The Effect of Social Barriers

On Drone Infrastructure Development

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On my honor as a University Student, I have neither given nor received unauthorized aid on this

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Introduction:

Humans, by their nature, are resistant to change. Preexisting norms, values, and a sense of security in familiarity often lead to resistance to sweeping changes that alter the status quo. Historically, technology has always been a victim of this resistance. Although this has always been the case, as the rate of technological development has exponentially increased, it has been harder for society to accept the integration of new technologies at a rate that is proportional to the speed of their development (Juma, 2016). The interconnectedness of our current societal systems and the existence of mass information through the internet and social media further amplifies the societal pushback to new technologies and widespread fear over their possible implications. This is especially true for technologies that have applications within and around residential and urban areas, as they can be widely seen by the public. An example of this in recent times, and the focus of this paper, is the development and integration of drone technologies into our modern-day logistics and infrastructure systems.

Drone technology is not necessarily a new technology, the first working concepts of a remotely controlled aircraft were created in the early 20th century. Throughout most of its lifetime, drone technology has not been heavily utilized and has only entered the public view in recent decades. In the last 2 decades, however, the innovation in the field of drone technologies has exponentially increased and has even entered the realm of civilian use. From a tool for military operations to a toy for tech-enthusiast children, drones have shown that they have a wide variety of uses and applications that we are just now beginning to utilize fully (Emad, 2024). One of the most promising applications of drone technology is its use as a logistical tool operating within civilian areas, offering many benefits over traditional solutions; however, it is also one of

the most divisive. Drone operation within civilian areas faces several challenges that limit its widespread integration into existing infrastructure due to concerns over public safety and privacy. This includes both public perception as well as legislative and governmental barriers. *Given the perceived benefits that drones can offer, why do these social barriers exist to their implementation, and how will these barriers influence the development of drone infrastructure in the future?*

Background:

Drones in Logistics

When drones first entered the public zeitgeist, they were seen as weapons of destruction and government oversight. Heavy utilization in military operations in the Middle East and the casualties inflicted by the technology largely contributed to this view. In recent decades, drones have transitioned from purely military and governmental applications to a technology that is widely available to the public and is increasingly being integrated into the private sector and civilian applications. Specifically in the area of logistics, drones have proven their ability to outperform and improve supply chains. Drones can be widely split into two different categories: UAVs, which utilize wings and forward thrust in order to maneuver and stay airborne and are more suited to surveillance and reconnaissance applications, and hovering drones, which utilize rotors much like a helicopter, and are more suited to low-altitude and ground-based applications. Although they are very different in their form and function, both of these types of drones have important applications within logistics systems.

As a logistical tool, drones have begun to be utilized in a couple of different applications. One of the most publicized uses is their adoption into transportation infrastructure, including

parcel delivery with companies such as Amazon (Greenwalt, 2024) and medical organ transport (Emad, 2024). In this context, drones are superior in several different ways compared to traditional ground based transportation infrastructure. Drones are not bound by standard routes like roads and can bypass traffic and lights that would lead to longer delivery times. With the implementation of autonomous capabilities, drones are also capable of working around the clock without a controller, eliminating the need for sleep required by a human. From an environmental standpoint, drones are a greener option compared to ground-based vehicles, producing lower or zero emissions. They are also generally a more cost-effective option in the long run, with lower fuel costs and maintenance requirements compared to ground-based vehicles.

Drones are not simply just a tool for moving things from one place to another either. They can also be a key asset in logistical analysis. In the area of inventory management, drones have proven to be a boon in terms of both efficiency and accuracy. Within warehouses, hovering drones are able to perform tasks such as counting, scanning, and replenishing inventory. These tasks are tedious and time-consuming when utilizing human labor, but drones can successfully automate these tasks while also greatly increasing the speed at which they can be completed. Another way that drones have been used to enhance logistical analysis is in the area of infrastructure. The ability for drones to bypass terrain and height constraints allows for more thorough and regular analysis of infrastructure such as bridges, wind turbines, dams, and power lines that are often hard to reach for inspections. Drones can be equipped with advanced material sensors and probes, which can detect material degradation preemptively, allowing for quicker responses to infrastructure damage before accidents or defects occur. They are also extremely useful as a tool for mapping and planning construction and infrastructure projects, with UAVs allowing for quick and easy surveying of large areas (Cvitanic, 2020).

Barriers to Implementation

Although the technology has proven its ability to provide significant improvements over traditional logistics solutions, there is still an underlying stigma surrounding the possible use of drones as a tool of government and corporate overreach, as weapons, and as a possible risk to security and individual privacy. Citizens have concerns surrounding the capability of drones operating within civilian areas to be used as a tool to collect data and conduct surveillance. Concerns over drone breakdowns or accidents causing damage to property and people are also an issue. The merging with technologies such as AI has further complicated this problem as the combination of these technologies serves to both offer new, helpful applications while simultaneously increasing the ability for bad actors to use the technology for nefarious purposes. AI technologies such as facial recognition open the door for individual surveillance and data collection, while the possibility of artificial intelligence controlling the functions of the drone system creates problems with trusting it to make the correct decisions.

An overall lack of government regulations surrounding the technology is also a huge hurdle for integration into infrastructure. Drone technologies must navigate through FAA regulations as well as local an state laws Although there hasn't been much legislation introduced surrounding the subject of drone infrastructure, there have been several drone-specific pieces of legislation and regulations have been introduced by the FAA and Congress, which have been created specifically to regulate commercial drone use.

Literature Review

Due to the recency of drone implementation into the commercial industry and infrastructure in civilian areas, there are very few concrete statistics concerning the direct effect that integration has had on society and industry. Although there is not much data to pull from,

there are a variety of studies that present preliminary predictions of the benefits of and barriers to drone integration.

One study from 2020 conducted a systematic literature review of 111 papers concerning the perceived benefits and problems of drone use for commercial purposes. The study found that nearly half of the relevant literature mentioned the primary benefits of the technology to be economic. Roughly a fifth of the quotations mentioned the societal benefits while only around a tenth mentioned the environmental benefits. In terms of the perceived barriers, around half of the quotations mentioned technical limitations of the technology in terms of autonomous flight and airspace integration, while a fifth of the publications mentioned legal and ethical problems concerning drone integration. Furthermore, around 15% mentioned the problem of public acceptance of the technology. The study concluded that the primary concerns surrounding the integration of drones will be logistical and regulatory with a standard framework surrounding drone operations being a requirement for further development of the infrastructure system while the prospective benefits were mainly economic. The study also put forward the concern that drone infrastructure could lead to socioeconomic disparities between richer and poorer areas, with the richer areas receiving increased infrastructure grants compared to more economically disadvantaged areas (Kellerman, 2020).

Another study in 2019 analyzed public knowledge and acceptance of drone technologies through the use of a survey utilizing the KAP model, a standardized model meant to analyze the overall knowledge and perception of a target population surrounding a given issue. This study found that the general public mainly hears about drone technologies through media such as movies and the news. From a list of 40 drone applications, a majority of the general public were not aware of a majority of the applications. Additionally, commercial and hobby uses for drones

were not widely supported by the general public (Aydin, 2019). This study reveals a general lack of knowledge of drone technologies in the general public as well as a general unwillingness to accept drone technology for commercial use.

Conceptual Framework

Social construction of technology is a theory that posits that technology is determined by the social systems that exist around it. The way in which a technology develops and its overall success are determined by how individuals and society perceive the technology and how they choose to utilize it (Altimore (1982), Pinch & Bijker (1984/2012)). Utilizing SCOT as a foundation for my analysis, I will analyze how the development of logistical drone infrastructure is and will be shaped by the social systems around it. I will first conduct an analysis to explain why the drone infrastructure technology is uniquely dependent on these societal barriers. I will then conduct a detailed analysis of the societal barriers that currently exist surrounding the technology. Finally, I will present an overall analysis of how drone technology and society exhibit a mutual shaping and the steps that must be taken in order to see progress toward implementation.

Methods

The primary methodology that serves as the foundation for my research is a variety of literature reviews concerning existing drone infrastructure and an analysis of legislation and regulation around industry drone use. To understand the barriers to full drone integration into existing infrastructure, government laws and regulations, peer-reviewed surveys, and scholarly analysis of the societal perspective surrounding drone integration will be referenced. Through both an analysis of existing drone infrastructure and the social barriers to its full implementation,

I hope to convey a full picture of how drone infrastructure development is beholden to societal forces and the obstacles that we as a society must navigate in order to create an environment where widespread integration of drone technology into our infrastructure is possible.

Results and Analysis

Dependence on Social Systems

Drone integration differs from other forms of new infrastructure technology in several different ways, which make it extremely dependent on public perception, the creation of supporting infrastructure, and the creation of legal frameworks in order to be implemented. Unlike most industry technologies, drones require entirely new infrastructure to be implemented fully while still being beholden to the existing infrastructure that exists below it. In order to handle the volume of air traffic that their use entails new procedures will have to be introduced in terms of air traffic control and airspace routes. These will have to take into account existing ground infrastructure as well as residential areas. This will require legislation and regulations in order to be implemented. Due to the stigma surrounding drones as weapons and tools of surveillance, there additionally exists a preexisting public bias against their implementation. Drone in logistics, specifically transportation logistics, are in a unique position where they are vulnerable to vandalism due to the public areas in which they operate. There have been a variety of instances where individuals have caused harm to drone systems which are flying over their houses. There is also the issue of possible drone breakdowns; compared to ground-based systems, drone breakdowns have a much higher likelihood of causing damage to individuals and property which is below it. While a car may stop in the middle of the road causing some traffic, a

drone may crash into a house or an individual causing personal harm and property damage. This adds to the regulatory hurdles and precautions that must be taken in order to implement it into transportation infrastructure. However, it should be noted that the prospective rates of aircraft and drone accidents are extremely low compared to ground based transportation and around 80% of these accidents occur during takeoff and landing, mitigating the risk to ground infrastructure (Baek, 2025). Lastly, the inherent ability for drone technologies to be used both as a surveillance tool and as weapons has led to the creation of strict regulations on the sourcing of drones for use in civilian areas.

Legislation and Regulation

The primary barrier to drone integration into logistic infrastructure is the rate of legislation not matching the speed of technological development. There are multiple legal considerations that must be taken into account before widespread adoption of drone technologies in civilian areas can occur. This includes legislation that regulates the use of civilian airspace, data collection, and automated drone systems. As of 2025, several pieces of legislation have been introduced that work to regulate commercial drone use. The FAA's part 135 Air Carrier and Operator Certification is the current piece of regulation that dictates the majority of commercial drone use for transportation. This piece of legislation outlines requirements and guidelines for commercial drone use for the delivery of property for drones under 55lbs. As of November 2024, there are 6 licensed companies that have been granted permission to use drones under part 135 for commercial package delivery (FAA, 2025). Although part 135 lays out federal guidelines for general requirements of package deliveries using drones, it is a broad piece of regulation that encompasses all non-chartered flights, including non-drone operations. It only functions on a

small scale and does not take into account the volume and specific needs that will be required for large-scale drone integration.

In 2024, part 108, a new set of drone-specific criteria, was introduced. Part 108 would create a set of standards that would effect all beyond visual line of sight (BVLOS) drone operations for commercial use. Prospective provisions include a requirement for detect and avoid technology, integration of drones into national airspace, operational limits, and minimal operational standards (Dukowitz, 2025). Although part 108 serves as a beacon of hope for full-scale drone integration, it has been delayed several times, prompting stakeholders and industry leaders to push the FAA to expedite the process. The delay shows how complex the issue of drone integration into existing infrastructure really is. In order to fully integrate drone technology into existing infrastructure a large amount of resources must be allocated to the FAA to handle the increase in air traffic and unique procedures that will be required for large scale implementation, a reality that seems increasingly difficult with recent government-wide cuts which have affected the FAA.

In regards to drones in infrastructure analysis congress has recently introduced the drone infrastructure inspection grant which passed the house in 2022. This bill allocates $100 million of spending into drones to conduct analysis on aging infrastructure (HR-5315, 2021-2022). This bill serves as the first hurdle that drones for infrastructure analysis has cleared but the scope of their implementation is still hampered by regulations concerning BVLOS operations and automation concerns.

Despite this preliminary legislation, drones are still have a long way to go and several additional legal hurdles that they most overcome. Even if the federal regulations exist, there are still questions about state and local laws concerning things such as noise level.

Public Perception

When it comes to drone technology, there is the ever-present factor of how new technology can shift the dynamics of power within a society. People in power want to stay in power and are also the ones who primarily lead the push for innovation and integration of new technologies, often for the purpose of maintaining and expanding this power (Vogels, 2020). The use of drone technologies by corporations and government entities is a prime example of a technology that could be used to expand government power and destroy individual privacy, and the public is aware of this fact. A large factor determining the trust individuals put into entities that hold authority over them is the assurance that that authority is working within their best interests (Mooijman, 2023). In the modern day and age, this trust between the citizens and those in power, whether they be corporate or governmental, is severely lacking (Bell, 2024), which has consequently led to public backlash in response to new drone technologies. The capability of drones to be used by governments and corporations for data collection and surveillance must be addressed or, at the very least, mitigated in order for widespread adoption of the technology to become possible.

The integration of autonomous systems into existing drone technologies presents another layer of complexity to the issue. As AI technologies become more integrated into our daily lives, it is clear that there is unrest surrounding the issue of privacy and public safety in regard to their adoption by government and corporate entities and the merging of it with other technologies such as drones. There are several reasons that create this feeling of distrust within our modern society when discussing the integration of AI into existing technologies. A large factor contributing to this mistrust is the variety of dystopian literature that dominates the cultural zeitgeist surrounding

AI. Fictitious works such as 2001: A Space Odyssey, Wall-E, and The Matrix paint an extremely negative picture of artificial intelligence and have created a general mistrust of technology through their dystopian depictions of self-learning machines (Dwork & Minnow, 2022). A cultural bias against AI combined with the rapid development and integration of the technology has led to apprehension about state overreach and unknown unknowns.

The last factor is how global conflicts and political tensions have contributed to drone distrust. For example, the war in Ukraine has demonstrated the capability of consumer-grade drones to be used in a military context to cause harm (Milley, 2024). While previously military drones were larger aircraft that could only be practically acquired by militaries, recent developments have shown that readily available, cheap consumer drones are capable of becoming weapons quite easily. This is combined with the fact that nations such as China have invested heavily in drone and AI technology (Atkison, 2024), evidenced by their various record-breaking drone shows, and the fact that a single Chinese company, DJI, controls around 80% of the consumer drone market. The view of small civilian drones as potential weapons has contributed to the fears that surround drone technologies and their widespread integration.

In order to make this integration a reality several steps must be taken to quell the public distrust of the technology. Measures must be put into place to mitigate the possibility of data collection and invasions of privacy; these could be legal frameworks or built into the design of the drone systems themselves. In conjunction with these precautionary measures, due to a general misunderstanding of drone technologies and the general public consensus coming from media (Aydin, 2019), there is a need for public education surrounding both drone capabilities, applications, and benefits. Without a general public consensus on the benefits of drone technology it is unlikely that the technology will receive appropriate support in order to be fully

integrated into public and commercial infrastructure. However, it is noteworthy that even in a survey involving experts on the subject, there are still considerable concerns regarding certain aspects of drone technology which could present potential risks if introduced to a civilian setting (Wang, 2025).

Drone Infrastructure as an Example of Mutual Shaping

Due to the variety of barriers which drone integration faces, the technology will have to adapt if it wants to be widely integrated within our society. In order to meet FAA and local standards, commercial drones will be forced to adapt to certain standards such as range, communications capability, and noise levels. This development has already been seen with the development of the Amazon MK30 drone system which is specifically designed to be optimized for drone delivery in civilian areas. The system produces lower noise levels, has a greater range, and is resistant to weather phenomena such as rain (Greenawalt, 2024). In addition to technical requirements for domestically created drones pushed by the government will require an increasing number of domestic drone manufacturers in order to meet the demand for domestic production. Even if the sector fully shifts in order to meet these regulatory requirements, the creation of infrastructure will ultimately be dependent on the public acceptance of the technology. The cultural focus around AI has led to more regulatory pressure surrounding autonomous drones as well.

If measures are not taken it is likely that further incidents involving drone vandalism and possible protests against the technology will occur if the technology is adopted prematurely. Parallels could be drawn to the integration of nuclear energy in this regard.

Drone infrastructure has also worked to influence society. The rise in media coverage of drone technology and its use by companies such as Amazon have contributed to public discourse

surrounding issues such as privacy and safety and have even caused cases of mass paranoia within certain communities. The prospective benefits that drone technology could offer has influenced the creation of legislation such as the drone infrastructure inspection grant and part 108 of the FAA guidelines in order to support further development of the infrastructure and create standards by which further development can follow.

Conclusion

Overall the role of drone technology has a bright future ahead of it as long as it can continue to adapt to the ever changing sociotechnical climate that surrounds it. Given adequate time for society to adjust through standardized regulation, public acceptance, and creation of supporting infrastructure there is a good chance that we will see drones zipping around through the sky very soon. This progression will no doubt cause a shift in the direction of drone development, with higher bars for safety and performance, and society as a whole, leading to a new landscape in the sectors of freight and logistics.

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