

## Industrial Revolution 4.0 Issues: Changes in Community Values and Challenges

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### Abstract

*Globalization has begun a new era termed as the Industrial Revolution 4.0. Newly created technology trends are selective automation, the Internet of things and physical-cyber systems. However, the progress of the Industrial Revolution 4.0 is perceived as disregarding the values that exist in a society. The objective of the present study was to discuss issues related to changes in community values as a result of technological changes and the challenges faced by the society in Industrial Revolution 4.0 technology. This study utilised a descriptive qualitative method using literature search. The study of modernization of life in the era of the Industrial Revolution 4.0 is just a new technology with emphasis on making profits at the expense of the changes in values of a society. The Industrial Revolution 4.0 poses challenges to the young generation in terms of education, employment and environmental pollution. The present study serves as a pilot study for more development of a humanity approached model systems that are in line with current technological challenges.*

**Keywords:** Industrial Revolution 4.0, Community Values, Humanity, Internet of Things

## INTRODUCTION

Industry Revolution 4.0 is an industrial process involving digital connections and various types of technologies ranging from the 3D printing technology to robotics technology with the effects of increased productivity and adding competitive advantage. The term ‘industrial revolution 4.0’ first appeared in Germany at Hannover Fair in 2011 (Kagermann & Wahlster, 2013) and is associated with business, political as well as academic development (Hermann, Pentek & Otto, 2016). Germany has a great interest in the Industry 4.0 as Germany has part of the technology development intelligence termed as the High Tech Strategy 2020 which aimed at making Germany to be at the forefront of the global manufacturing technology.

Known as Industry 4.0 and Smart Factory, the Industrial Revolution 4.0 (IR4.0) is an improvement from the third Industrial Revolution or the Digital Revolution. Also known as ‘smart manufacturing’ or ‘industrial internet’ (Rahman, et.al 2017; Hermann, Pentek & Otto, 2016), the IR4.0 is increasingly becoming a global discussion including in Malaysia. The IR4.0 technology uses automation and data exchange in the manufacturing technology called cyber physical system that combines physical, digital and biology impacting all disciplines, economies and industries (Hermann, Pentek & Otto, 2016). The impact of technology brought by IR4.0 has penetrated the education sector and associated with the human issues (Che Harun et al., 2023).

The initial concept of the 4.0 industrial revolution was first introduced by Professor Klaus Schwab as the founder and executive chairman of the 2016 World Economic Forum in Geneva. Professor Klaus Schwab (2016) produced a book entitled The Fourth Industrial Revolution where he explained how the industrial revolution 4.0 has changed lives, thinking patterns and ways of working people. He put forward eight strategic

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intelligences which include ethnics and identity, agile and technology governance, inequality, business disruption, disruption to jobs and skills, security and conflict, innovation and productivity, and fusing technologies. Additionally, technologies such as supercomputers, smart robots, unmanned vehicles, genetic editing and the development of neurotechnology were forecasted to enable humans in further optimizing brain function (Schwab, 2016).

The IR4.0 technology has a vast potential to continue to connect billions of individuals into a single network (web) and drastically improve business and organizational efficiency as well as help to re-establish the natural environment through better asset management. Areas such as robotics and Artificial Intelligence (AI), nano technology, quantum computing, genetic engineering, bio technology, and 3D printers will be the new frontiers which were not anticipated before (Fana, Mbongi & Busisiwe, 2020). Besides that, IR4.0

However, concerns loom over various risks and dangers, especially in the erosion of community values coming from various parties, including religious groups, policy makers and community members. Research on values, guidelines or references that can be applied and held by members of the community in the face of IR4.0 era technology is still lacking. Hence, the present study discusses various aspects of arguments pertinent to the changes in values that have taken place as well as the challenges posed by the IR4.0.

## **CHANGE OF COMMUNITY VALUE**

The IR 4.0 has inadvertently made changes to lifestyles as well as posing impacts on cultures, values, religion, and the way of thinking in the employment sector across various industries and individuals at all levels (Abdul Rahman, 2005). Malaysia, as a developing country, which is heavily dependent on industries as a major source of economy is of no exception as the IR4.0 takes effect because more than half of the employment sectors in Malaysia faces the threats and risks of automation (US Bureau of Labor Statistics, 2020). Automation such as "smart manufacturing" combined with cyber intelligence and physical capabilities between machines and humans through communications via systems or websites (Hermann, Pentek & Otto, 2016) would have an impact especially in the role of artists in cultural arts.

Exclusive identity between humans and the objects and the ability to transfer data over a network without the need for human-to-human directions such as human interaction to computers (Burange & Misalkar, 2015) is the hallmark of IR4.0's leading technology of the Internet of Things (IoT). The IoT optimizes life based on intelligent sensors and smart devices that work together over the internet (Keoh, Kumar & Tschofenig, 2014) and connects equipment (things) to the internet infrastructure (wired or wireless) rendering connection to a monitor or to control equipment remotely. Connection of billions of individuals through one network (web), leads to radical improvement in the efficiency of doing businesses across different organizations. A new industrial era featuring robotics and AI, nanotechnology, quantum computing, genetic engineering, bio technology, and 3D printers are the trademarks of IR4.0 implementation (Schwab, 2016; Hermann, Pentek & Otto, 2016).

As the IoT becomes the main driver in IR4.0, important major changes to the application of information and communication technology are evidenced particularly in the use of navigation applications such as Waze or Google Maps which provide drivers real-time information on the route and travel. This will be further abetted by the use and the enhancement of 4G and the coming 5G which is the fifth generation technology standard for broadband cellular networks rendering connectivity to most current mobile phones. Areas such as Cloud Computing covering digital economy, AI, big data, robotic, blockchain, 3D printing, Big Data, space technology and CCTV security systems (Vaidyaa et al., 2018) will be the prerequisites to the new frontiers of IR4.0. Mastery of coding serves as a crucial factor in facilitating the interaction with the technology.

Social media such as the Facebook, Twitter and Netflix are the products of coding technology combined with high level languages with Graphical User Interface (GUI) (Wood et al., 2017). This has grown so rapidly that it can become overloaded with information various stages, shapes and sizes (Wood et al., 2017; Schwab, 2016).

The ease of internet access and technology renders unlimited Social interaction. However, Klaus Schwab (2016) predicts IR4.0 will result in a profound impact on national and international security. Additionally, digital access

facilities pose influence on the morals, attitudes and behaviors of a society. In the face of the technological facilities offered in IR4.0, there exists negative effects and threats to human identity such as the sense of privacy, notion of ownership, consumption patterns, time allotted for work and rest, how to build a career, as well as in building and cultivating skills (Schwab, 2016).

In addressing the threats, the key in facing IR4.0 should not only be focused on coping with technological advancement, but also requires members of the community to hold strongly to certain values in addressing accordingly the negative impacts of the development of IR4.0 technology. These values can be serve as a 'balancer' affording participation in IR4.0 activities in a more organized manner without disregardment of certain ethics and values of a society (Abdul Khalil, Othman, & Saidon, 2020).

Ethics and values of a society are important reference in countering the threats brought by the development of IR4.0 such as cyber-syndrome, cybercrime, hackers, plagiarism in education and censorship of difficult cyber information. The present study will therefore examine some of the changes that have taken place in the role of humans such as the creation of humanoids and the introduction of massive automation in the industry sectors that affect the employment sector following the implementation of the IR4.0 technology.

## **THE ROLE OF MAN**

The development of the IR4.0 denotes the advent of modern digital technology which partly involves manpower or manual labour reduction involving industrial operations switching to automated systems through computerized systems or computer-readable formats (Hermann, Pentek & Otto, 2016).

The digitalization has allowed for information to be obtained through performance of various activities via a virtual space which expedite the efficiency in information transmission, and render more dynamic despite the space and time constraints. Digital connections through internet-based smartphones have facilitated human interaction by means of social media platforms such as Facebook, YouTube, Instagram and others (Wood et al., 2017) which may play a role in shaping the society towards a new lifestyle characterized by post-modernism such as extreme secularism, individuals against society, human freedom, human rights movement and the right to challenge cultural norms and religious values (Vitz, 2016; Kim & Heo, 2018 ; Wang & Siau, 2019; Pratama, 2019).

One of the caveats of human dependence on the technology in the IR4.0 centralises on increased individual interactions with digital devices leading to loss of human interactions as well as fading interactions within the society. Despite the benefits of becoming more efficient at finding out data and information and in such reducing the burden of how our brains works, attachment to technology (Ali et al., 2017), the IR4.0 also brings about the possibility of the rise of the concept of transhumanism such that there is an increased tendency of humans to act as machines characterized by efficiency and intelligence (Badhrulhisham, Johar & Rashid, 2019).

Additionally, the AI technology helps increase human productivity through the use of robotics and additionally, the use of Blockchain helps provide banking access, and coordinate Return of Investment (ROI) (Wood et al., 2017).

New technologies aiming for profit after profit and in reducing human roles especially in the labour sectors in the IR4.0 pose certain challenges against certain cultural norms and religious values in a society. Therefore, the lack of control on this new technology may proffer negative impacts on human thoughts and behaviors.

## **HUMANOID CREATION**

Humanoid or human robot is a human-like appearance robot created based on common human structures, and is computer programmed and has no natural behavior (Bringsjord, 2008). With the advent of the IR4.0 technology, the creation of Humanoid or human robot has entered a new debate where arguments have been made such that the existence of such robots would negate the the role of human beings in terms of the human relations with another human beings bringing about questions on the changes in terms of morality where there are possible limitless interaction (Shen, 2011). The creation of a robot named Sophia built in Hong Kong by Hanson Robotics with the ability to see, speak, and understand speeches as well as the meaning of each word

with thousands of facial expressions has been trajectory in the IR4.0 technology (UN Web TV, 2017) which draws closer attention as Sophia says robots need more human rights than humans (Van Badham, 2017).

Despite the news of a marriage between a robot creator in China and his created robot Yingying, humans and robot's interaction will not be able to replace universal human values and norms (Haas, 2017). The creation of robots that resemble human roles to be normal life partners but do not fulfill human nature further emphasizes the 'loneliness' syndrome faced by today's society severely lacking human to human interaction. Even the existence of humanoids as nurses to manage the elderly in Japan (Hurst, 2018) can not replace the real role of nurses in treating and providing emotional care to patients.

## **EMPLOYMENT SECTOR**

According to a released report by the McKinsey Global Institute (2017), the IR4.0 will cause 800 million jobs to disappear by 2030 as manual labour will be replaced by automation robots (Abdul Malik, 2019). Industry 4.0 has caused drastic job losses in the manufacturing sectors (Kim & Heo, 2018) leading to shrinking manpower in the employment sector (K. Zhou, Taigang Liu & Lifeng Zhou, 2015). The advent of cyber physical systems, machines and new technological methods indirectly solve the problems of dependence on human resources which brings about remarkable change to the future of workforce.

In addition, the US Bureau of Labor Statistics (2020) states that there are some employment sectors that have the probability of 95% or more to be automated. This includes jobs such as employment cashiers, office clerks, secretaries and administrative assistants, bookkeeping, accounting and auditing clerks, cooks, restaurants, team assemblers, receptionists and information clerks. However, according to Graham Brown-Martin (2018) three areas of work will not be replaceable by automation such as creative endeavours (everything from scientific discovery to creative writing and entrepreneurship), social interaction (robots lack the kind of emotional intelligence that humans do) and physical dexterity and mobility (millennia of hiking mountains, swimming lakes and dancing practice gives humans extraordinary agility and physical dexterity) (Graham Brown-Martin, 2018).

A big concern that looms over the industry 4.0 is that more focus is placed on advancing economic returns and this has unknowingly denied the existence of jobs for the younger generation in the future. As humans invented machines and humans also operated those machines in the industry 3.0, the industry 4.0 is the opposite and this has invariably caused fundamental changes in the work landscape (De Stefano, 2016; Frey & Osborne, 2017). The invention of robotic technology, IoT, artificial intelligence (AI), software simulation, mobile communication systems, three-dimensional (3D) printing, image processing, cyber security, analytical data, and digital system integration are among the new elements that are beginning to take over job functions in the existing systems (Abdul Malik, 2019; Hermann, Pentek & Otto, 2016).

Moreover, the shift to computer technology and automation not only increases efficiency and effectiveness of worker's promotion, but also poses a major impact on the expansion of work culture (Abdul Malik, 2019). Competitive advantage includes drastic cost savings as well as profit increment. Nevertheless, the emotional well-being of employees in particular should also be emphasized in training strategies and human resource development skills. Emotional well-being is important in facilitating the organization in implementing changes as well as empowering human resources (Ali et al., 2017). Healthy competitiveness as a result of good emotional wellbeing of workers in an organization helps the company in facing the challenges against any risks or changes to company environment (Hasim et al. 2020).

Additionally, changes in the employment sector will also lead to an increase in the number of individuals with no permanent jobs and may involve works in a series of more independent tasks and projects (De Stefano, 2016) rewarded with smaller wages which leave individuals vulnerable to stress. As a result, declined morale and motivation as well as increase in employee turnover coupled with job dissatisfaction problems would lead to loss of interest in employment (Ali et al., 2017; Kim & Heo, 2018). These are the stumbling blocks to any organizational management efforts especially in implementing strategies and introducing effective changes to the organization or company. In addition, increased unemployment as a result of digitalization technology affects emotional stability and induces a higher level of stress with further risk of mental disorders such as depression.

## **CHANGES AND CHALLENGES OF TECHNOLOGY IR4.0**

The progress in achieving IR4.0 is not a straightforward process and is time consuming. A nation may need around 10 years or more to realize it (Zhou et al., 2015). As the IR4.0 is a new challenge to all services and industrial sectors at home and abroad, upskilling in all sectors is imperative in digitally transforming the services and the industry sectors.

The IR4.0 technology covering technologies such as automation, IoT, big data analysis, simulation, system integration, robotics and cloud computing will further advance the landscape of the modern industrial world (Wood et. al., 2017; Schwab, 2016). Competitive advantage in the era of industrial development 4.0 demands creative and modern innovations in speeding up production as well as in creating a wider economic market.

This can only be accomplished with a comprehensive understanding of the technologies of IR4.0, such as the automation systems generated from AI which will enable the production of high-quality products which are managed and dependent on a much-reduced number of employees (Abdul Malik, 2019). Che Harun et al. (2023) discovered that the development of scientific intellectual force without strong spiritual development will develop an unbalanced personality and identity, which will eventually jeopardize the sustainability of civilizational development. Therefore, the challenges faced in relation to intellectual relationships between humans and machines, technological generation and environmental changes that are brought about by IR4.0 warrant further studies.

## **HUMAN AND MACHINE INTELLECTUAL RELATIONS**

Each industrial revolution is assessed by the development of science and technology. The IR4.0 has witnessed massive production and automation based on manufacturing robots in IR3.0 being replaced by the features of physical cyber collaboration and manufacturing (Irianto, 2017; Hermann et al., 2015). Technological knowledge with sophisticated level of digital systems in the field of cyber physical system, robot automation, big data, IoT, smart manufacturing and many other forms of new technological advances are the facets of the IR4.0 (Hermann, Pentek & Otto, 2016). These knowledge and skills changes are prerequisites in creating a variety of technologies in the global economic system.

Additionally, the IR4.0 technological advances introduce changes and simplify life leading to a new generation formed by different thinking patterns, characters and having certain paradigms shifts (Yaakob, 2018). Schwab (2016) put forth different types of IRP4.0 intelligence namely contextual intelligence, emotional intelligence, inspired intelligence, and physical intelligence (Oosthuizen, 2016). The contextual intelligence is defined as "context has to do with the nature of relations and interdependencies among and between agents (eg, people, ideas, values, experiences, cultures, etc.), political alliances, organizations, religious alignment, social contexts, and private context" (Oosthuizen, 2016).

In IR4.0, Impacted industries are the ones involving mass production of products (Abdul Malik, 2019) in which machines (robotics) are able to predict and act in self-driving forms with less human intervention (Schwab, 2016). Additionally, this also involves machines that receive and act on instructions through a communication network that allows interaction with other machines as well as humans in manufacturing products or goods (Keong, 2017; Schwab, 2016).

## **TECHNOLOGY GENERATION**

The development of the internet technology caused changes to way of life (Mohd Ayub, Zainal Abidin & Suwirta, 2014) in particular to the generation Z children (Gen-Z), a generation born and brought up along with the sophistication of IR4.0 technology. The Gen-Z has a special understanding and intelligence as well as an articulation for advanced digital capabilities. Armed with incredible assets of the internet era, this new generation is more adaptive in making innovations which are more imaginative, inventive and expressive (Majidah, Dian Hasfera & M. Fadli, 2019).

It is important to note that, the rapid advancement of technology in IR4.0 inevitably results in children growing up in an environment with limitless access for information (Miftachul et al., 2017). The significant lifestyle changes result in the growing up period of today's generation, from childhood to the adolescence phase to be

heavily influenced by social media. Social media poses influence on the education, behavior and personality of children (Stapa, Ismail & Yusuf, 2012). Herein, the underlying risks, despite this sophistication of technology are cyber-syndrome, denial of reality life and depression to name a few (Kim & Heo, 2018).

Excessive use of gadgets among children is also associated with health problems such as obesity (Feng, et.al., 2011) due to lack of physical and cardio movement in children. Additionally, excessive gadget use results in weaken finger and hand muscles which are used for writing (Stapa, Ismail & Yusuf, 2012; Feng, et.al., 2011). Importantly, physical activity has a strong relationship with the psychological well-being and mental health of individuals (Pasco, et.al., 2011).

An advantage of the technology offered in IR4.0 is a more sophisticated security systems using IoT devices and the resulting data serve as effective tools in crime surveillance (Schwab, 2016). Creators and IoT users focus on security in terms of personal data and physical security, which may potentially disrupt national security and governance in the long run. IR4.0 therefore will have a huge impact on national and international security (Schwab, 2016).

Indirectly, security and national monopoly will be affected by smart manufacturing (Arizmendi, Pronk & Choi, 2014) where humans and objects are connected with exclusive identities and enhanced ability to transfer data over a network without the need for physical interaction (Burange & Misalkar, 2015). The IoT development is seen as the most suitable platform to leverage various fields of technology, adding values to various industries leading to a more technologically advanced, sophisticated and modern generation.

## **ENVIRONMENTAL CHANGE**

Technology in industry 4.0 provides convenience from a smaller scale to a larger scale such as matters of national administration and is evolving in line with new discoveries and in meeting various diverse needs. The close relationship of today's generation with the internet (Burange & Misalkar, 2015) is one of the direct effects of the IR4.0 with more technological advances through digital systems developed through cyber physical systems, smart factories, internet of things, and internet service (Hermann, Pentek & Otto, 2016).

This results in an increased production of electronic products with an increase in uncontrolled electronic waste (e-waste) (Putu Udiyana Wasista, 2020; Deubzer, 2011) such as solid wastes from electronic goods that can no longer be used or expired (end of life) (Deubzer, 2011). Dangerous toxic substances cause environmental pollution and further exacerbate the global climate crisis (Putu Udiyana Wasista, 2020). There are over 100 scholarly articles from 1996 to 2012 written on the issues and adverse effects of electronic waste. Data on the adverse effects of e-waste are published through specialized websites which state the increasing amount of global electronic waste from the year of 2010 to 2018 (Putu Udiyana Wasista, 2020).

To address this, the management of electronic waste requires collaboration between the central government and the private sector as exemplified in Portugal. Special garbage dumpsters for electronic garbage at shopping malls in the country have been set up to facilitate the public in disposing electronic garbage. In an interview, Prof. Aux. Flavio of University of Minho Portugal states that, "...*Provincial government doesn't provide whole system for every region, because of decentralization. Government provide to other institution then institution provide to public. Some of public place like malls provide e-waste collector bin, people can throw their e-waste like cell phone, batterays, and other small electronic appliances to the e-waste collector bin...*" (Riza Fadholi Pasha, 2015: 368-369).

The downside of solely prioritising economic growth is the depletion of natural resources as well as causing environmental pollution (Sabri & Teoh, 2006). Uncontrolled disposal of e-waste, toxic and nuclear waste, incineration of fossil fuels in industry cause increased water pollution, air pollution, ozone depletion, mangrove swamps and jungles, declining natural resources, rising temperatures and acid rain problems (Yaacob, Hameed & Ismail, 2003).

A heightened awareness of the importance of the environment should be used as a balancing factor against the rapid technological advancement in Industry 4. Environmental destructions result in increased landslides, floods, depletion of ozone to name a few (Sabri & Teoh, 2006; Yaacob, Hameed & Ismail, 2003). Nonetheless, there is still low and disappointing level of public awareness on the importance of caring for the environment

(Mahat, et.al., 2015) coupled with some unclear understanding of the environmental care (Desjean-Perrota, Moseley & Cantu, 2008). Hence, awareness on preserving the environment in order to create a sense of responsibility plays a crucial role (Satem, A., 2004).

Environmental-related problems should be resolved through education (Lampa, Greculescu & Todorescu, 2013; Moroye, 2005; Hopkins & McKeown, 2002) although it would be a misguided attempt to change the attitudes towards environmental through persuasion (Yaacob, 2000). Nonetheless, it of equal importance to increase individual awareness of the environmental quality to transform society towards a more sustainable development (Foo, 2013; Fielding & Head, 2012; Doost, et.al., 2011). Despite the goal of producing a proactive attitude when it comes to the environmental problems, individual and public awareness is still not fully achievable (Yaacob, 2000). Continuous efforts through environmental education are crucial for the next generation (Perikleous, 2004). The human psychology also must be taken seriously since there are many challenges of 4IR and one has to be prepared physically, emotionally, spiritually, intellectually, and socially (Abu Zahrin et al. 2022).

## CONCLUSION

The IR4.0 has brought great influence on the world progress which should be anticipated despite the rapidly changing future. Despite facilitating easier tasks and solving complex solutions, the rapid IR4.0 progress has underlying weaknesses at the detriment of human nature and the natural environment. Hence, in addition to technological advancement of the IR4.0 era that serves as an indicator of human intelligence and competitiveness, there are still challenges ahead if the advancement is not aligned to ethical, society and religious values. Therefore, the present study suggests the need for a guideline or a model system based on human values which are in line with the technological advances of IR4.0.

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## Conflict Of Interest

The authors would like to declare no conflict of interest.

## REFERENCES

- Abdul Aziz, A. R. 2005. Nilai & Etika dalam Pembangunan. Sintok: Penerbit Universiti Utara Malaysia.
- Abdul Khalil, A., Othman, M. K. & Saidon, M. K. 2020. Memacu Pendidikan di Era Revolusi Industri 4.0: Penerapan Nilai-nilai Islam dan Inovasi dalam Pengajaran di Institusi Pengajian Tinggi. *Islamiyyat (Isu Khas)* 42: 13 - 20
- Abdul Malik. 2019. Creating Competitive Advantage through Source Basic Capital Strategic Humanity in the Industrial Age 4.0. *International Research Journal of Advanced Engineering and Science*. 4(1): 209-215.
- Ali, S., Rose Alinda, A., Syed Norris, H., Marlia, P., & Siti Hamisah, T. 2017. Higher education 4.0: Current status and readiness in meeting the fourth industrial revolution. Ministry of Higher Education Malaysia, (August), 23–24.
- Arizmendi, C., Pronk, B., & Choi, J. 2014. Services no longer required? Challenges to the state as primary security provider in the age of digital fabrication. *Small Wars Journal*, 22(11). Retrieved from, <http://smallwarsjournal.com/print/15839>.
- Badhrulhisham, A., Johar, M. H. M. & Rashid, T. A. 2019. Mendeapani Cabaran Revolusi Industri 4.0 (IR 4.0) Dalam Konteks Mahasiswa: Analisis Menurut Perspektif Islam. *Jurnal Ilmi*. 1(9): 90-101.
- Bringle, R. G., & Hatcher, J. A. 1995. A service-learning curriculum for faculty. *Michigan Journal of Community Service-Learning*. 2: 112–122.
- Bringsjord, S. (2008). Ethical robots: The future can heed us. *AI & Society*, 22(4): 539-550.
- Burange, A. W. & Misalkar, H. D. 2015. Review of Internet of Things in development of smart cities with data management & privacy. *International Conference on Advances in Computer Engineering and Applications*, Ghaziabad, 2015: 189-195.
- Che Harun, C.S., Yaacob, M., Abu Zahrin, S.N. & Wan Hassan, W.Z. 2023. Challenges in educational values and 4th industrial revolution. *Jurnal Hadhari: an International Journal* 15(2): 167-182.
- Daniel, J. 2012. Making sense of MOOCs: Musings in a maze of myth, paradox and possibility. *Journal of Interactive Media in Education*, 3(18).
- Desjean-Perrota, B., Moseley, C., & Cantu, L. E. 2008. Preservice teachers' perceptions of the environment: Does ethnicity or dominant residential experience matter?. *Reports & Research*, 39 (2): 21-31.

- De Stefano, V. 2016. The rise of the “just-in-time” workforce: On-demand work, crowdwork, and labor protection in the gig-economy. *Comparative Labor Law & Policy Journal*, 37: 471-503.
- Deubzer, Otmar. 2011. *E-waste Management in Germany*. United Nations University Institute for Sustainability and Peace (UNU-ISP). Bonn: Germany.
- Doost, H. K., Sanusi, Z., Fariddudin, F., & Jegatesan, G. 2011. Institutions of higher education and partnerships in education for sustainable development: Case study of the regional centre of expertise (RCE) Penang, Malaysia. *Journal of Sustainable Development*, 4(3): 108–117.
- Fana M. Sihlongonyane, Mbongi Ndabeni Lindile L. Ndabeni and Busisiwe Ntuli. 2020. *The Fourth Industrial Revolution: Synopses and Implications for Sti Policy Development*. Science and Innovation: Republic of South Africa.
- Feng D, Reed DB, Esperat MC, Uchida M. 2011. Effects of TV in the Bedroom on Young Hispanic Children. *American Journal of Health Promotion*. 25(5): 310-318.
- Fielding, K.S., & Head. B.W. 2012. Determinants of young Australians’ environmental actions: The role of responsibility attributions, locus of control, knowledge and attitudes. *Environmental Education Research*, 18(2): 171-186.
- Foo, K.Y. 2013. A vision on the role of environmental higher education contributing to the sustainable development in Malaysia. *Journal of Cleaner Production*, 61: 6-12.
- Frey, C. B., & Osborne, M. 2017. The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, 114 (23): 254-280.
- Graham Brown-Martin. 2018. Education and the Fourth Industrial Revolution (Jan 15, 2018). Retrieved from, <https://medium.com/@grahambm> (24 October 2020).
- Haas, B. 2017. China Bans Religious Names for Muslim Babies in Xinjiang. *The Guardian*, (April 24, 2017) World news. Retrieved from <https://www.theguardian.com/world/2017/apr/25/china-bans-religious-names-for-muslims-babies-in-xinjiang> (27 August 2020).
- Hasim, N. A., Amin, L., Mahadi, Z. Mohamed Yusof, N. A., Che Ngah, A., Yaacob, M. Olesen, A. P. O. & Abdul Aziz, A. 2020. The integration and harmonisation of secular and Islamic ethical principles in formulating acceptable ethical principles in formulating acceptable ethical guidelines for modern biotechnology in Malaysia. *Science and Engineering Ethics* 26: 1797-1825.
- Hermann, M., Pentek, T., & Otto, B. 2016. Design principles for industrie 4.0 scenarios. In *System Sciences (HICSS)*. 2016 49th Hawaii International Conference on: 3928-3937.
- Hopkins, C. & McKeown, R. 2002. Environment education for sustainability: Responding to the global challenges. In D.Tilbury, R.B.Stevenson, J. Fien, & Schreuder (Eds.), *Education and sustainability: Responding to the global challenge*. Cambridge: IUCN (World Conservation Union).
- Irianto, D. 2017. *Industry 4.0: The challenges of tomorrow*. Seminar Nasional Teknik Industri, Batu Malang.
- Kagermann, H. Lukas, W.D., & Wahlster, W. 2013. Final Report: Recommendations for Implementing the Strategic Initiative Industrie 4.0. *Industrie 4.0 Working Group*, Germany.
- Keoh, S., Kumar, S. and Tschofenig, H. 2014. Securing the Internet of Things: a standardization perspective. *IEEE Internet of Things Journal*. 1(3): 265-275.
- Keong, GC. 2017. Judicial Reforms through the Use of Technology in Malaysia. *European Academic Research*, 5(1): 399-409.
- Kim, J., & Heo, W. 2018. A Study on Issues and Tasks of Humanity and Social Science in a Fourth Industrial Revolution Era. *Journal of Digital Convergence*, 16(11): 137–147.
- Lampa, I., Greculescu, A., & Todorescu, L.-L. 2013. Education for sustainable development-Training the young generation for the Future. *Procedia-Social and Behavioral Sciences*, 78: 120-124.
- Majidah, Dian Hasfera & M. Fadli. 2019. Keterampilan literasi informasi mahasiswa dalam menghadapi revolusi industri 4.0. *Shout al-Maktabah: Jurnal Perpustakaan, Arsip dan Dokumentasi*, 11(1): 1-11.
- Mahat, H., Idris, S., Hashim, M., Nayan, N. & Saleh, Y. 2015. Transforming Sustainability Development Education in Malaysian Schools through Greening Activities. *Review of International Geographical Education Online*, 5(1): 77-94.
- Miftachul Huda, Kamarul Azmi Jasmi, Aminudin Hehsan & Ismail Mustari. 2017. Empowering Children with Adaptive Technology Skills: Careful Engagement in the Digital Information Age. *International Electronic Journal of Elementary Education*, 9(3): 693-708.
- Mohd Ayub, A. F., Zainal Abidin, N. & Suwirta, A. 2014. Hubungan Antara penggunaan internet bermasalah umum dan kesunyian dalam kalangan pelajar sekolah menengah. *Jurnal Kajian Pendidikan*, 4(2): 189-200.
- Moroye, C. 2005. Common ground : An ecological Perspective on teaching and learning. *Curriculum and Teaching Dialogue*, 7(1/2): 123–139.
- Pasco, J.A, Jacka F. N., Williams L. J., Brennan SL, Leslie E & Berk M. 2011. Don’t worry, be active: positive affect and habitual physical activity. *Australian and New Zealand Journal of Psychiatry*, 45(12): 1047-1052.
- Perikleous, E. 2004. The status of environmental education in Cyprus today. (In) MIO-ECSDE. The status of environmental education in the mediterranean countries within the formal & non-formal educational systems. December, Issue No. 34.
- Pratama, D. A. N. 2019. Tantangan Karakter Di Era Revolusi Industri 4.0 Dalam Membentuk Kepribadian Muslim. *Al-Tanzim: Jurnal Manajemen Pendidikan Islam*, 3(1): 198-226.
- Putu Udiyana Wasista. 2020. Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0. *Prosiding Seminar Nasional Desain dan Arsitektur (SENADA)*, Mac 2020, Vol. 3.



- Rahman, N. A. A., Kadir, S. A., Mohammad, M.F., & Moin, M. I. 2017. Higher Tvet Education in Aviation: Teaching Quality and a Master Key to Industry 4.0. *International Journal of Education, Psychology and Counselling*, 2(5): 44-53.
- Riza Fadholi Pasha. 2015. Identifikasi Karakteristik Sampah Elektronik (E-Waste) dan Implikasinya pada Kebijakan Daerah di Kota Yogyakarta. *Jurnal Bumi Indonesia*. 364-374.
- Sabri, M. F. & Teoh, Y. Y. 2006. Tahap keprihatinan alam sekitar dan amalan kepenggunaan hijau pengguna di Petaling Jaya, Selangor. *Pertanika Journal of Social Sciences & Humanities*, 14 (2): 95-109.
- Satem, A. 2004. *Asas Pembentukan Sekolah Lestari*. Dewan Bahasa dan Pustaka: Kuala Lumpur.
- Schwab, K. 2016. *The Forth Industrial Revolution*. World Economic Forum, 2016. Geneva.
- Shen, S. 2011. The Curious Case of Human-Robot Morality. *IEEE International Conference*: 249-250.
- Stapa, Z., Ismail, A. M. & Yusuf, N. 2012. Faktor persekitaran sosial dan hubungannya dengan pembentukan jati diri. *Jurnal Hadhari Special Edition (2012)*: 155-172.
- Abu Zahrin, S.N., Sawai, R.P., Sawai, J.P. & Che Harun, C.S. 2022. Muslim psychologists in facing challenges of the 4.0 industrial revolution. *Islamiyyat: International Journal of Islamic Studies* 44 (1): 145-156.
- UN Web TV. 2017. 'Sophia' the robot tells UN : I am here to help humanity create the future. *The Guardian*. <https://www.theguardian.com/technology/video/2017/oct/13/sophia-the-robot-tells-un-i-am-here-to-help-humanity-create-the-future-video> (24 September 2020).
- US Bureau of Labor Statistics. (1 September 2020). *Occupational Outlook Handbook*. Retrieved from, <https://www.bls.gov/ooh/> (25 October 2020).
- Vaidyaa, S., Ambadb, P. &, & Bhoslec, S. 2018. Industry 4.0 – A Glimpse. *2nd International Conference on Materials Manufacturing and Design Engineering*, 20: 233–238.
- Van Badham. 2017. We can beat the robot, with democracy. *The Guardian*. Retrieved from, <https://www.theguardian.com/commentisfree/2017/nov/03/we-can-beat-the-robots-withdemocracy> (11 August 2020).
- Vitz, P. C. 2016. The Role of the Family in the Transmission of the Moral Life. *Journal of Law, Philosophy and Culture*, 3(1): 181–198.
- Wang, W., & Siau, K. 2019. Artificial Intelligence, Machine Learning, Automation, Robotics, Future of Work and Future of Humanity: A Review and Research Agenda. *Journal of Database Management (JDM)*, 30(1): 61-79.
- Wood, J., Nguyen, T., Sharda, S. & Schlosser, A. 2017. ASEAN 4.0: What does the Fourth Industrial Revolution mean for regional economic integration? White paper: World Economic Forum and the Asian Development Bank (ADB).
- Yaacob, M. 2000. Pembangunan, pambandaran dan masalah persekitaran dalam konteks pembangunan berterusan. *MALIM: Jurnal Pengajian Umum Asia Tenggara*, 01.
- Yaacob, M. R., Hameed, R. S. & Ismail, N. R. 2003. Perceptions of educated consumers on environmentally friendly products in the East Coast of Peninsular Malaysia. *Malaysian Journal of Consumer and Family Economics*, 6: 42-49.
- Yaakob Z. 2018. Alam sekitar dan environmentalisme dalam menghadapi Revolusi Industri Keempat. *Wacana Usuluddin & Falsafah siri 1/2018*. Bangi: UKM.
- Zhou, K., Taigang L., & Lifeng, Z. 2015. Industry 4.0: Towards future industrial opportunities and challenges. In *Fuzzy Systems and Knowledge Discovery (FSKD)*, IEEE 12th International Conference: 2147-2152.