Air passenger attitudes towards pilotless aircraft

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Abstract

This paper presents the results of an investigation into attitudes towards and willingness to fly in pilotless aircraft (PAs) among a sample of 711 UK people known to fly at least occasionally. A problem with past studies in the area is that attitudes have only been measured explicitly, using questionnaire items drawn from literature in the field. Also, distinctions between attitude strength and attitude structure have not been considered. The present investigation employed an implicit measure of attitudes and examined attitudes via (i) a structural topic modelling procedure (in order to measure the structure of attitudes within the sample) and (ii) an Implicit Association Test (to evaluate attitude strength). Outcomes to the Implicit Association Test contributed significantly and substantially to the explanation of the sample members' degrees of willingness to fly in PAs. These are important matters considering the need for airlines, government agencies and aircraft manufacturers to induce public acceptance of PAs. Determinants of attitudes were posited to include self-image congruence, fear of flying, general anxiety syndrome, interest in new technologies, age, gender, and exposure to information about pilotless aircraft. A model containing these variables was assembled and estimated, the results providing a good fit (R^2=.58) with data obtained from the sample. Three primary components of attitude emerged from the investigation: risk, excitement and innovation. Four variables exerted the greatest effects on attitude structure, namely self-congruence, interest in new technologies, prior knowledge of PAs, and the age of the participant. Fear of flying and generalised anxiety impacted on the risk element of attitude structure, but not on excitement, innovation or attitude strength. Neither the fear of flying variable nor generalised anxiety had significant influences on attitude strength, although they did have significantly negative effects on willingness to fly in a pilotless airplane. Thirty-one per cent of the sample members disagreed or strongly disagreed with a question (five-point scale) asking whether a person was willing to fly in a pilotless aircraft. The results of the study have important implications for public information campaigns initiated by state agencies and for the marketing activities and promotional messages of airlines that will need to seek public acceptance of pilotless aircraft.

Key words: Pilotless Aircraft, Fear of Flying, Self-congruence, Attitude Structure, Attitude Strength; Implicit Attitude Test, Structural Topic Model, Structural Equation Model.

Highlights

* Examines attitudes towards pilotless aircraft and assesses people's willingness to fly in them
* Distinguishes between attitude structure and attitude strength
* Uses a structural topic model to measure attitude structure and an Implicit Association Test to evaluate attitude strength
* Employs regression analyses to identify key determinants of attitudes and willingness to fly in pilotless aircraft
* Offers suggestions for public information and commercial marketing campaigns promoting pilotless aircraft

1. Introduction

Research into public attitudes regarding autonomous passenger transportation has focused heavily on potential demands for the lease or purchase of driverless vehicles, on issues involving public transport and autonomous vehicles, and on the benefits and problems expected of driverless vehicles (for details of relevant literature see, for example, Kyriakidis, Happee and de Winter, 2015; Liljamo, Liimatainen and Pollanen, 2018; Acheampong and Cugurullo, 2019; Bennett and Vijaygopal, 2018; Bennett, Vijaygopal and Kottasz, 2019; Kanwaldeep and Rampersad, 2019). Unmanned ships have also received attention (e.g., Kretschmann, Burmeister and Jahn, 2017; Levander, 2017). Of increasing importance is the matter of public attitudes towards fully autonomous (pilotless) aircraft. This is a matter of concern considering the growing demand for air passenger transportation (IATA, 2016; 2020; Statista, 2020), and the long-term shortage of pilots (Rice et al., 2014; Meredith, 2019). Civil aviation is reported to require 790,000 new commercial pilots over the next two decades; including 261,000 in Asia and 206,000 in North America (Naylor, 2019). All the necessary technologies for the use of commercial pilotless air services are now in place (Mogg, 2019). Passenger aircraft already employ online communications with a ground base for assistance when taking-off and landing, and for 80% of all time spent in the air (Markoff, 2015). A pilotless airplane crossed the Atlantic in July 2018 (Hawkins, 2019). Uber has scheduled the introduction of a pilotless air taxi service by 2032 (Paton, 2018). Several major airlines have announced plans to operate all their flights autonomously by 2030 (Deahl, 2017; Paton, 2018).

However, a pre-requisite of the successful introduction of pilotless aircraft (PAs) is the creation of favourable public opinion towards them (cf. Hoang-Tung and Kubota, 2018). Clothier and Walker (2006) observed how, despite civilian operators aspiring to use airplanes without pilots as quickly as possible, a passenger airline's premature acquisition of PAs could be extremely costly if the public were unwilling to accept them. Acceptance of this new technology, i.e., "behavioural responses that support implementation of the new technology in contrast to impeding it" (Linzenich, Arning, Offermann-van Heek and Ziefle, 2019 p. 207) must be secured among all socio-political groups including, inter-alia, politicians, the voting public, citizen and community associations, frequent and infrequent flyers, and people who live near airports (Kreps, 2014; Sanbonmatsu et al., 2018; Nunes, 2019). Soon, therefore, state agencies, passenger airlines, manufacturers and other interested parties will soon have to mount information and promotional campaigns designed to persuade the public to accept pilotless airplanes (PAs). This will require the determination of the sorts of message that will be most effective for persuading people to travel in pilotless aircraft. Some degree of segmentation of target audiences (and thus of marketing messages) will be necessary as, in the words of Anable (2005), "policy interventions must recognise that a combination of instrumental, situational and psychological factors affect choice of mode of travel and these factors differ for disparate groups of people" (p. 65). Writing in the context of driverless motor vehicles, Acheampong and Cugrullo (2019) reported how public acceptance of autonomous vehicles "will depend on approval by a complex network of heterogeneous potential users who possess different attitudes, perceptions, motivations, preferences, socio-demographic attributes and mobility needs" (p. 350). Knowledge of the views of the flying (and currently non-flying) public about PAs will help state agencies and commercial interests to develop and implement appropriate and effective marketing and public sector communications strategies.

The present study aimed to determine both the structure of attitudes towards PAs aircraft, and the strengths of these attitudes, among a sample of 711 individuals known to fly at least occasionally. It then sought (i) to identify variables possibly affecting attitude strength and structure, and (ii) to evaluate connections between attitude strength and structure and the sample members' willingness to fly in PAs. The paper proceeds as follows. Section 2 examines past literature in the area, and is followed by section 3 which discusses the structure and strength of attitudes to PAs. The fourth section suggests a number of covariates that might affect attitudes. Next, the methodology of the investigation is presented and the technique of structural topic modelling is outlined. Then the results of the estimation of the STM are presented and the features of the IAT employed to measure attitude strength are explained. Details of the outcomes to the IAT are provided, followed by a discussion of the results, a statement of certain limitations of the study and suggestions for future research.

2. Past literature

Academic research into attitudes towards PAs has been sparse relative to the investigation of attitudes towards autonomous motor vehicles and has mainly concentrated on issues to do with trust in technical PA systems and safety (see Hughes, Rice, Trafimow and Clayton, 2009; Rice et al., 2014; Molesworth and Koo, 2016). There is however a substantial amount of grey literature (from Internet sources, consultant's reports, blogs, etc.) on the subject. Some research into public attitudes regarding uncrewed aerial vehicles (UAVs) *in general* (usually relating to drones) has been undertaken the results of which have indicated that, while most people accepted their use for monitoring dangerous and remote locations, for aerial photography and for military applications, there was little support for the application of of UAVs to serve any other purpose (see, for example, MacSween-George, 2003; Castillo-García, Hernandez and Gil, 2017; Aydin, 2019). Public attitudes towards single-pilot aircraft have also been investigated (e.g., Stewart and Harris, 2019), with passengers' trust in the technology relating to this type of aircraft emerging as a major determinant of willingness to fly in them. As regards fully pilotless aircraft, Rice et al. (2014) examined differences in trust in PAs between samples of 104 air passengers in the USA and 97 passengers in India, concluding that cultural factors resulted in Indian flyers being more likely to trust journeys in PAs. Ragbir et al. (2020) completed another study in the USA and India that investigated, among a sample of 782 commuters, the factors underlying the participants' willingness to fly in autonomous air taxis. The results indicated that the sample members were most willing to fly in autonomous air taxis on short journeys and in good weather conditions. Molesworth and Koo (2016) used a student sample to develop a scale to measure an individual's attitude towards PAs, based largely on trust and perceived safety; a result reflecting that of an earlier study of 201 undergraduate students completed by Hughes et al. (2009).

An international survey of 8000 consumers undertaken by the UBT Corporation found that 54% of the respondents were "unlikely" to take a pilotless flight, and only 17% would "try" such a flight (see Deahl, 2017). Residents of the USA were the most likely to accept pilotless aircraft; while participants in France and Germany were the least likely. Attitudes were especially favourable among 18 to 34-year-olds and among the better educated. Similar results were reported in a study conducted by Embry-Riddle Aeronautical University and the Florida Institute of Technology, which concluded that most members of the public did not favour fully autonomous flights (see Rice, 2019). Male participants in the Embry-Riddle study were more willing than females to fly in PAs. People of Asian heritage regarded PAs more favourably than did individuals of other ethnicities. Younger adults were more willing than the elderly, and passengers who were knowledgeable about automation *in general* were more willing than people with little knowledge of automation. A market study of 1688 US residents completed by NASA (2018; 2021) revealed that only half of the participants were potentially comfortable with the use of pilotless aircraft. Safety and high ticket prices were the main concerns expressed. NASA recommended unified messaging in order to counteract misinformation, proactive engagement with interest groups, and large scale demonstrations to assuage public fears concerning PAs.

Rice and Winter (2015) conducted a series of experiments in which 198 members of the public viewed pictorial representations of six basic emotions (anger, fear, etc.) while considering their liking for various pilot configurations (no pilot at all, one pilot, two pilots, etc.). The participants were then asked to state the emotion they rated the highest for each pilot configuration. Fear and anger emerged as the dominant emotions associated with the pilotless option. In a similar study, Rice et al. (2019) presented 520 US residents with a hypothetical scenario of a journey in a pilotless airplane, finding that 60% of the sample members were unwilling and 30% willing to travel in a PA. The authors attributed this result to lack of knowledge of PAs among the participants. Factors that significantly explained willingness to travel in a PA were prior knowledge of PAs, liking for new technologies, fear, a "fun factor", age, and educational level. Molesworth and Koo (2016) found that "trust" was the primary consideration encouraging acceptance of PAs by a sample of 196 first year undergraduate students. This result reflected that of an earlier study of 201 undergraduate students completed by Hughes, Rice, Trafimow and Clayton (2009). Molesworth and Koo's (2016) investigation concluded that, on the average, people preferred conventional to pilotless aircraft *provided* all other characteristics of a flight (inflight service, age of the aircraft, etc.) were satisfactory. People with positive views of new technologies were more likely to hold favorable attitudes towards PAs. The Internet travel booking company Travelzoo completed a survey of confidence in autonomous flight technology among a sample of 6000 travelers in six countries. Confidence was low, with just 7% stating a preference to use a PA compared to conventional aircraft (Travelzoo, 2019). Overall, 76% of consumers did not trust pilotless technology and 78% stated they would be "very" or "quite" worried about its safety and reliability.

Benefits of PAs identified by the abovementioned literature include lower costs (airlines will not have to pay for the training and employment of pilots [Molesworth and Koo, 2016]), reduced insurance premiums (most air accidents result from human error so insurance costs should fall [Nunes, 2019]), resulting possibly in ticket prices falling by at least ten per cent following the removal of pilots from aircraft (Deahl, 2017). Passenger safety should be better in a PA compared to conventional aircraft, given that human pilots can over-react to emergencies, become tired, exceed safe limits, lose concentration, and/or experience dysfunctional emotions such as anger or depression (see Paton, 2018; Rice, Winter, Mehta and Ragbir, 2019). Drawbacks of PAs could arise from passengers' fears vis-à-vis possible computer breakdowns, cyber-attacks, unforeseen weather conditions, lightning strikes, mid-air collisions with other aircraft, birds or drones, terrorist hijacks, or the absence of personnel to deal with unruly passengers (Opperman, 2016).

2.1 Contribution of the present study

The current investigation builds upon previous research in the area in a number of ways. Prior studies of attitudes concerning PAs have usually measured attitude by assessing a person's agreement or disagreement with questions based on prior literature. (An exception was the study of Molesworth and Koo [2016], which used 20 items relating to three themes suggested to them by four specialists in the aviation field.) The present study employed the method of structural topic modelling (STM) (Roberts et al., 2014) to analyse replies to a completely open-ended question regarding PAs. A second contribution of the investigation relates to the scope and depth of the analysis of attitudes to PAs. Strength of attitude was measured as well as the elements of attitude structure. Connections between attitude strength, attitude structure, and sample members' willingness to fly in a pilotless airplane were also examined. Collectively, the outputs to the investigation provide an indication of how airlines, government agencies and aircraft manufacturers might best present PAs to the general public.

3. Components of attitudes regarding PAs

Hogg and Vaughan (2005) defined attitude as "a relatively enduring organisation of beliefs, feelings, and behavioural tendencies towards socially significant objects, groups, events or symbols" (p. 127). "Attitude" is a complex construct (Guénin-Paracini, Malsch and Paillé, 2014) which, nevertheless, has often been found to connect significantly with consumer behaviour in the transportation field (see Katz, 1960; Garling, Gillhom and Garling, 1998).

3.1 Attitude structure

Attitude structure, according to Ajzen (1989), "has to do with the ways in which the components of attitude are organised and with divergent attitudinal properties that emerge as a result of different organisational patterns" (p. 255). Conventional views of attitude structure often assert that it comprises three kinds of element: cognitive, affective and conative (see Baloglu [1998] for a review of literature regarding this matter). Yet, there is no consensus in the academic literature as to the precise meanings of each of these types of component, and several alternative interpretations have been offered. Explanations differ with respect to whether beliefs and feelings are components of attitude or causes of attitude (see Crano and Prislin, 2006; Nolder and Kadous, 2018), and whether attitudes need to include a conative element (with cognitive and affective components explaining behaviour as a dependent variable) (Bagozi and Burnkrant, 1979). Nevertheless, several studies have concluded that attitude structure has two main “affect” dimensions, respectively based on (i) pleasure and pleasantness (or the reverse), and (ii) arousal and elation (or the reverse). These are said to combine with cognitive elements that are associated with memory and beliefs (see Bodur, Brinberg and Coupey, 2000). Cognitive elements might involve knowledge and experience of an entity and congruence between the entity and a person’s self-concept (Ajzen, 1989).

3.2 Attitude strength

Some attitudes exert powerful influences on thinking and behaviour, whereas others may be fleeting and inconsequential (see Eagly and Chaiken, 1998; Howe and Krosnick, 2017). Strong attitudes (i) are firm and resistant to change, (ii) will guide information processing, and (iii) can motivate behaviour. Weak attitudes, conversely, might be easily changed (Wang, Hodges and Wilson, 1995). Research has found attitude strength to depend on prior knowledge of an entity, experience of the entity (not relevant in the present study), the personal relevance of the entity, and a person’s psychological attachment to the entity (see Fazio, 1995; Spira, 2002). Attitude strength is determined by cognitive accessibility, which is assessed by how quickly an entity comes to mind when mentioned (Fazio, 1995; Howe and Krosnick, 2017).

4. Covariates likely to affect attitudes

A review of literature regarding acceptance of new transportation opportunities (electric cars for example, see Egbue and Long [2012]; Rezvani, Jansson and Bodin, [2015]; Anania et al. [2018]; Bennett, Vijaygopal and Kottasz [2019]; Acheampong and Cugrullo [2019]) and other new technologies revealed a number of recurring discussions of variables potentially relevant to the explanation of attitudes towards PAs. The limited amount of literature (grey as well as academic) available on PAs was also examined to identify possible covariates. The variables in question are examined below.

4.1 Fear of flying

Dunn and Hoegg (2014) defined fear in relation to consumer behaviour as "an emotional response to the presence or anticipation of a danger or threat" (p.152). Fear affects nearly all aspects of cognition, attention, memory and judgement, especially within contexts of uncertainty and risk (Mendl, Burman and Paul, 2010). Flying is by far the safest means of transportation. The global accident rate for air passenger transportation is less than 2.5 incidents per million flying hours and, when accidents do occur, less than 8% of passengers are killed. Thus, fear of flying is irrational (Oakes and Bor, 2010). Nevertheless, many people dislike flying and a person who is apprehensive about flying might feel highly uncomfortable at the prospect of flying in a pilotless airplane. Fear of flying ("aviophobia") has been estimated to affect between 10 and 25% of the population and, in addition, 20% of people who fly are known to rely on alcohol or sedatives to calm their nerves during flights (Rothbaum, Smith, Lee and Price, 2000; Clark and Rock, 2016). Research has established that fear of flying is a heterogeneous issue that can result from many sources, e.g., fear of injury, mutilation or death; agoraphobia; dislike of being confined in a small space; feelings of loss of control; fear of terrorism, fear of having a panic attack during a flight, or a combination of these and other possible considerations (Ekberg, Seeberg and Bratsberg-Ellertsen, 1989; Wiemer and Pauli, 2016).

4.2 Generalised anxiety

Some people tend to feel anxiety in general and this characteristic could significantly increase an affected individual's disquiet about travelling in a PA (cf. Armfield, 2006; Clark and Rock, 2016). Indeed, Depla et al. (2008) reported that 59% of aviophobes will experience some other anxiety disorder within their lifetime. Anxiety, according to the American Psychiatric Association, is "the apprehensive anticipation of future danger or misfortune accompanied by a feeling of dysphoria or somatic symptoms of tension" (APA, 2000 p.355). It is a distressing condition often accompanied by disorientation and stress. Anxiety differs from "fear of flying", however, in that whilst fear is a direct response to a *specific* threat, anxiety is a continuous condition. The term "generalised anxiety" is used to describe protracted and uninterrupted feelings of anxiety (APA, 2000) which cause the individual to feel anxious about a wide range of situations (NHS, 2018) and to have difficulty in controlling worries (see Spitzer, Kroenke and Williams, 2006).

"Transportation anxiety" arises from the belief that a journey will expose a person to risk (Gossling, 2017). It can induce feelings of nervousness and discomfort (even dread) about travelling (Butcher, 2018). In extreme cases, transportation anxiety can arouse irrational fears of accidents. The literature cited above implies that transportation anxiety is likely to exist in people who experience generalised anxiety, making them apprehensive about new transportation technologies. This suggests that people with high-generalised anxiety may possess less favourable attitudes towards PAs. Generalised anxiety has parallels with the "risk aversion" factor in attitudes to PAs noted by Rice et al. (2019).

4.3 Self-image congruence

A substantial body of research has concluded that congruence between (i) an activity (flying in a PA for instance), and (ii) a person's self-image, may impact heavily on the individual's attitude towards the activity (see Farhat and Khan, 2012; Zhu, Teng, Foti and Yuan, 2019). Self-image congruence (SIC) has been recognised as an important determinant of consumer behaviour (Sirgy, 1986; Jamal and Goode, 2001). SIC can have a functional aspect that relates to utilitarian benefits and the satisfaction of practical needs, and a symbolic dimension that involves self-identity and the satisfaction of hedonic needs (see, for example, Sirgy, Johar and Clayborne, 1992; Jamal and Goode, 2001). Sirgy (1986) identified four types of SIC: "actual", "ideal", "social" and "ideal social". Sirgy et al. (1992) defined actual SIC as the goodness-of-fit between an entity or activity and a person's actual self-image, whereas ideal SIC was the match between the entity or activity and an individual's ideal self-image, i.e., how people would *like* to see themselves, rather than how they actually see themselves. Social SIC relates to links between the entity or activity and how a person believes s/he is seen by others, while ideal social SIC refers to how the individual would *like* to be seen by others. According to Sirgy (1986), high levels of any of these forms of SIC can motivate a person to think positively about an entity or activity, because each form can satisfy a particular need.

4.4 Personal interest in new technologies

A person's interest in new technologies could motivate the individual to look favourably on a development such as pilotless aircraft (cf. Anable, 2005). Interest in new technologies has been found to be associated with a liking for technologically advanced products, with early adoption of advanced products, and with self-confidence in the use of new technologies (see Egbue and Long, 2012). Thus, interest in new technologies might enhance the personal relevance of PAs to people with high levels of this characteristic (cf. Rice et al., 2019). Individuals interested in new technologies appreciate innovation for its own sake, are open to the latest innovations (Anable, 2005), and will seek information about new developments (Hurtt, 2010; Ozaki and Sevastyanova, 2011). It is likely, therefore, that individuals with high levels of interest in new technologies will be interested in new transportation options and ideas, although it is known that sometimes people only pay close attention to information that confirms their existing attitudes (see Lee et al., 2015).

Research concerning autonomous *vehicles* has found that individuals high in technology interest look favourably on the introduction of autonomous transportation options (Bennett and Vijaygopal, 2018; Bennett, Vijaygopal and Kottasz, 2019). People high in technology interest are likely to view autonomous vehicles as technically superior and will enjoy psychological associations with them (see for example Grewal, Mehta and Kardes, 2000).

4.5 Prior knowledge

An individual's trust in pilotless aircraft may be higher if the person has received substantial amounts of information about pilotless flights (Rice et al., 2014; Rice, 2019), although prior knowledge of pilotless aircraft could in fact worsen a person's attitude towards PAs. Research has established that, in general, prior knowledge of an entity is a critical source of individual differences in attitudes and behaviour regarding the entity. Prior knowledge will influence, inter alia, the ways in which individuals organise, interpret and explain their thoughts about the entity (see Cheron and Hayashi, 2001).

As PAs have yet to appear commercially, a person's prior knowledge of them will have been obtained from television programmes, newspaper or magazine articles, conversations with other people, social norms (Moons and De Pelsmacker, 2012; Rezvani, Jansson and Bodin, 2015), or from "mere exposure" (Le Hebel, Montpied and Fontanieu, 2014). Regardless of the source of prior knowledge, it is known to be an important factor in consumer attitudes towards new transport options (Egbue and Long, 2012; Rezvani et al., 2015; Bennett and Vijaygopal, 2018). Moreover, prior knowledge can facilitate the acquisition of completely fresh information about a new transportation method. This in turn can affect attitudes (Tsai, Chang and Ho, 2015) *and* a person's feelings of self-confidence when considering using the method (Park and Lessig, 1981; Park and Moon, 2003). Studies completed by Howe and

Krosnick (2017) and Rice et al. (2019) found prior knowledge to be an important influence on attitudes towards pilotless aircraft.

4.6 Other variables

Age and gender have been found to influence people's attitudes towards new technologies, with younger people and males exhibiting more favourable attitudes (see Linzenich et al., 2019). A study by Rice et al. (2019) concluded that age and education level could affect an individual's willingness to fly in a PA. Woosnam et al. (2019) argued that a person's history of travel use (number of trips per year) is a good predictor of attitudes concerning transportation. Also, frequent fliers might regard PAs as more personally relevant to them than is the case with occasional fliers. Rice et al. (2014) suggested that a person's attitude towards pilotless aircraft may be less favourable if the individual is told that a child is on the airplane. Thus, the questionnaire in the present study asked the respondents for information on these matters.

5. Methodology

A sample of 711 people known to fly at least occasionally was recruited from the England and Wales panel of a commercial research company (QualtricsXM UK). The sample comprised groups of people who match national averages in terms of gender, income, educational level and geographical area of residence. All panel members had flown at least once. Table 1 shows the characteristics of the sample. Figures for the UK population are shown (if available) in parentheses.

TABLE 1 HERE

The participants were emailed by the research company and requested to answer, in their own unprompted words and without being given any detail about the study, an open-ended question regarding their thoughts and feelings about "pilotless airplanes". Immediately thereafter, each member of the sample completed a questionnaire containing items for constructs that might explain their attitudes. Table 1 lists the extents of the sample members' agreement/strong agreement relating to the main constructs covered by the study. Replies to the open-ended question were analysed using an STM procedure (Roberts, Stewart and Tingley, 2018) to determine the structure of the participants' attitudes concerning PAs. The outcomes to the STM were used as a foundation for the second part of the study, i.e., the application of an implicit association test (IAT), which was administered one month later to measure the strengths of the sample members' attitudes

5. 1 Assessing attitude structure: The structural topic model

A structural topic model (STM) (Roberts et al., 2014; Roberts, Stewart and Tingley, 2018) was used to establish the components of the structure of attitudes towards PAs among the sample members. Structural topic modelling is a semi-automated machine-learning qualitative research method used to identify latent structures within replies to an open-ended question. This approach was selected because (i) due to the paucity of robust academic literature in the area, very little is known about people's views on PAs, and (ii) it avoided the need to apply any particular definition of "attitude" during the research. (The latter would be necessary if attitude were assessed via a written questionnaire.) An STM algorithm examines the co-occurrence of words across responses and organises responses into "topics" determined by the homogeneity of the sample members' comments within each topic. The algorithm computes the degree to which a participant's comments belong to each topic, e.g., 15% to topic one; 30% to topic two, etc.; the percentages summing to 100. These "topic prevalence" figures, i.e., the degrees to which responses belong to various topics, can be averaged across individuals to reveal an overall *structure* of attitudes.

Topic prevalence figures for each participant may then be employed as dependent variables in regressions using covariates selected by the researcher as explanatory variables. Thus, it is possible to show the influences of the covariates on each of the topics that the sample members regarded as most important. The most frequently occurring words in each topic can be extracted and representative answers may be displayed. It is necessary to compute the model for differing numbers of topics (e.g., two to eight) and then to select the most coherent solution in terms of internal homogeneity and the greatest level of discrimination (for details see Roberts et al., [2014]). Topics can be correlated, and words can belong to more than one topic. Critically, topics *emerge* from the data and are not pre-assumed. There is no need for the researcher to construct a coding scheme.

The participants were asked the open-ended question: "*Please write down all your thoughts and feelings - everything that comes to mind - about pilotless airplanes and about travelling in an airplane that does not have a pilot. The airplane has a steward who serves refreshments, etc., but no pilot flying the plane, which is controlled remotely from the ground"*. STM models involving two to six topics were estimated; a three-topic model emerging in terms of superior results for exclusivity (i.e., topics with words that have high probabilities of appearing in one topic but low probabilities of appearing in others) and semantic coherence (i.e., individual responses within a topic containing very similar words). On average, the participants wrote 54 words (median 41, range seven to 244 words). The responses were examined by the authors to identify common themes within each topic. Topic one involved aspects of safety and the risk of crashes and collisions and accounted for 35% of the responses. Themes indicative of danger, insecurity, accidents, and unsafe journeys appeared in statements belonging to this topic. Topic two also attracted 35% of the responses and reflected the view that PAs offer adventure and excitement, are thrilling, and breath-taking. In the third topic, thirty per cent of the responses saw PAs as cutting-edge, innovative, state-of-the-art and ultramodern technology. Table 2 presents the outcomes, which labels the three topics as "Risk", Excitement" and "Innovation" respectively. These outcomes were used to construct the IAT (see section 6.2 and Table 4 below).

TABLE 2 HERE

FIGURE 1 HERE

5.2 Determinants of attitude structure and willingness to fly

Appendix 1 lists the items employed to measure the constructs used in the study plus the sources of items and (i) the value (lambda) of the leading factor in a principal components analysis of the items in a construct, and (ii) the associated value of Cronbach's alpha. Constructs measured by multiple items were averaged for use in subsequent analysis. Figure 1 shows the conceptual framework relating to the first part of the investigation. The covariates are presumed to help determine attitude structure, each component of which is hypothesised to affect a person's willingness to fly in a pilotless airplane. ("Willingness" to fly in a PA was employed as a dependent variable because there was no actual behaviour to observe.) Figure 1 also supposes that the covariates may influence willingness to fly independently of the mediating three-topic prevalence variables. As several variables in the model were not normally distributed the model was estimated using the method of partial least squares.

TABLE 3 HERE

Table 3 presents the results of the estimation, which indicates that all the topic prevalence variables exerted significant influences on willingness to fly in a PA. Fear of flying and generalised anxiety affected topic 1 (the perception that PAs will be risky) but not excitement or innovation. This suggests that people who are fearful and anxious vis-à-vis the risk aspect of PAs might *also* believe that PAs are innovative and that travelling in a PA could be exciting. Self-congruence with PAs, interest in new technologies and prior knowledge of PAs had significant influences with all three of the topic prevalence variables. Age also exerted significant effects on the three topic prevalence variables, implying that older participants saw PAs as riskier and regarded PAs to be less exciting and less innovative. Income, gender and education did not exert significant effects on any of the dependent variables. The frequency with which a person travelled by air did not influence structure, but had a significant impact on willingness to fly in a PA. Likewise for whether the respondent had a child under age 16. Overall, 31% of the sample gave responses in the bottom two categories of the "willingness to fly in a PA" variable formed by averaging the five items measuring the construct.

6. Assessing attitude strength: The IAT

A variety of devices have been employed in attempts to measure the strength of a person's attitudes towards an entity or activity, e.g., word association tests, pictorial techniques, sentence completion exercises, Thurstone scales, projective tests and direct observation. Problems apply to each of these techniques, especially the possibility of social desirability bias (see Ostrom, Bond, Krosnick and Sedekides [1994] for a discussion of this issue). The present study used an Implicit Association Test (IAT) (Greenwald, McGhee and Schwartz, 1998) constructed from the results of the estimation of the structural topic model to assess the strength of favourability (or otherwise) of a person's attitude towards PAs. IATs measure how easily or quickly an attitude can be retrieved from memory. They measure implicit as well as explicit biases in assessments by evaluating the strengths of connections between automatically made associations. In the current investigation a participant was presented with words on a computer screen that are potentially associated with a PA and was asked to place these words into categories, e.g., by pressing the plus or minus keys on a computer or keys on a smartphone. Strength of association is measured by performance speed and accuracy. Instant judgements are required, so the participant cannot analyse information before responding, thus avoiding social desirability bias but revealing potentially hidden prejudices (Greenwald and Banaji, 1995; Devine, 2001). The faster and more accurately any two options are sorted together (e.g., crashes and pilotless aircraft), the stronger they are presumed to be linked in a person's mind. The faster the speed, the stronger the assumed association. Thus, by measuring how strongly an individual subconsciously associates a series of pairs of options, an IAT measures the *strength* of a person's attitude (Greenwald, McGhee and Schwartz, 1998).

6.1 Administration of the IAT

The 711 participants in part one of the study were contacted four weeks after the last of the questionnaires was received and were requested to complete an IAT. Greenwald and Farnham (2000) argued that an IAT should be administered after rather than before test subjects have filled in a questionnaire because the completion of an IAT prior to completing a questionnaire might influence the self-report measures. (Other studies have not found any systematic effects of the order of implicit and explicit measures [see McCartan et al. 2019].) Five hundred and sixty-seven people replied. To begin the test the participant was confronted with two divisions (Pilotless aircraft and Conventional aircraft) located at opposite ends of a computer (or smartphone) screen. The person then categorised a word displayed in the screen's centre into the PA category or the conventional aircraft category by hitting either a plus or a minus keypad button. Further words now appeared one by one, as listed in Table 4.

TABLE 4 HERE

The on-screen locations of the words "Pilotless aircraft" and "Conventional aircraft" at each top corner of the computer screen were then reversed and the exercise repeated. The IAT employed in the present study (which was estimated using cognilab software) is given in Table 4, which presumes that attitudes to PAs are structured in terms of the topics identified in part 1 of the study. Thus, the words listed in sections C to E of the IAT shown in Table 4 are those obtained from the STM analysis, and hence represent the elements of the participants' stated attitudes concerning PAs.

Critics of IAT methods have claimed that, because the researcher pre-specifies the comparison words employed in an IAT, the outcomes will depend in part on the words chosen. In the present study, the words came directly from the open-ended STM and as such were entirely appropriate for the investigation. Another issue is whether some members of a sample might misunderstand the meanings of the words presented to them and that tiredness can affect responses (see Brunel, Tietje and Greenwald [2004] for an overview of these matters). The words used in the present study were straightforward and readily understood, and no questions or queries about the meanings of words arose during the investigation. Tiredness should not have been an issue as the participants were able to complete the questionnaire electronically at a time of their choosing.

6.2 Analysis of IAT scores

IAT scores can lie between .001 and 1, with high scores indicating strong valence vis-à-vis attitude to PAs. In the present study, IAT scores varied between .04 and .92 and significantly and substantially explained willingness to fly in a PA (b = .68). Table 5 shows the outcome to regressions (completed using partial least squares) of the explanatory variables relating to attitude structure (see table 3) on IAT, and IAT on willingness to travel in a pilotless airplane. Comparison of table 5 with table 3 reveals four major differences. Firstly, fear of flying and generalised anxiety did not affect IAT significantly but did have a significant impact on willingness to travel. This could mean that members of the sample high in these traits did not have strong reservations about PAs *relative* to conventional aircraft and were reluctant to fly in either type of aircraft. Secondly, females exhibited significantly lower levels of *strength* of attitude towards PAs, even though gender had no effect on attitude structure. Thirdly and fourthly, a participant's frequency of flying and whether the individual had a child under 16 years of age were significantly associated with strong attitudes towards PAs (positive valence in the former case and negative valence in the latter). However, neither of these variables affected attitude structure, although they did influence willingness to fly in a PA. Education level and household income did not impact significantly on IAT scores.

TABLE 5 HERE

7. Conclusion and implications

Three primary components of attitude emerged from the investigation: risk, excitement and innovation. These themes significantly influenced willingness to fly in a PA and should, therefore, figure prominently in advertising and public information campaigns intended to secure public acceptance of PAs. Hence, promotional materials should emphasise (i) the safety features built into PAs (e.g., the nature and extent of ground control systems), (ii) the excitement of passenger involvement in a racy new technology, and (iii) the excellence of this dynamic and innovative way to fly. As regards the determination of variables capable of influencing attitude structure, four variables exerted the greatest effects on structure: self-congruence, interest in new technologies, prior knowledge of PAs, and the age of the participant. The findings concerning self-congruence imply that promotional messages which attempt to convince viewers that they are the *type of person* who will enjoy travelling in a PA, will be likely to succeed. A substantial amount of research has reported the effectiveness of advertising campaigns built on themes of self-congruence (for details see Hong and Zinkhan, 1995; Hosany and Martin, 2012; Zhu, Teng, Foti, and Yuan, 2019). Hong and Zinkhan (1995) observed how "appeals congruent with viewers' self-concept are generally superior to incongruent appeals in terms of advertising effectiveness" (p. 53). The variables that measured interest in new technologies and prior knowledge of PAs were major determinants of attitude structure, suggesting that state agencies, airlines and other interested parties will need to furnish the public with copious amounts of factual information about PAs (cf. PytlikZillig, Duncan, Elbaum and Detweiler, 2018). This information will need to focus on the benefits of PAs (greater efficiency, lower prices, no possibility of pilot error, etc.).

Older people were more inclined to believe that PAs involve risk and were less disposed to feel excited about their introduction. Younger people in the sample, conversely, were more interested in the fresh technologies represented by PAs and reported knowing more about them. Achieving acceptance of PAs among older people might occur through advertising in magazines and newspapers read by older people and on radio and television programmes heard or watched by older individuals. The insignificance of influences on structure of income, frequency of flying and whether a participant had children under age 16 imply that there would be little point in segmenting aircraft passengers with respect to these variables. The third research aim was to measure the strengths of attitudes towards PAs and to examine possible antecedents of attitude strength. An IAT revealed a wide range of levels of strength of attitude. The main determinants of attitude structure also explained attitude strength, but attitude strength depended also on gender and frequency of flying.

Several interesting relationships became evident regarding the fourth research aim, i.e., the identification of connections between attitude strength, attitude structure, and sample members' willingness to fly in a pilotless airplane. Fear of flying and generalised anxiety impacted on the risk element of attitude structure, but not on the other two topics or on attitude strength. Neither the fear of flying variable nor generalised anxiety affected attitude strength significantly, although they did have negative and significant influences on willingness to fly in a PA. This could mean that sample members high in these traits did not want to fly in *any* kind of aircraft, irrespective of whether the aircraft was conventional or pilotless. The individuals concerned did not possess strong feelings against PAs over and above their negative sentiments towards conventional aircraft. Thus, *special* inducements additional to those presently available to people who fear flying in conventional aircraft will not be required in order to encourage these individuals to fly in PAs. Female gender had no effect on attitude structure but did contribute negatively and significantly to attitude strength. However, females were no more or less willing to travel in a PA than males. Respondents who flew regularly exhibited a stronger positive attitude to PAs when compared to infrequent flyers. The same situation applied to participants with children under age 16. Neither frequency of flying nor whether a person had children under age 16 impacted significantly on attitude structure.

7.1 Limitations

The outcomes to the study offer a template for the configuration of advertisements and public information campaigns intended to secure public acceptance of pilotless aircraft. Nevertheless, certain limitations apply to the study. These were overcome in part by the measures described below.

7.1.1 Willingness to travel

Willingness to travel in a PA was employed as the dependent variable in the absence of data on actual behaviour. Presumed linkages between attitude and behaviour have been the subject of much discussion, and several attempts to demonstrate actual connections have been unsuccessful (for details see, for example, Hini, Gendall and Kearns [1995]; Grewal et al. [2000]). It seems, however that, in the words of Guyer and Fabrigar (2015), "for the most part, attitude researchers now no longer support or even seriously debate the extremely pessimistic conclusions advanced in the late 1960s regarding the utility of intent as a predictor of behaviour" (p.4). Thus, it is suggested that a strong favourable attitude towards PAs will result in positive behaviour vis-à-vis PAs.

7.1.2 Need for replications

The study was undertaken in a single country using a single sample. Replications elsewhere would be useful. The present investigation obtained a sample from the panel of a commercial market research company. This company vetted panel members to ensure that participants had characteristics near to national averages. However, all the sample members were volunteers who regularly completed questionnaires in return for points leading to vouchers that can be spent in various retail outlets. Repeating the study with members of the general public solicited at random in street locations would help validate the results, although the exercise would be difficult in that, as well as filling in a questionnaire, the respondents would also have to complete an IAT. This could be done on the participant's mobile 'phone or at home on the person's laptop. Securing a large enough sample of people willing to go through all the necessary procedures would be a challenge.

7.1.3 Open-ended question

An open-ended questioning method was applied, creating the possibility that some respondents may have misconstrued the meaning of the question. However, the question asked was straightforward and left few opportunities for disparate interpretations of its meaning. Another issue is that the lengths of the replies to the open-ended question varied substantially, with some respondents answering with just a few words. Such responses might not have involved the depth of thought applied by participants who gave long responses. The authors examined all the replies to the open-ended question looking for evidence of flippancy, none becoming evident. Hence there did not appear to be any grounds for supposing that any of the sample members had adopted a superficial approach when answering the question. Also, open-ended responses avoid biased responses arising from the cues that are often present in structured question research methods.

7.2 Future research

Studies are needed into *how* the four variables that were found to explain attitude structure (self-congruence, etc.) can best be incorporated into marketing communications concerning PAs. Possibilities include endorsements by celebrity endorsers, social media campaigns, online information centres, and conventional media advertising. Fear of flying and generalised anxiety are complex issues with many dimensions. It would be useful to examine the effects of various aspects of fear of flying and generalised anxiety on attitudes towards PAs. The impacts on attitudes of personality characteristics other than those included in the present investigation could be investigated. Attitudes to PAs held by certain groups are worthy of further research, e.g., people with various forms of physical disability. The results of the study provide information about how promotional messages can be segmented to reach people with various characteristics, but only in general terms. A more sophisticated segmentation study could examine segments more comprehensively and at a granular level.

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APPENDIX. THE QUESTIONNAIRE

Apart from factual queries and the open-ended question, all items were measured on five-point scales: 5=strongly agree; 1=strongly disagree.

1. *Demographics*

I am: female/male. My age category is: under 21; 22-30; 31-40; 41-50; 51-60; 61-70; 71+. Compared to most other people I know, I am: financially better off; about the same; worse off. I do/do not have at least one child under age 16. My highest educational qualification is: high school; undergraduate degree or diploma or equivalent; postgraduate qualification.

2. *Attitude regarding pilotless aircraft*

Please write down all your thoughts and feelings - *everything* that comes to mind - about pilotless airplanes and about travelling in an airplane that does not have a pilot. Assume that the airplane has a steward who serves refreshments, etc., but no pilot flying the plane, which is controlled remotely from the ground.

3. *Travel frequency*

On average I fly: 1-3 times a year: 4-6 times a year; 7-9 times a year; 10 or more times a year.

4. *Self-congruence* (source: adapted from Sirgy and Johar [1999[). Following Sirgy and Johar (1999), the scores from the responses to the four components were summed (after adjusting for reverse-scored items) to create an overall formative index of the strength of a person's user SIC with respect to PAs)

Actual (lambda=3.3; alpha=.85)

(a) I regard myself as being the type of person who will enjoy flying in a pilotless airplane
(b) I cannot relate to people who object to flying in a pilotless airplane
(c) I am very much like the typical person who will be content to fly in a pilotless airplane
(d) People who object to flying in a pilotless airplane are very different to me

Ideal (lambda=3.3; alpha=.87)

(a) I will think highly of myself if I am one of the first people to fly in a pilotless airplane

(b) I like the image of the sort of person who will enjoy flying in a pilotless airplane

(c) Being one of the first to fly in a pilotless airplane would make me feel special

(d) The sorts of people who will object to pilotless aircraft do not appeal to me.

Social (lambda=3.5; alpha=.89)

(a) People close to me would have a hard time thinking of me as someone who will enjoy flying in a pilotless airplane
(b) My friends, relatives and colleagues will think I am very different to the sorts of people who will dislike flying in a pilotless airplane
(c) The image of the sorts of people who will enjoy flying in a pilotless airplane is highly consistent with how I am seen by people who are close to me
(d) People who know me will think of me as someone who will be happy to fly in a pilotless airplane.

Ideal social (lambda=3.0; alpha=.82)

(a) People I associate with will probably have a poor image of people who object to flying in a pilotless airplane
(b) My friends and relatives would not like to see me as someone who objects to flying in a pilotless airplane
(c) People will think more of me if I tell them that I am the type of person who will enjoy flying in a pilotless airplane
(d) My friends and relatives will probably have a very favourable image of people who are happy to fly in a pilotless airplane.

5. *Interest in new technologies* (source: adapted from Haboucha, Ishaq and Shifttan [2017] and Rice et al. [2019]) (lambda=3.6; alpha=.90)

(a) I usually try to take up new technologies before my friends, neighbours and other people I know
(b) I tend to fear new technologies until they are proven to be safe
(c) I am excited by new technologies
(d) I am a keen enthusiast where new technologies are concerned
(e) New technologies scare me

6. *Prior knowledge of pilotless aircraft* (sources: adapted from Bennett and Vijaygopal, 2018; Rice et al., 2019) (lambda=3.2; alpha=.86)

(a) I am not familiar with pilotless aircraft
(b) I have little knowledge of pilotless aircraft
(c) I know more about pilotless aircraft than the average person
(d) I have read about pilotless aircraft.

7. *Generalised anxiety* (sources: adapted from Hopkins Anxiety-proneness Checklist [Spitzer et al., 2006]) (lambda=6.3; alpha=.91)

(a) I often suddenly feel scared for no reason
(b) I often feel fearful
(c) I often feel nervous and shaky inside
(d) I often feel tense or keyed up
(e) I often have spells of panic
(f) I spend a lot of time worrying about things
(g) I often feel afraid that something awful might happen.

8. *Fear of flying* (source: adapted from Lucas, Van Gerwen, Spinhoven and Diekstra, [1997] and Lucas et al. [1999]) (lambda=5.4; alpha=.91)

(a) My dislike of flying causes me to avoid flying whenever possible
(b) I experience considerable discomfort prior to each flight
(c) Flying is an unpleasant experience
(d) I feel nervous just thinking about having to fly
(e) I feel uncomfortable and nervous all the way through a flight
(f) I have a fear of flying

9. *Willingness to travel in a pilotless airplane* (source: adapted from Konig and Neumayr, 2017; Kyriakidis et al., 2015) (lambda=4.3, alpha=.88).

(a) The prospect of travelling in a pilotless airplane does not appeal to me at all (reverse scored)
(b) I would be willing to travel in a fully automated airplane without a pilot

(c) I would be comfortable travelling in a fully automated airplane without a pilot

(d) I think that travelling in a pilotless aircraft will be enjoyable

(e) I would be delighted to travel in a pilotless airplane

FIGURE 1. CONCEPTUAL FRAMEWORK: ATTITUDE STRUCTURE

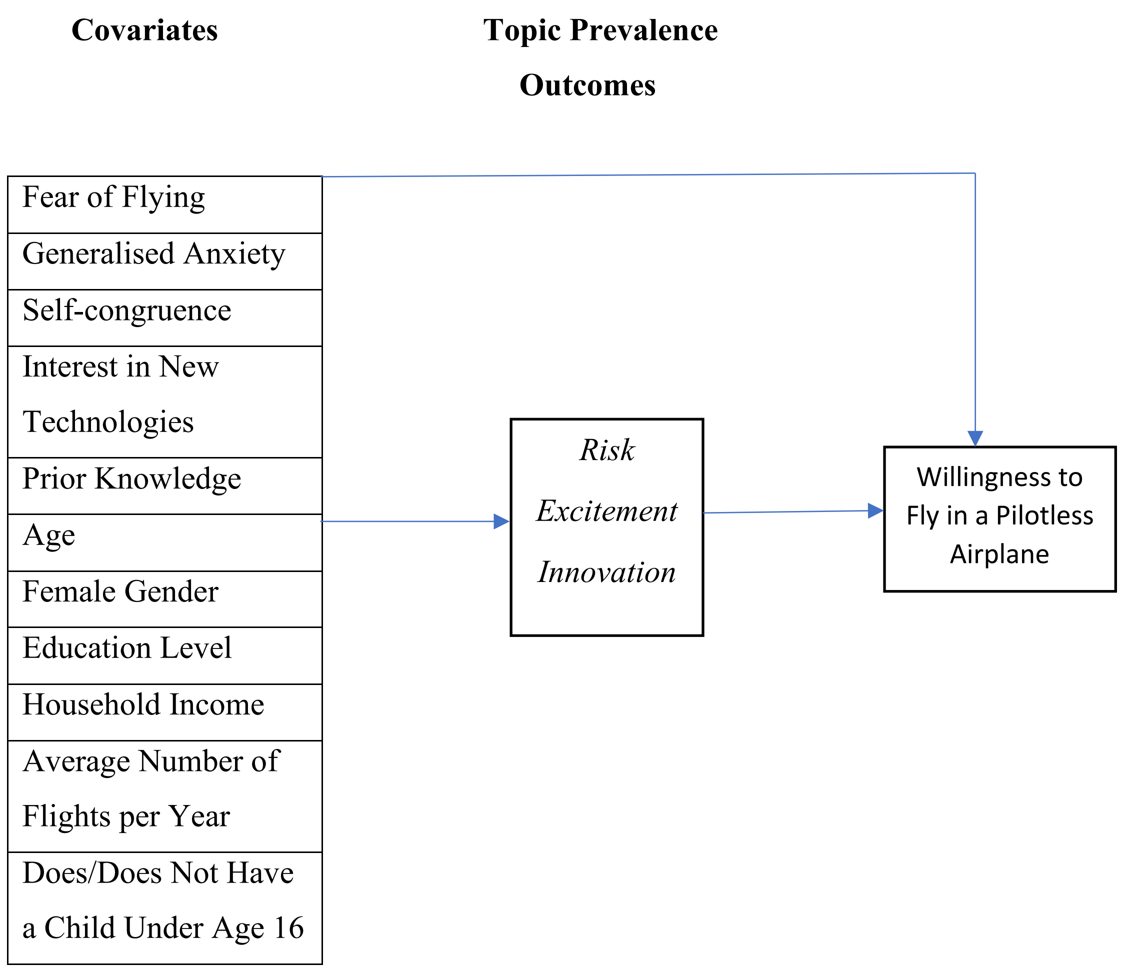

TABLE 1. SAMPLE CHARACTERISTICS

Average age (mean) - % between 18 and 39 years - % between 40 and 59 years - % aged 60 or over *Figures in parentheses refer to all UK people age 18 years or over.	39.4 (39.0)[a] 41.3% (38.7%)[d*] 35.5% (36.6%)[d*] 23.2% (24.7%)[d*]	N=711
Percentage female	48.0% (50.6)[a]	N=341
Education level: post school but without a degree has a degree level qualification	 44.0 % (42%)[b] 28.0 % (30%)[b]	 N=313 N=199
% with a child under age 16	42% (39.8%)[a]	N=299
Household income regarded as: lower than average about the same above average	 29% (23.0%)[c] 42% (49.4%)[c] 29% (27.6%)[c]	 N=206 N=299 N=206
Number of flights per year: 1 to 3 4 to 6 7 to 9 10 or more	 46% 28% 16% 8%	 N=327 N=199 N=114 N=57
Percentages of responses in the top 2 agree/strongly agree categories for: - Fear of flying - Generalised anxiety - Self-congruence	 15% 14% 11%	 N=107 N=100 N=78

- Interest in new technologies - Prior knowledge of PAs	20% 14%	N=142 N=100

Sources: [a]ONS (Office for National Statistics) (2021), Overview of UK Population 2019, London, ONS. [b]DoE (Department of Education), Education and Training Statistics for the UK 2019, London, DoE). [c]Full Fact (2019), Inequality in the UK, London, Full Fact. [d]GovUK (2020), Ethnicity Facts and Figures 2019, London, The Cabinet Office.

TABLE 2. COMPONENTS OF ATTITUDE STRUCTURE: RESULTS OF STM ANALYSIS

Topic number and label	*Prevalence (mean average) (%)*	*Most common words and phrases**	*Representative comment*
1. PAs are RISKY	35%	Accident, crash, skyjack (hostage taking), no control, collision, unsafe, scary	I'm really scared that the plane will crash into something, mountain, ground, etc. If there is sudden mechanical failure, who will rescue the plane if no one is controlling it? If another plane or object flies near the pilotless aircraft, how will the plane be able to manoeuvre itself away if no one sees it? How does the plane know if there is something in its way i.e. mountain, building, etc. How will the passengers know if there is an emergency landing so need to get into correct position if no pilot to tell you?

2. PAs are EXCITING	35%	Adventure, fascinating, can’t wait, amazing, intriguing, racy, bold	Absolutely fascinating, I can't wait to try this out! Amazing stuff. It’s straight out of an adventure movie, but I’m willing to give it a go. I am very curious and would love to see how it feels to actually travel in a pilotless plane.
3. PAs are INNOVATIVE	30%	Scientific, science fiction, advanced technology, the future, experimental, edgy, new world	Technology is changing the world in unimaginable ways and there is great potential with every new technology. I am a big fan of technology and never ever tire of trying anything techy. Pilotless airplanes are as technically innovative as you can get and are definitely how we will fly in years to come.

**The words and phrases shown are summary interpretations of the many words and phrases used to describe these feelings.*

TABLE 3. DETERMINANTS OF ATTITUDE STRUCTURE

	Dependent Variables			
Explanatory variables	Topic 1 Prevalence: RISK	Topic 2 Prevalence: EXCITEMENT	Topic 3 Prevalence: INNOVATION	Willingness to Fly in a PA
Topic 1 Prevalence: RISK				-.44 (4.13)**
Topic 2 Prevalence: EXCITEMENT				.29 (2.99)**
Topic 3 Prevalence: INNOVATION				.37 (3.88)**
Fear of Flying	.37 (2.95)*	-.15 (1.09)	.13 (1.21)	-.22 (2.99)**
Generalised Anxiety	.38 (3.98)**	-.10 (1.59)	.07 (0.66)	-.20 (1.99)*
Self-congruence	.34 (3.88)**	.39 (4.09)**	.29 (2.94)**	.31 (3.00)**
Interest in New Technologies	-.39 (3.39)**	.31 (3.15)**	.54 (4.05)**	.29 (2.84)**

Prior Knowledge	-.41 (5.22)**	-.31 (2.32)*	-.38 (4.08)*	.26 (2.50)*
Age	.29 (2.49)*	-.29 (2.26)*	-.28 (2.34)*	-.19 (1.96)*
Female Gender	.09 (1.11)	.06 (0.09)	-.12 (1.21)	-.08 (0.88)
Education level	-.09 (0.99)	.10 (1.10)	.13 (0.67)	.02 (1.00)
Household income	-.08 (0.96)	.05 (0.9)	.06 (0.66)	.10 (0.88)
Average number of flights per year	-.100 (1.20)	.10 (1.10)	.08 (1.14)	.29 (2.95**
Does/does not have a child under age 16	-.08 (0.99)	0.02 (0.55)	.12 (1.30)	-.23 (2.07)*
R^2	.49	.39	.35	.58

*Standardised coefficients. T-values in parentheses. *Indicates significance at the .05 level or below; **at the .01 level or below*

TABLE 4. THE IMPLICIT ASSOCIATION TEST

A. Top left corner of screen (then reversed); Conventional aircraft.

B. Top right corner of screen (then reversed): Pilotless aircraft.

C. Words related to Topic 1 “Risk”: Crash; danger; accident; insecure; hijack; air collision; scary; risky.

D. Words related to “Excitement”: Adventure; thrill; fascination; intriguing; exhilaration; dramatic; stimulating; exciting.

E. Words related to “Innovation”: Technological; dynamic; scientific; state-of-the-art; ingenious; effective; inventive; innovative.

TABLE 5. DETERMINANTS OF ATTITUDE STRENGTH

Explanatory Variables	IAT Score	Willingness to Fly in a PA
IAT Score		.68 (5.85)**
Fear of Flying	-.11 (0.87)	-.30 (3.22)**
Generalised Anxiety	.10 (1.10)	-.25 (2.44)*
Self-congruence	.36 (3.02)**	.30 (3.07)**
Interest in New Technologies	.20 (2.33)*	.25 (2.22)*
Prior Knowledge	.40 (5.05)**	.30 (2.56)*
Age	-.36 (3.28)**	-.25 (3.00)**
Female Gender	-.29 (3.66)**	.05 (0.05)
Education Level	.11 (0.88)	.14 (1.24)
Household Income	.08 (1.09)	.11 (1.09)
Average Number of Flights per Year	.37 (4.00)**	.33 (4.08)**
Does/Does Not Have a Child Under Age 16	-.21 (2.05)	-.32 (3.05)**
R^2	.37	.50

*Standardised coefficients. T-values in parentheses. *Indicates significance at the .05 level or below; **at the .01 level or below*

NOTES ON THE REVISIONS

Reviewer #1: RTBM-D-20-00404 Review

1. Abstract:

-Overall the abstract is well written, but I would indicate some more of the results, namely the amount of variance explained by the model within the abstract.

-I was glad to see the large sample size, especially considering the use of structural modeling

procedures.

-The PA acronym in the abstract should be defined for the reader (Line 25-26).

Additional results have been inserted in the abstract including the amount of variance explained by the model constructed to predict willingness to fly in pilotless aircraft. The PA acronym is now defined at the start of the abstract.

2. Highlights:

-The highlights appear to summarize well the main facets of the paper.

Thank you for this positive comment.

3. Introduction/Literature Review:

-The introduction and establishment of the problem is well documented. As NASA in the U.S. has created their National Campaign for UAM development, consumer acceptance is one of the four main pillars. I think the current content is well written, but the author(s) may want to consider additionally citing the NASA National Campaign on UAM to further justify the value and need for studies investigating consumer acceptance of autonomous aircraft.

The NASA market study is now included in the literature review.

-I believe the author(s) have covered and cited the relevant articles related to the topic. However, some of the authors they cite have recently published a related paper they may wish to consider:

-Ragbir, N.K., Rice, S., Winter, S.R., Choy, E.C., & Milner, M.N. (2020). How Weather, Terrain, Flight Time, and Population Density Affect Consumer Willingness to Fly in Autonomous Air Taxis. Collegiate Aviation Review International, 38(1), 69-87. Retrieved from http://ojs.library.okstate.edu/osu/index.php/CARI/article/view/7962/7350

This paper is now included in the literature review.

-The present study section explains well the novel contributions the present study makes to the body of knowledge.

Thank you for this positive comment.

-For Table 1, I would like to see n reported for each group, in addition to the percentage

This has been done.

4. Methods:
- The structural topic modeling section is explained well, and Table 2 visually presents the findings well.
-Covariates are explained and justified with supporting literature.

Results:
--In reviewing Table 3, it appears that all directional aspects of the relationship make sense given the variables under investigation.
-Overall, the results are well presented and documented.

5. Conclusions and Discussion
- The conclusions are well grounded by the findings of the study and within the limits of generalizability given the sample.
-Overall, I feel the study was well done, and the paper is well written.

Thank you for these positive comments.

Reviewer #2: Interesting paper with some novel research but needs the presentation needs to be reconfigured so that the methodology employed and constructed is transparent.

1. *At present methodological stages are presented in several places.*

The paper has been restructured in order to bring together all aspects of methodology under a single heading.

2. *The aim/s of the research are not explicit from the introduction*.

A short paragraph stating the aims of the research has been added to the end of the introduction.

3. *Abstract: Does not identify the research problem or its significance. Uses the acronym PA without defining it in the abstract.*

The acronym PA is now defined at the start of the abstract. Sentences relating to the research problem and its importance have been added to the abstract.

4. Introduction

Inconsistency in terminology used to refer to aircraft. Sometimes aircraft and sometimes aeroplanes. I would suggest airplane in place of aeroplane to increase reach and discovery. In the title they are referred to as pilotless aircraft but in the body text pilotless aeroplanes Uses the acronym PA without defining it.

Aeroplane has been changed to airplane as suggested. The first use of the acronym in the introduction is now defined.

5. *Structure of the paper needs to be defined at the end of the introduction. Why is the structure presented at the end of section 2?*

The section on structure has been shifted to the end of the introduction.

6. Sample Membership

I would expect to see these representative population figures to be shown in Table 1 I would also like to see more detail. Past research has shown age to be significant when considering acceptance of new technology what proportion of the sample is in various ages bands?

National UK figures have been added. We could not find reliable national data on number of flights per person.

7. *Detail needed on when people participated in each stage of the study. The method implies that the same sample was asked to completed the open ended questions and then the survey. But, what dates were these conducted over? How long after stage 1 was stage 2*

conducted? What impact might this have on peoples' responses? How many people undertook stage 1 but not stage 2?

This information was in fact included in the original submission, see line 32 and line 43. However, to emphasise that both parts of stage 1 were completed at the same time the text now states that the questionnaire was completed immediately after the open ended question.

8. *Was there financial compensation? What effect might this have had?*

The home university of one of the authors has a contract with Qualtrix and all surveys paid for by the university have to be conducted via this company. Therefore, the authors had nothing to do with compensation arrangements. Qualtix rewards its panel members by giving them shopping vouchers according to how many different questionnaires they complete within a given period. There is no reason to believe that this situation would give rise to any influences on responses to the questionnaire used by the present study.

9. *What detail was given to the respondents before each stage - could this have pre-conditioned responses? This detail is then provided later. A clear methodology section is missing.*

No information about the study was given to the participants prior to their receiving the open-ended question and questionnaire from Qualtrix. Hence, responses were not preconditioned. A note of this is included in the revised version.

The manuscript has been restructured and now contains a separate methodology section containing all aspects of the research methods.

10. *"but no pilot flying the plane" should this be not? No line number presented but on page 8*

A slight adjustment has been made to the wording in order to clarify the matter to readers of the paper.

11. *Define how topic labels are defined in STM .*

This has been done.

12. *The conclusions are centred around research aim one and two. But these are not presented at any point in earlier sections of the paper*.

Words relating to research aims “one and two” have been removed, leaving the discussion without reference to “one and two”.