0.003)
Adj_R^2	0.57	0.07	0.50	0.012	0.12
N (Obs)	32(1800)	8(206)	58(4720)	17(1017)	14(635)
Panel B: Extended TM Model					
α	0.099	-0.218**	0.053	-0.045	0.170
	0.145	(0.104)	(0.232)	(0.062)	(0.251)
β	0.515***	0.022	0.571***	0.029	0.351***
	0.034	(0.022)	(0.056)	(0.018)	(0.072)
θ	0.003	-0.000	0.004	0.001	0.002
	0.002	(0.002)	(0.004)	(0.002)	(0.003)
Adj_R^2	0.57	0.04	0.53	0.04	0.16
N (Obs)	32(1800)	8(214)	58(4411)	17(1034)	14(565)

Notes: Obs is the number of observations. The asterisks ***, **, and * indicate significant level at 1%, 5% and 10%, respectively.

Robustness Check on Panel Analysis Using Random Effects (REs)

In order to check the robustness of the results in Table 3, the panel data random effects (REs) are employed to the Extended TM Model. The results are reported in Table 5. Table presents results of Extended TM Model when random effects (REs) applied. The dependent variable is the fund's mean excess monthly return. This extended model sample period is from December 1995-April 2009 using MSCI for the conventional foreign benchmark, and from January 1996-April 2009 when the Islamic foreign benchmark, the DJIM is employed. All the returns (in percentage) are net of all expenses and adjusted for the risk free rate of return using Malaysian one month t-bill. The results are adjusted for the heteroskedasticity standard error robust on panel data using the method of White (1980). Standard errors are given in parentheses below the coefficient estimates. VIF is also presented indicating that there is no multicollinearity in the regression conducted when the VIF is below than 5. The reason of using panel effects is by the fact that pooling data or panel regression with no effects ignores the data those are originated from different funds. The Hausman test is conducted in order to identify whether the fixed effects (FEs) or REs that shall be continued with the data sample. The null hypotheses cannot be rejected that the result of the test is not significant. Therefore the data is appropriated with the REs with the assumption that the error terms are not homogenous and uncorrelated with each other. Furthermore, the serial correlation and cross sectional heteroskedasticity may also existing in the data. To mitigate the issue, the generalised least squares (GLS) panel estimator based on one way

random error effects is conducted. The one way random error is chosen because the data serve as unbalanced panel data.

On average, the results in Table 5 denote that there is no significant outperformance and no market timing expertise among the IMFs fund managers. The results are robust and do not suffer the multicollinearity problems as all the variance inflation factors (VIF) of the variables are below than 5. The results denote that there is a significant positive relationship between large stock index and foreign index benchmarks with the return performance of the fund. On the other hand, there is insignificant outperformance of IMFs in relation to the Islamic foreign benchmark. In summary, the overall findings show similar results as obtained from the analysis of pooled regression or panel with none effects. Therefore, the findings in this study are considered robust.

Table 5. Robustness Check on Market Timing Analyses for Extended TM Models

Variable	**Extended TM Model with MSCI**		**Extended TM Model with DJIM**	
	Coefficient	VIF	Coefficient	VIF
α	0.041	0.000	0.011	0.000
	(0.150)		(0.150)	
θ	0.003	1.106	0.003	1.095
	(0.003)		(0.003)	
B_PL	0.520***	2.073	0.534***	1.530
	(0.042)		(0.039)	
B_PS	-0.015	1.570	-0.011	1.594
	(0.018)		(0.019)	
B_PF	0.051*	2.214	0.020	1.606
	(0.030)		(0.035)	
B_PB	-5.131	1.738	-3.812	1.616
	(4.682)		(4.516)	
B_Pm	6.582	1.672	6.299	1.682
	(4.682)		(4.803)	
Adj_R^2	0.45	-	0.46	-
N (Obs)	129	-	129	-
	(8,024)		(8,013)	

Notes: Obs is the number of observations. The asterisks ***, **, and * indicate significant level at 1%, 5% and 10%, respectively.

CONCLUSION

This study aims to evaluate excess return performance of IMFs against single and multiple benchmarks based on CAPM model using panel data analysis. The main finding shows the returns performance of Islamic funds is comparable to the market benchmark. The result also reveals a statistically insignificant difference in return performance of the Islamic funds relative to the single and multiple benchmarks. The findings further exhibit perverse or no market timing expertise among IMFs fund managers, even when the Extended TM Model is employed. However, there is an evidence of insignificant superior fund selectivity skill of fund managers across the models. The panel data REs are employed to the Extended TM Model for the robustness

check and the overall findings show similar results as obtained from the analysis of pooled regression or panel with none effects. However, some issues regarding IMFs and CMFs performances remain unresolved, since this paper limits the investigation on performance of diversified funds and the broad fund asset classes. the fund asset c thus the results cannot be specific or scrutiny on particular fund asset classes. The examination of fund performance can be scrutiny particularly on equity fund alone in order to appreciate some issues like fees and fund performance. Therefore, further research shall be conducted to focus on the fees and other fund attributes and their relationship on fund performance.

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ASSESSING THE EFFECTIVENESS OF THE DIFFERENT LEVELS OF INSTRUCTIONAL STRATEGIES [DLIST] FOR ONLINE LEARNING BY UNDERGRADUATE STUDENTS AT THE UNIVERSITY OF SOUTHERN QUEENSLAND (USQ), AUSTRALIA

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ABSTRACT

Based on Chickering and Gamson's Seven Principles for Good Practice this research attempted to bring together the a priori mentioned conceptual framework with Merrill's Different Levels of Instructional Strategy. The *purpose* was to determine whether the Seven Principles could be revitalized by amalgamating them with the Different Levels of Instructional Strategy. The resultant standardized measure would then be proposed for use either as a rubric for facilitating the implementation of DLISt, or as diagnostic process indicators for assessing the quality of learning experienced by students with the aim of improving the design of future online courses.

***Keywords*:** Assessment, Factor Analysis, Instructional Design, Instructional Technology, Internet, Measurement, Online Learning, Online Pedagogy, Quasi-experiment

INTRODUCTION

As an educator, have you ever stopped to wonder how successful we have been at leveraging what the PC and Internet have to offer in terms of conceptualizing and delivering online education to learners? What use is there of knowing what instructional technology has to offer when educators themselves are hesitant about when, where and how to best use instructional technology to support learners and the teaching process. Is there a missing link in the synergy of events between cognitive presence, social presence, teaching presence and strategies or tactics for online learning and teaching?

As it stands, pedagogy is defined as the actual function of teaching, or what teachers do when implementing their craft to assist their student's learning. Hence, would it not be a logical aim by any standards to improve upon the efficiency of how online learning is designed, developed and implemented so as to better support the process of knowledge construction and possibly the transfer of skills using sound educational theory and practice?

The primary goal of this research project was to obtain data that would facilitate the development, validation and standardization of a measure for assessing the effectiveness of DLISt. As a rule, a measure is said to be standardized when (a) its rules of measurement are clear, (b) it is practical to apply, (c) is not demanding of the administrator or respondent, and (d) its results do not depend upon the administrator.

RESEARCH METHODOLOGY

Initially, the proposed methodology for the research project was that of a follow-up sample web survey. However, such a design would suffer from an absence of designed comparison. This need for comparison is important because survey research limited to a single group often leads to invalid conclusions about cause-and-effect relationships because it only provides a static snapshot for that particular point in time. Hence, the decision to opt for a longitudinal non-equivalent pre-test-post-test control group Internet quasi-experiment. In light of this research being conducted over the Internet, it also qualifies as a field experiment because the research was in a real-life setting. The significance of in the field Internet experimentation cannot be overlooked because they are useful in terms of determining if a manipulation will work in the real-world. Thus, the design of this research attempts to make good use of the advantages offered by Internet experiments, for example (1) ease of access to participant populations that are demographically and culturally diverse, (2) being able to bring the quasi-experiment to the participant, instead of vice versa, (3) access to large samples enabling high statistical power, and (4) cost savings in terms of administration, equipment, person-hours and physical space. Moreover, there are also the value added advantages of speed, low cost, external validity, experimenting around the clock, a high degree of automation of the experiment (i.e., low maintenance, limited experimenter effects), and a wider sample.

Sampling

Sample members were drawn using a three-stage purposive cluster sampling technique. The first sampling element used was that of nationality. This was followed by the second element of how far the participants had progressed in their degree at USQ. The third sampling element was that of academic affiliation. The goal was two-fold. Firstly, to obtain data that would be large enough to minimize the effect of sampling error and increase the reliability of the correlations. Secondly, to obtain a representative sample that would afford valid inferences and generalizations to be made possibly across different nationalities.

Participants were recruited based on enrolment in intact courses subject to approval from Faculty. The whole process took sixteen months to complete beginning late November 2009, when the ethics application was first submitted followed by feedback that conditional approval had been granted subject to evidence of approval from the relevant USQ faculties. Full ethics clearance was granted by USQ's Fast Track Human Research Ethics Committee (HREC) on November 15, 2010 (H10REA016). The whole process finally came to fruition by early March 2011 in time for the start of Semester 1, 2011.

DISCUSSION

In an effort to build on what is there and not reinvent the wheel, it is proposed that instructional strategies be utilized to enable the learning experienced by students to be systematically scalable to different levels of complexity. Skillfully wielded, this should culminate in the ability to traverse and satisfactorily complete complex tasks. The rationale is to move away from information-only presentations towards a task-centered

approach that increases in level of complexity to promote more effective, efficient and engaging learning.

CONCLUSION

With DLISt, teaching staff would conceivably have the flexibility of being eclectic in their choice of pedagogy for guiding students to work their way through the pathways of knowledge to find their own answers with successively less guidance provided with each subsequent task until they are completing tasks on their own. Metacognitive comprehension about DLISt could also potentially benefit students in terms of generating awareness about the difference between planned instances of instructional strategies as opposed to random acts by teaching staff.

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THE MODELLING OF THE EFFECT OF AIR FUEL RATIO ON UNBURNED HYDROCARBONS FOR MILD COMBUSTION

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ABSTRACT

Unburned hydrocarbons (UHC) are a waste and pollution to the environment. UHC will happen when rich combustion occurred. In the case of exhaust gas recirculation (EGR) utilized to diluted the oxidiser, UHC in the EGR can result in unwanted combustion at unwanted locations (i.e. in the EGR pipe). FLUENT was utilised to model the open furnace. The volume flow rate for air and fuel was the main parameter of the study. In order to consume all the fuel by the combustion, the air fuel ratio (AFR) must be higher than 5:1. Lean combustion (AFR more than 5:1) will eliminate the possibility of UHC in flue gas.

***Keywords*:** MILD combustion, unburned hydrocarbons, exhaust gas recirculation, air fuel ratio

INTRODUCTION

Global concern on combustion pollution emission makes moderate and intense low oxygen dilution (MILD) combustion [1,2] or flameless oxidation (FLOX) [3,4] more important. MILD combustion emits low NO_x and CO pollutant emissions and high thermal efficiency. CO_2 is one of greenhouse gases (GHG). By using biogas [5] or low calorific value (LCV) gas, CO_2 emitted by the combustion will be utilized by biomass, which is the source of biogas. In this study LCV gas used was produced by mixing the methane, hydrogen and carbon dioxide.

FUEL COMPOSITIONS

The fuel mole fraction for this work to produce LCV is 53.44% CH_4, 30.00% CO_2, 13.36% H_2, 1.30% N_2, 1.70% C_2H_6, 0.01% C_3H_8 and 0.01% C_4H_{10}. The air mole fraction is 21.008% O_2 and 78.992% N_2. The oxygen in the oxidizer will be diluted by EGR to the required level.

EXHAUST GAS RECIRCULATION

Exhaust gas recirculation (EGR) was the key for MILD combustion. EGR was previously used for MILD combustion [6] and play important role to preheat the oxidiser and dilute the oxygen. EGR can be achieved by enclosing the combustion chamber and collecting the flue gas. Then EGR was flowed downward to mix with fresh air. The EGR ratio will be determined based on the dilution ratio required by the combustion. MILD combustion can be achieved when the oxygen level is between 3~13%.

FUEL VOLUME FLOW RATE

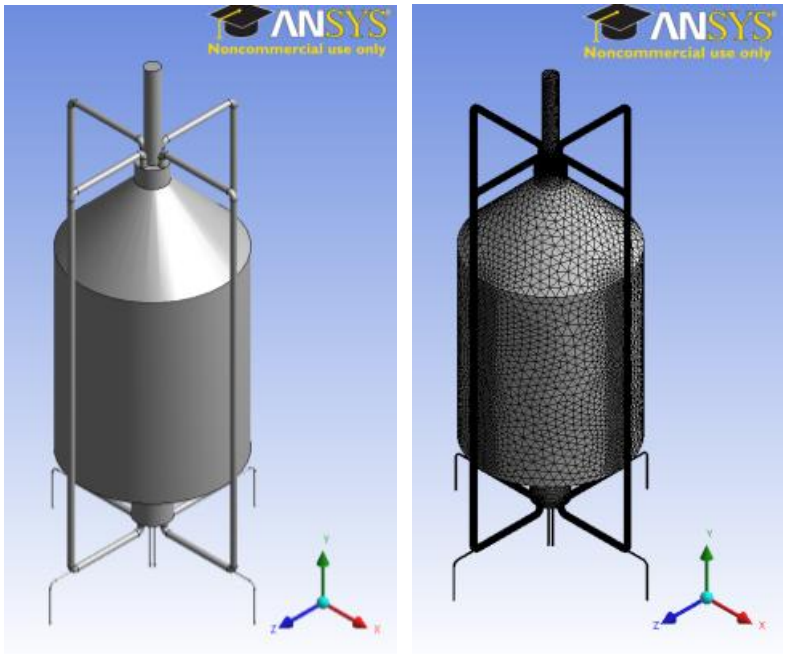
Fuel enters the burner through a central hole after merging through 4 inlets with 5mm in diameter with total 78.5 mm2 inlet area. If the velocity of the fuel injected is 10 m/s, the volume flow rate for the fuel is 7.85×10^{-4} m^3/s (7.8 cm^3/s).

AIR VOLUME FLOW RATE

Air injected through 4 inlets at the side of EGR with 5mm diameter each. If the air injected at 50 m/s, the air volume flow rate is 3.9×10^{-3} m^3/s (39 cm^3/s).

MODEL DEVELOPMENT

The open furnace was modelled (Figure 1(a)) using FLUENT 13.0 with the size of 1.8 m height and 0.6 m width and mesh (Figure 1(b)) with advanced sizing function of proximity and curvature. Element refinement was used at air, fuel inlet and EGR inlet and outlet. The air fuel nozzle size ratio for this model is 4:1.



(a) (b)

Figure 1. Open furnace with 4 EGR (a) geometry (b) 501,831 mesh element and 111,975 nodes

RESULTS AND DISCUSSION

The open furnace was modelled with the AFR reported in Table 1. The AFR of 1:1 will give the highest unburned CH_4 mole fraction. When AFR reaches 5.0, unburned CH_4 will become 0. This unburned CH_4 (Figure 2) in flue gas will flow through EGR and will burn at unwanted location when CH_4 mixed with O_2 at the fresh air supply (Figure3). Figure 4 is proper combustion with fuel consumed 100%.

Table 1. Air and fuel velocity compositions and mole fraction for unburned CH_4

Air (m/s)	Fuel (m/s)	AFR	UHC CH_4 mole fraction	UHC CH_4 mass fraction
50	50	1.0:1	0.1069	0.0615
100	50	2.0:1	0.0450	0.0258
90	40	2.3:1	0.0390	0.0215
75	30	2.5:1	0.0351	0.0201
100	40	2.5:1	0.0327	0.0185
60	20	3.0:1	0.0240	0.0119
100	30	3.3:1	0.0146	0.0082
55	15	3.7:1	0.0097	0.0056
60	15	4.0:1	0.0058	0.0033
65	15	4.3:1	0.0027	0.0015
70	15	4.7:1	0.0004	0.0002
100	20	5.0:1	0	0
80	16	5.0:1	0	0
50	10	5.0:1	0	0
70	13	5.4:1	0	0
90	15	6.0:1	0	0

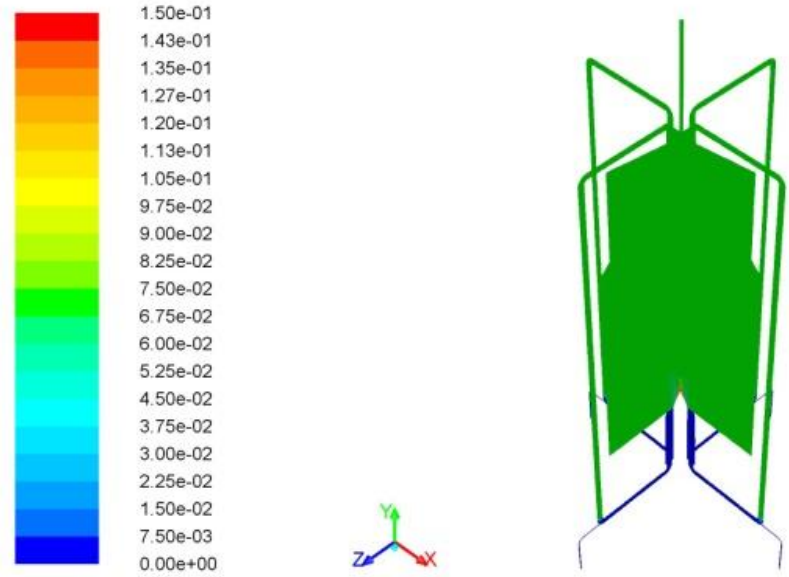


Figure 2. The CH_4 mole fraction between 0 to 0.15 with UHC in the EGR pipe

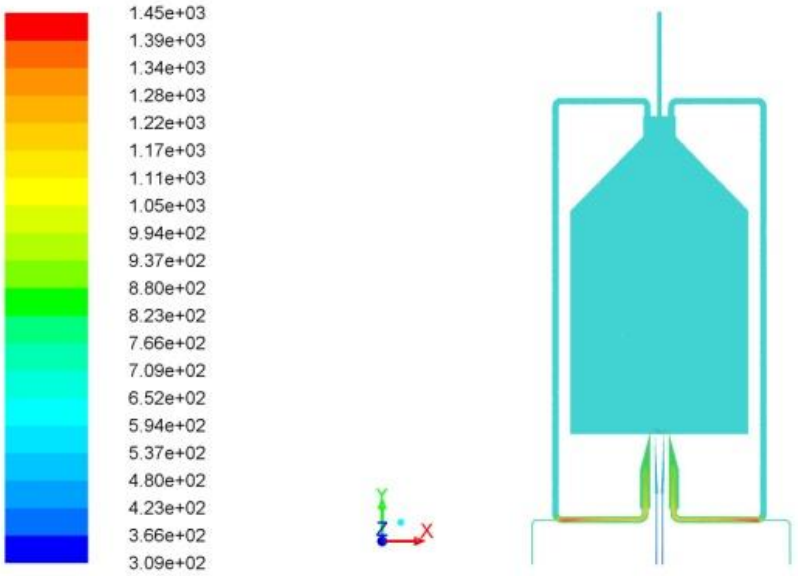


Figure 3. The combustion temperature with unwanted burning in EGR pipe due to unburned CH_4 in EGR (Figure 2)

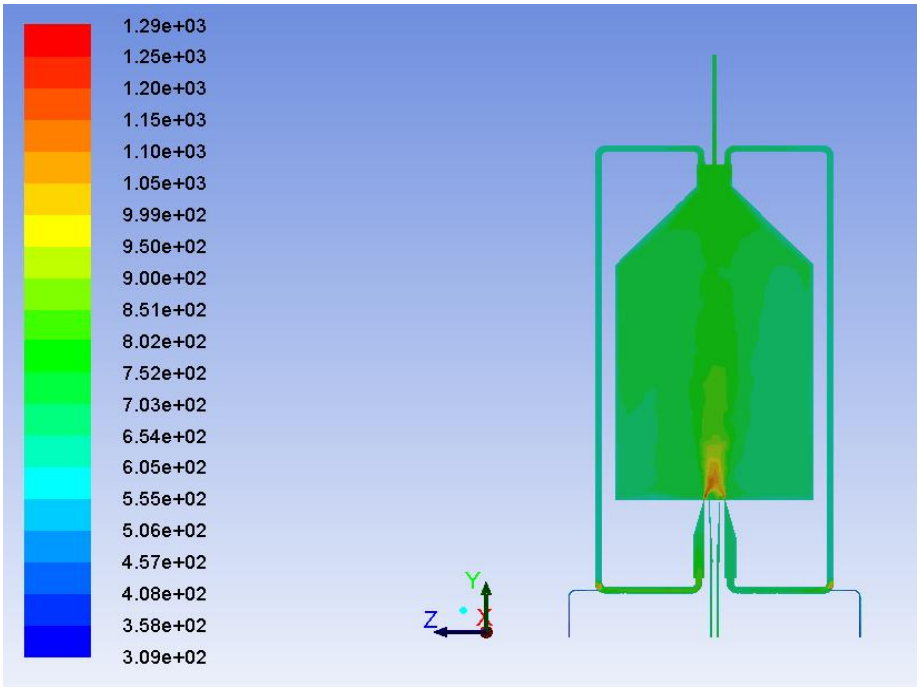


Figure 4. The maximum combustion temperature is 1290 K

CONCLUSION

The study of the effect of AFR to unburned CH_4 was successful. Both air and fuel play important role for the completed combustion. In order to consume all the fuel by the combustion, the AFR must be higher than 5:1. If AFR is lower than 5:1, unwanted unburned CH_4 will be produced.

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FINE-SCALE HABITAT MODELLING OF WILDLIFE SPECIES USING SPATIAL INFORMATION TOOLS

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ABSTRACT

Species habitat models (SHM) or species distribution models are numerical tools that combine observations of species occurrence or abundance with environmental estimates. Models that predict distributions of species by combining known occurrence records with digital layers from satellite imagery and Geographic Information System (GIS) inputs together with environmental variables have much potential for conservation applications and scenario modelling. In this research, four analytical techniques for multispecies modelling, i.e. maximum entropy (Maxent), random forest, artificial neural network, and mahalanobis typicality, will be explored to assess the species distribution. A methodological approach will be at the fine (5-10m) spatial scale, where studies at this level are lacking. Spotted-tail-quoll, Darling Downs Earless Dragon, Black-Breasted-Button-Quail, and Bulloak Jewel Butterfly, which are endangered and threatened species had been selected as case studies to test this framework.

Keywords: Species habitat modelling, multispecies, fine scale, maximum entropy, random forest, neural network, mahalanobis typicalities.

INTRODUCTION

Habitat models are now broadly used especially in conservation planning on regional scale or public lands. Determining the size, type and location of habitat to conserve is a complex area of conservation biology. Although difficult to measure and predict, the conservation value of a habitat is often a reflection of the quality (e.g. species abundance and diversity), endangerment of encompassing ecosystems, and spatial distribution of that habitat [1]. Habitat modelling is a transparent and repeatable technique for describing and mapping biodiversity values [2] either for flora or fauna or both. In this paper, a standardized modelling and newly developed models based on widely accepted techniques will be used to improve the conservation plans for four endangered and threatened fauna species. The integration of spatial information tools such as aerial and satellite remote sensing imagery, the Global Positioning System (GPS), and computerized GIS will enhance the habitat modeling outputs. We reviewed current habitat modelling methods and provide a habitat modelling review paper as a case study in the Southern Queensland region that we hope will serve as a methodological template for conservation planners and managers.

FINE SCALE MAPPING

Habitat mapping uses the term ‘scale’ in a generic manner to cover the complex interaction between area and size of habitat detail of mapping [3]. Scale therefore helps to define the approaches to habitat mapping. The applications of remote sensing data in landscape ecological studies are pervasive [4]. The use of fine scale mapping from high spatial resolution satellite images and digital layers of GIS base will enhance the modelling output. Models that can predict species distribution by combining known occurrence data with digital layers of environmental variables have much potential for conservation purpose.

MULTISPECIES HABITAT MODELLING

Habitat is a species-specific concept [3], in theory it demands the mapping needs to be conducted at the individual species level. Therefore, many researches in SHM are focused on a selected species, e.g. for adaptive management of horseshoe crabs and red knot [1], threaten reptiles such golden-tailed gecko and grey snake [5], marine communities. The single-species approach to habitat mapping has certain advantages for conservation planning but a focus on multispecies (but in the same taxonomic rank, e/.g. order) approach could be more justifiable in some condition [5].

ANALYTICAL ALGORITHMS

Several modelling techniques can be applied in SHM. The selection of method is largely depending on the type of available survey data to be used in model development: few or no data, presence-only data, presence-absence data, ordinal categories data and counts [6]. Some recent studies include bagging and random forests for ecological prediction [7], maximum entropy (Maxent) for modelling with presence-only data [8], malanobis typicality algorithm as a land change modeler in IDRISI [9], and artificial neural network [10]. Every single method has their own advantages and disadvantages that need to be considered prior to model development. In this research, four analytical techniques for multispecies modelling, i.e. maximum entropy (Maxent), random forest, artificial neural network, and mahalanobis typicality, will be used to assess the species distribution. These selections are related to test new models that had been developed special for ecological aspect and also these sorts of models can fit into different aspect of data that we are dealing with such as few or no data, presence-only data, and presence-absence data.

CONCLUSION

This study has demonstrated the possibility of a habitat map for a group of endangered and threatened species. This layout assumes that some species of this endangered and threatened species in the study area share certain common habitat requirement and preference [6]. For conservation planning and wildlife management, specifically in reserved or protected areas, a habitat map for multispecies of endangered and threatened species can be more justified than a single species approach. A shared habitat for these selected species will become a best case for rehabilitation and preservation.

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HEDGE FUND PERFORMANCE IN AUSTRALIAN MARKET: AN EMPIRICAL STUDY

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ABSTRACT

This study determines the factors affecting the hedge fund returns and examines the performance of Australian hedge funds. The performance measurement framework by Fung and Hsieh (2001 and 2004) is employed to estimates the hedge fund performance. The model includes the asset-based (ABS), return-based (RBS) and estimate returns of primitive trend-following (PTFS) factors as the explanatory variables. It covers 46 Australia hedge funds with ten years of monthly observation from 1998 to 2008. The model is tested on the panel random effect regression and shows mixed results. The explanatory variables depict a fairly good indicator of the market.

***Keywords*:** Hedge funds, funds' performance, market performance

INTRODUCTION

Hedge funds have grown rapidly since the 1997 Asian financial crisis. Investors are increasingly looking for alternative investments to ensure protection from the market decline. At the same time the investors may receive a great return from their investment. This paper investigates the performance of Australian hedge funds on different hedge funds strategies. It also tests whether selective asset based (ABS) and risk based (RBS) factors have an impact on hedge funds' performance. Out of 85 Australian hedge funds, only 46 funds are selected from the Hedge Funds Research (HFR) Database. The choice are based on the length of historical data i.e., it has to be for more than 12 months and between 1998 to 2008. The Fung and Hsieh model [2] is employed in this study. This RBS and ABS model have been shown to be valuable explanatory variables for the fund and hedge fund returns [1,3,4]. The model includes two equity factors, two fixed income factors and five primitive trend-following (PTFS) factors. The equity factors are S&P 500 return minus risk-free rate (asx200) and small cap minus large cap return (scmc). The fixed income factors change in the constant maturity yield of the 10-year Treasury (treasury) and change in the spread of bond minus the 10-year Treasury (spread). The five primitive trend-following (PTFS) factors [5] are bond PTFS (Tbond), currency PTFS (Tforex), commodity PTFS (Tcomm), interest PTFS (Tinterest) and stocks PTFS (Tstock).

PERFORMANCE MODEL

The estimated linear equation used in this study is,

$$Y_t = \alpha_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \ldots + \beta_n X_{nt} + \epsilon_t.$$

where Y is the dependent variable. The alpha (α) is the model intercept. All X variables are the explanatory variables. Meanwhile, the Beta (β) values explain how much the dependent variables change by a change in the explanatory variables and the ϵ is the error-term. The other parameters to be considered is the R-squared (R^2), which indicates the explanatory power of the model. Many of the hedge fund studies have shown small R-squared [1,2,3,4].

RESULTS

Table 1 indicates the Macro funds strategy which has the highest average return (0.89%) and the lowest average return is the Relatives Values funds strategy (0.26%). However, the Relatives Value fund has 4.59% standard deviation.

Table 1. Result of Random Effect Regression

Strategy	Relatives Value (n=4)	Macro (n=12)	Equity Hedge (n=22)	Event Driven(n-4)	Fund of Fund (n=4)
α	0.0023 (0.0070)	0.011533* (0.001125)	0.006505* (0.001017)	0.0065* (0.0012)	0.005322* (0.001873)
β_{asx200}	0.0890 (0.1168)	0.07384 (0.07755)	0.1805* (0.04131)	0.0835* (0.0286)	0.2788* (0.08215)
β_{scmc}	0.0328 (0.1446)	0.03143 (0.04695)	0.02172 (0.03784)	0.0229* (0.0094)	-0.1528* (0.05836)
$\beta_{treasury}$	-0.00003* (0.0000)	-0.000062** (0.000036)	0.000035 (0.000030)	0.000 (0.0000)	-0.02779 (0.01781)
β_{spread}	0.0002 (0.0001)	0.000285 (0.000217)	0.000045 (0.000105)	0.0001 (0.0001)	0.02771 (0.01767)
βT_{bond}	-0.0147** (0.0088)	0.03501* (0.01232)	0.01005* (0.007624)	0.0118* (0.0043)	-0.01669* (0.005389)
βT_{forex}	-0.0303 (0.0200)	0.013628 (0.011088)	-0.006039 (0.005247)	0.0045 (0.0045)	-0.03959 (0.07500)
βT_{comm}	0.0089 (0.0249)	0.05025* (0.01419)	0.008208 (0.005752)	0.0019 (0.0027)	0.03782* (0.01050)
$\beta T_{interest}$	-0.0130 (0.0084)	-0.01629* (0.004253)	-0.01347* (0.002427)	0.0108* (0.0017)	-0.02346* (0.004415)
βT_{stock}	-0.0418* (0.0083)	0.03203* (0.01334)	-0.03946* (0.01446)	0.0066 (0.0135)	-0.01033 (0.01049)
Mean Return	0.002587	0.008876	0.006556	0.00603	0.002604
Std Dev.	0.04592	0.03972	0.04053	0.01417	0.02719
R^2	0.1076	0.0991	0.1223	0.2634	0.4068

*significant at 5% confidence level ( ) standard error
** significant at 10%onfidence level

It is the highest risk fund compared to other funds. Meanwhile, the Event Driven fund shows the least risk fund at 1.42%. The R-squared for most funds are lower than sufficient level (30.0%), except the R-squared for the fund of fund at 40.68%. However, this explanatory variable is relevant to explain the model since the hedge funds returns has a non-normal distribution.

All funds have positive alpha and 80% of the funds is significant at 5% confidence level. Only Relatives Value fund with the 0.007 standard error is insignificant. More than 50% of the funds have positive relationship with the descriptive variables. All funds have positive relation with the ASX200, commodity option and spread of the fixed income. Meanwhile, all funds are statistically insignificant with spread of the fixed income and currency. About 66.67% parameters in Macro funds and Fund of Funds are significant at 1% and 5%. Generally, the average of 44.44% of the variables has influence on the hedge funds performances in all fund strategies.

CONCLUSION

This study explains the performance of Australian hedge fund in the various strategies, following the Fung-Hsieh [2] RBS and ABS model. The observation shows mixed results. It may be due to non-normal return distribution and diversification of hedge fund strategies. At the same time these funds strategies can reduce the total risk and increase returns. Most of the explanatory variables are able to explain the hedge funds' performance. For future research, there are more quantitative tests can be done to get sufficient models that could explain the factors of return for the five Australian hedge fund classes that been studied.

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EXPLORING LANGUAGE ANXIETY OF MALAYSIAN LEARNERS

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ABSTRACT

This paper reports initial findings of a study on language anxiety of 205 Malaysian undergraduates of a public university towards learning English as a second language (L2). The Foreign Language Classroom Anxiety Scale (FLCAS) (Horwitz et al. 1986) was administered to groups of English language learners. The pre-scores from the questionnaire were calculated for descriptive statistics. This pilot study also aimed to confirm the reliability of the FLCAS as an instrument to measure potential sources of anxiety in language classrooms in Malaysian learning context.

***Keywords*:** language anxiety, second language learners, FLCAS

INTRODUCTION

Learning English as a second language (ESL) causes many learners to experience language anxiety. Language anxiety is defined as the feeling of tension and apprehension specifically in second-language contexts, including speaking, listening, reading, and writing (MacIntrye and Gardner, 1994). The implementation of the National Education Policy in 1970 marked the unification of a system comprising Malay language as the medium of instruction whilst English was accorded the status of second language (L2). However, Malaysian learners are still inhibited by their social factors such as the lack of motivation and interest to learn English (Thang et.al, 2011). They result in problems of acquisition, retention and production of the language (MacIntyre and Gardner, 1991), which ultimately affects their performance and grades. A study by a team of researchers from a local university in Malaysia revealed that local graduates failed to market themselves due to lacking personal qualities and communication skills. They emphasized skills in English as the most common issue of concern raised by employers (Shuib, 2005). The paucity of research within Malaysia on tertiary L2 learners' language anxiety has led to the undertaking of the present study.

FLCAS

Horwitz, Horwitz and Cope (1986) developed a 36-item Foreign Language Classroom Anxiety Scale (FLCAS) to measure the learners' anxiety levels. For analysis purposes, Horwitz (1986), MacIntyre and Gardner (1991) and several other researchers identify three related foreign language anxieties:

1. Communication apprehension, arising from learners' inability to adequately express mature thoughts and ideas;
2. Fear of negative social evaluation, arising from a learner's need to make a positive social impression on others;
   and
3. Test anxiety, arising from learners' feelings of apprehension over academic evaluation

METHODOLOGY

This study reports the preliminary findings of the FLCAS section of the pre-test online questionnaire which was administered at the beginning of the semester. The population for the study consisted all undergraduate learners who enrolled for an English course which was also the compulsory university course registered in 15 faculties of a public university in Malaysia. They were invited to respond to the questionnaire which once launched was uploaded on the learning management system (LMS) of the university. A total of 205 questionnaires were returned. Exploratory data analysis on the FLCAS items were analysed using Statistical Package for the Social Sciences (SPSS) for frequency. However, further analysis will be carried out.

RESULTS AND DISCUSSION

The Cronbach coefficient alpha referring to the internal reliability of the FLCAS section was 0.916, indicating that the internal consistency is satisfactorily reliable. Of the 205 respondents, 68 (33.2%) were male and 137 (66.8%) were female. The most frequent factor of anxiety for Malaysian language learners is fear of negative social evaluation when they need to respond in the L2. The Malaysian education system has a strong orientation toward the national based assessment and has generally produced learners who report that they worry very much if they might fail the English course and if they are being corrected by their English teachers. These characteristics indeed discourage and inhibit learning of the target language. The next most frequent anxiety factor is communication apprehension, which reflects the individual level of anxiety associated with either real or anticipated communication with other learners. Although they have adequate input of the target language, the learners' feelings of reticence, shyness, introversion, and social anxiety still impact their ability to communicate. The high importance placed on achieving good grades in examination further exacerbates the language learning process. It is also observed that anxiety is occurring at each stage of language learning namely acquisition (input), retention (processing) and production (output). It is occurring most often at the processing stage of learning when learners experience uneasiness learning and thinking in L2 and at the output stage when learners need to speak in the L2.

CONCLUSION

The present study confirms the recurring language anxiety at every stage of language learning. The pervasive emotions can be debilitating and learners' beliefs about the nature of language learning are difficult to change. While language teachers may have measures to reduce anxiety level of L2 learners, learners themselves should be more willing and active in using the language to achieve a more positive impact on learning.

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ISSUES AND CHALLENGES OF USING WEB PORTFOLIOS: AN ANCIENT APPROACH IN A NEW ENVIRONMENT

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ABSTRACT

This paper reports on the initial findings of a doctoral project exploring the use of Web portfolios in the training of pre-service ESL teachers in Malaysia. Web-based portfolios or Web portfolios were introduced in a computer-assisted language learning (CALL) course offered at a teacher training institution in Malaysia. Its use is twofold: as an assignment of the CALL course where students display their understanding of CALL, and as a learning approach that fosters collaboration and reflection. Through focus group interviews, the paper highlights issues and challenges experienced by students throughout their development of Web portfolios in the CALL course. Initial findings suggest that tensions do exist between the use of portfolios as an assessment tool and its use as a learning tool. Conflicting expectations of students owing to their limited understanding of the portfolio concept and their unfamiliarity with the Web as a learning environment are identified as the two main challenges for Web portfolio success in the CALL course.

***Keywords*:** Portfolio, Web portfolio, teacher training, computer-assisted language learning.

INTRODUCTION

Portfolios, in general, have been known to be used since centuries ago. While there has already been a long tradition of their use in various disciplines, the application of portfolios has recently gained popularity in the field of education. Studies have reported that when used as an alternative form of assessment, portfolios create valuable opportunities for students to document and showcase their learning (Barrett, 2000; Barrett, 2011; DiMarco, 2006). However, there are a number of conflicting views with regards to their application. Of particular interest is when portfolios are used both as a learning and assessment tool.

THE WEB PORTFOLIO CONCEPT

A Web portfolio is defined as an electronic portfolio that is delivered via the Internet and presented as Web pages instead of the other typical formats of delivery platforms such as CD-ROM and DVD (DiMarco, 2006). A Web portfolio also allows users to include artefacts in several media types that are organised using hypertext links (Barrett, 2000). The concept underlying the construction of Web portfolios in this study is derived from the 'Learning Portfolio Model' by Zubizarreta (2004). There are three dimensions to this model: documentation, collaboration and reflection. In this study,

these three dimensions are further developed to include two other dimensions: technology and assessment. The development of Web portfolios in the study was also designed to align well with constructivist approaches in learning where learning is viewed as "an active process of constructing rather than acquiring knowledge" (Duffy & Cunningham, 1996, p. 171).

METHODOLOGY

The participants were first year pre-service ESL teachers enrolled in a computer-assisted language learning (CALL) course in a teacher training institution in Malaysia. Their participation required them to each develop a learning Web portfolio for the CALL course within a seven-week period. Students' experiences in using Web portfolios as a learning and assessment tool were drawn through focus group interviews. A total of 25 students participated in focus groups interviews and seven focus groups were conducted. The focus group interviews were audio-taped and transcribed.

RESULTS AND DISCUSSION

As a product and a learning tool, Web portfolios were found to be a unique platform for students to display their learning experiences. Students claimed to have included their assignments from the present and previous semesters. They have also allowed other students access to view their work with an aim of exchanging learning experiences. As an assessment tool in the CALL course, many students commented that they had spent a lot of time using technology to project their personality in their Web portfolios. This resulted in many of them to embark on new learning experiences discovering various Web applications available on the Internet. However, it was found that students had issues in identifying the true value of their Web portfolios. Firstly, students pointed out that the development process was a challenge for them as they were still unclear of the of the learning portfolio concept. They had regarded the Web portfolio more of a storage space rather than a space to enhance their learning experiences. Secondly, students were also found to be unfamiliar with the Web as a learning environment. The students mentioned that they had to spend a lot of time online to complete their Web portfolio and some resorted to asking help from more computer competent course mates because they were unable to proceed on their own. From the feedback gathered, there seems to be more grounds for exploration in terms of the students' use of Web portfolios. Although there were students who have used their Web portfolios as a learning tool to reflect on their previous work and to learn from their past mistakes, many did not fully explore the dynamic nature of Web portfolios instead used them 'static' online space. In other words, characteristics of the ancient form of portfolios were still evident even when used in a 'new' environment. Further investigation is also required to ease the tension that exists between the use of Web portfolios as a learning and assessment tool.

CONCLUSION

To conclude, the use of Web portfolios in the CALL course had a lot of potential as a tool students use to display their computer skills and as a unique platform for them to express their individuality as learners. However, there were clearly some issues and challenges when Web portfolios were used both as a learning and assessment tool. As

part of further improvement, it may be worth considering the development process within the CALL course be improved and more practice in the use of Web portfolios be given to students.

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