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From my perspective

Regulation and innovation: How should small unmanned aerial vehicles be regulated?

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ABSTRACT

Regulation both promotes and suppresses innovation. Good regulation is effective in terms of realizing social values and objectives, and is efficient in promoting economic activities by minimizing direct and indirect costs. The use of alternatives rather than traditional prescriptive approaches has been encouraged, but is still the challenge of policy makers and researchers who still lack the expertise to introduce alternatives in regulation. In this paper, the authors discuss the regulation of small unmanned aerial vehicles (sUAVs), because sUAVs are advantageous in a variety of sectors although they also violate the safety of people, buildings, vehicles, and manned aircraft. This paper focuses on the current discourse on sUAV safety regulations in Japan, and extends the System-theoretic Accident Model and Process (STAMP) approach to assess the current regulations. The authors highlight four safety concerns and show alternative ways for more effective and efficient regulation in terms of the expectations of stakeholders for alternative regulation.

1. Introduction

When the safety and security of a citizen's physical, psychological, social, and environmental status are concerned, prompt governmental intervention is needed even if it seems to contradict economic efficiency. If this intervention is in the form of a “good” regulation, it will remove the anxiety of citizens and eventually support business growth. However, effective and efficient regulation is challenging in resolving a variety of concerns and in promoting development of a new technology while minimizing direct and indirect costs. While there are various regulation alternatives, the selection of such alternatives is not always optimized to realize a “good” intervention (Borras and Edquist, 2013). Policy makers are often likely to be risk averse (Coglianese et al., 2002; Hepburn, 2006). Policy makers and researchers still have limited expertise on regulation alternatives. Accumulation of researches in the selection of regulation alternatives is essential.

Many people believe in the large economic and social potential of sUAVs. The development of battery and sensor technology since the early 2000s has largely contributed to sUAVs becoming more useful and promising for applications in various business sectors. On the other hand, sUAVs may pose great risks to the public safety of people, buildings, vehicles on the ground, and manned aircraft. In many countries, civil aviation authorities, who have regulated manned aircraft for the safety of citizens, are under pressure to regulate sUAVs effectively for the safety of the citizens, but also efficiently to allow economic and social benefit. Japan is no exception.

There were no regulations explicitly mentioning sUAVs in Japan, even by early 2015. At that time, many companies expressed their concerns that the absence of proper regulations might result in dangerous operations and accidents. If dangerous operations and accidents frequently happen, the governments and society will refuse sUAV business. Due to such concerns, many companies have refrained from full-scale investment on sUAV applications. It was unclear when and even which government agencies would regulate sUAV activities at that time. On 22nd April 2015, however, when a sUAV was found on the roof of the official residence of the Prime Minister Shinzo Abe, the environment surrounding sUAVs changed drastically. On 24th April, Shinzo Abe and his cabinet held the first sUAV conference among related government agencies and started discussions to regulate sUAVs. In September 2015, Japan issued an amendment to the Civil Aeronautics Act (Act) and included sUAVs in the scope of Act. As a result, the first sUAV-related regulation was initiated by the Japan Civil Aviation Bureau (JCAB).

The publication of the amendment was very swift. However, just after the amendment, some people expressed their concerns that strict regulation might spoil business opportunities and possible economic benefits from sUAV applications. They worried that sUAVs were discussed in the frame of aviation law because the business of the civil

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aviation and that of sUAV should be different. On November 5th, the Prime Minister declared that Japan would accomplish sUAV delivery in three years and he instructed governments to review regulation obstacles for such an achievement. Responding to this instruction from the Prime Minister, since December 7th, 2015, the Public-Private Council and corresponding working groups have held meetings frequently to discuss the appropriate environment for the development of sUAVs.[1] Japan is just now (at the time of this paper) at a stage to discuss "good" regulations for sUAV.

Besides safety, there are various concerns and regulations concerning sUAV transition such as security, privacy, data protection and radio wave availability (Clarke and Moses, 2014; Luppicini and So, 2016; Rao et al., 2016). While government agencies such as the Cabinet Office (CO), the Ministry of Internal Affairs and Communications (MIAC) and the Consumer Affairs Agency, are responsible for regulating such concerns listed above and are members (Table 1) of the Public-Private Council, this paper focuses more specifically on the safety aspects of regulations. The Japanese public are very sensitive to failures of technology in terms of safety. If appropriate safety is not effectively regulated, companies may refrain from investment, and innovation opportunities will decrease (Fig. 1). Today, the only active working group at the Council is for safety and is chaired by JCAB. In Japan, governmental agencies other than those listed in Table 1 are seldom invited to participate in the working group about the safety of aircrafts. In this paper, we evaluate the effectiveness of current Japanese regulation for the safety of sUAVs, by analyzing whether an unsafe situation can occur within the current regulation. To do this, we have applied a Systems-theoretic Accident Model and Process, STAMP, which is a new safety analysis approach developed to enable analysis of the safety of today's human and software intensive systems (Fleming et al., 2013; Leveson, 2012; Lu et al., 2015; Stringfellow et al., 2010). The STAMP approach has been applied and evaluated as useful to a number of systems (Space systems; Leveson, 2012, Air traffic Management; Fleming et al., 2013; UAV; Lu et al., 2015; Pappot and De Boer, 2015). However, the previous literature focuses mainly on how to design products and operations and governmental regulation is only a given constraint to focused control loops. In order to design a system for the safety of society within the focused systems, the approach of including the design of regulation itself and the responsibility of stakeholders must also extend to the systems. This paper extends the STAMP approach to assess a regulation and demonstrates how to design a system for the safety of society and various stakeholders more effectively and more efficiently with the new technology, UAV. While the efficiency of regulation usually refers to minimizing direct and indirect costs both for the regulators in supervising users and for users in complying with the regulations, this paper takes the efficiency of regulation in a broad sense and uses the term to refer to the efficiency of regulation for innovation, that is, whether a regulation hinders or allows users to bring about innovation.

This paper is organized as follows: Section 2 presents previous literature discussions on alternatives for traditional prescriptive regulation. Section 3 evaluates the effectiveness of the Act for ground safety with the STAMP approach. Section 4 discusses the perspective of sUAV regulations with regulation alternatives and the final section, (Section 5), concludes this paper.

[1] In the U.S., a Drone Advisory Committee was formed and the first meeting was held on September 2016, just after Part 107 enforcement. The Drone Advisory Committee is similar to the Japanese Public-Private Council. Both are a place to discuss the next step for better (safe, secure and efficient) UAV integration into the national airspace. Certification of aircrafts, such as the airworthiness of aircrafts, BVLOS Conops, Performance Standards, Software/Hardware, and Autonomous Operations are listed as issues to tackle for the Drone Advisory Committee.

2. Regulation alternatives

Regulations are one of the most important factors that affect the transition of innovation into the market place (Geels, 2002; Kern, 2011; Rip and Kemp, 1998; Schot, 1998). For example, Schulze et al. (2015) studied the transition of automotive industry and described regulations as one of environmental forces impacting the change and stability of knowledge generation and the diffusion of innovation at the industry. Among innovation and regulation discussions, Porter (1991) brought a discourse in academic literatures (Ambec, 2013; Blind et al., 2017). According to the Porter hypothesis, strict environmental regulations can induce efficiency and encourage innovations that help improve commercial competitiveness (Porter, 1991). Before Porter (1991), dominant thought believed that environmental regulation and productivity were trade-offs. Many papers have investigated the effectiveness of being green toward markets (Ambec and Lanoie, 2008; Blacconiere and Pattern, 1994; Clemens and Douglas, 2006) and the effects of environment regulations to innovation transition (Feder and Umali, 1993; Norberg-Bohm, 2000; Riahi et al., 2015). Some researches are not limited to environmental regulation to investigate the impact of regulations on bringing innovation (ex. Amable et al., 2010; Amable et al., 2016; Reuchsteinm and Salter, 2006). However, how to design a regulation properly to induce innovation is not discussed enough (Finch, 2017). Furthermore, previous literatures on Porter Hypothesis don't differentiate regulation, which itself is not a simple concept (Lanoie et al., 2011; Cecere and Corrocher, 2016; Ambec, 2013). Lack of data caused these issues (Ambec, 2013; Blind et al., 2017). It is necessary to accumulate studies on how to regulate effectively and efficiently.

Regulations are generally regarded in two ways, i.e., prescriptive regulations and performance-based regulations (PBR), where the former prescribes what must not be done and the latter indicates what must be attained. Consideration of alternatives to traditional prescriptive regulation has been encouraged for effective and efficient governmental intervention for decades. The PBR, which specifies the required performance rather than the means to achieve the performance, has recently been encouraged in many sectors of many countries because PBR is considered to allow users to bring innovation and to take-up new technologies and approaches (Coglianese et al., 2002; Organization for Economic Co-operation and Development OECD, 2005). PBR may be an appropriate form for encouraging systemic technological change while prescriptive regulations may affect innovation at the level of components (Gann et al., 1998).

There are several reports and papers that have researched PBR effectiveness and efficiency in different sectors. Coglianese et al. (2002) held a workshop with decision makers in various U.S. government agencies and with other experts of regulations to identify conditions for the effective use of the PBR approach. The U.S. Government Accountability Office (GAO) (2010) studied the status and problems of PBR for aviation safety in the U.S. OECD (2005) studied the perspectives of PBR for the heavy vehicle sector. Gann et al. (1998) and Meachum (2010) studied building sectors which have also shifted from a prescriptive to a PBR approach.

These reports and papers presented scientific evidence and effective communication focused on successful PBR to manufactures and/or users about the risks of technology and products, the guidance of measures to meet the performance that PBR regulations specify, and information about the processes that test whether the technology or products comply with the specified performance for PBR. These papers discussed how the perception of risk is different among stakeholders, and how seeking measures to meet the performance that PBR regulations specify may be costly especially for individual and small companies, and finally, how uncertainty in the inspection process, in particular, discourages manufactures from seeking new technologies to meet performance.

Other policy institutions also exist in the discussion of regulations.