

REVIEW ARTICLE

Drone technology in maternal healthcare in Malaysia: A narrative review

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Abstract

Introduction: The vast advancement of technology and breakthrough in high-tech disciplines created multiple areas of research activities, including the emergence of the medical drone. Malaysia, a rapidly developing country in Southeast Asia is on track to achieving high-income status. However, the stagnant growth of Malaysian maternal healthcare does not run parallel with the aspiration. This review paper assessed and reported narratively the current condition of maternal healthcare in Malaysia, the possible application of drones in improving the sector, exploring in detail several challenges, and providing recommendations for experts in studying the rising technological phenomena. **Materials and Methods:** A literature search was done from June 2019 to November 2019 with restrictions to the English language. The search was performed in ScienceDirect, PubMed, and EMBASE databases, using a combination of search terms related to drones, Unmanned Aerial Vehicles (UAV), Unmanned Aerial Systems (UAS), maternal, obstetric, healthcare, medical products transportation and Malaysia. A discourse analysis followed and a narrative review was provided on this subject. **Results and Discussion:** The validated ability of drones in the delivery of blood products is highlighted as a possible application in improving maternal healthcare in Malaysia, particularly in the state of Sabah. Five key challenges are identified: infrastructure, technicalities, regulations, expertise, and social acceptance. Future predictions of drone technology in healthcare were outlined with the suggestion of three principle arms of application. **Conclusion:** The usage of the medical drone in medical products transportation supports the objectives of WHO MDG 5 for Malaysian maternal health. A study on the impact of drones in reducing the maternal mortality ratio is recommended for further exploration.

Keywords: Drone, obstetric emergencies, blood delivery, maternal healthcare, Malaysia

INTRODUCTION

Brief History of Drone and Malaysian Maternal Healthcare

Exponential developments in recent technology have created a new environment in the global megatrend and have continuously reshaped our future. Breakthroughs in high-tech disciplines such as digitalisation, Internet of Things (IoT), automation, cognitive computing, and artificial intelligence (AI) have increased both opportunities and challenges to the healthcare sector and community.¹ These advances include the creation and remarkable innovation of drone

technology. Drone or Unmanned Aerial Vehicle (UAV) is a small aircraft that is remotely controlled by operators.

Historically, it was designed as an automatic airplane as early as World War 1, and its successful deployment was first reported in the rescue of US special operations Marine using Gyrodyne QH-50 Drone Anti-Submarine Helicopter model.² To date, researchers continue to develop more studies and provide scientific evidence on the impacts of drones in various fields including healthcare.

Previously, a drone was perceived as a negative technology as it was used in military

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target killing, weapons, and active combats.³ Research and development activities successfully innovate drones from their initial weaponise and destructive use into constructive and lifesaving technology. For example, in 2018, the drone was already used for rescue and humanitarian missions during the hurricane Katrina and Haiti earthquake by providing medical supplies delivery to the victims. The drone was also used in aiding research into infectious disease led by Chris Drakeley, a professor of infection and immunity at the London School of Hygiene & Tropical Medicine, United Kingdom. His research tracked an emerging problem with *Plasmodium knowlesi* malaria in Sabah in Malaysia.⁴ The usage of drones in healthcare continues to expand worldwide including delivery of medical products and machines, rescue missions and remote telemedicine.

Malaysia, a rapidly developing country in Southeast Asia with a gross national income (GNI) per capita of US\$10,460, aspires to become a high-income nation by 2024.⁵ In addition, the Malaysian healthcare is also recognised internationally as a successful health system model. It was reported in the World Health Organization (WHO) health system review that “Malaysia has achieved impressive health gains for its population with a low-cost healthcare system that provides universal and comprehensive services”.⁶ The maternal

healthcare system in Malaysia has also improved greatly over the time period 1963–2013, with the maternal mortality ratio (MMR) falling by 89 percent, from 210 deaths per 100,000 live births to 23.2 deaths.

However, despite the remarkable performances in the Malaysian maternal healthcare, the MMR is still far from the Millennium Development Goal 5 (MDG-5) target outlined by WHO. The MDG target for Malaysia is to reduce MMR to 11 deaths per 100,000 live births by 2015 (Figure 1). The target also has plateaued over the past 15 years, with a slight increase between 1989 and 2012 from 19.6 to 23.2.⁷ Thus, this review paper aimed to assess and report narratively the possible application of the drone in improving the current situation in maternal healthcare in Malaysia, how it can be adopted, what are the possible key challenges of its implementation, and provide recommendations for practitioners, policymakers, commercial sectors, investors and researchers studying this rising phenomenon of drone technology.

METHOD

Critical understanding of extensive subjects involving the relationship of drone technology and societal impacts in maternal healthcare requires a suitably broad approach. We conducted a comprehensive literature search from June 2019

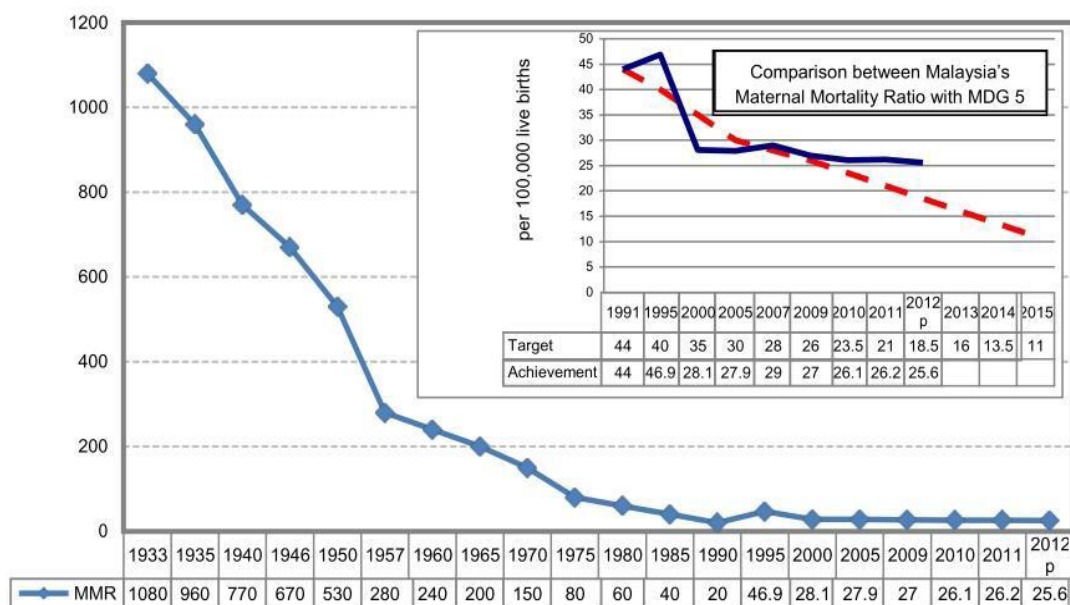


FIG. 1: Comparison of Malaysia's Maternal Mortality Ratio (MMR) with WHO Millennium Development Goal 5 (MDG 5) from 1993 to 2015. (Source: *Malaysian Health and Healthcare Performance Report General Health Status Maternal and Child Mortality* 2014).

to November 2019. The search was performed in ScienceDirect, PubMed, and EMBASE databases, using a combination of search terms related to drones, Unmanned Aerial Vehicles (UAV), Unmanned Aerial Systems (UAS), maternal, obstetric, healthcare, medical products transportation and Malaysia. We also included original research, systematic reviews, documents from scientific societies, inter-governmental organisations, and departments of health, related to maternal healthcare and drone technology. It is then followed by discourse analysis of these various documents to investigate the adaptation of drone technology in maternal healthcare and provide a narrative review on this subject. All documents were restricted to the English language during the search.

RESULT AND DISCUSSION

Drone as medical products transportation in maternal healthcare

The most common types of transportation in maternal healthcare are ground transportation (MedGRT) and air transportation (MedART). MedGRTs such as cars and ambulances are often used for inter-hospital transfer of patients as well as delivery of blood products in obstetric emergencies. MedART such as helicopters and planes help in more challenging geographical situations. Over the past ten years, studies on medical transportation have increased in numbers due to the desire to develop an efficient delivery system of medical management to patients. The choice of transportation in healthcare varies according to three striking factors: patient health status, socioeconomic status and geographic variability.⁸

In the near future, researchers believe that drones will be the next mode of medical products transportation. Sabah, a state in Malaysia, is located on the north of the island of Borneo and bordered by the South China Sea in the north, east and west. Sabah has an equatorial climate and covers nearly 25 percent by tropical rainforests. The geographical terrain of Sabah contributes to the challenges of transporting medical products. In Sabah and Labuan (an island province in Malaysia), even water transportation such as ferries and boats are used to deliver blood samples and blood products due to the considerable water barrier of more than 120 kilometers between the main blood processing center and receiver (Figures 2 and 3). Ground transportation in Sabah is extremely difficult and air transportation is less commonly used

as it is expensive for the health institution. Consequently, this condition has affected the MMR in Malaysia where the highest percentage of massive postpartum haemorrhage (PPH) cases is recorded in Sabah.⁹

Given the current situation, drones are an emerging technology in the Fourth Industrial Revolution (4IR) that can act as an alternative maternal healthcare delivery system in Sabah, Malaysia.¹⁰ Firstly, drones reduce travel time for diagnosis and treatment. According to a study in the Bavarian Alps in Germany, a parcel drone delivery trial took 8 minutes compared to 30 minutes by road trip, a significant reflection in saving time for obstetric emergencies. The faster drone response is estimated to increase the chances of maternal survival to 80% versus 8% for traditional emergency services.¹¹ Hence, timely and efficient access to medical treatment in obstetric emergencies may overall provide a solution for massive PPH, the main underlying factor of maternal death.¹²

Secondly, drones can overcome geographic variability. A California-based drone company called Zipline is currently serving the blood delivery system in Rwanda.¹³ Like Rwanda, Sabah is the second largest state in Malaysia, and it is also dominated by mountains and hills including the presence of Mount Kinabalu, the highest mountain in Southeast Asia. Many Sabahans live in remote locations with unreliable road infrastructure for access to health facilities. The remarkable ability of drones to overcome impassable terrain provides an ideal alternative transport system in the Malaysian maternal healthcare.¹⁴

Drone delivery of blood products for obstetric emergencies is possible and may serve as a way to improve MMR in Malaysia. In 2015, researchers from Johns Hopkins University School of Medicine conducted a pilot study of routine transport of diagnostic clinical laboratory specimens using drones. The results demonstrated that drone transportation does not affect the accuracy of routine chemistry, hematology, and coagulation test results.¹⁵ Later in 2016, the team also proved that there was no adverse impact of drone transport on blood products including Packed Red Blood Cells (PRBC), Platelet (PLT), and Frozen Plasma (FP24).¹⁶ To the best of our knowledge, there are only three published original research thus far that looked into this subject, and aggressive research needs to be carried out to further develop the full potential of the medical drone delivery

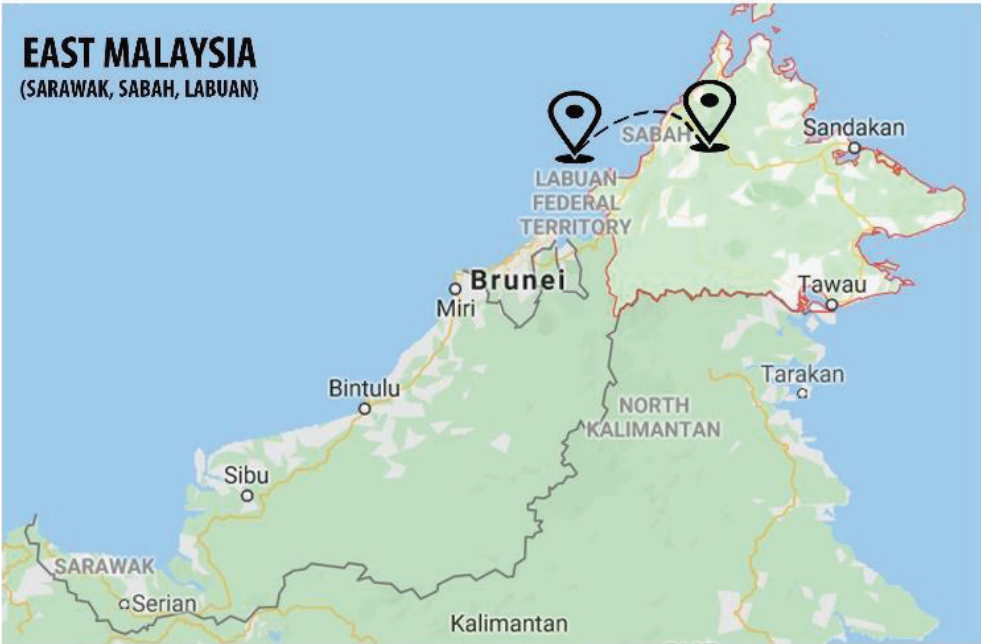


FIG. 2: Maps of East Malaysia depict the location of Sabah and Labuan province of Malaysia.

system and its adaptation in maternal healthcare. In particular, there has been no published data on issues pertaining to drone transportation of medical products in harsh tropical weather – the

heat, hale and rain.

Until this review paper was completed, no research has yet been conducted on the drone delivery of medical products in relation



FIG. 3: Photograph shows the ferry used between Sabah and Labuan regions of Malaysia for blood products transportation due to the distance of over 120 kilometers.

to direct maternal healthcare outcomes such as the impact of drone delivery in improving maternal morbidity, let alone mortality ratio. Fast response and efficient delivery of blood products are paramount in saving mothers' lives during obstetric emergencies.¹⁷

Key challenges in a drone transport implementation

Successful implementation of drone usage in maternal healthcare largely depends on the flexibility and versatility of the system to fit and meet local needs. Five key issues need to be addressed and tackled when it comes to technology pioneering: setting and infrastructure, technical limitations, regulations and legalities, talent and expertise, and social acceptance.

1. Setting and infrastructure

Lack of infrastructures such as drone stations, warehouses, and launchpad is a potential problem in drone operations as drones require continuous ground-based monitoring.¹⁸ This is important to ensure public safety, the safety of medical products delivery, and the safety of the unmanned vehicles themselves. Apart from the challenge of customising drones and its cargo carrier according to the nature of the products to be delivered, expertise is also needed in the development of drone infrastructure, and in determining the location decisions of warehouses in order to enable a timely delivery between distributors and receivers (demand points). The financial constraint also plays an important role in building the capacity of the desired infrastructure. The overall cost-effectiveness of drones in medical products transportation is yet to be explored once introduced.

For blood products delivery using drones, one of the crucial settings that is required is the drone hub, a specialised centre for drone-related activities such as launch preparation, maintenance works, parcel packaging, and monitoring station. Evan *et al.* (2019) described this infrastructure built in Rwanda as a "fulfillment centre" or "nest" comprising of a small cluster of buildings for drone activities. The hub is necessary to be equipped with a launching pad, catapult or runway according to the type of drone that will be used for the blood delivery.¹³

In addition, the location of the drone hub plays an important role in determining its functionality. The best location for building such infrastructure is within a short distance of the supplying blood

bank in order to routinely receive blood supply and must be located not too far from the health facilities to be served, in order to ensure the ability of the drone to fly within the desired flight distance. A study conducted by Judy *et al.* (2017) highlighted this trade-off issue of location decision between drone hub and demands points. The study also proposed at least two models of calculation of location decision to enable timely and efficient drone delivery in healthcare.¹⁹

2. Technical limitations

Current developments in drone technology are faced with several technical limitations. These limitations include the maximum payload capacity, the distance range and the average speed capability. The payload capacity of drones is defined as the total weight of products capable of being transported by drone, excluding drone-mounted equipments such as cameras, radars, sensors, and constructional components such as propellers, batteries and rotors. While each drone is designed according to its main purpose, their payload capacity is directly related to their distance range, average speed and battery life.

As an example, in the delivery of blood products, researchers require to know the minimum amount of blood needed to be transported during obstetric emergencies in order to save lives, together with the maximum payload capacity of the designed drone. The complex balance of size, power and weight is one of the greatest challenges for researchers to determine the ideal specifications for building medical drones as a cost-effective mode of transport.

Julián E. (2020) described this issue of technical limitations of weight and capacity in medical drone delivery and highlighted on the scarce empiric evidence and experiments, particularly the performance of the medical drone in different environments such as bad weather, extreme temperatures and dust.²⁰

3. Regulations and legalities

The surging popularity of drones has become an increasing security concern. Many flight disruptions were reported in multiple countries. For instance, in 2018 London's Gatwick Airport had flights grounded for 36 hours due to repeated drone sightings, stranding tens of thousands of passengers. Similar incidents also occurred in Singapore's Changi Airport. Research conducted by the Department for Transport (DfT) of the United Kingdom revealed that a small drone

weighing 400 grams is possible to break a helicopter windscreen, and a big drone weighing 2 kilograms can cause real damage to a passenger aircraft's windscreen.

While technology is evolving rapidly, countries around the globe have begun to draft drone laws and regulations. Currently, some of the rules listed are prohibition zones for drones, within an aerodrome traffic zone including airports and government facilities, the requirement for a pre-flight authorisation, and restriction against flying drones above 20 kilograms (44 pounds) without explicit written permission from the authorities.²¹ For Malaysia, drone laws are contained in the Civil Aviation Regulations 2016 (P.U.(A) 97) and closely monitored by the Civil Aviation Authority of Malaysia (CAAM).²² The Royal Malaysian Police (PDRM) has also started deploying anti-drone guns capable of disrupting drones from a distance of up to one kilometer as safety measures.

This understanding is interpreted as a challenge for the implementation of drones for healthcare including blood products delivery. As an example, a drone that will be used in the transportation of blood products will need to acquire CAAM authorisation as the flight altitude between blood bank and health facilities is almost certainly more than 400 feet from ground level and carries a biohazard package. The bureaucracy in obtaining this authorisation will consequently cost time and money for the healthcare industries in accomplishing the medical drone transportation. Therefore, a change in the current regulations is needed in order to fit the necessities of the technology upon system deployment. Any ambiguity and lack of clarity in the framework of legislation may give rise to uncertainty and leaves much room for misinterpretation or exploitation.

4. Talent and expertise

The issue of key talent is crucial in achieving the goals of medical drone development as a mode of transportation. Talents and expertise are expected to be available throughout the entire process, from assembling, maintaining, and operating the drone. The workforces also need to develop skills in management, detection, and elimination of malfunctions in drones, the use of technical equipment, remote piloting and the performance of operational missions. A job related to drone technology implies diverse

specialisations such as technician, operator, external pilot, programmer, and a few other expertise associated with high-tech industries and entrepreneurship.

For drone transportation of blood products delivery, one of the crucial talents is a pilot or co-pilot who is equipped with knowledge and skill sets of handling biohazards parcels. The knowledge and skill sets such as securing the package and removing the parcel from the drone carriage are important during the course of blood products delivery. These talents are also required to manage any drone accidents or unavoidable circumstances during the delivery process to ensure the safety of the parcels, civilians, and staff. Hence, the realization of this challenge is extremely critical for scientists, researchers, policymakers, industrial stakeholders and healthcare providers. Lack of these competencies can potentially threaten public safety and lead to failure to achieve positive outcomes in the healthcare sector.

5. Social Acceptance

Many issues have been raised regarding social and ethical aspects of drone development and its benefits to the community. Three principle concerns are identified, which include potential privacy infringement, dual-use of drone technology, and law enforcement of regulatory bodies.²³ The arguments lie on the basis of whether the existing regulations are capable of protecting citizens' privacy, and the cost-effectiveness justification of medical drones that may lead to a higher life-cycle cost for operations. A survey using the Knowledge Attitude Practice (KAP) model revealed that drones were not well accepted at present except for security and scientific research purposes.²⁴

Thus, the use of drones for blood products delivery should also take into consideration the acceptance rate of the drone technology and the readiness among the public and healthcare personnel such as doctors and scientific officers who are involved directly with the supply chain of blood products. Their acceptance and readiness to embrace what may be viewed as disruptive technology are important to facilitate the integration of drone technology into the Malaysian healthcare system. However, in spite of the importance, we found no local study exploring these perspectives of research at the moment and further studies are needed in this direction.

Future predictions of drone technology in healthcare

Top experts in drone technology believe drones or UAV is the future of business and human activities. It is anticipated that drone operators have a great financial prospect and will be among the top fifty jobs of the future. Comprehensive reports published by market analysts worldwide highlighted that the drone market is projected to display a robust growth, represented by a Compound Annual Growth Rate (CAGR) of 43% during 2019 – 2024.²⁵ This is enhanced by the prediction of the global drone market to be more than USD43 billion in 2024.

Despite the extensive technological revolution, the progress of medical drones is undeniably snail-paced. Nonetheless, drones are starting to play a larger role in saving lives. Conclusively, there are three fundamental arms of medical drone research for healthcare applications: search and rescue, medical care, and transport/delivery system (Figure 4). Search and rescue include disaster management, wilderness medicine, and water rescue, medical care including remote telemedicine, teleradiology, and robotic arm and transport/delivery system such as the delivery of

blood products, vaccines, medicines, anti-venom, laboratory samples, and Automated External Defibrillator (AED) device. These arms can be innovated further and applied to improve global maternal healthcare in order to achieve WHO MDG-5 targets for multiple countries including Malaysia.

CONCLUSION

Drones or UAVs have high potential to become a holistic solution for improved maternal healthcare in Malaysia. This is due to their faster response time, expected reduced transportation costs, and improved medical products or services delivery to remote areas such as the interior of Sabah. Among the suggested applications to be explored is the drone as a medical products transportation in obstetric emergencies. We recommend researchers look further beyond the currently available study, by relating the impact of drones in reducing MMR or on the number of assisted cases of obstetric emergencies. Nevertheless, the key challenges are present and need to be confronted by researchers. Together with the ongoing 4IR, the usage of medical drones in Malaysia will certainly support

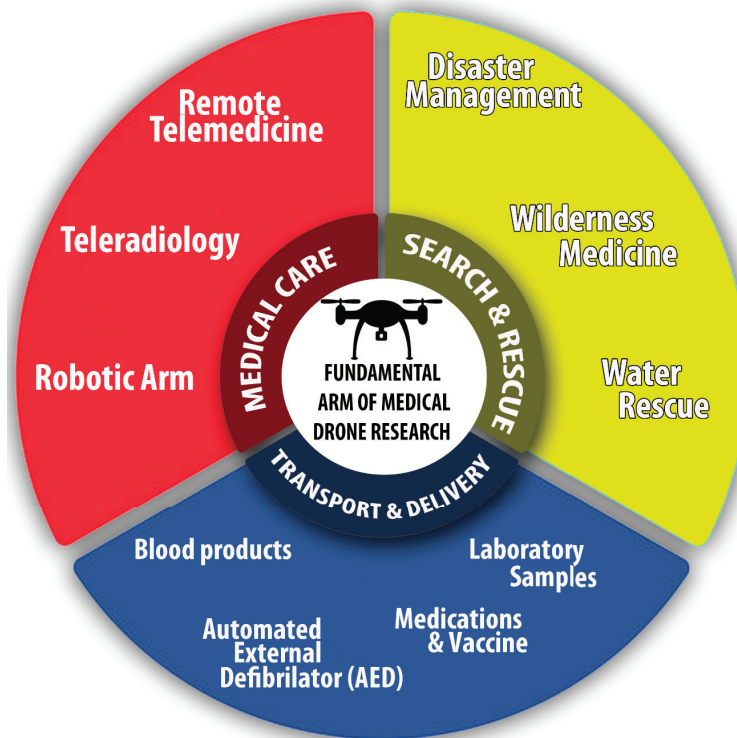


FIG. 4: Fundamental arm of medical drone research for healthcare applications.

MDG5 and SDG5 to reduce maternal mortality and morbidity and provide universal access to reproductive health.

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Authors' contributions: MAHZ led the review, was responsible for managing the synthesis, data extraction and drafted the report. RZARS provided expert clinical advice (pathology) and reviewed the final report. RAR provided expert clinical advice (obstetrics & gynaecology) and reviewed the final report. IMS provided expert clinical advice (emergency medicine) and reviewed the final report. AI provided advice for the narrative review and methodology and reviewed the final report. ZAM provided advice on the methodology and narrative review, made critical comments that helped in the interpretation of the results, helped in writing sections of the report and reviewed the final report. All authors read and commented on draft versions of the report.

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REFERENCES

- Five Megatrends and Their Implications for Global Defense & Security. [homepage on the internet] PricewaterhouseCoopers (PwC), 2016 [cited 2020 Jan 6]. Available from: www.pwc.co.uk/megatrends
- Ling G, Draghic N. Aerial drones for blood delivery. *Transfusion*. 2019; 59(S2): 1608-1611.
- Rao B, Gopi A, Maione R. The societal impact of commercial drones. *Technol Soc*. 2016; 45: 83-90.
- Sachan D. The age of drones: What might it mean for health? *The Lancet*. 2016; 387(10030): 1803-4.
- Malaysia to become high income nation. [homepage on the internet] Ganeshwaran K, 2019 [cited 2020 Jan 6]. Available from: <https://www.thestar.com.my/business/business-news/2019/07/02/malaysia-to-become-high-income-nation#5RPzX5zAjhyHdyAF.99>
- Rifat A, Peter B, William H, *et al*. Malaysia Health Systems Research Volume I: Contextual Analysis of the Malaysian Health System. *M Health Sys R*. 2016; 1 (3): 65-92.
- Malaysian Health and Healthcare Performance Report 2014. Malaysian Healthcare Performance Unit. Ministry of Health Malaysia.
- Hanchate A, Paasche-Orlow M, Dyer K. Geographic Variation in Use of Ambulance Transport to the Emergency Department. *Ann Emerg Med*. 2010; 70(4): 533-43.
- Ravichandran J, Shama D, editors. 4th Report of National Obstetrics Registry 2013-2015. National Obstetrics Registry Malaysia.
- Zailani MA, Sabudin RZ, Rahman RA, Saiboon IM, Ismail A, Mahdy ZA. Drone for medical products transportation in maternal healthcare: A systematic review and framework for future research. *Medicine* 2020; 99: 36(e21967).
- Scott J, Scott C. Drone Delivery Models for Healthcare. In: 50th Hawaii International Conference on System Sciences. 2017; 3297-304.
- Ravichandran J, editors. MDSR: The Role of Government Agencies & Professional Bodies. In: Workshop on Maternal Death Review Kuala Lumpur. 2011; 1-19.
- Evan A, Michael K. The blood is here: Zipline's medical delivery drones are changing the game in Rwanda. *IEEE Spectrum*. 2019; 56(5): 24-31.
- Rosser J, Vignesh V, Terwilliger B, *et al*. Surgical and Medical Applications of Drones: A Comprehensive Review. *JSLs: Journal of Society of Laparoendoscopic Surgeons*. 2018; 22(3): 1-9.
- Amukele T, Sokoll L, Pepper D, Howard D, Street J. Can Unmanned Aerial Systems (Drones) Be Used for the Routine Transport of Chemistry, Hematology, and Coagulation Laboratory Specimens? *PLOS ONE*. 2015; 10: 1-15.
- Amukele T, Ness P, Tobian A, *et al*. Drone transportation of blood products. *Transfusion*. 2017; 57(3): 582-8.
- Gutierrez M, Goodnough L, Druzin M, *et al*. Postpartum hemorrhage treated with a massive transfusion protocol at a tertiary obstetric center: A retrospective study. *Int J Obstet Anesth*. 2012; 21(3): 230-5.
- Laksham K. Unmanned aerial vehicle (drones) in public health: A SWOT analysis. *J Family Med Prim Care*. 2019; 8(2): 342-6.
- Judy ES, Carlton HS. Drone Delivery Models for Healthcare. 2017. Proceedings of the 50th Hawaii International Conference on System Sciences 2017: 3297-304. URI: <http://hdl.handle.net/10125/41557>.
- Julián Estévez, The limitations of drones for medicine delivery. [Internet] 2020, September 9. [cited 2021 March 31]; Available from: <https://mappingignorance.org/2020/09/09/the-limitations-of-drones-for-medicine-delivery/>
- Time to update drone laws. [homepage on the internet] Qishin T, 2019. [cited 2020 Jan 5]. Available from: <https://www.thestar.com.my/tech/tech-news/2019/11/26/time-to-update-drone-laws>
- Tackling the drone menace. [homepage on the internet] Buang S, 2019. [cited 2020 Jan 6]. Available from: <https://www.nst.com.my/opinion/columnists/2019/07/501058/tackling-drone-menace>
- Boucher P, Philip B. Civil Drones in Society. Societal

- and Ethics Aspects Systems, Science and Policy Report, European Commission. 2014; 1-50.
24. Aydin B. Technology in Society Public acceptance of drones: Knowledge, attitudes, and practice. *Technol Soc.* 2019; 5(7): 101180.
 25. Global Drones Market Outlook By Industry Size, Share, Revenue, Regions And Top Key Players Analysis From 2019-2024. [homepage on the internet] Azoth A, 2019. [cited 2020 Jan 5]. Available from: <https://www.marketwatch.com/press-release/global-drones-market-outlook-by-industry-size-share-revenue-regions-and-top-key-players-analysis-from-2019-2024-2019-09-19>

ABBREVIATIONS

1. 4IR Fourth Industrial Revolution
2. AED Automated External Defibrillator
3. AI Artificial Intelligence
4. CAAM Civil Aviation Authority of Malaysia
5. CAGR Compound Annual Growth Rate
6. DfT Department for Transport
7. FP24 Frozen plasma within 24 hours of collection
8. GNI Gross National Income
9. IoT Internet of Things
10. KAP Knowledge Attitude Practice
11. MDG Millennium Development Goal
12. MedART Medical products Aerial Transportation
13. MedGRT Medical products Ground Transportation
14. MMR Maternal Mortality Ratio
15. PDRM The Royal Malaysian Police
16. PLT Platelet
17. PPH Postpartum Hemorrhage
18. RBC Red Blood Cell
19. UAS Unmanned Aerial System
20. UAV Unmanned Aerial Vehicle
21. WHO World Health Organization