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Empirical Research Article

Space Tourism: A New Frontier for Future Generations

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Abstract

Commercial space tourism is being developed and this trend is expected to continue and accelerate. Although opportunities and threats of space tourism attracted the interest of academia, literature on potential demand, attitudes and people's motivations for space tourism is scarce. In this context, this paper investigates young generations' interest and motivations towards different forms of space tourism. The cluster analysis on 2,207 respondents highlighted an interest in space tourism although motivated by different reasons, levels of budget and sustainability aspects. Interest in space tourism varies according to how far it is perceived as potential, possible or sustainable, or to people's personal feelings. The paper adds to contributions in the tourism field by investigating the opportunities space can offer this industry.

Keywords

space tourism; Millennials; Generation MZ; sustainable tourism; consumer behavior

1. Introduction

Though outer space tourism may seem a distant dream, commercial space travel is currently possible and could become a viable tourism experience for many intrepid travelers in the coming decades (Chang, 2017). The history of space tourism is full of broken promises: in the past, less than ten tourists had travelled to space, all between 2001 and 2009; nowadays, however, the pace of modern technological development speed seems to suggest that commercial space tourism is officially ready to take off (Toivonen, 2020): the year 2020 was the year of the first private launch into space.

The dream of exploring space is appealing and has always been a human aspiration (Cohen & Spector, 2019; Crouch, 2001), as it is the logical development of tourism at ever-increasing distances (Peeters, 2018), promises an extraordinary experience (Chang, 2017) and perhaps the ultimate luxury experience (Toivonen, 2020). In fact, the privilege of being the first space tourist costs Dennis Tito 20 million USD, and although costs of commercial space tourism are decreasing, current figures suggest that it will remain exclusive (e.g., NASA recently advertised 35,000 USD per astronaut for a single night on the International Space Station, and Virgin Galactic advertises a two-hour suborbital space experience in its SpaceShipTwo at 200,000 USD per seat), raising questions about equitable social access (Cohen & Spector, 2020). If the uniqueness of the destination and the extraordinary hedonic experience offered by space travel are evident (Chang, 2017; Cohen, 2017; Laing & Frost, 2019;), some scholars argue that only a limited number of ultra-wealthy individuals would be able to afford it. Another issue affecting space tourism is its environmental sustainability (Spector 2020; OECD, 2020; Toivonen, 2020; UN COPUOS, 2018; Vedda, 2008). There are contrasting views on this point: from the positivistic perspective emphasizing space as an opportunity in terms of sustainable development (Fawkes, 2007), mobility, and even of exploration of new potential homes for human beings somewhere else than on Earth (Spector et al., 2017), to the perspective of those worried about potential environmental problems, or even disasters, as a result of a space economy and its exploitation through tourism (see for example OECD, 2020; Peeters, 2018; Ross et al., 2010). From this point of view, it is crucial to understand the perception of young generations since they will be the future of industries (e.g., Giachino et al., 2020; Liu et al., 2019; OECD, 2018; Rita et al., 2019) and, in this specific case, the future of space tourism (Reddy et al., 2012).

Moving from the call for further research into space tourism, including understanding the perceptions of potential space tourists on a country-specific and regional basis (Reddy et al., 2012), especially among western travelers, and with a focus on future environmental impacts and issues related to future equality (Toivonen, 2020), the focus of this research is on the younger generations - the "Millennials" and "Generation Z" (also called "Generation MZ" when considered as one digital generation), who were born since the 1980s (Dimock, 2018; Floros et al., 2021).

In particular, the research has a double aim: (1) empirically examine the interest of Generation MZ in space tourism and their willingness to pay for such an experience, and (2) investigate their perception of environmental issues.

Through a cluster analysis carried out on 2,207 collected answers, seven clusters of Generation MZ members with different average expenditure for the main tourism activities, different opinions on the sustainability of space tourism, different

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willingness to pay for such an experience, and different interests in space activities were identified.

Our study offers this research field multiple contributions. It adds to tourism literature by investigating future generations' interest in different forms of space tourism and the reasons for such interest (Reddy et al., 2012). Secondly, it answers the call for an improved and up-to-date understanding of consumer behavior regarding space tourism, especially in specific regions (Cohen, 2017; Laing & Frost, 2019; Toivonen, 2020). Thirdly, it introduces sustainability as an element of the analysis of consumer behavior concerning space tourism.

2. Theoretical Background

Space tourism refers to human space travel for recreational purposes (Von der Dunk, 2011), seems to be the next step in the expansion of tourism (Cohen, 2017; Laing & Frost, 2019), has enormous potential (Reddy et al., 2012), is becoming a driver of the space economy (Friel, 2020) and, in the form of suborbital space tourism (Chang, 2015), is expected to accelerate and be fully accomplished in the course of the twenty-first century (Cohen & Spector, 2020; OECD, 2020). The analysis of outer space as possible tourist destination, its opportunities, challenges, and sustainability, is thus receiving renewed attention from researchers and public opinion.

Table 1. Space tourism possible vehicles

Type of Vehicles	Possibilities	Expectations
Virgin Galactic rocket plane	Sub-orbital flight over 80km, six seat (two crew and four passengers), total flight time of around 90 minutes including about 4-minute microgravity.	Regular commercial services announced for 2022. Reported more than 600 individuals that paid a deposit for a seat priced around $250,000.
Blue Origin rocket and capsule	Sub-orbital flight over 100km, six passengers and it features six observation windows (the most and the largest in a space vehicle), capsule suborbital flight is around 10 minutes after separation and a few minutes of weightlessness, as well as possibility to see the curvature of the planet before returning to Earth.	Limited info about commercialization plan and pricing. A $28 million secured to an unidentified person the ticket for the first crewed New Shepard suborbital mission (July 20, 2021).
Space X shuttle	Orbital flight, capsule is capable of carrying up to seven people to the International Space Station. The Space X missions are expected to last three to four days from launch to splashdown.	Company has plans to launch Inspiration4, an all-civilian crew into orbit in late September 2021.

2.1 The Space Tourism Offer: Different Space Tourism Possibilities

Space tourism takes many forms and designs and can be divided into three main categories: spaceflight, terrestrial site-specific space tourism, and virtual space tourism (Cater, 2019; Damjanov & Crouch, 2018; Laing & Frost, 2019; Toivonen, 2020).

Spaceflight refers to space intersecting with or going beyond the Earth's atmosphere. Various options for commercial spaceflights are available: atmospheric spaceflights in the form of parabolic weightless flights and high-altitude jet fighter flights (atmospheric space tourism); Earth orbit flights, short-duration sub-orbital flights, and longer duration orbital trips into space. Future astrotourism might include other beyond-earth orbits, such as lunar or Mars voyages (Cater, 2019). In this case, a space traveler can live all facets of the space experience, including both its positive and negative components. Positive experiences include the possibility to see Earth from space (so called "overview effect"), try the sensation of weightlessness, experience something unusual and unique (Cohen, 2017; Reddy et al., 2012). Negative experiences include the risk embedded in space adventure in terms, for example, of its health consequences, the mandatory intense training and preparation, medical requirements, acceptance of high risks and substantial financial burdens (Crouch, 2001; Futron Corporation, 2002; Futron Corporation, 2006; Webber & Reifert, 2006). Space is not yet fully regulated (Cohen & Spector, 2020), nor is it clear whether insurance markets are ready to address the needs of space tourism operators (Reddy et al., 2012). These negative aspects, as well as some of the positive aspects, are not present in the other two forms of space travel, and this may either diminish or nullify interest in spaceflight, moving consumer preferences towards either terrestrial or virtual space tourism.

Terrestrial space tourism includes all the activities linked to space and taking place at a specific tourism site, such as visits to planetariums, radio telescopes, space-themed museums, attractions (Laing & Frost, 2019) and Earth destinations offering unique observation points for space phenomena, such as the northern lights (Toivonen, 2020); as well as simulations, tours and edutainment (Cater, 2019).

Finally, cyber space tourism, also called virtual space tourism**,** is a form of outer space exploration mediated by devices and virtual reality; a typical example being space apps offering Martian tours. Virtual adventures are increasing in popularity, thanks to the proliferation of various forms of virtual tourism set in outer space (Damjanov & Crouch, 2018). If on the one hand virtual space adventure is somehow a limited version of physical space travel, on the other hand, virtual forms of travel might be a potentially new normal form of tourism and space tourism, in unprecedented times such as during the current COVID-19 pandemic. As in other fields such as higher education, digital experience could move from being a second option to being the more convenient and preferred experience. In a recent study, virtual space tourism was widely evaluated as a sustainable space adventure option (in terms of environmental impact), as it does not involve any physical travelling (Toivonen, 2020). Moreover, consumers, especially younger generation ones, are already using augmented reality applications, as for example the filters in Snapchat and the Pokémon Go, for entertainment and adventures; thus, new technologies like the Augmented Reality for real can be a new way to see the world (Balabanovic, 2019) and enhance cyber space tourism.

2.2 The Demand for Space Tourism: Interest in and Motivation for Space Travel

A number of scholars have investigated consumer interest, attitudes and motivations regarding space tourism, using quantitative and a mix of quantitative and qualitative methodologies (Chang, 2017; Crouch et al., 2009; Laing & Frost, 2019; Reddy et al., 2012; Toivonen, 2020), alongside a number of market research studies published by private and public agencies (see for example European Commission, 2014; Futron Corporation, 2002; Futron Corporation, 2006; Webber & Reifert, 2006).

Table 2. Previous studies of space tourism

Authors	Context	Findings
Futron Corporation (2002) **Futron Corporation (2006)**	Market research. Space travel options analyzed: 15 minutes suborbital flight and 2-week long orbital flight. Sample: 450 telephone interviews of affluent Americans, "qualified" household with an income of at least S250,000 or a minimum net worth of $1,000,000; 70% male and mean age 57.	Space travel is an elastic market. Overall, 80% of respondents are interested in space travel and 18% willing to participate in orbital flight. Males more interested than females. Little age differences. Most important reasons for space travel: being a pioneer (24%); see Earth from space (15%); lifelong dream (12%), space enthusiasm (7%), other 25%), not interested (20%, main reason because it is too expensive). Forecasted space travel by 2021: 15,000 suborbital (updated to 10,000 by the 2006 report) and 60 orbital space travelers.
Webber and Reifert (2006)	Market research. Space travel options analyzed: all types of space flights. Online survey via the "Incredible Adventures" website. Sample: 998 adventures, people engaged in elevated risk activities. 91% male; 63% Americans; 14% millionaires; age distribution: 16% under 20, 48% 22-39, 30% 40-59, 6% over 60.	Interest in participating in spaceflight: 34% high altitude jet, 28% zero-gravity flight, 30% sub-orbital, 47% orbital. Little male/female difference in interest toward space tourism; younger seems to have less interested than adults and seniors. Willingness to Pay: respondents indicate as "fair price" for suborbital flights should be $50K or below, and $1M or below, for an orbital flight.
Crouch et al. (2009)	Modelling consumer behavior in space tourism. Discrete choice experiments embedded in an information-rich online survey (opt in, paid) to examine space tourism perceptions, attitudes and choice behavior. Space travel options analyzed: all types of space flights, namely high-altitude jet fighter flights, atmospheric zero-gravity flights, short-duration sub-orbital flights, and longer duration orbital trips into space. Sample: high income and/or high net-worth Australians; 53.6% female; average age 41 years (median = 39 years).	The study confirms that potential space travelers are highly sensitive to price. Demand determinants in terms of product features (e.g., nationality of the operator, level of passenger space, extent of pre-flight training required) and potential customer characteristics (e.g., gender, age, education, and extent of risk-taking behavior). A significant portion of high-income/high-net-worth individuals are favorable to engage in some form of commercial space tourism flight activity.
Reddy et al. (2012)	Modelling consumer behavior in space tourism. Space travel options analyzed: suborbital and orbital, no specified length. Sample: 164 individuals from Southern England. Ordinary people, no specific qualification criteria. 53% male; age distribution: 26% under 25 years, 23% 25-34: 30% 35-50, 21% above 50.	54% willing to experience space travel and 26% unlikely to participate in space flight (74% of which are women). Most important reasons for space travel: 67% see Earth from Space, 44% weightlessness; 43% unusual experience; 26% high speed; 19% scientific contribution. Motivations for not undertaking space flight: 34% too risky, 33% enough destinations to see on earth, 9% environmental concern, 7% health problems, 17% other.
European Commission (2014)	Special Eurobarometer to survey Europeans' attitudes to space activities in general.	There is no clear consensus among Europeans about how important it is for the EU to invest further in space exploration: 47% say it is important, while 46% say it is not important. Future sub-orbital flights are expected by Europeans to be most useful for travelling faster between two points (34%) and for transporting urgent or valuable goods to distant destinations (30%).
Chang (2017)	Examination of the relationship between consumers' innovativeness, perceived novelty and consumer attitude toward space travel. Sample: 354 individuals resident in Hsinchu (the main science area in Taiwan); 71.8% males; age distribution: 28.8% 21-30, 9.6% 31-40, 42.9% 41-50; 18.6% above 50 years old.	Consumer space innovators are very likely to be representing a valuable market segment. High-social and high-hedonic individuals are more likely to perceive the novelty of developments in innovative space tourism technology and tend to express more positive attitudes towards space travel. Their desire for uniqueness could be satisfied by designing unique and customized space travel offering and allocating more resources to marketing the novelty aspect of a service.
Laing and Frost (2019)	Examination of the motivations of potential space tourists. Sample: four proposed space tourists interviewed and published interviews with two individuals who had flown to the ISS as Space Tourists.	Greater complexity of motivations underlying desire for space traveling than previous studies. There may be at least three main categories of motivations and a total of nine potential motivations for engaging in space tourism, including hedonic motivations such as thrill-seeking or risk-taking, a desire for freedom/escapism and novelty, along with more eudemonic motivations such as challenge, curiosity, spirituality, and nostalgia and extrinsic motivations like craving distinction or seeking to motivate or assist others. Marketing space trips to potential tourists should emphasize the diverse aspects of the activity, in order to tap into the different motivations.
Toivonen (2020)	Examination of the perceived sustainability of space tourism: Survey sample of 132 individuals 18-75 years old and living in urban Southern Finland. Delphi survey sample of ten Finnish professionals (sustainable tourism and future research, space legislation, meteorology and space technology, space tourism company).	Technological innovation and individually oriented adventure seeking are enhancing the commercial space tourism. Sustainability aspects, including issues related to environmental focused technology and ethical concerns related to future quality. Already existing terrestrial space tourism could be enhanced with virtual technology.

Futron Corporation (2002) surveyed 450 affluent Americans, analyzing the role of price in their attitudes toward space tourism, and confirming that space tourism is an elastic market; however, consumers were indifferent about whether space vehicles were developed by public or private companies. In summer 2006 Webber and Reifert (2006) used the Incredible Adventures website to survey adventure travelers online, adding questions about the space tourism experience people want to enjoy to the Futron/Zogby survey (Futron Corporation, 2002). The sample of 998 respondents regarded spaceflight as the ultimate adventure experience and provided much-needed customer perception feedback, for example that the price of current space travel, both suborbital and orbital, was too high, but that 88% of respondents would pay a premium of 20% or more for extra vehicular activity (EVA) spacewalking, and there did not seem to be much interest at the time in an orbital hotel destination.

Laing and Crouch (2004) investigated Australian public interest in space tourism and potential demand, suggesting a higher level of public interest compared to previous studies. Fifty-eight percent of respondents expressed their interest in space travel if it was possible, with a substantially stronger interest from young males, explained by their higher risk-taking attitudes. Crouch et al. (2009) analyzed the preferences of high income or high net-worth Australians regarding four options for commercial spaceflight tourism - high-altitude jet fighter flights, atmospheric zero-gravity flights, short-duration sub-orbital flights, and longer duration orbital trips into space - to determine expected consumer reactions, characteristics and flight features affecting the choice to potentially undertake a space adventure. Chang (2017) surveyed Taiwanese respondents regarding their attitude toward space tourism and highlighted the effect of customer innovativeness.

In Europe, Reddy et al. (2012) explored the perceptions of potential space travelers regarding key factors influencing their motivation, behavior and decision making. The findings suggested that 74% of people unwilling to experience space adventure are women. The main reasons people were unlikely to undertake space travel are linked to the fact it is too risky (34%), there are enough destinations on Earth (33%), and environmental concerns (9%). Conversely, a need for adventure, exploration and new recreational activities are the motivations for space tourism. The study concluded by suggesting that marketing efforts are focused on women and the under-investigated Generation Y as groups of interest.

Recent research by Laing and Frost (2019) qualitatively investigated consumer motivations for venturing into space. Three main categories of motivations emerged from the study: hedonic motivations, such as thrill seeking or risk-taking; eudemonic motivations, such as challenge, curiosity, spirituality, and nostalgia; and extrinsic motivations such as seeking distinction or a desire to motivate and assist others.

Although various information and data have been gathered about people's motivations and behaviors and there is agreement on the fact that space tourism "seems to attract individuals who are risk-takers and novelty seekers" (Olya & Han, 2020, p. 529), no studies focus on the most promising generation for the space tourism sector: Generation MZ (OECD, 2018; Reddy et al., 2012).

The approach of generational cohorts was first used in sociology (Mannheim, 1952) and led to different points of view on how generational cohorts can contribute to research (Parry & Urwin, 2011). However, this approach was often applied in tourism marketing to better understand the market (Lewis et al., 2021; Kim & Park, 2020; Giachino et al., 2020; Chen et al., 2019; Lewis et al., 2010; Tourism Research Australia, 2017).

Generation MZ generally includes people born after the 1980s (Dimock, 2018; Floros et al., 2021; Francis & Hoefel, 2018; Kim & Park, 2020), although scholars do not agree on any specific age range (Kaihatu et al., 2021). The two generations M and Z have characteristics in common: they are digitally and technologically oriented (e.g., Akkucuk & Turan, 2016; Bonadonna et al., 2017; Tsai & Chen, 2019), they usually pay attention to sustainability (Giachino et al., 2020; Hopkins, 2017; Miller et al., 2017), and their behavior is key to identifying future trends in a number of sectors among which tourism (Huang & Lu, 2017; Taylor & DiPietro, 2018; Wang, 2017; Woo & Chan, 2020).

2.3 Willingness to Pay for Space Travel

In the last two decades a number of market research agencies and scholars have engaged in the understanding and quantification of interest in space travel, investigating both the factors that could affect demand of commercial space tourism, and the willingness to pay to undertake a space adventure.

Space travel is an elastic market (Futron Corporation, 2002, 2006), as such potential space travelers are highly sensitive to price (Crouch et al., 2009), and there is the need for an up-to-date and more informed quantification of current potential market size and willingness to pay (Laing & Frost, 2019).

Crouch (2001) undertook an early review of studies about the demand for space tourism from 1994 to 1999 in several countries (the US, Japan, Germany, and the UK), and provided useful early indications, pinpointing, for example, a high level of interest and positive demand for space adventures, such as the Japanese studies which reported that respondents were willing to spend one year's pay or more on space tourism. Early studies were overoptimistic about development and demand in the space tourism market, and in the 1990s several billion USD and hundreds of thousands of travelers were assumed for the beginning of the century (Crouch, 2001), but more recent studies were more conservative about the size of the market. For example, in the 2006 update of a report for NASA (see Futron Corporation, 2002) the Futron Corporation cut their forecast for the potential number of annual sub-orbital space passengers by 2021, from 15,000 to 10,000.

Numbers are still very far from reality, as ticket price to access space is a fractional portion of the US$ 20-40 million paid for the privilege of travelling to ISS in the Russian Soyouz capsule as space tourists by seven private citizens in early 2000 (i.e., US$ 250,000 a trip in Virgin Galactic spacecraft). Moreover, the limited number of space tourists having experienced the trip and the consequent limited acknowledgment of offering conditions and features (e.g., perceived levels of safety and risks, length of the journey and of the training to access it, numbers of passengers, etc.), could affect consumers' acceptance (Hanemann, 1991), and ultimately willingness to pay for space tourism.

Crouch and colleagues (2009) advanced the understanding of space tourism demand determinants by using choice-modelling experiments consisting in illustrating the features of different forms of space tourism demand, thus enabling to measure the acceptance of trade-off among space travelling alternatives. Whilst findings suggest that a significant portion of the public, and specifically high-income/high-net-worth individuals, are favorably inclined towards commercial spaceflight activity, it is important to remind that those behavioral intentions do not always translate into actual behavior, and someone who might be willing to pay a certain price for a spaceflight may lack the means to undertake it (Crouch, 2001).

Yet, after over one decade of false starts, commercial space tourism has come in, reigniting the attention of public opinion for this new form of tourism. Whilst enthusiasm and concerns coexist, little is known about Generation MZ attitudes, motivations and willingness to pay for commercial space tourism activities.

2.4 Sustainability in Space Activities

The issues of sustainability and tourism have become central to the institutional, academic and public debate in the twenty-first century (McCool et al., 2001; Moyle et al., 2021).

A widely adopted approach in the field of sustainable tourism development involves the so-called Triple Bottom Line (see for example: Stoddard et al., 2012; Tyrrell et al., 2013). Briefly, the Triple Bottom Line is a framework for sustainable development framed around social, environmental and economic responsibilities, highlighting the need to combine the three dimensions to positively affect people, profit and planet (Elkington, 1994; Elkington, 2008). The Triple Bottom Line applied to tourism serves as a guide for governments, tourism development organizations and tourism operators to enhance their sustainability (Stoddard et al., 2012). Debate about the sustainability of space tourism is still in its infancy, but even if space tourism is perceived as an unsustainable activity, there are arguments supporting its development as sustainable in extant literature. Fawkes (2007) notes that if space tourism companies positioned themselves appropriately, they could contribute to more sustainable development, because the cost of access to space could be lower. Spector et al. (2017) introduce the concept of sustainable trajectory to examine the relationship between modern mobility and sustainability. Peeters (2018), conversely, argues that space tourism will not be part of sustainable tourism, but that it might represent a plan B for the long-term survival of humanity.

The Outer Space Treaty of 1967 establishes the freedom of space exploration and use of space for the benefit and interest of all countries, as well as the non-appropriation of outer space. This translates into a number of key sustainability challenges for current and future space activities in all the Triple Bottom Line dimensions (OECD, 2020).

Alongside the potential of space exploration, excursions and exploitation, there are issues of economic sustainability of space tourism, such as privileged access to space activities by richer nations, companies or even individuals, which is and will further be exasperating inequality (Ormrod & Dickens, 2017). Additionally, as economic and environmental objectives will increasingly need to be balanced to fulfil the commercial use of space whilst preserving the future equality of the outer space environment for future generations (OECD, 2020; Toivonen, 2020; UN COPUOS 2018), some authors call for a deeper investigation into the use of huge economic resources on space travel rather than on mitigating climate change on Earth (Peeters, 2018).

The environmental impact of space excursions presents a number of challenges in terms of pollution, crowding and congestion in certain orbits, increased risk of interference due to growing demand for the radio frequency spectrum, and accumulation of orbital debris in the low-earth orbit as the most pressing threats to long-term sustainability of space operations (OECD, 2020). There are also a number of potential environmental problems on Earth, such as the contribution that space launches make to climate change (Ross et al., 2010), through the exhaustion of the Earth's energy resources (Cohen & Spector, 2020).

Access to space tourism is controversial and has been investigated as regards social sustainability. Scholars noted the wide inequality of access to space tourism, where only millionaires can afford tickets and it is thus only available to the ultra-wealthy (Crouch, 2001; Toivonen, 2020; UN COPUOS, 2018). Moreover, there is limited investigation of the general public's acceptance of, and confidence in this type of tourism (Chang, 2015). Little is known about other social impacts, such as workforce composition (OECD, 2020), and there is a lack of empirical evidence regarding the role of sustainability attitudes, perceptions and expectations, involving space tourism.

Nevertheless, as this article is written, we acknowledge a lack of empirical evidence about the importance of the sustainability dimension in consumer buying behavior, and the perceived sustainability of space tourism itself.

3. Method

An empirical approach was taken in order to investigate the perceptions younger generations have of space tourism as a new opportunity for tourism activity (Reddy et al., 2012). Young adults in the North-West of Italy were chosen. The geographic area of the survey is relevant as a result of the presence of aerospace companies and companies involved in the production of goods and services for the aerospace industry. Italy was chosen as the study area due to the need for studies focused on specific countries/regions, its relevance to the space economy (OECD, 2019; Virgin Galactic, 2018) and the lack of previous studies in this country.

Initially, a focus group of six members aged between 19 and 27 years (three males and three females) was formed in order to deepen the theme of space tourism among people belonging to Generation MZ. This phase allowed the authors to collect useful information for building the first version of the questionnaire. It highlighted the perception of different interpretations of space tourism, including spaceflight, virtual space tourism, and terrestrial space adventures, so that all three kinds of space tourism were taken into account in the survey. This interpretation is partially in line with Crouch et al. (2009), who investigated choice behavior involving four types of spaceflight options. In this case, the authors included both terrestrial and virtual space tourism, to better understand motivations and attitudes towards all forms of space adventures and open a wider concept of space tourism. This approach enabled us to address the call for more in-depth understanding of prospective space traveler motivations (Laing & Frost, 2019) within Generation MZ (Reddy et al., 2012).

The first version of the questionnaire was then tested with a second group of people who were currently working in the space sector or had a background in the space sector, in line with Reddy et al. (2012) and Toivonen (2020). This group included seven people aged from 27 to 41 years, four men and three women, of whom three worked in the aerospace sector and four had specific competences in the aerospace sector. This second group was very important for gathering further indications about the accuracy of the questionnaire and, for example, enabled the authors to be more precise in the use of specific terms.

The second version of the questionnaire comprised closed-ended questions, in order to facilitate the statistical analysis of data and information. This version was pre-tested by 20 young respondents belonging to younger generations and different social groups as to gender, education, socio-economic condition. The pre-test allowed us to detect some typing errors and carefully evaluate the order of the questions proposed. The feedback obtained led the authors to add more possibilities to the reasons that may determine the choice to take part in spaceflight or not, such as seeing Earth from space, and health hazards.

The final version of the questionnaire comprised three parts.

The first part asked about the demographic and social characteristics of the interviewees, including gender, age, municipality of residence, level of education, University School of belonging, average expenditure on tourist trips and their opinions/sensitivity regarding socio-economic and environmental issues, such as, for example, social inclusion, sharing and redistribution of wealth, and desire for innovation. In these cases, the level of importance of the different aspects was weighted by a 7-point Likert scale.

The second part of the questionnaire investigated the perception of space tourism as a travel opportunity, the level of interest and the related motivations leading to desiring such an experience, or not. Again, a 7-point Likert scale was used to measure motivations and interest in space tourism.

Finally, the third part of the survey was dedicated to the perception of sustainability in the different hypotheses of space tourism proposed, from an environmental, social and economic point of view, in order to compare spaceflights, virtual space tourism, and terrestrial space adventures in terms of sustainability. A 7-point Likert scale was also used to measure the

different perceptions of the respondents regarding space tourism and its sustainability in the three different forms identified through the focus group and the literature review.

The questionnaire was sent in January 2020 to the Generation MZ group involved in the definition of its final version, who forwarded the survey link to other individuals belonging to the same generation. At the end of the month, 2,027 answers were collected.

3.1 Data Analysis Methodology

Given the breadth of the questionnaire administered, a step-by-step path was used to synthesize the answers, transforming them into useful information (Bollani et al., 2019; Giachino et al., 2021). First, the key points of the questionnaire – interest in space tourism, perception of sustainability, personal inclinations – were considered, each explored synthesizing a number of points gathered through the questionnaire; then a synthetic qualitative variable was obtained for each point, through a process of dimensional reduction conducted using Principal Component Analysis (PCA) and subsequent Hierarchical Clustering Analysis (HCA). The HCA was performed on the first dimensions of the PCA which overall allowed at least 75% of the variance to be explained.

The synthetized elements are:

• The reasons for being interested in space tourism. Reasons can be both favorable – in this case six variables measured with a Likert scale (Futron Corporation, 2002; Reddy et al., 2012) are investigated - and contrary – in this case three variables measured with a Likert scale (Futron Corporation, 2002; Reddy et al., 2012; Toivonen, 2020) are investigated. A qualitative variable was obtained by the subdivision of the respondents into four groups: Motiv_YES.Driven group (positive motivation, passive behavior and sensitive to external stimuli), Motiv_YES.Chosen group (positive motivation, active behavior oriented to specific experiences), Motiv_NO.Insust group (negative motivation, due to unsustainability), and Motiv_NO.Fear group (negative motivation, due to fear of direct experience in this area);

• The perception of sustainability, which was investigated through three groups of three variables, each evaluated using Likert scales. Each group involves one of the three forms of sustainability (environmental, economic, and social) (Elkington, 1994; Moyle et al., 2021; Stoddard et al., 2012; Tyrrell et al., 2013) and the three types of space tourism experience (spaceflights, virtual space tourism and terrestrial space tourism) (Cater, 2019; Laing & Frost, 2019; Toivonen, 2020). Three categories were identified with regard to environmental sustainability: EnvSusta.Flight (which considers spaceflight more environmentally sustainable than the others), EnvSusta.Terrestrial (more oriented towards considering terrestrial space tourism more environmentally sustainable than other experiences); and EnvSusta.Virtual (more oriented towards considering virtual space tourism more environmentally sustainable than other experiences). Three further categories were identified with regard to economic sustainability: EcoSusta.Flight (which considers spaceflight economically sustainable more than the others), EcoSusta.Terrestrial (more oriented towards considering terrestrial space tourism more economically sustainable than other experiences); and EcoSusta.Virtual (more oriented towards considering virtual space tourism economically sustainable rather than other experiences). Finally, as regards social sustainability, the sample was divided into two groups: SocSusta.Flight (which considers spaceflight more socially sustainable than the others), and SocSusta.NoFlight (which considers spaceflight less socially sustainable than the others);

• The interviewee's personal inclinations, investigated through nine variables evaluated using Likert scales, which led to three categories of subjects: Values.Prudence (oriented towards prudence) (Futron Corporation, 2002; Futron Corporation, 2006; Laing & Crouch, 2004), Values.EnvSocialOpen (open to environmental and social issues) (Toivonen, 2020) and Values.Efficiency (efficiency oriented) (Toivonen, 2020);

• The interviewee's personal motivation for a trip, investigated through eight variables evaluated using Likert scales, which led to three categories of subjects: PeopleSust (oriented to sustainability and social implications) (Reddy et al., 2012; Toivonen, 2020) SustBudget (oriented to budget) (Laing & Crouch, 2004), and Newness (oriented to newness) (Chang, 2017; Cohen, 2017; Reddy et al., 2012).

In the next step, the variables inherent to spaceflight and considered most interesting were taken into consideration. In addition to those summarized above, this included the interest in and perception of sustainability, and the willingness to pay for a space tourism experience, organized in bands of potential expense. A Multiple Correspondence Analysis (MCA) was obtained using these qualitative variables and then an HCA was carried out: the output is a dendrogram with a level of cut that produces seven clusters (Figure 1). Variables related to the interviewee's personal inclinations, in the form explained above, and other variables of interest (e.g., tourism budgets) were added as "illustrative" to better explain the results.

Multivariate analysis was performed using the R environment and the FactoMineR package (Lê et al., 2008). The PCA, MCA and HCPC (Hierarchical Cluster on Principal Components) functions were used (Bollani et al., 2019; Giachino et al., 2021).

3.2 Description of the Variables

The sample identified was made up of 2,027 individuals of whom 51.01% were female and 48.09% were male. The age of the respondents was distributed between two main ranges: 81.20% were between 18 and 24 years old (Generation Z), and 18.80% were aged from 25 to 40 years (Millennials). All the respondents were either Millennials (25-40 years old) – born since the 1980s – or GenZ (18-24 years old) – born after 1995.

The variables used in the analysis are described in Table 3. Some variables (particularly values, travel choice motivation, environment, economic and social sustainability perception and space motivation) were obtained by pre-processing the data, following the described methodology (more details are reported in the appendix).

4. Results and Discussion

An MCA was performed on the qualitative variables shown in Table 3 to identify the profile of the potential young generation interested in space tourism, and a hierarchical clustering analysis was made using the main MCA dimensions as input. Some details are reported in the data analysis appendix and the final results are shown in Figure 1 and explained below.

The hierarchical clustering analysis identified seven main clusters of young people with different average expenditure for the main tourism activities, different opinions on the sustainability of space tourism, different willingness to pay for such an experience, and different interests in the three possible means identified to participate in space tourism (i.e., spaceflight, terrestrial and virtual space tourism).

As demonstrated in literature, there is no single perspective on space tourism, although the idea of exploring space is attractive for many people (Cohen & Spector, 2019), and different opinions were expressed about the sustainability of space tourism (e.g., Fawkes, 2007; OECD, 2020; Toivonen, 2020).

Table 3. Variables, items and related descriptions

Variable	Item	Description	Freq	Freq %
Gender	Female	Female	1,035	51.01
	Male	Male	992	48.09
Age	18.24y	Respondents 18-24 years old (GenZ).	1,646	81.20
	25.40y	Respondents 25-40 years old (Millennials).	381	18.80
Tourism Budget	T.Budg_Gt1500	Average expenditure for main tourism activities over 1,500 euro (e.g., two-week holiday).	362	17.90
	T.Budg_500.1500	Average expenditure for main tourism activities between 500 and 1,500 euro (e.g., two-week holiday).	1,172	57.80
	T.Budg_Lt500	Average expenditure for main tourism activities up to 500 euro (e.g., two-week holiday).	493	24.30
Values	Values.Efficiency	Respondents oriented towards technological innovation as a tool for increasing wealth production and personal income.	644	31.77
	Values.EnvSocialOpen	Respondents oriented to environmental safeguarding and social sustainability.	538	26.54
	Values.Prudence	Respondents characterized by a widespread fear of what is unknown, oriented to human welfare.	845	41.69
Travel Choice Motivation	TC.PeopleSust	Respondents oriented to consider social and environmental sustainability and meet people as essential elements to choose a trip.	870	42.92
	TC.SustBudget	Respondents oriented to consider budget as essential element to choose a trip.	612	30.19
	TC.Newness	Respondents oriented to consider a new destination, a new experience and doing something unique as essential elements to choose a trip.	545	26.89
Environment Sustainability Aspect	EnvSusta.Flight	Respondents oriented to consider spaceflights the more environmentally sustainable option.	782	38.58
	EnvSusta.Terrestrial	Respondents oriented to consider terrestrial space adventures the more environmentally sustainable option.	696	34.34
	EnvSusta.Virtual	Respondents oriented to consider virtual spaceflights the more environmentally sustainable option.	549	27.08
Economic Sustainability Aspect	EcoSusta.Flight	Respondents oriented to consider spaceflights the more economically sustainable option.	793	39.12
	EcoSusta.Terrestrial	Respondents oriented to consider terrestrial space adventures the more economically sustainable option.	435	21.46
	EcoSusta.Virtual	Respondents oriented to consider virtual spaceflights the more economically sustainable option.	799	39.42
Social Sustainability Aspect	SocSusta.Flight	Respondents oriented to consider spaceflights the more socially sustainable option.	1,381	68.13
	SocSusta.NoFlight	Respondents oriented to consider virtual spaceflights and terrestrial space adventures the more socially sustainable option.	646	31.87
Space Motivation	Motiv_YES.Chosen	Respondents are interested in all space experiences, e.g., orbital, suborbital and jet flights, no gravity experience, seeing Earth from space.	991	48.89
	Motiv_YES.Driven	Respondents are interested in space tourism, but their interest is oriented to aspects other than space experiences i.e., trip risks, nationality of tour provider, trip duration and starting location, type of used aircraft.	634	31.28
	Motiv.NO.Fear	Respondents are not interested in space tourism, which generates fear and insecurity.	254	12.53
	Motiv_NO.Insust	Respondents are not interested in space tourism, which is considered an economically, environmentally and socially unsustainable activity dedicated only to a small group of wealthy consumers.	148	7.30
Willingness to Pay for a Spaceflight	S.Pay_Gt10k	Respondents are willing to pay over 10,000 euro for a spaceflight.	265	13.10
	S.Pay_5k.10k	Respondents are willing to pay between 5,000 and 10,000 euro for a spaceflight.	382	18.90
	S.Pay_1500.5000	Respondents are willing to pay between 1,500 and 5,000 euro for a spaceflight.	612	30.20
	S.Pay_500.1500	Respondents are willing to pay between 500 and 1,500 euro for a spaceflight.	301	14.80
	S.Pay_Lt500	Respondents are willing to pay up to 500 euro for a spaceflight.	65	3.20
	S.Pay_zero	Respondents are not willing to pay for a spaceflight.	402	19.80

Source: authors' elaboration.

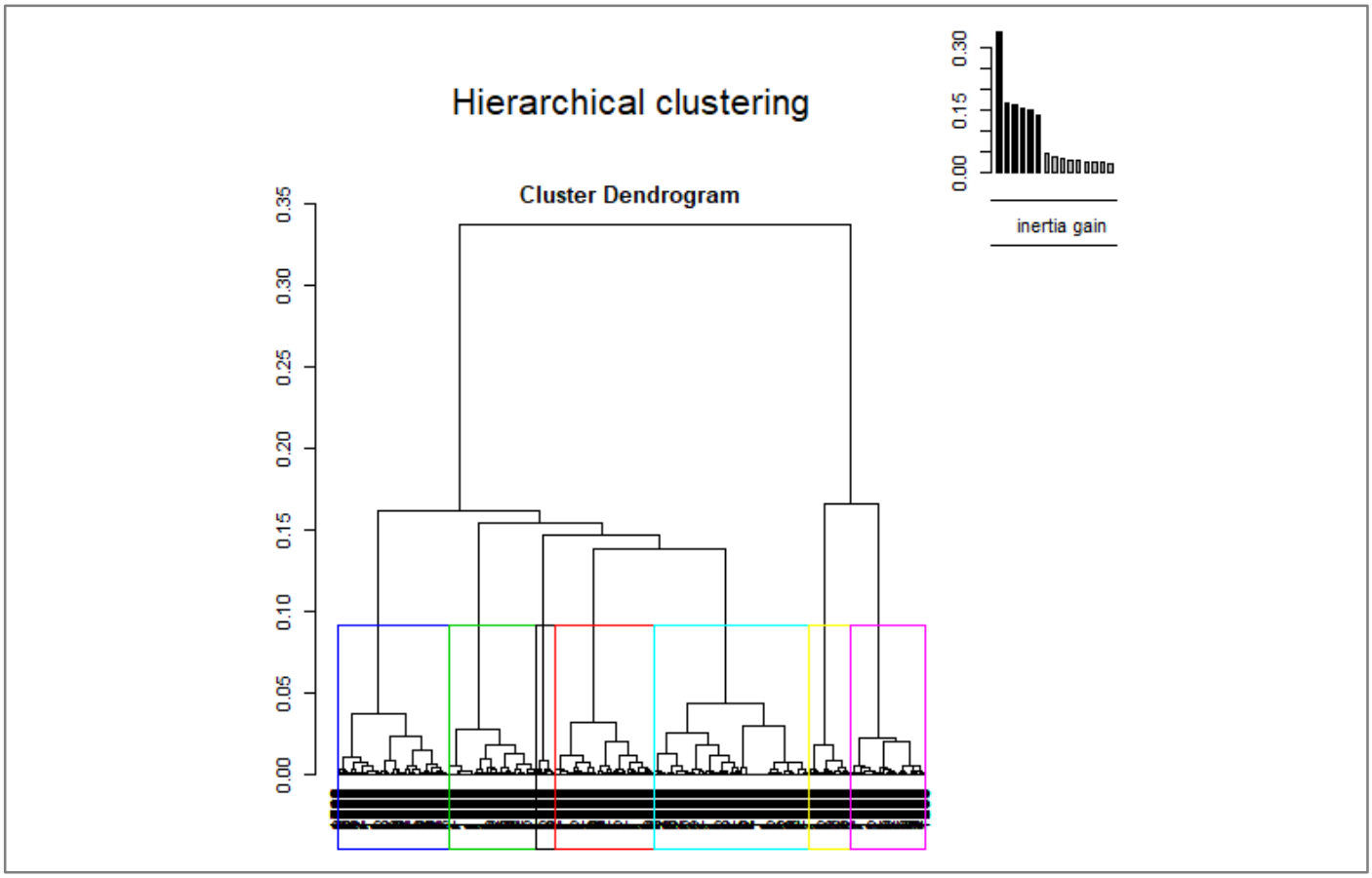

Fig. 1. Hierarchical clustering and cluster dendrogram. Source: authors' elaboration.

Table 4. Summary of interests, willingness to pay (WTP), budget for vacation and sustainable solution for each cluster

No.	Cluster	Interest(Y/N)/ Reason	WTP	Budget	Environmental Sustainability	Social Sustainability	Economic Sustainability
65	Economic Sustainable flight (Black)	Yes/Chosen	0.5k	0.5k	Flight	-	Flight
343	Social Sustainable Flight (Red)	Yes/Driven	> 10k	> 1.5k	-	Flight	-
301	Environmental Sustainable Flight (Green)	Yes/Chosen	0.5-1.5k	0.5k	Flight	-	-
382	Economic virtual experience (Blue)	Yes/Chosen Yes/Driven	5-10k	> 1.5k	-	-	Virtual
534	Neutral (Pale Blue)	Yes/Chosen Yes/Driven	1.5-5k	0.5-1.5k	-	-	-
254	Fear (Violet)	No/Fear	0	-	Virtual	-	-
148	Unsustainable (Yellow)	No/Not sustainable	0	0.5k	Virtual	Virtual/Terrestria	Virtual

Source: authors' elaboration.

The cluster "economic sustainable flight" (black) is made up by those very interested in spaceflight (65 respondents, 3.21%). The interest is for all space tourism experiences, including, for example, orbital, suborbital and jet flights, and seeing Earth from space. However, since respondents usually spend no more than 500 euro for their holidays they are not willing to pay more than that amount of money for a space tourism adventure. Moreover, they believe that spaceflight is the most sustainable form of space tourism from an environmental and economic point of view. Lastly, they are characterized by a widespread fear of what is unknown and they are oriented to human welfare.

The "social sustainable flight" cluster (RED) (343 respondents, 16.92%) is interested in space tourism but the motivation is not linked to living this experience. They believe it is important to evaluate trip risks, the nationality of the tour provider, trip duration and starting location, and the type of aircraft. They are willing to pay more than 10,000 euro, although they usually spend no more than 1,500 euro on holidays (two-week vacation). Moreover, they believe that spaceflight is the most sustainable form of space tourism from a social point of view. Lastly, they believe it is important to protect the environment and safeguard human and social welfare. They are mainly males.

The "environmental sustainable flight" cluster (GREEN) (301 respondents, 14.85%) is very interested in spaceflight, and, as for the "economic sustainable flight" cluster, the main reason is the experience they can live. Budget is an essential element to choose a trip, and as to space tourism, respondents are willing to pay between 500 and 1,500 euro, while they usually spend less than 500 euro for holidays. Spaceflight is considered more environmentally sustainable than the other forms of space tourism. Respondents are mainly females and are characterized by a widespread fear of what is unknown, as well as oriented to human welfare.

The "economic virtual experience" cluster (BLUE) (382 respondents, 18.85%) is interested in spaceflights and the reasons are not limited to the experience lived. In this case, respondents are willing to spend no more than 10,000 euro for the flight experience vs the 1,500 euro (and more) they usually spend for holidays. They see virtual space tourism as more sustainable in economic terms than the other two solutions. They believe it is important to protect the environment and safeguard human and social welfare. They are mainly males belonging to Generation Z.

The "neutral" cluster (PALE BLUE) (534 respondents, 26.34%) is interested in space tourism and, as in the "economic virtual experience" cluster, the reasons are various: the experience is important, but other aspects also need to be considered, such as evaluating trip risks, the nationality of the tour provider, trip duration and starting location, and the type of aircraft used. The respondents are willing to pay between 1,500 and 5,000 euro for space tourism while they usually spend less than 1,500 euro for holidays. They mainly belong to Generation Z.

The "fear" cluster (VIOLET) (254 respondents, 12.53%) includes people who are not interested in spaceflight, mainly due to fear, and, consequently, their willingness to pay for such an experience is almost zero. They see virtual space tourism as more sustainable in environmental terms than the other two solutions. They are mainly females belonging to the Millennial generation, characterized by a widespread fear of what is unknown as well as oriented to human welfare.

The "unsustainable" cluster (YELLOW) (148 respondents, 7.30%) is not interested in space tourism mainly because it is not considered a sustainable form of tourism, although its members see technological innovation as a tool with which to increase wealth production and personal income. This cluster is not willing to pay for a spaceflight, and evaluates terrestrial tourism as socially sustainable, and virtual tourism as environmentally, economically and socially sustainable. They are mainly females belonging to the Millennial generation.

The two clusters who are not interested in space tourism ("fear" and "unsustainable") are made up above all of females belonging to the Millennial generation, supporting the results of Reddy et al. (2012) who suggested that females were generally less interested in space than males. The five remaining clusters show an interest in space tourism although motivated by different reasons, supported by different levels of budget, and with different opinions about its sustainability.

In line with current research, the analysis of Generation MZ revealed different perspectives on space tourism sustainability and on the three investigated types of space tourism. However, over 80% of the respondents reported being interested in space tourism in its different forms, which confirmed a general interest in this kind of tourism (Cohen & Spector, 2019). The level of interest in space tourism varies according to how far it is perceived as sustainable or according to the people's personal experiences and feelings (Table 4). Willingness to pay varies greatly across the clusters: as Futron Corporation (2002) demonstrated, space tourism is an elastic market.

5. Conclusions and Implications

Commercial space travel is developing fast and the dream of intrepid travel to reach a new destination in space could soon materialize (Chang, 2017). This explains a renewed interest in space activities by scholars, who, over the last few years, have developed numerous studies investigating the phenomenon from different points of view (see for example Cohen & Spector, 2019; Hobe & Cloppenburg, 2004; Laing & Frost, 2019; Olya & Han, 2020; Toivonen, 2020). Literature calls for further investigation on the motivations of potential space tourists on a regional and country-specific basis (Reddy et al., 2012), enlarging the pool of potential space travel participants surveyed, beyond the ultra-wealthy (Laing & Frost, 2019), and including sustainability as part of the future debate and research (Toivonen, 2020). This study thus investigated Generation MZ's interest in three different forms of space tourism: spaceflight, virtual space and terrestrial space.

The data analysis (N=2,027) demonstrated that the majority (80%) of respondents were interested in space tourism, in line with extant studies (Cohen & Spector, 2019), and their opinions about the sustainability of space tourism in some cases influence their decision. The two clusters not interested in space tourism were characterized by the presence of females belonging to the Millennial's generation who found space experience not sustainable at all; moreover, they were afraid or not willing to pay for such experience. The other five clusters were characterized by a stronger presence of males and a stronger interest in space activities; however, differences among clusters were mainly linked to sustainability aspects and budget.

Three clusters interested in spaceflights indicated spaceflight as the most sustainable form of space tourism from an environmental, economic and social point of view. The other two clusters, characterized by the presence of Generation Z, are divided between those interested in spaceflights but indicating virtual space tourism as the most sustainable form of space activity from an economic point of view, and those with just a generic interest in space tourism.

Among the five clusters interested in space tourism, only in two cases willingness to pay is up to 10,000 euro; in one case it is 5,000 euro, while in the other two cases the budget for space activities is the same used for vacation (500-1,500 euro).

Willingness to pay for such an adventure varies greatly and not necessarily according to the level of respondents' interest in space activities. The 18% of people very interested in space activities is willing to spend no more than 1,500 euro, the 37% of people having an interest in space activities is willing to spend up to 10,000 euro or more, while the 26% of people with a generic interest in space activities is willing to spend no more than 5,000 euro. The declared budget is a small amount of money considering the current cost of spaceflight, but an important amount considering that it is at least three times (and up to 10 times and over) higher than the average expenditure incurred for a two-week vacation.

From a general point of view, the younger generations see flight as more sustainable on a social, economic and environmental level – however, one cluster not at all interested in space tourism explained this position according to the unsustainability of such tourism (i.e., flight), while seeing the virtual/terrestrial experience as socially sustainable and the virtual experience as economically and environmentally sustainable.

It seems that interest in space adventure and perceived sustainability of space tourism are interrelated: the deeper motivation toward spaceflight and experiencing this unique form of tourism is, the more optimistic is the perception of its sustainability. On the contrary, the perceived un-sustainability of space tourism is a further argument used by those not interested in space tourism to explain their limited, or even negative, attitude toward travelling space.

From a theoretical perspective, this research contributes to answer the need for papers on the perceptions of potential young travelers (Reddy et al., 2012) with focus on sustainability aspects (Toivonen, 2020). It sheds light on the opportunity to effectively pursue the dream of commercial space tourism, investigating the real interest of Generation MZ, which represents the future of the

tourism sector (Liu et al., 2019; OECD, 2018; Rita et al., 2019), and is still under-investigated in space tourism research (Reddy et al., 2012). In this context, the research contributes to defining a feasible tourism market among young generations considering the different forms of space tourism, and underlines the opinion of young generations on sustainability and space tourism. The contribution may open a debate on how Generation MZ perceives space tourism according to the TBL approach, and underlines differences according to gender and motivation. Moreover, it contributes to the tourism industry by investigating the possibilities space can open.

From a managerial point of view, private companies can carefully consider Generation MZ as potential customers in the near future; rather than focusing their attention only on spaceflight, however, they might also be analyzing other possible forms of space tourism, virtual and terrestrial; this should open the way for a progressive implementation of space initiatives, in order to gradually attract more people toward space. Generation MZ's appreciation and its willingness to try this type of tourism demonstrate a basically positive orientation to evaluating it as an alternative to conventional leisure and holiday period activities. Moreover, space companies have to consider that the sustainability aspect of space activities can influence the choice of young generations for undertaking such experiences. From this point of view, the research gave information about how Generation MZ is divided according to interests and sustainability aspects and which activity is the most suitable for each cluster.

This study also highlighted the natural tendency of the young generations to take an interest in novelties, and, in some ways, in what is not well known, such as space and related activities. Sustainability seems to be positively associated to space tourism and flight in most cases.

Although this research contributes to extending the literature on space tourism, the collected data present a limitation, because the sample was limited to a particular area of Italy, North-West Italy, and to a particular group of subjects, young generations. Further research should thus extend the study to other target groups to compare the results and adequately evaluate the propensity for "extra-terrestrial" tourism. Future research on the topic could examine in more depth whether the educational path of young generations and their propensity for innovation can affect their level of interest in space and their willingness to pay. Results also indicate that sustainability as a topic is very important to people and more detailed analysis could help to understand how sustainability can really have an effect on their choices.

Declaration of competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Luigi Bollani is Assistant Professor at the Department of Economic, Social, Mathematical and Statistical Sciences (ESOMAS), University of Turin. His main research topics concern social statistics and sample surveys. His recent publications include "Innovation and social responsibility in the food ingredients market" (in Sustainability, 2019) and "The impact of leverage on the cost of capital and market value. Evidence from Sharīʿah-compliant firms" (in Management Research Review, 2020). Until 1988 he is a Member of SIS - Statistical Italian Society – and, until 2014, he is a member of ASA - Applied Statistical Association.

Alessandro Bonadonna, PhD in Culture and Enterprise, is Associate Professor in Commodity sciences at the Department of Management, University of Turin, Italy. His research interests include food quality, sustainable tourism and consumer behavior, with specific focus on young generations. He is a research member of several projects and his teaching activities are concerned with operations and supply chain management,

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Chulmo Koo is a Professor of Smart Tourism Education Platform (STEP), College of Hotel and Tourism Management at Kyung Hee University, South Korea. Dr. Koo has a strong record of research and scholarship in smart tourism with significant contributions to both education and service. Dr. Koo received prestigious research award such as the *Kyung Hee Research Fellowship (2018-2020)* and *Excellent Professor of Kyung Hee (2019)* at the university level and the *Best Research Paper Award* in the ENTER (2015) and the *Best PhD Proposal Paper Award* in the ENTER (2022) conference at the IFITT (International Federation of IT and Travel & Tourism). He has h-index 44 and i10-index 91. Overall performance (2016-2021): Scholarly Output (52), Field-Weighted Citation Impact (3.06), Citation Count (904), Citations per Publication (17.4), Outputs in Top Citation Percentiles (32.7%), Publications in Top Journal Percentiles (43.8%), International Collaboration (32.7%).