Potential Use of UAVs in COVID19 Vaccination: A Case Study of Nepal

Pawan Thapa (✉ pawan.thapa@ku.edu.np)
Kathmandu University

Research Article

Keywords: Application, UAVs, Vaccine, COVID 19, Remote places

Posted Date: July 13th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-568371/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Potential Use of UAVs in COVID19 Vaccination: A Case Study of Nepal

Pawan Thapa¹

1. Department of Geomatics Engineering, Kathmandu University, Dhulikhel, Nepal
pawan.thapa@ku.edu.np

Abstract

Background: The infectious diseases vaccine program started in Nepal. Transportation facilities using uncrewed aerial vehicles (UAVs) will support the COVID 19 vaccine for remote areas where accessibility is unavailable and takes enormous time to reach the primary health center.

Methods: This case study provides one of the possible ways of transporting vaccines using UAVs to the remote areas of Nepal from two approaches; one approach will be by developing a customized prototype of UAVs and deploying it. The next will be studying the research articles on this particular field and implement them in this study.

Results: The results show that drones can supply the medical kit to the primary health post to reduce cost, time, and life. It has been practicing that literature review on this related field states UAVs' possible implication in handling pandemics.

Conclusion: This alternative can help to vaccine vulnerable groups deprived of health care. One of the significant steps to providing the vaccine for epidemic control in remote areas. It can support government plans to vaccine people incorporation with emerging technologies.

20

21 Keywords: Application; UAVs; Vaccine; COVID 19; Remote places

22

23

24

1. Introduction

25

26 The coronavirus threatens millions of lives worldwide; however, vaccines thrive to save and stimulate the body's immune system. This year, at least seven different vaccines intend to provide access to all the countries and their vulnerable groups (*COVAX*, n.d.; *COVID-19 Vaccines*, n.d.). More than 200 additional vaccines will develop in upcoming days, p where more than are in clinical development(Welle (www.dw.com), n.d.). Vaccine development and safe transport are critical issues for the developed and underdeveloped countries. Proper vaccination and transportation will be a game-changer for the world to minimize its spread. Remote and isolated people are among the significant problems in delivering the vaccination to undeveloped countries like Nepal. A handful of drone-delivery businesses are vying for a logistical role in transporting Covid-19 vaccinations from distribution facilities to health clinics, which it expects to be a massive and complex endeavor (*Drone Startups Aim to Carve out Role in Delivery of Potential Covid-19 Vaccine*, 2020; Vartabedian, 2020). To distribute Covid-19 vaccinations, several companies have lately formed medical delivery agreements with drug companies and merchants.

38

39 Meanwhile, some firms have explored their ability to deploy unmanned aerial drones to distribute vaccination doses, primarily in rural places, with governments worldwide. Nepal is the first country to receive COVID-19 vaccine doses via the COVAX Facility, a collaboration between CEPI, Gavi, UNICEF, and WHO made possible by generous donations from governments, international organizations, foundations, and the business sector (*Nepal among the First Countries in Asia to Receive COVID-19 Vaccines from COVAX Facility*, n.d.). Depending on funding, the COVAX Facility hopes to provide Nepal with enough vaccine doses to vaccinate 20% of the population. The COVAX Facility will supply 1.92 million vaccine doses to Nepal under the first COVAX allocation by the end of May 2021, supporting Nepal's statewide vaccination campaign (*DevelopmentAid*, n.d.).

48

49 The five people who arrived from the United Kingdom confirmed that they had a novel form of coronavirus. Many investigations have discovered that the government does not pay enough attention

50

to and plan for vaccination in rural areas. Few studies have been conducted in Nepal to understand better the COVID-19 epidemic's spread and predictability (Bhandary et al., n.d.; Thapa, 2020, 2021; White et al., n.d.). Vaccine distribution in Nepal's rural areas where road networks have yet to be developed. One alternative could supply from the nearest airport using drones for transporting to the isolated community health post. Since late 2018, many countries have employed drones to deliver vaccines (*Drones for Social Good* | UNICEF Office of Innovation, n.d.; *How Drones Can Help Get Vaccines to Where They Are Needed Most*, n.d.).

2. Materials and Methods

2.1. Study Area

More than half of the Nepalese population are still away from access to road facilities that impact million to get safe, nutritious food and health care (*A Closer Look at Hunger and Undernutrition in Nepal - Country Case Studies*, n.d.; *Why roads matter in Nepal*, 2013). It is one of the world's worst places for children, women, and old-aged people to fall ill. Almost half of its population lives in high mountains and rugged hills. People living in such places have the weakest infrastructure, such as roads, hospitals(*Nepal: Nutrition Profile*, 2018). Humla is not connected to the rest of the world via a road that runs through the isolated northwestern region. Nearly every local units build a road in the name of development; however, this cannot fully operate most of the time due to appropriate technical feasibility study. Simikot is at least four days' walk from the nearest road. A small district hospital in Simikot is not always fully staffed, and there are twelve health posts. Vaccine delivers in the rural, remote, and no-road access areas through UAV quadcopter drones to these health posts. It is a feasible option to support COVID 19 vaccine delivery to reach indigenous people in isolated areas.

2.2. Data Collection

The datasets acquired from the UAV quadcopter drone carry a heavy load up to 10-12 kg with a vaccine carrier box that maintains a low temperature for 3-7 days. The dimension of carrier is 40 cm x 30 cm x 30 cm. The total weight of the carrier around 8-9 kg and held 400 x 0.5 ml vials.

2.3. Methods

This study chose a road less village Humla, remote and isolated, only connected by the Simikot Airport. From that airport to the local Mission hospital, the Simikot distance is around 2 km with rugged terrain and snow cover. The drone with a vaccine carrier takes about a 400-meter journey time of about 11-15 minutes. It might take approximately one hour to reach the destinations.

3. Results

The Mission hospital Simikot has situated around 2 km from the Simikot Airport. It locates 2983 meters above mean sea level (MSL) and one of the steeper terrain. . There is no road. However, there is only a walking trail available to access the hospital. There is heavy rainfall and snow during the rainy season, making the track full of snow and slippery.

Figure 3.1: Landscape, terrain, and elevation between Simikot Airport and Mission Hospital Simikot

The transporting vaccine cooler box by walking trail approximately requires one hour from the Simikot Airport (Figure 3.1). At the same time, the walking path was not in smooth and flat routes since the village situates in rugged terrain near high mountains. The walker has to face many obstacles, while delivering the vaccine using a foot trail takes time, cost, and chances of damaging it.

Figure 3.2: Walking and Drone routes to access from Simikot Airport to Mission Hospital Simikot

Drone transport uses a straight-line route of 400 m, whereas a walking trail of 2 km (Figure 3.2). It will reduce time, cost and increase efficient delivery. Around eight heavy-lift drones are available for commercial use. UAV quadcopters with load capacity range from 3 to 20 kg, and the scope for flight time was 16-50 minutes is used to test on the study area.

Figure 3.3: Drone payload, flight time (minutes), and occurrence

The box plot shows cargo (Kilogram), flight time (minutes), and occurrence (Figure 3.3). For 40-60 kg, cargo requires 20-50 minutes, whereas 5-30 kg load needs 10-30 minutes. Higher load rises flight

time and minor occurrence. Less flight time will increase by two or three shifts of flight with the same battery.

Figure 3.4: Delivery time of vaccine through available two modes of transportation

The drone with a load capacity of 8-10 kg appropriate for the one-way delivery of 400 vials of coronavirus vaccine (Figure 3.4). The bar chart depicts less flight time, safe than the walking mode for transporting the vaccine. By walking, it will approximately take 40-45 minutes for the delivery of 400 vials. Using a drone for the same items will deliver around 20-25 minutes.

4. Discussion

This study focuses on the potential of drone delivery of coronavirus vaccines for remote and isolated areas. It finds that it is feasible, safe, quick, and cost-effective. It can be helpful in the places where the mode of transportation, such as road, is unavailable of its rugged terrain. This platform will deliver one or multi-time which support the medical system and communities. The limited research has tested the possibility of drone transportation on vaccine delivery (Adwibowo, 2021; Benham & Health, n.d.; Kundu, 2021). One of the projects operating collects tuberculosis samples with a drone in remote and road-less areas of Nepal (Times, n.d.). For transporting, this method is convenient and cheaper in high mountains and rugged terrain. Similar studies found a vast prospective for a drone to support importing and exporting medical and daily goods in isolated regions (Laksham, 2019; Rosser et al., 2018). The major problem will be weather, landing points, and electricity to charge its batteries. At the same time, these challenges can be minimized by proper planning like spare batteries if there is no electricity and landing on the roof of the health post. The cost required for drone-assisted vaccine delivery is less for logistics, administration. It reduces time and improves vaccine availability. It will lower the distance and make access to rugged terrain and isolated areas. As stated, this study was fit for vaccine transportation between rural health facilities to the nearest airport but isolated tribal villages. This technology is recommended for decision-makers to improve effective and efficient COVID 19 vaccines in remote places.

5. Conclusions

Recently, there has been a surge in interest in employing a drone to carry medicines to outreach areas instead of walking or driving. In contrast, just a few studies have been conducted on the practicality and impact of drones, particularly large-scale COVID 19 vaccine administration, which necessitates the use of heavy-lift drones. This study indicates that drone transportation of the COVID 19 vaccine is

both practical and efficient, showing that drone viability in aiding COVID 19 vaccine delivery has significant potential. Then, utilizing different drones, this study can be used as a model for future studies to broaden and boost COVID 19 vaccine coverage and delivery.

6. Declaration

• Consent for publication

Not applicable.

• Ethics approval and consent to participant

Not applicable.

• Availability of data and materials

The data used are cited with their sources; if data used in the manuscript are not precise, the author is agreed to send a dataset on request.

• Competing interests

There are no competing interests.

• Funding

No funding.

• Authors' contributions

The author performed analysis, evaluation, writing, editing of the paper, methods, and result.

• Acknowledgements

I want to acknowledge the people who directly and indirectly contributed to this study.

• Authors' information (optional)

Pawan Thapa, Lecturer, Department of Geomatics Engineering, Kathmandu University, Dhulikhel, Nepal.

7. References

A Closer Look at Hunger and Undernutrition in Nepal—Country Case Studies. (n.d.). Retrieved May 6, 2021, from <https://www.globalhungerindex.org/case-studies/2020-nepal.html>

Adwibowo, A. (2021). Assessments of heavy lift UAV quadcopter drone to support COVID 19 vaccine cold chain delivery for indigenous people in remote areas in South East Asia. MedRxiv, 2021.01.09.21249494. <https://doi.org/10.1101/2021.01.09.21249494>

Benham, B., & Health, J. B. S. of P. (n.d.). Drones Could Be Cheaper Alternative To Delivering Vaccines in Developing World. Johns Hopkins Bloomberg School of Public Health. Retrieved May 6, 2021, from <https://www.jhsph.edu/news/news-releases/2016/drones-could-be-cheaper-alternative-to-delivering-vaccines-in-developing-world.html>

198 Bhandary, S., Shrestha, S. L., Khatiwada, R. P., Shah, D. N., Munankarmi, N. N., Banjara, M. R.,
199 Thapa-Parajuli, R., Das, K., Adhikari, R., & Tuladhar, R. (n.d.). 1 Trend analysis, modelling
200 and impact assessment of 2 COVID-19 in Nepal. 30.

201 COVAX. (n.d.). Retrieved May 5, 2021, from <https://www.who.int/initiatives/act-accelerator/covax>
202 COVID-19 vaccines. (n.d.). Retrieved May 5, 2021, from
203 <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines>
204 DevelopmentAid. (n.d.). DevelopmentAid. Retrieved May 6, 2021, from
205 <https://www.developmentaid.org/>

206 Drone startups aim to carve out role in delivery of potential covid-19 vaccine. (2020, November 2).
207 Mint.
208 [https://www.livemint.com/news/world/drone-startups-aim-to-carve-out-role-in-delivery-of-po-](https://www.livemint.com/news/world/drone-startups-aim-to-carve-out-role-in-delivery-of-potential-covid-19-vaccine-11604303605793.html)
209 [tential-covid-19-vaccine-11604303605793.html](https://www.livemint.com/news/world/drone-startups-aim-to-carve-out-role-in-delivery-of-potential-covid-19-vaccine-11604303605793.html)

210 Drones for Social Good | UNICEF Office of Innovation. (n.d.). Retrieved May 6, 2021, from
211 <https://www.unicef.org/innovation/stories/drones-social-good>

212 How drones can help get vaccines to where they are needed most. (n.d.). World Economic Forum.
213 Retrieved May 6, 2021, from
214 [https://www.weforum.org/agenda/2021/04/india-s-covid-19-crisis-how-drones-can-deliver-va-](https://www.weforum.org/agenda/2021/04/india-s-covid-19-crisis-how-drones-can-deliver-vaccines/)
215 [ccines/](https://www.weforum.org/agenda/2021/04/india-s-covid-19-crisis-how-drones-can-deliver-vaccines/)

216 Kundu, R. (2021, May 3). Pros and cons of delivering covid-19 vaccines via drones. Mint.
217 [https://www.livemint.com/news/india/explainer-how-will-drones-deliver-vaccines-116200347](https://www.livemint.com/news/india/explainer-how-will-drones-deliver-vaccines-1162003473775.html)
218 [3775.html](https://www.livemint.com/news/india/explainer-how-will-drones-deliver-vaccines-1162003473775.html)

219 Laksham, K. B. (2019). Unmanned aerial vehicle (drones) in public health: A SWOT analysis. Journal
220 of Family Medicine and Primary Care, 8(2), 342–346.
221 https://doi.org/10.4103/jfmpc.jfmpc_413_18

222 Nepal among the first countries in Asia to receive COVID-19 vaccines from COVAX Facility. (n.d.).
223 Retrieved May 6, 2021, from
224 [https://www.who.int/nepal/news/detail/07-03-2021-nepal-among-the-first-countries-in-asia-to-](https://www.who.int/nepal/news/detail/07-03-2021-nepal-among-the-first-countries-in-asia-to-receive-covid-19-vaccines-from-covax-facility)
225 [-receive-covid-19-vaccines-from-covax-facility](https://www.who.int/nepal/news/detail/07-03-2021-nepal-among-the-first-countries-in-asia-to-receive-covid-19-vaccines-from-covax-facility)

226 Nepal among the first countries in Asia to receive COVID-19 vaccines from COVAX Facility. (n.d.).
 227 [Text]. EEAS - European Commission. Retrieved May 6, 2021, from
 228 [https://eeas.europa.eu/delegations/australia/94379/nepal-among-first-countries-asia-receive-co](https://eeas.europa.eu/delegations/australia/94379/nepal-among-first-countries-asia-receive-covid-19-vaccines-covax-facility_ka)
 229 [vid-19-vaccines-covax-facility_ka](https://eeas.europa.eu/delegations/australia/94379/nepal-among-first-countries-asia-receive-covid-19-vaccines-covax-facility_ka)

230 Nepal: Nutrition Profile. (2018). 7.

231 Rosser, J. C., Vignesh, V., Terwilliger, B. A., & Parker, B. C. (2018). Surgical and Medical
 232 Applications of Drones: A Comprehensive Review. JSLS: Journal of the Society of
 233 Laparoendoscopic Surgeons, 22(3). <https://doi.org/10.4293/JSLS.2018.00018>

234 Thapa, P. (2020). Predicating COVID19 epidemic in Nepal using the SIR model.

235 Thapa, P. (2021). Time Series Analysis and Forecast of COVID19 Pandemic.

236 Times, N. (n.d.). Nepal anti-TB drone project awarded. Retrieved May 6, 2021, from
 237 <https://www.nepalitimes.com/latest/nepal-anti-tb-drone-project-awarded/>

238 Vartabedian, M. (2020, November 1). Drone Startups Aim to Carve Out Role in Delivery of Potential
 239 Covid-19 Vaccine. Wall Street Journal.
 240 [https://www.wsj.com/articles/drone-startups-aim-to-carve-out-role-in-delivery-of-potential-co](https://www.wsj.com/articles/drone-startups-aim-to-carve-out-role-in-delivery-of-potential-covid-19-vaccine-11604239201)
 241 [vid-19-vaccine-11604239201](https://www.wsj.com/articles/drone-startups-aim-to-carve-out-role-in-delivery-of-potential-covid-19-vaccine-11604239201)

242 Welle (www.dw.com), D. (n.d.). COVID-19 vaccinations: What's the progress? | DW | 21.04.2021.
 243 DW.COM. Retrieved May 5, 2021, from
 244 <https://www.dw.com/en/covid-19-vaccinations-whats-the-progress/a-55648707>

245 White, P. L., Letchford, D. N., Pokharel, D. S., Dipti, D., & Zaman, D. R. (n.d.). Modelling of
 246 COVID-19 Strategies in Nepal. 48.

247 Why roads matter in Nepal. (2013, June 20). The New Humanitarian.
 248 <https://www.thenewhumanitarian.org/ar/node/253648>