

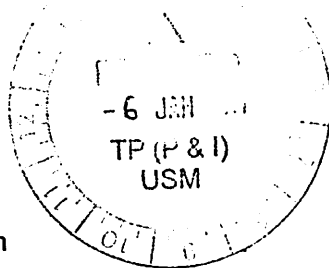


Laporan Akhir Projek Penyelidikan Jangka Pendek

**Potential Of Oil Palm Ash As A New Filler
in Natural Rubber Compounds**

**By
Prof. Dr. Hanafi Ismail**

2013



En. Ab. Hafiz Bin Ab. Hadi

Pejabat Pengurusan & Kreativiti Penyelidikan

Aras 6, Bangunan Canselori

11800 Minden, USM

2 Januari 2014

Tuan,


Laporan Akhir Projek Penyelidikan ScienceFund: "Potential of Oil Palm Ash As A Filler in Natural Rubber Compounds (305/PBAHAN/6013380) No Projek: 03-01-05-SF0491

Saya dengan hormatnya merujuk kepada perkara di atas.

2. Bersama surat ini saya sertakan Laporan Akhir Projek (HardCopy) bersama bahan-bahan bukti. Saya juga telah mengemukakan Laporan Akhir Projek secara online melalui system eSciencefund.

Sekian, terima kasih.

Yang Benar,



(PROF DR HANAFI ISMAIL, FASc)

End of Project Report For ScienceFund

A. Description of the Project

1. **Project number** : 03-01-05-SF0491
2. **Project Title** : Potential of oil palm ash as a new filler in natural rubber compounds
3. **Project Leader** : Hanafi Ismail
4. **Project Team** :

(please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)

All the project team members are in School of Materials and Mineral Resources Engineering, Engineering Campus, USM, Nibong Tebal, Penang

5. **Industrial Partnership** :

(Please describe the nature of collaborators with relevant industry)

United Oil Palm Industries Sdn Bhd - provide the oil palm ash for research project.

6. **National/International Collaboration** :

(Please identify research organisations and describe the nature of collaboration)

7. **Project Duration** : 24(months)
Start date : October (month) 2011 (year)
End date : September (month) 2013 (year)
8. **Total Budget Approved** : RM 183504

B. Objectives of the Project

1. Socio-economic Objectives (SEO)

Which socio-economic objectives are addressed by the project? (Please identify the Research Priority Area, SEO Category and SEO Group under which the project falls. Refer to the Malaysian R&D Classification System, 4th Edition).

Research Priority Area : INDUSTRY Sub Cluster : Advanced Material
SEO Category : Natural Sciences, Technologies and Engineering
SEO Group : Applied Sciences and Technologies
SEO Area : Applied Sciences and Technologies

2. Fields of Research (FOR)

Which are the two main FOR Categories, FOR Groups, and FOR Areas of your project? (please refer to the Malaysian R&D Classification System, 4th Edition)

a. Primary field of research

FOR Category : Environmental Sciences
FOR Group : Applied Sciences and Technologies
FOR Area : Other environment technology/ industry

b. Secondary Field of research

FOR Category : Material Sciences
FOR Group : Polymeric Materials
FOR Area : Polymer composites

C. Objective Achievement

- Original project objectives

(Please state the specific project objectives as described in Section II of the Application Form)

The aim of the study is to investigate the properties of oil palm ash (OPA) filled in natural rubber compounds which will be compounded using a conventional two roll mill followed by compression molded. Specifically, the objectives of the study are:

1. To utilize the OPA as a new filler in natural rubber compounds and study the effect of OPA loading on curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the palm oil ash filled natural rubber compounds.
2. To evaluate the effect of modification of OPA on the properties of natural rubber compounds in term of curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the OPA filled natural rubber compounds.
3. To determine the potential application of OPA filled natural rubber compounds.

- Objective Achieved

(Please state the extent to which the project objectives were achieved)

All original objectives were achieved.

- Objectives not achieved

(Please identify the objectives that were not achieved and give reasons)

N/A

D. Technology Transfer / Commercialisation Approach, if any.

(Please describe the approach planned to transfer/commercialise the results of the project)

E. Assessment of Research Approach

(Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)

Research approach was done according to initial proposed project.

F. Assessment of the Project Schedule

(Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)

The project was completed according to the milestone even though the 2nd year allocation was not received on time.

G. Assessment of Project Cost

(Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)

Although RM 189,504.00 was approved for this project, but the allocation for 2nd year RM136,985.00 was only received at the end of December 2012 and not according to the original budget allocated. However, the allocation was used accordingly and the balance at the end of this project was RM 62.89. (Statement from Bendahari USM as shown in appendix A)

H. Additional Project Funding Obtained

(In case of involvement of other funding sources, please indicate the source and total funding provided)

I. Benefits of the Project

(please identify the actual benefits arising from the project as defined in Section III of the Application form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section III of the Guidelines for the Application of R&D Funding under ScienceFund)

1. Direct Outputs of the Project

(Please describe as specifically as possible the outputs achieved and provide an assessment of their significant to users)

i. Technical contribution of the project

a. What was the achieved direct output of the project :

For basic oriented research projects?

- Algorithm
- Structure
- data
- Other, please specify :

For applied research (technology development) projects :

- Method/technique
- Demonstrator/prototype
- Product/component
- Process
- Software
- Other, please specify:

b. How would you characterise the quality of this output?

- Significant breakthrough
- Major improvement
- Minor Improvement

ii Contribution of the project to knowledge

a. How has the output of the project been documented

- Detail project report
- Products/process specification documents
- Other, please specify :

b. Did the project create an intellectual property stock?

- Patent obtained
- Patent pending
- Patent application will be filed
- Copyright

c. What publications are available?

		National	International
<input checked="" type="checkbox"/>	Article(s) in scientific publications	How many : 0	8
<input checked="" type="checkbox"/>	Paper(s) delivered at conferences/seminars	How many : 5	4
<input type="checkbox"/>	Book	How many : 0	0
<input type="checkbox"/>	Other, please specify :		

d. How significant are citations of the results?

<input type="checkbox"/>	Citations in national publications	How many : 0
<input checked="" type="checkbox"/>	Citations in international publications	How many : 4
<input type="checkbox"/>	Not yet	
<input type="checkbox"/>	Not known	

2. Organisational Outcomes of the Project

(Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to expertise development

a. How did the project contribute to expertise?

<input checked="" type="checkbox"/>	PhD degrees	How many : 1
<input checked="" type="checkbox"/>	MSc degrees	How many : 1
<input type="checkbox"/>	Research staff with new specialty	How many : 0
<input type="checkbox"/>	Other, please specify :	

b. How Significant is this expertise?

<input type="checkbox"/>	One of the key areas of priority for Malaysia
<input checked="" type="checkbox"/>	An important area, but not a priority one

ii. Economic contribution of the project?

a. How has the economic contribution of the project materialised?

<input type="checkbox"/>	Sales of manufactured product/equipment
<input type="checkbox"/>	Royalties from licensing
<input checked="" type="checkbox"/>	Cost savings
<input type="checkbox"/>	Time savings
<input type="checkbox"/>	Other, please specify :

b. How important is this economic contribution?

<input type="checkbox"/>	High economic contribution	How many : RM0
<input type="checkbox"/>	Medium economic contribution	How many : RM0
<input checked="" type="checkbox"/>	Low economic contribution	How many : RM0

c. When has this economic contribution materialised?

<input type="checkbox"/>	Already materialised
<input type="checkbox"/>	Within months of project completion
<input type="checkbox"/>	Within three years of project completion
<input checked="" type="checkbox"/>	Expected in three years or more
<input type="checkbox"/>	Unknown

iii. Infrastructural contribution of the project

a. What infrastructure contribution has the project had?

- | | | |
|-------------------------------------|--------------------------|------------------|
| <input type="checkbox"/> | New equipment | Value : RM0 |
| <input type="checkbox"/> | New/improved facility | Investment : RM0 |
| <input checked="" type="checkbox"/> | New information networks | |
| <input type="checkbox"/> | Other, please specify : | |

b. How significant is this infrastructure contribution for the organisation?

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | Not significant/does not leverage other projects |
| <input checked="" type="checkbox"/> | Moderately significant |
| <input type="checkbox"/> | Very significant/significantly leverages other projects |

iv. Contribution of the project to the organisation's reputation

a. How has the project contributed to increasing the reputation of the organisation

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | Recognition as a Center of Excellence |
| <input checked="" type="checkbox"/> | National award |
| <input type="checkbox"/> | International award |
| <input type="checkbox"/> | Demand for advisory services |
| <input checked="" type="checkbox"/> | invitations to give speeches on conferences |
| <input type="checkbox"/> | Visits from other organisations |
| <input type="checkbox"/> | Other, please specify : |

b. How important is the project's contribution to the organisation's reputation?

- | | |
|-------------------------------------|------------------------|
| <input type="checkbox"/> | Not significant |
| <input checked="" type="checkbox"/> | Moderately significant |
| <input type="checkbox"/> | Very significant |

3. National Impacts of the project

(If known at this point in time, please describe as specifically as possible the potential sectoral/national benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to organisational linkages

a. Which kinds of linkages did the project create?

- | | |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | Domestic industry linkages |
| <input type="checkbox"/> | International industry linkages |
| <input checked="" type="checkbox"/> | Linkages with domestic research institutions, universities |
| <input type="checkbox"/> | Linkages with international research institutions, universities |

b. What is the nature of the linkages?

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> | Staff exchanges |
| <input checked="" type="checkbox"/> | inter-organisational project team |
| <input type="checkbox"/> | Research contract with a commercial client |
| <input type="checkbox"/> | Informal consultation |
| <input type="checkbox"/> | Other, please specify : |

ii. Social-economic contribution of the project

a. Who are the direct customer/beneficiaries of the project output?

Customers/beneficiaries	Number
Palm Oil Industries	50
Total	50

b. How has/will the socio-economic contribution of the project materialised?

- Improvements in health
- Improvements in safety
- improvements in the environment
- Improvements in energy consumption/supply
- Improvements in international relations
- Other, please specify :

c. How important is this socio-economic contribution?

- High social contribution
- Medium social contribution
- Low social contribution

d. When has/will this social contribution materialised?

- Already materialised
- Within three years of project completion
- Expected in three years or more
- Unknown

Date :

Signature :

PROGRESS REPORT

Report Period : Jul-Dec 2013

(please indicate report period)

A. PROJECT DETAILS

Project number : 03-01-05-SF0491
 Project Title : Potential of oil palm ash as a new filler in natural rubber compounds
 Project Leader : Hanafi Ismail
 Project Duration : 24(months)
 Project Start date : October (month) 2011 (year)
 Project End date : Sep (month) 2013 (year)
 Tel 045996113 Fax 045941011 Email hanafi@eng.usm.my

B. FINANCIAL PROGRESS

- i. Approved Project Allocation : RM 183,504.00
 Year 1 (2011) : RM 46,519.00 Year 2 (2012) : RM 136,985.00 Year 3 (2013) : RM .00
- ii. Total Allocation Received Todate : RM 183,504.00
- iii. Total Expenditure Todate : RM 183,442.00 or 100% (Total Expenditure / Total Allocation received X 100)
- iv. Balance of Allocation Todate : RM 62.00
- v. Actual Project Expenditure (Please report total cumulative expenditure up to the past report period)

Project Cost Components	Total Approved Budget (RM)	Total Allocation Received (RM)	Total Cumulative Expenditure (RM)
* Temporary and contract personnel (V11000)	73,254.00	73,254.00	43,089.00
* Travel and transportation (V21000)	18,750.00	18,750.00	12,402.00
* Rentals (V24000)	4,000.00	4,000.00	0.00
* Research materials and supplies (V26000)	57,000.00	57,000.00	108,263.00
* Minor modifications and repairs (V28000)	9,500.00	9,500.00	5,734.00
* Special services (V29000)	21,000.00	21,000.00	13,954.00
* Special equipment and accessories (V35000)	0.00	0.00	0.00
Total direct expenses			
Total	183,504.00	183,504.00	183,442.00

Is this performance in line with plan? Yes No (Please complete para vi and vii)

vi. Reasons for variations from budget (Please provide the reasons)

vii. Proposed corrective action (Please give details of the proposed action)

C. PHYSICAL PROGRESS

i. Milestone Achievement

No	Planned	Planned Milestone Date (MM/yyyy)	Achieved *(Yes/No)	Actual Completion Date (MM/yyyy)
1	Preliminary Stage: Preparation of oil palm ash (OPA) and compounding of new OPA filled NR compounds	12/2011	Yes	12/2011
2	Stage 1: Study of cure characteristic, mechanical properties, thermal properties with different load	08/2012	Yes	08/2012
3	Stage 2: Improving the properties of new OPA filled NR compounds by modifying the OPA particles	02/2013	Yes	02/2013
4	Stage 3: Data analysis and determination of the potential application OPA filled NR compounds	06/2013	Yes	06/2013
5	Project Completion	09/2013	Yes	09/2013

ii. Project Achievement *(please provide details on the project achievements, its status and prospects with regards to the followings:)*

1. Intellectual Property Rights *(Patent, Industrial Design, Trademark, Copyright etc)*

2. Publications and papers *(International, national, books, citations etc)*

1) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2012). A comparative study of ageing characteristics and morphology of oil palm ash, silica, and carbon blacks filled natural rubber compounds. In: National Symposium on Polymeric Materials 2012 (NSPM 2012), 3rd - 5th October 2012, SERC Universiti Sains M

4) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). A comparative study of ageing characteristics and thermal stability of oil palm ash, silica, and carbon black filled natural rubber vulcanizates. *Journal of Applied Polymer Science*, 130(6): 4474-4481.

4) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Curing and tensile behavior of untreated and treated-oil palm ash reinforced natural rubber composites. In: 22nd Scientific Conference of Microscopy Society Malaysia (MSM 2013), 26th - 28th November 2013, Primula Beach Hotel, Terengganu, Malaysia.

1) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2012). The effect of oil palm ash loading on curing characteristics and tensile properties of natural rubber vulcanizates. In: The 8th Asian-Australasian Conference on Composite Materials (ACCM-8), 6th - 8th November 2012, Kuala Lumpur Convention Centre,

2) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2012). Curing characteristics, tensile properties, morphological of oil palm ash filled in natural rubber compound: In comparison with silica and carbon black. In: 21st Scientific Conference of The Microscopy Society Malaysia, 22nd - 24th November 2012, R

9) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Curing Characteristics, Mechanical, Morphological, and Swelling Assessment of Liquid Epoxidized Natural Rubber Coated Oil Palm Ash Reinforced Natural Rubber Composites. *Polymer Testing*, Accepted & In-Press.

2) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Dynamic mechanical properties and tensile behavior of oil palm ash filled natural rubber vulcanizates. In: The 1st Asia Pacific Rubber Conference (APRC 2013), 5th - 6th September 2013, Diamond Plaza Hotel, Surat Thani, Thailand.

3) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). The Effect of Hydrochloric Acid Treatment on Properties of Oil Palm Ash-filled Natural Rubber Composites. *BioResources*, 8(4): 5133-5144.

4) Ismail, H., Ooi, Z.X., and Abu Bakar, A. (2013). Oil palm ash (OPA) as a new reinforcing filler in natural rubber composites. In: 12th International Conference on Frontiers of Polymers and Advanced Materials (ICFPAM 2013), 8-13 December 2013, Owen G Glenn Building, University of Auckland, New Zea

5) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2014). Dynamic Mechanical Properties and Tensile Behavior of Oil Palm Ash Filled Natural Rubber Vulcanizates. *Advanced Materials Research*, 844: 305-308.

1) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Synergistic effect of oil palm ash filled natural rubber compound at low filler loading. *Polymer Testing*, 32(1): 38-44.

7) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Characterization and Properties of Pretreatment Effect on Oil Palm Ash Filled Natural Rubber Vulcanizates. *Polymer-Plastics Technology and Engineering*, Accepted & In-Press.

8) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Chemically modified Oil Palm Ash-Filled Natural Rubber Composites and Its Properties. *Polymer Composites*, Accepted & In-Press

5) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Thermo-oxidative ageing of untreated and treated-oil palm ash filled natural rubber composites. In: 22nd Scientific Conference of Microscopy Society Malaysia (MSM 2013), 26th - 28th November 2013, Primula Beach Hotel, Terengganu, Malaysia.

2) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Optimisation of oil palm ash as reinforcement in natural rubber vulcanisation: A comparison between silica and carbon black fillers. *Polymer Testing*, 32(4): 625-630.

3) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Effect of cetyltrimethylammonium bromide on tensile properties of natural rubber/oil palm ash vulcanizates. In: Mini Symposium Universiti Sains Malaysia (USM) -Nagaoka University of Technology (NUT), 21st October 2013, Science and Engineering Resea

3) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2012). Study on ageing characteristics of oil palm ash filled natural rubber compound. In: 21st Scientific Conference of The Microscopy Society Malaysia, 22nd - 24th November 2012, Renaissance Kota Bharu Hotel, Kota Bharu Hotel, Kelantan, Malaysia.

6) Ooi, Z.X., Ismail, H., and Abu Bakar, A. (2013). Characterization of Oil Palm Ash (OPA) and Thermal Properties of OPA Filled Natural Rubber Compounds. *Journal of Elastomers and Plastics*, Accepted & In-Press.

3. Expertise Development (*PhD, Masters, Research Staff with new specialty etc*)

1 MSC student has graduated and 1 Phd in the process of submitting thesis

4. Prototype (*prototype name, type eg, lab scale, engineering scale, commercial scale etc*)

5. Commercialisation (*licensing, royalty, spin-off, direct sale etc*)

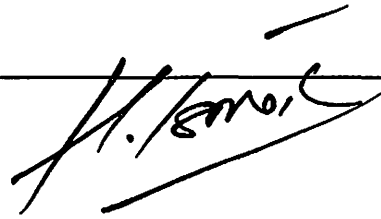
iii. General Comment (*please provide additional information, if any, on the future direction of this project in terms of its prospects to commercialization*)

All 3 milestones were successfully achieved including milestone no.3 where Oil Palm Ash can be used as reinforcing filler to replace commercial fillers such as carbon black and silica in natural rubber products. However, the filler loading used was not more than 10 phr.

Date :

2/1/2014

Signature :

A handwritten signature in black ink, appearing to read 'H. Smith', written over a horizontal line.

Progress Report

End of Project Report For ScienceFund

A. Description of the Project

1. **Project number** : 03-01-05-SF0491
2. **Project Title** : Potential of oil palm ash as a new filler in natural rubber compounds
3. **Project Leader** : Hanafi Ismail
4. **Project Team** :

(please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)

All the project team members are in School of Materials and Mineral Resources Engineering, Engineering Campus, USM, Nibong Tebal, Penang
5. **Industrial Partnership** :

(Please describe the nature of collaborators with relevant industry)

United Oil Palm Industries Sdn Bhd - provide the oil palm ash for research project.
6. **National/International Collaboration** :

(Please identify research organisations and describe the nature of collaboration)
7. **Project Duration** : 24(months)
Start date : October (month) 2011 (year)
End date : September (month) 2013 (year)
8. **Total Budget Approved** : RM 183504

B. Objectives of the Project

1. Socio-economic Objectives (SEO)

Which socio-economic objectives are addressed by the project? (Please identify the Research Priority Area, SEO Category and SEO Group under which the project falls. Refer to the Malaysian R&D Classification System, 4th Edition).

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SEO Category : Natural Sciences, Technologies and Engineering
SEO Group : Applied Sciences and Technologies
SEO Area : Applied Sciences and Technologies

2. Fields of Research (FOR)

Which are the two main FOR Categories, FOR Groups, and FOR Areas of your project? (please refer to the Malaysian R&D Classification System, 4th Edition)

a. Primary field of research

FOR Category : Environmental Sciences
FOR Group : Applied Sciences and Technologies
FOR Area : Other environment technology/ industry

b. Secondary Field of research

FOR Category : Material Sciences
FOR Group : Polymeric Materials
FOR Area : Polymer composites

C. Objective Achievement

- Original project objectives

(Please state the specific project objectives as described in Section II of the Application Form)

The aim of the study is to investigate the properties of oil palm ash (OPA) filled in natural rubber compounds which will be compounded using a conventional two roll mill followed by compression molded. Specifically, the objectives of the study are:

1. To utilize the OPA as a new filler in natural rubber compounds and study the effect of OPA loading on curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the palm oil ash filled natural rubber compounds.
2. To evaluate the effect of modification of OPA on the properties of natural rubber compounds in term of curing characteristics, tensile properties, thermal properties, swelling behavior, morphology of tensile fracture surface and Fourier transform infrared (FT-IR) of the OPA filled natural rubber compounds.
3. To determine the potential application of OPA filled natural rubber compounds.

- Objective Achieved

(Please state the extent to which the project objectives were achieved)

All original objectives were achieved.

- Objectives not achieved

(Please identify the objectives that were not achieved and give reasons)

N/A

D. Technology Transfer / Commercialisation Approach, if any.

(Please describe the approach planned to transfer/commercialise the results of the project)

E. Assessment of Research Approach

(Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)

Research approach was done according to initial proposed project.

F. Assessment of the Project Schedule

(Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)

The project was completed according to the milestone even though the 2nd year allocation was not received on time.

G. Assessment of Project Cost

(Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)

Although RM 189,504.00 was approved for this project, but the allocation for 2nd year RM136,985.00 was only received at the end of December 2012 and not according to the original budget allocated. However, the allocation was used accordingly and the balance at the end of this project was RM 62.89. (Statement from Bendahari USM as shown in appendix A)

H. Additional Project Funding Obtained

(In case of involvement of other funding sources, please indicate the source and total funding provided)

I. Benefits of the Project

(please identify the actual benefits arising from the project as defined in Section III of the Application form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section III of the Guidelines for the Application of R&D Funding under ScienceFund)

1. Direct Outputs of the Project

(Please describe as specifically as possible the outputs achieved and provide an assessment of their significant to users)

i. Technical contribution of the project

a. What was the achieved direct output of the project :

For basic oriented research projects?

- Algorithm
- Structure
- data
- Other, please specify :

For applied research (technology development) projects :

- Method/technique
- Demonstrator/prototype
- Product/component
- Process
- Software
- Other, please specify:

b. How would you characterise the quality of this output?

- Significant breakthrough
- Major improvement
- Minor Improvement

ii Contribution of the project to knowledge

a. How has the output of the project been documented

- Detail project report
- Products/process specification documents
- Other, please specify :

b. Did the project create an intellectual property stock?

- Patent obtained
- Patent pending
- Patent application will be filed
- Copyright

c. What publications are available?

	National	International
<input checked="" type="checkbox"/> Article(s) in scientific publications	How many : 0	8
<input checked="" type="checkbox"/> Paper(s) delivered at conferences/seminars	How many : 5	4
<input type="checkbox"/> Book	How many : 0	0
<input type="checkbox"/> Other, please specify :		

d. How significant are citations of the results?

- | | | |
|-------------------------------------|---|--------------|
| <input type="checkbox"/> | Citations in national publications | How many : 0 |
| <input checked="" type="checkbox"/> | Citations in international publications | How many : 4 |
| <input type="checkbox"/> | Not yet | |
| <input type="checkbox"/> | Not known | |

2. Organisational Outcomes of the Project

(Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to expertise development

a. How did the project contribute to expertises?

- | | | |
|-------------------------------------|-----------------------------------|--------------|
| <input checked="" type="checkbox"/> | PhD degrees | How many : 1 |
| <input checked="" type="checkbox"/> | MSc degrees | How many : 1 |
| <input type="checkbox"/> | Research staff with new specialty | How many : 0 |
| <input type="checkbox"/> | Other, please specify : | |

b. How Significant is this expertise?

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | One of the key areas of priority for Malaysia |
| <input checked="" type="checkbox"/> | An important area, but not a priority one |

ii. Economic contribution of the project?

a. How has the economic contribution of the poroject materialised?

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | Sales of manufactured product/equipment |
| <input type="checkbox"/> | Royalties from licensing |
| <input checked="" type="checkbox"/> | Cost savings |
| <input type="checkbox"/> | Time savings |
| <input type="checkbox"/> | Other, please specify : |

b. How important is this economic contribution?

- | | | |
|-------------------------------------|------------------------------|----------------|
| <input type="checkbox"/> | High economic contribution | How many : RM0 |
| <input type="checkbox"/> | Medium economic contribution | How many : RM0 |
| <input checked="" type="checkbox"/> | Low economic contribution | How many : RM0 |

c. When has this economic contribution materialised?

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> | Already materialised |
| <input type="checkbox"/> | Within months of project completion |
| <input type="checkbox"/> | Within three years of project completion |
| <input checked="" type="checkbox"/> | Expected in three years or more |
| <input type="checkbox"/> | Unknown |

iii. Infrastructural contribution of the project

a. What infrastructure contribution has the project had?

- | | | |
|-------------------------------------|--------------------------|------------------|
| <input type="checkbox"/> | New equipment | Value : RM0 |
| <input type="checkbox"/> | New/improved facility | Investment : RM0 |
| <input checked="" type="checkbox"/> | New information networks | |
| <input type="checkbox"/> | Other, please specify : | |

b. How significant is this infrastructure contribution for the organisation?

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | Not significant/does not leverage other projects |
| <input checked="" type="checkbox"/> | Moderately significant |
| <input type="checkbox"/> | Very significant/significantly leverages other projects |

iv. Contribution of the project to the organisation's reputation

a. How has the project contributed to increasing the reputation of the organisation

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> | Recognition as a Center of Excellence |
| <input checked="" type="checkbox"/> | National award |
| <input type="checkbox"/> | International award |
| <input type="checkbox"/> | Demand for advisory services |
| <input checked="" type="checkbox"/> | invitations to give speeches on conferences |
| <input type="checkbox"/> | Visits from other organisations |
| <input type="checkbox"/> | Other, please specify : |

b. How important is the project's contribution to the organisation's reputation?

- | | |
|-------------------------------------|------------------------|
| <input type="checkbox"/> | Not significant |
| <input checked="" type="checkbox"/> | Moderately significant |
| <input type="checkbox"/> | Very significant |

3. National Impacts of the project

(If known at this point in time, please describe as specifically as possible the potential sectoral/national benefits arising from the project and provide an assessment of their significance)

i. Contribution of the project to organisational linkages

a. Which kinds of linkages did the project create?

- | | |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | Domestic industry linkages |
| <input type="checkbox"/> | International industry linkages |
| <input checked="" type="checkbox"/> | Linkages with domestic research institutions, universities |
| <input type="checkbox"/> | Linkages with international research institutions, universities |

b. What is the nature of the linkages?

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> | Staff exchanges |
| <input checked="" type="checkbox"/> | inter-organisational project team |
| <input type="checkbox"/> | Research contract with a commercial client |
| <input type="checkbox"/> | Informal consultation |
| <input type="checkbox"/> | Other, please specify : |

ii. Social-economic contribution of the project

a. Who are the direct customer/beneficiaries of the project output?

Customers/beneficiaries	Number
Palm Oil Industries	50
Total	50

b. How has/will the socio-economic contribution of the project materialised?

- Improvements in health
- Improvements in safety
- improvements in the environment
- Improvements in energy consumption/supply
- Improvements in international relations
- Other, please specify :

c. How important is this socio-economic contribution?

- High social contribution
- Medium social contribution
- Low social contribution

d. When has/will this social contribution materialised?

- Already materialised
- Within three years of project completion
- Expected in three years or more
- Unknown

Date :

2/1/2014

Signature :

