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ELECTRICITY GENERATION OF ELECTRIC COASTER IN TRAPPING SOLAR HEAT

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ABSTRACT: Environmental concerns and shortages of electricity and battery capacity limitations have prompted efforts aimed at the mass production of biodegradable materials. Renewable energy from solar trap heat is the optimal way to prevent climate change and decarbonization. The new technology of the EV body made with Al2O3 Epoxy Resin (ER) filler sandwiched by Carbon Fiber and Lithium thin plates is an advanced technology used to generate electricity by trapping solar heat. The developed laboratory-scale model car body will be able to generate 15% energy from the 8.46 kWh battery pack and reduce 20% of the 30-kWh traction power by reducing 15% of the car's total weight of 1800 kg. Furthermore, the proposed body is very environmentally friendly as it can be easily recycled for new products. Based on the overall benefits, the proposed car body has the potential to reduce oil dependence and environmental emissions. However, the main limiting factors are thermal behavior and ionic conductivity at high temperatures.

ABSTRAK: Kebimbangan alam sekitar dan kekurangan tenaga elektrik dan had kapasiti bateri telah mendorong usaha yang bertujuan untuk pengeluaran besar-besaran bahan terbiodegradasi. Tenaga boleh diperbaharui daripada haba perangkap suria adalah cara optimum untuk mencegah perubahan iklim dan penyahkarbonan. Teknologi baharu badan EV yang dibuat dengan pengisi Al2O3 Epoxy Resin (ER) diapit oleh plat nipis Serat Karbon dan Litium ialah teknologi canggih yang digunakan untuk menjana elektrik dengan memerangkap haba suria. Badan kereta model skala makmal yang dibangunkan akan dapat menjana 15% tenaga daripada pek bateri 8.46 kWj, dan mengurangkan 20% daripada kuasa cengkaman 30 kWj dengan mengurangkan 15% daripada jumlah berat kereta sebanyak 1800 kg. Tambahan pula, badan yang dicadangkan itu sangat mesra alam kerana ia boleh dikitar semula dengan mudah untuk produk baharu. Berdasarkan manfaat keseluruhan, badan kereta yang dicadangkan itu berpotensi untuk mengurangkan pergantungan minyak dan pelepasan alam sekitar. Walau bagaimanapun, faktor pengehad utama ialah kelakuan terma dan kekonduksian ionik pada suhu tinggi.

KEYWORDS: *Electricity generation, Energy saving, Lithium thin plate, Carbon fiber, Epoxy resin*

1. INTRODUCTION

Carbon fibers composites are generally known as Carbon-fiber-reinforced polymer, carbon-fiber-reinforced plastic or carbon-fiber reinforced thermoplastic (CFRP, CRP, CFRTP or often simply carbon fiber). Carbon fiber is an extremely lightweight material consisting of fibers about 5–10 .m in diameter and composed mostly of carbon atoms. Sometimes, it is known as graphite fiber, carbon graphite or CF. Composite materials offer many advantages including high specific mechanical properties, high stiffness-to weight ratio and high

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strength-to-weight ratio. It is used as an alternative for structural materials in automotive and aerospace field by replacing not only steel but light alloys. In the auto industry, the use of carbon composites has been limited to race cars, high-end performance vehicles and some high-end luxury vehicles. The higher cost of these materials is more easily justified based on performance advantages. There are a number of design modifications that can improve engine efficiency, structural weight reduction and it has a multiplier effect on fuel economy.

Much research is being done to develop effective material combinations of polymer nanocomposites with tailored properties. Commercial products such as automotive parts, sporting goods, and packaging materials are already available that make use of nano-sized fillers. Typically, the mechanical, barrier, and fire performance of polymer nanocomposites is better to that of traditional microcomposites. Author [1] has demonstrated load bearing capability and electrochemical cyclability of a structural battery with tunable mechanical properties by fabricating carbon nano-fiber-reinforced active material composites. They postulated that a fiber form of electrodes would be ideal for structural batteries. The study has been conducted [2-5] on the carbon fiber electrochemical properties. They reported that its electrochemical potential against Li is less than 0.5 V throughout the state of charge (SOC) and specific capacity of 372 mA h/g is larger than common cathode materials such as $LiCoO_2$, $LiMn_2O_4$, and $LiFePO_4$. The multifunctional battery cells based on the assumed advantage of carbon as both an electrochemical substrate and a structural material has focused on either (a) predictions of total device improvement based on assumed properties of multifunctional materials [7][9]] or (b) demonstrations of specific technologies built on structural materials platforms [10][11][12]..

Polymers with thermally conducting fillers such as AlN, BN, Al2O3, and SiC are emerging as cost-effective materials to cope with thermal management issues [13][14]-. A very high micro-filler loading, normally 60 vol.% or even higher, is needed to satisfy percolation thresholds and to obtain a high thermal conductivity to form continuous heat conducting chains in the polymer. However, conductive metal fillers and polymeric resin can give a better conductivity because of their high electrical characteristics and chemical stability [12]. Fundamental studies at the nanoscale level to develop filler materials with enhanced thermal performance have been conducted [15][16][17]. They reported that filler materials are generally the inner materials used in composites materials to reduce cost and improve mechanical and electrical properties. Author [18] has studied the performance of dielectric properties of solid polymer electrolyte. He reported that the dielectric properties of solid polymer electrolyte can be increased by adding 15wt% of Al_2O_3 filler and 20wt% plasticizer at ambient temperature. The influence of the type of polymer matrix and filler on the electrical characteristics of the composite has been studied in many works [19][20][21]. The filling of a polymer with metallic particles results in an increase of both electrical and thermal conductivity of the composites obtained.

The use of a hybrid filler comprised of carbon nano materials has been explored and composite performance has been improved by combining the advantages of each type of filler. However, although a remarkable thermal conductivity (5W/mK) has been achieved with an extremely high concentration of nano fillers of about (50 wt.%), the mechanical properties have not been adequate for applications because this practice has resulted in a high density and poor mechanical properties [22][23].

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2. METHODOLOGY

The carbon-polymer composites do not depend on chemistry, which not only means a longer life but a quicker charge as well. The carbon fiber (CF) plate will be developed in this study with epoxy resin totaling 2% and 2.5% of the mass. The mold has been developed with two aluminum alloy plates spacer of 200µm. The Araldite CY231 epoxy resin with anhydride hardener Aradur HY925 has been used to develop CF. Nanotechnologies are estimated to impact and influence at least $3 trillion in the worldwide economy by 2020. Nanocomposites proposed perfections over conventional composites in mechanical, electrical, thermal, and resistance (barrier) properties [24][25][26]. The nano particle Al_2O_3 has been used to prepare the solidified electrolyte for the energy source [27]. Epoxy resin (ER) filling Al_2O_3 micro particles fabrication has been conducted by following the steps: as below:

- Mixing ER with Al_2O_3 by conventional mechanical high shear stirring
- Degassing
- Mixing in an ultrasonic bath at 42 kHz
- Casting into the molds of spacer 200 µm
- Curing for 3 hours at 140^0C
- Post curing for 3 days at 140^0C

The epoxy resin specimens (200µm) with loading concentrations of Al_2O_3 filler 0.1wt%, 0.3wt%, 0.5wt%, 1wt%, 3wt% and 5wt% will be produced. Samples for the investigation of thermal conductivity and electrical characteristics will be prepared. Polymer electrolyte films of Al_2O_3 filler PEO resin for the solid electrolyte was prepared by using solution – cast technique. Specimen of 20µm micro meter were prepared in room temperature and stored under dry condition with considering the following steps:

- The liquid solution of PEO has been heated at 100^0C for 15 to 20 minutes to reduce its viscosity. Furthermore, cooling process occurred in room temperature.
- Different amounts of Al_2O_3 has been added to ER with a high speed mechanical vacuum centrifugal mixture @ 4000 rpm for stirring about 30 minutes.
- The mixture has been poured to the mold and placed under the oven at 80^0C for 4 hours.

2.1 *Thermal Conductivity*

The thermal conductivity investigation was made with a THASYS system, produced by Hukseflux Thermal Sensors. This system will be used to perform the determination of the absolute value of the thermal conductivity. With a combination of a thin heater, homogeneous thermal field has been made through the samples with a well-defined heat flux. The thermal conductivity of polymer can be calculated using the following formula:

$$\lambda = \rho\ C_p \alpha \left(\frac{T_i - T_f}{T_i} \right) \tag{1}$$

where, λ is the thermal conductivity in the W/m.K, α thermal diffusivity in m^2/s, C_p the specific heat capacity j/g.K, ρ is the density of the sample in g/m^3, T_i and T_f are the initial and final temperature in ^{0}K.

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2.2 *Electrical Conductivity*

The electrical conductivity of Al_2O_3 filler ER can be estimated by using the equation:

$$\sigma_c = \frac{4}{\pi}\left(\frac{d_c}{d}\frac{I}{d}cos^2\theta\right)\left(V_p\sigma_f\right)x \tag{2}$$

$$\text{with, } V_p = \beta V_f,\ \beta = \frac{V_f - V_{crit}}{V_t - V_{crit}};\ x = 0.59m,\ \ m = m_{\max}\left(\frac{V_p}{V_t}\right)$$

where, σ_c is the conductivity of the composite, σ_m is the conductivity of the matrix, σ_f is the conductivity of the fibers, d_c is the diameter of the circle contact, d is the diameter of the fiber, l is the average fiber length, and θ is the fiber orientation angle. For the equation (2), β is equal to 0 below the percolation threshold, V_{crit}, and 1 at a 'saturated' volume fraction V_t. Symbol X represents a factor depending on the contact number of fibers, m. For all cases, the maximum number of contacts m_{max} is assumed to be 15.

The dielectric strength of Al_2O_3 filler ER electrolyte composite has been conducted in this study by using lithium foil (Li-F) as electrodes and Carbon Fiber (CF) as anode. The sample has been placed between the electrodes and the AC voltage @ 50 Hz with continuously increasing till the sample brake down (fail).

The breakdown voltage, V (kV) of the samples has been record and the dielectric strength, E (kV/mm) has been be calculated as

$$E = V/t \tag{3}$$

where t is the thickness of the sample in millimeters. During all of the measurements, the temperature will be maintained at room temperature. Thus, the influence of temperature on results can be ignored. The permittivity can be calculated by:

$$Log\,\varepsilon_c = \phi.Log\,\varepsilon_f + (1-\phi)Log\,\varepsilon_m \tag{4}$$

$$\text{with } \varepsilon_c = \varepsilon_m + \frac{2.\phi.\varepsilon_m.\varepsilon_f}{2\varepsilon_m + (1-\phi).\varepsilon_f}$$

where, ε_c, ε_f, ε_m is the dielectric constant of the composite, filler and matrix respectively and Ø is the volume fraction of the filler. The voltage can be calculated by:

$$V_0 = \frac{\Delta C}{2(2C + \Delta C)}V_{in} \tag{5}$$

where, V_0 is the developed voltage from car body in volts, V_{in} is charging voltage of Al_2O_3 of the electrolyte polymer in volts, and C is capacitance in farad. The V_0 will be zero if the solid polymer electrolyte charging voltage (V_{in}) reaches to cut-off voltage (or 85% of V_{in}). The capacitance of the capacitor can be estimated as,

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$$C = \varepsilon_c \frac{A}{d} \tag{6}$$

where, ε_c is the dielectric constant, A is area of plates in m^2, and d is the distance between plate in m. Instantaneous charging current of the capacitor by the car proposed body can be estimated as,

$$I_s = \frac{C_s}{t_s}(V_s) \tag{7}$$

where, I_s is the instantaneous charging current of the capacitor in ampere, C_s instantaneous capacitance, V_s is the instantaneous voltage developed by the car body in time t_s.

3. COMPOSITE BODY FABRICATION

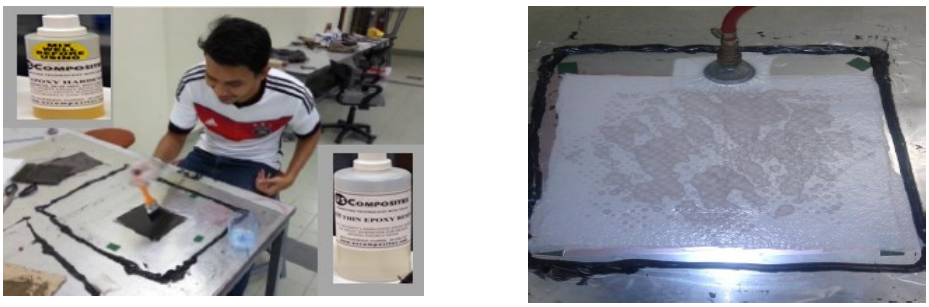
This section has discussed the development of proposed car build with Al_2O_3 filler ER sandwiched by CF and Li thin plate. The following section has presented the fabrication for each of the components.

3.1 Fabrication of Carbon Fiber

The fabrication of the composite plate in this paper has done by using vacuum bagging method as shown in Fig. 1. This method uses the hand lay-up's technique as shown in Fig. 1(a). Hand lay-up involves the construction of a composite material through integration of resin and reinforcement (fiber) components to form a matrix. The resin provides stiffness to keeps the fiber in position and structure to the component while the fiber component provides the strength.

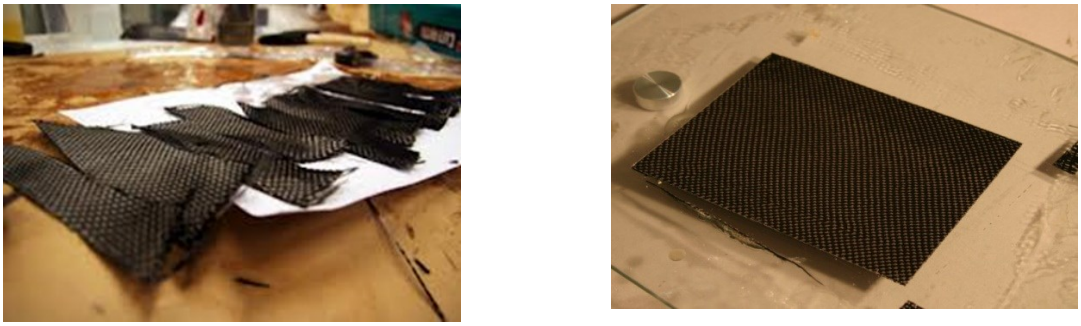
A few specimens of carbon fiber with different thicknesses need to be produced for the comparison of strength performance and also the effective thickness for conductivity. Four layers of carbon fiber sheet with 10.0 cm length and 10.0 cm height is prepared. The epoxy resin and the hardener were mixed together with 2:1 ratio respectively. The mixture was then stirred till it became lukewarm. The mixture then was poured a bit onto a mold layered by lamina plastic and brushed evenly. The processes were repeated until all the carbon fiber sheets have been put in. The upper part of the mold was then put on the layers and compressed tightly with a force of 250 N to prevent air bubbles exist in the carbon fiber mixture.

For ensuring the air carbon fiber mixture, a vacuum bagging process with a pump has been adopted as shown in Fig. 1(b). Then, the vacuum hose is connected to the vacuum pump. The handle on the pump is turned to 900 as an indicator that the pump's valve is closed. The presence of the air is detected if the maximum level of vacuum not achieved (-28″Hg). The leaking is around the sealed area and which can be confirmed if the hissing sound is heard. The vacuum pump is left to turn on for 45-60 minutes. Then, the pump is switched off. The weight of 20N is applied to the laminated composite and left to cure for 24 hours. Nine test plates for tensile test and 6 specimens for impact test are obtained from the whole process and the thickness of each plate is measured using a digital Caliper Gauge. The specimen was left to be compressed for 24 hours. Different thicknesses of specimens were made by repeating the process as shown in Fig. 2.



(a) (b)

Fig. 1. Carbon fiber fabrication (a) hand lay-up's method, (b) Vacuum bagging process



(a) (b)

Fig. 2. Carbon fiber plate (a) Woven carbon fiber, (b) Carbon fiber plate with 6 piles (26.9g and 2.39mm thickness.

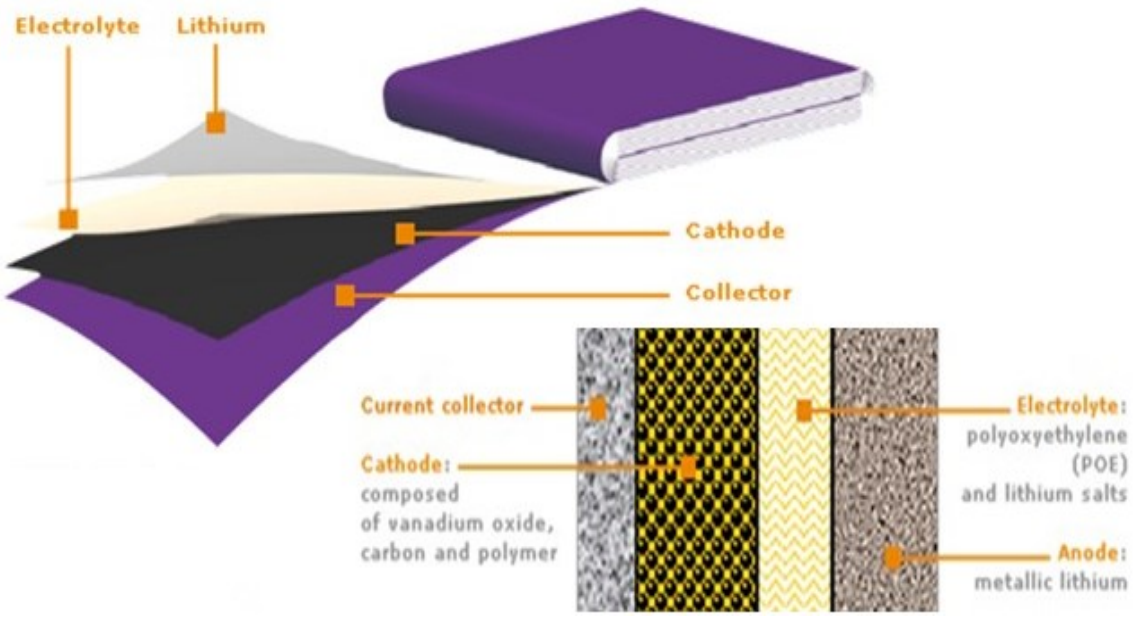


Fig. 3. Proposed composite car body sample.

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3.2 *Fabrication of Polymer Electrolyte*

Acetonitrile, polyethylene oxide (PEO) aluminum oxide (Al_2O_3) and ethylene carbonate which are used to make polymer electrolyte. The specimen was made via solution casting technique. The polyethylene oxide acts as host matrix, acetonitrile as dissolver, aluminum oxide as filler and ethylene carbonate as plasticizer. The polyethylene oxide was first dissolved using acetonitrile. Then the Al_2O_3 of 15% wt was added to the mixture followed by the ethylene carbonate of 20% wt. The mixture was then stirred for 24 hours to ensure a complete solution. Then the mixture was poured into a mold of 10.0 cm length and 10.0 cm wide and was put into a desiccator and let to be dried for 1 – 3 days. The procedure was done under room temperature and stored under dry place. Fig. 3 shows the proposed car body. It was then being compress and the electricity test was performed using voltmeter.

Table 1: Description of the specimen

1st specimen . Number of plies: 3 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0 . Nominal thickness: 1.17mm . Mass: 12.85g	2nd specimen . Number of plies: 3 layer . Size: 200mm x 50mm .S tacking sequence: 0/0/0 . Nominal thickness: 1.24mm . Mass: 13.59g	3rd specimen . Number of plies: 3 layer . Size: 200mm x 50mm . Stacking sequence: 0/0/0 . Nominal thickness: 1.18mm . Mass: 12.5g
4th specimen *. Number of plies: 6 layer* *. Size: 200mm x 50mm* *. Stack ing sequence: 0/0/0/0/0/0* *. Nominal thickness: 2.29mm* *. Mass: 24.51g*	*5th specimen* *. Number of plies: 6 layer* *. Size: 200mm x 50mm* *. Stacking Sequence: 0/0/0/0/0/0* *. Nominal thickness: 2.35mm* *. Mass: 26.72g*	*6th specimen* *. Number of plies: 6 layer* *. Size: 200mm x 50mm* *. Stacking Sequence: 0/0/0/0/0/0* *. Nominal thickness: 2.39mm* *. Mass: 26.9g*
7th specimen *. Number of plies: 9 layer* *. Size: 200mm x 50mm* *. Stacking Sequence: 0 0 0 0 0 0 / 0 / 0 / 0]* *. Nominal thickness: 2.9mm* *. Mass: 32.92g*	*8th specimen* *. Number of plies: 9 layer* *. Size: 200mm x 50mm* *. Stacking Sequence: 0/ 0/ 0/ 0/ 0 /0 / 0 / 0 / 0]* *. Nominal thickness: 2.85mm* *. Mass: 31.9g*	*9th specimen* *. Number of plies: 9 layer* *. Size: 200mm x 50mm* *. Stacking Sequence: 0 0 0 0 0 0 / 0 / 0 / 0]* *. Nominal thickness: 2.81mm* *. Mass: 32.63g*

Table 2: Strength of Carbon Fiber

Number of woven plies	Specimen no.	Nominal thickness (mm)	Maximum force (N)	Maximum stress (N/mm^2)	Maximum stroke
3	1	1.17	3789.6	101.06	2.53
	2	1.24	5271.3	140.57	3.5
	3	1.18	4301.1	114.69	3.13
6	1	2.29	17369.2	458.7	4.10
	2	2.35	17445.0	465.2	4.16
	3	2.39	17507.2	466.86	4.50
9	1	2.90	29928.8	798.1	6.11
	2	2.85	27988.1	787.29	5.98
	3	2.81	27690.9	780.20	5.91

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3. RESULT AND DISCUSSION

Laboratory experiments have been conducted to investigate the strength of CF, thermal and electric conductivity of Al_2O_3 filler ER and the ionization characteristics of Li thin plate. The carbon fiber tensile strength tests were carried out in accordance with ASTM D30392, by using nine specimens. The tensile tests were performed by using a UNIVERSAL TESTING MACHINE MTS, model 744, with hydraulic grip and MTS 632 12C-20 extensometer, at constant speed of 2.0 mm/min at room temperature on each of the specimens of CF for investigating strength. The thickness of the composite laminated has been made by adding the number of plies 3, 6 and 9 were considered. The nominal thickness of the samples varies from 1-3 mm as shown in **Table 1**. The tensile test results are presented in Table 2 and Fig. 4. The strength test of carbon fiber has been carried out for laminated woven carbon fiber with number of piles and nominal thickness. The stress was recorded 530.5 N/mm^2 for specimen 1 number of plies 9, 417 N/mm^2 for specimen 3 number of plies 6, and 140.5 N/mm^2 for specimen 2 number of plies 3 for the strain of 3.85%. The modulus of elasticity 133 Gpa for specimen 1 of composite plies 9, 103.86 for specimen 3 for composite plies 6, and 36.51 Gpa for 36.51 for specimen 3 for composite plies 3 indicate that increasing thickness of laminated composite increase the tensile strength, stiffness, and modulus of elasticity. The number of composite piles of carbon fiber is good for car body in terms of electric and thermal conductivity as the requirement for the objective of this study. However, the composite size optimization depends on the car manufacturer.

4.1 *Impact Testing*

The impact testing has been conducted by using LS-DYNA and validated by the results [15] by designing a hemispherical shape composite and an impactor. The mesh of composite plate is made up of 8 piles with the diameter and nominal thickness is 75mm and 2mm respectively. Each ply thickness is considered as 0.25 mm. The first ply, the layer is located at the center point considering coordinates as (0 mm,0 mm, 0 mm). The second ply, the layer is located below the first layer with coordinates z = -0.25 and the remaining layer are repeat with the same step with the -0.25 decrement value in z-coordinates. Figure 6 below shows the 8 plies plate after mesh. The shape for the laminated composites is circular plate with 75mm in diameter and nominal thickness is 2mm. For the impactor, composite has been designed as hemispherical shape with diameter of 15mm. Impactor's mass and energy imposed on the composites is considered as 1.5 kg and 11.025 J respectively. The maximum of the force for this simulation is considered as 3.6 kN and the force approaches zero at time 8ms with 8 plies mesh composite and an impactor. The agreement between simulation studies [15] and simulation result has a closed agreement, which is substantially valid the result. Figure 6 shows the velocity impact behavior of laminated composite of specimen 3, 4 and 5 for applied energy of 5 J and 10 J respectively.

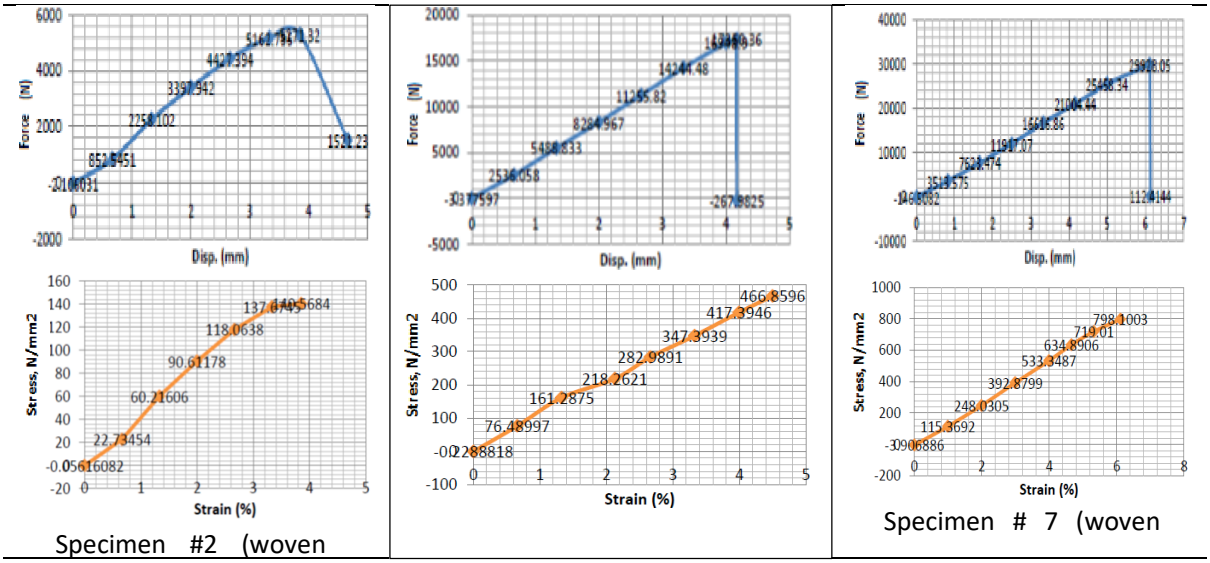
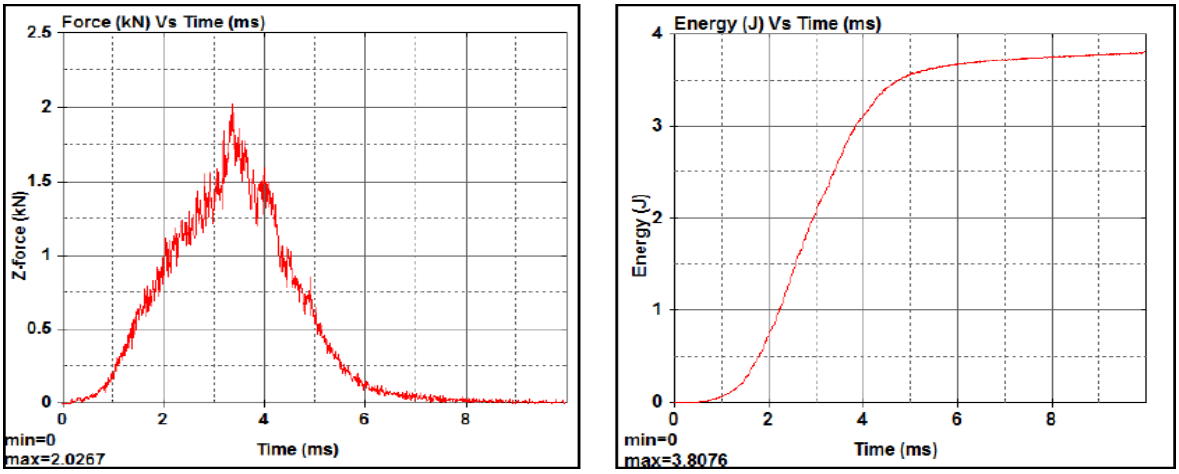
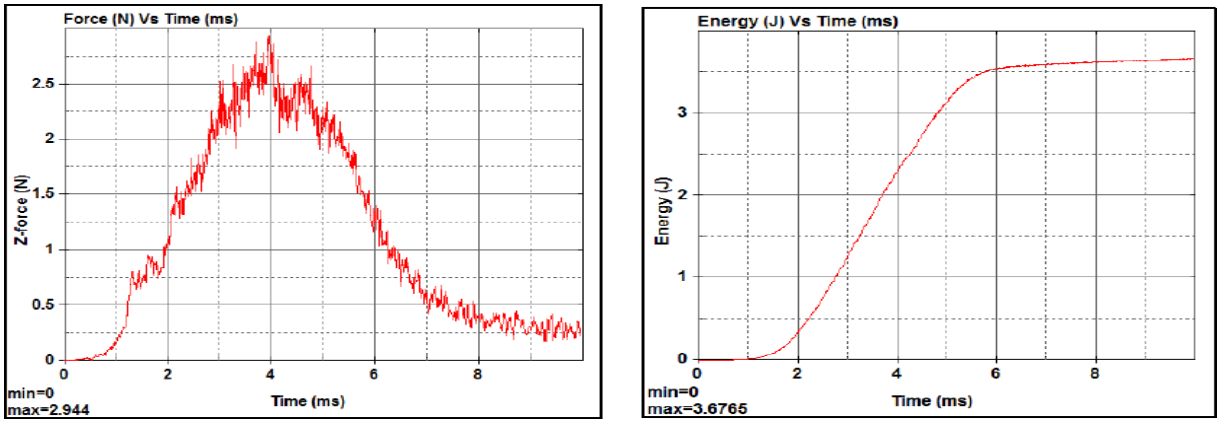


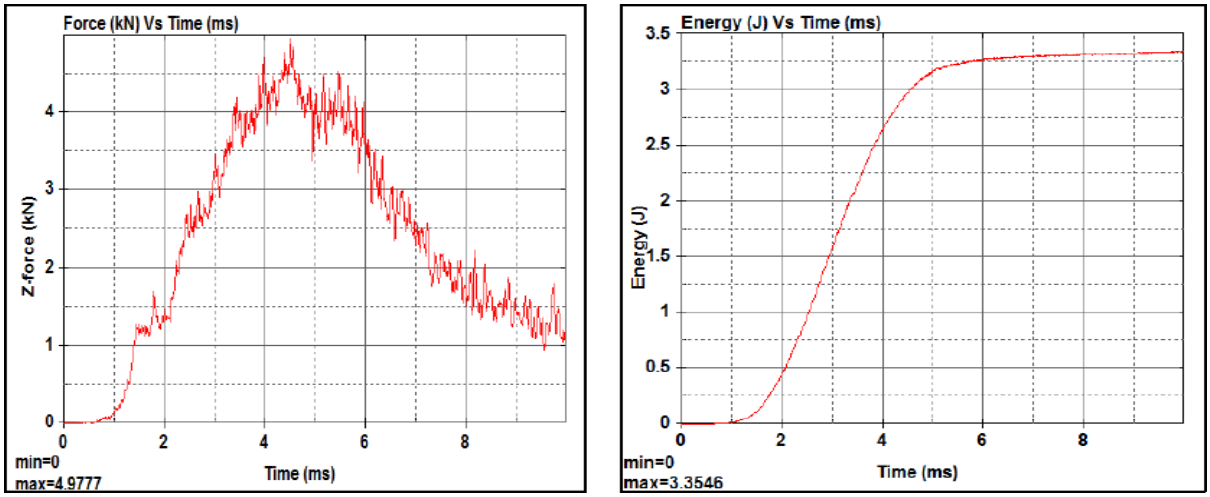
Fig.4. Tensile test result for specimens.



Specimen 3 for impact energy 5 J

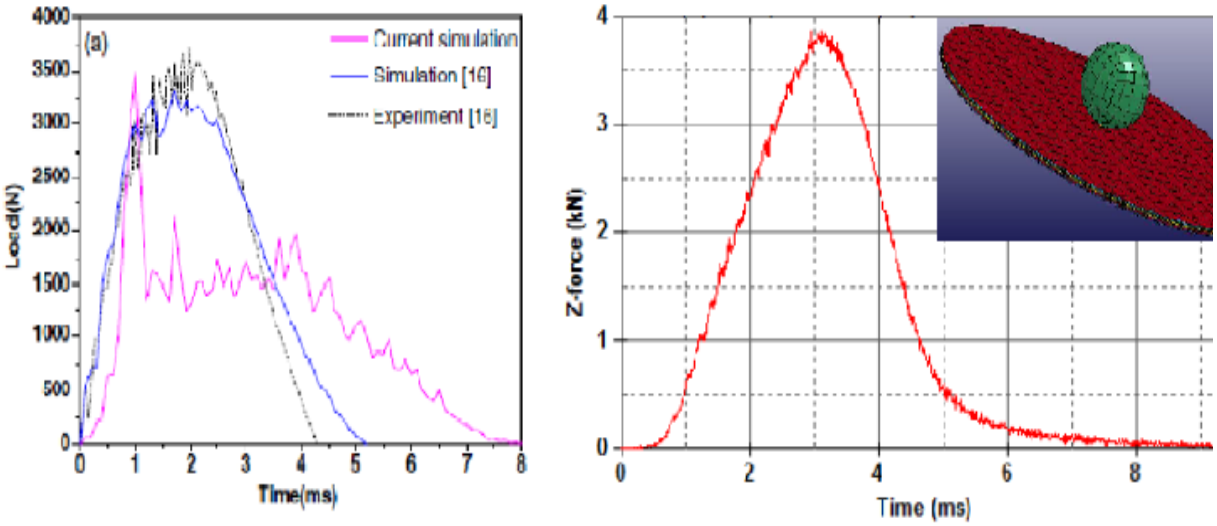


Specimen 4 for impact energy 10 J



Specimen 5 for impact energy 10 J

Fig. 5. Impact testing of CF for low velocity



(a) Qiu et al. (2014)

(b) Simulated result by LS-DYNA

Fig. 6. Impact testing of Carbon Fiber Composites.

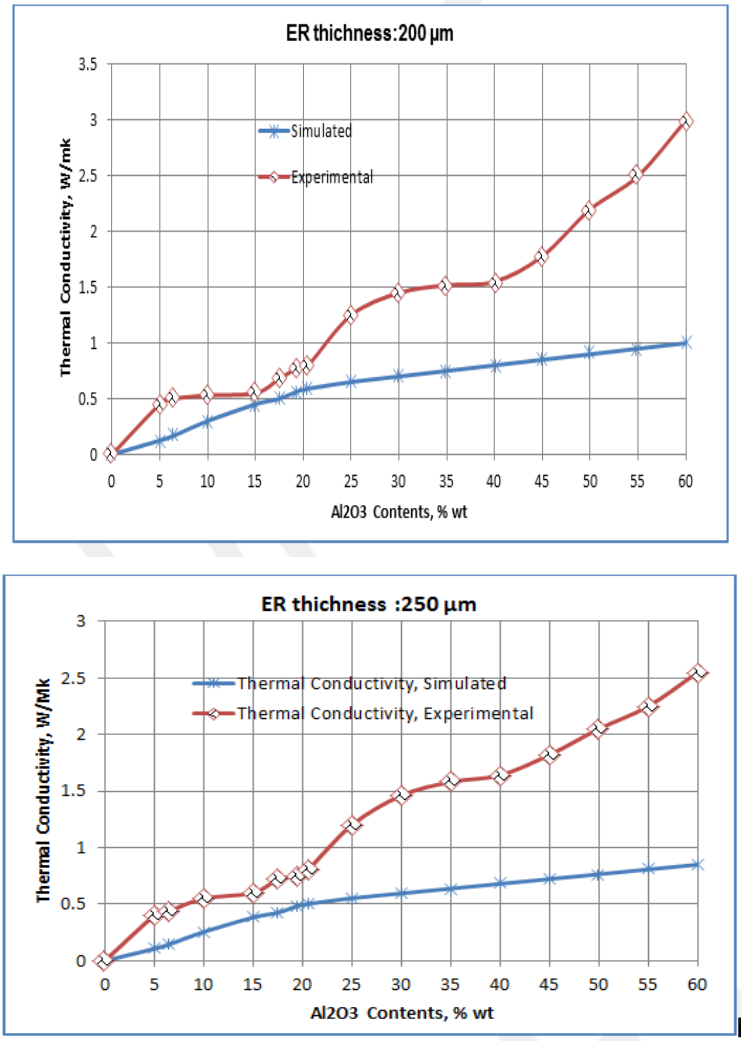
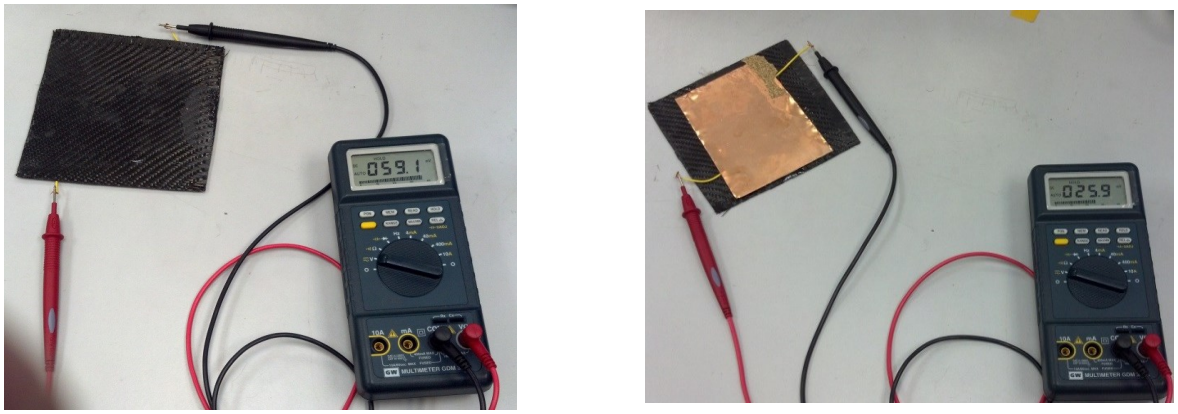


Fig. 7. Thermal Conductivity of Al_2O_3 filler ER electrolyte

Table 3: Electrical resistance for composite car body

Sample Thickness (mm)		Electrical strength (V/mm)					Thermal Conductivity (experiment) W/m^0K)
Polymer electrolyte + % wt of Al_2O_3	CF	Theoretically		Experimentally			
		Sample surface area, m^2					
		25	1000	25	1000		
0.3 +15% wt of Al_2O_3	0.3	0.5	26	0.3	12.8	29A	0.5
0.3+20% wt of Al_2O_3	0.3	0.55	27	0.33	13.15	30A	0.56
0.4 +15% wt of Al_2O_3	0.4	0.6	30	0.35	14.4	34A	0.63
0.4+20% wt of Al_2O_3	0.4	0.7	32	0.38	15.2	34.5A	0.71
0.5+15% wt of Al_2O_3	0.5	0.8	32	0.40	16.22	37A	0.72
0.5+20% wt of Al_2O_3	0.5	0.85	33.5	0.45	17.32	38A	0.76

Notifications: CF represents carbon fiber composite of woven plies 3 and 'A' represents ampere



(a) (b)

Fig.8. Sample performance measuring under the solar temperature 32C (Sample with carbon fibre (b) sample without carbon fibre.

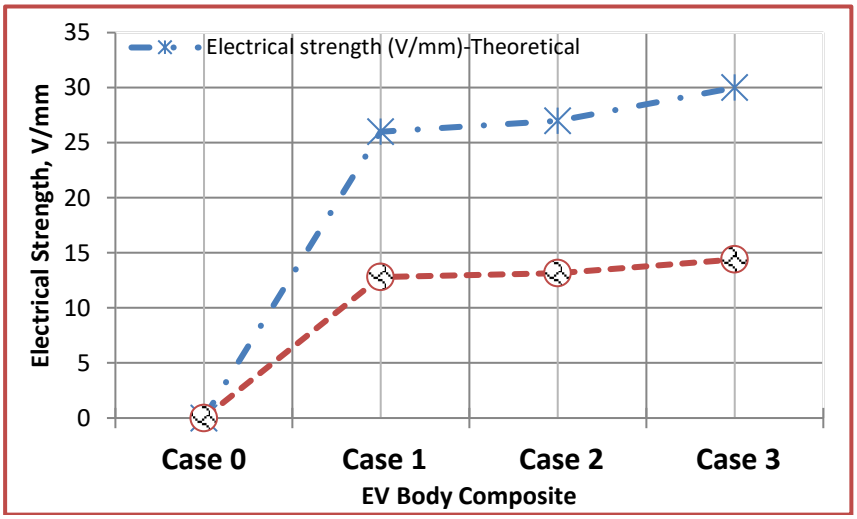


Fig. 9. Electrical strength measurement of proposed car body.

4.2 *Solid Polymer Ionic Conductivity Testing*

Solid polymer electrolyte has many advantages such as high ionic conductivity, high specific energy, solvent-free condition, wide electrochemical stability windows, lightweight and ease of process ability. The dielectric properties of fillers and thermal treatment are major determinants for the ionic conductivity enhancement of solid electrolyte. The fillers will affect the orientation of matrix which is PEO (poly ethylene oxide) by their ability to align dipole moments, whereas thermal conductivity determines the flexibility of the polymer chains for ion migration. Fig. 7 shows the thermal Conductivity of Al_2O_3 filler ER electrolyte. The ER thickness 250µm has performed better than the polymer thickness of 200

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μm for the different contents of Al_2O_3. The result indicates that increasing the filler materials with ER has increased the ionic conductivity which increases the electrical strength and makes filler ER more stable and linear incremental trends. Table 3 shows the thermal conductivity of different ER thickness with different % of filler Al_2O_3. Figure 8 shows the experimental measurement of the electricity generation of proposed car body for the three cases by using the voltage and current measuring digital meters. The results have been presented in Fig. 9.

5. CONCLUSION

Filler Polymer and Copper foil embedded car body can generate 38A current and a power of 489 W. However, 700 W is needed to operate the actuator of a car. If we can increase the power generation, the actuator can be replaced and thus the production cost of the vehicle will decrease meanwhile performance will increase. However, a voltage of 13.2 V is not enough to recharge the battery. In conclusion, due to financial incapability we could not use lithium foil; although lithium has grater thermal conductivity and greater ionization potential compared to copper foil. Therefore using lithium foil we surly can generate more current and power that can replace the actuator of a car for power generation.

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SPIRITUAL HOMO DEUS: MULYADHI KARTANEGARA INDIGENOUS ISLAMIC ENVIRONMENTALISM THOUGHT

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ABSTRACT: This study seeks to explore Mulyadhi Kartanegara's idea of Indigenous Islamic Environmentalism. It is called indigenous because, in Mulyadhi's perspective, there is a problem with uprooting Muslims from their intellectual tradition (indigenous knowledge). For Mulyadhi, this disconnection provides an opportunity for the inclusion of a materialistic western conception of cosmology and influences the perspective of Muslims in general. Because of this trend, the behavior of Muslims towards nature is not much different from modern humans in general, who view nature as an object that can be exploited without limits. To fight the tendency of this dominating relationship, Mulyadhi attempted to formulate alternative ecological ideas based on inspiration from the indigenous Islamic intellectual tradition that developed in the medieval Islamic world: the views of the Ikhwan Al-Shafa/ brethren of purity (peripatetic tradition) and Rumi (gnosis tradition).

The ecological ideas developed by Mulyadhi centered on the theistic evolutionary concept of the universe. For Mulyadhi, this universe is a living entity and has a strong sense of love for God. The reason is, the love that nature has is divine, seeking perfection. At the same time, God is a perfect being itself. In this context, the universe with its love carries out a transformative motion to get closer to God. One of the fruits of this transformative movement is humans, who the Ikhwan position as a microcosm. The reason is that the nature of the universe is wholly contained in humans (minerals, vegetable souls, animal souls, and rational souls). However, Rumi states that man is a macrocosm because he is the vital goal of the transformation process, like fruit (man) produced from the tree of life (nature). So, for Mulyadhi, humans are the essential evolutionary stage of the universe, like the mouth to the body. At the peak of creation, humans are expected to be the liaison between God and the universe. With the help of a human, the universe can feel the blessings of this divine connection. As an inseparable part of nature, humans also become a kind of mirror that will reflect the natural reality outside of themselves. If the inner state of a human being experiences darkness, it will also impact the destruction of nature or vice versa. So, this ecological idea demands the transformation of the human soul as a prerequisite for overcoming environmental problems. The change in question is the continuity of human spiritual Evolution (trans cosmic voyage), which will give birth to a new person termed Insan Kamil (the perfect man), namely humans who can "manifest" the attributes of God in everyday life. Using Harari term, Insan Kamil (the perfect man) is a "Spiritual" Homo Deus.

ABSTRAK: Penelitian ini berupaya menggali gagasan Mulyadhi Kartanegara tentang Environmentalisme Islam yang bersifat indigeneous. Disebut indigeneous karena dalam pandangan Mulyadhi ada persoalan mencabut umat Islam dari tradisi intelektualnya (indigenous knowledge). Bagi Mulyadhi, keterputusan ini memberikan peluang masuknya

konsepsi kosmologi barat yang materialistis dimana mempengaruhi cara pandang umat Islam secara umum. Karena kecenderungan tersebut, perilaku umat Islam terhadap alam tidak jauh berbeda dengan manusia modern pada umumnya yang memandang alam sebagai objek yang dapat dieksploitasi tanpa batas. Untuk melawan kecenderungan hubungan yang mendominasi tersebut, Mulyadhi berupaya merumuskan gagasan-gagasan ekologi alternatif berdasarkan inspirasi tradisi intelektual Islam indigeneous yang berkembang di dunia Islam pada abad pertengahan yakni pandangan Ikhwan Al-Shafa (tradisi peripatetik) dan Rumi (tradisi gnosis).

Ide ekologi yang dikembangkan Mulyadhi berpusat pada konsep evolusi teistik tentang alam semesta. Bagi Mulyadhi, alam semesta ini merupakan satu kesatuan yang hidup dan memiliki rasa cinta yang kuat terhadap Tuhan. Menurutnya, cinta yang dimiliki alam bersifat ilahi yakni mencari kesempurnaan. Pada saat yang sama, Tuhan diposisikan sebagai Dzat yang Maha Sempurna. Dalam konteks ini, alam semesta dengan kecintaannya melakukan gerak evolusi untuk mendekatkan diri kepada Tuhan. Salah satu buah dari gerakan transformatif ini adalah kemunculan manusia yang diposisikan Ikhwan sebagai mikrokosmos. Alasannya karena hakikat alam semesta seluruhnya terkandung dalam diri manusia (mineral, jiwa nabati, jiwa hewani, dan jiwa rasional). Berbeda dengan Ikhwan, Rumi menyatakan bahwa manusia adalah makrokosmos karena ia adalah tujuan akhir dari proses evolusi, kayaknya buah (manusia) yang dihasilkan melalui pohon kehidupan (alam). Jadi, bagi Mulyadhi, manusia adalah tahap evolusi paling esensial dari alam semesta, ibaratnya perjalanan dari mulut menuju tubuh. Sebagai puncak dari proses evolusi/penciptaan, manusia diharapkan menjadi penghubung antara Tuhan dan alam semesta. Dengan bantuan manusia-lah, alam semesta dapat merasakan berkah Ilahi. Sebagai bagian yang tidak terpisahkan dari alam, manusia menjadi semacam cermin yang mencerminkan realitas alam di luar dirinya. Maka, jika keadaan batin manusia mengalami kegelapan secara otomatis akan berdampak pula pada rusaknya alam, begitupun sebaliknya. Jadi, gagasan ekologi indigeneous ini menuntut transformasi jiwa manusia sebagai prasyarat untuk mengatasi permasalahan lingkungan. Perubahan yang dimaksud adalah urgensi melanjutkan Evolusi pada tataran spiritual manusia (transcosmic voyage) yang akan melahirkan manusia baru yang diistilahkan dengan julukan Insan Kamil (manusia sempurna), yaitu manusia yang dapat “mewujudkan” sifat-sifat Tuhan dalam kehidupan sehari-hari. Jika meminjam istilah Harari, Insan Kamil (manusia sempurna) dapat dikatakan adaalah manifestasi dari Homo Deus yang bercorak spiritual.

KEYWORDS: *Man, Nature, Divine Love, Spiritual Evolution, Homo Deus*

1. INTRODUCTION: Beyond the Legacy of Lynn White

This study seeks to explore the ecological ideas of Mulyadhi Kartanegara, a Muslim philosopher from Indonesia. This study positions Mulyadhi's ecological thinking as indigenous Islamic environmentalism because the thought he developed has a uniqueness, namely by trying to dig back the wisdom of the Islamic intellectual tradition in the Middle Ages (Kartanegara, 2005). One historical phase in Islamic civilization was marked by great civilization's rise in the Middle East region, which many western historians later termed the "Golden Age of Islam" (Leuprecht, 2012).

Mulyadhi's distinctive way of thinking by emphasizing the revitalization of indigenous ideas from Muslim intellectuals has become an essential contribution concerning the development of religion and ecology studies. Since the emergence of the academic world's attention to environmental and religious issues in the 60s, various terms have been used to describe the dialogue process starting from "theology and ecology," "eco-theology," and finally "religion and ecology" (Bauman, 2017). We cannot separate this change in efforts to find a

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more "inclusive" dialogue framework apart from the Christian framework. For example, the term theology is very distinctive in the Christian tradition. In contrast, in various other religious traditions, the relation between religion and nature cannot be fully summarized under the umbrella of theology. This study tries to redefine the meaning of indigenous religion. The indigenous religion in this study refers not only to the religion of indigenous peoples. In other words, the definition of indigenous can include either the religion of indigenous peoples such as Indian religion or ancestral religion, which is more "local", or "world" religion characterized by a broad geographical scope (Grim, 2017). In the context of "world" religion, the word indigenous in this study refers to the interpretation or view of the cosmos that developed in the pre-modern era and many cases, still exists today.

Referring to Nasr's parameters, we can divide world religions into two broad categories. First, adherents of world religions that still preserve their pre-modern heritage. On the other hand, there is a tendency for some followers of these world religions to follow the framework of the modern world -which in White's terms is based on techno-scientific logic. Furthermore, Nasr stated that even under the domination of a materialistic and anti-sacred modern framework, the "traditional" theology and vision of the cosmos are still alive, especially ini non Western world. This paper follows Nasr's logic so that even if it is necessary to divide religion, it is more reasonable to divide it according to the extent to which it is "subject" to modern Western logic or not. Subdued religious reasoning can be called "modern" theology, while those that are still trying to resist occupation or maintain the "originality" of tradition can be called "traditional" or "indigenous" theology (Nasr, 1996).

We can say that Mulyadhi is one example of an indigenous Muslim thinker in the contemporary era who seeks to revitalize the indigenous tradition of Islamic intellectuals in the past (Kartanegara, 2005). Mulyadhi Kartanegara is more confident in his choice to revive the "past" than to follow the "modern trend" (reconstructing his theology/philosophy according to the idea of Western modernity) (Kartanegara, 2019c). This position is different from many contemporary intellectuals, both at the global and national levels. An example of an academic who follows this "modern trend" in Indonesia is Nurcholish Madjid. This study also believes that Mulyadhi's thought can be positioned as a critique of the tendency of the academic world, especially in religious and environmental studies, which still uses the perspective of Lynn White's legacy, which tends to be "antagonistic" to monotheistic religions, including Islam. The figure of Lynn White can be said to be very influential in the study of religion and the environment (Brotton, 2017). Perhaps his name can be equated with the names of August Comte, Weber, Marx, and Durkheim in the study of sociology. His work entitled "The Historical Root of our ecological crisis" (1967) can be said to be a kind of "classic" work that continues to influence the perspective of many academics after that who also tend to view monotheistic religion negatively for the future of the environment (Conradie, 2006).

One thesis put forward by White is that we cannot separate the root of today's environmental damage from a wrong way of thinking. This complicated way of thinking is based on a perspective that places humans as superior beings over nature. Nature is positioned solely as an object to fulfill human satisfaction. Furthermore, for White, this dichotomous perspective lies in the idea of placing humans above other living beings. This way of thinking then was later strengthened by the development of science and technology (Lowental, 2019). The combination of science and technology (techno-scientific culture) can be seen as an extension of the human hand that allows him to exploit nature more massively and destructively compared to the previous era (Geus, 2013).

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One thing that later became known by later academics as "White's Thesis" was White's attempt to trace the roots of this anthropocentric way of thinking (Simkins, 2017). Because for White, if we don't get to the basis of the problem, then the solution we are deploying today to tackle ecological issues will only be artificial (Cummings, 2008). Interestingly, White, who is a historian who studies medieval intellectual traditions, then concludes that monotheistic religion, especially Christianity, is the religion that causes the large-scale environmental damage we have seen today (Dietzel, 2014). He uses two main arguments to emphasize his critical attitude towards monotheistic religion, namely that monotheistic religion justifies the position of humans being "higher" compared to the nature around them (Simkins, 2017). Monotheistic faiths also tend to emphasize a rational view of looking at nature (Callicott, 1989). This rationalistic view of nature is manifested in the development of natural theology in monotheistic religions - especially Christianity - which contributes to the development of science (Eaton, 2017). White acknowledged that secularization happened in the idea of natural theology (White, 1967). However, he believes that secularization is only a "minor problem" because the "major" issue remains in the hands of the problematic monotheistic theology that gives way to the destruction of nature (White, 1967). Secularization is only a process of "radicalization" of the monotheistic way of thinking. So, for him, the secularism project does not depart from the monotheistic metaphysical framework (White, 1967).

White's position that minimizes the problem of secularization can undoubtedly be questioned again. Is it true, for example, White's thesis that the secularization that is taking place in Europe is still not outside the monotheistic framework, or has it gone beyond it? For example, this kind of criticism has been made by Hossein Nasr, a contemporary Muslim philosopher from Iran who has influenced Mulyadhi a lot (Nasr, 1990). However, this paper emphasizes that White became a pioneer in creating an academic discourse that positions monotheism as a religion with anti-environmental tendencies. Furthermore, White provides an analysis that is no less controversial. For White, in contrast to monotheistic religions, animistic religions are forms that inherently tend to appreciate nature more significantly (Lane, 2019). Even for White, these animistic religions, due to their high sacredness to the cosmos, so do not dare to carry out various activities that will destroy this sacredness (Eames, 2003). In other words, contrary to the monotheistic religion, in the framework of animistic religion, humans do not have a unique position in this world -or at least humans have a strong connection with nature – (Stubblefield & Fields, 2021). So, the logic of high connectivity makes the attitude of its adherents more ecological (Rowland, 2005).

White also asserts that animistic religions do not engage with nature with a rationalistic approach (Walter, 19840. The absence of this rational approach makes them not pretend to develop a scientific approach (objectification of nature) in their struggle with nature as a monotheistic religion (Livingstone, 2002). For White, this is an advantage of animistic religion, which is more "immune" than the potential to develop a science and technology-based civilization, which then impacts the decline in the ecological quality of that civilization (Northcott, 2020). The contrasts between monotheistic and animistic religions underlie White to conclude that there is a need to change from monotheistic to non-monotheistic (White, 1967). For White, without a shift at the level of consciousness, ecological activism will not produce much of a significant impact (Leal, 2004). It should be noted that White made Zen Buddhism an alternative religion that he had thought of replacing monotheistic faiths, especially Christianity, because he was discussing the European case (Rots, 2019). White's choice of Zen Buddhism also shows that the religion considered an alternative is not limited to

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only "indigenous" religions (in this case, ancestral religion) (White, 1967). For information, Buddhism transcends its birthplace in India and then spreads to East and Southeast Asia (Eckel, 2009). One of the essential things about Zen for White was the non-monotheistic nature of that Eastern religion (Jackson, 2010). Furthermore, there is a broad acceptance of Zen teachings among the European public who also tried to change their life orientation towards being more ecological spiritual (Callicott, 1994).

White's position on Zen Buddhism is not entirely wrong. Nasr, for example, also stated that, in general, religions practiced in non-Western areas still maintain a more intimate perspective on the relationship between nature and humans (Nasr, 1996). However, the problem is that White contrasts these non-monotheistic religions with monotheistic ones he considers anti-environmental. White has a kind of "essentialist" reason that makes him establish a sharp dichotomy between monotheistic and non-monotheistic faiths. This "essentialist" view also makes him imagine that only by shifting the dominance of monotheistic religions – in the case of Europe, Christianity – to non-monotheistic ones can we achieve the transformation towards a more ecological civilization (White, 1967).

We should note that White is aware that there is a phenomenon of "secularization" of natural theology in the Western context that makes science tend to abandon the "God Hypothesis" (White, 1967). White recognition about the effect of the secularization phenomenon that negates the "God hypothesis" is what we should re-discuss to assess the extent to which White's thesis is correct that we can blame monotheism for environmental damage. Blaming secularism instead of monotheism is not a strange hypothesis (Nasr, 1990). If White admits secularism can dispel the "God hypothesis," then why not think secularism has created an entirely different framework from monotheism (White, 1967). It is surprising that removing God, a central aspect of monotheism is not seen by White as a complete disconnection of science from the logic of monotheism (White, 1967).

So, it is possible to build the opposite thesis from White. We can say that not secularization operate within the framework of monotheism (Steiguer, 2006). What's happened is the opposite, namely, the teachings of monotheism, which then undergo reinterpretation following the framework of secularism (Nasr, 1990). For information, this secularization thesis was developed by Nasr in many of his works concerning religion and nature (Nasr, 2003). Nasr believes that belief in monotheism is not inherently problematic (Nasr, 2001). Still, the influence of secularism makes adherents of monotheistic teachings perceive nature entirely different from the perspective developed in the pre-modern era (Nasr, 1990).

One thing that is quite interesting is that although White has shown sympathy for Zen Buddhism, he seems to be aware that the proposal for religious change is too "radical" to be carried out in a European context (White, 1967). So later in the same article, he also wrote an "alternative" proposal to revitalize the Christian tradition, which he considered "marginal." The practice he refers to the teaching of Francis of Assisi as he deems different from the mainstream tradition in Christianity, which tends to be "rationalistic" in viewing nature (Minteer & Manning, 2005). Including, in this case, Francis of Assisi is considered not to strongly affirm the doctrine of the "superiority" of humans over other creatures (Stephens, 2018). For White, his "alternative" proposal is seen as more realistic in the context of European society because it does not radically uproot the religious traditions they adhere to, but at the same time, can encourage a more ecological perspective in the future (White, 1967).

White's "alternative" proposal can be very promising compared to the first proposal, which seems to be "essentialist" in viewing monotheistic religion as inherently anti-ecological. In this "alternative" proposal, White sees that there are various traditions in monotheistic religion. Still, he claims that these traditions are "marginal" in Christianity so that they are by default a religious "heretic" (Hamlin, 2020). So, there is still a strong skepticism in White against monotheistic religion, and only by "rebellion" from this central doctrine of monotheism can a more environmentally friendly theology be developed (White, 1967). This paper will not discuss whether Francis of Assisi's teaching can be positioned as a "deviation" in Christianity. One thing to emphasize in this paper is that if we refer to White's thesis, we can conclude that it is essential to revitalize religious traditions that existed in the pre-modern era (whether they are considered deviations or not). The revitalization is a crucial step to improve the perspective of modern humans -including those of religious background - towards nature which tends to be exploitative.

White's "alternative" proposal, which implies a strategy of revitalizing a religious perspective on the cosmos in this pre-modern era as an effective way to save the environment, has a common ground with Mulyadhi's proposal or his "teacher" Hossein Nasr (Nasr, 1990). Although if we examine the views of Mulyadhi and his "teacher" Nasr, we will find one fundamental difference with White's position. Both Mulyadhi and Nasr believe that efforts to revitalize pre-modern scientific traditions are not in the context of finding and reviving traditions that "deviate" from the doctrine of monotheism (Kartanegara, 1994). Both of them believe that the perspective on the Cosmos developed by Islamic intellectuals departs from the effort to uphold the teachings of monotheism from the "attack" of other philosophies that tend to reject monotheism (Nasr, 2003). For example, in the works of Muslim philosophers dealing with ancient Greek thought, there is no attempt to copy the stories of Greek gods who also influenced his philosophical tradition (Kartanegara, 2007b). This selective attitude shows the efforts of Muslim philosophers not to accept what comes from outside if it is contrary to the spirit of monotheism (Kartanegara, 2014).

Furthermore, if we look at the ecological ideas developed by Mulyadhi, we will find the antithesis to White's position. Mulyadhi adopted the Islamic intellectual tradition with a spirit of "anthropocentrism" and a strong belief in science. In particular, Mulyadhi took a lot of inspiration from the gnosis tradition developed by Rumi and the peripatetic tradition maintained by the *Ikhwan Al-Shafa* (Kartanegara, 2017). A prominent feature of the two schools of thought is their strong emphasis on anthropocentrism (Kartanegara, 1986). In the case of the *Ikhwan*, they were scientists who attempted to create an encyclopedia of medieval science known as the *Rasail*. In other words, the desire to develop solid scientific studies among the *Ikhwan* is very high. If we consistently use White's parameter, then the two concepts that Mulyadhi adopted from the Islamic intellectual tradition should influence Mulyadhi's negative view of nature. However, what happened was that Mulyadhi saw the importance of protecting the environment and not demeaning it (Kartanegara, 2007a).

In contrast to White's conclusion that the two concepts are considered central to environmental damage, for Mulyadhi, the doctrine of "anthropocentrism" developed by the *Ikhwan* and Rumi, including the *Ikhwan's* positive attitude towards science, has become an essential basis for Mulyadhi's ecological ideas (Kartanegara, 2017). In other words, by tracing Mulyadhi's thoughts, which took a lot of inspiration from Rumi and the *Ikhwan*, we can criticize White's central thesis. White believes that monotheistic religion, particularly its two main pillars: belief in science and anthropocentrism, will automatically have implications for a

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destructive perspective. Mulyadhi's thoughts will help us rethink the possibility of developing the idea of positive "anthropocentrism" and more environmentally friendly science in the future (Kartanegara, 2021b).

2. Reorientation of Modern (Religious) Man: Ecologizing Mind through learning from Indigeneous Perennials Tradition

White's "alternative" proposal to address environmental problems confirms the importance of exploring the traditions of religious reasoning in the past that were more ecological than the contemporary era. White's proposal has similarities with Mulyadhi's proposal, who also believes that revitalizing Islamic intellectual traditions in the past (medieval period) is an alternative needed to overcome the problem of environmental damage today (Kartanegara, 1994). The difference is that White is trying to find traditions that are considered "deviant" from the doctrine of monotheism (especially regarding anthropocentrism and also support for science). On the other side, Mulyadhi is trying to find traditions that he considers the embodiment of monotheistic reasoning (Kartanegara, 2007a). The monotheistic reason, for Mulyadhi, has experienced degradation due to the entry of modernity and Western knowledge systems into the Islamic world (Kartanegara, 2003).

Before discussing Mulyadhi's proposal, which can be said to reverse White's logic of thinking that attacks anthropocentrism and science in general, it is better to look first at how Mulyadhi came to a different conclusion from White's in identifying environmental problems. Just as White was an intellectual who studied intellectual history in the medieval era, we can say that Mulyadhi was a philosopher whose main study was Islamic philosophy in the medieval period (Kartanegara, 2019c). In other words, there are similarities between the intellectual backgrounds of the two thinkers who both studied scientific treasures in the medieval era. Although it is undeniable that there are also significant differences between the two, White emphasizes his studies in the medieval European period, while Mulyadhi is in the medieval Islamic era.

Furthermore, White's proposal can be said to be a "non-indigenous" proposal because it seeks to find a tradition in Christianity in the past, a "subversion" of the monotheistic central doctrine of Christianity (White, 1967). While on the other hand, Mulyadhi makes a proposal that is "indigenous" because it is not trying to find a tradition that "deviates" from monotheism but runs under the framework of monotheism (Kartanegara, 1994). Both thinkers have in common that most of their adherents have forgotten medieval ideas full of ecological values. This forgetfulness, according to White, cannot be separated from the dominance of monotheism, which marginalizes the old tradition. At the same time, Mulyadhi believes that the uprooting of Muslims from their past is the result of Western modernity (Kartanegara, 2005).

Mulyadhi's firm belief that medieval Islamic intellectual traditions can inspire solving environmental problems can be traced to his writing entitled "Environmental Ethics in a Sufistic Perspective," written in 1998. This paper is the result of research he carried out with his colleague Irfan Abu Bakar and Philip Buckley at McGill Canada (Kartanegara, 2019b). This article was later republished in his work entitled "Islamizing Reason: A Response to Modernity," published in 2007. From the book's title, we can see the strong spirit of Mulyadhi, who does not believe in monotheism as the dominant narrative in this modern era (Kartanegara, 2007a). For Mulyadhi, Western reasoning is the dominant one at this time. Including, in this

case, Western logic broadly influences the way of thinking of many people, including the Muslims themselves (Kartanegara, 2007a).

Mulyadhi later identified the influence of modern reasoning as the cause of the disorientation of modern humans, including Muslims (Kartanegara, 1994). This disorientation has led to the disconnection of the Muslim community from their indigenous traditions (Kartanegara, 1994). Furthermore, this disorientation gave way to the emergence of a way of thinking/theology which, although it seems religious, is actually under the influence of modernist reasoning (Nasr, 1990). In other words, there is a kind of pseudo-religious reasoning that is developing today that people will think that such reasoning is religious reasoning (Nasr, 1990). If viewed further, it is unnecessary to physically look like a religious person, including what he says using religious language. Still, his spiritual way of thinking may have been eroded and replaced by modern materialistic reasoning (Kartanegara, 2014).

What Mulyadhi stated was not just an external observation that was happening around him. We can say that Mulyadhi internally also experienced this existential disorientation and even experienced a separation from Islamic intellectual tradition - even Islamic theology - (Kartanegara, 2005). The implication is that although physically he appears to be a Muslim intellectual with religious reasoning, Mulyadhi himself admits that "inwardly" he has become a person who doubts God (Kartanegara, 2005). Mulyadhi realizes this disorientation because it cannot be separated from the influence of Western intellectual works that have become references in various campuses, including religion-based campuses such as the UIN where he studied (Kartanegara, 2005). Mulyadhi admits that as a result of the influence of Fraud, Darwin, Laplace, Marx, and other Western intellectuals, he became increasingly doubtful about God - a central doctrine in monotheism- (Kartanegara, 2005). After experiencing a crisis of faith, this atheism also impacted his way of seeing himself and the universe outside himself in a materialistic and mechanistic way (Kartanegara, 2005).

For example, Mulyadhi explained that he even saw various life events become entirely "dry" from more spiritual explanations (Kartanegara, 2005). Death, for instance, is not a "big" existential phenomenon (Kartanegara, 2005). Death for Mulyadhi was a kind of ordinary mechanical event where something underwent a breakdown process, and this happened naturally without any significance (Kartanegara, 2005). In other words, the modern reasoning that Mulyadhi obtained through various academic works resulted in a "cold" reading of the universe and even himself, which was considered to have no significance whatsoever. Just like a machine that breaks down and is then removed from life. A "cold" process without any existential feeling towards it.

Regarding the view of nature, Mulyadhi explained that in the modern Western framework, the human idea of nature has become very "cold." For example, Mulyadhi gave an example that the concept of space and time in the modern Western perspective of space does not have "sacredness" (Kartanegara, 2014). Modern logic treats space as an inanimate entity that can be dismembered in such a way (Kartanegara, 2014). The way to dismembered nature was done using homogeneous measures (e.g., kilometers, decameters, centimeters, millimeters) that are part of modern science (Kartanegara, 2019a). This perspective may not seem problematic, but for Mulyadhi, by absolution these homogeneous dimensions, the modern people will gradually think that the space around him is purely a "cold" entity without any sense of "sacred" (Kartanegara, 2019a). For example, there is no room for a more existential meaning of space in this measure, such as a sacred space for religious adherents (Kartanegara,

2019). In this kind of physicalist reasoning, it does not make sense that there is such a "holy" space, as we can often find its manifestation in places of worship such as mosques (Kartanegara, 2019a).

In the modern Western perspective, there is no difference whatsoever between one space and another (Mulyadhi, 2003). For example, in the way we interpret sacred space, we are learning to build a non-materialistic way of relating to the universe (Kartanegara, 2003). However, with the disappearance of belief in holy places, the more "intimate" relationship between us and nature is eroding daily (Kartanegara, 2014). For example, in the past, people who liked to commit vandalism were still influenced by the concept of sacred space to stop their actions to scribble on sacred spaces (e.g., places of worship). Still, we can say that the idea is increasingly being erased from them so that even sacred spaces are not ashamed to be crossed out.

Interestingly, in this existential disorientation situation, Mulyadhi admits that intellectually he has doubted the existence of God and various spiritual beliefs about nature and humans (Kartanegara, 2019a). But at the level of unconsciousness -in this case, when he dreams- he often admits to dreaming about spiritual things and disturbs his existential consciousness (Kartanegara, 2019a). For example, he dreams of being at a height that allows him to see the stars -in other words, being in the sky-(Kartanegara, 2019a). In a state of fear of falling, he automatically asks for protection from God to be returned to his body. Mulyadhi admitted that the experience was a traumatic experience that disturbed his stance, which could be 'agnostic' or even close to 'atheism' (Kartanegara, 2019a).

In the end, his struggle with his subconscious made Mulyadhi re-establish a relationship with a more religious intellectual tradition (Kartanegara, 2005). He became acquainted with Muhammad Iqbal, a well-known Pakistani thinker, who made a significant change in the way he saw the world and himself (Kartanegara, 2005). It was from his reading of Iqbal that Mulyadhi tried to explore further the sources of Iqbal's thoughts which, according to him, led to Jalaluddin Rumi and Bergson (Kartanegara, 2005). We can say that Mulyadhi's discovery that Rumi convinced him that by returning to a more indigenous tradition such as Rumi's, he could recover his metaphysical view of God, nature, and humans who were "damaged" due to the influence of modern reason (Kartanegara, 2019a). Just as Mulyadhi considers Iqbal an enlightened figure due to reading Rumi, he also sees that he and other Muslims will be enlightened if they explore the works of Muslim intellectuals in the medieval era, whether Rumi or other Muslim thinkers (Kartanegara, 2019d).

One thing that deserves to be elaborated on is that during his "break" with religious reasoning, it turns out that there is still a kind of "spiritual connection" that can quickly encourage Mulyadhi to return to his religious rationale (Kartanegara, 2005). Nasr has mentioned this kind of situation that in religious communities, especially in non-Western areas, the spiritual side is still alive and well (Nasr, 1996). Thus, in contrast to Western society, which is more strongly uprooted from their traditions, people in the non-Western world find it easier to reclaim their spirituality which has been "eroded" due to the influence of modern materialistic Western reasoning (Nasr, 1996).

Of course, Nasr's words do not mean that everyone can easily be "liberated" from the influence of this materialistic reasoning. But in general, because the effect of spirituality is still strong -albeit with various weaknesses from various sides- it will be easier to recover the mental state experiencing disorientation compared to Western society (Nasr, 1996). We can say that

Mulyadhi is an exciting example of Nasr's thesis, where Mulyadhi admits that even in an atheist mental state, he is still compelled to pray regularly. In other words, at the "physical" level, Mulyadhi is not wholly uprooted.

Based on Mulyadhi's existential experience, it is natural for him to formulate an Islamization project (Kartanegara, 2014). In other words, the reasoning of many modern humans, including Muslims, must be restored to their religious rationale (Kartanegara, 2009). In the context of Islamizing modern reason, we can say that one thing that needs to be Islamized by Mulyadhi is regarding the contemporary human perspective on humans and the cosmos, which tends to be problematic (Kartanegara, 2006b). Islamization of our view on the cosmos and its relationship with humans is a form of deep ecological reasoning (Kartanegara, 1994; Kartanegara, 2007a). Calling Islamization as ecologizing reason is not an exaggeration. In Islamic cosmology, there is an intimate relationship between humans and nature due to the non-materialistic perspective of the Cosmos (Nasr, 2007). In other words, the article "Environmental ethics in a Sufistic Perspective" is a more specific strategy on how ecologizing reason is possible. In this case, Mulyadhi emphasizes the Sufistic tradition, especially Rumi, as a foothold in building environmental ethics (Kartanegara, 1994). Although it is undeniable that besides the Sufistic practice, the thoughts of Ibn Sina, which are "traditionally" included in the peripatetic tradition, were also welcomed by Mulyadhi in the article to strengthen his argument (Kartanegara, 2007a).

We can say that Mulyadhi's 1998 article entitled "Environmental Ethics in a Sufistic Perspective" shows the centrality of Rumi's thought in Mulyadhi's ecological ideas (Kartanegara, 2007a). As mentioned earlier, we cannot tell Mulyadhi's strong interest in the figure of Rumi from the existential experience of Mulyadhi in the past (Kartanegara, 2019a). So, it is natural that Mulyadhi tries to elaborate more deeply on what his "spiritual teacher" can offer to answer contemporary environmental problems. In other words, the research at McGill is also Mulyadhi's opportunity to explore Rumi's thoughts related to ecology, based on his views on Islamic cosmology (Kartanegara, 2019c).

Although Mulyadhi strongly emphasized Rumi in his paper, he also explored Ibn Sina's thoughts (Kartanegara, 2007a). This move shows that Mulyadhi did not just revitalize the ideas of Rumi and other Islamic thinkers in the medieval era. He does a process of creative synthesis to produce an original thought of his own without leaving Rumi's framework. In other words, we can claim that his article entitled "Environmental Ethics in a Sufistic Perspective" -and continued with other publications- is the original thought of the Mulyadhi without being uprooted from its indigenous/perennial roots.

We can say that Mulyadhi's Islamic environmentalism thinking continues to develop without being disconnected from his original work, which was written in 1998. The development of Mulyadhi's Islamic environmentalism thought can be more "implicit" than "explicit" in his other works (Kartanegara, 2006b; Kartanegara, 2009; Kartanegara, 2021a). But what's interesting is that in his latest work, "Rumi and the Modern World: Mawlana's Messages for the Contemporary Man," published in 2021, Mulyadhi again makes his environmental ideas explicit when he talks about the relevance of Rumi's thinking for the modern context.

One exciting development in Muyadhi's thinking was when he decided to explore the thoughts of Muslim scientists and philosophers known as the *Ikhwan Al-Shafa* (Kartanegara, 2017). The *Ikhwan Al-Shafa* is more explicit than Rumi in supporting the development of

science in the Islamic world (Nasr, 1993). We can say that *Ikhwan's* work, *Rasa'il*, was an ambitious attempt to create an encyclopedia of medieval science that included various kinds of knowledge from different rational disciplines. However, it is undeniable that the Ikhwan also included mystical fields in its encyclopedias. In other words, we can say that Mulyadhi's idea of environmentalism has, on the one hand, become more complex since his original 1998 essay because of his contact with various Islamic intellectual traditions that are more diverse (Kartanegara, 2009). However, at the same time, the development of these ecological ideas further demonstrates the originality of Mulyadhi's thinking, which can mix these various traditions without leaving the foundation that refers to Rumi's framework.

3. Mulyadhi Message to Modern (Religious) Man: Building Indigenous Environmentalist Tradition based on Synthesis of *Ikhwan al-Shafa* and Rumi Thought

In building his ecological ideas, Mulyadhi took a lot of inspiration from Rumi and then enriched it with other Islamic intellectual traditions such as the thoughts of Ibn Sina and especially the *Ikhwan Al-Shafa*. Interestingly, Mulyadhi synthesized these various ideas by maintaining Rumi's thinking framework about humans and the universe (Kartanegara, 1994). This paper concludes that the synthesis carried out by Mulyadhi can be understood in one crucial keyword, namely the idea of theistic evolutionism (Kartanegara, 2021b). This framework of theistic evolutionism can be said to be the hallmark of Mulyadhi's thought. For comparison, Nasr, a figure who has influenced Mullyadhi, does not believe in Evolution. Nasr even does not believe in the theistic form of the theory of Evolution (Nasr, 1987).

We can trace Mulyadhi's encounter with the theory of Evolution when he experienced existential disorientation. One of the works that caused him to abandon religious reasoning was Darwin (Kartanegara, 2007a). Darwin stated that living things came into existence not because of creation but a random and aimless process of Evolution (Kartanegara, 2007a). So that the diversity of living things today is not because there is a designer, but mere coincidence and without meaning (Kartanegara, 2014). We could argue that Darwin's atheistic discourse attacks religious reasoning in the sense of eradicating the idea of God and any significance to the universe and human beings because they are essentially coincidental (Kartanegara, 2021b).

Interestingly, in the phase of Mulyadhi's return to the Islamic intellectual tradition through the works of Muhammad Iqbal, he was influenced by two thinkers, namely Henri Bergson (modern French thinker) and Rumi (medieval thinker) (Kartanegara, 2019a). Bergson and Rumi both have one central idea, namely spiritual Evolution and anti-Darwin's materialistic explanation (Kartanegara, 2005). For Bergson, if a change is understood from a Darwinian perspective, we will not find the diversity of living things, including even humans, as they are today (Kartanegara, 2005). Because according to Bergson, the most adaptive living things to various forms of the environment are amoebas (Kartanegara, 2005). In contrast to the "higher" level animals, which, according to Bergson, do not have an advantage because they tend to have difficulty adjusting to an extremely changing environment (Kartanegara, 2005).

Bergson also believes that using the natural selection model as an evolutionary mechanism will not explain the diversity of living things today because natural selection tends to be deterministic and does not allow unlimited creativity (Kartanegara, 2019a). So as a critique of Darwin, Bergson came up with the idea of *elan vital*, super energy that permeates

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all life on this earth that can encourage creativity in life itself which constantly shows newness from time to time (Kartanegara, 2019a).

For Mulyadhi, Bergson's explanation of the *elan vital*, although it contradicts Darwin's point of view, also has the potential to be similar to him from the other side (Kartanegara, 2021b). This tendency can be seen in Bergson's explanation. Bergson states that the evolutionary process based on *elan vital* will produce a continuous renewal of life and not just mechanical (static) (Kartanegara, 2007a). Bergson believes that natural selection based on law does not have the power to do so create newness (Kartanegara, 2007a). On the other hand, Bergson thinks that *elan vital* can indeed explain the continuous renewal of life (Kartanegara, 2007a). But Berson then explains that this vital eval does not contain a teleological spirit, which means moving towards a specific goal (Kartanegara, 2007a). Bergson has this kind of perspective because he sees Evolution continuing to occur until the era he lives. This belief led him to reject the possibility of a teleological dimension of Evolution. Bergson's anti-teleological position makes Mulyadhi conclude that *elan vital* is essentially also a kind of random process because it moves aimlessly except perhaps to renew itself continuously (Kartanegara, 2021b). A process which for Mulyadhi also becomes absurd because, without a clear goal, the long process of the Evolution of the universe becomes completely meaningless (Kartanegara, 2021b).

Mulyadhi saw in Bergson's explanation that criticizing Darwin still had a fundamental weakness. For Mulyadhi, a clearer picture of Evolution can be seen in Rumi's thoughts (Kartanegara, 2021b). Evolution is based on the energy of love and with a clear goal, namely the universe moving closer to God (Kartanegara, 2021a). Rumi describes this evolutionary process as a moth moving toward the light (Kartanegara, 2006b). The moth's attempt to approach the lamp must transform itself (from termites) and make a long journey to the light source and end with the "death of the moth," which is burned by the light (Rumi, 2009; Schimmel, 1993). This death symbolizes that when Evolution has reached its final phase, the "self" of the moth will "disappear" before God. Although in Rumi's thought, he states that the "disappearance" of this self does not mean destruction. The self still exists but with a different orientation, transcendence-oriented compared to inherent tendencies (Kartanegara, 2021b).

This idea of Rumi's Revolution can be the foundation of the concept of environmentalism developed by Mulyadhi. Rumi's evolutionist scheme implies a close relationship between humans and nature. Nature is seen as an entity with a soul, not just an inanimate object (Kartanegara, 2017). The belief that nature has a soul is a logical implication of love energy as a mechanism of evolutionary motion in Rumi's framework (Kartanegara, 2021a). Something that can love and be loved is something that has life and deep feelings like humans (Kartanegara, 2007a). Furthermore, love must have a beloved object (Kartanegara, 2021). In Rumi's scheme, the love of the universe is directed to God (Kartanegara, 2021b). In other words, we can say that the love energy that Rumi refers to is divine love, the love of the universe towards its Creator (Kartanegara, 2021b). The universe created and bestowed with love by God then performs a Tran-substantial movement to draw closer to God (Kartanegara, 2021b). Like the moth, this transformation of the universe moves in a vertical direction towards the divine light (Kartanegara, 2021a).

In other words, it is different from Bergson's idea where there is tremendous energy called *elan vital. Still,* it is not clear that this energy drives the evolutionary process to a specific goal (Kartanegara, 2005). In Rumi's scheme, this love energy has only one plan: moving

towards something he loves (Kartanegara, 2021b). Like the moth love of light, which transforms termites into animals with wings, a novelty in Evolution is interpreted as a renewal of form (Tran substantial motion) to further perfect themselves to reach God's love (Kartanegara, 1986). So, in the Evolution of the universe, initially at an inorganic level, the universe continues to move in a more complex direction to become an inorganic level from low to high levels (from plants to animals) and finally humans (Kartanegara, 1986).

In Rumi's evolutionary scheme, it appears that man's position is at the top of the great chain of being (Kartanegara, 2017). In other words, when using the term White, there is a strong spirit of anthropocentrism in this scheme. Mulyadhi accepted this spirit of anthropocentrism. He even elaborated on other Islamic intellectual traditions to strengthen Rumi's position that humans are indeed unique creatures among other creatures (Kartanegara, 2006a). Mulyadhi then refers to the explanation of the *Ikhwan Al-Shafa* that humans are a manifestation of the love of nature, namely heaven and earth (Kartanegara, 1986). The emergence of humans cannot be separated from the grand scheme of the universe's evolutionary process, which continues to grow and eventually produces a creature that can perform the transcendence process optimally (Kartanegara, 2021b). So do not be surprised if, in the literature of the *Ikhwan Al-Shafa,* they used the term "small universe" to refer to humans (Kartanegara, 2017). Man is positioned as a "small universe" because he contains all the elements contained in the universe, including in this case he also has a vegetable and animal soul, as well as a rational soul, which is a unique human soul (Kartanegara, 2017). So, we can say that humans are unique creatures because they are a small representation of all the universe's evolutionary processes and additions (namely rational souls) (Kartanegara, 2017). This potential enables humans to carry out the following transformation process, namely self-transcendence, to have a "connection" with the metaphysical world (Kartanegara, 2006b).

It is also interesting to mention that the *Ikhwan Al-Shafa* refers to nature as a "big man." Through this term, the *Ikhwan* describes the intimate connection between man and the universe. Nature is considered a "big man" because he is an inanimate object and has a soul called the universal soul (Kartanegara, 1986). One picture suggests that nature is truly like a human being who can love and be loved (Kartanegara, 2007b). In an ecological context, *Ikhwan Al-Shafa's* thought emphasizes that although humans are indeed unique creatures in the context of this universe, they must not forget their relationship with the universe, which has a human-like soul (Kartanegara, 2017). By seeing nature as a living entity and having a deep love for God, including humans as a particular part of nature, it is hoped that a new paradigm will strengthen our intimacy with nature (Kartanegara, 2006b). For example, we are developing affection with the creatures around us - for example, a cat - who loves us and wants to be loved by us. In a relationship that does not objectify each other but is based on affection and love, we can strongly build a "harmonious" relationship between humans and animals. So not infrequently, we see people willing to spend money to buy food or check their beloved animal.

If we enlarge this love on a more macro scale where we and nature have a similar relationship, we can minimize the environmental damage. The concrete step for Mulyadhi is that humans must realize the love of nature that is present in the form of blessings that make human life possible on this earth (Kartanegara, 2007b). For example, without sufficient sunlight, there will be no life on this earth, likewise, with the presence of air, water, fertile soil surfaces, and various other blessings that support human life (Kartanegara, 2007b). It is this love of nature that humans should respond to by giving their love back to nature (Kartanegara, 2007b). However, it should be noted, according to Mulyadhi, that this love for nature is not

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manifested by worshiping nature (Kartanegara, 2007b). This move is wrong because nature is a channel of blessings from God to humans, or in the language of philosophy, nature is positioned as "secondary causes" (Kartanegara, 2021a). In contrast, "primary causes" are outside nature (Kartanegara, 2006a). In other words, servitude is only given to God as a form of human gratitude but love for nature is manifested by treating nature wisely and not looking at it with hatred, and also declaring war on it (Kartanegara, 2006b).

The human ability to realize the love of nature in various blessings scattered in human life requires a vital mastery of science. A "simple" view can indeed see how the sun influences life, for example. However, with a rational approach through science, we can understand this blessing to humans in more detail (Kartanegara, 2009). For example, we can realize that sunlight that enters the earth has been filtered by the atmosphere to reduce the entry of harmful rays to human life if exposed to excess, such as infrared and ultraviolet. We can also find out more about the nutritional content in animals and plants that are useful for our lives through science (Kartanegara, 2006c). In other words, science, for the *Ikhwan Al-Shafa*, is an essential means for humans to reflect on the various blessings around them (Nasr, 1999).

In other words, the *Ikhwan Al-Shafa* helps to clarify the anthropocentrism inherent in Rumi's perspective. Humans as unique beings do not mean that they are free to exploit nature, but they are creatures who have more awareness to understand and respond to the love of the universe (Kartanegara, 2017). In this awareness, humans can know that this natural love is essentially a form of divine love. So as unique beings, humans have an essential task, namely being able to continue the process of Evolution by transcending human beings through spiritual journeys to turn into individuals who can channel divine blessings to this universe (Kartanegara, 2021b). In other words, the goal of Evolution, which is to bring nature closer to its beloved Creator, continues (Kartanegara, 2021b). Humans have the task of being the link between the immanent universe and the transcendent divine light (Kartanegara, 2021b). In Nasr's terms, humans must be Pontifical Man and not Prometheus Man who affirms himself by dominating and shaping nature according to his desires (Nasr, 1989). This pontifical man can become a kind of "window" through which divine light can enter the universe and then illuminate it perfectly (Nasr, 1989). In the context of man as a Pontifical man, he functions as an actor who must beautify and not destroy the earth due to obeying his low desires (Nasr, 1989).

This critical role of man as a Pontifical man is elaborated quite deeply in Rumi's thinking. Unlike the *Ikhwan Al-Shafa,* which calls humans a "small universe" because humans contain natural elements, Rumi calls humans a "big universe" because humans are the ultimate goal of creation (Kartanegara, 2017). Rumi likened it to the fruit that appears at the end after all parts of the tree's body have fully grown (Kartanegara, 2017). Even though the fruit appears at the end, it is precisely the fruit that is the "crown" of the tree (Kartanegara, 2017). Furthermore, the fruit is the future of the tree. The fruit contains seeds that are crucial for the survival of the plant in the future. If the seeds fail to grow, then the extinction of the species can be inevitable (Kartanegara, 2017). But if the seeds can grow ideally, then the survival of the tree is guaranteed (Kartanegara, 2017). In the context of the central human position like fruit, this is a significant task that accompanies it. He must transform into *Insan Kamil* (perfect man), who can "absorb" divine light and spread it to the universe (Kartanegara, 2021b). Humans are like mouths and windows, where the window and mouth determine whether food or light can enter (Kartanegara, 2021b). If the windows and mouth do not function, as usual, the food will not properly nourish the body, and the house will be dark without light

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(Kartanegara, 2021b). This darkness and hunger ultimately affect the universe and man himself because he is a part of nature (Kartanegara, 2021b). So, for Rumi, the process of Evolution does not just stop at the human level (Kartanegara, 1984). Humans still have to go through the process of evolution too - which means spiritual Evolution - to ensure that they can become a bridge between the metaphysical world and the physical world (Kartanegara, 2016).

Man has to carry out the spiritual evolution process that determines whether the environment can be saved or not in the future (Kartanegara, 2006b). The current condition is that the human soul has not evolved but devolved (Lennox, 2009). As a result, the "blackness" in the human soul also affects the reality outside itself (Kartanegara, 2021b). If this sick spiritual state continues, then not only the universe but humans will die also (Sponsel, 2012). This potential is now feared by scientists and environmental activists who call the climate emergency, including an analysis of the Anthropocene condition where human activities that occur today can lead to the end of humans as a species (Wagles, 2018). When viewed from Rumi's point of view, this situation necessitates the will of modern man to change his soul from adopting Promethean logic to pontifical man's reason (Nasr, 1989).

4. CONCLUSION: Toward Spiritual Homo Deus

One conclusion we can draw from Mulyadhi Kartenegara's thought is that we cannot separate current environmental problems from the problem that occurred at the level of modern human consciousness (Kartanegara, 2007a). Modern humans -including, in this case, modern Muslims- have been uprooted from their connection with Perennial/indigenous Islamic intellectual traditions (Kartanegara, 1994). Whereas in the Islamic intellectual tradition, both "rational" (peripatetic) such as the *Ikhwan Al-Shafa* (brethren of purity) and also more "mystical" traditions (gnosis/ Sufism) such as Jalal ad-Din Rumi have a more positive view of the relationship between nature and humans (Kartanegara, 2021b). This indigenous intellectual tradition shows that although, for example, the *Ikhwan Al-Shafa* has a strong interest in science, it does not make them materialists like modern scientists in viewing nature (Kartanegara, 2007b). In contrast, the *Ikhwan Al-Shafa* considers that Cosmos is alive and has high connectivity with humans through the concept of "big humans" and "little universe" (Kartanegara, 2007b).

Like *Ikhwan*, Rumi, who emphasizes the importance of human creativity in relating to nature, illustrates that humans must be strong creatures like lion - but the "superiority" of humans that Rumi envisions is not humans who exploit nature arbitrarily like modern humans (Kartanegara, 1994). The "superhuman" imagined by Rumi is a person who can carry out his teleological function in beautifying this universe through his position as a channel of blessing in this universe (Kartanegara, 2021b). In other words, the existence of "superhumans" is more defined as an entity that can "re-connect" between the immanent (nature) and the transcendent (God) through its Divine blessings (Kartanegara, 2021b). Through this *barakah* (blessing), humans are positioned like the mouth of the universe (Kartanegara, 2021b). Humans will channel the barakah to other parts of the body (the universe) so that the world will also be "illuminated" by Divine blessings (Kartanegara, 2021b).

Mulyadhi's idea shows that "anthropocentrism" and a man's positive attitude towards science do not form a mindset that demeans nature as "raw material" that can be exploited arbitrarily (Kartanegara, 2007b). The Islamic philosophical-mysticism tradition has a strong

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belief in science and the need for humans to be more active in their struggle with nature, leading to an increasingly intimate relationship between humans and nature. In other words, it is not because of science or the spirit of "anthropocentrism" that is inherently problematic. But the most important thing is that the development of science should not be separated from the larger framework, namely the idea of divine love (Kartanegara, 2007b).

The central idea of divine love in Islamic philosophical-mysticism tradition is that love becomes energy that pushes the transformative movement of the Cosmos to a higher level to get closer to the Creator (Kartanegara, 2005). Furthermore, divine love is also the cause of the "birth" of humans, which in the thoughts of the *Ikhwan Al-Shafa* and Rumi is symbolized as a tree that produces fruit (Kartanegara, 1986). In other words, humans are an integral part of the Cosmos movement of love (Kartanegara, 1986). Through the intercession of humans, the Evolution of Cosmos will continue and reach its finality marked by the spiritual connection between Cosmos and God (Kartanegara, 1986).

This logic of love is removed in the modern world and replaced by a positivist logic built on an attitude of "hate" or antagonism with nature (Badri, 2018). For example, Rachel Carson, who is positioned as a pioneer of the modern environmental movement, openly identifies the logic of positivism as a logic of war, where humans want to make a colossal war against nature to subjugate it (Lear, 2009). Although for Carson, this war will essentially turn on humans because humans are part of nature. Interestingly, Carson is also a scientist who can identify traces of the "war" of humans against nature in his legendary book Silent Spring with his scientific abilities. In other words, it is different from Lynn White's assumption, which assumes monotheism -including Islam-as a religion that is not environmentally friendly because of its proximity to science and also the spirit of anthropocentrism (White, 1967). We can say that White's thesis is built on weak assumptions if we compare it with Mulyadhi's thinking.

Mulyadhi's explanation evidences the weakness of White's thesis. For Mulyadhi, if you return to the perennial/indigenous roots developed by philosophers-scientists like the *Ikhwan Al-Shafa* and Practicing Sufis, which is more "positive" in viewing life like Rumi, we can create positive ideas about the relations between nature and humans. Moreover, in the case of Rumi, as Mulyadhi emphasized, the universe's Evolution has not ended with the birth of humans (Kartanegara, 2021b). Humans must continue to evolve and take a spiritual journey to elevate their status to become *Insan Kamil* (Kartanegara, 2021b). In this *Insan Kamil* stage, the potential in every human being to channel divine blessings into the universe has actualized (Kartanegara, 2021b). Of course, the position of *Insan Kamil* can be obtained after we have done many exercises and spiritual journeys to cleanse ourselves to become like a "clear mirror" to receive divine light (Kartanegara, 2006b).

From Mulyadhi's thoughts, we can say that the idea of indigenous Islamic environmentalism, which emphasizes efforts to re-connect modern humans to their perennial/indigenous traditions, will have implications for transformation at the level of consciousness. It is hoped that with this re-connection, the human perspective on nature will become more positive -and also intimate due to the re-growth of his love for nature-. We can say that Mulyadhi's idea can also help bridge the tension between science and contemporary environmentalism. Modern science has become an essential part of the destruction of nature because it facilitates humans with various deadly "weapons" in the form of "terminator" technologies to win their war against nature (Badri, 2018). However, this destructive form of

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science is because the logic of scientific activities was influenced by the spirit of hatred and humans' separation from nature (Badri, 2018). We can analyze that the separation between humans and nature in scientific thinking can't be separated from the physicalist way of thinking that sees nature as dead objects (Castro-Díaz, Perevochtchikova, Roulier, & Anderson, 2019). This "typical" materialist way of thinking has influenced the development of science and modern technology into a destructive technology to nature and humans. However, if the spirit of separation and hatred is replaced with love, it will affect the design of contemporary science to be more friendly to nature (Badri, 2018).

The reorientation of science, for example, can benefit from the research activities of the *Ikhwan Al-Shafa* in the past. For example, the *Ikhwan*, as stated by Mulyadhi, try to analyze God's Compassion for His creatures that live below the surface of the earth. The *Ikhwan Al-Shafa*, with its scientific study, identified these animals as having no eyes. But blindness is not a weakness in these creatures, but rather an advantage because if there are eyes attached to the animal's body, they suffer immensely. In other words, the science developed by the *Ikhwan Al-Shafa* makes us feel more empathetic towards the creatures around us and also draws closer to God (Nasr, 1999).

Finally, Mulyadhi emphasizes that environmental damage cannot be separated from the damage that occurs in the human soul (Kartanegara, 2021b). Like a mirror that reflects what is in front of him (Kartanegara, 2021b). Consequently, if we want to halt the environmental damage, it essentially requires a change in the human psyche as well (Kartanegara, 2021b). Of course, this does not mean that the various ecological activists targeting improvements at the physical level are meaningless (Nasr, 1990). But if there is no improvement at the inner level, then this damage will remain unresolved (Nasr, 1990).

In the first stage, we must re-connect modern humans to their perennial/indigenous traditions (Kartanegara, 1994). However, after the connection is established and humans are aware of their position in this universe - namely as the universe's mouth - they must turn their potential into something actual (Kartanegara, 1984). In the second stage, humans must continue the evolutionary process. He needs to carry out a process of spiritual Evolution to connect himself with his Creator (Kartanegara, 2017). This necessity of spiritual transformation is what in the Rumi language and other Sufistic circles is called the trans cosmic voyage of the human soul (Kartanegara, 2014). When humans have undergone this spiritual Evolution, they will reach the *Insan Kamil* stage (Kartanegara, 1994). For Rumi, *Insan Kamil* has characteristics like a king in the animal kingdom (Kartanegara, 1994). Like the lion that rules over the other animals in the jungle (Kartanegara, 1994). At this stage, we can say that humans have become new beings who are no longer the same even though physically they will look the same as other humans (Kartanegara, 2021b).

For Mulyadhi, the idea of spiritual Evolution through a spiritual journey is an essential prerequisite for saving today's environment. Interestingly, we can compare the concept of spiritual Evolution conveyed by Mulyadhi with the idea initiated by a well-known historian Yuval Noah Harari about Homo Deus (Harari, 2018). According to Harari, Homo Deus is the next stage of Evolution into a new, superior creature (Harari, 2018). Homo Deus, for example, is characterized by the human ability to develop technology so that it can modify its physical limits so that it eventually achieves "immortality" (Harari, 2018). Because humans can embrace immortality, they become a kind of "god" (supernatural beings). So, it is not strange if Harari

calls this new creature Homo Deus, where the term Deus implies divinity in humans (Coeckelbergh, 2020).

Harari envisioned that humans could reach the Homo Deus stage through a technological revolution (Weizsäcker & Wijkman, 2018). In that case, we can say that Mulyadhi's idea of spiritual Evolution also has "Homo Deus" tendencies but in a spiritual sense. In Mulyadhi's thinking, it is not the transformation of the body that becomes the core -because this is essentially continuing the logic of war with nature - but the transformation of the soul based on the love of God (Kartanegara, 2014). So, in Mulyadhi's thought, humans must strive to be a channel of blessing for the universe around them through the spiritual voyage (Kartanegara, 2021b). When humans successfully carry out the soul transformation process, they will transform like a mirror reflecting divine light (Kartanegara, 2021b). So, in the new human being, there is also a sacred dimension beside his physical form (Kartanegara, 2021b).

In Harari's conception of Homo Deus, we can say that divinity means humans are becoming more and more at the center of the universe (secular anthropocentrism). At the same time, humans increasingly negate God from their daily lives. Moreover, humans are also increasingly trying to subjugate nature's laws to overcome their mortal status. In contrast, we can say that in the concept of the "spiritual" Homo Deus proposed by Mulyadhi, humans find their genuine connection with the Transcendent reality (Kartanegara, 2021a). At the same time, humans also connect themselves with the nature surrounding them (Kartanegara, 2021b). In this evolutionary stage, we can say that humans are now the center or become "middle" actors (pontifical man) that function as a bridge to channeling Divine blessing to the entire Cosmos (Nasr, 1989).

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ENGINEERING ETHICS FOR GENERATION Z: A REVIEW OF CURRENT APPROACHES AND PROPOSAL FOR FUTURE DIRECTIONS

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ABSTRACT: The engineering profession has a crucial role to play in shaping the future of our society, and with the increasing complexity of technology, there is a growing need for engineers to have a strong understanding of ethical principles. This paper provides a comprehensive review of the current approaches to teaching engineering ethics, with a specific focus on how these approaches can be tailored to meet the needs of the Generation Z students. The authors examine the current approaches and its key challenges faced by this generation, such as the impact of technology on the teaching and learning approaches. The role of case studies and experiential learning in promoting ethical decision-making among this group of generation is also reviewed. Finally, the paper discusses the future directions for teaching engineering ethics, including the use of emerging technologies such as virtual and augmented reality. The paper concludes with a call for further research to better understand the ethical challenges facing the engineering profession and to develop effective strategies for addressing these challenges and for the students to internalize the importance of the ethical decision and become the agent of change in the society for the betterment of Ummah.

ABSTRAK: Profesion kejuruteraan mempunyai peranan penting dalam membentuk masa depan masyarakat kita, dan dengan peningkatan kerumitan teknologi, adalah satu keperluan bagi jurutera untuk mempunyai pemahaman yang kukuh tentang prinsip-prinsip etika seorang jurutera. Kertas kerja ini menyediakan ulasan menyeluruh tentang pendekatan semasa untuk mengajar etika kejuruteraan, dengan tumpuan khususnya bagaimana cara pendekatan ini boleh disesuaikan untuk memenuhi keperluan pelajar Generasi Z. Penulis mengkaji pendekatan semasa dan cabaran utama yang dihadapi oleh generasi ini, sebagai contoh kesan teknologi terhadap pendekatan pengajaran dan pembelajaran. Selain itu, peranan kajian kes dan pembelajaran berasaskan pengalaman dalam membuat keputusan beretika dalam kalangan kumpulan generasi ini juga dikaji. Akhir sekali, kertas kerja ini membincangkan hala tuju masa depan untuk mengajar etika kejuruteraan, termasuk penggunaan teknologi baru seperti realiti maya dan reality terimbuh. Kertas kerja ini diakhiri dengan saranan bagi melauskan penyelidikan di masa hadapan untuk lebih memahami cabaran etika yang dihadapi oleh profesion kejuruteraan dan untuk membangunkan strategi yang berkesan bagi menangani cabaran ini supaya pelajar lebih memahami kepentingan keputusan beretika dan menjadi agen perubahan dalam masyarakat untuk kebaikan ummah.

KEYWORDS: *Engineering Educations, Engineering Ethics, Generation Z, Ethical decision*

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1. INTRODUCTION

The engineering profession plays a vital role as a key driver of technological progress and innovation in society. As technology becomes increasingly complex, engineers must grapple with a wide range of ethical issues. These issues can include everything from privacy concerns to the ethical use of emerging technologies like artificial intelligence and autonomous systems. As engineers continue to develop ground-breaking technologies and shape the future, it is essential for them to have a strong understanding of ethical principles. In a survey of engineering students, it was found that students had limited knowledge of engineering ethics and the ethical implications of their work [1]. The authors argue that there is a growing need for engineers to be trained in ethics, both as part of their formal education and as part of their ongoing professional development. Not just that, the engineers must also take a holistic approach to their work, considering social, economic, and environmental factors in addition to technical considerations, includes:

Ethical Considerations in Technological Progress: Technological progress brings about numerous ethical considerations that engineers must address. Issues such as data privacy, artificial intelligence, autonomous systems, and genetic engineering require engineers to make ethical decisions that have far-reaching societal implications. According to Johnson and Wetmore (2019), engineers have a responsibility to consider the ethical, social, and environmental impacts of their work to ensure technological progress aligns with human values and societal well-being [2].

Responsible Innovation and Sustainable Development: Engineering ethics plays a pivotal role in driving responsible innovation and sustainable development. By integrating ethical considerations into the design and development process, engineers can minimize negative impacts and maximize positive outcomes. For instance, ensuring sustainable practices in engineering projects can mitigate environmental harm and promote long-term viability [3]. Engineers must be mindful of ethical frameworks, codes of conduct, and sustainability principles to create a more sustainable and equitable future.

Social Implications and Public Trust: Technological advancements have profound social implications, and public trust is vital for the successful implementation of these innovations. Engineering ethics helps foster public trust by ensuring transparency, accountability, and adherence to ethical standards. According to van de Poel et al. (2017), ethics in engineering contributes to the establishment of responsible and trustworthy technological systems that benefit society as a whole [4].

Global and Cross-Cultural Perspectives: In a globally interconnected world, engineering ethics must consider diverse cultural, social, and ethical perspectives. Engineering professionals must navigate ethical challenges arising from cultural differences, power dynamics, and differing value systems. Incorporating cross-cultural perspectives in engineering ethics education promotes inclusive and culturally sensitive decision-making [5].

As technology continues to shape society, engineering ethics emerges as a crucial component in guiding responsible and sustainable technological progress. Engineers have a responsibility to consider the ethical implications of their work and ensure that technological advancements align with societal values and aspirations. The challenges faced currently are on how to ensure the current generation, Generation Z, internalise these moral values and ethical decision making in carrying these responsibilities.

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2. GENERATION Z

Generation Z, born between the mid-1990s and early 2010s, possesses distinct characteristics that make them particularly relevant to the field of engineering ethics [6]. Generation Z individuals are known for their digital fluency and immersion in technology, having grown up in an era of rapid technological advancement and connectivity. They are highly adaptable, innovative, and quick to embrace new ideas and technologies. They are also marked by a strong sense of social responsibility, social justice, and ethical business practices. They value transparency, inclusivity, and the ethical use of technology. In the context of the engineering profession for generation Z, engineering ethics education plays a critical role in preparing them to understand and address ethical issues. There are, however, some difficulties facing by the engineering ethics educators in teaching and making the students of this Generation to internalize the subject due to:

1. Generation Z's exposure to constant digital stimuli may lead to a shorter attention span and difficulty in engaging with in-depth discussions on complex ethical issues.
2. Generation Z students may have idealistic aspirations for ethical decision-making, but they need guidance in navigating the practical constraints and trade-offs that occur in real-world engineering scenarios. Helping them understand the complexities of balancing ethical considerations with other project constraints can be challenging.
3. Generation Z's exposure to simplified online information may lead to a misunderstanding of the complexity of ethical dilemmas in engineering.
4. Generation Z tends to value hands-on experiences and practical applications of knowledge. Integrating real-life case studies, simulations, and experiential learning opportunities can help them connect ethical principles to tangible engineering scenarios.
5. Generation Z students, like any group, may display overconfidence in their ability to make ethical decisions and may be unaware of their ethical blind spots. Educators should foster humility and self-awareness to ensure a more comprehensive understanding of ethical challenges.
6. While Generation Z is generally aware of ethical principles, translating this knowledge into consistent ethical behavior can be challenging.

Therefore, there is a need to address these difficulties, and the efficiency of the current approaches needs to be analyzed and suggestions as well as recommendations for the future direction in approaching this subject can be made.

3. CURRENT APPROACHES TO TEACHING ENGINEERING ETHICS

There are several approaches to teaching engineering ethics, each currently offering unique benefits and opportunities for students to engage with ethical principles in a meaningful way. Among the common approaches, include classroom-based instruction, case studies, and experiential learning [7].

3.1. Classroom-based instruction

Classroom-based instruction is a traditional, yet effective method employed in teaching engineering ethics. It forms the backbone of ethics education, where instructors deliver lectures

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and facilitate discussions to impart ethical knowledge and foster a deeper understanding of ethical principles in the context of engineering practice. Its instruction serves as a platform for students to build a foundational understanding of ethics. Instructors introduce fundamental ethical theories and concepts, such as utilitarianism, deontology, virtue ethics, and professional codes of conduct. Through these lectures, students gain essential knowledge about ethical frameworks that guide their decision-making processes [8].

In the classroom, students explore theoretical concepts related to engineering ethics. They analyze case studies, hypothetical scenarios, and historical examples that highlight ethical dilemmas faced by engineers in various industries. This theoretical exploration allows students to consider the ethical dimensions of engineering beyond mere technical considerations. While classroom discussions enable students to apply ethical principles to engineering practice. Instructors facilitate conversations on real-world engineering projects and the ethical challenges they entail. Students learn to identify potential ethical issues and consider how ethical decision-making can influence the outcomes of engineering endeavors. This pedagogy also encourages students to engage in critical analysis of ethical dilemmas. They are prompted to question assumptions, evaluate arguments, and challenge ethical norms. By actively participating in discussions, students develop their critical thinking skills, enabling them to navigate complex ethical situations in their future careers.

The classroom setting allows for interactive learning experiences. Students can ask questions, seek clarifications, and engage in debates with their peers and instructors. This interactive exchange fosters a collaborative learning environment, where diverse viewpoints contribute to a more comprehensive understanding of ethical issues. Instructors with expertise in engineering ethics provide guidance and mentorship to students. They offer insights into ethical decision-making processes, drawing from their own experiences and expertise. This mentorship helps students develop their ethical reasoning abilities and professional judgment. Instructors can adapt their teaching approach to suit the specific needs and interests of the students. They can tailor discussions and examples to resonate with the diverse backgrounds and experiences of the class, making the learning experience more relevant and relatable.

Classroom-based instruction lays the foundation for students to become ethical leaders in engineering. As they advance in their careers, they can draw on the ethical knowledge and skills developed in the classroom to guide their teams and organizations in making responsible and ethical decisions. On top of that, it can build an ethical culture within engineering programs and institutions. By emphasizing the importance of ethical conduct and values, it instils a sense of ethical responsibility in future engineers, shaping a generation of professionals committed to ethical engineering practices.

3.2. Case Study instruction

Case studies play a crucial role in engineering ethics education by providing students with tangible and authentic examples of ethical challenges that engineers encounter in their professional lives. These real-world scenarios allow students to analyze and discuss ethical dilemmas, enabling them to bridge the gap between theoretical knowledge and practical application [9]. Case studies present students with real and complex ethical situations that engineers may encounter in their careers. These scenarios are often based on actual events, offering students a glimpse into the real challenges faced by engineering professionals. By immersing themselves in these authentic scenarios, students can better appreciate the intricacies and nuances of ethical decision-making in engineering. When presented with a case

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study, students are prompted to critically analyze the ethical dimensions of the situation. They evaluate the actions and decisions of the individuals involved, considering the ethical principles and consequences at play. This process encourages students to think deeply about the ethical implications of various courses of action and the ethical reasoning behind those decisions.

This approach provides context-specific situations, reflecting the diverse settings and industries in which engineers operate. Students must consider the unique factors and constraints in each case, such as cultural norms, regulatory requirements, and project objectives. This context-specific analysis helps students understand that ethical decision-making is not one-size-fits-all but rather requires adaptability and sensitivity to varying circumstances. It serves as a practical platform for applying ethical principles and theories learned in the classroom. Students can identify which ethical theories align with specific actions taken in the case and assess the ethical justifications behind them. This application of ethical principles helps students see the relevance of theoretical concepts in real-life situations.

Case studies often include examples of both ethical lapses and ethical successes in engineering practice. Students can learn valuable lessons from the mistakes made in past cases, understanding the consequences of unethical behavior. Conversely, they can also learn from cases where ethical decisions positively impacted the outcome of engineering projects, reinforcing the importance of ethical conduct. Through this approach, students are encouraged to consider the perspectives of various stakeholders impacted by engineering decisions. They learn to recognize the needs and concerns of clients, communities, and the environment, fostering empathy and a holistic understanding of the ethical implications of engineering projects.

Case studies often evoke diverse opinions and viewpoints among students. This diversity of perspectives sparks lively discussions and debates, enriching the learning experience. Students learn to appreciate the complexities of ethical issues and the value of engaging in ethical deliberations with colleagues and stakeholders. By engaging with case studies, students develop their ethical reasoning skills. They learn to identify ethical dilemmas, evaluate alternative actions, and consider the long-term consequences of different decisions. These skills are essential for future engineers to make ethically sound choices in their professional roles. Exposure to a wide range of case studies equips students with the tools to navigate ethical challenges they may face in their engineering careers. By understanding how others have addressed ethical dilemmas, students are better prepared to handle similar situations with ethical integrity and confidence [10].

3.3. Experiential Learning

Experiential learning is a powerful approach in engineering ethics education that emphasizes hands-on activities and practical exercises to immerse students in ethical challenges and decision-making processes. This method goes beyond traditional theoretical discussions, offering students the opportunity to actively engage with ethical issues in a tangible and immersive manner [11]. This approach requires students to actively participate in activities, making the learning process more dynamic and engaging. Rather than passively receiving information, students are encouraged to interact with real or simulated ethical scenarios, making decisions and experiencing the consequences of their choices. On top of that, its learning activities provide a connection to real-life engineering contexts, making the ethical dilemmas more relevant and relatable to students. Through practical exercises, service-learning

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projects, or internships, students encounter ethical challenges that they might face in their future careers, preparing them to navigate these situations with ethical integrity.

Experiential learning allows students to apply ethical theories and principles learned in the classroom to practical situations [12]. By grappling with ethical dilemmas first-hand, students develop a deeper understanding of how ethical considerations play out in engineering practice and the significance of ethical decision-making in real-world projects. Engaging in experiential learning activities fosters critical thinking and problem-solving skills. Students must analyse complex ethical issues, weigh different factors, and consider various perspectives to arrive at well-reasoned ethical decisions [13]. This analytical process enhances their ability to think critically about ethical challenges they may encounter in their careers and encourages students to consider the perspectives of various stakeholders affected by engineering decisions. This empathetic approach helps students understand the broader impact of their choices on clients, communities, and the environment, promoting ethical decision-making that aligns with societal values.

The activities in this approach often provide immediate feedback to students on their decisions and actions. This feedback loop allows for reflection on the consequences of their ethical choices and helps students learn from their experiences, reinforcing ethical reasoning and sensitivity to ethical implications. Experiential learning contributes to the development of students' ethical identity. As they engage in ethical decision-making through practical experiences, students become more aware of their values, beliefs, and ethical principles, shaping their ethical character as future engineers.

By combining these approaches - classroom-based instruction, case studies, and experiential learning - educators can create a comprehensive and engaging learning environment for teaching engineering ethics. This multi-faceted approach enables students to develop a well-rounded understanding of ethical principles and their practical application in engineering practice.

4. CHALLENGES IN CURRENT APPROACHES

While the approaches of classroom-based instruction, case studies, and experiential learning are valuable for teaching engineering ethics, there may be some challenges and considerations when applying them to Generation Z students. As a result of growing up in the digital age, this generation is exposed to a vast array of digital stimuli, including social media, smartphones, and online entertainment. While this exposure has its advantages in terms of access to information and connectivity, it has also led to concerns about the attention span and focus of this generation of students, particularly when it comes to engaging in-depth discussions on complex ethical issues.

One of the primary challenges for educators is capturing and retaining the attention of Generation Z students during ethics classes. Traditional methods of teaching, such as lengthy lectures or reading assignments, may struggle to hold their interest. To address this issue, educators must employ innovative and interactive teaching approaches that cater to the digital preferences and learning styles of Generation Z.

On top of that, due to their shorter attention span caused by exposure to constant digital stimuli, this Generation Z has difficulties maintaining their focus and interest throughout their

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learning process. Notifications, messages, and other digital stimuli may divert their attention away from the topic at hand, impacting their ability to fully focus on ethical discussions. In a digitally connected world, there may be limited time for students to engage in offline activities that encourage self-reflection and critical thinking. Deep thinking and contemplation, crucial for ethical reasoning, may be overshadowed by the constant need for online stimulation. With easy access to information online, this generation of students might rely on quick answers without delving deeper into ethical complexities. This may result in a superficial understanding of ethical dilemmas and the underlying principles that inform ethical decision-making. They have been bombarded with an overwhelming amount of information on the internet. Sorting through this vast pool of data can be challenging, and students may struggle to identify accurate and trustworthy sources amidst the noise, and they need guidance to recognize and critically assess the credibility of the information they encounter online.

Generation Z, as a generation that has witnessed various societal and political challenges, may display cynicism or skepticism towards institutions, authority figures, and traditional structures. This skepticism can extend to educational settings, including skepticism towards educators and the information presented in the classroom and towards traditional teaching methods, including case studies and lectures and the much in need to emphasize the real-world relevance of ethical principles and their impact on engineering practice and society.

While idealism is a valuable characteristic that can inspire positive change, this Generation Z is struggling to balance it with pragmatism to navigate the complexities of real-world engineering scenarios. There are also major challenges that need to be addressed and quite crucial; to balance between the theory and the practice. It lies in the potential disconnect between understanding ethical principles in a theoretical context and applying them effectively in real-world engineering scenarios. While students may grasp ethical theories and concepts in the classroom, they may face challenges when it comes to translating that knowledge into practical ethical decision-making during their engineering careers. Several key issues contribute to this gap between theory and practice in engineering ethics education:

1. *Complexity of Real-World Scenarios*: Engineering projects often involve complex and multifaceted ethical dilemmas that are not fully captured in theoretical discussions. Real-world scenarios can present conflicting values, various stakeholders with different interests, and practical constraints, making ethical decision-making more challenging and nuanced than theoretical models might suggest.

2. *Ambiguity and Uncertainty*: Unlike textbook examples, real-life engineering situations can be ambiguous and uncertain, leaving engineers with imperfect information when making ethical choices. Students may struggle to navigate this uncertainty and apply ethical principles in a context where there is no clear "right" or "wrong" answer.

3. *Time and Resource Constraints*: In real-world engineering practice, professionals often face tight project schedules and limited resources. This can create pressure to prioritize other project considerations over in-depth ethical analysis, leading to decisions that may not fully align with theoretical ethical principles.

4. *Ethical Blind Spots*: Even when students are well-versed in ethical principles, they may still face ethical blind spots, where they are unaware of potential ethical implications in certain situations. Ethical blind spots can result from overconfidence in one's ethical judgment or a lack of exposure to diverse ethical challenges.

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5. *Cultural and Contextual Differences*: Engineering projects often involve working in diverse cultural and international contexts. Ethical norms and practices can vary across cultures, leading to potential ethical clashes or misunderstandings that students may not have encountered in theoretical settings.

6. *Lack of Guidance and Mentorship*: Students may not have sufficient guidance or mentorship in ethical decision-making during their educational journey. Having ethical role models and mentors can help students navigate ethical challenges and gain insights into practical ethical considerations.

7. *Integration of Ethics into Technical Training*: Engineering programs may not fully integrate ethics education into technical training. When ethics education is treated as a separate or optional component, students may struggle to see its relevance to their technical coursework and future careers.

5. PROPOSAL FOR FUTURE DIRECTION

Proposing future directions in teaching approaches for engineering ethics can help address the specific needs and characteristics of Generation Z students while enhancing the overall effectiveness of ethics education. The authors would like to propose some potential future directions:

1. Technology-Integrated Learning: Embrace emerging technologies such as virtual reality, augmented reality, and interactive simulations to create immersive and engaging learning experiences. These technologies can allow students to explore complex ethical dilemmas in realistic engineering scenarios, promoting active learning and critical thinking [14].
2. Blended Learning Models: Adopt a blended learning approach that combines traditional classroom-based instruction with online resources and interactive platforms. This allows for flexible learning, catering to diverse learning styles and accommodating the digital preferences of Generation Z students [15].
3. Gamification and Game-Based Learning: Introduce gamification elements into ethics education to enhance motivation and student engagement. Developing ethical decision-making games and simulations can foster experiential learning while making the learning process enjoyable [16].
4. Role-Playing and Ethical Debates: Organize role-playing exercises and ethical debates to encourage students to take on different perspectives and explore ethical dilemmas from multiple angles. These activities promote empathy and a deeper understanding of the complexity of ethical decision-making [17].
5. Collaborative Learning and Peer Discussions: Foster collaborative learning environments where students can engage in group discussions and peer-to-peer interactions on ethics-related topics. Encouraging open dialogue and the exchange of diverse viewpoints can enhance critical thinking and ethical reasoning [18].
6. Service-Learning and Community Engagement: Integrate service-learning projects that allow students to apply ethical principles while addressing real community needs.

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Engaging in ethical problem-solving within real-world contexts instils a sense of social responsibility and practical ethical application.

7. Global Perspectives on Ethics: Explore ethical considerations in a global context and address challenges related to cultural diversity, international collaborations, and the impact of engineering decisions on a global scale.
8. Mentorship and Ethical Leadership Development: Establish mentorship programs with industry professionals and ethical leaders to provide guidance and role models for Generation Z students. Ethical leadership development can empower students to become ethical advocates in their future engineering careers.
9. Well-Being and Mindfulness Practices: Integrate well-being and mindfulness components into ethics education to support students' emotional intelligence and resilience. Emphasizing the importance of personal well-being can enhance ethical decision-making and promote a healthy work-life balance.
10. Ethical Innovation and Design Thinking: Incorporate design thinking methodologies into ethics education, encouraging students to identify ethical challenges, generate creative solutions, and consider the ethical implications of their engineering designs and innovations.

By embracing these future directions, educators can create an enriching and transformative learning experience for Generation Z students, empowering them to become ethical and socially responsible engineers who contribute positively to society's well-being and sustainable development. While the proposed future directions in teaching engineering ethics offer valuable opportunities, there are also some limitations and challenges to consider:

1. Access to Technology: Implementing technology-integrated learning, gamification, and virtual reality simulations may require access to advanced technological resources. Ensuring equal access to technology for all students can be a challenge, as some institutions or students may face limitations in obtaining the necessary equipment and infrastructure.

2. Time Constraints: Integrating new teaching approaches and experiential learning activities may require additional time and resources, which can be a constraint within a traditional curriculum. Finding a balance between covering essential theoretical concepts and engaging in practical experiences can be challenging.

3. Faculty Training: Educators need to leverage technology and interactive tools to enhance the learning experience and cater to Generation Z's digital preferences. Faculty members may require training and support to effectively implement innovative teaching approaches. Faculty development programs are essential to equip educators with the necessary skills and expertise to navigate the changing landscape of ethics education.

4. Ethical Considerations in Technology Use: While technology can enhance learning experiences, educators must consider the ethical implications of using certain technologies, such as data privacy and security concerns in virtual learning environments.

Despite the challenges faced in introducing new methods of teaching engineering ethics to Generation Z, the integration of Islamic values is imperative to foster internalization of ethical principles and promote the well-being of society. Generation Z students, with their unique characteristics and preferences, may require innovative approaches to engage with ethics education effectively. By incorporating Islamic values, such as integrity, compassion, justice,

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and social responsibility, educators can appeal to the inherent moral compass of students and align ethical teachings with their cultural and Islamic backgrounds. The ethical teachings of Islam emphasize empathy, fairness, and concern for the greater good, aligning closely with the broader goals of engineering ethics in promoting societal well-being. Embedding Islamic values in ethics education not only resonates with students' personal beliefs but also enhances their motivation to make ethically sound decisions that positively impact their communities and the world at large. Ultimately, this approach can contribute to the development of ethically conscious and socially responsible engineers who actively work towards the betterment of Ummah through their engineering practices.

By embedding engineering ethics education with Islamic values, educators can create a more holistic and culturally relevant learning experience for students while promoting a broader understanding of ethics in engineering practice. This approach fosters ethical engineers who are not only technically proficient but also grounded in their values and committed to making positive contributions to society guided by Islamic principles.

6. THE NEED FOR FUTURE RESEARCH

While significant strides have been made in understanding the role of engineering ethics and its integration with Generation Z, it is evident that further research is needed to address certain key aspects comprehensively. Firstly, as Generation Z continues to evolve and adapt to the changing technological landscape, there is a necessity to explore the dynamic impact of digital distractions and online ethics on their ethical decision-making processes. Investigating the long-term effects of these influences on ethical behavior can provide valuable insights into the development of effective ethics education strategies. Secondly, while the proposal for incorporating Islamic values in engineering ethics education shows promise, further research is essential to understand its impact on internalization and the promotion of societal well-being. Studies comparing the effectiveness of different ethical frameworks, including Islamic values, in various cultural and educational contexts can help identify best practices for fostering ethical values among Generation Z students.

The effectiveness of innovative teaching methods, such as gamification, role-playing, and experiential learning, requires further examination. Longitudinal studies assessing the retention of ethical knowledge and its practical application in engineering careers can shed light on the sustained impact of these approaches on ethical decision-making abilities. Researching the potential impact of engineering ethics education on the attitudes and behaviors of Generation Z engineers throughout their professional journey is essential. Understanding how ethics training influences their decision-making and social responsibility can guide the continuous improvement of ethics education curricula.

While the existing research provides valuable insights into engineering ethics education for Generation Z, further investigation is warranted to address the complexities and challenges unique to this dynamic generation. By engaging in continued research and assessment, educators and stakeholders can refine ethics education strategies, develop targeted interventions, and empower the next generation of engineers to become ethical leaders who contribute positively to society. The call for ongoing research in this field is crucial to ensure that engineering ethics remains effective, relevant, and responsive to the ever-changing landscape of engineering practice and societal needs.

7. CONCLUSION

The field of engineering ethics plays a crucial role in shaping the future of our society. With the increasing complexity of technology and the emergence of Generation Z as the next cohort of engineers, it is vital to adapt teaching approaches to effectively engage and internalize ethical principles. Despite the challenges of short attention spans, digital distractions, and skepticism, educators can bridge the gap between theory and practice by incorporating real-world case studies, experiential learning, and diverse perspectives. Moreover, the integration of Islamic values offers a valuable opportunity to resonate with Generation Z students and promote the internalization of ethical values. By addressing these challenges and embracing innovative teaching methods, we can empower the next generation of engineers to navigate ethical dilemmas effectively, develop a strong ethical foundation, and contribute to the well-being of society. As we prepare Generation Z for their roles in engineering, we must ensure that they not only possess technical expertise but also embody ethical leadership, compassion, and social responsibility to create a sustainable and equitable future for all.

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TELEWORKING MONITORING SYSTEM USING NILM AND K-NN ALGORITHMS: A STRATEGY FOR SUSTAINABLE SMART CITIES

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ABSTRACT: Working from home or teleworking has become a common practice for most office employees during certain special situations such as pandemic. One of the challenges faced by employers, however, is monitoring workers who are working from home. Webcam, live video feed, or mobile phone tracking deemed to be intrusive. Therefore, in this work, a non-intrusive monitoring approach is used to effectively help employers to keep track of teleworking employees through specific electrical appliances operating condition while maintaining users' privacies. This strategy uses non-intrusive load monitoring (NILM) approach to recognize four electrical appliances' switching events used during teleworking measured from a single power point. Together with an event classification method known as K-Nearest Neighbor (k-NN) algorithm, the teleworking event and duration can be identified. The results were presented using classification metrics that consist of confusion matrix and accuracy score. An accuracy of up to 62% has been achieved for the classifier. It is observed that the similarity of appliances' power usage affects the model accuracy and confusion matrix is constructed to help identify the number of events that are correctly classified as well as wrongly classified. Results from NILM and k-NN strategy can be implemented in the smart city towards sustainability to create a sustainable and employees well-being. It is also useful for an organization to evaluate an employee's performance who opt for teleworking.

ABSTRAK: Bekerja dari rumah telah menjadi amalan biasa bagi kebanyakan pekerja-pekerja pejabat semasa situasi khas tertentu seperti wabak penyakit. Salah satu cabaran yang dihadapi oleh para majikan, adalah memantau para pekerja yang bekerja dari rumah. Kamera web, suapan video langsung atau penjejakan telefon mudah alih adalah dianggap mengganggu privasi. Oleh itu, dalam kajian ini, pendekatan pemantauan tidak mengganggu privasi digunakan untuk membantu para majikan dengan berkesan menjejak para pekerja yang bekerja dari rumah melalui keadaan operasi peralatan-peralatan elektrik tertentu sambil mengekalkan privasi pengguna. Strategi ini menggunakan pendekatan pemantauan beban elektrik tanpa gangguan (NILM) untuk mengenali empat situasi pensuisan peralatan-peralatan elektrik yang digunakan semasa bekerja dari rumah diukur dari satu titik kuasa. Bersama-sama dengan kaedah-kaedah pengkelasan situation yang dikenali sebagai algoritma K-Nearest Neighbor (k-NN), acara bekerja dari rumah dan tempoh boleh dikenal pasti. Keputusan telah dibentangkan menggunakan metrik klasifikasi yang terdiri daripada matriks

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kekeliruan dan skor ketepatan. Ketepatan sehingga 62% telah dicapai untuk pengkelasan. Adalah diperhatikan bahawa persamaan penggunaan kuasa peralatan-peralatan elektrik mempengaruhi ketepatan model dan matriks kekeliruan dibina untuk membantu mengenal pasti bilangan peristiwa yang dikelaskan dengan betul serta dikelaskan secara salah. Hasil daripada strategi NILM dan k-NN boleh dilaksanakan di bandar pintar ke arah kemampanan untuk mewujudkan kesejahteraan para pekerja dan mampan. Ia juga berguna untuk organisasi menilai prestasi para pekerja yang memilih untuk bekerja dari rumah.

KEYWORDS: *Non-Intrusive Load Monitoring (NILM), K-Nearest Neighbors (k-NN), Teleworking, Sustainability, Smart Cities.*

1. INTRODUCTION

Smart cities are one of the solutions for countries to achieve sustainability [1]. Therefore, to build a smart city, sustainability through improving energy efficiency is an important element. A review paper of research works on energy efficiency summarizes improving, monitoring, and reducing energy consumption on buildings can achieve sustainability [2]. In the area of improving energy efficiency, the main solution is to be able to identify faults in the electrical load and systems. Various researchers have proposed non-intrusive fault monitoring in detecting possible faults through analyzing electrical signals measured at the utilities and systems level [3 and 4]. Next, to reduce energy consumption, energy usage behavior is an important factor. A survey done by researchers on a group of secondary school students in Gombak, Malaysia analyzes that energy efficiency knowledge is crucial to their energy consumption behavior [5].

In monitoring energy consumption, many researchers have worked on non-intrusive monitoring. Energy management and monitoring is an integral part of building a sustainable city [6]. Researchers work on a model-agnostic hybrid federated learning framework to work together to train non-intrusive electrical load monitoring as a city-wide approach for sustainable city application [7]. Researchers have also utilized deep transfer learning and deep domain adaptation of energy systems to perform energy prediction based on the data of human mobility for smart city applications [8].

The Non-Intrusive Load Monitoring (NILM) is a technique used to separate individual appliances based on their power consumption while respecting the consumers' privacy and this technique are often used as an alternative for the users to pursue energy efficiency [9]. One of the major advantages of this method is the non-intrusive nature as it does not require sensors to be mounted on directly onto each appliance to monitor its energy consumption. Although the method of using sensors ensures a high accuracy of energy consumption measurements, this method is costly because several sensors need to be installed and monitored for load identification [10]. Meanwhile, the NILM approach obtained the data to be analyzed and disaggregated to recognize daily electrical appliances consumption from a single point measurement. Based on the studies made in [11], the general framework of a NILM system consists of data acquisition, event detection and load identification.

Data acquisition is a process of acquiring data before further processed with the algorithms in event detection, load identification and anomaly detection in the non-intrusive load monitoring (NILM) system. The data is collected using the NILM technique as such the data will be collected from a single point measurement in the building without invading the consumer's privacies. Devices such as smart meters, current transformer or specific hardware

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are used to measure the voltage drop over the device and the current that flows through the device that will be used for the NILM algorithms.

To perform the segregation of the power consumption of appliances, it is important to obtain and understand the features of the appliances. These features can represent various types of appliance data such as ON/OFF trends, voltage and current, power consumption (real, reactive, and apparent) and its temporal variations [12]. It is easy to segregate two devices with very different power profiles. However, if several appliances have approximately similar power profiles, then segregation becomes a difficult task. Moreover, devices that consume very low power are also a problem for classification since such low-level power can often be regarded as noise. One of the ways to tackle this is to detect the events of the appliances [13].

Based on the study in [10], the machine learning algorithms used for load classification in NILM can be classified into two which are supervised and unsupervised. Supervised techniques create databases information to design the classifier by using offline training. Some of the commonly supervised techniques are Support Vector Machines (SVM) [14], k-Nearest Neighbors (K-NN) [15,16], Naïve Bayes [15, 17], Conventional Neural Networks [18] and many more. In contrast, the unsupervised techniques do not require any training prior to load classification which will reduce human involvement in building database information. Despite the important advantage mentioned, unsupervised techniques are more costly, and the accuracy of load disaggregation is relatively low.

Based on a study made in [9, 20] states that NILM algorithm can efficiently recognize various types of human activity in a household through the information on the appliances' power consumption used inside the household at a particular time. To recognize the activity, the training datasets of daily routine obtained in the early stages of NILM system are fed into the NILM algorithm. K-NN has been used in various research for appliance disaggregation and it has been proven to be effective at classification [15].

Working from home (WFH) or teleworking is a common practice that has been introduced during the COVID-19 pandemic where there is no physical contact with the other colleagues [19]. Many workers are coming back to the office as the pandemic finally recedes but there are also companies that have a regular option to work from home. Due to that, teleworking during pandemic has also seen an increase in the use of technologies for employees' monitoring purposes. The existing hardware and software monitoring solutions such as webcam, live video feeds, mobile phone tracking, keyboard strokes, sensors, mouse movement, etc. deemed to be intrusive [11,14]. Therefore, a non-intrusive approach is more efficient for employers to keep track of employees' working attendance by monitoring the employees from their daily electrical appliances' consumption data. Researchers have proposed to utilize non-intrusive load monitoring to determine an electrical appliance's anomaly [21]. Previous work has initially been done to monitor electrical appliances for energy consumption [22].

In this paper, the novelty of our work is utilizing selected electrical appliance's anomaly and energy consumption and integrating the concept of NILM with K-NN to facilitate employers to implement an effective time and attendance system for teleworking activities. The paper is organized as follows: in section "Methodology", discussion of the methodology used in this project. In section "Results and Analysis", the results of the classification algorithm implementation are discussed. Finally, conclusions are drawn in "Conclusion" section.

2. METHODOLOGY

As depicted in Fig. 1, the main components of the NILM system consist of four types of electrical appliances namely laptop charger, kettle, fan, and mobile charger. The electrical appliances are linked to the 4-gang multi plug extension, that serves as single point entry of NILM system. To acquire data on power consumption from a single point, a current transformer will be clamped onto the extension's live wire. The current transformer sensor is connected to Arduino Uno for data collection through AC measurement circuit. The NILM algorithm will be developed to disaggregate the power usage of each appliance through a single point measurement of its signal load. The disaggregated data then will be further processed to classify the working events as 'Late' or 'On Time' based on the time the employee clocks in.

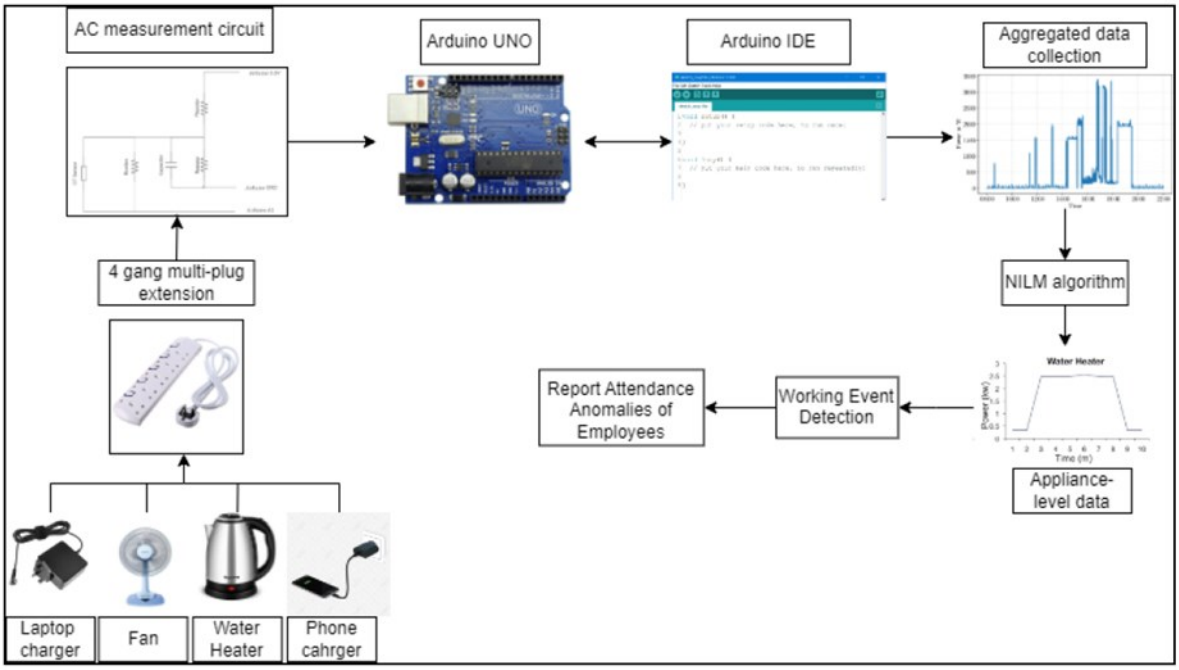

Fig. 1. The overall system for Teleworking using NILM and KNN Algorithm.

2.1. Data Collection of Teleworking Power Consumption

The experiment is conducted using four electrical appliances: phone charger (P), laptop charger (L), fan (F), and water heater (WH) which are the common appliances in any home. All the appliances will be plugged into a 4 gang multi-plug extension before being connected to the current transformer and AC current measurement circuit. The dataset provides appliance-level power consumptions along with aggregated power consumption. Since this project has four electrical appliances, there are sixteen probabilities of usage. The data on power consumption of all sixteen events will be acquired and stored in a CSV file. A fundamental part of NILM is detecting events accurately. Existing threshold-based event detection techniques rely heavily on the threshold that is selected manually. They are not expected to perform well on appliances that have similar power ranges. In this section, we propose event-based detection techniques that overcome all these challenges and accurately detect events of the appliances.

A total of 400 data are collected, labels with high accuracy each event of the aggregated signal with appliance mode transition as depicted in Table 1. The dataset obtained is properly

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labelled to events of the aggregated power signal. The datasets then will be uploaded into Jupyter Notebook to undergo code construction for the training and testing of the algorithm utilized in this work was conducted in Python language while using *sklearn* module for machine learning.

Table 1: Probability of Events for Monitoring Appliances

Events	State			
	Water Heater	Laptop Charger	Fan	Phone charger
1	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	ON
3	OFF	OFF	ON	OFF
4	OFF	OFF	ON	ON
5	OFF	ON	OFF	OFF
6	OFF	ON	OFF	ON
7	OFF	ON	ON	OFF
8	OFF	ON	ON	ON
9	ON	OFF	OFF	OFF
10	ON	OFF	OFF	ON
11	ON	ON	ON	OFF
12	ON	ON	ON	ON
13	ON	OFF	OFF	OFF
14	ON	OFF	OFF	ON
15	ON	ON	ON	OFF
16	ON	ON	ON	ON

2.2 Classifying Teleworking Event using KNN

Once the probability of events during teleworking has been identified (Table 1), the data will be classified using KNN algorithm. It identifies the classes of appliances from the extracted features and event detection results. In this work, the k-NN will find the data nearest neighbours' distance by utilizing the Euclidean distance calculation. K-nearest neighbour algorithm measures the distance between the test data and training data. For any test data, the attributes of the test data are compared with the previously trained data using distance measurement method. The k-NN algorithm is chosen as the classifier because this work only utilizes one feature to classify the appliance which is the power feature.

In the k-NN classifier, the number of nearest neighbours, k is varied, and the prediction accuracy for different k values is recorded. The highest percentage prediction accuracy with the corresponding training data set size, k value, is analysed. It is calculated by the square root of the sum of the squared differences of the values of horizontal axis, xi and vertical axis, yi. The formula, Eq. (1), used in Euclidean distance is as below:

$$d(x,y) = \sqrt{\sum_{i=1}^{m}(y_i - x_i)^2} \quad (1)$$

2.3 Confusion Matrix

The accuracy of an algorithm can be further evaluated using confusion matrix to evaluate the performance of the classification. Table 2 shows the confusion matrix for the two-class

classifier that provide the visualization of the performance of the algorithm. Through the table, two sets of data will be compared with each other and show the number of instances that are correctly and incorrectly predicted. There are four basic terms that should be defined to complete the confusion matrix. The first type, true positives (TP), is the test result correctly predicted the presence of the condition. Second type, false positives (FP), corresponds to test result incorrectly predicted the presence of the condition and, it is false. The third type, true negatives (TN), refers to test result correctly predicted the absence of the condition and, it is true. The fourth type, false negatives (FN), refers to test result incorrectly predicted the absence of the condition and, it is false.

Table 2: Probability of Events for Monitoring Appliances

		Actual	
		+	-
Predicted	+	TP	FP
	-	FN	TN

3. RESULT AND ANALYSIS

3.1. Power Consumption of Appliances

After the analysing the power signals of the teleworking appliances, one observes that some of the appliances exhibit very similar power value distributions which causes difficulty in discriminating the appliances especially in cases where the power values fall in the range of more than one category. The dataset power consumption values and number of samples for each type of event are listed in Table 3. Fig. 2 shows the distribution of power values for sixteen different events of the appliances where it illustrates the extent of which the distribution of power values of the events overlapped with each other in graphical manner. The overlapped power value distributions pose difficulty to pre-define the threshold of the appliances.

Table 3: Power consumption values and number of samples for each event

			Power Rating	
Events	Appliances	No. of samples	Min (Watt)	Max (Watt)
1	All OFF	25	1.8	10.14
2	P	25	12.76	40.81
3	F	25	20.67	42.73
4	P, F	25	55.49	97.04
5	L	25	53.8	77.28
6	L, P	25	55.08	62.85
7	F, L	25	77.07	102.36
8	F, P, L	25	86.51	118.23
9	WH	25	1553.65	1576.06
10	WH, P	25	1559.42	1603.54
11	WH, L	25	1601.97	1613.39
12	WH, P, L	25	1597.37	1629.35
13	WH, F	25	1604.69	1620.4
14	WH, F, P	25	1616.02	1655.93
15	WH, F, L	25	1650.11	1672.17
16	WH, F, L, P	25	1681.78	1702.6

3.2 Classification of Teleworking

The experiment has been conducted by applying event-based detection as feature extraction and a machine learning model for data classification. From the training set size of 60% to 10%, it is observed that the training set size of 50%, at the number of nearest neighbours, k=5 produces the highest accuracy at 62%. Table 4 records the prediction accuracy

for different k values. The highest percentage prediction accuracy with the corresponding training data set size, k value, is analysed.

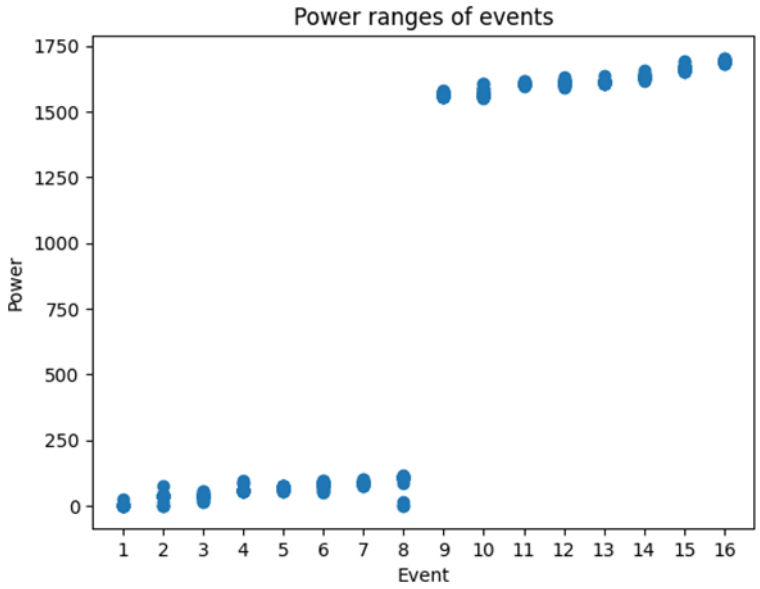

Fig. 2. Power distributions of the 4 appliances according to events

Table 4: k-NN prediction accuracy from varying training set size and k-value

Training (%)	k =1	k=2	k=3	k=4	k=5	k=6
10	60.28	57.77	50.55	41.667	46.11	40.55
20	60.625	55.0	50.312	53.75	55.31	47.19
30	58.93	57.86	55.714	55.714	55.714	60.714
40	60.42	60.0	61.25	62.92	60.83	62.08
50	59	58.5	57.5	60.5	62	59.5
60	60	56.875	57.5	59.375	60.625	60.625

3.3 Classifier Performance

To define the performance of the classification algorithm, confusion matrix was used. The matrix table as shown in Table 5, summarizes the number of testing data that are correctly classified and misclassified. In the analysis of confusion matrix, the predicted appliances are mapped to the actual appliances. The diagonal values represent the instances that are correctly predicted while others are wrongly predicted with other events.

From the confusion matrix in Table 5, it is observed that the classifier has difficulty in predicting between Event 2 and Event 3. There are 7 power events that belong to Event 2, but they are misclassified as Event 3 by the K-NN classifier algorithm. There are also 7 power events that belong to Event 4 but classified as Event 5 by the classifier. On top of that, from the confusion matrix table, it is observed that the K-NN classifier has difficulty in classifying Event 7. There are 9 power events of Event 7 that are misclassified as Event 6. This proved

that the classifier is unable to discriminate Event 7 and Event 6. There are also 7 power events of Event 10 that are misclassified as Event 9. Besides that, there are also 6 power events in Event 11 and Event 13 that are misclassified as Event 12. It has already been observed that the appliances have similar power ranges and cause overlapping of power values. Overlapping of power values causes difficulty for the classifier to classify which switching events are occurring.

Table 5: Confusion Matrix for KNN Classifier

PREDICTED \ Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	12	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	9	0	0	0	1	0	0	0	0	0	0	0	0	0	0
3	0	7	7	1	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	9	0	0	1	0	0	0	0	0	0	0	0	0
5	1	0	0	7	5	1	0	0	0	0	0	0	0	0	0	0
6	0	0	1	1	1	2	9	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	3	10	1	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	6	7	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	6	6	0	0	1	0	0	0
11	0	0	0	0	0	0	0	0	0	0	7	0	5	0	0	0
12	0	0	0	0	0	0	0	0	0	0	6	2	6	0	0	0
13	0	0	0	0	0	0	0	0	0	0	1	0	9	1	0	0
14	0	0	0	0	0	0	0	0	0	0	0	1	0	11	1	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11

3.4 Monitoring Working Event of Employees for Teleworking

After loading the data to the K-NN algorithm, the classified data will undergo a process where the timestamp of when the working event occurred was used to classify if the employee clock-in 'On Time' or 'Late' from the working event. Every company implements its own time and attendance policies based on the needs of the organization. This approach helps the employers to keep track of employees' working from home attendance and the implementation of this system can be useful for an organization to evaluate an employee's performance. In this project, the official working hours are specified to start at 8.00am.

Firstly, the program will classify Event 1, Event 2, Event 3 as 'Not Working'. This is due to the overlapping of power usage between fan and phone charger, which is Event 2 and Event 3. Since these two will be perceived as the same event by the algorithm, a condition was set where these two appliances need to be combined with other appliances to be considered as working. Next, the program classified the working event as 'On Time' if the employee clocked in at 8.00am sharp or earlier as shown in Fig. 3.

The implementation of this teleworking system could differ depending on the companies' policies and management style. However, regardless of the policies and management style, companies still need to process attendance of each employee working from home to improve operations and increasing productivity. Fig. 4 depicted the total of late ins by an employee in percentage. Having this information helps the management to determine the compliance rate of remote employees.

The labor law in Malaysia is regulated by Employment Act, 1995. The law governs the term and conditions of employment such as working hours, holidays, annual leave, and other employment conditions. By implementing an effective attendance system for work from home setting, the management will be able to analyze attendance anomalies. Attendance anomaly refers to any time discrepancy apart from the official attendance policy. After analyzing the

attendance anomaly situation in the company, appropriate actions could be taken by the company to improve their operations.

	TIME	DATE	POWER	Prediction	Time in	Hour	Minute	Status
0	7:55:00	1/12/2022	77.28	6	2022-12-01 07:55:00	7	55	On time
1	8:01:00	2/12/2022	73.39	5	2022-12-02 08:01:00	8	1	Late
2	7:57:00	5/12/2022	60.94	4	2022-12-05 07:57:00	7	57	On time
3	8:07:00	6/12/2022	85.79	7	2022-12-06 08:07:00	8	7	Late
4	8:00:00	7/12/2022	50.76	4	2022-12-07 08:00:00	8	0	On time
5	7:59:00	8/12/2022	1569.25	9	2022-12-08 07:59:00	7	59	On time
6	8:20:00	9/12/2022	1561.44	10	2022-12-09 08:20:00	8	20	Late
7	7:50:00	12/12/2022	1557.21	10	2022-12-12 07:50:00	7	50	On time
8	8:00:00	13/12/2022	1601.97	11	2022-12-13 08:00:00	8	0	On time
9	7:51:00	14/12/2022	1686.34	16	2022-12-14 07:51:00	7	51	On time
10	7:59:00	15/12/2022	1692.79	16	2022-12-15 07:59:00	7	59	On time
11	8:22:00	16/12/2022	111.67	8	2022-12-16 08:22:00	8	22	Late
12	8:23:00	19/12/2022	26.45	3	2022-12-19 08:23:00	8	23	Not working
13	8:24:00	20/12/2022	2.66	1	2022-12-20 08:24:00	8	24	Not working
14	8:00:00	21/12/2022	33.36	3	2022-12-21 08:00:00	8	0	Not working
15	7:56:00	22/12/2022	53.55	4	2022-12-22 07:56:00	7	56	On time
16	8:02:00	23/12/2022	35.59	2	2022-12-23 08:02:00	8	2	Not working
17	8:00:00	26/12/2022	35.06	2	2022-12-26 08:00:00	8	0	Not working
18	7:51:00	27/12/2022	1616.96	13	2022-12-27 07:51:00	7	51	On time
19	8:11:00	28/12/2022	80.55	6	2022-12-28 08:11:00	8	11	Late
20	7:59:00	29/12/2022	155.47	8	2022-12-29 07:59:00	7	59	On time
21	10:51:00	30/12/2022	10.65	1	2022-12-30 10:51:00	10	51	Not working

Fig.3. The classified data showing staff working state.

```
On time        50.000000
Not working    27.272727
Late           22.727273
```

Fig. 4. The result of Teleworking monitoring system shows 22% late clock-in of an employee.

This work can be refined to develop a system that is more accurate in predicting working events of employees working from home. One of the suggestions was to count the duration of appliances switched ON during the day to monitor how many hours the employee worked in a day at home. This will ensure the accuracy to monitor working activity of the employees. Therefore, more data should be analyzed in the future for more accurate results in monitoring working events of the employees. Next, this project can also be improved by using more features such as harmonics or V-I trajectory and so on to further improve the classification of appliances.

4. CONCLUSION

In summary, from this project, the methods to improve the efficiency of employees' monitoring by the employer and at the same time respecting the privacy of employees have been discussed and implemented. By classifying the working events in the power consumption of electrical appliances used in teleworking activities, employees monitoring can be implemented.

For future work, this project can be refined to develop a system that is more accurate in predicting working events of employees working from home. One of the suggestions was to count the duration of appliances switched ON during the day to monitor how many hours the employee worked in a day at home. This will ensure the accuracy to monitor working activity

of the employees. Next, this project can also be improved by using additional features to obtain the highest predictive performance. Besides that, more data should be analyzed in the future for more accurate results in monitoring working events of the employees.

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PERSUASIVE MASTERY: EXPLORING A MUSLIM CELEBRITY PODCASTER'S APPEALS IN 'LIGHT UPON DARKNESS'

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ABSTRACT: This study explores the persuasive appeals of logical, emotional, and credibility appeals employed in the podcast series "Light Upon Darkness" by a prominent Muslim celebrity turned influencer. Thematic analysis using elements from the Toulmin Model, Maslow's Hierarchy of Needs, and Aristotle's Rhetoric of Ethos reveals that the podcaster employs a diverse approach, utilizing some elements of the Toulmin Model to strengthen logic, integrating all of Maslow's Hierarchy of Needs to evoke emotional resonance with the audience and establishes credibility by sharing personal background, life experiences, expertise, and thoughts while showing respect to the audience. These findings offer insights into the dynamics of persuasive communication in podcasting and contribute to a broader understanding of the role of appeals in shaping effective communication within the digital realm.

ABSTRAK: Kajian ini meneroka daya tarikan persuasif rayuan logik, emosi dan kredibiliti yang digunakan dalam siri podcast "Light Upon Darkness" oleh seorang selebriti Muslim terkenal yang menjadi pempengaruh. Analisis tematik menggunakan unsur-unsur daripada Model Toulmin, Hierarki Keperluan Maslow dan Retorik Ethos Aristotle mendedahkan bahawa pelbagai pendekatan telah digunakan dari beberapa elemen Model Toulmin untuk mengukuhkan logik, menyepadukan semua Hierarki Keperluan Maslow untuk membangkitkan resonans emosi dengan pendengar dan mewujudkan kredibiliti dengan berkongsi latar belakang peribadi, pengalaman hidup, kepakaran dan pemikiran sambil menunjukkan rasa hormat kepada pendengar. Penemuan ini menawarkan pandangan tentang dinamik komunikasi persuasif dalam podcasting dan menyumbang kepada pemahaman yang lebih luas tentang peranan rayuan dalam membentuk komunikasi yang berkesan dalam alam digital.

KEYWORDS: *Persuasive language, Logical Appeal, Emotional Appeal, Credibility Appeal, Podcast*

1 INTRODUCTION

Persuasive speaking aims to influence attitudes and behaviors through rhetoric strategies (15). Podcasts have emerged as a significant medium for persuasive communication in the digital age, with their popularity on the rise (6). Research on podcasts has explored their

potential as a storytelling platform and their impact on audiences. For example, (10) investigated how music podcasts persuade listeners to engage with music, while (7) analyzed interruptions in mixed-gender podcast conversations in the Malaysian context. Recent studies have also focused on communicative strategies used by well-known personalities 'directive illocutionary acts (3), expressive speech acts (13), and dominant illocutionary acts in various podcast contexts (8); (17). Even when podcasts have continued to grow in popularity, a comprehensive exploration of persuasive elements in podcasts, particularly the analysis of persuasive appeals in Islamic content, remains relatively underexplored.

This study delves into analyzing the persuasive appeals employed by a prominent Muslim celebrity podcaster in her "Light Upon Darkness" podcast series. Understanding how these appeals are strategically employed holds significance for both content creators and scholars alike. As podcasts continue to gain prominence, this research contributes to elucidating effective communication strategies within this evolving medium, benefiting creators who are seeking ways to enhance their content and enriching researchers' understanding of persuasive communication dynamics.

2 METHODOLOGY

2.1 DATA COLLECTION

Detailed in Table 2.1 below, the study's data comprises eight episodes from the "Light Upon Darkness" podcast series, accessible on Spotify.

Table 2.1: List of Episodes

Title	Duration	Date Published	Link
Episode 1: The Beginning	10 min 28 sec	September 2022	http://surl.li/nhzbw
Episode 2: The Rock Bottom & The Awakening	6 min 34 sec	September 2022	http://surl.li/nhzcj
Episode 3: The Realisation	7 min 6 sec	September 2022	http://surl.li/nhzcr
Episode 4: The Pilgrimage	6 min 47 sec	September 2022	http://surl.li/nhzcw
Episode 5: The Journey	5 min 46 sec	September 2022	http://surl.li/nhzdh
Episode 6: The Detachment	10 min 27 sec	October 2022	http://surl.li/nhzdr
Episode 7: The Battle Within	9 min 37 sec	October 2022	http://surl.li/nhzea
Episode 8: The Determination	8 min 18 sec	October 2022	http://surl.li/nhzel

2.2 DATA ANALYSIS AND PROCEDURE

The podcast data was analyzed through repeated listening to each episode, adopting a multi-framework approach to analyze logical, emotional, and credibility appeals. For logical appeals, the Toulmin model's (1) key elements of claims, grounds, warrants, backing,

qualifiers, and rebuttals. Table 2.2 shows how the elements of the Toulmin Model were identified.

Table 2.2: Questions to Identify the Elements of Toulmin Model (1)

Toulmin Model's Elements	**Questions**
Claim	What exactly is your position statement?
Ground	What is the evidence that…?
Warrant	What strengthens the reasoning results?
Backing	Is the warrant solidly backed for supporting the grounds?
Qualifier	Is there any other possibility?
Rebuttal	Does the wording of the claim allow for these exceptions?

For emotional appeals. thematic analysis, guided by Maslow's Hierarchy of Human Needs, was employed, categorizing data into themes aligned with physiological, safety, love and belonging, self-esteem, self-actualization, and self-transcendence needs (2), (11), (21); (16) as seen in Table 2.3

Table 2.3: Maslow's Hierarchy of Human Needs (2), (11), (21); (16)

Hierarchy	**Needs**
Highest	• self-transcendence • self-actualization • self-esteem • love and belonging • safety
Lowest	• physiological

Similarly, credibility appeals were analyzed using thematic analysis grounded in Aristotle's Rhetoric of Ethos, identifying the main themes related to credibility indicators following the framework used by (20). Table 2.4 below shows the indicator for rhetorical appeals grounded in Aristotle's Ethos.

Table 2.4: Indicator for rhetorical appeals grounded in Aristotle's Ethos (20)

Ethos	**Indicator**
Appeal to credibility and trust in the speaker or audience	• Shows the speaker as capable and close to citizens • Shows the good background of the speaker • Shows the speaker as an expert in a particular field • Shows that the speaker comes from the same group as the audience

- Shows respect for the rights and feelings of the audience
- Appeals to ethics, that is, the character, personality, and other characteristics of the speaker
- May use phrases such as “in truth”, “in my opinion”

3 RESULTS AND DISCUSSION

3.1 BUILT OF LOGICAL APPEALS

It was revealed that even though all six elements of the Toulmin model were applied, elements of claims where the podcaster asserts a viewpoint or assertion, grounds that justify the claim, and warrants that connect the grounds to the claim were largely used. This approach of reasoning is close to those made in academics (1); (4) and political contexts (19). Examples are seen below in Table 3.1.

Table 3.1: Elements Employed to Build Logical Appeals in the “Light Upon Darkness” Podcast

Toulmin Model’s Elements	**Examples of Utterance**
Claim	"The older you get, the more you realize that you need to surround yourself with people who are positive and good"
Ground	"Because the more you surround yourself with people who are negative and bad, then you will become like them."
Warrant	"Because it's, a hadith says, you know, when these friends like perfume, you know, like if it's a good friend. So, you will have the effect of that perfume wherever you go, but if your friends are bad friends, then you know you will have that burnt smell with you as well. So, you're going to be like them too."

3.2 BUILT OF EMOTIONAL APPEALS

The findings show that the podcaster took the approach of storytelling in the podcast and presented emotional appeals by relating to all of Maslow’s levels of needs, similar to approaches taken by politicians. This can create powerful connections and a sense of belonging with the audience, evoking their emotions (12). (9) and (18) reported that both positive and negative emotional connections in political communication can effectively evoke emotions among voters and secure support. Table 3.2 below depicts the summary of key themes for emotional appeal and examples of utterances.

Table 3.2: Elements Employed to Build Emotional Appeals in the “Light Upon Darkness” Podcast

Hierarchy	**Needs**	**Examples of Utterance**
Highest	Self-Transcendence	**Spiritual Enhancement** “I think that realization came when I started become more spiritual, when I started become more aware of Allah, when I started getting older.”

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		"When I look back at the different hardship that I had, you know. We're still having, you know, alhamdulillah there are blessings. Because anything that happened to you and it brings you closer to Allah, it's great, alhamdulillah".
	Self-Actualization Needs	**Self-Realization** "Something missing inside of me? I need to go look for that, I need to look for what it is you know". "It is a constant purification process every single day. and it is something that we need to be aware of, of ourselves, we have to be really real with ourselves, like wait a minute, do I need purification? Am I okay? What's why heart at? Am I focused on Allah? Am I praying like a robot? What's going on? right, so this purification process is forever, and this battle doesn't stop, but that is the jihad, right?"
	Self-Esteem Needs	**Personal Contribution** "So, I think having that spotlight taught me that yes, I'm responsible, I need to make sure that I have, I leave a good effect on people, right?" **Ambitious** "And I when I was a girl, I, when I was like 8 years old, I wanted to be like Janet Jackson. I was like ohh I wanna be that I wanna be that, so I aspired to be an artist from a very young age." "It wasn't because I wanted to go out there and become famous. I love the culture. and I suppose when I grew older, I wanted to be somebody." **Nonconformity Confidence** "There is a feeling of safety. There's a feeling like I'm OK, there's a feeling like I don't have to prove myself to anyone anymore. I don't have to stress myself the way that I used to for people anymore, right? And I don't have to please them all the time, right?" "So, there's always hope for a better day, right. And I feel like if you're going through a journey right now to take it step by step, you know it's not an overnight thing, it is a process. So, trust in the journey, trust the process and what Allah has prepared for you and embrace it, right? Don't be afraid to embrace it. And always, you know, if you are feeling down, rely upon Allah. Just call out to him."
	Love and Belonging Needs	**Strong Family Bond** "You know alhamdulillah my parents, MashaAllah, Alhamdulillah, they gave me wonderful guidance,

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		they provide for me, Allah provides me for all of us, but they gave me a wonderful childhood and a loving family and Alhamdulillah." **Cared for by others.** "And only like a few close people that really knew me very well, inside and out. They knew that I needed help. And that's when they said, Nina, you need to stop right now. If not, I'm gonna tell your parents." **Social Adeptness** "Because the hip hop industry, Malaysia at that time, it was all guys, they were all men. There are probably just like one or two girls. So, I was very inspired. I was like, OK, I wanted to be as good as the guys."
	Safety Needs	**Toxic Environment** "cause there's so many other things that linked to music and entertainment with the dark side of things, you know, whether it's clubbing, drugs, alcohol, you know, addictions and really toxic things that really, you know, pull a person down, and it's the environment, it's the people, right? So being in these kinds of environments, it exposes you to all of these things." **Finding Security** "….it was about letting go of these toxicities, you know…" and "…if I don't stop this right now, I'm going to die. I'm going to die. I have to do something." **Emotional Safety** "I think that knowledge is very grounding from the Quran and Sunnah, it's something that keeps a person steady no matter what happens in your life."
Lowest	Physiological Needs	**Fulfillment of Basic Needs:** "I've got all the awards already. I have my family, you know? I alhamdulillah, I have everything else?". "The whole realization that, you know, I have everything, but there's still something missing".

3.3 BUILT OF CREDIBILITY APPEALS

The podcaster's strategies to build credibility appeals were categorized using Aristotle's Rhetoric of Ethos. The result shows that the storytelling approach also encompasses all indicators of credibility, as illustrated below in Table 3.2. This approach as pointed out by (5) strengthens a speaker's position and reinforces the authenticity of the messages delivered, contributing to the overall impact of the podcast on the audience's perspectives and beliefs (14).

Table 3.3: Elements employed to build Credibility Appeals in the "Light Upon Darkness" Podcast

Indicators	Examples of Utterance
• Shows capability and closeness to citizens	"I think my journey throughout my career has taught me that adab, of I suppose to being able to regulate myself in social media and. and when people look at me when people talk about me, when people criticize, you know, I've learned what to do, how to handle it."
• Shows own good background	"Alhamdulillah, I'm an 80's child, so I'm like right in the middle of you know, analog and digital. Alhamdulillah, I got to see, you know, Walkmans and boom boxes and box TV's. "
• Shows own expertise in a particular field	"Alhamdulillah, I pretty much lived most of my life in the entertainment and music industry. radio industry as well. And then after that I shifted my career and I moved into Da'wah."
• Shows a sense of similarity with the audience	"We all have different things that we need to purify ourselves with. But I think what really helps us tawba making sincere tawba, you know asking forgiveness from Allah SWT and at the same time, find your, find a space whereby you can forgive yourself as well. You know when you are too hard to yourself sometimes you don't give yourself space to be able to heal and really let it go."
• Shows respect for the rights and feelings of the audience	"Everybody has their own journey. Everybody has their own challenges in terms of finding this happiness."
• Shows the character and own personality	" So, I had to really dig deep in myself and really expose myself to Allah. Expose myself and say "Ya Allah, I've been really you know, selfish. You know, I had so much ego" and Alhamdulillah Allah made it easy for the layer of ego to like to shred off until it was just me and him."
• Use phrases to show opinions or thoughts	"I think, Allah, Alhamdulillah made it easy for me to keep my hijab on, to continue on the journey of purification"

4 CONCLUSION AND RECOMMENDATION

In conclusion, the analysis of the "Light Upon Darkness" podcast series provided valuable insights into the persuasive strategies employed within the podcasting medium to attract the audience's attention and initiate change. Through the examination of logical, emotional, and credibility appeals, it is evident that the podcaster communicates with a good tapestry of appeals and creates an intricate pattern of support for the claims made, incorporates a diverse array of needs, and employs sharing of background, life experiences, expertise, and personal thoughts. Even though the focus of the study was only on a single podcast series, its findings add to the broader understanding of persuasive communication in digital media that can be learned or inculcated. Recommendations for future studies include expanding the scope to analyze a diverse range of podcasts and incorporating various theoretical perspectives to enhance the analytical framework, thereby providing a more comprehensive exploration of persuasive communication strategies within the podcasting domain.

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