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A Systematic Review on Unmanned Aerial Vehicles in Sub-Saharan Africa: A Socio-Technical Perspective

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Abstract

In recent times, Unmanned Aerial Vehicles (UAVs) popularly known as drone technology have gradually gained widespread adoption all over the world. UAVs' relevance within modern society stems from it being able to solve socio-economic issues as well as improve productivity.

Sub-Saharan Africa has become a region of global interest with regards to technological development, leapfrogging and foreign investment, despite the lag in socio-economic development in comparison with other regions. Backed by socio-technical theory, the aim of this paper is to investigate UAV adoption and its usage in Sub-Saharan Africa by means of a systematic literature review methodology. Selected papers were reviewed, assessed and results were categorized according to the domain within which UAVs have been and are being deployed in Sub-Saharan Africa. We also determined whether the research reported on existing projects or rather made proposals on the use of UAVs.

Our results reveal that UAV adoption in the sub-region is still in its early phase, with a number of implemented cases primarily focusing on healthcare and crop farming.

The study makes theoretical and practical contributions to the topic of UAVs/drone technology within the sphere of Sub-Saharan Africa from a socio-technical perspective.

Keywords: *Unmanned Aerial Vehicles, Sub-Saharan Africa, Socio-Technical Theory, Systematic Review*

Introduction

Sub-Saharan Africa (SSA) is perceived to be one of the world's most deprived regions with a history of civil unrest, corrupt governance, low educational enrolment levels, poor healthcare delivery, a wide digital divide, as well as lacking infrastructure to meet present day global socio-economic demands. Within the past decade, there have been massive shifts in the realization of the role of technology and innovation in contributing to the alleviation of the woes of the sub-region. For example, mobile technology and smartphones are playing a pivotal role in service delivery, human development, the diffusion of knowledge (be it formal or informal education), and in many other facets of the livelihood in SSA – irrespective of the country's income category, legal origins, religious orientation or the state of the nation (Asongu et al., 2016).

One of such technological innovations is drone technology or unmanned aerial vehicles (UAVs). UAVs are playing a huge role in various sectors of developed economies and are gradually making their way into emerging markets. As SSA is on the verge of a technological revolution in all spheres, due to spillover from developed economies, UAVs are beginning to make their way into the sub-region for commercial and national developmental purposes. In the medical field, studies have revealed that UAV deployment in SSA has skyrocketed and the sub region is leading

the way in providing universal medical assistance (Ackerman & Strickland, 2018; McCall, 2019). This can be linked to the dire need for unconventional medical solutions to locations cut-off from civil development. According to the authors, there has been a rapid adoption rate in the region and the developed world is yet to catch up in this particular respect.

Most research in the area of UAVs in SSA have not discussed extensively and comprehensively in a report format, how UAVs are gradually influencing socio-economic development in the whole of the sub-region. Due to the lack of literature that assesses the current state of UAVs and their usage within the SSA region, our study aims at closing the gap regarding the inexistence of literature. In light of this, our study focuses on exploring research findings on UAVs/drone technology with respect to SSA so as to assess the extent to which the technology has seeped into the sub-region and to ascertain its widespread impact. Table 1 points out the research questions and objectives of the study:

No.	Research Question	Motivation
RQ1	What are the benefits of UAVs in SSA?	To investigate the successful implementation cases of UAVs in SSA.
RQ2	What are the drivers of drone technology adoption in SSA?	To assess the key factors that drive the adoption and usage of the UAVs in SSA.
RQ3	What are the areas of focus with respect to UAV adoption in SSA?	To investigate the possible areas of focus / domains within which UAVs have been/are being applied in SSA.
RQ4	Are the studies on UAV adoption in each area empirically validated or proposed models?	To analyse whether the areas of application of UAVs are proposed models or empirically validated studies.
RQ5	What are the existing drone regulations in SSA?	To investigate the existing regulations with respect to UAVs in SSA.
RQ6	What is the future of UAVs in SSA?	To explore the future potential of UAVs in SSA.

Table 1. Research Questions

The nature of our study demands that we employ a systematic literature review (SLR) methodology to provide a thorough overview which ultimately answers the research questions outlined in table 1. Kitchenham (2004) defines systematic literature review as "a means of evaluating and interpreting all available research relevant to a particular research question or topic area or phenomenon of interest". With this definition as a guide for our study, we aim to evaluate the extent to which research has focused on UAV adoption in SSA.

It should be noted that this article uses the words drone technology and UAV(s) interchangeably to represent the same concept. The next section delves into an overview on the state of the art (worldwide and on the African continent inclusive), followed by a theoretical backing of the study which then leads to the subsequent

section. The following section explores the methodology for the study, followed by discussions of findings and finally draws conclusions.

Literature Review

Unmanned Aerial Vehicles (UAVs) have manoeuvred their presence into the civilian airspace (Altawy, 2017) owing to their effectiveness, agility and nimbleness (Rao, 2014). These attributes have been witnessed in the military and defence world following an intensive research conducted on them as deployable weapons (Sharkey, 2011). This then sparked off the growing interest for their use in different sectors of economy by number of stakeholders worldwide in their respective spheres (Cavoukian, 2012). UAVs are believed to have flexible features and capabilities which can be leveraged on in favour of modern day business processes which leads to cost saving, longevity, durability, effectiveness and safety (Clarke, 2014). A series of research have been conducted and are still being conducted in order to fully capitalize on the capabilities of drones and how to integrate them cautiously into civil society (Rao, 2014) without infringing on basic human rights. Large companies such as Amazon (Pandit, 2014), Google (Katikala, 2014), DHL, and Russian Post, Mail.ru Group among others have taken up research on cutting-edge UAV implementations and invested into the technology in order to find the best possible structure to integrate them in their business model and reap the benefits of their enormous capabilities (Wan, 2011). However, UAVs like any other emerging technology come with their own repercussions. According to Andrew (2006), drones pose a great threat to civil society which prompts legal regulators, through aviation bodies, to conduct research on how to curb the growth of drones in a way that does not halt the development but also doesn't fully set them free without limitations (Jone, 2017). Furthermore, originating from military and defence sector, UAVs portray a negative image as they are presented as weapons in the eyes of society – be it real life experiences, the gaming world, movie and entertainment or science fiction. As such, regulators are tasked to ensure the safe integration of UAVs into civil airspace (Geoffrey, 2009).

Currently, UAV applications span across the following areas: precision agriculture (Tripiccchio 2015), aerial photography, migration and border control (Thompson, 2012), geographical surveying and mapping (McNeil 2016), search and rescue missions (Camara D, 2014), mail and parcel delivery (Bamburry, 2015), filmmaking (Cleveland, 2017), oil and gas exploration (Satterlee, 2016), inspections of public facilities (Jordan, 2017), public safety (Finn, 2011), Weather forecasting (Passner, 2012) as well as in environmental and wildlife monitoring (Casella, 2016; Provost et al., 2020).

In spite of its societal benefits, UAVs on the other hand, according to research, pose a threat to safety, privacy and security within civilian air space (Altawy, 2017). This is due to their enormous capabilities such as the ability to carry different payloads (Vergouw, 2016) which might be weaponized to harm society. Also, due to their portable, mobile and agile features, a swarm of UAVs or a single UAV can be used to attack passenger planes. Cameras mounted on UAVs may be used in collecting data during their flight over private premises which poses a threat to one's privacy without their consent (Cavoukian, 2012).

Since drones are being integrated into civil society it is pertinent that they be identified as technical components of the social construct. In light of this, the study is

underpinned theoretically by the Socio-Technical Theory (STT). As defined by Geels (2004):

a. STT suggests that new technology is diffused through its interactions with social groups (i.e., users) and rules/regulations.
b. STT draws from sociology, institutional theory, and innovation studies and describes the diffusion of new technological systems.
c. STT is made up of interconnected dimensions that upon interacting with each other are vital to the diffusion and development of new technology. These dimensions are namely: technological systems; rules and institutions; and social groups, human actors, and organizations (pp. 903).

Scholars have also defined the STT as a theory which encompasses the interaction among people, society, the technical means and technologies as well as offers various necessary means to attain a common optimization (Shmelova et al., 2018). According to Cartelli (2007) any organizational system maximizes performance only if the interdependency of the subsystems is explicitly recognized and any design or redesign must seek out the impact each subsystem has on the other, and planning must aim at the achievement of superior results by ensuring that all the subsystems are working in harmony. Figure 1 represents the schema of the STT as proposed by Bostrom and Heinen (1977).

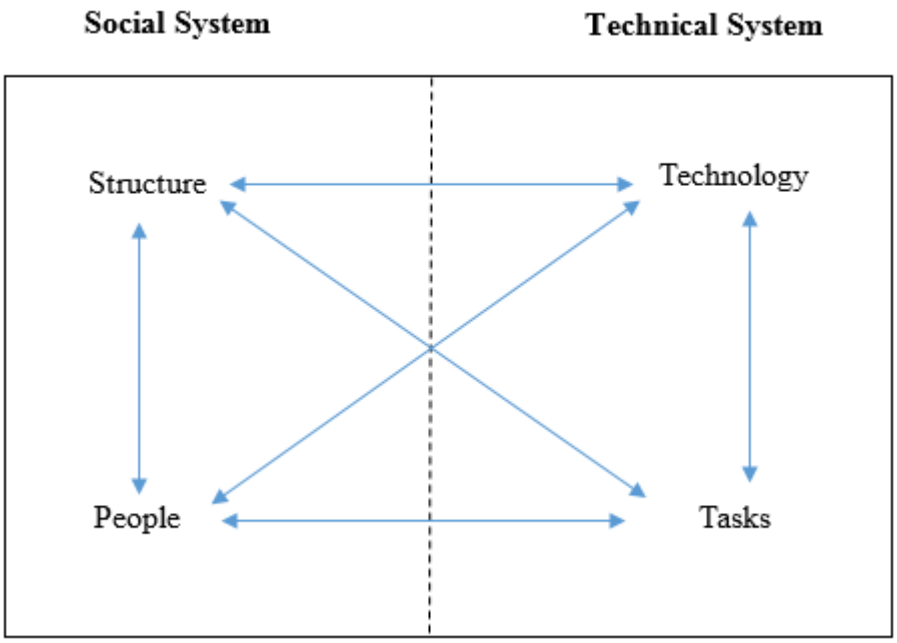

Figure 1. Schematic Representation of Socio-technical theory

Kling & Lamb (1999) state that considering technology as a tool rather than a socio-technical system is the reason for the high rate of failure of a large number of information systems. Similarly, UAVs must be viewed as socio-technical systems in order for policymakers to formulate formidable structures that will support its success and contribute positively while safeguarding human livelihood.

Socio-technical systems are described as an action or work system where technical and human sub-systems exist and together build one entity (Ropohl, 2009). UAVs therefore fall under the category of socio-technical systems because they are technological systems that play a role in society by performing certain tasks (security,

agricultural, medical, recreational, and many others). Thus, UAVs as socio-technical systems are able to function optimally within the realm of society when they co-exist with the environment (community, farms, urban/residential areas, etc.) they're placed in by being regulated (i.e. the structures) to prevent catastrophes and reckless management and promote sustainable development. Interpreting UAVs through the lens of socio-technical theory, UAVs cannot be standalone technological infrastructure but require an ecosystem to function optimally; humans to develop and manage them; regulations to protect the UAVs as well as people's freedoms from infringement; and perform the necessary responsibilities they were built for. With this perspective, our assertions are in line with an important point made by Clegg et al. (2017) that, with respect to the socio-technical systems theory, changes in any component, will cause and necessitate changes elsewhere in the system due to its complex interactive nature. This means that policymakers and regulators will be able to draw up strategies for keeping society safe as well as promoting socio-economic development through UAVs. Therefore, with a solid understanding of socio-technical systems theory and its sub-component by policymakers and regulators, UAVs will be capable of co-existing in equilibrium with society.

STT fits perfectly into the narrative of drone technology diffusion, its sociological implications and its interactivity with social constructs, regulations and human actors. Thus, it is important for SSA policy makers to view UAVs as a socio-technical system. Against this background, the study adopts the socio-technical theory (STT) in performing a systematic review of literature as well as interpreting the research findings due to the fact that UAVs can be classified as socio-technical systems. The next section discusses the methodology of the research.

Methodology

In order to fully comprehend the usage of UAVs in Sub-Sahara Africa (SSA), the systematic literature review (SLR) methodology best fits as an efficient research approach. In this SLR, we identify research on UAV technology adoption and drivers, its usage, and regulations within the context of SSA.

This study is aimed at filling the gap identified in the literature with respect to a lack in scholarship of UAV technology in SSA as well as UAVs as a socio-technical system. In order to capture the required scholarly materials, the study followed Kitchenham's SLR methodology guidelines: planning, conducting, and reporting (Kitchenham, 2004) so as to reduce the likelihood of bias (as seen in table 2). In the planning and conducting phase, inclusion and exclusion criteria were adopted to ensure that research materials obtained were relevant to the research objectives. The search strategy was performed for all articles and involved the following query terms and the results yielded listed below in Table 3.

Inclusion Criteria	Exclusion Criteria
Studies available in the Scopus Database	Duplicated Articles
Studies published till 2018	Studies outside the context and domain of biology (i.e. drone of bees)
Full length peer reviewed articles, conference proceedings, book chapters	Studies published in the other languages
Studies within the context and domain of UAV, drone technology, and sub-Saharan Africa	

Studies published in the English language	

Table 2. Inclusion and Exclusion Criteria of the study

Search Query Terms	Scopus (TITLE-ABS-KEY ("drones") OR TITLE-ABS-KEY ("uav") OR TITLE-ABS-KEY ("unmanned aerial vehicle") AND TITLE-ABS-KEY ("sub sahara*"))	12 DOCUMENTS
	Web of Knowledge TOPIC: (drone*) AND TOPIC: ("sub sahara*")	9 DOCUMENTS
	Web Of Knowledge TOPIC: (UAV) AND TOPIC: ("sub sahara*")	4 DOCUMENTS
	Web of Knowledge TOPIC: ("unmanned aerial vehicle") AND TOPIC: ("sub sahara*")	1 DOCUMENT
Years	2007 – 2018	
Databases	Web of Knowledge & Scopus	

Table 3. Literature Search Query

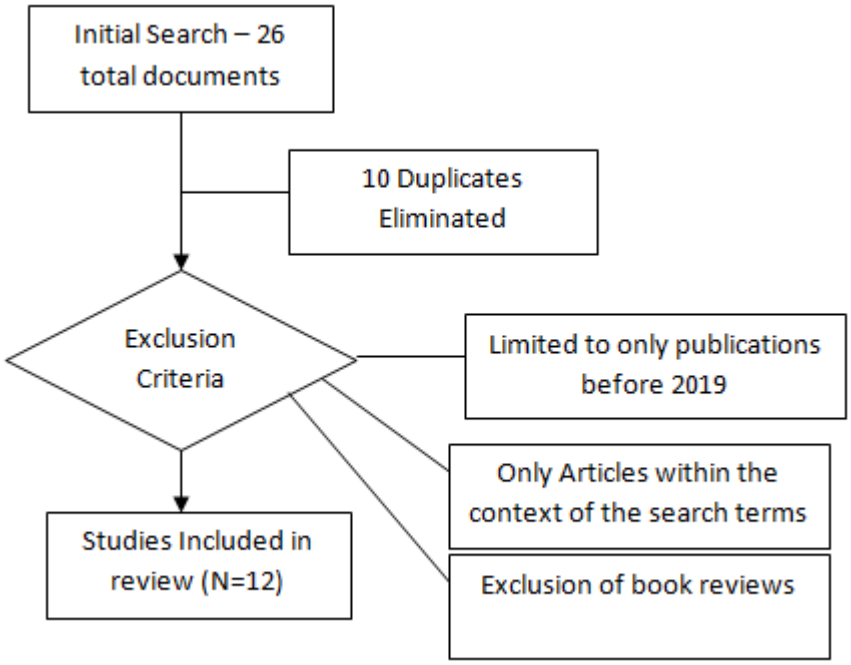

Figure 2. Article selection & inclusion/exclusion process flow diagram

As a result of applying the literature search procedure (visible in figure 2), the systematic review search yielded a total of 26 sources. Two (2) articles were excluded because they had no bearing on the topic of interest. 12 articles were deemed fit for incorporation into the review study. Tables 2 and 3 indicate how the 12 sources were merged from the two (2) research databases considered for the study (Web of

Knowledge and Scopus). Results were exported from the databases and imported into Endnote (version 6) software to be compiled, sorted and processed using the exclusion and inclusion criteria.

Findings

This section reveals the results of the systematic literature review search procedure and summarizes the findings of our study. Here, we focus primarily on both the social and technical contexts in which UAVs in SSA have been adopted as pointed out by previous research. We also indicate whether the referenced research articles discussed UAVs in SSA as an idea with possible implementation potentials (i.e. *proposals*) or were studies documenting exact use cases as well as the country or countries of implementation (*i.e. reality*) .

a. Agriculture (Remote Sensing):
    i. *Proposal*– Investigating the potential of very high spatial resolution (VHSR) satellite systems and Unmanned Aerial Vehicles (UAVs) in assisting smallholder farmers in sub-Saharan Africa so as to alleviate the spatial resolution problem and insight of the usability of remote sensing on smallholder farming needs to be developed. Within this context, UAV data was used to derive information at this fine spatial scale because it is established that UAV-derived vegetation indices maps have a great potential in the agricultural sector (Stratoulias et al., 2015).

    ii. *Reality (Zimbabwe)* – Their research performed a case study on conservation agriculture management practices in the light of projected soil degradation and fertility loss which will affect yield of crops in Sub-Saharan Africa. The study reinforced the usefulness of UAV and its associated image processing for high throughput plant phenotyping studies under field conditions. Here, data (aerial measurements) was acquired using two UAV flights (a. RGB digital camera and b. multispectral and thermal cameras) (Gracia-Romero et al., 2018).

    iii. *Reality (Kenya, Zimbabwe) & Proposal* – An acceleration of crop breeding advances is urgently needed to confront increases in the frequency and intensity of climate change-induced extreme weather events. This is the case with maize in Sub-Saharan Africa, being the top staple crop for low-income populations, and currently suffering from the appearance of new diseases, which together with abiotic stresses (heat, drought, low N fertilization) are challenging the very sustainability of African societies. In their study, UAV-based remote sensing platform which was equipped with a multi-spectral camera to obtain RGB-indexes employed for precise crop management in wheat and maize for both fertilizer and irrigation treatments, as well as disease conditions, and as effective high-throughput phenotyping techniques in breeding programs aimed to improve cereal crop performance to under a wide range of conditions (Kefauver, 2015).

b. Healthcare:

i. *Proposal* – The MedizDroid Project is aimed at using UAVs in the automation of Indoor residual spraying, Outdoor residual spraying, Larval source management (i.e. treatment of breeding sites and water bodies and later on proceed to External environment & habitat management, modification and manipulation, in developing affordable and sustainable UAV-based systems that can be deployed in malaria endemic sub-Saharan Africa and elsewhere. At the time of publishing their work, the project was at the stage of specifying, simulating and prototyping subsystems. This functions involved: Heavy-weight lifting and long endurance UAVs using hybrid power; composite and parasite UAVs; electronically controllable vector control payloads; structured software platforms and architectures (Amenyo et al., 2014)

ii. *Proposal* – With the advances in robotics and ICTs, the study explored the potential of deploying a defibrillator UAV in the foreseeable future. Based on literature study of telemedicine and its future within the sphere of ubiquitous spatial-temporal healthcare delivery models Bwalya (2017).

iii. *Proposal* – Drawing on past experiences with the outbreak of Ebola in 2014/2015, this research suggested initiatives to strengthen diagnostic preparedness for infectious disease outbreaks. According to the author, specimen transport remains inconvenient in many rural areas but with connectivity to transmit and receive results, new approaches to specimen collection and transport (eg. the validation of rectal swabs and the use of UAVs to transport specimens to distant laboratories) now enable remote testing feasible Semret (2018)

c. Land Mapping:

i. *Reality (Rwanda, Ethiopia, Kenya)* – There is an ongoing challenging to map millions of unrecognized land rights in Sub-Saharan Africa. The its4land (an European Commission Horizon 2020 project that aims to develop innovative tools inspired by the continuum of land rights, fit-for-purpose land administration, and cadastral intelligence) project has established a strategic collaboration EU and East Africa. The major tasks include tool development, prototyping, and demonstration for local, national, regional, and international interest groups (Koeva, 2017).

ii. *Reality (Malawi, Tanzania)* – Their work involved designing and developing a new low cost flying wing model to serve delivery and remote sensing applications in the developing world (i.e. EcoSoar) with the goal of: Delivering medical and diagnostics packages, Imaging areas for environmental assessment, and Creating business opportunities for local entrepreneurs who were going to be fabricating, operating, and maintaining the aircraft. The UAVs low cost provides a workable financial model for sustained UAV delivery and imaging services unlike other UAV operations in sub-Saharan Africa (Standridge et al. (2018).

d. Military and Defense:

i. *Proposal & Reality (Djibouti, Seychelles, Niger, Kenya, Central African Republic (CAR), Mali, Mauritania, Burkina Faso, Uganda, Ethiopia, and probably South Sudan)* – The author revealed that UAV technologies shed light on the structural shortcomings of African armed forces (i.e. equipment availability, maintenance or training, of organisation, doctrine, command and control, or of tactical and operational skills).
According to the author, the lack of relevant industrial capabilities, the integration of UAVs into organisational structures and doctrines of African forces can only be realised by enhanced cooperation with countries leading in UAV technologies (US, the UK and France).
As such, the technological progress in military UAVs emphasises the urgent need for the reorganisation and professionalization of the military forces in sub-Saharan Africa, including anti-corruption measures and reliable political (democratic) control of the military. The author proposed the necessity for the emerging civil society in African countries to engage robustly in a public discourse about the legal and ethical aspects of the use of UAVs in combating insurgencies and terrorism (Rotte, 2016).

ii. *Proposal (Niger)* – A UAV base was proposed in Agadez, Niger as a counterterrorism mechanism in the region as well as smuggling and human trafficking. The study explored the potential for the success of UAV operations in the region by monitoring terrorist movements and identifying targets due to the topography of the land. Also, the potential for increased air raids which could serve as a deterrent to terrorist groups (Ajala, 2018).

iii. *Reality (Uganda, Somalia, Ethiopia, Seychelles, Eritrea)* – This study was aimed at conceptually understanding the present day reconfiguration of US military doctrine and practice taking place under the guise of stability. Apparently, it has been discovered that the US military has engaged in covert operations in non-war zones. The United States Africa Command (AFRICOM) played a role in the war against the LRA in Uganda by employing surveillance actions (aerial surveillance missions) and drone attacks against suspected terrorists. In the case of Somalia, the country is known to be mapped by UAVs that start from airfields on the Seychelles and in Ethiopia. This speculation was confirmed by the United Nations Monitoring Group on Somalia and Eritrea which reported that 'unidentified unmanned aerial vehicles routinely operate in Somali airspace' (Bachmann, 2014).

In summary, it can be observed that, UAV implementation across Sub-Saharan Africa is primarily focused on fundamental necessities such as healthcare and agriculture due to the fact that food and personal well-being are very essential for survival.
It must be noted that, articles eliminated from this systematic review were not connected to the core goals of this study but rather made reference to drones of bees and agriculture or biology research with respect to Africa. The next section discusses our findings.

Discussions

In this discussion section, we give further details about the answers to the proposed research questions earlier on in the paper. The purpose of this study was to explore the research that outlines drone technology (i.e. UAV) within the sub-Saharan African region from a socio-technical perspective by performing a systematic review of literature from the two (2) core research databases (Scopus and Web of Knowledge).

From the understudied literature, it can be inferred that more research on UAVs/drone technology in Sub-Saharan Africa is needed and this can be associated to its low level of initial adoption over the years. This explains why numerous countries have no existing drone regulations. Our results reveal that UAVs in SSA have primarily been used in conjunction with remote sensing techniques in crop agriculture due to the gradual transition from traditional farming practices to modern practices – for example precision agriculture (Musvoto & Nortje, 2018).

Literature has also revealed that the agricultural sector is the leading driver of the adoption of drone technology in SSA (for example in Ghana and Zimbabwe). The growing demands of the health sector have also proved to be a strong driver of drone technology adoption in SSA (Staruch et al., 2018). Within the health sector in SSA, UAVs are being deployed to carry out medical services (i.e. in Rwanda, Zimbabwe, and Nigeria). A study by Yiadom et al. (2018) discussed the rationale behind the need for implementation and adoption of emergency medical systems, its role in fuelling national health and economic development in Ghana as well as how Ghana's UAV deployment could possibly be a model for low to middle income countries. Land surveying and mapping have also driven adoption of UAV technology in SSA where UAVs are used to survey land and mapping purposes by civil engineers and realtors. Hobbyists have also contributed towards the adoption of UAV technology in SSA using them to capture aerial imagery, and capturing events.

From the systematic literature review, we conclude that, the adoption of UAVs in SSA has the potential of creating business opportunities for local entrepreneurs (fabrication, operation, and maintenance); counterterrorism and security through monitoring terrorist movements and identifying targets/threats; healthcare delivery; land administration, and cadastral intelligence; fertilizer and irrigation treatments; crop performance improvement; automation of pestilence combating.

Despite UAVs being an innovative tool to positively impact social livelihood, research indicates that the commercial use of UAVs raises safety, privacy, and ethical concerns. As pointed by Luppicini and So (2016) in a techno-ethical study on UAVs, the enforcement of safety and regulatory measures for UAVs would minimize the negative impacts of commercial drone development (Luppicini, R., & So, A. (2016). A study on privacy and security threats caused by UAVs indicated the following circumstances heighten threats: when a UAV goes beyond line of sight, UAVs can be used as signal sniffers; drones can be used for cyber-attacks; interdiction of other drones; GPS spoofing; and many others (Vattapparamban, 2016). These threats must be carefully considered before implementing because, drone technology has the capacity to improve upon service delivery in the agriculture, health and security sectors of sub-Sahara Africa (SSA). Sociotechnical systems force us to think anew when it comes to the way we attribute responsibility to designers and users in the ethical questions that surround technology due to the unpredictable behaviour of modern technology (Vermaas et al., 2011). From ethical standpoint socio-technical systems require regulation, governance (attainable through design, enactment and

adaptation) which must aim at promoting well-being, promoting human and property safety, collective stakeholder engagement, accountability and promoting privacy (Chopra and Singh, 2018). In an age where personal privacy and security are a huge topic of discussion, it is pertinent that policymakers view UAVs through an ethical sociotechnical perspective in order to satisfy developmental demands without infringing on human rights.

In summary, we answer the following research question posed earlier on:

i. **RQ2. What are the drivers of drone technology adoption in SSA?**
With the few SSA countries implementing UAVs, a study by Efron (2015) reveals the drivers for UAV adoption within the sub-region as: severity of agricultural and health delivery issues as a result of a lack of effective and acceptable solutions; the ability of UAVs to motivate youth into agriculture and provide employment; a desire for innovative and modern mechanized methods; and a growing stakeholder support. In a nutshell, UAVs have been identified by SSA governments as a possible tool for supporting the development process in health and agriculture.

ii. **RQ3. What are the areas of focus with respect to UAV adoption in SSA?**
From findings section, it can be inferred that the primary focus areas for UAV technology integration include: agriculture, healthcare, land mapping (remote sensing, wildlife preservation (Smith, 2015)), as well as defence and military purposes. Research has also pointed out that UAVs are being used on a commercial bases for photography, videography and cinematography in recent years (Cheng, 2015). Thus, for recreational purposes as well.

iii. **RQ5. What are the existing drone regulations in SSA?**

With respect to UAV regulations in the sub-region, the following are the classifications and their corresponding countries[1]:

a. Countries that banned UAVs: Senegal and Cote d'Ivoire.
b. UAV regulations Exist: Namibia, South Africa, Rwanda, Kenya, Uganda, Tanzania, Botswana, Cameroon, Chad, Ghana, Malawi, Mauritania, Mauritius, Nigeria, Namibia, Seychelles, Swaziland, Zambia and Zimbabwe.
c. No official UAV laws: Angola, Burundi, Cape Verde, Central African Republic, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Gambia, Guinea, Guinea Bissau, Mali, Mozambique, Niger, South Sudan, and Sudan.

[1] Africa Progresses with Drone Regulations , URL: https://www.uasvision.com/2019/01/28/africa-progresses-with-drone-regulations/

Figure 3. Status of UAV regulations in Africa (source: Food and Agriculture Organization[2])

Figure 3 illustrates the state of the presence of UAV regulations on the African continent per country. The presence of regulations in place mostly within Southern and Eastern Africa can be linked to the sporadic adoption of UAVs as presented in the findings of our systematic review.

iv. RQ 6. What is the future of UAVs in SSA?

Companies such as Facebook are already looking into implementing UAVs as affordable internet service providers to the less connected areas in the sub-region Lee at al. (2015). Thereby bridging the wide digital divide. In the medical sphere, plans are underway to delivery blood and medical equipment via UAVs to last mile locations. Zipline, a Silicon Valley startup, after successfully delivering blood in Rwanda, partnered with the Ghana Health Service to launch a medical drone program[3] and more of such deployments are soon to be witnessed within the sub-region as a result of the continued success stories.

Sandvik (2015) pointed out that there is the presence of drone utopianism in the sub-region but reiterated that drones have been recommended in the future for crime fighting, solving insecurity and unrest issues, preventing poaching, increased medical assistance in the face of health crises, and a game changer in the development of Sub-Saharan Africa. Thus, drone technology and its regulation is poised for a great future in SSA.

From a socio-technical perspective, raising awareness and provision of resources to assist commercial and recreational UAVs operators could adequately address privacy, data protection and ethical issues as easily digestible information (Finn & Wright,

[2] FAO, African Union embraces drones technology for agriculture, URL: http://www.fao.org/e-agriculture/news/african-union-embraces-drones-technology-agriculture

[3] Quartz Africa, K. G. Asiedu, 2019, An ambitious drone delivery health service in Ghana is tackling key logistics challenges, URL: https://qz.com/africa/1604374/ziplines-drone-delivery-launches-in-ghana-with-vaccines/

2016). This is because, UAVs as socio-technical systems are developed by people to perform specific tasks, and when regulations are in place, UAVs are able to co-exist in their environment without being a nuisance to residents or harming lives. Thus, addressing issues of privacy is highly recommended so as to encourage the use of UAVs to boost agricultural productivity, security and economic progress in SSA.
Novel means of assessing UAV readiness within SSA have been formulated in the works of Nzaramba et al. (2017) and we highly recommend policymakers, public sector and private sector stakeholders to adopt the study in order to evaluate their level of readiness, as well as improve upon shortcomings. The next section concludes on the study.

Conclusion

Before concluding, one major limitation to the study was the fact that we limited our scope of research materials for the systematic review to only the Scopus and Clarivate Web of Knowledge databases. As such we recommend that future work extend the sources to a larger number of databases as well continue with research that spans beyond the years we limited our work to. We also recommend researchers to comparatively evaluate the adoption of UAVs in various industries in Sub-Saharan Africa and other continents, trade blocks or geographically related countries. Finally, we observed that research has not delved into the security and privacy aspect of UAVs and as such we recommend future research to probe into this.
The paper presented a systematic review on drone/UAV technology adoption and usage within the context of Sub-Saharan Africa through a socio-technical lens, which is a first of its kind. Thus, the study serves as a revelation of the state of the art in the sub-region as well as motivation for further research on the topic.
Our study described UAVs as socio-technical systems and used the socio-technical theory to explore the role drones have played in several Sub-Sahara African countries. The paper revealed that UAVs are primarily being adopted in the agricultural and healthcare sectors and this can be attributed to the pressing needs and rising demands in those sectors as a result of increased population growth. We also linked the growth in drone regulations in South and Eastern Africa to its sporadic adoption and startup culture within that part of the region. Also we observed that, the presence of UAVs in SSA for safety and security purposes is not initiated and solely manned by locals but rather foreign troops which have partnered with the governments in certain parts of the region to counter terrorism and crime.
With respect to theoretical implications of the study, this research contributes to a broad aspect of fields such as in policy development and regulations as well as the adoption of innovation in developing economies – primarily Sub-Saharan Africa.
With the rise in innovation-driven uses of other modern novel technological breakthroughs together with UAVs, it is also pertinent that Sub-Saharan African governments revise policies and setup legal landscape so as to be prepared when UAV usage increases in the sub-region.

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