UNIVERSITAS
ISLAM
INDRAGIRI

INVOICE

DATE: AUGUST 20, 2021
INVOICE NO: 001/UNISI/VIII/2021

UNIVERSITI TEKNOLOGI PETRONAS

32610 Seri Iskandar, Perak
Malaysia
Attn : Abdullah Bin Ahmad

PAYMENT METHOD

ACCT NO: 0175 01 001140 30 3
BANK NAME: Bank Rakyat Indonesia
SWIFT CODE: BRINIDJA
BENEFICIARY ACCOUNT NAME : Universitas Islam Indragiri

ITEM	QTY	TOTAL
Kolaborasi Riset antara Universiti Teknologi Petronas (UTP) dengan Universitas Islam Indragiri (UNISI) tahun 2021-2022	1 package	Rp. 198.000.000-,

Subtotal	Rp. 198.000.000-,
GRAND TOTAL	**Rp. 198.000.000-,**

Questions?
Email us at info@unisi.ac.id
or call us at (0768) 21386

Dr. Najamuddin,Lc.,MA
Rector Universitas Islam Indragiri

Payment Advice

Company
UNIVERSITAS ISLAM INDRAGIRI
JL. PROVINSI NO: 01
TEMBILAHAN HULU, INDRAGIRI HILIR
RIAU
INDONESIA

Reference

Document
6700012477
Value Date
01.10.2021
Payment Method
WT
Our accounting clerk

Telephone

Fax

Email Address

Your vendor reference no. with us
3000076179

Bank Beneficiary

Bank ID:
BRINIDJAXXX
Account:
017501001140303
Bank Address:
BANK RAKYAT INDONESIA (BRI)
Indonesia

By order of : 0015 - UNI TEKNOLOGI PETRONAS

Document	Your document	Invoice Date	Deductions	Gross amount
6500008022	01/UNISI/VIII/21	08.09.2021	0	198,000,000
Sum total			0	198,000,000

Payment document	Date	Currency	Payment amount
6700012477	**01.10.2021**	**IDR**	******198,000,000*

KNOW YOUR COUNTERPARTY QUESTIONNAIRE

PETRONAS is committed to the highest standards of integrity, openness and accountability in the conduct Group's business and operations. PETRONAS seeks to conduct its affairs in an ethical, responsible and transparent manner. The PETRONAS Code of Conduct and Business Ethics ("CoBE") sets out PETRONAS' core principles and detailed policy statements on the standards of behaviour and ethical conduct including with respect to ethics and integrity, competition, sanction, export control and data privacy.

As part of our commitment, PETRONAS and its subsidiaries expect their third party counterparties, as per but not limited to the following i.e. customers, partners, contractors, subcontractors, sellers, vendors, consultants, suppliers, distributors, agents, representatives and others supplying materials, work or services for or on behalf of the Group, to comply with all applicable laws and subscribe to the same values and ethical standards of integrity as PETRONAS in the conduct of their business, as well as any other PETRONAS and its subsidiaries relevant guidelines or manual.

Therefore, before PETRONAS and its subsidiaries engage with any third party counterparties (hereinafter referred to as 'Company' or 'Counterparty'), we are obligated to conduct appropriate third party due diligence to understand the business and background of our prospective business counterparties.

The following questionnaire for all three (3) parts is mandatory to be completed. You may use additional pages when necessary, and return a scanned, signed copy to the PETRONAS focal person in charge. Please attached the required documents listed in Document Checklist, signed and stamped the document under the Certification Section. If you subsequently learn that any of the information provided below is incorrect or incomplete, please correct or complete it (as applicable) and notify us as soon as possible.

PART A

1.Corporate Details

Registered Company Name (Full Legal Name)	UNIVERSITAS ISLAM INDRAGIRI		
Other Name (Any previous Legal Name/ Trading Names)	UNISI		
Registration Number	86/DO/2008	**Tax Registration Number**	02.710.654.1-213.000
Country of Incorporation	INDONESIA	**Date of Incorporation** (dd/mm/yyyy)	22 MAY 2008
Corporate Status (Private Limited, Limited, Partnership	PRIVATE UNIVERSITY	**No. of Employees**	213

Listed, etc.)			
Nature and Line of Business (Please state your core industry and main activity e.g. Core Industry - Oil & Gas, Main activity - Trading)	COLLEGE		
Registered Address	JL. PROVINSI NO.01 TEMBILAHAN HULU, INDRAGIRI HILIR, RIAU - INDONESIA		
Business Address	JL. PROVINSI NO.01 TEMBILAHAN HULU, INDRAGIRI HILIR, RIAU - INDONESIA		
Telephone Number	0768 - 324918		
Email Address	info@unisi.ac.id		
Website	www.unisi.ac.id		
Branch (if any)	-		
Branch Address	-		

2. Contact Details

Primary Contact Person	Dr. ABDULLAH, S.Si.,M.Kom		
Department	Faculty of Technology and Computer Science		
Telephone Number	+62 812-7580-419	Email	

Secondary Contact Person	-		
Department			
Telephone Number		Email	

3. Shareholders

Parent Company (Full Legal Name)	-	**Country**	-
Ultimate Parent Company (Full Legal Name)	-	**Country**	-

MEMORANDUM OF UNDERSTANDING

BETWEEN

INSTITUTE OF TECHNOLOGY PETRONAS SDN. BHD.
(COMPANY NO. 352875-U)

AND

UNIVERSITAS ISLAM INDRAGIRI
(IZIN OPERASIONAL NO. 86/D/O/2008)

THIS MEMORANDUM OF UNDERSTANDING (hereinafter referred to as the "MoU") is made and entered into this 4 day of October 2019.

BETWEEN: **INSTITUTE OF TECHNOLOGY PETRONAS SDN. BHD.** [Company No. 352875-U], a company incorporated in Malaysia and having its registered address at Tower 1, PETRONAS Twin Towers, Kuala Lumpur City Centre, 50088 Kuala Lumpur (hereinafter referred to as "ITPSB");

AND: **UNIVERSITAS ISLAM INDRAGIRI** [Izin operasional No. 86/D/O/2008] an institution of higher learning and having its registered address at Jl. Provinsi Parit 1, Tembilahan Hulu, Kabupaten Indragiri Hilir, Riau 29213, Indonesia (hereinafter referred to as "UNISI").

(ITPSB and UNISI are collectively referred to as the "Parties" and individually as the "Party")

WHEREAS:

A. ITPSB, a subsidiary of PETRONAS, owns and manages Universiti Teknologi PETRONAS (hereinafter referred to as "UTP"), a private higher learning institution established under the Private Higher Educational Institutions Act 1996 located at Bandar Seri Iskandar, Perak.

B. UNISI is an established University which is committed to promoting its academic cooperation and to creating international partnerships, located at Tembilahan Indragiri Hilir Riau, Indonesia.

C. The Parties desire to establish a collaboration to enhance their respective scientific, technical and engineering competencies and to develop beneficial programmes pursuant thereto (hereinafter referred to as the "Collaboration").

D. The Parties have accordingly agreed to enter into this MoU to outline the understanding of the Parties in relation to the scope and objectives of the Collaboration and the respective rights and responsibilities of the Parties thereto.

NOW THEREFORE, the Parties hereby agree as follows:-

1. SCOPE OF THE COLLABORATION

1.1 The Parties shall, at their discretion hereto, collaborate in:

1.1.1 Exchange of teaching, research and administrative personnel;

1.1.2 Student mobility which include but not limited to student exchange and student internship;
1.1.3 Collaborative research projects;
1.1.4 Joint seminar, publications and student supervisions; and
1.1.5 Any other areas of co-operation to be mutually agreed upon by the Parties from time to time during the term of this MoU.

In the event the Parties mutually agree to pursue a particular research project in the abovementioned areas, a separate agreement shall be entered into to detail out the roles and obligations of the Parties.

1.2 Each Party shall use all means reasonably available to it subject to ordinary budgetary and financial constraints so as to ensure successful implementation of the Collaboration and the Parties shall use their best endeavour to collaborate in good faith to the best interest of all Parties.

2. CONFIDENTIALITY

2.1. The Parties agree that the Collaboration may involve the disclosure of certain confidential information of the Parties respectively. For the purpose of this MoU, the term "Confidential Information" refers to any and all information including but not limited to information pertaining to curriculum, courses, syllabus, teaching materials, research activities and technical information made available by a Party ("Disclosing Party") to the other Party ("Receiving Party") during the course of the Collaboration. All "Confidential Information" shall be marked or identified as "CONFIDENTIAL" in writing and in a conspicuous manner at the time it is disclosed to the Receiving Party.

2.2. The Receiving Party hereby covenants to keep in strict confidence all Confidential Information and undertakes not to divulge or disclose the Confidential Information to any third party without specific written permission of the Disclosing Party. The confidentiality obligations hereunder shall not apply to the Confidential Information which:-

a. is or has become obsolete or is already in the public domain without any breach of the provisions in Clause 2 herein;
b. is already in the possession of the Party prior to the execution of this MoU;
c. is independently developed or obtained by the Party;
d. is obtained by the Party from any third party without confidentiality obligations; or
e. a court of competent jurisdiction orders to disclose.

2.3. The provision of this Clause 2 shall survive the expiry or termination of this MoU.

3. INTELLECTUAL PROPERTY

3.1. For the purpose of this MoU, Intellectual Property Rights shall include all data, specifications, materials, research activities and technical information solutions, drawings, know-how and technical information developed, obtained, created, written, prepared or discovered, whether patentable nor not, arising from the Collaboration or otherwise brought into existence pursuant to this MoU.

Specifically:

a. Background Intellectual Property Rights shall include any Intellectual Property Rights that are possessed by each Party prior to the commencement of this MoU and/or developed independently by the Parties. Any Background Intellectual Property Rights that are made available as between the Parties for the performance of the Collaboration shall remain the separate property of the Party making such Background Intellectual Property Rights available, and nothing in this MoU shall be construed to grant any implied license to the other Party to use such Background Intellectual Property Rights other than in performance of this Collaboration.

b. Foreground Intellectual Property Rights shall include any Intellectual Property Rights that arise, or are obtained or developed, created, written, prepared and discovered jointly by the Parties, arising or otherwise brought into existence pursuant to this Collaboration.

3.2. The ownership of all Foreground Intellectual Property Rights arising out of the Collaboration shall be expressly subject to a Joint Development Agreement to be mutually agreed by the Parties.

4. DURATION, TERMINATION AND WITHDRAWAL

4.1. Duration

(i) This MoU shall come into effect upon signing by the Parties and remain in force for a period of five (5) years. The Parties may, by a three (3) month written notice to the other before expiry of the MoU, apply to extend this MoU on mutually agreed terms failing which this MoU shall lapse and shall be of no further effect and neither Party shall have any further claims against the other thereafter.

(ii) Without prejudice to the provisions in (i) above, the Parties may in the course of implementation of the terms of this MoU, execute a formal Collaboration Agreement or any other such written agreements in respect of any developments and/or expansion to the scope of the collaboration arising from the MoU.

4.2 Termination and Withdrawal from the MoU

(i) Either Party may terminate or withdraw from this MoU for any reason whatsoever by providing to the other Party a six (6) month written notice of its intention to terminate or withdraw from this MoU.

(ii) The Parties do agree that such rights of termination under sub clause 4.2 (i) above may be as a result of a written directive or instruction from the Government of Malaysia.

(iii) Upon termination of this MoU, neither Party shall be liable to the other in respect of any claims, damages, costs or expenses of any nature except for those rights arising from Clause 2 herein before provided.

5. COST AND EXPENSES

5.1. Each Party shall bear its own costs and expenses incurred in preparing, executing and implementing the collaboration under this MoU.

5.2. Each Party shall bear its own solicitor's costs in the preparation and stamping of this MoU.

6. DISCLAIMER

Each Party shall be solely responsible for its own acts and omissions (and the acts and omissions of its directors, employees, consultants and other agents) and no Party shall have the authority nor shall it purport to act for, or legally bind, the other Party in a transaction with a third party except as authorised in writing by the Parties.

7. GOVERNING LAW

This MoU shall be governed by and construed in accordance with the laws of Malaysia.

8. RELATIONSHIP OF THE PARTIES

Nothing contained in this MoU shall be construed as establishing or creating between the Parties a relationship of master-and-servant or of principal-and-agent. The relationship between the Parties shall be that between equal independent contractors.

9. NON-BINDING OBLIGATIONS

9.1. The Parties do hereby agree, declare, covenant and undertake that this MoU outlines the understanding between the Parties with regard to the

subject matter herein and may be subject to change or variation at the absolute discretion of the Parties herein, in the course of implementation of the collaboration, provided always that such discretion is exercised only upon mutual consent of the Parties.

9.2. The Parties do further hereby agree, declare, covenant and undertake that except where it is specifically provided herein, the MoU is not intended to create any legal obligations and shall not be legally binding on the Parties hereto.

10. NAME, OFFICIAL EMBLEM AND LOGO

10.1. Neither Party shall use, nor permit any person or entity to use the name, acronym, official emblem, logo trade mark (or any variation thereof) or other Intellectual Property (hereinafter referred to as "Brand Materials") that is/are identified with or belongs to the other Party on any publication, document, paper, audio or visual presentation, or for publicity purposes.

10.2. Any use of the Brand Materials for the purposes stated in para 10.1 above shall first obtain the written consent of the other Party and shall comply with all reasonable instructions as to the use of the other party's Brand Materials.

11. MISCELLANEOUS

11.1. The official language to be used for execution and cooperation under this MoU shall be English.

11.2. Any amendment or modification to this MoU shall be made upon mutual consent of the Parties vide a written notice executed by the duly authorised representative(s) of each Party hereto.

11.3. A waiver of any of the rights or remedies available to any Party hereto shall not be valid and effective unless expressed in writing and executed by the duly authorised representative(s) of the Party. Such a waiver by any of the parties hereto shall not be construed as a waiver in respect of any other breach, antecedent or future.

11.4. Each Party shall be solely responsible for their respective tax implications (if any) arising out of the performance of the terms and conditions of this MoU.

12. NOTICES

12.1. Any notice required to be delivered hereunder shall be sent to the Parties at the following respective addresses:

(i) **If to ITPSB**:

Universiti Teknologi PETRONAS
32610 Bandar Seri Iskandar
Perak
Malaysia
Facsimile: -
Email: aidid@utp.edu.my
Attention to: Chief Strategy Officer

(ii) **If to UNISI**:

Universitas Islam Indragiri
Jl Provinsi Parit 1, Tembilahan Hulu
Kabupaten Indragiri Hilir
Riau 29213, Indonesia
Facsimile:
Email: viviarsh1@gmail.com
Attention to: Student affairs and Cooperation Officer

11.2 Every notice or communication so sent shall be considered to have been received upon actual receipt.

11.3 Any Party may substitute or change its address by written notice to the other Party.

[END OF CLAUSES]

IN WITNESS WHEREOF, the Parties hereto have caused this Memorandum of Understanding to be executed by their respective duly authorised representatives on the day and year first above written.

For and on behalf of
INSTITUTE OF TECHNOLOGY PETRONAS SDN. BHD.

By	:	..... 16 AUG 2019
Name	:	Prof. Dr. Mohamed Ibrahim Bin Abdul Mutalib
Designation	:	Vice Chancellor and CEO
In the presence of	:	.....
Name	:	Ir. Dr. Aidid Chee Tahir
Designation	:	Chief Strategy Officer

For and on behalf of
UNIVERSITAS ISLAM INDRAGIRI

By	:	.....
Name	:	Dr. H. Najamuddin, Lc MA
Designation	:	Rector
In the presence of	:	.....
Name	:	Edy Syafwannur, SE., MP.
Designation	:	Tasik Gemilang Foundation Head

MASTER RESEARCH COLLABORATION AGREEMENT

BETWEEN

UNIVERSITAS ISLAM INDRAGIRI

AND

UNIVERSITI TEKNOLOGI PETRONAS

This **MASTER RESEARCH COLLABORATION AGREEMENT** is made on the day of 2021 (hereinafter referred to as “this Agreement”);

BETWEEN **UNIVERSITAS ISLAM INDRAGIRI** [Izin Operasional No. 86/D/0/2008] is an institution of higher learning and having it registered address at Jl. Provinsi Parit 1, Tembilahan Hulu, Kabupaten Indragiri Hilir, Riau 29213, Indonesia (hereinafter referred to as “UNISI”) of the second part.

AND **INSTITUTE OF TECHNOLOGY PETRONAS SDN. BHD.** [Company No. 199501023672 (352875-U)], a company incorporated in Malaysia and having its registered address at Tower 1, PETRONAS Twin Towers, Kuala Lumpur City Centre, 50088 Kuala Lumpur, Malaysia (hereinafter referred to as “**ITPSB**”) which has been established to manage **UNIVERSITI TEKNOLOGI PETRONAS** (hereinafter referred to as “**UTP**”), a private higher learning institution established under the Private Higher Educational Institutions Act 1996 of the first part;

UNISI and UTP shall hereinafter be referred to collectively as the "Parties" and individually as the “Party”.

WHEREAS

A. UNISI and UTP have entered into a Memorandum of Understanding dated 4 October 2019 (hereinafter referred to as “MoU”) for the purpose of establishing a collaboration to enhance their respective scientific, technical and engineering competencies and to develop beneficial programmes pursuant thereto.

B. Pursuant to that MoU, UNISI and UTP are of the view that there are synergistic benefits to be derived from the Parties collaboration by way of sharing and further developing the knowledge and expertise of both parties through research and development activities in three (3) research projects (hereinafter referred to as “Project(s)”) as further detailed out in this Agreement.

C. The Parties hereby agree to enter into this Agreement for the purposes of establishing a framework of the collaboration for defining the principles, philosophy and obligations of each Party, particularly in respect of the Project(s) which includes establishing a framework for each Project.

NOW IT IS HEREBY AGREED AS FOLLOWS:

CLAUSE 1 – DEFINITIONS AND INTERPRETATIONS

1.1 In this Agreement, unless the context otherwise requires: -

"**Affiliate**" means a company or corporation or other entity which currently or in the future directly or indirectly through one or more intermediaries, owns or controls, is controlled by, or is under common control with, a Party. For the purpose of this definition, “control” or “controlled” means the possession of at least fifty percent (50%) of the issued share capital of the Party or other entity or having the right to control the composition of the board of directors of the Party or other entity.

"**Agreement**" means this Master Research Collaboration Agreement, including the recitals, schedules and addendums which forms an integral part of this agreement and which may be amended, varied, supplemented or otherwise modified at any time or

from time to time by mutual agreement in writing between the Parties.

"**Background Information**" means all technical data, information (including confidential information), drawings, designs, operating experience and procedures, techniques, know-how and other knowledge in any form, including Intellectual Property relating to technology owned or possessed by each Party at the date of commencement of this Agreement.

"**Competition Authority**" means any governmental authority having jurisdiction in competition or antitrust matters under any competition or antitrust legislation in any country in which the Parties carry on or intend to carry on business or where its activities may have an effect;

"**Competition Laws**" means all applicable laws that are designed to prohibit, restrict or regulate actions having the purpose or effect of monopolization, abuse of dominance, lessening of competition, impeding effective competition, restraint of trade or collusion;

"**Force Majeure**" or "**Force Majeure Event**" means any cause affecting the performance of this Agreement arising from or attributable to any acts, events, non-happenings, omissions or accidents beyond the reasonable control of the Party to perform and could not have been foreseen or prevented by them exercising reasonable diligence, in particular but without limiting the generality thereof shall include strikes, lock outs, industrial action, governmental orders, civil commotion, riot, invasion, war, threat of or preparation for war, fire, explosion, storm, flood, earthquake, subsidence, epidemic, pandemic or other natural physical disaster, impossibility of the use of railways, shipping, aircraft, motor transport, or other means of public or private transport, or political interference with the normal operation of either Party, but shall not include:

(a) breakdown of any equipment of whatever nature unless caused by a Force Majeure Event;

(b) a contractual commitment between the Party and a third party;

(c) an act or omission of the Party or its Affiliate; or

(d) any financial distress on the part of the Party or any of its Affiliates.

"**Intellectual Property**" means

(a) Inventions; manner, method or process of manufacture; method or principle of construction; or design; plan, drawing or design; or scientific, technical or engineering information or document;

(b) Improvement, modification or development of any of the foregoing;

(c) Patent, application for a patent, right to apply for a patent or similar rights for or in respect of any intellectual Property referred to in paragraph (a) or (b);

(d) Trade secret, know-how, confidential information or right of secrecy or confidentiality in respect of any information or document or other intellectual Property referred to in paragraph (a) or (b);

(e) Copyright or other rights in the nature of copyright subsisting in any works or other subject matter referred to in paragraph (a) or (b);

(f) Registered and unregistered trademark, registered design, application for registration of a design, right to apply for registration of a design or similar rights for or in respect of any work referred to in paragraph (a) or (b);

(g) Any Intellectual Property in addition to the above which falls within the definition of intellectual property rights contained in Article 2 of the World Intellectual Property Organisation Convention of July 1967; and

(h) Any other rights arising from intellectual activities in the scientific, literary or artistic fields,

Whether vested before or after the date of this Agreement and whether existing in Malaysia or otherwise and for the duration of the rights.

"**Personal Data**" means any information in respect of commercial transactions, which (a) is being processed wholly or partly by means of equipment operating automatically in response to instructions given for that purpose; (b) is recorded with the intention that it should be wholly or partly be processed by means of such equipment; or (c) is recorded as part of a relevant filing system or with the intention that it should form part of a relevant filing system, that relates directly or indirectly to an individual, who is identified or identifiable from that information or from that and other information in the possession of an organisation, including any Sensitive Personal Data (as hereinafter defined) and expression of opinion about the individual.

Project(s) means the three (3) research and development projects undertaken by the Parties jointly by virtue of this Agreement.

"**Sanctions**" means all applicable laws concerning economic sanctions (including embargoes, export controls, restrictions on the ability to make or receive international payments, freezing or blocking of assets of targeted Persons, or the ability to engage in transactions with or involving specified Persons or countries, or any applicable law that threatens to impose economic sanctions on any Person for engaging in targeted behaviour) of any jurisdictions including:

(a) the United Nations;
(b) Malaysia;
(c) the European Union;
(d) the United Kingdom (including those administered by HM Treasury);
(e) the United States (including those administered by the Office of Foreign Assets Control of the Department of the Treasury, the Bureau of Industry and Security of the Department of Commerce, or the Department of State);

"**Sensitive Personal Data**" means any Personal Data consisting of information as to the physical or mental health or condition of an individual, his political opinions, his religious beliefs or other beliefs of a similar nature, the commission or alleged commission by him of any offence or such other Personal Data as may be determined under Malaysia's Personal Data Protection Act from time to time.

1.2 Any word (including a word defined or given a special meaning) denoting the singular shall include the plural and vice versa.

1.3 Any word denoting one gender only shall include each other gender.

1.4 A reference to a person shall include a corporation as well as a natural person.

1.5 A reference to a Schedule is a reference to a Schedule to this Agreement.

CLAUSE 2 - COLLABORATION

2.1 The Parties agree to establish and record in this Agreement the following three (3) research and development Project(s):

No	Project Title	UNISI Principal Investigator	UTP Principal Investigator
1	Halalan Tayyiban in Islamic Concept: Drying System for White Copra Quality Improvement.	Dr. Najamuddin, Dr. Ridhoul Wahidi, Dr. Fitri Wahyuni, Dr. Edi Susrianto, Siti Wardah	AP Dr Mahmod Othman
2	Green Tech development on Coconut's Shell Production to Reduce Glasshouse emissions and improve the welfare of coconut farmers.	Dr. Indra Muchlis Adnan, Khairul Ihwan, Muannif Ridwan, Triyana Safitri dan Bayu Fajar Susanto	AP Dr Hanita Binti Daud
3	Intelligent Hybrid ARIMA-ANN Time Series Model to Forecast Coconut Price	Dr. Abdullah, Gunawan Syahrantau, Zainal Arifin, Yusriwarti	Dr. Rajalingam AP Dr Mahmod Othman Richard Manu Nana Yaw Sarpong-Streetor, Abdus Samad Azad

2.2 The Parties agree that the details of each of the above Projects shall be affected in the form of an Addendum(s) in accordance to the format set out in Schedule A.

2.3 In the event the Parties jointly agree to pursue additional research projects pursuant to this Agreement, the Parties shall execute the Addendum in accordance to the format set out in Schedule A. The said Addendum shall be deemed to incorporate the terms and conditions of this Agreement unless expressly indicated otherwise.

2.4 The Parties agree to collaborate on the Project and shall use reasonable endeavors to carry out in a diligent manner those parts of the Project allocated to it, in accordance with the details specified in **Schedule A**. The Parties recognize that the Project is research in nature and hence completion within the period of performance or the achievement of the deliverables or milestones specified in Schedule A is feasible but not guaranteed.

2.5 The Parties acknowledge that the primary mission of the Project is education and the advancement of knowledge; and, consequently, the Project will be performed in a manner best suited to carry out that mission. Each Party will make best efforts to achieve the objectives of the Project but does not represent or warrant that the Project will be successful in any way or that any specific results will be obtained.

2.6 The Parties shall ensure that the Project Team as defined in Schedule A of this Agreement are given full access to all information and to all areas within either Parties' sites which are relevant for them to carry out work on the Project subject to the rules and regulations applicable to each Party.

2.7 The Parties shall furnish such necessary facilities and equipment available at their respective sites as necessary for the performance of the Project.

During the course of the Project, a Party may find it advantageous to modify the Project. Any modifications will be documented and formalized in a written amendment to this Agreement and any such amendment will become effective only if signed by all Parties to this Agreement through their authorized representatives.

2.8 Nothing in this Agreement will be construed to limit the freedom of each Party or its faculty, researchers or students who are participants under this Agreement, from engaging in similar research under other grants, contracts, or research agreements with other parties SUBJECT ALWAYS to Clause 6 on Confidentiality.

2.9 Financial Obligations

2.9.1 The Parties undertake to provide the following research funding (hereinafter referred to as the "Funding") for the purposes of implementing the Project:

(a) UNISI shall provide a research grant amounting to Rupiah Indonesia One Hundred and Ninety Eight Million (Rp. 198,000.000) Only for a total of three (3) Projects, of which each Project shall be allocated with an individual fund of Rupiah Indonesia Sixty Six Million (Rp 66.000.000) only to perform the Project(s).

(b) UTP shall provide a research grant amounting to Ringgit Malaysia Sixty Thousand (RM60,000.00) Only for a total of three (3) Projects, of which each Project shall be allocated with an individual fund of Ringgit Malaysia Twenty Thousand (RM20,00.00) only to perform the Project(s).

2.9.2 Within sixty (60) days upon signing of this Agreement:

a) UNISI shall submit an invoice to UTP for the Funding (hereinafter referred to the "UNISI Research Grant") and UTP shall transfer the UTP Research Grant amount to UTP within thirty (30) days from the date of receipt of the invoice. For the avoidance of doubt, UTP shall utilise the UTP Research Grant solely for the purpose of performing the Project.

b) UTP shall submit an invoice to UNISI for the Funding (hereinafter referred to the "UTP Research Grant") and UNISI shall transfer the UNISI Research Grant amount to UNISI within thirty (30) days from the date of receipt of the invoice. For the avoidance of doubt, UNISI shall utilise the UNISI Research Grant solely for the purpose of performing the Projects.

2.9.3 Each Party shall bear its own costs in transferring the amounts described in Clause 2.9.2 above, including but not limited to bank charges and shortfall due to foreign exchange currency transaction, if any.

CLAUSE 3 – TAXES

3.1 Each Party shall be responsible for and shall pay at its own expense when due and payable all taxes assessed against it by a taxation authority of competent jurisdiction in connection with this Agreement. All taxes levied on each Party shall be for the account

of each Party and shall not be reimbursed by the other Party.

3.2 Each Party shall fully protect and indemnify the other Party and hold the other Party safe and harmless from any and all claims or liability for taxes assessed or levied by the tax authority of competent jurisdiction, whichever is applicable against UTP or UNISI for or on account of any payment made in connection with this Agreement.

3.3 Each Party further shall fully protect and hold the other Party harmless from all taxes assessed or levied against or on account of wages, salaries or other benefits paid to or enjoyed by each Party's employees, and all taxes assessed or levied against, on or for account of any property or equipment of the other Party in connection with the performance of this Agreement.

3.4 For the avoidance of doubt, "tax" or "taxes" as mentioned above include but shall not be limited to all income, profit, withholding tax, franchise, excess profits, royalty, other taxes, personal property taxes, employment taxes and contributions, imposed or that may be imposed by law, regulations or trade union contracts, which are enforced by or on behalf the tax authority of competent jurisdiction and includes penalties, interest and fines in respect thereof.

CLAUSE 4 – GENERAL RESPONSIBILITIES OF THE PARTIES

In consideration of and subject to the terms of this Agreement and all applicable laws, the Parties shall carry out their respective responsibilities in accordance with the provisions of this Agreement.

4.1 The Parties shall conduct and perform the Project(s) under this Agreement with due care, diligence and efficiency and in conformity with sound scientific, management and financial practice in respect of personnel and property of the Parties and in respect of the environment in which the activity is performed.

4.2 The Parties shall at all times undertake the Project(s) in such a manner as to always safeguard and protect the Parties' mutual interests and the Parties shall further take all necessary and precautionary steps to prevent abuse or uneconomical use of facilities and equipment, made available by the Parties.

4.3 Each Party shall exercise their duties in good faith, transparency and accountability with regards to the conduct of the Project(s) and further undertakes to ensure that the channels of communication between each Party shall remain open to ensure the success of the Project(s).

4.4 The Parties recognise that it is impracticable to make provisions in this Agreement for every contingency that may arise in the course of performance and implementation of the Project(s) and accordingly agree that it is their mutual intention that this Agreement shall operate between them with fairness and equity and if in the course of performance and implementation thereof unfairness to a Party is disclosed or foreseen then the Parties shall use their best endeavour to mutually agree upon such action as may be necessary to fairly and equitably remove the cause or causes of the same.

4.5 Both Parties through their Project Team shall furnish the other Party with written reports as to the progress of works carried out for the Project from time to time.

4.6 Each Party shall respond promptly to any queries from the other Party from time to time in respect of the progress of the works in relation to the Project and any other matters in relation thereto by such means as are agreed from time to time by the Parties hereto.

CLAUSE 5 – INTELLECTUAL PROPERTY

5.1 For the purpose of the Project(s):

(a) Background Intellectual Property Rights
Background Intellectual Property Rights shall include any Intellectual Property Rights that are made available as between the Parties, and which may include Background Information, which are to be used for the Project(s), subject to discussion and mutual agreement between the Parties. Background Intellectual Property Rights shall remain the separate property of the Party making such Background Intellectual Property Rights available.

(b) Foreground Intellectual Property Rights
Foreground Intellectual Property Rights shall include any Intellectual Property Rights that arise, or are obtained or developed, created, written, prepared and discovered jointly by the Parties, arising or otherwise brought into existence pursuant to this Agreement.

(i) To the extent that the Foreground Intellectual Property is generated or developed by UNISI alone, then it shall vest in and be owned absolutely by UNISI.
(ii) To the extent that the Foreground Intellectual Property is generated or developed by UTP alone, then it shall vest in and be owned absolutely by ITPSB;
(iii) To the extent that the Foreground Intellectual Property are generated or developed by UNISI jointly with UTP, then it shall vest in and be owned jointly by UNISI and ITPSB;

Each Party hereby grants to the other, a royalty-free, irrevocable, non-transferable, non-sublicensable, non-exclusive license to use the joint Foreground Intellectual Property as provided in Clause 5.1(b)(iii) for the purpose of carrying out the Project and for its own internal research and development.

5.2 The ownership of all Foreground Intellectual Property Rights arising out of the Project(s) shall be expressly subject to a separate Aareement to be mutually agreed by the Parties.

5.3 The provision of this Clause 5 shall survive the expiry or termination of this Agreement.

CLAUSE 6 – CONFIDENTIALITY

6.1 The Parties agree that the Project may involve the disclosure of certain confidential information of the respective Parties. For the purpose of the Project, the term “Confidential Information” refers to any and all information including but not limited to data and information pertaining to curricula, courses, syllabi, teaching materials, research activities and technical information made available by a Party (“Disclosing Party”) to the other Party (“Receiving Party”) during the course of the Project.

6.2 All Confidential Information shall be marked or identified as “CONFIDENTIAL” in writing and in a conspicuous manner at the time it is disclosed to the Receiving Party.

6.3 All Confidential Information disclosed to or provided by or on behalf of the Disclosing Party pursuant to this Agreement may not be disclosed, published, used or in any way

exploited or permitted to be disclosed, published, used or exploited by the Receiving Party to any third party or re-produced for any purpose other than for the Project without first obtaining the prior written approval of the Disclosing Party.

6.4 The obligations under this Clause 6 shall extend to and bind all of the Receiving Party's officers, directors, employees, advisors, contractors, sub-contractors, consultants, agents or representatives to whom the Confidential Information and/or document or documents in which it is contained is made available except where the Confidential Information is in or has come into the public domain otherwise than by the default or negligence of either Party or is required to be disclosed by any governmental or other authority or regulatory body to such extent only as is necessary for that purposes or as is required by law.

6.5 The confidentiality obligations under this Clause 6 shall survive the expiry of this Agreement.

CLAUSE 7 – RIGHT TO PUBLISH

7.1 The data and information accruing from the Project, which are of academic importance for the enrichment of knowledge, may be JOINTLY published by UTP and UNISI Principal Researcher and Researchers in accordance with respective Parties' policy. A publishing Party shall provide the other Party with a copy of any such proposed publication and the other Party may have at least twenty-one (21) days or such mutual extended period to be agreed upon by both Parties from the date of the other Party being provided with the copy of such proposed publication, for review of data and information deemed confidential as defined in Clause 6 above relating to confidentiality or patentable items (hereinafter referred to as the "Review Period"). The purpose of this clause is to protect the rights of UNISI and UTP with respect to any contemplated publication concerning details of an invention or confidential information, etc.

7.2 If deemed reasonably necessary by UNISI and UTP to protect such interests, any contemplated publication containing details of an invention, etc. shall be withheld until a patent application is filed or other appropriate steps to protect commercial value have been completed. However, in no event shall any delay of publication exceed twelve (12) months from the date the proposed publication is submitted to the other Party. All publications shall not include the Parties' confidential information as defined in the Confidentiality Clause as reasonably determined and communicated to a Party within the Review Period.

CLAUSE 8 – RELATIONSHIP OF THE PARTIES

Nothing in this Agreement shall be construed as establishing or creating a partnership or a relationship of master and servant between any of the Parties hereto or as constituting any party as an agent or representative of the other Party for any purpose or in any manner whatsoever.

CLAUSE 9 – DURATION AND TERMINATION

9.1 This Agreement shall come into effect on **1 May 2021** (hereinafter referred to as the "Commencement Date") and remain in force **for a period of twelve (12) months** until **30 April 2022.**

The Parties may, by a three (3) month written notice to the other before expiry of this Agreement, apply to extend this Agreement on mutually agreed terms failing which this Agreement shall lapse and shall be of no further effect and neither Party shall have any further claims against the other thereafter.

9.2 If either Party ("Defaulting Party") commits any of the conditions stated below, then, the non-defaulting Party shall be entitled to terminate this Agreement by serving a notice to that effect:

9.2.1 the Defaulting Party becomes insolvent or is unable to pay its debts when due or admits in writing its inability to pay its debts; or

9.2.2 the Defaulting Party enters any arrangement or composition with its creditors generally, or a receiver or manager is appointed; or

9.2.3 the Defaulting Party goes into liquidation or passed a resolution to go into liquidation, otherwise than for the purpose of reconstruction; or

9.2.4 the Defaulting Party fails to comply with any of the obligations under this Agreement.

9.3 The notice to terminate in the case of sub-clauses 9.2.1 to 9.2.3 shall not be less than twenty-one (21) days, save for in the case of sub-clause 9.2.4, whereby the notice to terminate shall take effect only after the affected party first giving twenty-one (21) days' notice in writing to the defaulting party to remedy a default, and where such default is not remedied in that period, upon giving not less than further twenty-one (21) days' notice of termination.

9.4 The termination of this Agreement shall be without prejudice to the rights of the party terminating to seek and obtain damages for any breach of this Agreement by the other party.

CLAUSE 10– CONSEQUENCES OF TERMINATION AND RETURN OR DESTRUCTION OF CONFIDENTIAL INFORMATION

10.1 Upon termination of this Agreement, both Parties shall have no obligation to each other, and UTP shall be paid only for the actual costs reasonably and properly incurred for the obligations performed up to the date of termination. For the avoidance of doubt, the payment shall not include profit and accordingly there shall be no claims for future loss. In addition, UNISI shall have no further or other liability to ITPSB in relation to this Agreement.

10.2 Notwithstanding Clause 10.1, the obligations of the Parties under Clauses 5 and 7 with regard to Foreground Intellectual Property only shall survive the termination of this Agreement.

10.3 Unless otherwise agreed by the Parties, upon the expiry/termination of this Agreement or where the Disclosing Party so requests in writing, the Receiving Party shall:

10.3.1 return to the Disclosing Party all original and copy documents containing Confidential Information;

10.3.2 destroy all original and copy documents containing analyses, studies, compilations and other materials derived from the Confidential Information;

10.3.3 permanently remove all Confidential Information from any computer, disk or other device containing Confidential Information; and

10.3.4 provide a written confirmation signed by the authorised representative of the Receiving Party confirming compliance with the obligations contained in this

Clause 10.3.

10.4 Notwithstanding Clause 10.4, any Confidential Information retained in the Receiving Party's computer back-up systems shall be destroyed in accordance with the relevant person's regular ongoing retention process and the Receiving Party may retain for corporate secretarial, good governance purposes or where required to do so by the rules of any regulatory or supervisory body with which such person is required to comply (and then only for so long as necessary to satisfy such purposes) one copy of the Confidential Information, which shall remain confidential and subject to this Agreement

CLAUSE 11 - FORCE MAJEURE

11.1 A Party shall not be liable to the other Party for any loss, damage, delay or failure of performance or obligations according to this Agreement, if, and to the extent that, such delay or failure is attributable to the Force Majeure Event.

11.2 The Party affected by a Force Majeure Event shall give immediate written notice to the other Party. In the event of any delay or failure of performance resulting from the Force Majeure Event, the Party concerned shall use its reasonable diligence to rectify or overcome the event or circumstances and resume full performance of its obligations under this Agreement at its own cost as soon as possible. Such Party shall provide periodic notices to the other Party with respect to its actions and plans for actions in accordance with the foregoing and provide prompt notice to the other Party of the cessation of the Force Majeure Event.

11.3 Nevertheless, the settlement of strikes, boycotts, lockouts or other industrial disputes, or obstructive action by any organization, including its own or local inhabitants, shall be entirely within the control of that Party concerned and shall not be considered as the Force Majeure Event.

11.4 Any costs or expenses resulting from the foregoing listed herein shall be at the sole costs and expenses of the Party claiming the Force Majeure event.

11.5 Subject to the Force Majeure Event, no Party shall be considered to be in default under this Agreement when and to the extent that performance of obligations under this Agreement is prevented, whether wholly or in part, by any circumstance of the Force Majeure Event which arises after the date of this Agreement and each Party shall be entitled to suspend performance of its obligations to the extent that such Party is prevented wholly or in part in carrying out its obligations under this Agreement.

11.6 If any Party shall rely on the occurrence of a Force Majeure Event as a basis for being excused from the performance of its obligations under this Agreement, then the Party relying on the event of condition shall:

a) Provide prompt notice to the other Party of the occurrence of the event or condition giving an estimation of its expected duration and the probable impact on the performance of its obligations hereunder;
b) Exercise all reasonable efforts to correct or cure the event or condition excusing the performance; and
c) Exercise all reasonable efforts to mitigate or limit damages to the other Party to the extent such action will not adversely affect its own interests.

11.7 If a Party is prevented from performing its obligation under this Agreement by reason of the Force Majeure for a cumulative period of fourteen (14) days in any period of twenty one (21) consecutive days, or if in the other Party's reasonable opinion, the

Force Majeure Event is anticipated to last more than fourteen (14) consecutive days, then such other Party not affected by the Force Majeure may terminate all or part of this Agreement by giving seven (7) days written notice to the Party suffered from the Force Majeure.

11.8 UNISI shall not be entitled to receive any payment for the Force Majeure Event; and, in the event of termination then UNISI shall be entitled to receive the amount of money then due under this Agreement up to the milestone immediately preceding the Force Majeure Event.

CLAUSE 12 – PUBLIC STATEMENT

Both Parties agree that no public statement shall be made on the Project(s), or in relation to any products, processes or inventions developed as a result of the Project(s) unless approved first by both Parties.

CLAUSE 13 - NAME, OFFICIAL EMBLEM AND LOGO

13.1 Neither Party shall use, nor permit any person or entity to use the name, acronym, official emblem, logo trade mark (or any variation thereof) or other Intellectual Property (hereinafter referred to as “Brand Materials”) that is/are identified with or belongs to the other Party on any publication, document, paper, audio or visual presentation, or for publicity purposes.

13.2 Any use of the Brand Materials for the purposes stated in Clause 13.1 above shall first obtain the written consent of the other Party and shall comply with all reasonable instructions as to the use of the other party’s Brand Materials.

CLAUSE 14 – ASSIGNMENT

This Agreement shall not be assigned in whole or in part by either Party without the prior written consent of the other.

CLAUSE 15 – APPLICABLE LAW

This Agreement shall be governed by the laws of Malaysia.

CLAUSE 16 – DISPUTE RESOLUTION

16.1 In the event of any difference or dispute arising between the Parties relating to the validity, interpretation, construction or performance of this Agreement, the Parties shall use their best endeavours to settle amicably such difference or dispute by consultation and negotiation.

16.2 If, and to the extent that, any dispute has not been settled pursuant to Clauses 16.1 above, then the dispute shall be referred to and finally resolved by arbitration in Kuala Lumpur in accordance with the Asian International Arbitration Centre for the time being in force, which rules are deemed to be incorporated by reference to this Clause 16. The language of the arbitration shall be English. Any award made hereunder shall be final and binding upon the Parties hereto and judgment on such award may be entered into any court or tribunal having jurisdiction thereof.

CLAUSE 17 - PERSONAL DATA PROTECTION

17.1 During the ordinary course of dealings between the Parties and in connection with the

performance of this Agreement, the Parties acknowledge that they need to process Personal Data belonging to or supplied by each Party or from authorized third parties or any other persons from time to time by electronic or paper-based means.

17.2 By entering into this Agreement, the Parties expressly and explicitly acknowledge and consent to:

(a) the processing of such Personal Data by each Party for the purpose of performance of this Agreement and for all other purposes that are necessary, incidental or related to the performance of this Agreement;

(b) the processing of such Personal Data within and, where necessary, outside Malaysia;

(c) the transfer and disclosure of such Personal Data to third parties authorised by each Party within and, where necessary, outside Malaysia, provided that these third parties undertake to keep such Personal Data confidential, or to any persons, authorities or regulators to whom the Parties are compelled, permitted or required under the law to disclose to.

For the purpose of this clause, “third parties” include but not limited to each Party’s holding or parent company, subsidiaries, related and/or associated companies, vendors, suppliers, business partners, professional advisers, agents, contractors, third party service providers, insurance companies, banks and financial institutions.

17.3 The Parties expressly and explicitly agree to process such Personal Data in accordance with the requirements of any applicable law or such other applicable data protection laws and regulations.

CLAUSE 18 - SANCTIONS AND EXPORT CONTROLS

18.1 Each Party shall perform this Agreement in compliance with any applicable Sanctions laws. No Party shall be obliged to perform any obligation under this Agreement if this would not be compliant with, would be in violation of, inconsistent with, or would expose either Party to punitive measures under any laws, regulations applicable to either Parties relating to Sanctions.

18.2 Warranties

(a) The Parties warrant and declare that to the best of its knowledge, information and belief, each of their respective directors, officers, employees, agents and representatives:

(i) are not the target or subjects of any Sanctions;
(ii) are not owned or controlled by any person who is the target or subject of any Sanctions;
(iii) are not acting for the benefit of or on behalf of any person that is the target or subject of any Sanctions; and
(iv) have not been engaging and will not engage in any conduct/activity that would result in breach of any Sanctions or becoming a target or subject of Sanctions.

(b) Specifically, UTP warrants that:

(i) it is not prevented by any Sanctions from fulfilling its obligations under the Agreement;
(ii) by entering into this Agreement with UNISI, it will not result in UNISI violating

any of UNISI's obligations under any Sanctions; and

(iii) where necessary, UTP has obtained all the relevant permits and/or licences that are required under any applicable laws for the performance of this Agreement.

(c) UTP undertakes to promptly notify UNISI in the event it is no longer able to comply with the warranties above. UTP fully indemnifies UNISI, its directors, shareholders and employees for any losses arising from a breach of these warranties.

18.3 Suspension and Termination

(a) Where any performance by a Party of any obligation in this Agreement would be in violation of, inconsistent with, or expose such party, or a parent company of such party, to punitive measures under any Sanctions, the Party shall, suspend the affected obligation and immediately give written notice to the other party of the affected obligation. Once such notice has been given the Parties shall be entitled to –

(i) suspend the affected obligation (whether payment or performance) until such time as the obligation is no longer affected; and/or

(ii) where the obligation continues to be affected (or is reasonably expected to continue to be affected) until the end of the contractual time, for discharge thereof, to a full release from the affected obligation,

in each case, subject as provided above, without any liability whatsoever (including but not limited to any damages for breach of contract, penalties, costs, fees or expenses).

(b) Where the affected obligation materially affects the performance of the Agreement, the Parties shall enter into consultation in good faith with a view to mutually agree on appropriate measures/actions to continue with this Agreement in manner which strictly complies with the applicable laws. Where the Parties could not agree on such measures/actions within fourteen (14) days from the start of the consultation, either Party shall have the right, to immediately terminate this Agreement.

(c) Notwithstanding any of the above, where the relevant obligation relates to payment for goods which have already been delivered, the affected payment obligation shall remain suspended (without prejudice to the accrual of any interest on an outstanding payment amount) until such time as the payment obligation is no longer affected.

18.4 Export Controls

a) Each Party warrants to the other Party that all goods or services supplied under this Agreement shall not be used for any activities that will or may facilitate the design, development, production and delivery of or in connection with the weapons of mass destruction or any terrorism activities or any restricted activity under the Malaysian Strategic Trade Act 2010 ("STA") or any other applicable export controls laws. Each Party fully indemnifies the other Party for any losses arising from the breach of the STA and/or any other applicable export controls laws.

b) Notwithstanding anything to the contrary contained herein, all obligations of the Parties are subject to prior compliance with export regulations applicable to each Party and such other related laws and regulations as may be applicable to each

Party, and to obtaining all necessary approvals required by the applicable government entity. Each Party shall each use its reasonable efforts to obtain such approvals for its own activities. Each Party shall cooperate with the other Parties and shall provide assistance to the other Parties as reasonably necessary to obtain any required approvals.

CLAUSE 19 - ANTI-MONEY LAUNDERING

The operations of UTP and its Affiliates are, have been conducted, and will at all times hereinafter be conducted in compliance with applicable financial recordkeeping and reporting statutory requirements, money laundering statutes (and the rules, guidelines and regulations thereunder) and any related or similar rules, regulations or guidelines, issued, administered or enforced by any governmental agency in or outside of Indonesia having jurisdiction over UTP and/or any of its Affiliates (collectively, "**Money Laundering Laws**") and no action, suit or proceeding by or before any court or governmental agency, authority or body or any arbitrator and no regulatory investigation involving UTP and/or any of its Affiliates with respect to the Money Laundering Laws is pending or threatened or will hereinafter be instituted or commenced by any governmental agency in or outside of Indonesia against UTP or any of its Affiliates.

CLAUSE 20 - ETHICS

None of UTP or any of its Affiliates, nor, any director, officer, agent, employee or other person acting on behalf of UTP or any of its Affiliates is aware of or has taken any action, directly or indirectly that would result in, or is at any time prior to or after the date hereof being subject to any internal and/or regulatory investigation in relation to, a violation by such persons of the UNISI Code Ethics

CLAUSE 21 - COMPETITION LAWS

21.1 UTP has not:

a) been party to or engaged in or the subject of any agreements, decisions, concerted practices, or activities which in whole or part are prohibited or void or in breach of Competition Laws in any jurisdiction in which it carries on or intends to carry on business or where its activities may have an effect;

b) committed any abuse, either alone or jointly with any other enterprises, of a dominant position in Indonesia and/or in any jurisdiction;

c) made any submission or application or given any undertaking (whether or not legally binding) to a Competition Authority in any jurisdiction in respect of any agreements, decisions, or concerted practices pursuant to or in connection with Competition Laws in any jurisdiction;

d) been the subject of any investigation or enquiry by Competition Authority in any jurisdiction; or

e) received any process, notice, request for information or other communication (formal or informal) from a Competition Authority in any country in which the institution carries on or intends to carry on business or where its activities may have an effect.

21.2 In respect of this Agreement, UTP undertakes:

(a) to comply, and will procure its Affiliates to comply, with all applicable Competition Laws;

(b) to promptly notify UNISI in writing of any suspected or occurrence of infringement of any Competition Laws; and

(c) to promptly notify UNISI in the event it is no longer able to comply with the warranties in paragraph 20.1 above.

21.3 UTP fully indemnifies UNISI, its directors, shareholders and employees for any losses arising from a breach of the warranties in Clause 21.1 above.

CLAUSE 22 - WAIVER

22.1 The waiver by a Party in respect of any breach of a term of this Agreement by the other party shall not be deemed to be a waiver in respect of any other term or of any subsequent breach of that term.

22.2 The failure of a Party to enforce at any time any term of this Agreement shall in no way be interpreted as a waiver of such term.

CLAUSE 23 – NOTICES

23.1 Any notice (including any approval, consent or other communication) in connection with this Agreement shall be:

a) made in writing in the English language.

b) delivered by hand or sent by prepaid courier to the address of the addressee and marked for the attention of the person so specified, or to such other address or facsimile number, and/or marked for the attention of such other person as the relevant party may from time to time specify by notice given in accordance with this clause.

23.2 The relevant details of each Party at the date of this Agreement are provided in Schedule C. In the absence of evidence of earlier receipt, any notice shall take effect from the time that it is deemed to be received in accordance with Clause 23.3 below.

23.3 A notice is deemed to be received in the case of delivery by hand or by prepaid courier to the address of the addressee, on the day on which it is received at that addressee's address.

23.4 A notice received or deemed to be received in accordance with Clauses 23.2 and 23.3 on a day, which is not a Business Day, or after 5 p.m. on any Business Day according to local time in the place of receipt, shall be deemed to be received on the next following Business Day.

23.5 For the purposes of this Clause 23.4, "Business Day" shall mean a day not being a Saturday, Sunday or gazetted public holiday on which trading banks are generally open for business in the place where the notice is received.

23.6 Each Party undertakes to notify the other Party by notice served in accordance with this Clause if the address specified herein is no longer an appropriate address for the service of notices and/or formal correspondence.

23.7 Electronic Communication

Any communication to be made between any Parties under or in connection with this Agreement may be made by electronic mail or other electronic means, to the extent that the Parties agree that, unless and until notified to the contrary, this is to be an accepted form of communication and if the Parties:

a) notify each other in writing of their electronic mail address and/or any other information required to enable the sending and receipt of information by that means;

b) notify each other of any change to their address or any other such information supplied by giving them not less than five (5) Business Days' notice; and

c) any electronic communication made between the Parties will be effective only when it is actually received in a readable form.

CLAUSE 24 – WARRANTY, INDEMNITY AND LIABILITY

24.1 The Parties undertake to indemnify and keep each other indemnified from and against any and all loss, damage, or liability resulting from the breach of the Agreement including any act, neglect, or default of their respective employees or agents.

24.2 Each Party represents to the other Party that:

24.2.1 it has legal power, authority and right to enter into this Agreement and to perform its obligations hereunder;

24.2.2 it is not at the Commencement Date a party to any agreement or understanding with any third party which in any significant way prevents it from fulfilling any of its material obligations hereunder; and

24.2.3 to the best of its knowledge, the title in any Intellectual Property disclosed or made available in pursuant to this Agreement or anything made, used or otherwise disposed of in connection with the same will be free from infringement of patents, copyrights, trademarks or other intellectual property rights of any third party.

24.3 Nothing in this Agreement shall be construed as an obligation by the Party to bring or prosecute or defend actions or suits against/by third parties for infringement of patents, copyrights, trademarks or other intellectual property or contractual rights, whether in connection with the Know-how and Intellectual Property or the Project IP or otherwise.

24.4 A Party, including its affiliates, officers, directors, employees, agents, or contractors, shall not be liable, in contract, tort, negligence, breach of statutory duty or on any other legal theory or basis, for any indirect or consequential loss, including loss of profit, revenue or goodwill, incurred by another Party arising from or in connection with this Agreement.

24.5 Each Party shall be solely responsible and liable for the acts and omissions of its directors, agents, contractors, and employees.

24.6 The parties acknowledge and agree that in the event of a material breach of the Agreement by either party, the non-defaulting party shall endeavor to do all things as may reasonably be necessary to mitigate any losses that it may suffer pertaining such breach.

CLAUSE 25 - ENTIRE AGREEMENT

The terms of the Agreement between the Parties are those set out in this Agreement and the Schedules and no written or oral agreement or understanding made or entered into prior to the date of this Agreement shall in any way be read or incorporated into this Agreement.

CLAUSE 26 – SUCCESSORS-IN-TITLE

This Agreement shall be binding on the respective heirs, personal representatives, receivers, successors-in-title and assigns of the Parties hereto.

CLAUSE 27 – AMENDMENT/MODIFICATION

Any provision of this Agreement may be amended or modified by mutual consent between the Parties and such amendment/modification shall be in writing and signed by the duly authorised representative of the Parties.

CLAUSE 28 – CONTINGENCY

The Parties recognise that it is impracticable to make provisions in this Agreement for every contingency that may arise in the course of performance and implementation of the Agreement and accordingly agree that it is their mutual intention that this Agreement shall operate between them with fairness and equity and if in the course of performance and implementation thereof unfairness to a Party is disclosed or foreseen then the Parties shall use their best endeavour to mutually agree upon such action as may be necessary to fairly and equitably remove the cause or causes of the same.

CLAUSE 29 – AS IS BASIS

Any information relating to the Project and/or under this Agreement is provided by UNISI to UTP on an "AS IS" basis. UNISI shall, on a BEST EFFORT basis, ensure that the information provided works under normal conditions.

CLAUSE 30 – COSTS AND EXPENSES

Each Party shall bear its own costs and expenses incurred in the preparation, execution, stamping and implementation of this Agreement.

CLAUSE 31 – LIMITATION OF LIABILITY

Notwithstanding anything contained to the contrary in this Agreement, neither Party shall be liable to the other Party under this Agreement for or in respect of any indirect, incidental or consequential losses and/or damages arising or alleged to arise out of either Party’s failure to properly carry out its obligations under this Agreement.

CLAUSE 32 – COUNTERPARTS

This Agreement may be executed in counterparts all of which shall constitute one agreement binding on both Parties and shall have the same force and effect as an original instrument notwithstanding that both Parties may not be signatories to the same original or the same counterpart.

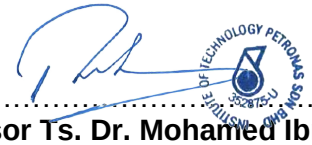
CLAUSE 33 - DIGITAL SIGNATURE

The Parties may sign and deliver this Agreement by facsimile or by emailed portable document format (“PDF”) document (or other mutually agreeable document format), and a reproduction of this Agreement with a Party's signature made by facsimile or PDF, sent by facsimile or email shall have the same effect as and be enforceable as a signed and delivered original version of this Agreement.

[End of Clauses]

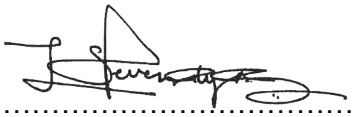
IN WITNESS WHEREOF, the Parties hereto have caused this Agreement to be signed in their respective names as of the day and year first above written.

Signed by and on behalf of:
INSTITUTE OF TECHNOLOGY PETRONAS SDN. BHD.



……
Professor Ts. Dr. Mohamed Ibrahim Abdul Mutalib
Vice Chancellor and CEO

In the presence of:



……
Professor Ir. Dr. Mohd. Shahir Liew
Deputy Vice Chancellor Research and Innovation

Signed by and on behalf of:
UNIVERSITAS ISLAM INDRAGIRI

……
Dr. H. Najamuddin, Lc., MA
Rector

In the presence of:

……
Gunawan Syahrantau, SP., MMA
Vice Rector Academic, Student Affairs and Coperation

SCHEDULE A (3)
FORMAT OF ADDENDUM

Addendum Relating to the Master Research Collaboration Agreement between Universitas Islam Indragiri ("UNISI") and Institute of Technology PETRONAS Sdn Bhd ("ITPSB")

This Addendum is issued pursuant to the Master Research Collaboration Agreement between ITPSB and UNISI dated _____ (the "Agreement"). It is acknowledged and agreed between the Parties that the terms and conditions of the Agreement shall apply in full to this Addendum and the Parties agree to abide by the provisions of the Agreement when performing the Project(s) in accordance with this Addendum.

Project No	3
Project Title	Intelligent Hybrid ARIMA-ANN Time Series Model to Forecast Coconut Price
Duration	From 1 May 2021 until 30 April 2022 Twelve (12) months

1. Project Objectives

Generally, these studies can be used to analyze many issues as mentioned in the problem statement. Specifically, this research is only used to fulfill the following objectives:

a) To develop Intellegent hybrid ARIMA-ANN forecasting model for coconut price.
b) To evaluate the developed intelligent hybrid ARIMA-ANN models by comparing with ARIMA and ANN.
c) To forecast future coconut price by applying the develop hybrid ARIMA-ANN forecasting model.

2. Background/Scope of Works

Coconut price is vey important in Indragiri Hilir Regency. Therefore, it is imperative for Indragiri Hilir to have a clear understanding on the future coconut price to support the local government planning over a short and long term period in order to sustain the Indragiri Hilir economy. Literature review show that the following techniques are used to forecasting coconut price in Indragiri Hilir regency: double moving average, exponential smoothing, Auto Regressive Integrated Moving Average (ARIMA) and Artificial Neural Network (ANN) etc. Coconut price forecasting using time series analysis is consists of complex linear and non-linear patterns which are difficult to forecast accurately. Neither ARIMA nor ANN can be adequate in forecasting coconut price. The ARIMA model cannot deal with nonlinear relationships while the neural network model alone is not able to handle both linear and nonlinear patterns equally well. In this research, a hybrid methodology that combines both ARIMA and ANN models is proposed to take advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modeling. The empirical results with Indoenesia coconut price data indicate that the hybrid model can be an effective way to improve the electricity consumption forecasting accuracy obtained by either of the models used separately. The developed hybrid ARIMA-ANN models will be evaluate by comparing with ARIMA and ANN mean absolute error (MAE), root mean square error (RMSE) and mean absolute percentage forecast error (MAPE).

3. Project Schedule

Activities/Months	2021/2022											
	5	6	7	8	9	10	11	12	1	2	3	4
Literature Search												
Acquiring data												
Develop ARIMA model and develop ANN model on residual												
Develop hybrid ARIMA-ANN model												
Evaluation of hybrid ARIMA-ANN Modeling												
Report writing												
Literature Search												
Acquiring data												

4. Project Team

	UNISI	UTP
Principal investigator	Dr Abdullah	Dr. Rajalingam
Team Member(s)	Gunawan Syahrantau, Zainal Arifin, Yusriwarti.	AP Dr Mahmod Othman Richard Manu Nana Yaw Sarpong-Streetor, Abdus Samad Azad

5. Project/Progress Reporting

For UTP, as a standard requirement for every matching project, the UTP Project Team need to prepare six (6) months Progress Report and the Final Report to be submitted within a month after project end date.

Progress Report
The Progress Report including a financial information to be submitted by the researchers to Lembaga penelitian dan pengabdian masyarakat at the **end of six months**.

Final Report
Researchers are required to submit to respective RMCs within one (1) month from the date of project completion. The final report presentation and indexed publication for journal should be attached with the report in LPPM system.

6. Deliverables and Expected Outcome

a) The proposed method will be helpful in forecasting coconut price that benefit to government and farmer for future work.

b) The study will provide a feasible methodology for private organization and government especially HR ministry on decision makers to effectively investigate and govern

contaminated sites with the aim of reducing the harmful effects of air pollution on public health and the environment. We believe that the results will provide important information to explain the stochastic behaviors of the API data and spatial dependence to improve public health and develop proper strategies for controlling the air quality issues.

c) Novel theories/New findings/Knowledge
The novelty of this study is that the developed hybrid ARIMA-ANN forecasting model apply to predict the agriculture and commercial sectors coconut price consumption in Indragiri Hilir Regency.

d) Research Publications :1 conference and 1 journal publications

e) Specific or Potential Applications : Energy povider can use the proposed forecasting model for future work

7. Project Cost and Payment Schedule (whichever applicable)

Universiti Teknologi PETRONAS		
Category	**Item**	**Amount (MYR)**
Vote 11000 - Wages and Allowances for Temporary and Contract Personnel	n/a	n/a
Vote 21000 - Travel &Transportation	**Conference oversea (ASEAN region)** - flight (RM 1000), accommodation (RM 1300), ground traveling (RM 700), meal allowance (RM 1000)	4,000.00
	Visit to Universiti Islam research collaboration meeting and discussion - flight (RM 500), accommodation (RM 700), ground traveling (RM 600), meal allowance (RM 600)	4,000.00
	Research collaboration meeting and discussion with other potential partners for future collaborations Accomodation (RM 2000), Meal allowance (RM 1000), Transportation (RM 1000)	4,000.00
Vote 24000 - Rental	n/a	n/a
Vote 27000-Research Materials & Supplies	n/a	n/a
Vote 28000-Minor Modifications & Repairs	n/a	n/a
Vote 29000-Special Services	• Conference fee (RM 2000) • Journal publication (RM 5000) • Research Assistant (RM 3,400)	8,000.00
Vote 35000-Special Equipment & Accessories	n/a	n/a
	Total	20,000.00

Universitas Islam Indragiri		
Category	**Item**	**Amount (IDR)**
Vote 11000 - Wages and Allowances for Temporary and Contract Personnel	n/a	n/a
Vote 21000 - Travel and Transportation	• **Conference oversea (ASEAN region)** - flight accommodation, ground traveling, meal allowance • **Visit to Universiti Islam research collaboration meeting and discussion** - flight, accommodation, ground traveling, meal allowance. • Research collaboration meeting and discussion with other potential partners for future collaborations • Accomodation, Meal allowance, TranSportation	13.200.000 13.200.000 13.200.000
Vote 24000 - Rental	n/a	n/a
Vote 27000-Research Materials & Supplies	n/a	n/a
Vote 28000-Minor Modifications & Repairs	n/a	n/a
Vote 29000 - Special Services	Conference fee, Journal publication and Research Assistant	26,400.000
Vote 35000 - Special Equipment and Accessories	n/a	n/a
	Total	66.000.000

SCHEDULE B
NOTICE

	Universitas Islam Indragiri	Institute of Technology PETRONAS Sdn. Bhd.
For Contractual Matters	Rectorat Jl. Propinsi Parit 1 Tembilahan Hulu Indragiri Hilir Riau Indonesia Tel.: +62768324918 Email: info@unisi.ac.id	Legal Services Office Universiti Teknologi PETRONAS 32610 Bandar Seri Iskandar Perak Darul Ridzuan, Malaysia Tel.: +605-3688239 Email: utp.legal@utp.edu.my
For Technical Matters	Vice Rector academic, student affairs and Coperation Jl. Propinsi Parit 1 Tembilahan Hulu Indragiri Hilir Riau Indonesia Tel.: +62768324918 Email: info@unisi.ac.id	Research Management Centre Universiti Teknologi PETRONAS 32610 Bandar Seri Iskandar Perak Darul Ridzuan, Malaysia Tel.: +605-3687200 E-mail: rahim.othman@utp.edu.my Director

IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received 8 March 2023, accepted 3 May 2023, date of publication 11 May 2023, date of current version 24 May 2023.

Digital Object Identifier 10.1109/ACCESS.2023.3275534

RESEARCH ARTICLE

Intelligent Hybrid ARIMA-NARNET Time Series Model to Forecast Coconut Price

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This work was supported by International Collaborative Research Grant -015MEO-220-223, between Universitas Islam Indragiri Indonesia and Universiti Teknologi PETRONAS Malaysia. The National Collaborative Research Fund (015MC0-032) at Universiti Teknologi PETRONAS Malaysia also supported the work.

ABSTRACT The global demand for coconut and coconut-based products has increased rapidly over the past decades. Coconut price continues to fluctuate; thus, it is not easy to make predictions. Good price modelling is important to accurately predict the future coconut price. Several studies have been conducted to predict the price of coconut using various models. One of the most important and widely used models in time series forecasting is the autoregressive integrated moving average (ARIMA). However, price fluctuations is considered a problem with uncertain behaviour. The existing ARIMA time series model is unsuitable for solving this problem, because of the nonlinear series. Artificial neural networks (ANN) have been an effective method in solving nonlinear data pattern problems in the last two decades. The non-linear autoregressive neural network (NARNET) gives good forecast, most especially when series are non-linear. Therefore ARIMA- NARNET is considered a universal approach to forecasting the coconut price. The aim of the study is to establish a linear and nonlinear model in time series to forecast coconut prices. The ability of a hybrid approach that combines ARIMA and NARNET(ANN) models is investigated. Based on the experimental study, the experimental results show that the proposed method ARIMA- NARNET, is better at forecasting the price of coconut, an agriculture commodity, than both the ARIMA model and NARNET models. The expected benefit of the proposed forecasting model is it can help farmers, exporters, and the government to maximize profits in the future.

INDEX TERMS ARIMA- NARNET, intelligent hybrid, coconut price, forecasting, time series.

I. INTRODUCTION

Indonesia produced 17.13 million tons of coconut in 2019. Based on the World Atlas report, coconut production in Indonesia is the highest in the world. Referring to the data from the Indonesian Central Statistics Agency (BPS), coconut exports from Indonesia reached 1.53 million tons or US$ 819.26 million as of the third quarter of 2020. The countries which are the destinations for Indonesia's coconut exports includes fthe United States, Netherlands, South Korea, China, Japan, Singapore, Philippines and Malaysia [1]. Therefore, the coconut price forecast has a fundamental importance in the trading strategy of Indonesia. A good forecasting model is critically important to predicting the future price of coconut accurately, thus proper planning could be made by the farmers, exporters, and the government to maximize future profit. The forecast of the coconut price in time series is considered one of the most challenging because of fluctuation issues of coconut price. Fluctuations in agricultural prices affect the supply and demand of commodities and have a significant impact on consumers and farmers [2]. Fluctuations in coconut price lead to uncertainty of income

The associate editor coordinating the review of this manuscript and approving it for publication was Xianzhi Wang.

for the farmer, making it difficult for the government to put in place policies and stabilize supply and demand.

The Autoregressive integrated moving average (ARIMA) model has been one of the vital and widely used methods in time series forecasting [3], [4], [5]. The popularity of the ARIMA model is due to its statistical properties as well as the use of the well-known Box-Jenkins methodology in the model-building process [6]. This model assumes the time series under study is generated from a linear process. Several methods have been used to model and predict coconut prices including the ARIMA model [7], [8], [9]. Results showed the potential of the ARIMA model accurately predict coconut price data. However, ARIMA time series models are generated from linear processes and therefore may be unsuitable for most practical problems that are nonlinear. Prices of industrial agriculture are largely influenced by eventualities, and seasonality, consequently prices are nonlinear and difficult to predict [10]. The fluctuation of coconut prices is considered an uncertain behaviors and changes over time. Some factors that influence the fluctuations of coconut price are company pricing, falling market demand for coconut, and declining quality, and quantity of coconut products. Therefore, it is a challenge to propose an appropriate approach to forecast coconut prices.

Recently, time series data can be modelled using artificial neural networks (ANN). The main advantage of a neural network is its flexible functional form and universal functional approximator. ANN is effective in solving nonlinear data pattern problems. Many non-linear problems are relevant today, including forecasting stock markets with uncertain behaviour and changing over time. There are several studies where neural networks are used to address agricultural commodity price forecasting [11], [12], [13], [14]. The results conclude that the ANN is a better model for forecasting agriculture commodity prices than the ARIMA model [15]. However, the use of a single ANN model could not be complementary in capturing patterns to obtain an optimal prediction. The literature review demonstrates that the ANN model is suitable for nonlinear time series data and the ARIMA model is suitable for linear time series data. In this paper, a hybrid model of coconut price prediction is proposed. The motivation behind this hybrid model is the fact that coconut price fluctuation is complex. The hybrid methodology combines both ARIMA and ANN models to take advantage of ARIMA and ANN models in linear and nonlinear modelling. The ability of a hybrid approach combining ARIMA and ANN models for coconut price forecasting is investigated. The use of hybrid models could be complementary in capturing patterns of coconut price data and could improve forecasting accuracy. Quite different from the ARIMA model and ANN model, this proposed hybrid model combines the ARIMA, and ANN to more accurate predictions for coconut prices. The coconut price prediction model proposed in this study will help farmers, exporters, and the government to maximize profits in the future.

This paper is organized as follows: Section II discusses the methods used in the research work. Section III presents the results of ARIMA-NARNET modelling process for coconut price prediction. NARNET is a version of ANN. Section IV summarizes the present study and draws some conclusions.

II. RESEARCH METHODS

The research methods section involves acquiring the data, process' used to develop the models, forecasting process and lastly the evaluation of the forecasts.

A. DATA

The data for the study is the monthly price of coconut obtained from the Department of Industry and Trade, Indragiri Hilir Regency, Indonesia. The data sample is the average coconut price per month starting from January 2014 to February 2022. Therefore, there are 115 coconut price data points in rupiah currency which have been collected for 8 years and 3 months. The historical data of the coconut prices per month fluctuated over time. This is shown in Figure 1. The data can be found online at: https://bit.ly/3M7TvcM

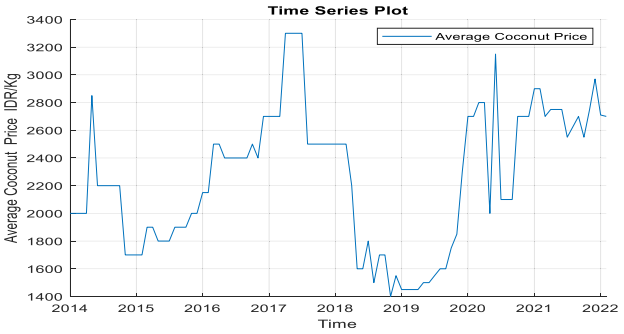

FIGURE 1. Average coconut price in rupees per kilogram from 2014-2022.

B. ARIMA MODEL

$ARIMA(p, d, q)$ model is stochastic in nature and has been used in diverse fields for prediction studies [16], [17], [18]. ARIMA was first put into use in time series for modelling and forecasting by Box Jenkins in 1970 [19]. The model is made up of three parts; autoregressive (AR), integrated (I), and moving average (MA). ARIMA model is developed in three steps: (1) Model Identification, (2) Parameter Estimation and (3) Diagnostic Checking

1) MODEL IDENTIFICATION

Model identification involves finding the order of the ARIMA model using the sample autocorrelation function (SACF) and sample partial autocorrelation function (SPACF) charts [20]. SACF of a time series is the correlation of its past's values with its future values. Given that data points of the time series with first $N - 1$ observation is $X_t : t = 2, 3, \ldots, N$, where

$t = 1, 2, \ldots, N-1$, the relationship between X_t and X_{t+1} is defined as equation (1) and equation (2);

$$r_1 = \frac{\sum_{t=1}^{N-1} (x_t - X_1)(x_{t+1} - X_2)}{\left[\sum_{t=1}^{N-1} (x_t - X_1)^2\right]\left[\sum_{t=1}^{N-1} (x_t - X_1)^2\right]} \quad (1)$$

$$r_1 = \frac{\sum_{t=1}^{N-1} (x_t - X)(x_{t+1} - X)}{\sum_{t=1}^{N-1} (x_t - X)^2} \quad (2)$$

X_1 is the first $N-1$ observation's mean. When N is substantially large, variations among sub-period means X_1 and X_2 are neglected and r_1 is calculated by equation (3):

$$r_k = \frac{\sum_{t=1}^{N-1} (x_t - X)(x_{t+k} - X)}{\sum_{t=1}^{N-1} (x_t - X)^2}. \quad (3)$$

SACF is used to identify the moving average order of a stationary time series. SPACF is the correlation between lag values with other shorter lags of the group at various lags k, where $k = 1, 2, 3 \ldots$. SPACF at varied lags k is defined by equation (4);

$$r_{kk} = \frac{r_k - \sum_{j=1}^{k-1} r_{k-1,j} r_{k-1}}{1 - \sum_{j=1}^{k-1} r_{k-1,j} r_j} \quad (4)$$

$r_{k,j} = r_{k-1,j} - r_{kk} r_{k-1,k-j}, j = 1, 2, \ldots, k-1$. SPACF is used to identify the autoregressive order of a stationary time series. SPACF of an $AR(p)$ process at lag $p+1$ and beyond is zero.

2) PARAMETER ESTIMATION

The Box–Jenkins model of order $ARIMA(p, d, q)$ is given by equation (5).

$$\phi(1+L)^p (1+L)^d y_t = c + \theta(1+L)^q \varepsilon_t \quad (5)$$

The variable y_t, the future value at time step t, is taken to be a linear function of several past observations y_{t-n}, $1, 2, \ldots, n < t$ and random errors, ε_t as demonstrated by equation (5). p is the autoregressive order; q is the moving average order and d represents the differencing order of the coconut price time series. L is the Lag operator. ϕ and θ are the coefficients of regressions for the autoregressions and moving averages [21], [22].

3) DIAGNOSTIC CHECKING

The residual (white noise) of models is assessed using the correlogram (SACF and SPACF), Ljung–Box Q tests [23] and Durbin–Watson test [24] to test the sufficiency of the models.

C. ANN MODEL

The artificial neural network has the potential to represent complex, nonlinear relationships [25], [26], [27], [28], [29], [30], [31], [32], [33], [34]. The evolution of ANN has given rise to the multilayer perceptron (deep learning), which is effective at modelling and predicting complex, nonlinear relationships in time series. It is made up of an input layer, hidden layer; and an output layer. The hidden layer is a network of

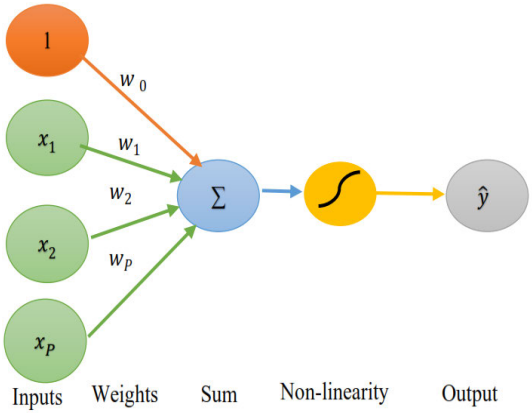

FIGURE 2. The perceptron forward propagation.

three layers connected by open-chain linkages as shown in Figure 2.

$w_{i,j}$ and w_j where $i = 0, 1, 2, \ldots, P$ $j = 1, 2, \ldots, Q$ and are the model parameters. Also referred to as connection weights, the model parameters have P as the number of input nodes and Q as the number of hidden nodes.

After the hidden layers, the sigmoid function, equation (6), among others is employed as an activation

$$Sig(x) = \frac{1}{1 + e^{-x}} \quad (6)$$

function to introduce nonlinearity to the output of the neural network. The nonlinearity allows the network to arbitrarily approximate complex functions as the perceptron is a linear combination of the weights and the input vector.

The network is trained after the activation function is applied. Training is done through Optimization (backpropagation) of the activated perceptron. This allows some of the activated perceptron to drop out as the weight approaches zero (regularization). The perceptron is trained in mini-batches to allow the central processing unit (CPU) or graphical processing unit (GPU) to process the network in a fast, accurate estimation of gradients, smooth convergence of gradients and also allow large learning rates [35]. The remaining perceptron acts as an input node again, and weights are added to form a new network. The backpropagation is done again. The training process continues until there is one perceptron node left. Equation (7) is the mathematical equation between inputs $(y_{t-1}, \ldots, y_{t-p})$ and output (y_t).

$$y_t = w_0 + \sum_{j=1}^{Q} w_g g\left(w_{0j} + \sum_{i=1}^{p} w_{i,j} y_{t-i}\right) + e_t \quad (7)$$

$$y_t = f(y_{t-i}, \ldots, y_{t-P}, W) + e_t. \quad (8)$$

The ANN model, equation (7) maps the input data to the forecast values, y_t. The connection weight, W is a vector containing all parameters [31]. Equation (7) implies one output node emerges as the step-ahead forecast. It shows that the network is robust and can model any function when the number of neurons of the hidden nodes (Q) are high enough [36]. An out-of-sample forecasting can be effectively

done using a primary network layout with a modest number of hidden nodes (Q) [37]. The parameter Q is influenced by the input data and therefore there is no alternative process for determining it. The selection of the number of input vectors, P, and its dimensionality is critical to ANN modelling [37]. The autocorrelation, a nonlinear framework of the time series is defined by P. It is one of the most vital parameters to estimate in an ANN model. Known hypothesis have not been able to assist in P selection. Research is mostly done to identify appropriate Q and P. In the implementation phase, we select the NARNET, a shallow learning model in MATLAB to model the residual of the ARIMA model.

D. INTELLIGENT HYBRID ARIMA-NARNET MODEL

The hybrid modelling process has the linear (ARIMA), and nonlinear (NARNET) components of the model defined respectively as $\hat{L}_t$ and $\hat{J}_t$ [38]. The Intelligent hybrid model $\hat{y}_t$ is estimated using the equation (9).

$$\hat{y}_t = \hat{L}_t + \hat{J}_t \tag{9}$$

$\hat{J}_t$ is the NARNET model trained from the residual of the ARIMA model $\hat{J}_t$ at time t.

E. FORECAST EVALUATION

The forecasts are evaluated using the Multiple Forecast Comparison method (MDM) and if possible, the Diebold Mariano (DM) test. The multiple forecast comparison method investigates whether three or more forecasts for example, the Hybrid ARIMA-NARNET, ARIMA, and NARNET perform equally in terms of specific loss B () functions such as mean absolute error (MAE) and mean squared error (MSE). The Diebold Mariano test is used to compare whether two forecasts performed equally.

The hypothesis for the Multiple forecasts' comparison test of Equal predictive ability (EPA) is;

$$H_o\colon \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{1,t}\right)\right] = \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{2,t}\right)\right], \ldots, = \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{k+1,t}\right)\right].$$

The alternative hypothesis is;

$$H_1\colon \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{1,t}\right)\right] \neq E\left[\mathrm{B}\left(\mathrm{e}_{2,t}\right)\right], \ldots, \neq \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{k+1,t}\right)\right].$$

A test of significance level is conducted by rejecting the null hypothesis of EPA when;

$$SorS_c > X^2_{k,1-\alpha}.$$

Her, $X^2_{k,1-\alpha}$ is the quantile of $X^2_{k,}$ distribution. Rejection of the null hypothesis using S *or* Sc implies that one or more of the alternative models stands out in terms of predictive ability [39]. The hypothesis for the Diebold Marino test of EPA is

$$H_o\colon \mathrm{B}\left[\mathrm{L}\left(\mathrm{e}_{1,t}\right)\right] = \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{2,t}\right)\right],$$

implies that the observed differences between the performance of two forecasts are not significant, while the alternative hypothesis,

$$H_1\colon \mathrm{E} \neq \mathrm{E}\left[\mathrm{B}\left(\mathrm{e}_{2,t}\right)\right]$$

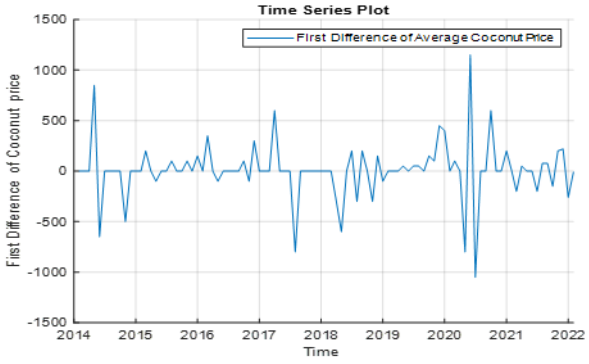

FIGURE 3. First difference plot of average coconut price.

implies that the observed differences between the performance of two forecasts are significant. The DM test has a normal distribution [40]. The assumption for the test is that the models are not nested. Alternative models are invariant to any permutation (reordering) [39], [40], [41], [42], [43], [44].

III. RESULTS AND ANALYSIS

In this section, The Intelligent ARIMA-NARNET model is developed and its forecasting power is assessed. A 12-month forecast of coconut price is made using the ARIMA, NARNET and ARIMA-NARNET Hybrid models.

A. COCONUT PRICE ARIMA MODELING

The ARIMA modelling is presented in this section.

1) ARIMA MODEL IDENTIFICATION

The entire data obtained is used to train the ARIMA model. The data as seen in Figure 1 is not stationary. A condition necessary to train the ARIMA model is that the data is stationary. The ARIMA model is anticipated by identifying a stationary time series at the first difference, $d = 1$. This is shown in Figure 3.

The SACF and the SPACF are plotted from the stationary time series. The ARIMA p, q parameters were identified using SACF and SPACF plots which are shown in Figure 4 and Figure 5 respectively. Observing the SPACF, the autocorrelations spike at lag 1, and die off sharply for the other lags, hence the p is estimated to be 1. The identified tentative model for the coconut price data is an $ARIMA(1, 1, 0)$ with equation (10).

$$(1 - \emptyset_1 L)\,(1 - L)\,y_t = \epsilon_t \tag{10}$$

Equation (10) is expanded to give equation (11).

$$y_t = y_{(t-1)}\,(1 + \emptyset_1) - \emptyset_1 y_{(t-2)} + \epsilon_t \tag{11}$$

2) ARIMA MODEL PARAMETER ESTIMATION

The model parameters are estimated using the MATLAB Econometric Modeler [45]. Tentative models are assessed and compared, using the AICs and BICs; for instance, the ARIMA models with and without the constant terms were compared and the models trained under the Gaussian, and t

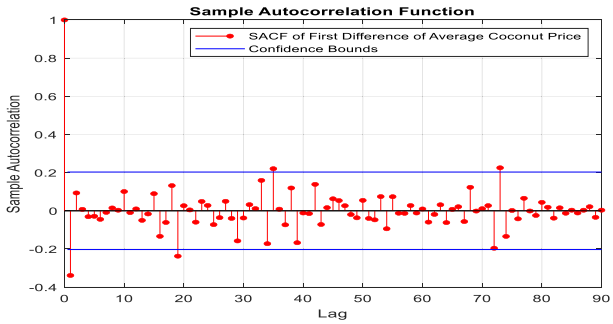

FIGURE 4. Sample autocorrelation function for the first difference of coconut price.

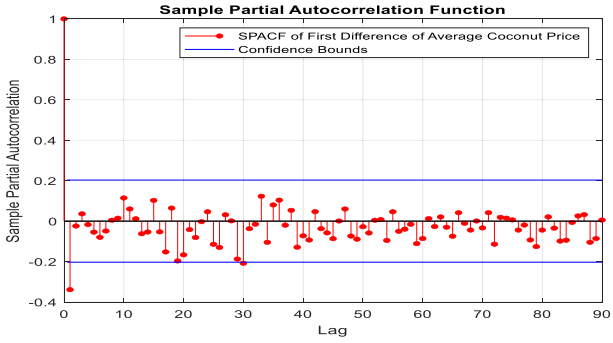

FIGURE 5. Sample partial autocorrelation function for the first difference of coconut price.

TABLE 1. Parameter estimates for ARIMA (1,1,0) model.

Parameter	Value	Standard Error	*t* Statistic	*P*-Value
Constant	-			
***AR* (1)**	-0.33438	0.060473	-5.5294	3.214e-08
Variance	71167.9454	6807.4798	10.4544	1.3992e-25

TABLE 2. Performance values of ARIMA(1, 1, 0) model.

Model	AIC	BIC
ARIMA (1,1,0)	1374.1748	1379.3035

distributions are compared. The results obtained by following the iterative procedure of ARIMA model estimation are given in Table 1 and Table 2.

The estimation is done with the Gaussian probability distribution and the constant term omitted to optimize the model. The parameters in Table 1 are substituted into the model, equation (11) which gives equation (12).

$$y_t = 0.66562y_{(t-1)} + 0.33438y_{(t-2)} + \epsilon_t \qquad (12)$$

The MATLAB code for equation (12) is Appendix I. Appendix I is then applied in Appendix II to carry out the ARIMA forecast. Figure 6 and Figure 7 are the ARIMA Model Fit Plot and Residual Plot of the Average Coconut Price respectively.

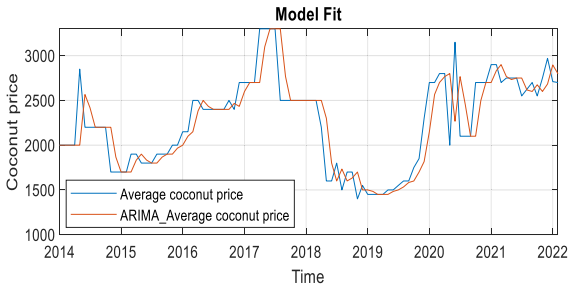

FIGURE 6. Plot of ARIMA(1,1,0) model.

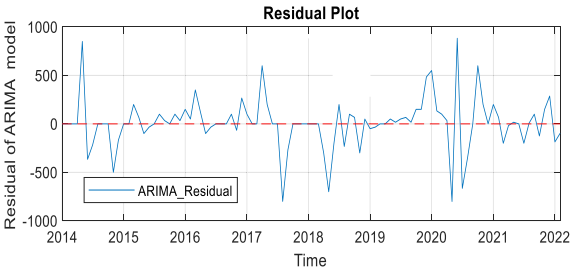

FIGURE 7. Plot of residual of ARIMA (1,1,0) model.

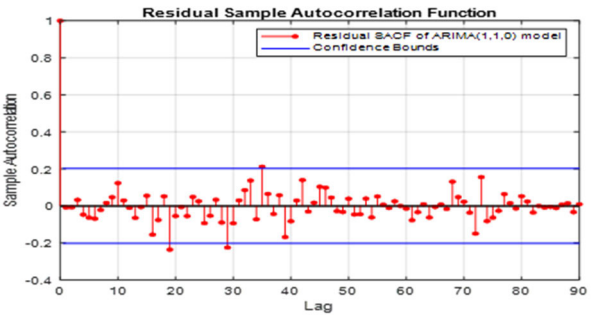

FIGURE 8. Residual sample autocorrelation function.

3) DIAGNOSTIC CHECKING

The ARIMA Model Fit Plot and Residual Plot model is assessed using the Residual Sample Autocorrelation Plot as shown in Figure 8. There are spikes in the Residual SACF which indicates autocorrelation in the residual data, thus the ARIMA model is still not sufficient for the coconut price data hence the need to model the residual data. The Nonlinear Autoregressive Neural network (NARNET) is used to model the residual.

B. RESIDUAL NARNET MODELING

The NARNET modelling process involves three steps (1) setting the input parameters for the NARNET training, (2) training the Network and (3) deploying the Neural network. The NARENT modelling process is discussed below.

1) SETTING INPUT PARAMETERS FOR NARNET TRAINING

The training process is achieved using the Neural Net Time Series application which is part of the Machine learning and Deep learning Applications cluster in MATLAB [46]. The residual time series is used as the only input for the NARNET

and requires a continuous feed of forecasted data to allow the network to continue working. The input of the neural network is the residual of the ARIMA model. The residual is retrieved using the code provided in Appendix III. The input data is 98 months data points; short by 1 month because of the first differencing at the ARIMA modelling stage. The delay time step is set at 2 months. 70% of the data is used for training the neural network, 15% is used to test the trained network and the other 15% is used to validate the Network. The neural network architecture is set as per Figure 9 for a single horizon forecast and Figure 10 for multiple horizons forecast.

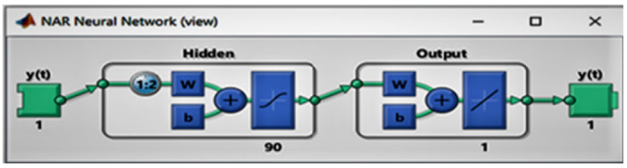

FIGURE 9. Closed loop NARNET architecture.

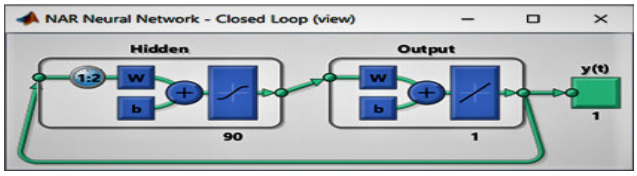

FIGURE 10. Open loop NARNET architecture.

There are 90 hidden layers and one output layer with an output node. The 90 hidden layers are optimal and were arrived at through continuous testing process.

The NARNET is first initialized using random weights at the start of the training process. A Levenberg-Marquardt Back Propagation (LMBP), an iterative algorithm is chosen to train the NARNET model. The LMBP algorithm locates the minimum of a function expressed as the sum of the squares of nonlinear functions through an iterative process. The training cycle 'epoch', is set automatically by converging at the minimum point of the function. The least MSE is used in the NARNET training to identify the best number of layers and associated neurons in each hidden layer [39].

2) TRAINING RESULT

After the NARNET architecture has been set, in the workflow, Appendix IV, or the training application window, the training command is executed by clicking the train button and waiting up until it is done. The training outputs of the neural network have several parameters which are necessary for the neural network to be trained optimally.

The Progress box in Figure 11, the Trained output, shows the error performance of the network which is initialized at 4.06 × 10+7 MSE and stopped at 2.53 × 10+4 MSE. The training performance window in Figure 12 shows that overfitting and underfitting are avoided by training the network such that training, testing, and validation performance graphs are parallel. The *R*, an indication of the linear relationship between the outputs and targets, which measures the goodness of fit, of the neural network model is above 71% for the training set. Figure 13 shows the model summary where the testing and validation sets are above 42%. Here there is a little compromise on the *R* for the validation and testing *R*. The training is repeated until *R* above 50% is achieved for the training and the testing and validation sets. The fitted model for the residual is presented in Figure 14. Figure 15 is the errors associated with the neural network model. The sufficiency of the neural network is assessed using the autocorrelation of errors. There is no autocorrelation in the errors (Erro1) as shown in Figure 16.

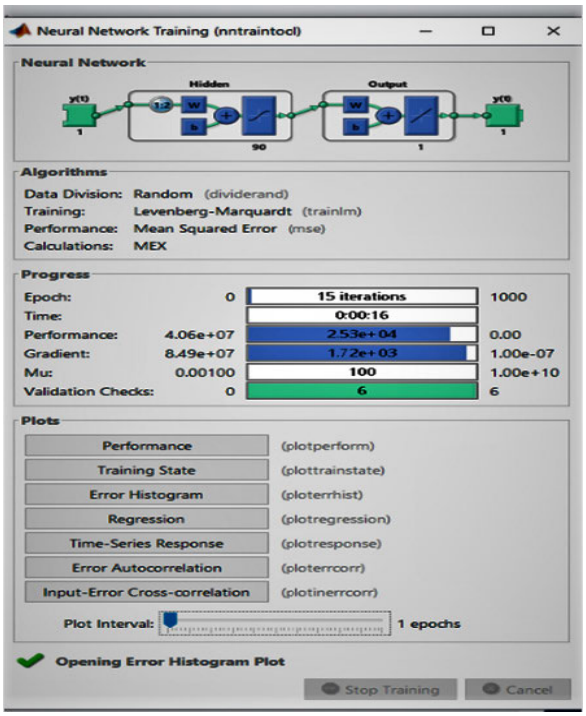

FIGURE 11. Trained output.

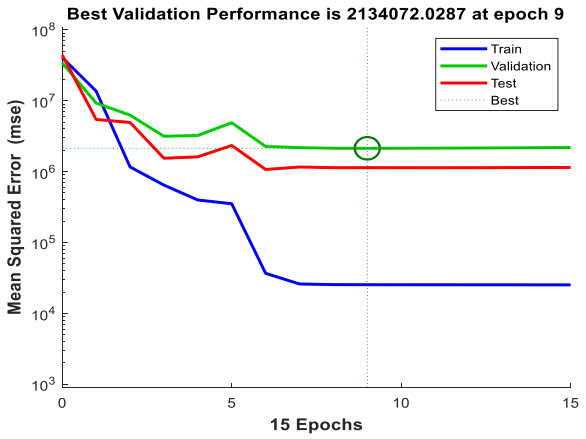

FIGURE 12. Training performance.

The spikes do not die sharply beyond the first lag for the non-zero correlations from the neural network errors. It is the same case in the autocorrelation correlation between Input1 and Error1 (Target1 – Output1) as shown in Figure 17.

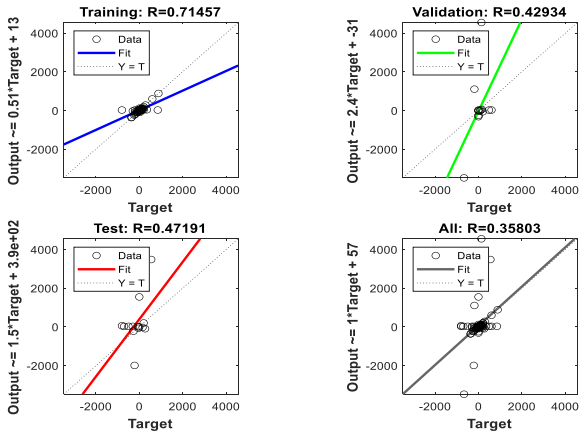

FIGURE 13. Model summary.

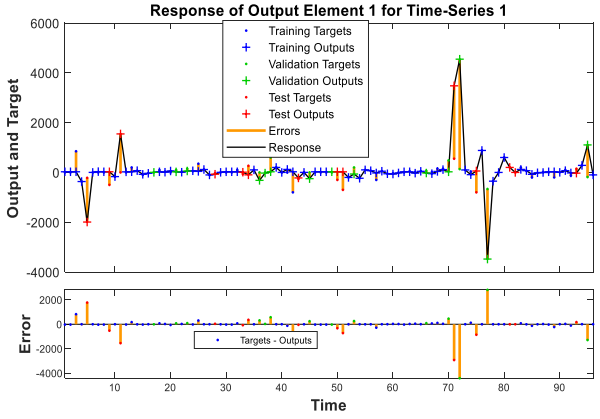

FIGURE 14. Response of output element for residual time-series.

There is no evidence of a correlation between errors (Erro1), and input (ARIMA residual). The inference is that the NARNET model is now sufficient to model the residual component of the coconut price.

3) DEPLOYING THE NARNET

The NARNET model is deployed as a function with the input Arguments stored in the trained network structure in the MATLAB workspace, Appendix V is the function. The advantage of deploying a trained network in such way is to avoid the network behaving as a stochastic model but as a deterministic function.

C. INTELLIGENT HYBRID ARIMA-NARNET MODELING

The hybrid model is deduced from equation (9). The ARIMA model can be expressed mathematically as equation (12), which is also in MATLAB code as Appendix II, but the NARNET model as shown in Appendix IV cannot easily be expressed in a single mathematical equation, instead, the hybrid model is expressed in the code form as presented in Appendix VI.

D. A 12-MONTH FORECAST USING THE MODELS

In Figure 18, the forecast of coconut price is plotted, for three different models, ARIMA, NARNET and Intelligent

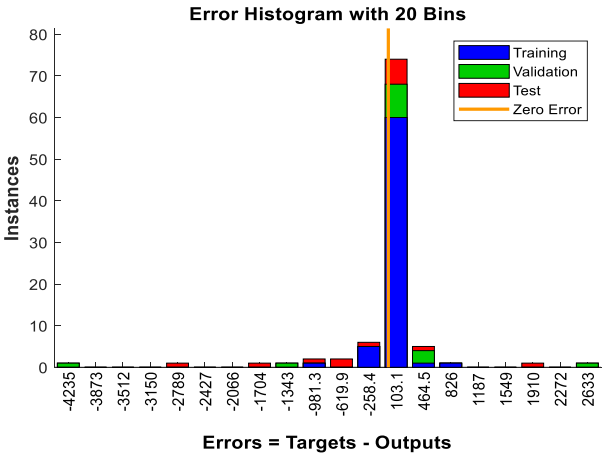

FIGURE 15. Errors of the fitted residual neural network.

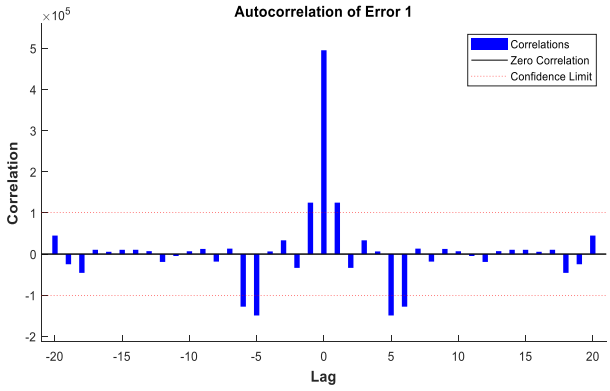

FIGURE 16. Autocorrelation of Error1.

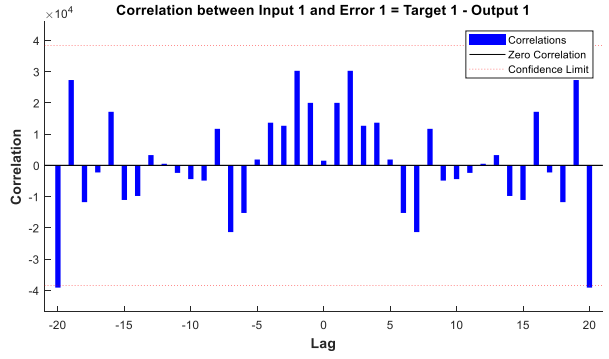

FIGURE 17. Autocorrelation correlation between Input1 and Error1 (Target1 – Output1).

Hybrid ARIMA-NARNET. Other features of the plot are: the observed price time series and the 95% confidence bound of the Intelligent Hybrid ARIMA-NARNET model. The are some missing prices from March 2023–August 2023 from the observed prices time series; however these do not have any impact on the forecast as the data used for the model span from January 2014-February 2023. The previous month January 2023 is used to estimate the missing month's prices.

E. FORECAST EVALUATION

The MDM test showed a test statistic of S or Sc at infinity for the first forecast horizon and NAN for the other forecast

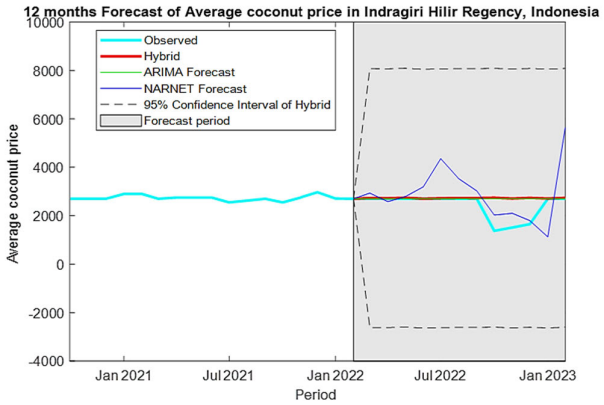

FIGURE 18. Forecasted monthly coconut price.

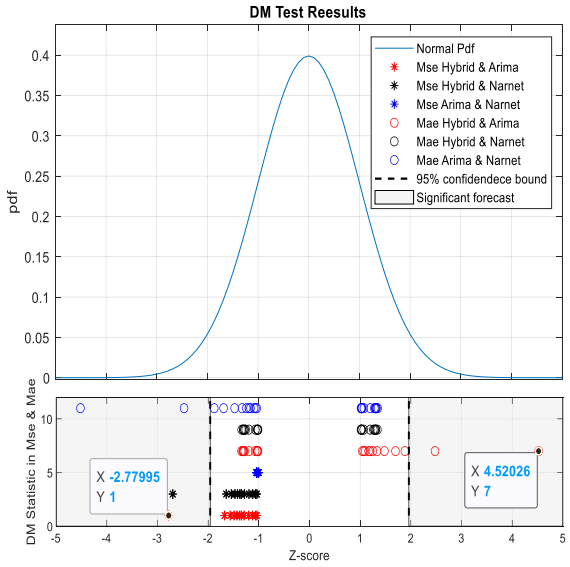

FIGURE 19. The DM test result.

horizons (2nd to 12th). The NAN signifies that the test was not successful, this may be due to the models having nested properties and this results in the singular matrixes in calculating the S and Sc Statistics. On the other hand, the infinity on the chi-square scale signifies that there is at least one of the models with superior predictive ability, concerning the other models in the first forecast horizon. The DM test is resorted to identifying the model with the superior predictive ability. Here the assumption was that the models are 4th-order polynomials as can be seen in Figure 1. Per the nature of the DM statistic in this particular test, it may produce equivalent statistics at both ends of the normal distribution curve as can be seen in Figure 19. The DM test statistics generally reduce as the forecast horizon increases. Rejection of the null hypothesis using DM statistic implies that one or more of the alternative models have superior predictive ability. The models are characterized in a 95% confidence interval bound which is equivalent to the test statistic 1.96. or below. It is expected that the alternative model has superior predictive ability, if the DM statistic >1.96. as shown in Figure 19. The DM test result shows, the hybrid ARIMA-NARNET and ARIMA forecast comparison for the first month/horizon has a superior predictive ability. The ARIMA and NARNET comparisons are not considered as their results are inconsistent for both loss functions. Comparatively hybrid ARIMA–NARNET is better than ARIMA from the forecast graph (Figure 18). The hybrid ARIMA–NARNET blends some nonlinear features which are captured by the NARNET with the ARIMA.

IV. CONCLUSION

The results conclude that the Hybrid ARIMA-NARNET model is better for forecasting agriculture commodity prices than both the ARIMA and NARNET models. This is because a single ARIMA model cannot capture all patterns for an optimal forecast, it captures mostly the linear patterns. Per the analysis above, the NARNET model is ideal for nonlinear time series. In this paper, a hybrid model of coconut price prediction is proposed. The forecast evaluation indicates that the hybrid ARIMA-NARNET model is the best at forecasting coconut prices as it has the strongest predictive ability. Hybrid models can complementarily capture patterns of coconut price data and improve forecasting accuracy. The proposed hybrid forecasting model blends linear and nonlinear model features. The coconut price forecast model suggested in this study will help farmers, exporters, and the government to maximize profits in the future.

APPENDIX A
SUPPORTING INFORMATION

Supplementary codes associated with this article can be found online at: https://bit.ly/3XopI2B

ACKNOWLEDGMENT

The authors are grateful to the department of industry and trade, Indragiri Hilir Regency, Indonesia for providing coconut price data. The authors are grateful to the International Collaborative Research Grant -015MEO-220-223, between Universitas Islam Indragiri Indonesia and Universiti Teknologi PETRONAS Malaysia. The authors are also grateful to the National Collaborative Research Fund (015MC0-032) at Universiti Teknologi PETRONAS Malaysia for supporting the Research.

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