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Gender Diversity in UAV (Drone) Industry

Joanne Kuzma[1], Kate Dobson[2]

[1]University of Roehampton, UK, [2]University of Worcester, UK

ABSTRACT
In the past decade, progress has been made with increasing the number of women employed in science, technology, engineering and mathematics (STEM) fields. However, their numbers remain far below their male colleagues. The purpose of this study is to analyse the gender differences in employment in the new STEM area of Unmanned Aerial Vehicles (drones). We address the following research questions: (1) Do women have lower levels of employment within various job functions in the drone industry compared to their male colleagues? (2) Is there a gender difference in drone industry employment between various countries? Statistical analysis of personnel information found on the websites of 112 drone services firms in seven countries found that women were under-represented in the drone industry. They were also less likely to hold technical or managerial roles such as drone pilots or technical managers among all countries surveyed. The practical and theoretical implications of gender exclusion were reviewed.

KEYWORDS
Gender roles, male-dominated occupations, Drones, UAVs, Women in STEM

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INTRODUCTION

Despite efforts to promote women's participation in STEM fields, gender segregation and low levels of female employment are still prevalent. According to Prescott and Bogg (2011), segregation can occur both vertically, concentrating individuals in the lower echelons of an organisation, and horizontally, concentrating individuals in particular occupations, making some occupations either 'men's' or 'women's' work. This is disturbing as high-tech careers offer interesting, exciting and challenging work environments, job security, and excellent opportunities for progression and development. However, barriers for women remain and STEM fields, such as cybersecurity, are viewed as a 'man's job' by wider society and by customers and clients, and there is perceived gender inequality in recruitment, opportunities and progression (Peacock and Irons, 2017).

Worldwide statistics in traditional STEM fields show a lack of gender diversity. However, new STEM areas have not yet been studied fully. This paper is of current relevance to the new commercial drone industry, where there has been limited attention in academic research.

THEORETICAL FRAMEWORK AND CONTEXTUAL BACKGROUND

Growth of UAV industry

The use of drones or Unmanned Aerial Vehicles (UAVs) in commercial applications has the potential to dramatically alter commercial applications and impact daily lives (Rao, et. al., 2016). According to Goldman Sachs (2017), by 2020 the forecast for the commercial and civil drone market will be $100 billion, with the top industries being construction, agriculture, insurance and oil/gas. The report states that the consumer demand for drones will build significantly, from 450,000 shipments and $700 million in revenue in 2014 to 7.8 million consumer drone shipments and $3.3 billion projected revenue in 2020. According to Atwater (2015), the global drone market is expected to grow by 19 percent per year from 2015 to 2024.

The use of UAV's can have a huge economic impact on a variety of industries and contribute to cost efficiencies. For example, firms in the telecommunications industry may use drones instead of helicopters to monitor high-tension towers, thus cutting down the cost of hiring a helicopter and paying for wages, as well as reducing the risks of injury or loss of life (Chamata, 2017). According to Park (et. al., 2015), UAV's can be used in the agricultural industry to evaluate damage in the case of agricultural disasters and can increase the prediction accuracy which in turn helps to maintain the agricultural supply and demand.

Gender in the Drone Industry

Like many other STEM areas, the commercial drone industry and corresponding field of higher education suffer from a lack of involvement of women. Men are the overwhelming buyers of commercial drones. According to Guarino (2016), in the U.S. about 1% of drone sales are to women, and 97-98% of customers are male.

Issues with gender stereotyping in the drone arena can be traced to the beginnings of the UAV industry. According to Guarino (2016), early drone kits were aimed at men with a cultural inclination to engage in 'tinkering'. However, Guarino (2016) believes this mentality will change over time, and drones will become the new iPhone, thus attracting more women into the field. Drones can be used not only by businesses, but also as a disruptive technology in the areas of politics and sociology. Suárez (2017) describes how drones can be used as pivotal instruments in a larger network of technologies through which social collectives seek to mobilize knowledge, create awareness, and contest power in order to combat violence against women in Mexico.

Lin (et. al., 2015) performed a study of 101 participants to investigate the relationship between video game experience and gender on performance of imaging and weapon release tasks in a simulated multi-UAV supervisory control station. Results showed that men do not hold any physiological advantages over women in performance, and thus results would encourage firms to recruit UAV operators from nontraditional populations.

An analysis of the USA Federal Aviation Authority (FAA) 2016 civil aviator's statistics found that women hold fewer than 4% of remote pilot certificates (McNabb, 2017). Margheri and Ball (2017) estimate that women make up less than 1% of the commercial drone industry. In Australia, fewer than 50 women are certified commercial drone pilots (Morphet, 2017). There are few female drone pilots in the military, and they often encounter cultural problems. In a study of drone military pilots, a female pilot indicated 'It was tough to be the only woman in a male-dominated warrior culture' (Murch, 2015).

McCue (2016) states that the drone industry mirrors other STEM technology fields with the lack of women in top management, and most of the drone firm executive teams have few or no women on executive teams. Montoya (2017) provided statistics on four prominent UAV firms, where the number of women in executive positions ranged from only 9% to 30%. Websites images relating to the drone industry shows a disparity among gender. A 2015 study of 1,617 drone images on Thinkstock only included three images of women and girls engaging with drones, compared to 18 for men and boys. On Shutterstock, there were four girls, 28 boys, 12 women, and over 100 men (Stone, 2015). Stone (2015) asserts there are several reasons the drone industry is gender biased. First, a high percentage of the market is men, so vendors continue to market towards males. Second, many drone conferences and events feature male-dominated atmospheres with scantily clad women models, thus exacerbating the exclusion of women as customers.

As with their industry counter-parts, women academics are under-represented in many STEM faculties at colleges and universities in the United States (Grubbs and Grubbs, 2016). This underrepresentation extends into the numbers of male students outnumbering females in sciences. The drone field also follows this trend and according to Guarino (2016) at the college level, men dominate drone courses.

Best (et. al., 2013) studied women's participation in STEM fields in Germany and found that there was still a significantly disproportionate number of women in STEM, and female students still report a non-inclusive STEM culture and women opt out of STEM-related academic fields in larger proportions than do their male fellows. Other studies have found the same lack of women in STEM fields in the UK (Chapple and Ziebland, 2017), India (Sharma and Dhal, 2016), India, Sri Lanka and Bangladesh (Morley and Crossouard, 2015).

Diversity in STEM

According to the U.S. Department of Commerce (2017), women filled 47 percent of all U.S. jobs, but only held 24 percent of STEM jobs, and women with STEM degrees are less likely than males to work in STEM fields. Harrison (2017) concurs that women are underrepresented in technology, such as the drone arena, and argues that it is important to have a more gender equal representation in both STEM and drone industry. The article indicates that the industry needs people from all types of backgrounds, and that drones are useful in many lines of business, they are not just 'boy toys'.

A study by Ruiz-Jiménez and del Mar Fuentes-Fuentes (2016) sampled 205 Spanish SMEs from technology sectors. They found management capabilities have a greater influence on both product and process innovation when the management team is more balanced in number of men and women. Gender diversity in the top management team appears to encourage a work climate that stimulates development of new ideas, exchange of knowledge, communication, and trust. A McKinsey study makes it increasingly clear that companies with more diverse workforces perform better financially and make sense in purely business terms. The study showed that companies in the top quartile for gender diversity are 15 percent more likely to have financial returns above their respective national industry medians (Hunt, et. al. 2015). Another study by Chen (et. al. 2016) suggests that female directors improve board effectiveness in risk management with respect to R&D investment.

Statistics for the lack of women in STEM are similar in most global studies. Ramirez and Kwak (2015) completed a study of 69 countries, and although there have been improvements in gender parity in STEM subjects, there are still low rates of parity. Some countries, such as India and Brazil show better numbers compared to countries such as Thailand, Malaysia and Senegal. Catalyst (2018) reports that averaged across regions, women accounted for less than a third (28.8%) of those employed in scientific research and development (R&D) across the world, and globally, women made up on 12.2% of women on boards in the information technology industry in 2015.

The subject of gender with the use of technological innovation in the armed forces has been previously studied. According to Archer (2017), the use of technology like UAV's has changed the types of war fought, and technology and intellectual skills override the importance of physical ability. Thus technical innovations (UAV) shift the traditional debate about women in combat roles.

Purpose and Framework

Research exists in the areas of gender diversity in traditional STEM industries. Examples from the literature as described above show a continued under representation of women. However, there is a gap in the research literature for the drone industry, particularly since this is a new field within STEM. The purpose of this study is to analyse the representation of women in the drone industry. The methodology utilized in this study is that of statistical analysis of personnel information found on the websites of 112 drone services firms.

The following research questions guided this study:

1. Do women have lower status job roles in the drone industry compared to their male colleagues?
2. Is there a difference in drone industry employment among different countries in relation to gender representation?

METHODOLOGY SAMPLING

The study population is composed of 112 firms that specialize in UAV services. The firms were chosen from seven countries (UK, France, Germany, Spain, Australia, Canada and USA), with 16 firms selected from each country. These were industrialized countries with large numbers of drone firms.

To choose the 16 firms in each country, initially a search was carried out on two drone industry websites – UAV Coach (2018) and HireUAVPro (2018). Both sites provide lists of drone firms throughout the world. For each company listed for the seven countries, the individual firm's website was checked to determine if the company specialised in drone services for that country. The website was scanned and analysed to determine if there was a listing of team members or employees. If an employee page was included in the site, the website URL was put into an excel spreadsheet for further analysis. If there were no employee pages on the site, the next website firm was checked. This resulted in 15 firms being candidates for analysis, but 97 additional company websites were needed.

To gather more firms, a Google search was performed of the terms 'drone, UAV, country'. The top 100 results for each country were checked to determine if the site had an employee page. To gather additional firms, the search was expanded with additional text searches. For example, for a search for German drone firms, the German word for drone 'drohne' was used to find additional German firms. Finally, LinkedIn was searched for the same wording criteria as in the Google searches to eventually obtain 16 firms from each country.

After a list of 112 firms was compiled, the next step was collecting two employee characteristics:

1. Gender distribution
2. Employee job functions

For each firm, the website was visually reviewed to find the 'About Us' or relevant page(s) showing employees or team members. The firm's website images and/or employee names were used to determine if the team members were male or female. Approximately 75 percent of the firms did have employees pictures on their 'about us' or 'team' pages, thus allowing easy identification of male versus female employees. For the other firms, a determination was made based on common female or male first names.

Finally, the specific job functions/titles for each employee listed on the company web site were compiled. Six different job functions were reviewed technical management, business development/accounting, human resources/marketing, pilot/engineer/software development, video processing and unknown. If an employee had two or more job titles, then the higher ranking or first listed title was used for the data collection. For example, if an employee had titles of 'Director of Marketing' and 'Drone Operator', then the 'Director' position was used in the statistical analysis.

RESULTS

Table 1 shows the compiled gender numbers for the drone firms by each country. The top columns list the results for each of the seven countries, along with the totals. The rows are divided into results for gender (male or female) for each of the countries. Total numbers and percentages are given for each cell.

The results of the study show that the drone industry is dominated by men in all countries. Of the 605 employees shown on company web sites, 529 (87%) are men. The numbers from each country range from the highest percentage of male employees in Germany (94%) to a low of 84% in Australia. For all seven countries, women represent 13% of employees in drone firms, with the lowest number in Germany (6%), and the highest representation in Australia (16%).

Table 1: Gender Numbers by Country

Country / Gender	UK	Fra.	Ger.	Spa.	USA	Can.	Aus.	Total
Men	85 (88%)	87 (86%)	67 (94%)	66 (89%)	80 (87%)	78 (86%)	66 (84%)	529 (87%)
Women	12 (12%)	14 (14%)	4 (6%)	8 (11%)	12 (13%)	13 (14%)	13 (16%)	76 (13%)
Total	97 (100%)	101	71	74	92	91	79	605

Table 2 shows a breakdown of gender representation by various types of job functions, and broken down for each of the seven countries. The total numbers and percentages are included for each.

Table 2: Positions by Gender for Countries

Country		UK	Fra.	Ger.	Spa.	USA	Can.	Aus.	Total
Men									
	Tech	33 (35%)	27 (27%)	19 (27%)	17 (23%)	18 (20%)	13 (14%)	20 (25%)	147 (24%)
	Bus Dev	9 (9%)	6 (6%)	6 (8%)	2 (3%)	4 (4%)	6 (7%)	3 (4%)	36 (6%)
	HR / Mkt	2 (2%)	10 (10%)	7 (10%)	1 (1%)	3 (3%)	5 (5%)	1 (1%)	29 (5%)
	Pilot	27 (28%)	29 (29%)	18 (25%)	35 (47%)	29 (32%)	38 (42%)	29 (4%)	205 (34%)
	Video	14 (15%)	11 (11%)	12 (17%)	10 (14%)	10 (11%)	9 (10%)	10 (13%)	76 (13%)
	Other	0 (0%)	4 (4%)	5 (7%)	1 (1%)	16 (17%)	7 (8%)	3 (4%)	36 (6%)
	Total	85 (89%)	87 (87%)	67 (94%)	66 (89%)	80 (87%)	78 (86%)	66 (84%)	529 (87%)
Women									
	Tech	1 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (3%)	1 (1%)	1 (1%)	6 (1%)
	Bus Dev	4 (4%)	2 (2%)	0 (0%)	1 (1%)	2 (2%)	2 (2%)	5 (6%)	16 (3%)
	HR / Mkt	5 (5%)	7 (7%)	1 (1%)	0 (0%)	2 (2%)	0 (0%)	1 (1%)	16 (3%)
	Pilot	0 (0%)	2 (2%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	4 (1%)
	Video	1 (1%)	0 (0%)	2 (3%)	6 (8%)	3 (3%)	2 (2%)	1 (1%)	15 (2%)
	Other	1 (1%)	3 (3%)	1 (1%)	0 (0%)	2 (2%)	7 (8%)	5 (6%)	19 (3%)
	Total	12 (13%)	14 (14%)	4 (6%)	8 (11%)	12 (13%)	13 (14%)	13 (16%)	76 (13%)
Men + Women	Total 100%	95	101	71	74	92	91	79	605

Statistical analysis of the types of positions show a disparity between men and women. Overall, the percentages of men in the technical and pilot positions are much higher than women. Women tend to be found in a higher percentage in the human resources, marketing and 'other' categories. Of 153 total employees in technical management, only six are women. This equates to women holding only 1% of the total technical management positions while men hold the vast majority of senior management positions. There are only four women in drone pilot or software positions while men hold 205 pilot positions. Women hold a higher percentage of business development (16 positions compared to 36 for men) and HR/marketing positions (16 women and 29 men) in the drone industry.

The video category comprises camera operators, video production, web design and artistic aspects of the industry. Women comprise 19% of these roles while men hold 76 of the 91 total positions. The 'other' category comprises a variety of positions including administration and office support, or where a person's position was not indicated on the team's web page. Women hold 19 of these 36 positions.

The comparison for each country shows a similar result among the technical versus non-technical positions. The USA had more women (3) in technical management, but the numbers were statistically of low significance. The number of female pilots was similar (between zero and two) in all countries.

DISCUSSION

1. Do women have lower levels of employment in various job functions in the drone industry compared to their male colleagues?

This research adds to the body of literature in the field of diversity in the technology arena, by its expansion into the drone sector. The results of research question 1 showed a significant difference in participation between men and women. As with other employment results from STEM studies, women employed in the drone industry are underrepresented compared to the general population.

Studies show that women in STEM industries are often employed in non-technical roles compared to their male colleagues. Men in STEM are more likely to be in a technical role designing, implementing or supporting IT (48% of men versus 31% women). Women are more often found in non-technical roles such as account management, marketing or back office support (12% of women versus 3% of men), (Glick, 2016).

Findings from the research in this study show the number of women in the drone industry follows the low numbers found in other STEM industries. Niemi (2017) states that in the gaming industry, women's roles tend to be heavily weighted towards operations, human resources, marketing and public relations, and they only hold five percent of the programmer roles. This is consistent with the statistics shown in this research, where women hold four (2%) of the 209 drone pilot positions, and six (4%) of the 153 technical management positions. Niemi (2017) explains that the billion-dollar game industry is growing, but women remain marginally involved. The U.S. Department of Commerce (2017) statistics indicate that women hold 14 percent of jobs in engineering and 25 percent of the STEM management jobs. Thus the statistics shown in this study show a more acute gender underrepresentation for the drone industry compared to the total STEM market.

2. Is there a difference in drone industry employment among various countries related to gender?

The results of the study show that underrepresentation is found across all countries, and validates studies found in other countries. The average rate of women employment was 13% across the various countries. The country with the

highest employment of women in the drone industry – Australia – only had 16% of female employees. Germany ranked lowest at 6% employment, thus showing a worrying disparity in the field. For various types of employment, there are similar statistics among most countries. For example, rates of women employed in technical or pilot positions show similar low rates for all countries (between 0% and 3%). In Spain, 8% of the video positions are filled by women, while rates are 0% to 3% for other countries.

LIMITATIONS AND CONSIDERATIONS FOR FUTURE STUDY

Several issues must be considered when reviewing the validity of this specific study. First, it is not clear how many employees will have their profile available on the website. There may be cultural differences in putting employee's information and/or images on websites. Alternatively, there is the possibility that only employees in specific job functions may or may not be included on profile pages. A second limitation is that the survey was limited to drone operating companies. Further studies encompassing a wider range of firms (such as drone manufacturing companies) could enhance the body of knowledge.

This research project analysed 112 drone service companies in highly industrialised countries to gauge the level of participation of women. For future studies, it may be beneficial to compile results on companies in the Global South and compare to see if there are differences in gender equity.

One bias in this study is the consideration that information from websites may not be enough to claim the gender of an employee. Basing the determination of gender or other identification from a photo could be disputed, as people may identify with a different gender compared to the photograph or name. Another area to consider for further research could be an analysis of race and ethnicity in drone firms. However, care would be taken in analysing this through visual representation as with identifying gender.

CONCLUSION

The aim of this article was to analyse the differences in employment between men and women in drone operations firms. There have been prior studies of women in STEM fields, and some limited studies of women in the drone industries (Montoya, 2017 and McCue, 2016). However, prior studies have concentrated on American or Australian firms, with no systematic study of firms across a wide range of countries. This paper analysed women in seven countries, and found that for all, there is a dearth of women employed by drone operations firms.

A second observation that contributes to the body of literature in this field is the examination of types of positions held by gender. The study clearly showed that women are concentrated in non-technical positions, such as sales and administration. Men however hold the majority of drone pilot and technical managerial positions. Women's exclusion from these areas severely hampers the career progression available to them and also reinforces gender stereotypes (Niemi, 2017). In order to ensure that women have the same employment opportunities and are encouraged to enter the drone field, it is imperative that the industry

reviews methods to attract a more diverse workforce including increasing the visibility of women on their company websites and other communications.

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