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Drone Implementation: Regulatory Barrier

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ABSTRACT

This paper discusses the relationship of the regulatory barriers and the level of innovation with regards to drones in the logistics industry. This relationship is shown in a cohesive and understandable two-by-two matrix that combines both industry and academic articles using a content analysis. This entire matrix not only shows where we are currently with drone technology but also where we are headed within logistics. This matrix can also be used to show how industries can move from different portions of the industry to one that works better for the business model they are pursuing. Also, the matrix can help to show what needs to be done from a regulatory perspective in order for mass implementation of drone technology to occur.

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This Honors Thesis is dedicated to the following people:

My parents for their constant support

My brothers for prodding me toward the right path

My extended family for being their when I need them

My girlfriend for supporting me through the whole process

My advisor for the constant direction

My professors and advisors who all helped me even when I lost motivation

To all of you I give all the thanks in the world, you are the reason I am where I am today.

INTRODUCTION

What are drones, how do they work, what are they used for? These are questions that many people have, and a question that everyone will need to know the answer to soon enough. Drones are remotely piloted vehicles that range from small flying air and ground drones to the large military drones, which are seen when watching the news. Drones can be used for surveying in the construction business, taking videos for sporting events or commercials, they can be used in racing as a new type of entertainment, or even just used for home recreational use (Joshi, 2017). However, there is one use that drones have that could have a massive impact, not just on people's lives, but also on the way that things move throughout our environment. Logistics, or the planning, implementation, and coordination of the details of a business or other operation, is the place where drone implementation could really be seen as making a difference in people's day to day lives (HarperCollins, 2018) .

Drones in logistics is a very new field when put into the larger picture of the history of delivery. But, with the ability to fly in a straight path to a customer, like an airplane, while still being able to do door-to-door delivery creates incredible potential to make a change within the industry. For example, a business can send emergency stock via drone to a warehouse and have it reach that warehouse on the same day, thereby eliminating what could have resulted in a stock out and lost sales (Oswald, 2017). One particular application that could affect almost everyone on any given night, is the fun idea of Dominoes drone delivered pizza (Scholz, 2016). This system has already been tested in other countries and has shown that the delivery time on pizza is massively reduced and results in a fresher pizza pie (Scholz, 2016).

A lot of questions come with this new technology. For example, will drones really take off on a large scale, and will government regulation catch up to drone technology, will companies really be interested in drones? All these questions add up to an uncertain future for drones, this uncertainty is primarily based on regulatory barriers currently facing drones and drone use. Public safety has also become a major concern. For example, drone collisions with aircraft have captured media attention and this attention causes setbacks for companies trying to implement this technology. One such story involved a drone that did crash into a plane in Canada, this crash was caused by private use of a drone that caused a backlash of public concern for commercial use (Zorthian, 2017). However, expectations of quicker delivery and higher on-time delivery from customers has driven companies to look into other alternatives to current delivery systems (Agg, 2015). This is a great opportunity for drone technology to show its worth to not only companies but to the concerned public as well.

The purpose of this entire article is to inform people on what drones are, where drones are headed, what they can do for the logistics industry, and what regulations are holding back this technology. All while creating an effective matrix that people in the industry can use to identify where they are on the spectrum compared to other companies using drone technology. The primary question to create this matrix and help inform people is; What kind of change in regulatory barriers needs to occur for mass implementation of drone technology to take off, and what alternative drone technologies are currently available/being developed? With this question in mind the type of research method to use was clear, a content analysis, this way all sides of the argument are considered, social, academic and industrial point of views. This allowed me to move

forward and take a look at drone implementation and start to develop some content for drone use.

BACKGROUND

Drones and how, and if, they are implemented depend on a multitude of factors. First, firms must be interested in implementing drone technology into some facet of their business (Joshi, 2017). Next, drones need to be specifically designed to effectively be used in this specific facet of the business. Then, the regulation in the country of use must be updated to standards that allow drone use to not only be applied but thrive. With all three of these steps coming together drones could become the future of not just transportation but across the entire supply chain (Oswald, 2017). Although there are a multitude of types of drones, ground drones, small air drones, military drones and warehouse drones, the primary focus of this paper is on air drones (Kunze, 2016). This is the focus because air drones are the most thought of drones when it comes to drone delivery, and many companies have been developing these air drones for future use (Kuckelhaues, Markus, Heutger, 2017).

WHY ARE FIRMS INTERESTED IN DRONE TECHNOLOGY?

So, what makes drone technology so interesting to companies in today's world? This question has multiple answers that all could peak the interest of all types of companies. The largest issue that drones are being used to solve is the last mile issue within the supply chain (Williams, 2018). The last mile problem is what occurs when a product reaches a warehouse or store and then needs to be delivered to a customer's door step, this can incur massive costs to the company when multiplied across a vast customer

base (Investopedia, 2018). Drones solve this issue by eliminating the need for delivery vehicles and gas expenditure, as drones can fly straight to and from someone's doorstep using an electric motor (McKinnon, 2017). This is just one-way drones can deliver, they can also be used in conjunction with driverless vehicles, can simply be ground drones making deliveries, or could be used for longer distance hauls between warehouses (Kunze, 2016). In addition, drones can add value in the form of quick, reliable, same day delivery, which in today's fast pace environment is very important (McKinnon, 2017).

Other areas that drones can be used in the supply chain is within a warehouse setting. The applications here are different than their delivery cousins. Within a warehouse, drones can be used to manage and track inventory, move product within a warehouse, and even scan in items as they come through the door (Williams, 2018). In the warehouse yard, drones can help keep track of trailers, scan in trailers, and make sure to notify management when an issue occurs with a delivery (Williams, 2018). With all these applications, how come drones aren't being implemented into the larger environment?

REGULATIONS AND THEIR IMPACT ON DRONE IMPLEMENTATION

Regulation, especially in the United States, is holding back many efforts to implement this drone technology across the supply chain. There are many categories of laws that affect multiple facets of why drones aren't implemented. The primary category has to do with drone operation, these laws are key to widespread drone use (FAA, 2017a). Drone operation has to do with where drones can operate, what airspace they are allowed to be in, and how far drones can travel from their operators (FAA, 2017a). The next categories are called pilot requirements and drone requirements (FAA, 2017a). Pilot

requirements have to do with the licensing drone operators need to have and how old they need to be to operate them. While drone requirements have to do with the size of the drones, the sizes of the packages they can deliver, and the weight limits set by the government (FAA, 2017a). Last, there is the exceptions category, which has to do with which laws the government will give limited leeway with and under what circumstances (FAA, 2017b). This is important to understand what direction law makers are looking to go to allow drone use (FAA, 2017b).

The operation category of regulation has the most impact because it is currently the category with the strictest laws. For example, drones cannot fly out of the line of sight of the pilot and drones cannot fly over people (FAA, 2017a). These two laws in tandem have a massive affect not only on the current industry but the future of drone technology in logistics as well as it tends to scare off potential entrants (Williams, 2018). A prime example of the impacts of these laws is a quote from Matt McLelland in the Supply and Demand Chain Executive magazine. McLelland is an innovation research manager at Kenco Innovation Labs, the research and development arm of the third-party logistics company. “To be able to commercially operate a drone, Federal Aviation Administration regulations stipulate that the drone must be within line of sight, which is really hindering their use for last-mile delivery” (Page 1, Mantey, 2017).

The next categories are pilot and drone requirements, these are important because the costs, of ensuring regulations are meet, can build up the more companies expand to a larger scale. Pilot requirements that are currently in place, require pilots to pass TSA vetting, have a remote pilot airman certificate and must be over sixteen years old (FAA, 2017a). These requirements aren’t really the primary problems for companies currently as

these laws are more about safety than really holding back the introduction of drones. The drone requirements do have an impact on what companies can do with drones (FAA, 2017a). These laws say that drones must be registered if they weigh over a half pound, and they cannot carry over 55 pounds worth of any package, commodity, etc. (FAA, 2017a). This means that drones are limited to mostly package delivery and smaller business to business deliveries.

The last category are the exemptions to the laws, these are important because they show where lawmakers are starting to allow drones, and show that there is a movement to get this all legalized. These exemptions come in the form of waivers that are given out by the government to companies who appeal for them (FAA, 2017b). These exemptions haven't been handed out to very many companies so far, however, and when given they are usually for very small trials (FAA, 2017b). There is another exemption, though, that shows promise and may get companies to go in more with larger implementation of drones. This exemption is under FAA law as part 107, it says that drone delivery is allowed in the United States as long as it abides by the laws previously stated in this section (FAA, 2018). This means that drone use in the United States is allowed on a small scale which gives companies the opportunity to develop better systems for drone use. However, to compare these laws with what industries are doing and researching, a comprehensive methodical deep dive into this field was necessary.

METHODOLOGY

I used a content analysis methodology to conduct my research on drones in logistics. Content analysis is defined as "any methodological measurement applied to text for social science purposes" (Duriau, 2007). In other words, I analyzed multiple text

formats and did a dive into each area and picked out what articles and papers are relevant to my topic and pulled them together to create a very informed and unbiased report for this area of study (Duriau, 2007). I also coded the articles and text into categories of laws and the effects that they will have on drone delivery systems. I also sorted these articles into two different dimensions, regulatory barrier and level of innovation, to produce a matrix. I used this process to conduct my research because I can easily validate and cross check what each of my sources is saying with one another, thus eliminating the topical biased that was in some of these articles.

The first articles I analyzed were within the academic realm of research, meaning any academic article having to do with drone use. The majority of articles that even mentioned drone use in logistics were from the journal of Physical Distribution & Logistics Management. These articles mostly discussed the overall idea of drone use rather than specific uses. For example in an article titled “Network video technology Exploring, an innovative approach to improving warehouse operations”, drones are discussed only lightly and it is mostly about video use in warehouse (D’Andrea, 2014). One article did however discuss how drones could be customized and mixed and matched as to be used in many different fields, including delivery (Anderson, 2012). This article mostly focuses on the use of drones in a commercial environment and how they could be used in a household setting, then it lightly mentions how could have future application in industry (Anderson, 2012). However, do to the limited information within academia on this subject much of my research was focused around articles within the industry.

This industrial research conducted was focused around finding companies with varying levels of innovation, who all were affected on different levels by laws and

regulations (Joshi, 2017). By using keywords such as, drones, logistics, delivery, and innovation, many sites popped up that related to my topic, most of these articles were related to two companies. These primary two companies that are involved in developing the system of drone deliver are Amazon and DHL. These two companies pop up repeatedly in searches and are both doing multiple types of things on either ends of the spectrum within drone innovation (Kuckelhaues, Markus, Heutger, 2014). These two companies, along with other companies who have developed their own systems and innovations (listed in Table 1 along with a brief description/relation to the matrix), are prime examples of the future of drone technology in logistics, and are all built in to the matrix.

Amid logistics drone implementation research came about an extra area that I explored. This area focused around the way the industry sees the future of drone use and what the industry is willing to invest in. For example, almost every company agrees that without law reformation then mass drone implementation would not result in the near future (Kunze, 2018). Also discussed, in the industry is how they could get past this regulation by convincing law makers of the safety of drones. This is shown in the fact that companies are in deep development of see and detect technology that would massively decrease the likelihood of drone crashes (Williams, 2018). In addition to this technology is the development of a Beyond Visual Line of Sight system that would allow drones to be accurately used when not in sight of the pilot, enabling longer distance deliveries (PR Newswire, 2017). With all the different types of drones, systems of implementation, and regulations, a matrix would help simplify this complexity and give a visual representation of the industry currently. The research brought together using this

methodology has given me the information needed to develop said matrix in a way that anyone, not just those in logistics, can understand.

Article Source	Brief Description
Oswald, Ed, 2017.	This article discusses the potential of an Amazon project that is develping an airborne fullfillment center. This type of technology would drastically change how warehouses are setup and create a sort of moving warehouse. This moving warehouse would utilize drones to deliver the packages from the airborne center to the end consumer.
Kunze, Oliver, 2016.	This article suggests the use of ground drones as a possible alternative to drone delivery. Further it discusses how these ground drones come in different varieties and how the basic technology used in these drones has been used for years already. This sort of technology would be easier to implement in larger cities in the current environment.
Agg, Steve, 2015	This article discusses the innovative idea from Facebook to create solar powered internet providing drones. With this technology internet could be provided to even the most remote region and further improve quality of life in areas with less infrastructure.
Kuckelhaues, Markus, and Matthias Heutger, 2014	DHL has come up with multiple ideas for drone use, here it discusses the use of a "parcel-copter". This is essentially a heli copter version of the current drones, these would have slightly more lift and power than normal drones. Also, these parcel copters could be redesigned to more of a horizontal aircraft, meaning it's more like an airplane. This would allow for farther reaching deliveries and larger carrying capacity.
McKinnon, Alan, 2016	Amazon, one of the biggest players in logistics, has come up with it's own system. Discussed in this article is the well known Amazon Prime Air, this is an air drone reliant system of delivery that has already been used in other countries. This is a prime example of the use of drones and how regulation is keeping these systems from being implemented
Mantey, Carrie, 2017	This article covers the Mercedes-Benz's partnership with Matternet, an autonomous drone company, to solve the last-mile delivery conundrum. The companies built a concept van (which already debuted at the Consumer Electronics Show in January) that implements roof-mounted autonomous drones and a robotic package-sorting system. This hybrid package sortation and delivery van aims to decrease the time to not only deliver packages, but also sort them.
Williams, Andrew, 2018	This article discusses an alternative use of airborne drones, warehouse and yard use. This means that the drones would be used to track and move inventory not only within the warehouse but in the yard outside the warehouse as well. This would increase the speed of delivery and provide a better system of tracking shipments throughout the warehouse space.
PR Newswire Association LLC, 2017	Although this article isn't about a specific delivery service, it discusses key concepts that would allow for drone implementation, most importantly, the use of beyond visual line of sight technology. This technology would allow drones to safely and reliably go out of the sight range of the operator and eliminate the worries the government currently has. This techology could lead to decreased regulation and allow for larger scale drone use.

Table 1 – Description of Drone Literature

Regulatory impact		Level of Innovation: Low	Level of Innovation: High
	High	**Present Oriented: Regulated** Urban airborne drones Airbus Skyways & SingPost Partnership (mail delivery) Amazon Prime Air (Urban)	**Future Oriented: Regulated** "Airborne fulfillment center"-Amazon "Parcel-copter"-DHL (United States) Facebook solar powered internet drones
	Low	**Present Oriented: Applicable** Ground drones Amazon Prime Air (Rural/medical) Sidewalk based drones D5Yard and warehouse drones	**Future Oriented: Applicable** Ground drones with automated vehicles See & avoid drone tech "Parcel-copter"-DHL (Europe) Mercedes benz-matternet vehicle drone combo

Figure 1 - Regulatory Impact and Innovation Matrix

DIMENSIONS AND MATRIX

This matrix (Figure 1) shows the relationship between the level of innovation and the level of regulation for different solutions to drone delivery. The level of innovation refers to how different and new the solution is when compared with current and past technologies (Emprechtinger, 2016). The low to high scale within the innovation dimension shows how much effort the company is putting in to forging a new path in this industry. This new path could be using an existing technology and combining it with another type of technology, like drones and driverless cars, or it could mean inventing a brand-new technology, like Amazon's airborne fulfillment center (Oswald, 2017). On the low end of innovation is the simple drone delivery. It is on this end due to the fact that it has been around for a while now and has been developed to the point where, in the modern sense, it is no longer new.

The level of regulation dimension is based on how much government regulation stands in the way of implementation of the companies' solution (Emprechtinger, 2016). The low to high here is slightly more relative because all drone technology, or a mix of drone and other new technology, is regulated higher than other industries. This scale is meant to show how much more or less regulation a solution faces, relative to the other

solutions presented in the matrix. More regulation has to do with the severity of the laws that are currently holding back the technology. For example, the line of sight law has a very severe impact on the implementation of air drone on a wide scale (FAA, 2017a). Meanwhile, there are some technologies within the matrix that are under high regulation simply because it is such a new technology that the laws aren't even there yet, i.e. the airborne fulfillment center (Oswald, 2017).Where a company wants to be within this matrix is relative to the goals of that company, or the goals of that solution that the company developed.

PRESENT ORIENTED: REGULATED

The upper left corner has the highest level of regulation combined with the lowest level of innovation, or present oriented. This means that a company is not really developing anything other than typical drone use and are still hitting an area with high regulatory barriers, i.e. urban drone delivery (Kunze, 2016). This is the least desirable of all the squares within this matrix as it shows a company is either unaware of the environment or is in a battle to decrease the regulation within this sector. The reason this square is so undesirable is the fact that companies cannot really turn this technology into profit currently, and they aren't developing something that will bring profit down the road. While it may not be the companies fault because laws are holding them back, like with urban drone delivery, it still is something is costing money to invest in with no returns currently (Williams, 2018).

To move from this category the company will either have to rethink its priorities and look to the long term, i.e. move to the right into the future oriented: regulated; work hard to decrease the regulation, move down; or move to develop a product that breaks the

mold within the current regulations, move diagonally (Oxford Analytica, 2015). Each of these moves has benefits and drawbacks, related to the time it will take for this change to become implemented, how much it will cost to change technology, and whether regulation can or will be changed (Williams, 2018). The benefits of moving down in the matrix is that you can create profits and get some return on investment now, but this has the drawback of not being very future oriented (Anderson, 2012). Moving to the right has some serious potential for future use, and profits, but still faces either strict regulation or a lack of any regulation. Moving diagonally brings in both the benefits of current profit and the benefits of being ahead of other companies from a technical perspective.

FUTURE ORIENTED: REGULATED

The upper right corner has the highest regulation and highest innovation, to the point of these projects being fully developed well down the road. This means that a company is breaking the mold to the point that no one knows how safe or unsafe it will be so there is a high regulatory barrier, until prototypes and tests have been run (Oswald, 2017). If a company is looking to the long term and wants to be ahead of the curve, an innovator, while still being able to handle the risk of either not knowing what regulation is, or having high regulatory barriers, then this is the category for them (Agg, 2015). This uncertainty on regulation causes some issues with how the company approaches the research and development, however, and will affect what new drone technologies or applications the company puts their money behind (Maney, 2017). What this means is that companies will have to do within this category is to put up a strong financial support for research without the knowledge of guaranteed returns.

The main move a company here would take would be down, this would result in less regulation meaning that implementation could occur quicker, unless major barriers to entry were in the way (Agg, 2015). This move would be made if the company is sticking with being on the higher level of innovation while stepping back from the risk of higher regulatory barriers. A company may, also, want to consider investing in one of the other categories within the matrix as well as this future oriented regulated category. For example, DHL is in both this category and the category below it with the same technology, the "Parcel-Copter" (Kuckelhaues, Markus, Heutger, 2014). This shows that DHL not only put money into developing this project in one country, but spread it to multiple countries to take advantage of the different level of regulatory barriers between the countries.

If a company was really looking for quick returns on smaller investments then they would move diagonally to the bottom left corner. With this moves companies are signaling that they want to stick with tried technology that won't have as much regulation, meaning the company doesn't want, or can't, take the larger risks with the future oriented regulated category (Kunze, 2016). Again companies may want to diversify their investments within this matrix, if they have the capital, in order to be in two of these categories. In this case Amazon is a prime example, they are in this future oriented regulated category with their airborne fulfillment center, but are also in the present oriented applicable category with Amazon Prime Air, in Europe (Oswald, 2017). This gives Amazon flexibility and provides them with a promising future while still getting near current profit with a more ready and reliable technology.

PRESENT ORIENTED: APPLICABLE

The lower left corner is the least innovative and has the lowest regulation. Most of the companies in this section are late adopters who don't want to put the risk of a new technology that doesn't pan out, but still wants to remain relevant (McKinnon, 2016). A company in this section is focused on short term goals and looking to adopt the drone technology that is closest to being fully implemented (Kunze, 2016). This decreases risk for any company here, but this could cost opportunities in the long term.

Moving left or moving diagonally in the matrix would be the most beneficial for companies that want to move toward the future. This move would be made in order to increase the company's chances of staying ahead of other companies that are investing in drone delivery systems. Moving to the left is very desirable if companies want to increase this chance while still not taking on a major amount of risk in regards to the regulatory barrier (Agg, 2015). Moving diagonally is a bold move for a company that is in this category because not only is the investment going to be high to develop such a new technology but the risk factor will increase dramatically (Kunze, 2016). This move would be for a company that wants to make a big shift in their company logistics strategy and wants to try to increase their chances of being the first ones in on a breakthrough in drone logistics (Kuckelhaues, Markus, Heutger, 2014).

While moving has its advantages, this category has its own benefits. In this category companies will likely be able to adapt quicker to drone delivery than companies who aren't looking into drone technology. But, the primary benefit is that companies here are avoiding much of the regulation and take on less risk by sticking with more tested technology. For example, ground drone technology is already being used, successfully,

by companies like Dominoes, to deliver pizza (Scholz, 2016). Also, air drone delivery has already been conducted in other countries and has proven effective to this point (Oswald, 2017). This kind of "tried and true" mentality is exactly what companies can benefit from if they choose to remain in this category.

FUTURE ORIENTED: APPLICABLE

The lower right is the most innovative with the least regulation, making it very ideal for most companies. This category has the benefits of being ahead of the curve in drone technology while still being able to implement in the relative near future (Kuckelhaues, Markus, Heutger, 2014). If a company is in this zone they are looking beyond just basic drone delivery and looking at technologies that are either improvements of drones or are combining drones with other technology, all while fulfilling company goals in a more attractive time frame. For example, the beyond visual line of sight technology is a major improvement on drones, not only from a technical perspective but also from a regulatory perspective (PR Newswire, 2017). With this added technology the drone would have the safety required for some of the current regulations to be relaxed, thus allowing a larger scale implementation (PR Newswire, 2017).

Moving out of this zone is very unadvisable because this is the most ideal scenario for the majority of companies. This is ideal because it combines the best two factors from the future oriented regulated category, being an innovator, and from the present oriented applicable category, being on a lower level of regulation (Mantey, 2017). Companies who are here are out of the norm because it is hard to develop a newer technology and still be able to know that the regulation will allow you to implement it in the near future. For example, ground drones combined with automated vehicles may

seem like something that would be highly regulated, but currently laws are relaxing driverless vehicles and ground drones (Kunze, 2016). This means that this system could be used in the near future, even though it is a very new, innovative idea (Kunze, 2016).

Getting to this category is hard, however, because regulation is hard to move for the majority of drone technology, especially with very new, innovative technology. This is, typically, because as the laws finally become loosened on a newer technology many companies have already adopted the new system and are developing some new system (Oswald, 2017). For example, this is currently the case with airborne drone technology, it has been around a while and companies have developed systems, i.e. Amazon, for these drones to be used but the laws are just now beginning to catch up (Oxford Analytica, 2015). Meanwhile, companies have already developed new uses, systems and technologies in addition to or in support of drones (Williams, 2018). This is what creates the conundrum within, and the high level off difficulty to enter, this particular category.

CONCLUSION

The matrix, combined with the analysis of the matrix, creates a system that companies can use to help categorize themselves in order to help identify what situation they are currently in when it comes to drone technology. In addition, students and other companies can use this to help educated themselves on drone technology and get a sense of what types of real life applications are being developed. Future development within this field will likely change which technologies and systems fit into each category, but this matrix is adjustable to future use as well. The definitions of high and low regulatory barriers and innovation will change as the technology changes within the industry. This matrix was created in hopes that it could be updated and change as time goes on and help

to generate conversation, within a professional or academic setting, on what it means to be in a particular category.

This entire paper is a culmination of where the field is at currently by pulling together multiple sources of information. By using a content analysis in this paper it doesn't just provide a view of where one company or field thinks about drones but across industries and fields of study. The application of drones within logistics provides many exciting avenues of application and research that can be addressed by future studies. But, one thing that needs to occur is an increase in research in an academic sense within this field. This topic is something that will continue to pop up in years to come and students coming up in the future need to be more aware and have a better grasp on not just what drones are but their applications. They need to be shown the impact drones can have on an entire supply chain, and the way drones can decrease one of the biggest issues in current supply chains, the last mile problem. One way or the other, drones will have an impact on the way the world works in the future, so it is good to know as much as possible about it today.

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