オーラルセッション ― フルペーパー

無人垂直離着陸機の ロジスティクス的実現に関する洞察

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要約

本稿は，近年さまざまな分野での応用可能性を期待される無人垂直離着陸機が将来のロジスティクスの分野において具体的にどのような形で実現されるかについての展望を論じるものである。一般にはドローンとも呼ばれる一群の航空機に対してその全体像について議論したあと，無人垂直離着陸機の最新の開発動向とサービスマーケティングという異なる二つの観点より輸送効率，ロジスティクス的機動性，安全性という3つの視点からそれらの実用性を吟味する。本稿は，無人垂直離着陸機を実用化するにあたって製造者・使用者が考慮すべき実用的な概念を提唱し，将来における航空機の開発，およびそれを用いたロジスティクスサービスに対する貢献を期待するものである。

なお，本研究は著者の個人的活動によるものであり，所属組織の業務や企業戦略とはいかなる関係もないことを断る。

キーワード

ドローン，未来予測，ロジスティクス，サービスマーケティング，IoT

I. Purpose

The main purpose of this study is to give several practical ideas into the argument on industrializing unmanned vertical taking-off and landing aircrafts (UVTOLAs), or so to call 'drones', in the field of logistics. After arguing the domain of the aircrafts to consider, this study will examine the use of UVTOLAs from three viewpoints: transport efficiency, logistical mobility, and safety. The ideas introduced in this study is aimed to help both aircraft manufactures and logistics providers consider practice of the aircrafts, such as development management, operation, profitability or sustainability.

II. Overview on the concept of UVTOLA

1. 'Drone' as a buzzword

In this section, the concept of UVTOLA will be constructed. The necessity of this is derived from the fact that the popular term 'drone' is a buzzword and so confuses and restricts our free onset, especially considering their use in the field of cargo transportation.

As Merleau-Ponty pointed out, meaning and the corresponding concept of word has, and will have been, drifted itself disorderly in a series of misinterpretation, and the term 'drone' is not at all an exception. Once spun off from the zoological field as a military sobriquet, the noun has gained miscellaneous acceptation differently in both military and commercial fields.

The inception of the term 'drone' in the meaning as unmanned aircraft, which was originally used to describe an ephemeral male bee, is assumed to be the humorousness to the nickname "Queen Bee" of the remote-controlled surface-to-air shooting trainer version de Havilland DH.82 Tiger Moth biplane developed in 1935 (Završnik). Since then, the term has broaden its domain roughly that nowadays indicated broadly as "an unmanned aircraft or ship guided by remote control or onboard computers[1)]". However, there seems to be a difference between the nuance of saying drone in military and commercial context. For the former, originally meant remote controlled aircrafts, it today unqualifiedly contains all kinds of unmanned air and water vehicles regardless of its size, propulsion, nor usage, except for self-destructive weapons, namely missiles and torpedoes (Shoaps and Stanley). On the other hand, as for commercial interest, the word seems to be often limited obscurely to uninhabitably small, relatively simple rotor-headed helicopters or multi-copters which initially entered the business field half a century late to the military with Yamaha's crop-dusting remote-controlled helicopter in 1990 (Royakkers and Est).

When discussing about future commercial application of unmanned VTOL aircrafts to cargo transports, this obscurely narrowed domain of the concept parallel to the term 'dorne' in the field of non-military industry may cause some restraint against liberal development of ideas. As for personal hobby or avial video shooting, which seems to be the currently bigest usage for themselves, the utility of what call to be 'drones' in a limited sences seems to be exclusive. However, when it comes to cargo service, a broader domain of prospective should be examined, and a new term should be given to that group of aircrafts. As each word has a limited value of its own, as Saussure indicates, using the term 'drone' in the commercial context is difficult (at least in the short run,) to give broader inspiration than the current domain of itself (Saussure). This restraint could become even stronger on 'drone' because the current image of the inexpensive, powerless small UAV exactly-nontheless-coincidentally matches that of a drone bee. Hence, this study on their logistical use will use the term 'unmanned VTOL aircraft (UVTOLA)' to indicate the set of aircrafts at stake in stead of 'drone'.

2. Looking into the comprehensive UVTOLA concept

The comprehensive idea of UVTOLA contains either aircrafts originally uninhabitably light or those initially developed as onboard-controlled and modified into unmanned air vehicles (UAVs) ex post facto. Furthermore, it subordinates optionally piloted vehicles (OPVs) and potential nevertheless not yet unmanned aircrafts as a periphery concept. This rich criterion will introduce the following two important insights to this study.

(1) Broader types of aircraft on consideration

One of the virtues of the comprehensive idea of UVTOLA is that it gives insight to various types of aircrafts regardless of their size, power plant nor navigation method. Although unmanned navigation benefits enterprises, as discussed later, all the factors except the automation should once be reexamined for logistics business practice. In fact, new category on unmanned VTOL transport vehicles such as the Air Mule have been developed (Eshel). Also, recent development on heavy robotized helicopters have shown capability and potential not only for attacking or combat but even for freight use.

For instance, Kaman aerospace has modified its K-1200 K-MAX "aerial truck" into a remote control OPV for military and civilian hazardous use. This aircraft is capable of carrying an external payload of 2,722 kg, which is as same as that of a delivery truck.

Another distinctive example is the Northrop Grumman MQ-8C of the US Navy. Developed as the successive series of the MQ-8 family, this cargo UVTOLA has become capable of handling payloads as three times heavier as its ancestor, the MQ-8B Fire Scout multi roll UAV, by using only the remote controlled navigation system of the MQ-8B and applying the whole airframe of the Bell 407 piloted helicopter.

These two facts mentioned above show a possible future that various types of existing regular helicopters could be easily unmanned by installing a navigation kit to be developed. Such navigation kit could in the future be less costed, even enough to be reasonable for civilian carriers, thanks to the current interest and the probable large investment from US Air Force, US Marine Corps and DARPA (Seck). The use of fly-by-wire in newly developed piloted VTOL aircrafts, such as the V-280 Valor could even realize the automation of heavy VTOL aircrafts. This would make much easier to make freight efficient UVTOLA by modifying existing cargo VTOL aircrafts.

(2) Consideration on benefits of unmanned navigation

The second strength of combining UVTOLA all together is that we can consider how different kinds of unmanned navigation can each by their own benefit enterprises. In this study, unmanned navigation will be divided into two types; remote controlled, which indicates those controlled fully or partially by a human pilot on ground, and automatically controlled (or robotized), representing those rely their navigation fully on onboard or grounded computers.

Initially, easily considerable, autonomic aviation will help enterprises, especially those who have not engaged in air freighting and hence have no human resource that can pilot air vehicle, reduce their investment towards human resources.

Secondly, it is necessary for making the craft light and small enough to be handled with ease. In an experimental development of UVTOLA home delivery ongoing in Chiba, Japan, the craft is aimed to land on a balcony of high-rise condominiums (The Japan Times).

Then, what advantage on heavy remote controlled UVTOLAs that lacks either the former two merits can be assumed? Even pilot needed on ground, these kind of UVTOLAs can make use of their weight of payload for carrying extra cargo, fuel, or non-piloting personnel. As the vast majority of piloted helicopters require two pilots for operation, and also have less payload-fuel efficiency compared to trucks, UVTOLAs modified from regular helicopters will have much advantage on this point.

Since most of the civilian logistics provider hasn' t joined VTOL transport and vice versa, it is undoubtable that automatic navigation most benefits enterprises newly entering the field of vertical lift regardless of the size of aircrafts. However, VTOL automation is only at its start, and uncertain when to be completed by their manufactures. As for their users, it would be an attractive option to inexpensively construct an automated navigation system by their own through their business service, using initially remote controlled UVTOLAs and adopting machine learning to them in a manner of agile development of software (See Fig. 1). Using existing human-involved technique for safety in the first phase for developing unmanned service system can be seen in existing projects, such as the driverless delivery system on going by Yamato Transport in Japan (Oliner). In further development, even the entire fleet as a swarm could also become able to be controlled by artificial intelligence. Hence, including remote controlled vertical aircrafts into the bounds of UVTOLA will not only have some realistic utility of its own, but also accelerate the evolution of the kind.

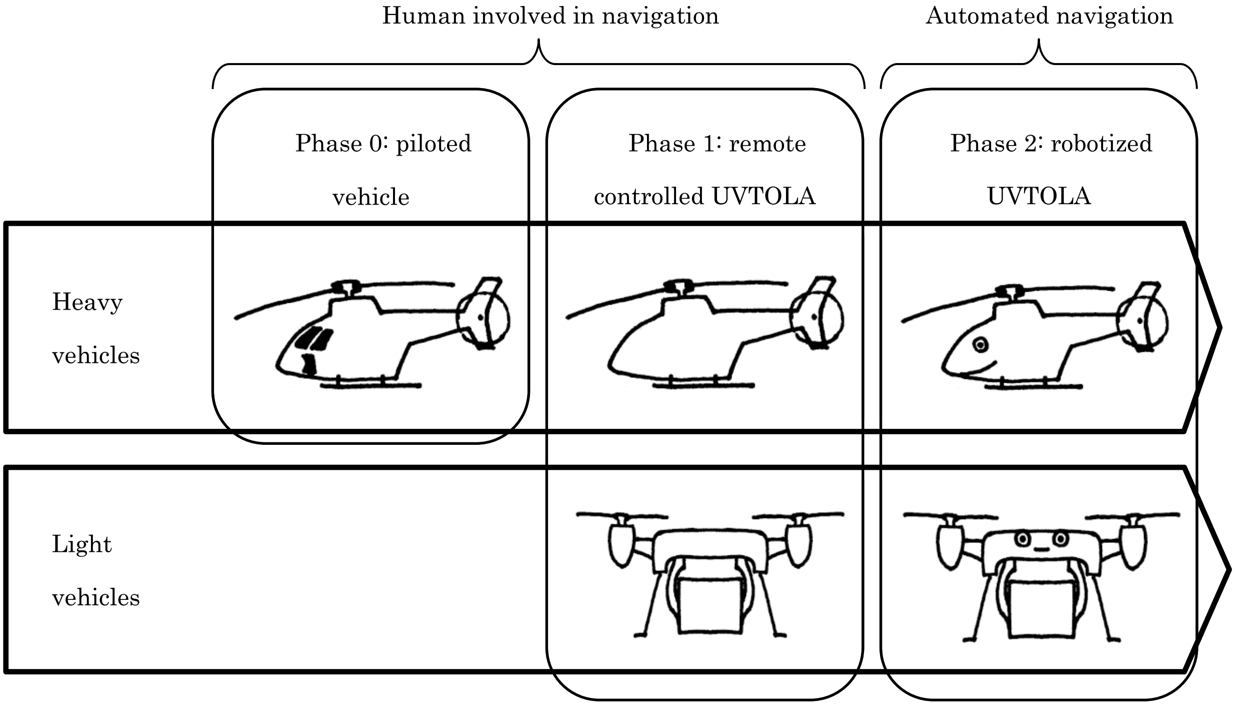
III. The logistics of UVTOLA transport

1. What 'logistical' originally means

The adjective 'logistical' as the objective of this study is not to indicate the state of the current business logistics practice that is to be, but to represent the philosophical idea of what logistics ought to mean; this study focuses on *how* UVTOLA can provide logistics, rather than *what* they can achieve.

Since its introduction in *Summary of the Art of War* written in 1838 by Jomini, the military terminology 'logistics' have been regarded commonly throughout history in the basic context of consideration on non-combat movements of personnel and goods in military science. However, as technology on weapons and transports improved, the practice and necessity of logistics has fluctuated a lot. Ito points out that once disregarded as an army idea because of its abbreviation due to the introduction of railroad, the concept of logistics has achieved its

Fig. 1 The development phases towards a completely automated navigation (illustrated by the author)



modern sense as "total management on physical distribution" when the Allies successfully executed the landing on Omaha beach on June 6th 1944, making its practical significance large enough to be referred by business science within the later several decades. In a more metaphysical description, from this point, the thought of logistics has gained its positive status in military science as what makes operation of a force available on any location on the globe regardless of distance, terrain or existing structure, which was then geographically restrained by water, road, rail and location of supply.

2. The importance of mobility and efficiency in business logistics

Though the marketing method of business logistics contains additionally the consideration on economical profit, it shares the basic idea mentioned above with modern military logistics thought. Practically, as well as transport efficiency, the importance of mobility for logistics is common among military and business.

Because business logistics is to make enterprises operate wherever they want to, the lines of supply should be connected or diverted as soon as possible whenever necessary from some business reason. In this context in a longer term, mobility means the ability to easily deploy and retreat local facilities, or in other words, to have less unmovable fixed capitals. This understanding can be seen in the increasing use of third-party logistics services and lease services as one way for enterprises to reduce its logistical fixed capital (Christopher).

When designing transports, logistical mobility should be considered in the equilibrium with operation efficiency. For instance, the special underground light rail formerly used by the Royal Mail connecting post offices and sorting hubs in London have had high efficiency on transport at its opening, however gradually lost its efficiency as the sorting hubs moved out from its wayside; the Royal Mail has announced that running it had costed five times more than simple truck transportation at its closure in 2003 (Dangerfield). Such transport design that lacks mobility should be classified as least logistical, whatever operation efficiency it has in the initial.

Logistical mobility should be seen in a strategical length of time, while transport efficiency is sought in daily practice. From a rough point of accountings, logistical mobility appears in the balance sheet as the amount of long-term depreciated fixed assets, while transport efficiency is shown in the profit and loss statement as simply comparing cost of sales for the transport system on consideration and its alternative. A business logistics service should be constructed in the balance of these two elements.

3. Constructing logistical UVTOLA service

(1) Transport efficiency

As mentioned above, transport efficiency will be decided on comparing the running cost of the transport system on consideration and its alternative. When constructing UVTOLA transports currently, it will be in many of the case comparison between truck transports. In other words, this comparison is to state what virtues of possible UVTOLA will rationally urge the modal shift from current ground transport.

In order to suggest at what circumstance the modal shift from today's ground transportation to UVTOLA will make sense, the author would introduce the mathematical idea of boundary. The mathematical concept of boundary is defined as: "the set of points, known as boundary points, which are members of the set closure of a given *S* and the set closure of its complement set" (Weisstein). The commutation will be stated as a surface laying in what Wittgenstein calls the *logical space*. This surface concept can represent the future state to be determined only as an infinite combination of possibility into a single formula. If one should predict a unique boundary point of modal shift, he/she has to rely on his/her subjective probability of each changes to occur in the future. The formula expressing the boundary will be independent from such ambiguity, with a tolerance to a width of performance of future technologies.

When a providing method of a service changes, market – including customer and the good itself – also changes; remind how the introduction of wide body passenger jets has changed the flight into a cheap and popular means of travel. However on the other hand, at the precise point of that change, both quality and quantity of the demand hardly changes; Boeing 747 was at its debut designed for the then existing relatively few luxury passengers rather than the potential customers, which as some fact like the installation of a vast piano lounge space instead of extra seats by some carriers shows (Bowman). Because of this slow-acting nature of innovation in service provision, which resembles to what is called the introduction stage in product life cycle phenomenon (Anderson and Zeithaml), the boundary will be stated simply as if the newly adopted UVTOLA could handle the quantity and economy provided by conventional transports.

Before conducting the formula that represents the boundary, the author finally has to explain the effect that UVTOLA will have on transfer hubs (THs). Many present cargo carriers bring each parcels into THs where they are sorted and aggregated for rationalizing its service. The combined cargo is then transported THs in each region, where it will be sorted again for their final destination. The current operation puts emphasis on night hours for this aggregation and transportation, which most of their customers are asleep or off business, and the traffic (including road, railway, and air) is free from crowded passenger traveling. On the contrary, by using intermittent helicopter flights that can avoid traffic jams and land just near the THs, logistics providers will be able to run THs and transfer cargo all through the day. This will not only increase the schedule speed of the service, but also minimize the cost needed for THs. How efficient will the UVTOLA help the running cost for THs is hard to calculate in a generalized matter, however, it can be re-described as 'how effectively they can eliminate the deviation in quantity of parcel sorting throughout the day'. Suppose a TH equipped with a fully automated sorting system, which at the current, handles 75% of the daily amount of parcels in the midnight 6 hours, while the residual 25% in the remaining 18 hours. If the enterprises using this TH could flatten this fluctuation by using UVTOLAs, the needed amount of sorting facilities, which were then required to meet the needs for the peak hours, could be one third of before the modal shift.

Thus, at the precise time point of the transition, the position of the modal shift boundary will be stated as a true proposition as:

$$\exists W_V \exists F_V \exists Cv_V P(W_V, F_V, Cv_V) \quad (1)$$

$$\text{s.t.} \quad W_V \times F_V \times n_V \times r - Cv_V \times n_V - Ch_V \geq W_T \times F_T \times n_T \times r - Cv_T \times n_T - Ch_T \quad (2)$$

$$W_V \times F_V \times n_V = W_T \times F_T \times n_T = q \quad (3)$$

$$Ch_V = x \times Ch_T \qquad 0 < x \leq 1 \quad (4)$$

$$W_T \geq 0, F_T \geq 0, Ch_T \geq 0, n_T \geq 0, q \geq 0 \quad (5)$$

The nomenclature of the formula above is given with proviso as follows:

W weight of cargo per service/flight (tons)
F transportation frequency per day, each vehicle
r usual benefit rate earned by moving cargo, per ton
n size of the running fleet
Cv running cost per a vehicle, a day
Ch cost caused by transfer hub using each transports, a day
q average daily quantity of parcels needed to be transported
(Subscript)
V UVTOLA
T trucks (or ground vehicles)

Each of the equation expresses the following statement: The boundary is explained by three variables representing capacity of the newly introduced helicopter that is, payload, transportation frequency, and running cost (1). Benefits earned by UVTOLAs; pure benefit earned by transferring the amount of cargo, minus total running cost of the entire fleet and the cost required for TH while using UVTOLAs, is larger than that by conventional transports (2). As mentioned above, the quantity of demand met by using helicopters can be assumed as the same as that of conventional transports (3). The cost required for THs when using helicopters is smaller than using conventional transports (4). Finally, all the figures are positive real numbers (5).

The proposition could be simplified as:

$$\exists W_V \exists F_V \exists Cv_V P(W_V, F_V, Cv_V) \quad (1)$$

$$\text{s.t.} \quad Cv_V \times n_V \times q + x \times Ch_T \leq Cv_T \times n_T \times q + Ch_T \qquad 0 < x \leq 1 \quad (2\text{-bis})$$

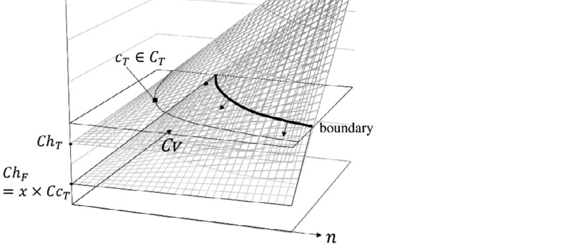
$$n_V = \frac{q}{W_V \times F_V}, n_T = \frac{q}{W_T \times F_T} \quad (3\text{-bis})$$

$$W_T \geq 0, F_T \geq 0, Ch_T \geq 0, n_T \geq 0, q \geq 0 \quad (5)$$

$$W_V \geq 0, F_V \geq 0, Cv_V \geq 0 \quad (6)$$

This proposition can be visualized in a three dimensional matter by using n_v instead of W_v and F_v, such as Fig. (1). Derived from equation (2-bis), the vertical z-axis represents the total cost (C) for using each transports; the boundary is seen as the UVTOLA's smaller cost than the present transports. When the precise cost needed for conventional transports decided uniquely as c_T by each fixed n_r and Cr_T, the boundary will be the intersecting line and below of the horizon containing the point c_T and the set surface of C_v (see Fig. 2 for geometrical understandings).

Fig. 2 A geometrical explanation of the boundary



Of course, the model is simplified that it wouldn't represent the reality as it would be. Even if UVTOLAs were to play a leading act in freight service, it won't completely expel other existing means of transportation; conventional transports do have some advantages, e.g. trucks and freight trains more economical during night time, and it should be auxiliary means for helicopters. However, the aim of this concept is to show both the UVTOLA manufacturers and cargo carriers in what condition could helicopter enter the main role of civilian regular cargo service. Hence, the simplified equation will contribute more to an implication on what is needed on UVTOLA or when to make the decision to replace the current transports.

Additionally, it should be considered that in reality, C_v is not completely independent but feebly subject to n because the fleet size should effect somewhat the running cost of each vehicles. Simply theorizing, the unit cost for repair and maintenance should reduce when the size of fleet gets bigger because it would enable to share precious facility, personnel and knowledge by existing and additional vehicles. However on the other hand, it is also well assumable that the large amount of assets causes confusion on identifying and managing them and affect negatively on rationalization. After all, it depends on the design of management towards the entire fleet. Since there haven't been any logistics provider that have possessed and managed such big fleet of UVTOLA so far, it is impossible to state the equation between C_v and n that has never recorded or thought to differ in occasions.

Moreover, the speed of the helicopter will absolutely create a new value that will earn extra benefits for logistics service providers, which seems to be ignored in the formula above. Since logistics is to make its customer available to have goods whenever they want, it means that shorter lead time makes better logistics. Effort on business logistics to make this pursuit towards the shorter time of order-to-delivery has largely been made on designing the informational platform so that it urged a reverse insight towards the military field and provoked a new idea of *net-centric operation* (Grimes). However, it is assumable that also the design on transports could shorten total lead time.

However, as mentioned before, this proposition represents the exact moment of the modal shift that the existing customers hasn't changed their preference towards the service. Besides, however there should be some hidden needs for such service, estimating them rationally is impossible. By excluding such ambiguous term that will cause danger of losing existing customer or causing massive loss, the formula could provide a safe standard on a decision making to step into an innovation waiting to be occurred.

A certain fact visible from the model is that smaller n_v or Cv_v is required in order to make the efficiency of UVTOLA superiority and achieve the modal shift. Smaller n_v could be achieved by introducing heavy UVTOLAs that handle more cargo at once. To make Cv_v smaller might be the development on propulsion. For instance, since conventional helicopters required high maintenance cost on their rotor head, alternative technologies such as hinge-less rotor to reduce the cost has been developed (Watkinson). Logistics provider aiming to enter the field of vertical flight should pay attention to the recent rapid development of UVTOLA that are to equipped with new type of propulsion in the point of their running cost.

(2) Logistical mobility

As mentioned before, long termed mobility is represented in lesser amount of fixed assets that is to be wasted when the receiver changes its location. This means that if a transport doesn't require any terminal facility for its service, the mobility would be maximum. UVTOLA will have this advantage against, at least, fixed-wing aircrafts since they require less area of ground for operation. Moreover, it apparently seems that an ultra-light UVTOLA capable of landing itself or dropping cargo directly to inside the customers' land without requiring any modification on there will fulfill this requirement. Major ongoing conception of UVTOLAs (or so to say "drones"), such as Amazon's Prime Air. However, two problems should be concerned.

The first is that such transport would apt to become one-way service. Current delivery service is constructed on the use of delivery vehicles with enough payload for multiple delivery and pickups. The amount of delivery and pickup parcels at a time is of course not always the same, and therefore, if the UVTOLA is to carry single parcel, the service flight should one-way. In sum, such flight should contain a large amount of empty flight time that won't earn any benefits. This inefficiency becomes more when the length of route extends. Therefore, the author predict that logistical UVTOLA will get bigger and more complexed as technology grows.

Secondly, the structure of the aircraft will become big or complicated not enough to be handled without terminal facilities when craft performance pursued after all. For instance, the series of Parcelcopter developed by DHL has increased its size and payload, and the latest Parcelcopter 3.0 (though payload limited to 2kg) is designed to land on a helipad called "SkyPort" which contains parcel locker function (Deutsche Post DHL Group).

Regarding these problems, a solution will be to make maximum use of human labor and turn operational cost into service cost. Ground support should be inevitable when UVTOLA is designed to handle multiple cargo for rationalization, and making personnel to handle loading and unloading parcels from the craft, the same personnel could be provide customer service. Additionally, this will also prevent from losing extra marketing benefits on collecting customer's unexpressed demand and handling unexpected trouble which human deliverers currently has.

Specifically, the service conceived above will be like as, arranging proper land for vertical landing and taking-off near the customer(s), such as an open parking space, and carry parcels from and to that extempore verti-field by ground personnel. It would be better to share one verti-field for several customers. In order to assure logistical mobility, the verti-field has to be very simple, and so, security of the flight will be partially (e.g. clearance) could be ensured by ground staffs. In short, the ground personnel would more look like a delivery driver without trucks.

Although this so-to-call 'human terminal' system would make UVTOLA service internal and not to make service design completely free from human labor, it should benefit logistics provider in reducing wasteful labor of drivers to just drive vehicles with his/herself, and turn them into a more service-oriented business resource sticking to the precise area of business. Also, as the size of the craft gets bigger and the airframe gets more sophisticated, it would be more difficult and dangerous to handle such UVTOLAs without proper training. Therefore, it is predictable that the future use of UVTOLAs in logistics service will be internal to service providers, and the style of delivery won't change dramatically even UVTOLA technologies evolve. In other words; *delivery service is too humoresque to be left to drones.*

(3) Safety design

In addition to transport efficiency and logistical mobility, safety should be achieved in order to operate in reality. Though there have been much technical approach to seek a safer VTOL aircrafts, this study will examine how the user could improve safety through their use. In this section, safety examination will be constructed considering mainly remote controlled UVTOLAs from mainly two reasons. One is because human-involvement in navigation is common with current helicopters (which is the only successful civilian VTOL aircrafts in 2016), the potential occasion of accidents could be assumed from the real helicopter safety records. In other words, the cause and danger of automated UVTOLAs whose development has not been completed yet is hard to predict. The other reason is that, as mentioned before, remote control navigation is likely to

Table 1 The occasion of accidents of helicopters

Contents of occasion	Frequency	Percentage
fundamentally avoidable with operational design		
T-O or landing outside public airports	25	14.2%
extremely low altitude flight	25	14.2%
hovering: observation	1	0.6%
training or experimental flight	35	19.9%
Subtotal	87	48.8%
potential danger in regular transport operations		
hovering: external cargo loading	1	0.6%
T-O or landing inside a public airport	14	8.0%
taxing or parking inside an airport	10	5.7%
approach or descent for landing	10	5.7%
ascent	4	2.3%
cruise flight	19	10.8%
other/unknown	32	18.2%
subtotal	89	51.2%
Total	176	100.0%

be the medium step towards the development of automated navigation system, and therefore, considering safety on remote controlled UVTOLA will make the first step towards the safe operation of automatically controlled UVTOLAs.

By taking a look into the present accident record of regular piloted helicopters, the safety aspect seems achievable solely by making careful design on both the operation and facilities. Table 1 shows each number of in what occasion civilian helicopter accidents occurred throughout the year 2014 inside and outside the USA [2).

In total, nearly 30% of the accidents occurred due to the hard use unique to VTOL aircrafts; during takeoff and landing outside an airport, or extremely low altitude flight that are usually served for temporal use, e.g. pesticide spraying, survey, hunting, cherry drying. These flexible yet dangerous actions, however, could be removed from the operation of civilian regular freight service if users could manage to build landing facilities with proper assistance equipment. Or perhaps even without such expensive facilities, if ground personnel mentioned above could attend the occasion of landing, he/she can check the clearance. Also, almost 20% of the events took place during instruction or test flight, which can be at least kept away from taking place near the operation area.

It is quite discovering that accidents occurred while hovering figures only 1.1% of the total accident, and moreover, only one accident out of 176 took place as for external loading. External loading of cargo is one of the unique benefits of VTOL aircrafts, which will shorten the time of service, reduce the number of airports needed, and increase payload. However, because hovering requires higher fuel consumption, adopting this maneuver should be reconsidered from an economical aspect in addition to safety.

In sum, logistics supplier using remote controlled UVTOLA can keep out of nearly half of the potential helicopter accident, at least inside or near their facilities. On the other hand, the remaining half of potential danger should be removed by device on operation.

The Federal Aviation Administration has announced its new helicopter safety rule aiming to improve safety, mainly while at airborne. Among the newly adopted regulations, such as requiring on-board instruments, were to request air ambulance service providers to establish their operation control centers (OCCs), which shows the prediction that in-flight accidents could be reduced by doing so. As for designing the operation of remote controlled UVTOLAs, if the remote controlling pilots could be gathered into OCCs where air traffic controllers and pilots can have physical face-to-face communication, the safety effect of OCC would become even bigger.

5.7% of the accidents occurred during taxing or parking inside an airport. Most of this type of accidents was caused by losing control during hover taxing, which could be solved by increasing stability of the craft while taxi. The primary requirement is to install wheeled landing gear. Craft arresting devices such as the “Beartrap” developed by the Royal Canadian Navy for flight deck landing assistance would possibly help improve safety. The accident on top of the Pan Am Building in 1977 shows that these kind of safety must be kept tight if logistics providers want to keep make use of the rooftop of their facilities as heliports and operate heavy UVTOLAs[3).

IV. Conclusions

This study has first argued the benefits of the domain of aircrafts to be examined in this study that is to include any kinds of UVTOLAs regardless of size, propulsion and navigation method all together. Then, the study has examined the use of UVTOLAs from three viewpoints: transport efficiency, logistical mobility, and safety. It is assumable that the ideas and cognition argued in this study will give insights among researchers, aircraft designers, project managers and logistics practitioners when designing the logistical use of UVTOLA in the possible future.

Notes

1) Drone. (n.d.). Retrieved July 1, 2016, from http://www.merriam-webster.com/dictionary/drone

2) The data is collected by the author from accidents which took place in the year 2014 and have been reported by NTSB including those non-fatal. All the 176 reports are among which occurred inside the USA, American-built helicopters involved, or both.

3) On May 16th, 1977, a broken landing gear of the New York Airways Sikorsky S-61L on a passenger ferry flight caused a roll over on the heliport on the roof of the Pan Am Building (the Pan Am Metro Heliport), killing four passengers waiting to board by its rotor, and one pedestrian on the street below by its broken parts. This accident had terminated the use of the Pan Am Metro Heliport for good. According to Chiles, the airline went bankrupt 2 years later due to this accident.

Bibliography

Anderson, Carl R. and Carl P. Zeithaml. "Stage of the Product Life Cycle, Business Strategy, and Business Performance." *Academy of Management Journal* 27.1 (1984): 5-24.

Bowman, Martin. *Boeing 747: A History: Delivering the Dream*. Barnsley: Pen and Sword, 2014.

Chiles, James R. *The God Machine - From boomerangs to Black Hawks: The story of the helicopter*. New York: Bantam, 2007.

Christopher, Martin. *Logistics and Supply Chain Manegement (fourth edition)*. London: Pearson, 2013.

Dangerfield, Andy. *Mail Rail: What is it like on the 'secret' Tube?* 28 January 2014. BBC News. 30 1 2016. <http://www.bbc.com/news/uk-england-london-25145632>.

Deutsche Post DHL Group. "DHL Parcelcopter 3.0." 9 May 2016. *Deutsche Post DHL Group*. http://www.dpdhl.com/en/media_relations/specials/parcelcopter.html. 21 August 2016.

Eshel, Tamir. *AirMule: Autonomous Cargo Delivery, Beyond Line of Sight*. 4 January 2016. Defense Update. 5 January 2016. <http://defense-update.com/20160104_airmule.html>.

Federal Aviation Administration, Department of Transportation. *RIN 2120–AJ53 Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations*. Washington D.C.: Federal Aviation Administration, DOT, 2014.

Grimes, John G. *(DoD) Net-centric services strategy*. Public document. Washington D.C.: Department of Defense, 2007.

Ito, Yu. "D-Day: When Logistics Came into Modern Sense." *Japan Marketing Academy Conference 2014*. Ed. Junzo Ishii. Tokyo: Japan Marketing Academy, 2014. 27-45.

Jomini, Antoine Henri. *Précis de l'art de la guerre ou nouveau tableau analytique*. Paris: Anselin, 1838.

Merleau-Ponty, Maurice. *The Prose of the World*. Evanston: Northwest University Press, 1973.

National Transportation Safety Board. *Aviation Accident*

Database & Synopses. 2014-2015. <http://www.ntsb.gov/_layouts/ntsb.aviation/Index.aspx>.

Oliner, Rachel. "The RoboNeko Yamato service will use self-driving cars to bring purchases to customers' homes starting in 2017." 28 July 2016. *psfk*. http://www.psfk.com/2016/07/driverless-delivery-service-will-launch-in-japan.html. 14 August 2016.

Royakkers, Lamber and Rinie van Est. *Just Ordinary Robots: Automation from Love to War*. Boca Raton: CRC Press, 2015.

Saussure, Ferdinand de. *Course in General Lingusitics*. New York: McGraw-Hill Book Company, 1915.

Seck, Hope Hodge. "Marines' future helicopter will be optionally manned: General." 29 July 2016. *DoDBUZZ: Online Deffense and Acqusition Journal*. http://www.dodbuzz.com/2016/07/29/marines-future-helicopter-will-be-optionally-manned-general/. 1 August 2016. <http://www.dodbuzz.com/2016/07/29/marines-future-helicopter-will-be-optionally-manned-general/>.

Shoaps, Robin and Sarah Stanley. "" Don't Say Drone" : Hits and Misses in a Rhetorical Project of Naming." Vanguri, Star Medzerian. *Rhetorics of Names and Naming*. London: Routledge, 2016. 102-126.

The Japan Times. "Japan starts trial drone home delivery service in Chiba." 11 April 2016. *The Japan Times*. http://www.japantimes.co.jp/news/2016/04/11/business/japan-starts-trial-drone-home-delivery-service-chiba/. 30 July 2016. <http://www.japantimes.co.jp/news/2016/04/11/business/japan-starts-trial-drone-home-delivery-service-chiba/#.V66ow5iLTIU>.

Watkinson, John. *Art of the Helicopter*. Oxford: Butterworth-Heinemann, 2013.

Weisstein, Eric W. *Boundary*. n.d. MathWorld--A Wolfram Web Resource. 19 January 2016. <http://mathworld.wolfram.com/Boundary.html>.

Wittgenstein, Ludwig. *Tractatus Logico-philosophicus*. London: KEGAN PAUL, TRENCH, TRUBNER & CO., LTD., 1922.

Završnik, Aleš. *Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance*. Berlin: Springer, 2016.