Information Needs in Commercial Space: Demand for Information and Services

Research Report for the Space Foundation

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Executive Summary

Commercial space is an industry that is growing and changing rapidly. The Space Foundation, a nonprofit organization and client for this report, would like to support the space community by offering information services as an additional earned income activity. The purpose of this research report is to assist the Foundation by providing accurate and up-to-date information on the information and service needs of organizations involved in the industry. A survey tool will be used to determine organizations' level of demand and will be administered at the Space Foundation's annual convention on October 31st through November 2nd of 2020. The convention originally set to take place March 30th through April 2nd was postponed until the fall due to the COVID-19 pandemic. As a result, experimental data were generated for the purpose of completing this report within the University of Colorado's semester timeline and the findings used as an example for the upcoming analysis. This generated data will eventually be replaced by real data after the survey is conducted at the Symposium. Additional information on the use of the experimental data is available in Appendix A. Results derived from the generated data do not provide true information on the space industry and the following conclusions and recommendations, which are based on those results, should be taken as representations of actual findings.

The analysis of the experimental data revealed that there is a need for information on the commercial space industry. Economic and commercial space industry information were found to have the highest levels of demand among information categories. Additionally, organization types with the greatest need for this material included associated commercial space industries and services, satellite manufacturing and related services, and commercial space transportation manufacturing and services. Results from the analysis also indicated that organizations are likely

to use external sources for their information needs, with associated commercial space industries, transportation manufacturing and services, and education and outreach institutions as the most likely to engage these services.

The following recommendations can be applied by the Space Foundation when forming its information service. First, the organization should focus on the information categories and organization types with the greatest level of demand and interest in outside resources. The Foundation should also ensure that its knowledge capacity is capable of providing clients with the latest and most accurate information available. To expand this study further, it would be beneficial for the Space Foundation to contact survey participants for more in-depth insights into the needs of their organizations. By following these next steps, the Foundation will be well positioned to offer valuable information services.

Introduction

Recent years have proven to be a time of swift growth for commercial space. The private sector conducts much of the activity in the space industry, which includes all products and services that come from the exploration and utilization of outer space (Wooten & Tang, 2018). The rise of this commercial industry is due to technological advances that have caused the price of access to space to fall dramatically (Lal, 2016). The cost to launch a rocket is estimated to be significantly less than it was in the early 2000s (Boroujerdi & Wolf, 2015). As a result, international activity in space is expected to double over the next decade with the private sector already benefitting from that growth (Lal, 2016). In fact, annual revenue from the global space industry was estimated to be between $300 and $415 billion in 2018 and is expected to grow to an average of $1.1 trillion by 2040 (Morgan Stanley, 2017; Federal Aviation Administration [FAA], 2018; Satellite Industry Association [SIA], 2019; Space Foundation, 2019a). The

commercial sector generates much of that current revenue with profits from the private industry exceeding government space expenditures, which has historically been the main source of space funding (Lal, 2016; Space Foundation, 2019a).

Changes in the United States space industry, in particular, are due to the shifting role of the government's space program, the National Aeronautics and Space Administration (NASA). Over the past decade, NASA's mission has changed substantially. The agency is chronically underfunded and its focus has shifted from science and engineering towards workforce and industry support (Mahler, 2016). NASA also had no way to launch astronauts into space from U.S. soil after the space shuttle was retired in 2011 (Lambright, 2015). As a result, the agency's control over space activities has diminished and the role of the private sector has increased (Lal, 2016; Mahler, 2016). This move was intended to spur innovation and reduce governmental costs through competition among commercial companies (Whealan George, 2019).

This shift has caused NASA to take on the role of facilitator and establish programs designed to assist private firms with the development of cargo and crew transportation (Lambright, 2015; Mahler, 2016). These programs call for companies to invest more of their own money with NASA acting as a partner by financing development and purchasing services (Weinzierl, 2018). Companies have more control over their projects and maintain ownership of their intellectual property, while greatly reducing the cost of services to NASA. Many of these programs have proven to be effective with private companies conducting cargo resupply missions to the International Space Station (ISS) since 2012 (Mahler, 2016).

As a result of these successful programs and increased confidence in the industry, investment in the private companies involved in commercial space has grown. Studies have estimated that $25.7 billion has been invested in 535 companies since 2009 (Space Angels,

2019). Of that total, a record amount of $5.8 billion was invested in 2019 alone. This represents a significant increase from 2001 to 2008, when less than $500 million was invested in start-up space firms annually (Bryce Space and Technology, 2019). The majority of that capital, estimated at 55%, is invested by U.S. firms, which shows the trust that the U.S. economy has in commercial space (Space Angels, 2019).

This rise in investment has led to a flurry of activity in space. In 2018 alone, the number of spacecraft deployed globally amounted to 463 with 198 of those from the U.S. (Space Foundation, 2019e). The American space industry is also challenging Russia's dominance in the commercial launch market with the launch of 26 licensed launches in 2019, compared to seven in 2013 (FAA, 2020a). Much of this activity comes from the satellite industry, which has enjoyed substantial growth over the past decade. The industry accumulated $277 billion in revenue in 2018, which is a significant increase from the $1.2 billion it amassed in 2007 (Bryce Space and Technology, 2017; SIA, 2019).

However, despite these accomplishments, the sustainment of this industry will face challenges as it grows. These opportunities and challenges require up-to-date information to successfully navigate the commercial space industry. Many organizations, including private companies, government institutions, media organizations, and educational and outreach institutions, require data on various aspects of the industry as it undergoes near constant change.

The Space Foundation (2020a), the client for this research report, is a nonprofit organization that has supported the global space community since 1983. The organization has been involved in this growing industry by providing education, spreading awareness, and offering advisement and assistance. The Foundation (2020b), with its collection of research and

data, is well positioned to serve as a valuable resource to other institutions in order to educate and enable growth in commercial space.

Many challenges await those seeking to engage in space activities (Space Foundation, 2019e). Operating in space comes with uncertainty and high levels of risk. Projects often take many years to come to fruition while the investment required to develop those projects is large. Many companies also find navigating space law and government regulation to be just as difficult. On top of these complexities, there is a lack of updated and accurate information on the industry which adds to the complications faced by many organizations. Fortunately, the Space Foundation's (2020b) Research and Analysis Department has amassed a wide range of research and data, much of which is organized and published in the organization's Space Report, which includes information on various factors affecting the commercial space industry, the space workforce, and opportunities within the industry.

The purpose of this study is to assist the Space Foundation by determining the level of demand for information on the commercial space industry, the space workforce, networking opportunities, the industry's economic status, and space law and regulation. Whether or not organizations have a need for outside services for their information needs is also addressed. Fundamentally, the analysis aims to determine organizations' level of demand for information on topics related to commercial space and their level of demand for external information resources.

This report is organized in the following manner. A review of the scholarly literature is first with a focus on social entrepreneurship and the different types of services and information to be analyzed. A description of the purpose of the study follows along with the plan for methodology for the assessment. Finally, the results of the analysis of the generated data are

displayed with recommendations for the best courses of action to take to achieve the Space Foundation's goals.

Literature Review

The following literature review will include scholarly information on nonprofit management and the commercial space industry. The topics covered in this section are all factors that need to be considered before the creation of a nonprofit service, including social entrepreneurship, the different types of services a nonprofit organization could offer, and the various types of information needed in the space industry.

Scholarly Literature

Social entrepreneurship. The formation of an earned income activity by a nonprofit organization is generally considered to be social entrepreneurship, which is defined as the application of business practices and the generation of income in order to sustain a social mission (Khieng & Dahles, 2015). Nonprofits should consider the potential benefits and consequences of adding this type of activity as there is currently a lack of consensus among scholars regarding the effects of earned income on these types of organizations. Some have found several possible benefits to engaging in social entrepreneurship (Eikenberry & Kluver, 2004; Guo, 2006; Bradshaw, Hayday, & Armstrong, 2007; Di Zhang & Swanson, 2013; Khieng & Dahles, 2015; Levine & Kim, 2018). Earned income activities could increase a nonprofit's self-sufficiency and sustainability in the long-term. They could allow the organization to operate with more autonomy and flexibility by making it less dependent on donors for financial support. In addition, social entrepreneurship can also lead to increased efficiency and effectiveness, which can improve a nonprofit's service delivery.

There are, however, possible disadvantages associated with earned income among nonprofits (Eikenberry & Kluver, 2004; Foster & Bradach, 2005; Khieng & Dahles, 2015; Levine & Kim, 2018). These activities could potentially distract from the organization's core mission with greater emphasis placed on client demands and revenue opportunities. They can take away limited resources from the nonprofit's main functions and social objectives. Entrepreneurship also poses a risk to the development of social capital. If organizations are focused on customers, they may have less time to nurture relationships with traditional stakeholders and donors.

Fortunately, nonprofits can position themselves to benefit from social entrepreneurship while likely avoiding the potential risks. An organization is more likely to be successful if it earns embedded revenue, which is income connected to the nonprofit's core mission and organizational identity (Levine & Kim, 2018; Daniel & Galasso, 2019). Activities that earn embedded revenue minimize logistical conflicts by utilizing the same resources that are already in use and by targeting customers that benefit from the nonprofit's principal mission. In contrast, external activities that are unrelated to the core mission use different resources and target different markets and therefore can lead to mission drift. These activities could also be classified as unrelated business taxable income (UBTI), which is taxable under Internal Revenue Service (IRS) guidelines (Estrada, 2020).

Organizations should consider all of these factors before implementing an earned income activity as there is a lack of scholarly agreement on the consequences to nonprofits (Eikenberry & Kluver, 2004; Foster & Bradach, 2005; Guo, 2006; Bradshaw, Hayday, & Armstrong, 2007; Di Zhang & Swanson, 2013; Khieng & Dahles, 2015; Levine & Kim, 2018). However, if the

activity generates embedded revenue, it is more likely to lead to improved organizational performance and increased sustainability (Levine & Kim, 2018).

Types of services. Nonprofit organizations can offer several different types of services. An organization can serve as an information resource as knowledge and information is especially important for effective decision-making in many industries (Citroen, 2011). Research, in particular, requires accurate information and is utilized in many different ways (Hirsh, 1999; Hirsh & Dinkelacker, 2003). Research is used to stay informed on current topics, meet everyday information needs, locate information on specific topics, and understand historical discoveries. Different types of information are also required at different stages of the research process. The majority of information-seeking occurs at the beginning stages where technical information is sought. The later stages require more business and market information, which is a substantial need for many companies.

Those looking for information consider several factors when deciding on a material resource. They take into consideration both the authority of the source as well as the time it will take to receive the necessary data (Hirsh & Dinkelacker, 2003). In addition, the cost, quality, and accessibility of the information are also important (Anderson, Glassman, McAfee, & Pinelli, 2001). Information-seekers typically choose the avenue that requires the least amount of effort and generally prefer direct communication with the source.

It is also important for an organization serving as an information resource to consider the ethics involved in both obtaining and distributing that information. Nonprofits have considerable public responsibilities and therefore must take care to abide by data-governance policies and procedures designed to ensure the appropriate transfer of information (Rhode & Packel, 2009; Mathies, 2018). A source may give permission to utilize data and information through the use of

contracts, but it is imperative that users not violate copyright or the legal rights of any involved parties (Carroll, 2015).

An organization could also use gathered resources to offer data analysis services in which analytic techniques are applied to data to answer questions or solve problems (Trkman, McCormack, Valadares de Oliveira, & Ladeira, 2010). Businesses have a need for high-quality results in increasingly complex environments, however, it can be expensive and challenging to manage large amounts of data internally (Spott & Nauck, 2006; Delen & Demirkan, 2013). Organizations can utilize outside resources to accurately interpret data in order to make more efficient and effective decisions (Delen & Demirkan, 2013; Demirkan & Delen, 2013).

Data analytics as a service can provide several benefits to client businesses when the results are accurate and delivered in a timely manner (Delen & Demirkan, 2013). Descriptive, predictive, and prescriptive statistics give companies the information necessary to better prepare for business opportunities and solve problems with effective solutions (Trkman et al., 2010; Delen & Demirkan, 2013).

Specialized knowledge and abilities can also be used to offer consultant services to companies that are engaging in increasingly complex missions (Poulfelt & Payne, 1994). A consultant is defined as a person or organization that is consulted for their knowledge and assistance in a specific area (Banai & Tulimieri, 2013). Many businesses have a need for external resources that can provide expertise and offer recommendations that produce innovative solutions to internal problems (Poulfelt & Payne, 1994). In order to do this effectively, it is vital that a consultant fully understand the organization, any potential problems that it is facing, and the industry that it is involved in (Poulfelt & Payne, 1994; Richter & Niewiem, 2009; Banai & Tulimieri, 2013). Clients often consider consultants' knowledge of the specific industry or

sector, their ability to communicate effectively, and their analytic skills. Above all else, a consultant must be able to provide an organization with actionable results that can be implemented in order to create effective change (Poulfelt & Payne, 1994).

In conclusion, nonprofit organizations have the option of offering several different types of services. An organization could serve as an information resource as scholars stress the importance of information used for research (Hirsh, 1993; Hirsh & Dinkelacker, 2003). Data analytics has the potential to provide clients with the information necessary for effective decision-making (Delen & Demirkan, 2013). Consultant services can also be used to assist businesses with their problem-solving, however, the literature stresses the importance of the consultants' full understanding of the organization (Poulfelt & Payne, 1994; Richter & Niewiem, 2009; Banai & Tulimieri, 2013). For all types of service to be successful, the information provided must be accurate, accessible, and delivered in a timely manner (Anderson, Glassman, McAfee, & Pinelli, 2001; Banai & Tulimieri, 2013; Delen & Demirkan, 2013).

Types of information. Those seeking to explore the various sectors of the space industry are in need of a wide range of knowledge and data. Literature on the industry has identified several significant categories of information, including information on the commercial industry, the economic market, and space law and regulation. The commercial space industry is multifaceted and the need for information on the companies involved is great as many new businesses arise out of space tourism advances, the reduced cost of access to space, and the increased use of small satellites (Denis, Alary, Pasco, Pisot. Texier, & Toulza, 2020). The number of payloads, or cargo launched into space, is rising with the increased use of satellite constellations, smaller satellites, and Earth observation satellites. New launchers have also been

developed and used to accommodate these payloads and the number of launches has steadily increased over the past decade (Wooten & Tang, 2018).

Many of these changes are a result of the new public/private partnerships (PPP) initiated by NASA that were designed to spur commercial innovation and benefit the entire space industry (Lambright, 2015). Commercial Orbital Transportation Services (COTS) and Commercial Resupply Services (CRS) were successful programs that provided cargo resupply services to the International Space Station. As these NASA programs move into new avenues involving crew travel and lunar exploration, businesses will need to fully understand contractual requirements in order to compete for contracts (National Aeronautics and Space Administration [NASA], 2018a; NASA, 2018b).

Despite this advancement, the space industry workforce is at risk of facing a shortage of workers and it is necessary to both understand these employment issues and rectify them in order to keep up with the growing industry. Many companies in the U.S. have reported that a large number of their employees are near retirement with a shortage of skilled workers available to replace them (Gruntman, 2007; Boylan-Kolchin, 2013; Aerospace Industries Association [AIA], 2016). The literature on the topic has identified several reasons for this issue, including the lack of STEM proficiency among American students, the failure of companies to retain talented employees, a lack of diversity in terms of race and gender in the industry, and restrictions imposed by International Traffic in Arms Regulations (ITAR) that limit the employment of foreign nationals (Gruntman, 2007; AIA, 2016; Magnus, 2017).

The growth of commercial space has also led to challenges in the supply chain, which delivers people, information, and supplies to different organizations throughout the industry (Wooten & Tang, 2018). Uncertainty and complexity has been growing in the expanding

industry, which has led to a lack of transparency and flexibility in the supply chain (Sinha, Whitman, & Malzahn, 2004; Ghadge, Dani, & Kalawsky, 2010). Companies need assistance to improve collaboration with their external partners (Tooten & Tang, 2018). Enhanced cooperation allows firms to gain access to new information and reduce risk, which is necessary for sustainability in the industry (Rebolledo & Nollet, 2011; Kishi, 2017).

Additionally, many organizations have a demand for information on the economic factors affecting the rapidly changing industry. Revenues of the private sector and investment in commercial business have increased dramatically over the past decade (Weinzierl, 2018; Anderson, 2019). Various sectors of the satellite industry, including internet usage and real time positioning technology, have experienced particularly significant growth (Lal, 2016; Denis et al., 2020). However, while market demand for commercial space products and services is potentially high, it remains uncertain due to the complexities of the industry (Chang, 2015; Weinzierl, 2018). Success requires a market focus with emphasis placed on consumer demand and cost effectiveness (Shove, 2005; Handberg, 2014).

Important factors that have an impact on market demand are the laws and regulations that govern commercial space operations. Many organizations find this legislation to be especially complicated and often experience difficulty navigating the legal landscape. Currently, there is a lack of coordination and consensus on international space law (Hertzfeld et al., 2016; Danilenko, 2017). The United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) (2020) is the international legislative body involved in space activities, however, its treaties have only created guidelines and do not establish a formal method of governance. Instead, countries are responsible and liable for all endeavors launched from their soil (Hertzfeld et al., 2016).

Domestic legislation is responsible for the oversight of a nation's commercial space industry and requires the registration of all space activities (De Man, 2017).

The fact that there are several different governmental bodies responsible for the oversight of commercial space in the U.S. complicates industry participants' ability to discern regulations (Leung, Sarkani, & Mazzuchi, 2013; Hao & Tronchetti, 2019). The Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) has traditionally been in control of commercial spaceflight. The National Oceanic and Atmospheric Administration (NOAA), that operates out of the Department of Commerce (DOC), is responsible for the regulation of remote sensing satellites, while the Federal Communications Commission (FCC) oversees the use of the electromagnetic spectrum. However, regulation and licensing procedures have been under development in recent years (Hao & Tronchetti, 2019). Changes to the authority of the FAA/AST and the DOC's Office of Space Commerce (OSC) have been proposed, although those modifications have yet to be ratified by Congress.

In summary, the literature has defined and explored several categories of information that are prominent in the space industry, including information on the commercial space sector, the economic market, and the laws and regulations that govern commercial space. The use of this information is likely to increase as the industry continues to grow. Additional material on the current status of the space industry is available in Appendix G.

Purpose of Study

Scholarly literature provides helpful information when considering the addition of an earned income activity at the Space Foundation. Social entrepreneurship can improve organizational performance, but a nonprofit should protect against mission drift by linking the revenue to its core mission (Eikenberry & Kluver, 2004; Foster & Bradach, 2005; Guo, 2006;

Bradshaw, Hayday, & Armstrong, 2007; Di Zhang & Swanson, 2013; Khieng & Dahles, 2015; Levine & Kim, 2018). If generating additional revenue is found to be advantageous and helpful to the space community, the Foundation has the opportunity to offer several different services, including information, data, and consulting services (Hirsh, 1993; Poulfelt & Payne, 1994; Hirsh & Dinkelacker, 2003; Richter & Niewiem, 2009; Banai & Tulimieri, 2013; Delen & Demirkan, 2013). The Space Foundation could utilize its expertise and knowledge and provide needed information on the commercial space industry, the industry's economic status, and space law and regulation (Sinha et al., 2004; Gruntman, 2007; Ghadge et al., 2010; Boylan-Kolchin, 2013; Leung et al., 2013; AIA, 2016; Hertzfeld et al., 2016; Danilenko, 2017; Wooten & Tang, 2018; Hao & Tronchetti, 2019; Denis et al., 2020).

This study addresses whether there is demand for this information in the space community and whether organizations are likely to use external sources to obtain it. This project assesses organizations, including private businesses involved in transportation, satellite companies, other associated commercial space industries, government institutions, media organizations, and educational and outreach institutions, to establish their level of interest and demand. The results of this study will provide answers to the following questions:

RQ1: To what extent do organizations have a demand for information on topics related to commercial space?

> *Sub-question 1*: To what extent do organizations have a demand for information on the commercial space industry?
> *Sub-question 2*: To what extent do organizations have a demand for information on the commercial space workforce?
> *Sub-question 3*: To what extent do organizations have a demand for information on networking opportunities in the commercial space industry?
> *Sub-question 4*: To what extent do organizations have a demand for economic information on the commercial space industry?
> *Sub-question 5*: To what extent do organizations have a demand for information on commercial space law and regulation?

RQ2: How likely are organizations to use outside resources, such as the Space Foundation, for their information needs?

Plan for Methodology

The following plan for methodology includes information on who the survey will be administered to and how it will be conducted at the Space Symposium on October 31st through November 2nd of 2020. This plan also contains information on the experimental data used as an example for this report, including the number of entries per organization type. Data analysis of actual data and the experimental data will be performed in the same manner, allowing the results from the generated data to serve as a realistic example of future findings.

Measurement and Data Collection

Evaluation techniques will be used to determine if the service would be considered valuable to potential clients and whether or not they would use it to address their needs (Goldstein & Gigerenzer, 2009; Halstead, 2016). A quantitative method using data analytics will test the level of demand for these different information categories and determine organizations' probability of using external sources to obtain that information (Orcher, 2014). A confidential multiple-choice survey tool will be distributed at the Space Symposium later this fall and will be used to evaluate respondents' opinions on these topics and determine if the new service will be an appropriate use of resources (Casey, 2007; Orcher, 2007; Babbie, 2016; Hofmann & Rutschmann, 2018). A total of nine close-ended questions are included to evaluate the following information:

- Type of Organization
- Respondent's Role in the Organization
- The Organization's Demand for Information
    - Commercial Space Industry Information
    - Space Industry Workforce Information
    - Information on Networking Opportunities
    - Economic Information
    - Law and Regulation
- The Likelihood of the Organization Using Outside Information Resources

Appendix B includes the full survey and Appendix C includes a measurement table that lists the measure and level of measurement for each survey question.

Sampling Plan

Survey data will be collected from participants of the upcoming Space Symposium taking place in October of this year (Space Foundation, 2020d). The units of analysis for this study are organizations involved in the space industry. Samples taken at the Symposium will be selected through the use of stratified random sampling, which requires that the population be split into groups based on certain characteristics (Orcher, 2007). Participants will be randomly selected at the convention with a focus on acquiring an adequate number of participants from each organization type. Respondents will be given a hard copy of the survey to complete and give back to the researcher.

Experimental survey data were generated for the purpose of this report and serve as an example of the analysis of responses from organizations within the space community. Additional information on how this data was obtained can be found in Appendix A. The results should be taken as a representation and will be replaced with the analysis of actual survey responses after the survey is conducted at the Space Symposium later this year. The generated data were categorized into the following organization types:

Organization Type	**Population Size**
Commercial space transportation manufacturing and services	9
Satellite manufacturing and related services	8
Associated commercial space industries and services	9
Government institutions	6
Media organizations	6
Education and outreach institutions	7
Other organization types	5
Total Sample Size	**50**

Validity and Reliability

This study will address a gap in the current literature by testing for the demand for information and services in commercial space. The analysis will have strong internal validity because the survey was designed to directly evaluate the information needs and interests of the participants at the Space Symposium, which make up the Space Foundation's target market (Walliman, 2011). However, the study will have relatively weak external validity because the results of the analysis are limited to the organizations that attend the convention. Further study is needed in order to generalize the findings to the broader space community.

Limitations to reliability are also taken into consideration. The reliability, or the finding of the same result in repeated evaluation, could be limited by the different people participating in the survey (Babbie, 2016). While individuals are expected to continue to hold the same views on their information needs, different people may have different requirements based on their roles in the organization and, therefore, may respond differently to survey questions. The survey addressed that issue by including a question on the respondent's position in their organization. Results will indicate if participants' responses are influenced by their professional roles. This attention paid to the validity and reliability will improve the accuracy and usefulness of the following analyses.

Data Analysis

Both actual data from survey responses and generated data will be coded and analyzed using several different data analysis methods (Orcher, 2014; Babbie, 2016). Level of demand codes ranged from "No Demand" to "High Demand" on a scale of one to four. The codes for the likelihood of using external information sources also varied from "Highly Unlikely" to "Highly

Likely" on a scale of one to four. Appendix D includes a comprehensive codebook that lists the codes assigned to each measurement.

Statistical analysis of the experimental data was conducted with IBM Statistical Package for the Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics, including frequency distribution, mean, standard deviation, and mode, were used to determine the level of demand for information based on organization type and on information category. Finally, the likelihood of using external information sources by organization type and by information category was established with descriptive and correlational statistics.

Results

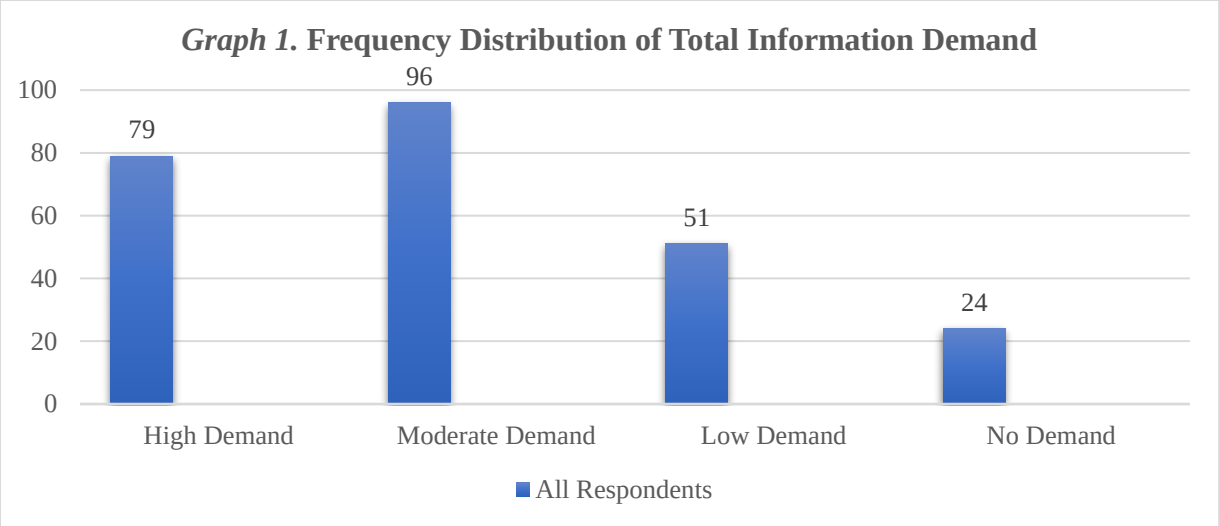
The statistical analysis of the generated responses from the survey tool yielded the following results presented in multiple tables and graphs. The raw data from individual responses can be found in Appendix E. Complete statistical results, including frequency distribution graphs and contingency tables, are available in Appendix F.

Data Analysis of Total Information Demand

The level of total demand for information is displayed in *Table and Graph 1*. Results show that the majority of respondents do have a need for space industry information with moderate demand as the most frequently cited response.

Table 1. **Descriptive Statistics of Total Information Demand** (N=250)

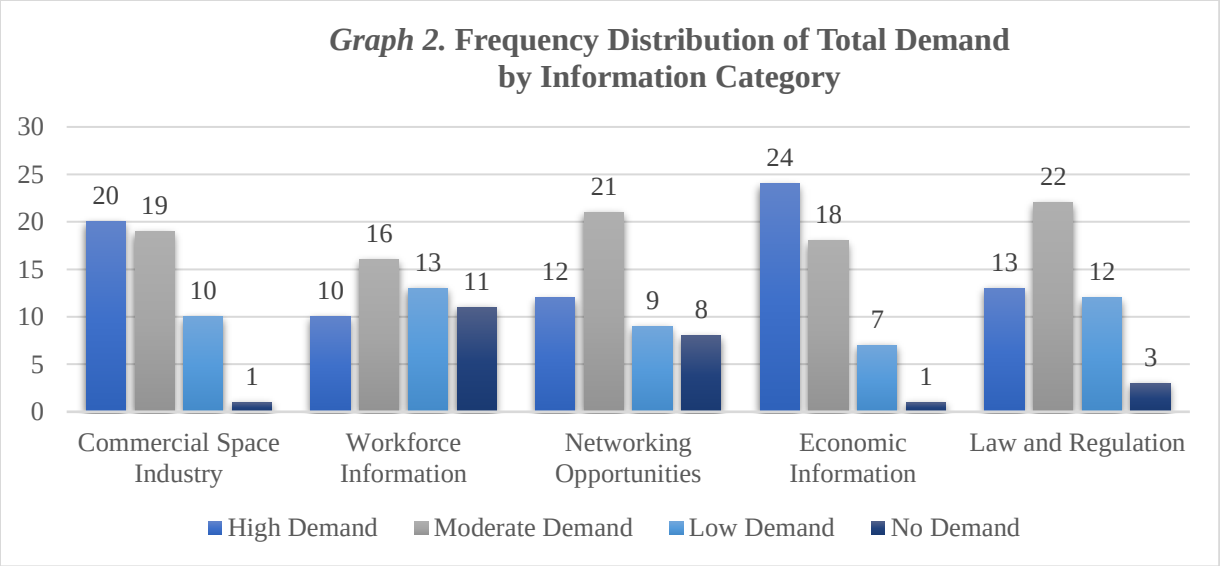
Mean	*Standard Deviation*	*Mode*
2.722	0.949	3



Data analysis of information demand by information category. The level of demand of all respondents by information category is conveyed in *Table and Graph 2.* Results show that respondents are most in need of economic information and commercial space industry information; however, they have less need for information on the space workforce. All categories had average levels of demand between 2.5 and 3.3, indicating that respondents have at least a modest demand for all types of information.

Table 2. **Descriptive Statistics of Total Demand by Information Category** (N=50)

Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.16	0.817	4
Workforce Information	2.50	1.055	3
Networking Opportunities	2.74	1.006	3
Economic Information	3.30	0.789	4
Law and Regulation	2.90	0.863	3

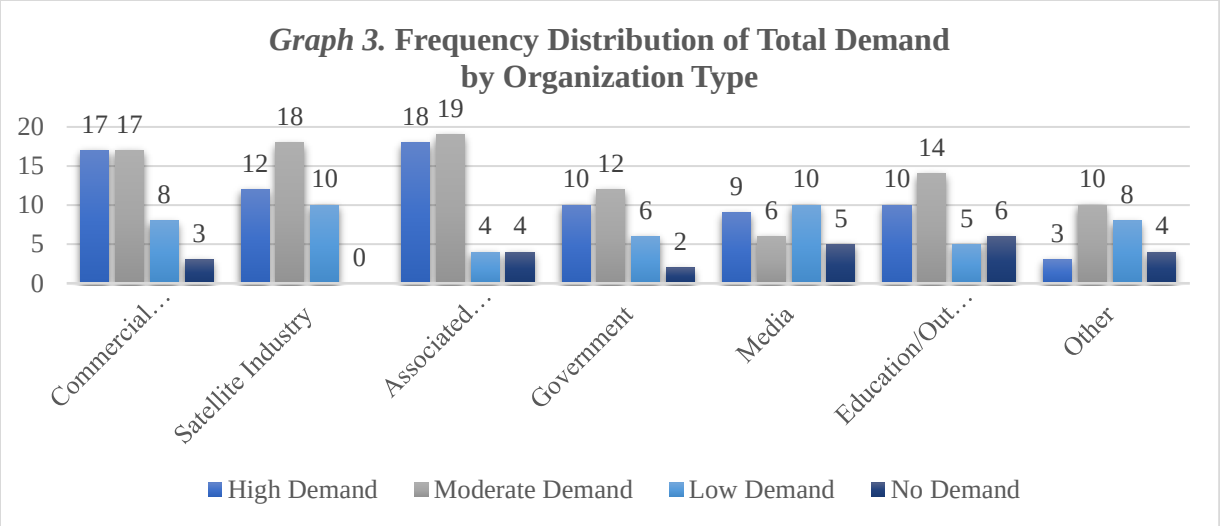


Data Analysis of Information Demand by Organization Type

The total level of demand for each organization type is exhibited in *Table and Graph 3.* Results show that satellite manufacturing and related services, associated commercial space industries and services, and commercial space transportation manufacturing and services have the greatest level of demand for information, while "other" types of organizations have the lowest need.

Table 3. **Descriptive Statistics of Total Demand by Organization Type**

Organization Type	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Transportation (N=9)	2.892	0.915	4
Satellite Industry (N=8)	2.955	0.749	3
Associated Industries (N=9)	2.945	0.919	3
Government (N=6)	2.830	0.910	3
Media (N=6)	2.379	1.098	2
Education/Outreach (N=7)	2.546	1.052	3
Other Organization Types (N=5)	2.288	0.918	3



Data analysis of demand of specific organization types by information category. The levels of demand of each organization type by information category are displayed in *Table 4*. Frequency distribution graphs for each organization type are available in Appendix F. The analysis shows that the transportation, satellite, and associated space industries all have a relatively high need for information with average demand levels ranging from 2.625 to 3.444 in all categories. However, "other" organization types have the lowest need with average levels of demand in each information category ranging from 1.8 to 3.

Table 4. **Descriptive Statistics of Demand of Organization Types by Information Category**

Commercial Space Transportation (N=9)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.222	0.833	4
Workforce Information	2.889	1.054	3
Networking Opportunities	3	0.866	3
Economic Information	3.333	0.707	3
Law and Regulation	2.889	1.167	3
Satellite Industry Demand (N=8)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.375	0.744	4
Workforce Information	2.625	0.744	2
Networking Opportunities	3.375	0.518	3
Economic Information	3	0.926	4
Law and Regulation	2.875	0.641	3
Associated Industries (N=9)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.333	0.707	3
Workforce Information	2.778	1.394	4

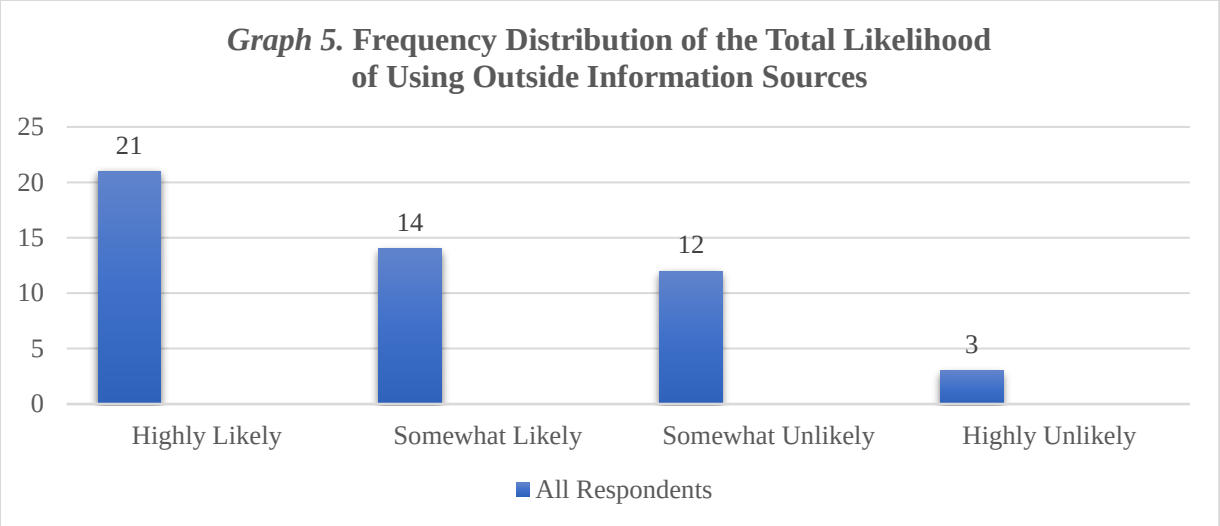
Networking Opportunities	3.444	0.527	3
Economic Information	3.444	0.726	4
Law and Regulation	2.667	0.866	3
Government (N=6)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.167	0.753	3
Workforce Information	2	0.894	3
Networking Opportunities	2.5	0.548	2
Economic Information	3.667	0.516	4
Law and Regulation	3.667	0.516	4
Media (N=6)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3	1.095	4
Workforce Information	2	0.894	3
Networking Opportunities	2	1.265	1
Economic Information	3.667	0.516	4
Law and Regulation	2.5	0.837	2
Education/Outreach (N=7)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.143	0.690	3
Workforce Information	2.429	1.397	1
Networking Opportunities	2.286	1.113	1
Economic Information	3.286	1.113	4
Law and Regulation	2.857	0.690	3
Other Organization Types (N=5)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	2.6	1.140	3
Workforce Information	2.4	0.548	2
Networking Opportunities	1.8	1.095	1
Economic Information	2.6	0.548	3
Law and Regulation	3	1	4

Data Analysis of the Likelihood of Using Outside Information Sources

The extent to which organizations are likely to use outside sources for their information needs is conveyed in *Table and Graph 5*. The results indicate that respondents are likely to use outside information sources, with most communicating that they are “highly likely” to use these services.

Table 5. **Descriptive Statistics of the Total Likelihood of Using Outside Information Sources** (N=50)

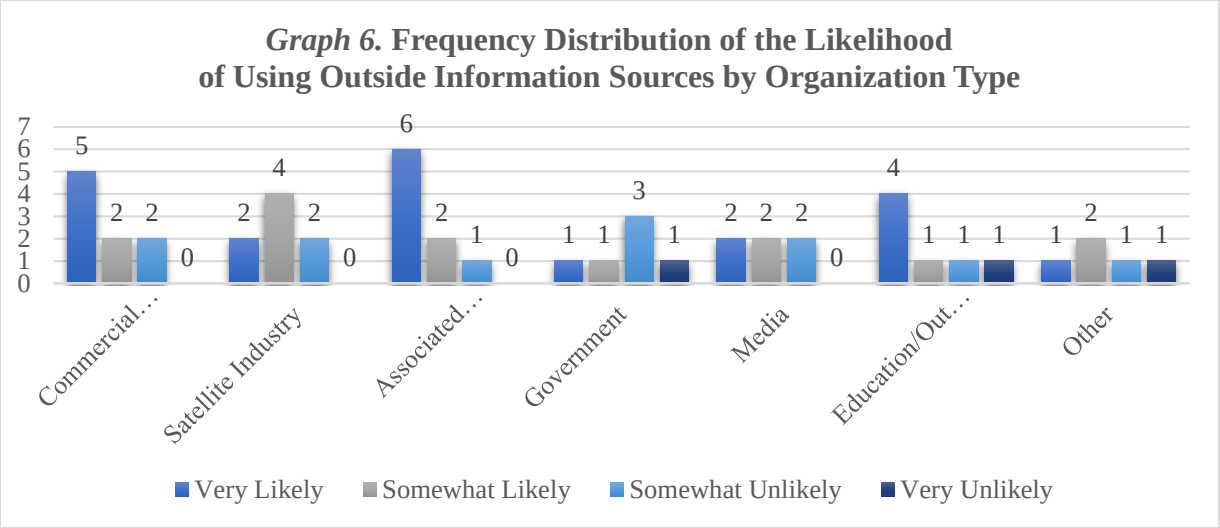
Mean	*Standard Deviation*	*Mode*
3.06	0.956	4



Data analysis of the likelihood of using outside information sources by organization type. *Table and Graph 6* display the likelihood of external service use by organization type. The findings show that associated space industries, the transportation industry, and education/outreach institutions are most likely to engage these services. Government institutions and "other" organization types are the least likely to seek out external sources of information.

Table 6. **Descriptive Statistics of the Likelihood of Using Outside Information Sources by Organization Type**

Organization Type	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Transportation (N=9)	3.333	0.866	4
Satellite Industry (N=8)	3	0.756	3
Associated Industries (N=9)	3.556	0.726	4
Government (N=6)	2.333	1.033	2
Media (N=6)	3	0.894	3
Education/Outreach (N=7)	3.143	1.215	4
Other Organization Types (N=5)	2.6	1.140	3



Correlational analysis of the likelihood of using outside information sources by information category. *Spearman's correlation coefficients* were calculated to evaluate the relationship between the demand for information in specific categories and the likelihood of using outside sources for that information. The results displayed in *Table 7* reveal that the only significant relationship found was between the demand for economic information and the likelihood of outside source usage. The coefficient value of +0.352 signifies a weak positive relationship between the two, which indicates a higher demand for economic information is weakly associated with a greater likelihood of external service use.

***Table 7.* Correlation Coefficient Values of the Likelihood of Using Outside Information Sources by Information Category**

Information Category	*Correlation Coefficient*	*Significance Value (p)*
Commercial Space Industry	+0.188	0.192
Workforce Information	+0.240	0.093
Networking	+0.145	0.315
Economic Information	+0.352	0.012
Law and Regulation	+0.061	0.671

* A relationship between variables is significant if $p < 0.05$.

In conclusion, the results of the statistical analyses of the generated data listed above provide a realistic example of the demands and needs of organizations involved in the space

industry. The following section offers information on how these findings can best be used by the Space Foundation.

Discussion

Interpretation of Results

Although the conclusions drawn from the generated data are not scientifically accurate, they provide a representation of the results that will be derived from survey responses acquired at the upcoming Space Symposium in October of 2020. Findings from the generated data revealed that there is a demand for information on the space industry as the majority of respondents indicated that need *(Table and Graph 1)*. Economic and commercial space industry information were found to have the highest levels of demand among information categories *(Table and Graph 2)*. The organization types with the greatest levels of demand for information were associated commercial space industries and services, satellite manufacturing and related services, and commercial space transportation manufacturing and services *(Graph and Table 3)*.

Results from the generated data also indicated that organizations are likely to use outside sources for their information needs *(Graph and Table 5)*. The organizations most likely to engage these services are associated space industries and services, transportation manufacturing and services, and education/outreach institutions *(Graph and Table 6)*. The assessment also found that demand for economic information is weakly related to the likelihood of external service use *(Table 7)*.

Although this analysis serves as a useful example of results derived from survey responses, the use of generated data is a significant limitation. The results stemming from this data do not provide accurate information on the demands and needs of the space community. Unfortunately, the survey was unable to be conducted at the Space Symposium in March 2020

due to the COVID-19 outbreak, however, it will be administered when the convention takes place later this year in October. This example can serve as a guide during that analysis of actual survey responses.

Recommendations

The Space Foundation can use the conclusions drawn from this study in several different ways. Findings can be used to identify target markets and services that are in high demand. This report can also be used to recognize and address any existing information gaps at the organization. Recommendations on how to proceed further with this study are also included, which will allow the Foundation to build off the results of this report.

Operational recommendations for the Space Foundation. The Space Foundation can take the following actions to prepare for information service delivery:

1) It is recommended, based on the results from the generated data, that the Foundation concentrate on providing economic and commercial space industry information.
2) The organization should also be targeting associated commercial space industries and services, satellite manufacturing and related services, commercial space transportation manufacturing and services, and education/outreach institutions.
3) It is essential that all information be accurate and current when assembling research and data to provide to potential clients.
4) The Space Foundation is also advised to increase its information capacity in the areas below. These recommendations are derived from an evaluation of the research on the space industry done for this report and not based on the analysis of experimental data. These recommendations, therefore, are relevant to the industry and can be applied by the Foundation.

- Commercial Space Industry Information
    - Spacecraft types that are currently available or in development (not including launch vehicles)
    - Suborbital vehicles that are currently available or in development
    - Most recent statistics of deployment by payload type
        - *FAA payload categories:* Commercial telecommunications, Science and engineering, Commercial remote sensing, Commercial crew and cargo transportation, Other commercially launched payloads (FAA, 2018)
    - Information on government contracts including contract types, available contracts, and requirements
- Information on Networking Opportunities
    - Current supply chain makeups
    - Opportunities and challenges in different commercial space industry sector supply chains
- Economic Information
    - Current launch costs by company and payload size
    - Industry investment by stage of investment
    - Investment trends by type of investment
- Law and Regulation
    - Current effects of the guidelines of the United Nations Committee on the Peaceful Uses of Outer Space on the space industry
    - Effects of current domestic law on space companies
    - Regulation requirements for licensing and approval

By ensuring access to the information listed above, the Space Foundation will have the best opportunity to provide in-demand material to organizations in need.

Next steps. After the survey is conducted at the Space Symposium and results from the responses are produced and analyzed, it is recommended that the study move into a qualitative phase with more in-depth insights and opinions obtained from survey participants. Reaching out and interviewing survey respondents and acquiring more information on the needs of organizations within their target market will allow the Space Foundation to develop its service to best serve potential clients.

To best prepare for service delivery, the Space Foundation should identify the specific needs of individual organizations. Interview participants will most likely cite more detailed information requirements within each information category, which will help the Foundation

identify the research that needs to be done to ensure that clients' demands are met. It would also be advantageous for the Foundation to inquire about the obstacles and challenges faced by individual organizations as well as any opportunities that they are interested in pursuing. The space industry is multifaceted with a wide range of factors to consider, including government contracts and regulations, investments, supply chains, commercial services, and mergers and acquisitions. Understanding the specific information needs of these companies and the issues that they face will give the Space Foundation an opportunity to provide valuable support that will assist organizations in the successful navigation of this industry. The results from this qualitative analysis would be used to further evaluate the information capabilities of the Space Foundation and its ability to meet the needs of potential clients. Any gaps should be identified and addressed.

This qualitative analysis will require time and personnel to complete. The Space Foundation could assign in-house employees or hire an external consultant to conduct the study. The researcher(s) involved will need to contact and interview survey participants and will need time to analyze responses. When the Foundation is prepared to establish its information service, it should develop an organizational and cost structure that outlines employee roles and the price of available services. A marketing plan should also be developed to inform potential clients about the launch of the service. When the information service is formally added to the organization's activities, the Space Foundation can begin to provide necessary research and data to others within the space community!

In Conclusion

The results of this study will offer valuable information on the information and service needs of organizations within the space community. While the analysis of experimental data used for this report does not provide accurate information, it does serve as a comprehensive example

of the results that will be derived from actual survey responses collected at the Space Symposium later this year. It is recommended that the Space Foundation use those future results to increase its knowledge capacity and effectively target the information categories and organization types with the highest levels of interest and demand. Avenues for future research were also proposed and can be used to expand on the results of this study for the benefit of the organization.

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Appendix A

Information on Experimental Data

The methods used for this study had to be altered due to the COVID-19 pandemic. The survey was unable to be administered as planned when the Space Symposium, originally scheduled to take place on March 30th through April 2nd of 2020, was postponed. The survey will be conducted at the rescheduled convention, which will take place on October 31st through November 2nd of this year, and this report will be updated with the authentic survey analysis at that time.

This report was completed with experimental data in order to comply with the University of Colorado's semester deadlines. An electronic version of the survey was sent to and completed by 50 of the author's acquaintances with instructions to respond as if they represented an organization in the space industry. Participants are not associated with any space-related organizations and, therefore, results derived for their responses are not a valid representation of the industry and should only be taken as an example of how actual findings will be displayed.

Appendix B

Survey: Information Needs in Commercial Space

Administered by the Space Foundation

Electronic Version

Hello! Thank you for participating in this survey to help the Space Foundation improve its service delivery. As commercial space continues to grow and change, there will be an even greater need to obtain accurate and up-to-date information on different segments of the industry. The Space Foundation has been supporting the global space community for decades and is able to provide valuable information on the commercial industry, the space economy, and space law and regulation to individuals and organizations.

Your insights and opinions will help the Foundation determine the level of demand for this information and for related services. The following questionnaire will take less than five minutes to complete and all responses will be kept confidential. Please select the best response to the nine questions below. If you have any questions, please contact Tara Larson at tara.larson@ucdenver.edu. Thank you for your time and dedication to the space community!

1) What is the name of your organization?

2) What type of organization would your organization most identify with?
   - o Commercial space transportation manufacturing and services, including launch and space travel
   - o Satellite manufacturing and related services, including satellite data usage
   - o Associated commercial space industries and services
   - o Government institution
   - o Media organization
   - o Educational/Outreach institution
   - o Other

3) Which of the following best describes your role in your organization?
   - o Business management
   - o Research
   - o Public relations
   - o Policy management and/or advisement
   - o Product and/or service development
   - o Education and/or outreach
   - o Other

4) To what extent does your organization have a demand for information on the commercial space industry, including information on space-related companies, launches and payloads, and public/private partnerships?
   - o High demand
   - o Moderate demand
   - o Low demand
   - o No demand

5) To what extent does your organization have a demand for information on the commercial space industry workforce, including information on industry employment and STEM education?
   - High demand
   - Moderate demand
   - Low demand
   - No demand

6) To what extend does your organization have a demand for information on networking opportunities in the commercial space industry, including information on knowledge transfer and industry supply chains?
   - High demand
   - Moderate demand
   - Low demand
   - No demand

7) To what extent does your organization have a demand for economic information on the commercial space industry, including industry revenues and costs, investment, and market demands?
   - High demand
   - Moderate demand
   - Low demand
   - No demand

8) To what extend does your organization have a demand for information on commercial space law and regulation, including international and domestic law and government licensing and approval requirements?
   - High demand
   - Moderate demand
   - Low demand
   - No demand

9) How likely is your organization to use outside sources, such as the Space Foundation, for your information needs?
   - Highly likely
   - Somewhat likely
   - Somewhat unlikely
   - Highly unlikely

Thank you for completing our survey!

Appendix C

Measurement Table for Survey

Measure	Level of Measurement	Survey question
Name of organization	Nominal	#1
Type of organization	Nominal	#2
Respondent's role in the organization	Nominal	#3
Demand for commercial space industry information	Ordinal	#4
Demand for industry workforce information	Ordinal	#5
Demand for information on networking opportunities	Ordinal	#6
Demand for economic information on the space industry	Ordinal	#7
Demand for information on space law and regulation	Ordinal	#8
Likelihood of using outside information sources	Ordinal	#9

Appendix D

Codebook for Survey Responses

Measurement	Code
Type of Organization	
Commercial space transportation manufacturing and services	7
Satellite manufacturing and related services	6
Associated commercial space industries and services	5
Government institution	4
Media organization	3
Education/Outreach institution	2
Other organization types	1
Respondent's Role in the Organization	
Business management	7
Research	6
Public relations	5
Policy management and/or advisement	4
Product and/or service development	3
Education and/or outreach	2
Other	1
Level of Demand	
High demand	4
Moderate demand	3
Low demand	2
No demand	1
Likelihood of Service Use	
Highly likely	4
Somewhat likely	3
Somewhat unlikely	2
Highly unlikely	1

Appendix E

Raw Data of Survey Responses

Organization ID	Organization Type	Role of Respondent	Demand for Industry Information	Demand for Workforce Information	Demand for Networking Opportunities	Demand for Economic Information	Demand for Law & Regulation Information	Demand for Outside Information Services
1	1	5	3	2	1	2	4	3
2	3	3	2	3	2	3	4	2
3	5	2	2	1	3	4	2	4
4	7	3	4	2	3	3	4	4
5	6	1	2	3	3	2	3	3
6	2	6	3	1	1	4	3	4
7	1	4	4	3	3	2	3	1
8	5	5	3	3	4	4	3	4
9	6	3	3	3	3	3	2	3
10	4	5	4	3	2	4	4	2
11	3	2	2	1	4	3	2	3
12	7	4	4	2	3	4	3	2
13	2	6	2	3	4	4	3	4
14	5	7	4	3	3	3	1	4
15	3	2	2	3	1	4	2	2
16	2	4	3	4	2	4	2	4
17	7	5	2	1	2	3	1	2
18	6	3	4	4	3	2	3	4
19	2	1	3	4	3	1	2	1
20	7	7	3	3	4	4	1	3
21	7	5	3	4	4	3	3	4
22	6	3	4	2	3	2	3	2
23	4	4	4	2	3	4	3	4
24	2	6	3	1	1	3	3	2
25	3	2	4	2	1	4	2	3
26	1	2	2	3	1	3	4	4
27	5	7	4	4	3	4	4	4
28	6	5	3	2	4	3	3	2
29	4	1	2	1	2	4	4	3
30	3	6	4	1	1	4	3	4
31	7	6	2	3	2	3	4	3
32	5	3	3	1	4	3	2	4
33	6	5	4	2	4	4	3	3
34	5	4	3	4	4	4	3	3
35	3	7	4	2	3	4	2	4
36	4	2	3	1	3	3	3	1
37	6	5	4	2	3	4	2	3

38	4	6	3	3	3	3	4	2
39	7	7	4	4	3	2	3	4
40	1	2	1	2	3	3	2	3
41	2	1	4	1	3	3	3	3
42	6	3	3	3	4	4	4	4
43	5	6	3	1	4	3	3	2
44	7	4	4	3	4	4	3	4
45	5	3	4	4	3	2	3	3
46	4	6	3	2	2	4	4	2
47	2	4	4	3	2	4	4	4
48	1	6	3	2	1	3	2	2
49	5	7	4	4	3	4	3	4
50	7	7	3	4	2	4	4	4

Appendix F

Complete Data Analysis Results

Data Analysis of Information Demand

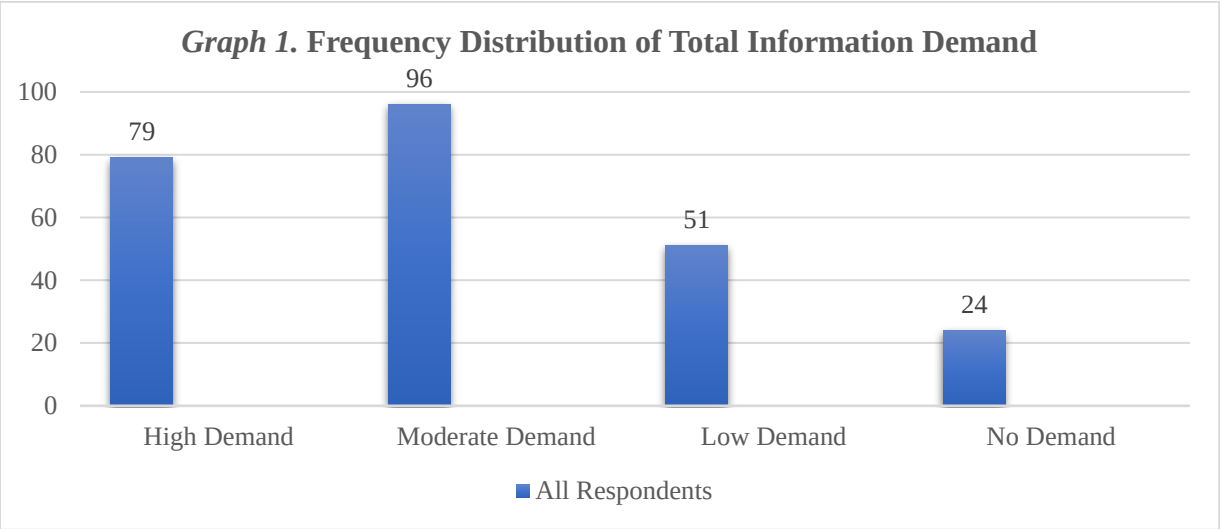


Table 1. **Descriptive Statistics of Total Information Demand** (N=250)		
Mean	*Standard Deviation*	*Mode*
2.722	0.949	3

Table 1a. **Contingency Table of Total Information Demand** (N=250)			
High Demand	*Moderate Demand*	*Low Demand*	*No Demand*
32%	38%	20%	10%

Data analysis of information demand by information category.

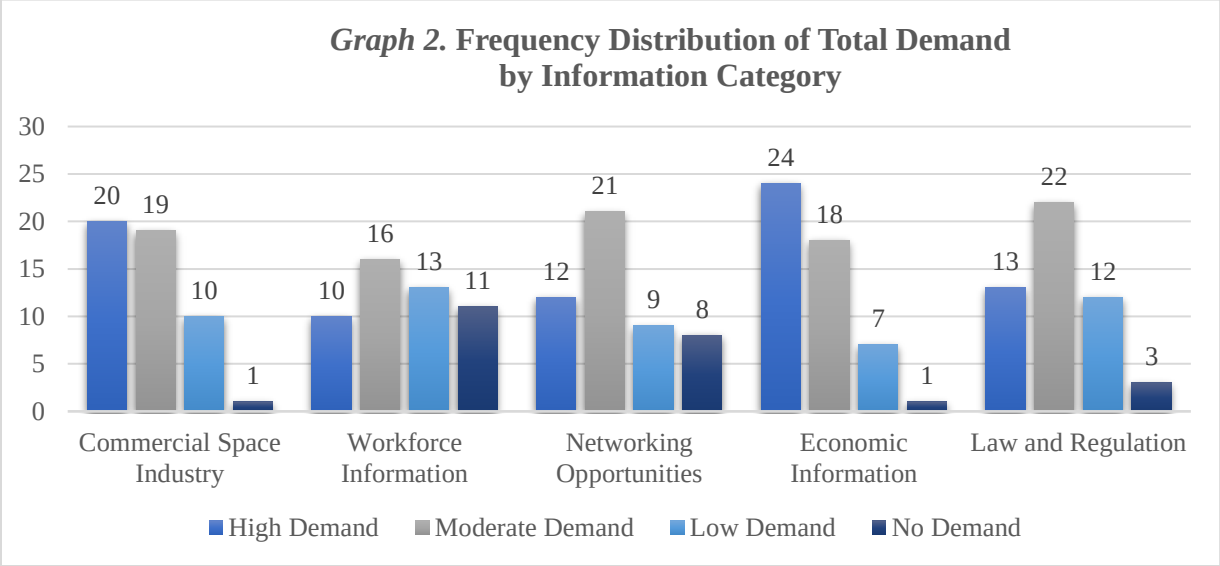


Table 2. **Descriptive Statistics of Total Demand by Information Category** (N=50)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.16	.817	4
Workforce Information	2.50	1.055	3
Networking Opportunities	2.74	1.006	3
Economic Information	3.30	.789	4
Law and Regulation	2.90	.863	3

Table 2a. **Contingency Table of Total Demand by Information Category**				
Information Category	*High Demand*	*Moderate Demand*	*Low Demand*	*No Demand*
Commercial Space Industry (N=50)	40%	38%	20%	2%
Workforce Information (N=50)	20%	32%	26%	22%
Networking Opportunities (N=50)	24%	42%	18%	16%
Economic Information (N=50)	48%	36%	14%	2%
Law and Regulation (N=50)	26%	44%	24%	6%

Data Analysis of Information Demand by Organization Type

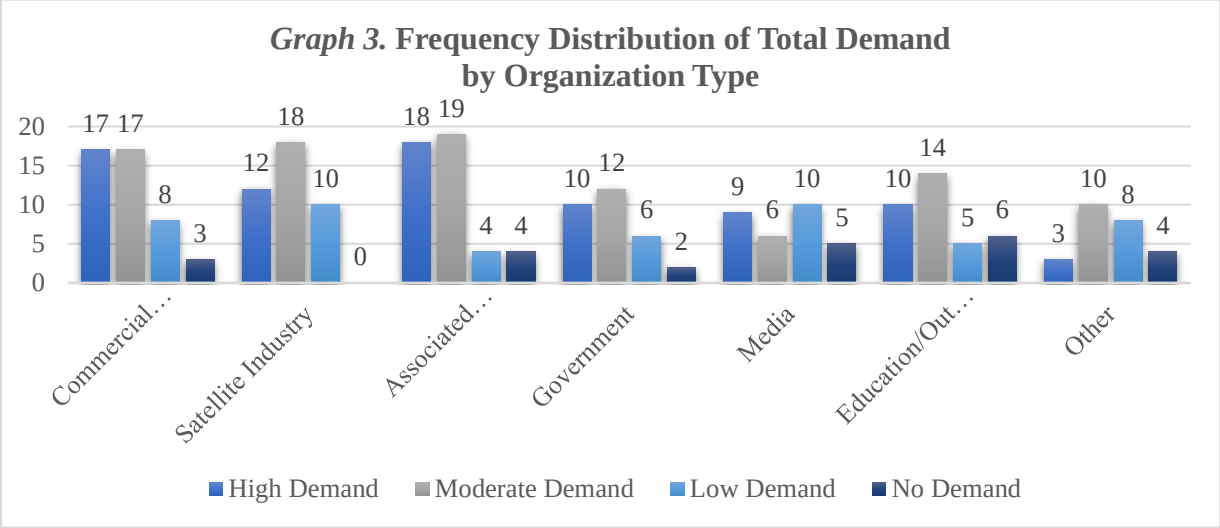
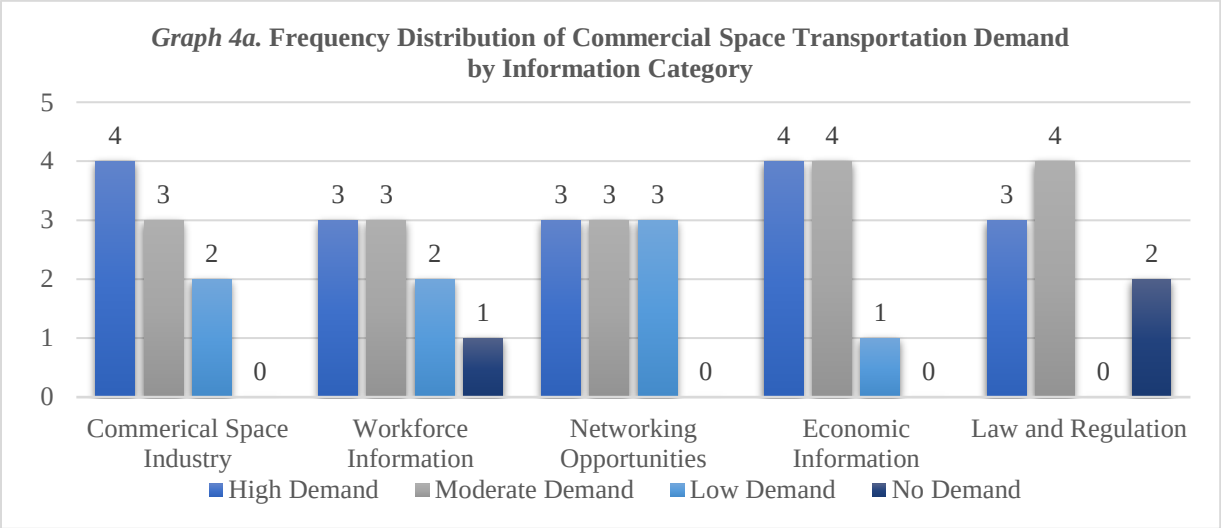


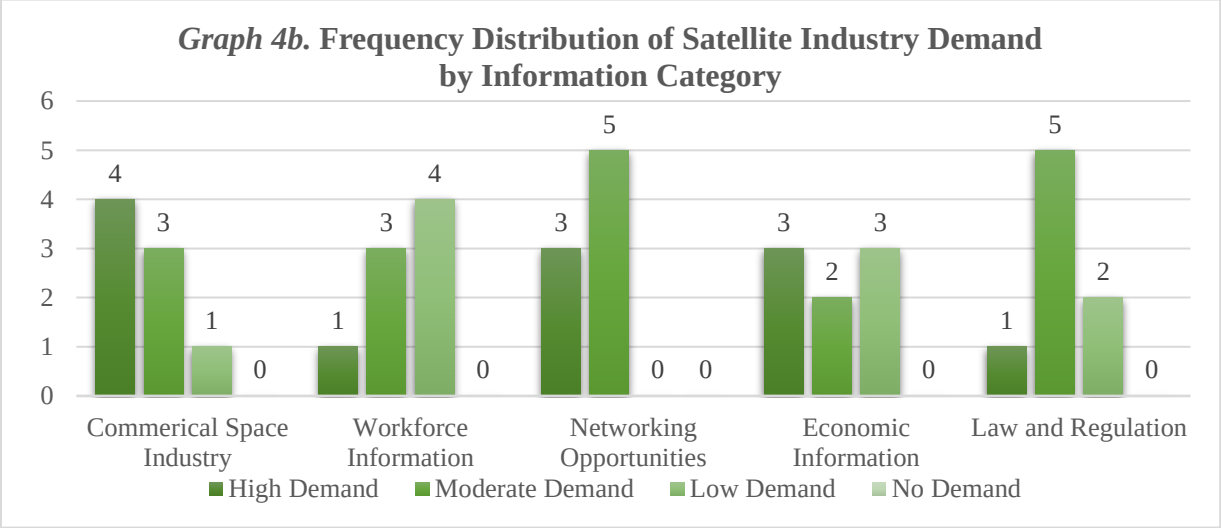
Table 3. **Descriptive Statistics of Total Demand by Organization Type**			
Organization Type	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Transportation (N=9)	2.892	0.915	4
Satellite Industry (N=8)	2.955	0.749	3
Associated Industries (N=9)	2.945	0.919	3
Government (N=6)	2.830	0.910	3
Media (N=6)	2.379	1.098	2
Education/Outreach (N=7)	2.546	1.052	3
Other Organization Types (N=5)	2.288	0.918	3

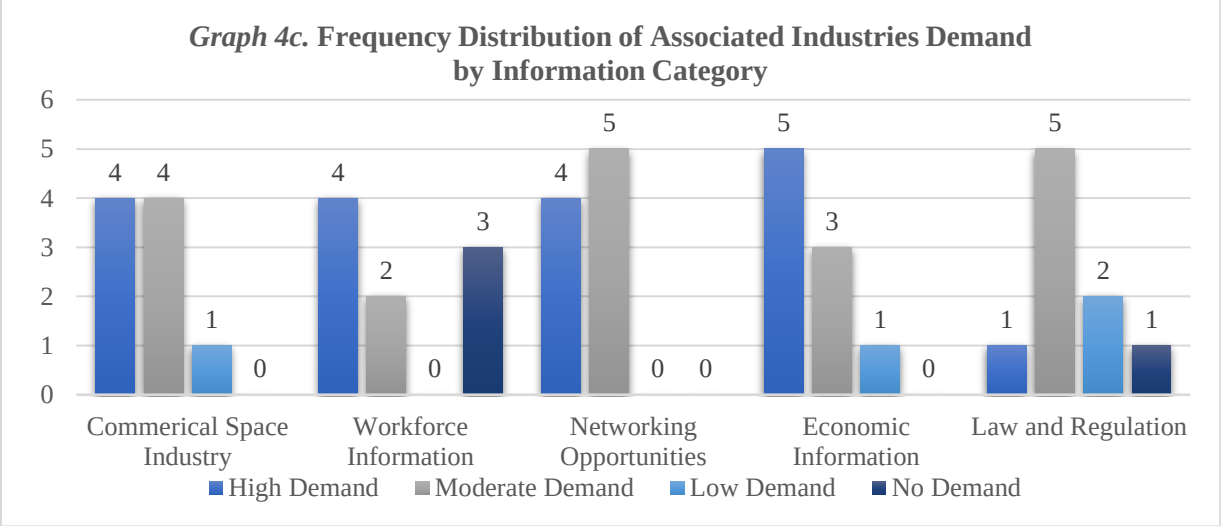
Table 3a. **Contingency Table of Total Demand by Organization Type**				
Organization Type	*High Demand*	*Moderate Demand*	*Low Demand*	*No Demand*
Commercial Space Transportation (N=9)	38%	38%	18%	7%
Satellite Industry (N=8)	30%	45%	25%	0%
Associated Industries (N=9)	40%	42%	9%	9%
Government (N=6)	33%	40%	20%	7%
Media (N=6)	30%	20%	33%	17%
Education/Outreach (N=7)	29%	40%	14%	17%
Other Organization Types(N=5)	12%	40%	32%	16%

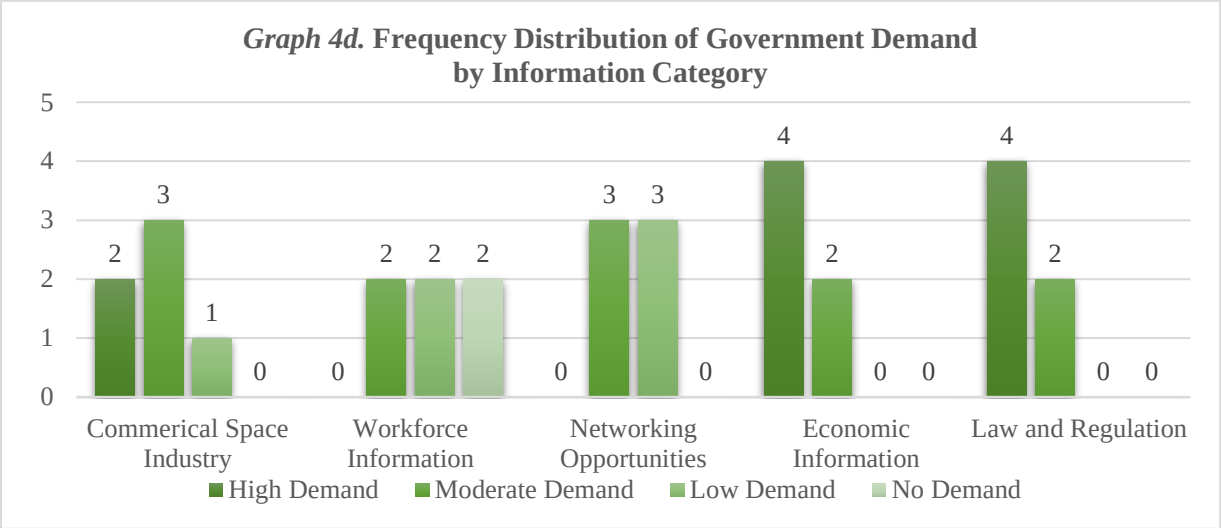
Data analysis of demand of specific organization types by information category.

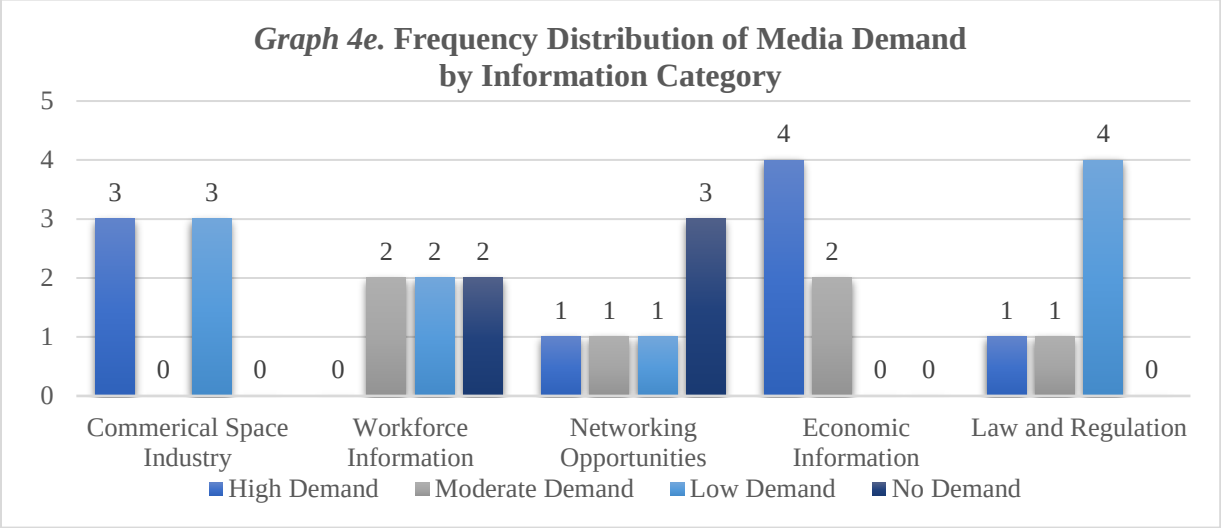
Table 4. **Descriptive Statistics of Demand of Organization Types by Information Category**			
Commercial Space Transportation (N=9)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.222	0.833	4
Workforce Information	2.889	1.054	3
Networking Opportunities	3	0.866	3
Economic Information	3.333	0.707	3
Law and Regulation	2.889	1.167	3
Satellite Industry Demand (N=8)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.375	0.744	4
Workforce Information	2.625	0.744	2
Networking Opportunities	3.375	0.518	3
Economic Information	3	0.926	4
Law and Regulation	2.875	0.641	3
Associated Industries (N=9)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.333	0.707	3
Workforce Information	2.778	1.394	4
Networking Opportunities	3.444	0.527	3
Economic Information	3.444	0.726	4
Law and Regulation	2.667	0.866	3
Government (N=6)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.167	0.753	3
Workforce Information	2	0.894	3
Networking Opportunities	2.5	0.548	2
Economic Information	3.667	0.516	4
Law and Regulation	3.667	0.516	4
Media (N=6)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3	1.095	4
Workforce Information	2	0.894	3
Networking Opportunities	2	1.265	1
Economic Information	3.667	0.516	4
Law and Regulation	2.5	0.837	2
Education/Outreach (N=7)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	3.143	0.690	3
Workforce Information	2.429	1.397	1
Networking Opportunities	2.286	1.113	1
Economic Information	3.286	1.113	4
Law and Regulation	2.857	0.690	3
Other Organization Types (N=5)			
Information Category	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Industry	2.6	1.140	3
Workforce Information	2.4	0.548	2
Networking Opportunities	1.8	1.095	1
Economic Information	2.6	0.548	3
Law and Regulation	3	1	4

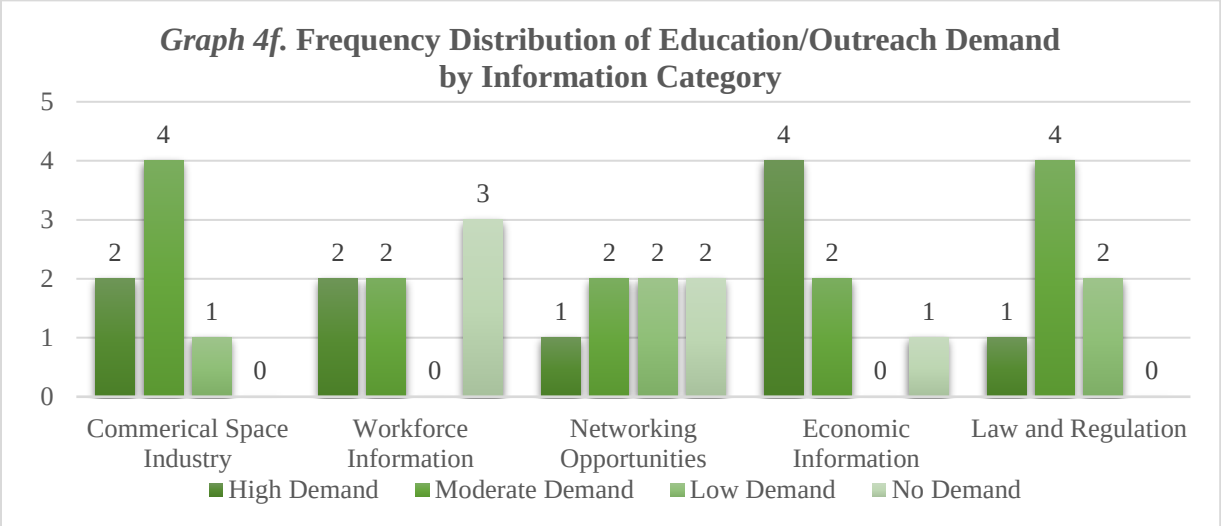

Graph 4a. Frequency Distribution of Commercial Space Transportation Demand by Information Category
5
4
3
2
1
0
4 3 2 0
3 3 2 1
3 3 3 0
4 4 1 0
3 4 0 2
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand

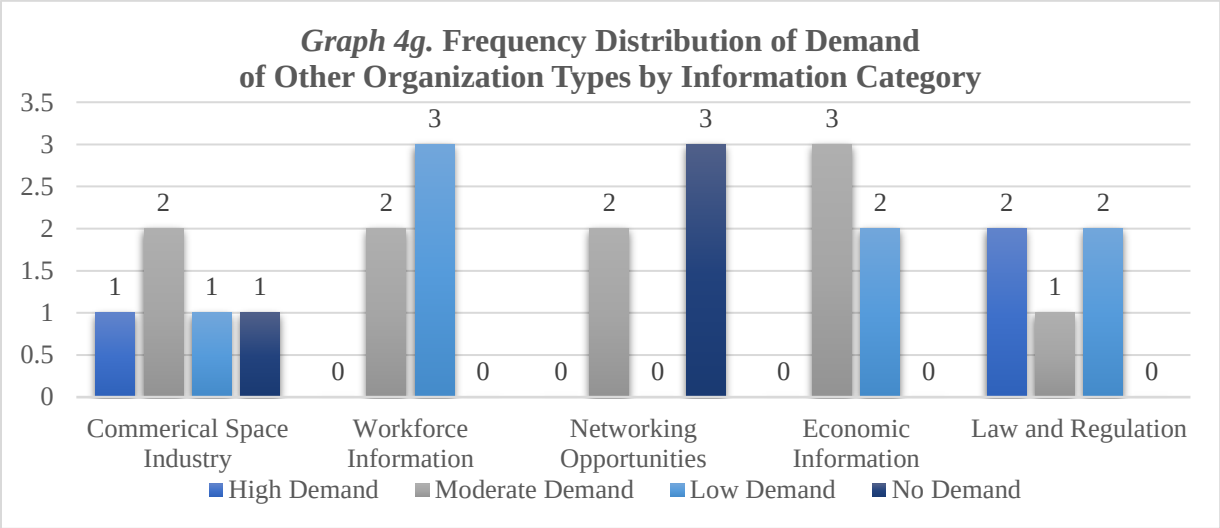

Graph 4b. Frequency Distribution of Satellite Industry Demand by Information Category
6
5
4
3
2
1
0
4 3 1 0
1 3 4 0
3 5 0 0
3 2 3 0
1 5 2 0
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand


Graph 4c. Frequency Distribution of Associated Industries Demand by Information Category
6
5
4
3
2
1
0
4 4 1 0
4 2 0 3
4 5 0 0
5 3 1 0
1 5 2 1
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand


Graph 4d. Frequency Distribution of Government Demand by Information Category
5
4
3
2
1
0
2 3 1 0 0 2 2 2 0 3 3 0 4 2 0 0 4 2 0 0
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand


Graph 4e. Frequency Distribution of Media Demand by Information Category
5
4
3
2
1
0
3 0 3 0 0 2 2 2 1 1 1 3 4 2 0 0 1 1 4 0
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand


Graph 4f. Frequency Distribution of Education/Outreach Demand by Information Category
5
4
3
2
1
0
2 4 1 0 2 2 0 3 1 2 2 2 4 2 0 1 1 4 2 0
Commerical Space Industry
Workforce Information
Networking Opportunities
Economic Information
Law and Regulation
High Demand
Moderate Demand
Low Demand
No Demand



Data Analysis of the Likelihood of Using Outside Information Sources

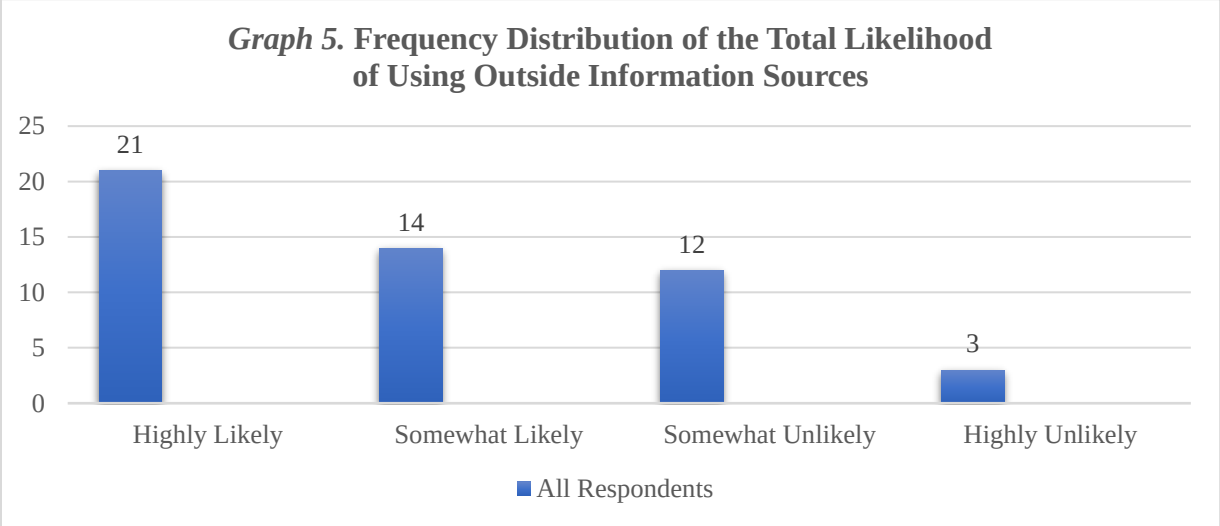


***Table 5.* Descriptive Statistics of the Total Likelihood of Using Outside Information Sources** (N=50)		
Mean	*Standard Deviation*	*Mode*
3.06	0.956	4

***Table 5a.* Contingency Table of the Total Likelihood of Using Outside Information Sources** (N=50)			
Highly Likely	*Somewhat Likely*	*Somewhat Unlikely*	*Highly Unlikely*
42%	28%	24%	6%

Data analysis of the likelihood of using outside information sources by organization type.

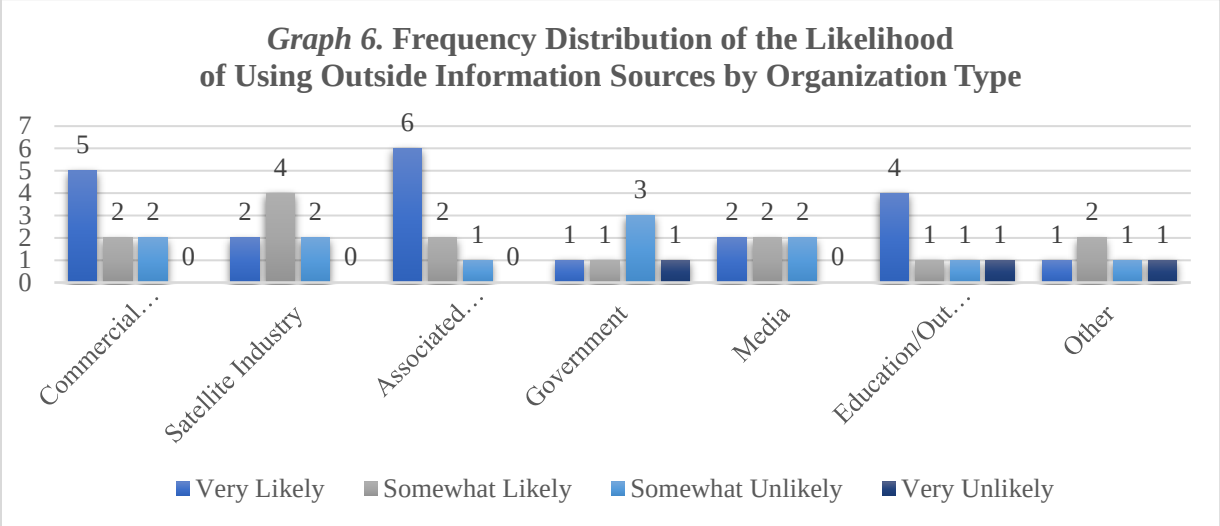


Table 6. **Descriptive Statistics of the Likelihood of Using Outside Information Sources by Organization Type**			
Organization Type	*Mean*	*Standard Deviation*	*Mode*
Commercial Space Transportation (N=9)	3.333	0.866	4
Satellite Industry (N=8)	3	0.756	3
Associated Industries (N=9)	3.556	0.726	4
Government (N=6)	2.333	1.033	2
Media (N=6)	3	0.894	3
Education/Outreach (N=7)	3.143	1.215	4
Other Organization Types (N=5)	2.6	1.140	3

Table 6a. **Contingency Table of the Likelihood of Using Outside Information Sources by Organization Type**				
Information Category	*Very Likely*	*Somewhat Likely*	*Somewhat Unlikely*	*Very Unlikely*
Commercial Space Transportation (N=9)	56%	22%	22%	0%
Satellite Industry (N=8)	25%	50%	25%	0%
Associated Industries (N=9)	67%	22%	11%	0%
Government (N=6)	17%	17%	50%	17%
Media (N=6)	33%	33%	33%	0%
Education/Outreach (N=7)	57%	14%	14%	14%
Other Organization Types (N=5)	20%	40%	20%	20%

Correlational analysis of the likelihood of using outside information sources by information category.

Table 7. **Correlation Coefficient Values of the Likelihood of Using Outside Information Sources by Information Category**		
Information Category	*Correlation Coefficient*	*Significance Value (p)*
Commercial Space Industry	+0.188	0.192
Workforce Information	+0.240	0.093
Networking Opportunities	+0.145	0.315
Economic Information	+0.352	0.012
Law and Regulation	+0.061	0.671

* A relationship between variables is significant if $p < 0.05$.

Data Analysis of Service Needs by Organizational Role of the Respondent

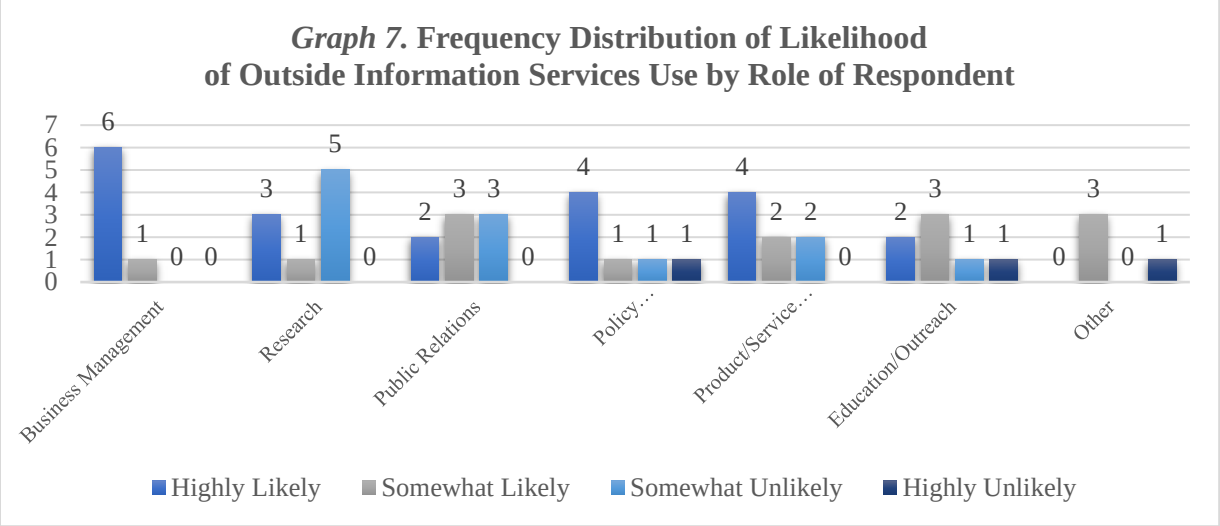


Table 8. **Contingency Table of the Likelihood of Using Outside Information Source by Role of Respondent**				
Role of Respondent	*Highly Likely*	*Somewhat Likely*	*Somewhat Unlikely*	*Highly Unlikely*
Business Management (N=7)	86%	14%	0%	0%
Research (N=9)	33%	11%	56%	0%
Public Relations (N=8)	25%	38%	38%	0%
Policy Management/Advisement (N=7)	57%	14%	14%	14%
Product/Service Development (N=8)	50%	25%	25%	0%
Education/Outreach (N=7)	29%	43%	14%	14%
Other (N=4)	0%	75%	0%	25%

Appendix G

Most Recent Information on the Space Industry

Commercial Space Industry

FAA Licensed Launches	
Year	*Number of Launches*
2020	9 (to date)
2019	26
2018	33
2017	23
2016	11
2015	9
2014	12
2013	8
2012	7

Source: FAA, 2020a

FAA Active Launch Licenses

- Rocket Lab Global (Electron—NZ)
- Orbital Sciences Corp (Pegasus—MH)
- Orbital Sciences Corp (Antares Configuration 230—VA)
- Space Exploration Technologies Corp (Falcon 9—FL)
- Space Exploration Technologies Corp (Falcon 9—CA)
- Orbital Sciences Corp (Minotaur 1—VA)
- United Launch Alliance (Atlas V—FL)
- Space Exploration Technologies Corporation (Falcon 9—FL)
- Exos Aerospace (SARGE—NM)
- Orbital Sciences Corp (Minotaur IV—FL)
- Astra Space, Inc. (Astra Rocket 3—AK)
- Lockheed Martin Commercial Launch Services (Atlas V—CA)
- Lockheed Martin Commercial Launch Services (Atlas V—FL)
- Blue Origin (New Shepard System—TX)
- S7 Sea Launch Limited (Zenit 3SL—Pacific)
- Orbital Sciences Corp (Pegasus—VA)
- Orbital Sciences Corp (Pegasus—FL)
- United Launch Alliance (Atlas V-401—FL)
- Space Exploration Technologies Corp (Falcon 9—FL)
- Virgin Orbit, LLC (LauncherOne—CA)
- Space Exploration Technologies Corporation (Dragon—Pacific)
- Orbital Sciences Corp (Pegasus—CA)
- Virgin Galactic (SpaceShipTwo—CA)
- Orbital Sciences Corp (Minotaur-C—CA)

FAA Active Launch Site Operator Licenses (FAA, 2020b)

- Jacksonville Aviation Authority (Cecil Field—FL)
- Midland International Airport (Midland International Airport—TX)
- Mojave Air and Space Port (Mojave Air and Space Port—CA)
- New Mexico Spaceflight Authority (Spaceport America—NM)
- Space Florida (Cape Canaveral Spaceport/Shuttle Landing Facility—FL)
- Alaska Aerospace Development Corporation (Pacific Spaceport Complex Alaska—AK)
- Adams County (Colorado Air and Space Port—CO)
- Virginia Commercial Space Flight Authority (Wallops Flight Facility—VA)
- Oklahoma Space Industry Development Authority (Burns Flat—OK)
- Space Florida (Cape Canaveral Air Force Station—FL)
- Houston Airport System (Ellington Airport—TX)

Source: FAA, 2020b

NASA Public/Private Partnership Programs

Cargo

- Commercial Orbital Transportation Services (COTS)
  - *Commercial Partners:* Space Exploration Technologies Corporation, Rocketplane Kistler (agreement terminated), Orbital ATK (now Northrop Grumman Innovation Systems)
  - *Duration:* 2006—2013
- Commercial Resupply Services (CRS)
  - *Commercial Partners:* Space Exploration Technologies Corporation, Orbital ATK (now Northrop Grumman Innovation Systems), Sierra Nevada Corporation
  - *Duration:* 2008—present

Crew

- Crew Transportation Concepts and Technology Demonstration (CCDEV)
  - *Commercial Partners:* Blue Origin, Paragon Space Development Corporation, Sierra Nevada Corporation, United Launch Alliance, Space Exploration Technologies Corporation, Boeing
  - *Duration:* 2010—2012
- Commercial Crew Integrated Capability (CCiCAP)
  - *Commercial Partners:* Space Exploration Technologies Corporation, Boeing, Sierra Nevada Corporation
  - *Duration:* 2012—2014
- Commercial Crew Transportation Capability (CCtCAP)
  - *Commercial Partners:* Boeing, Space Exploration Technologies Corporation
  - *Duration:* 2014—present

Lunar

- Commercial Lunar Payload Services (CLPS)
  - *Commercial Partners:* Astrobotic Technology, Blue Origin, Ceres Robotics, Deep Space Systems, Draper, Firefly Aerospace, Intuitive Machines, Lockheed Martin Space, Masten Space Systems, Moon Express, Orbit Beyond, Sierra Nevada Corporation, Space Exploration Technologies Corporation, Tyvak Nano-Satellite Systems
  - *Duration:* 2018—present
- Gateway for Artemis
  - *Commercial Partner for Power and Propulsion Element (PPE):* Maxar Technologies
  - *Commercial Partner for Habitation and Logistics Outpost (HALO):* Northrop Grumman Innovation Systems
  - *Duration:* 2018—present
- Human Landing System (HLS) for Artemis
  - Bids currently under consideration
  - *Duration:* 2019—present

Source: Space Policy Online, 2019a; NASA, 2020

Space Industry Employment

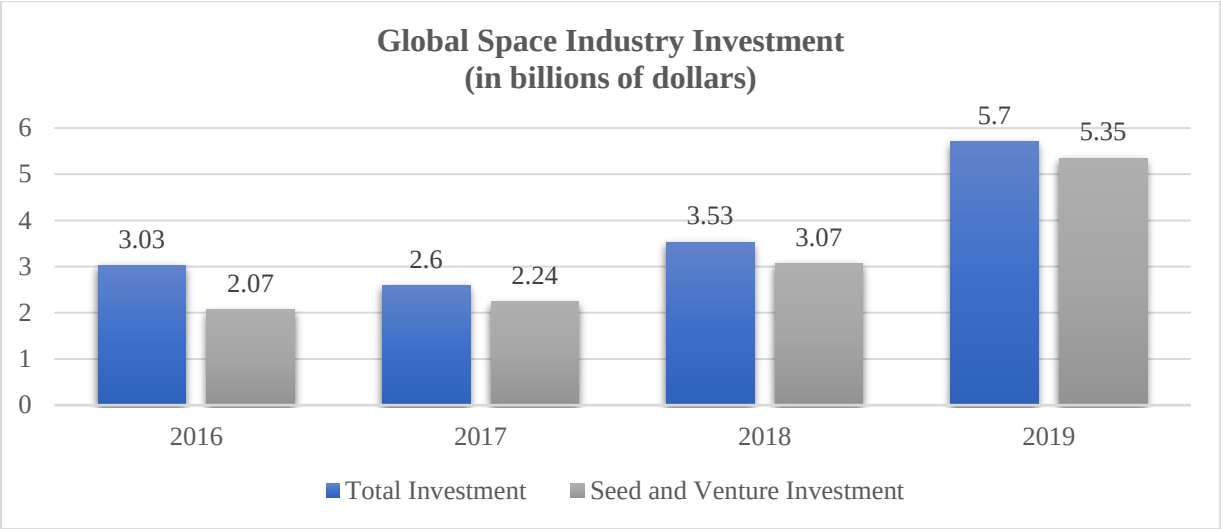
Employment Statistics by Industry Sector (selected list)				
Industry Sector	*NAICS Code*	*Employment by Year**		
		2017	*2018*	*2019*
Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	334220	48,470	48,527	48,686
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	334511	121,347	127,155	134,837
Aerospace Product and Parts Manufacturing	336400	484,358	503,765	535,653
Guided Missile and Space Vehicle Manufacturing	336414	59,634	62,887	66,827
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	336415	10,030	10,348	12,905
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	336419	5,553	5,614	7,157
Wired Telecommunications Carriers	517311	571,127	546,811	512,974
Satellite Telecommunications	517410	8,399	8,554	8,528
Research and Development in the Physical, Engineering, and Life Sciences	541715	391,980	413,853	435,655
Space Research and Technology	927110	17,301	17,124	17,225

* Statistics for 2017 and 2018 are annual averages. Statistics for 2019 are the most recent data from the third quarter of 2019.

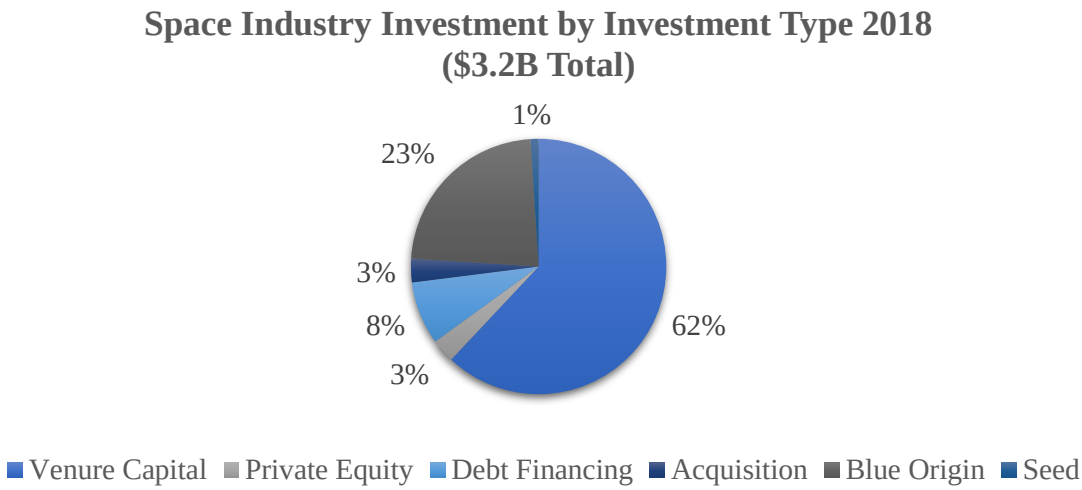
Source: U.S. Bureau of Labor Statistics, 2020

Space Industry Economic Information

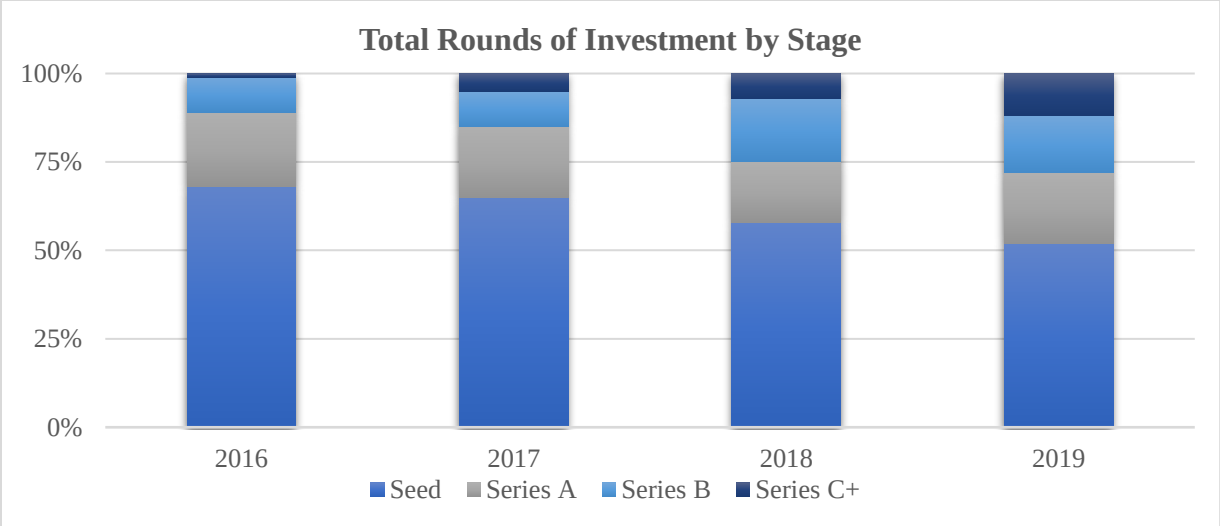
Space Industry Investment



Source: Bryce Space and Technology, 2019; Space Angels, 2019; Bryce Space and Technology, 2020



Source: Space Foundation, 2019e



Source: Space Angels, 2019

Space Industry Revenue

Global Space Industry Revenue by Sector			
Industry Sector	*Annual Revenue (in billions of dollars)*		
	2016	*2017*	*2018*
Satellite Services	$127.7	$128.7	$126.5
Satellite Manufacturing	$13.9	$15.5	$19.5
Launch Industry	$5.5	$4.6	$6.2
Ground Equipment	$113.4	$119.8	$125.2
Non-Satellite Industry	$84	$79.3	$82.5
Total Industry	**$344.5**	**$348**	**$360**

Source: SIA, 2017; SIA, 2018; SIA, 2019

Global Commercial Space Industry Revenue by Sector			
Industry Sector	*Annual Revenue (in billions of dollars)*		
	2016	*2017*	*2018*
Grounds Stations and Equipment	$118.75	$85.84	$92.47
Satellite Manufacturing (Commercial)	$4.83	$6.82	$5.28
Launch Industry (Commercial)	$2.05	$2.49	$1.49
Insurance Premiums	$0.63	$0.71	$0.46
Commercial Human Spaceflight (Deposits)	$0.01	$0.01	$0
Total Industry	**$126.26**	**$95.87**	**$99.69**

Source: Space Foundation, 2017; Space Foundation, 2018; Space Foundation, 2019b,c,d,e

Space Law and Regulation (selected list)

International Law and Regulation

- Outer Space Treaty (1967)—declared that outer space should only be used for peaceful purposes and for the interest of all mankind
- Astronaut Rescue and Return Agreement (1968)—agreement to return astronauts and objects launched into space from another country
- Liability Convention (1972)—holds the launching country liable for any damage caused by the vehicle
- Convention on Registration of Objects Launched into Outer Space (1975)—requires that all nations maintain a register of all objects launched into space
- Moon Treaty (1979)—agreement governing the activities of countries on the Moon (not ratified by any major space powers)

Source: UNCOPUOS, 2020

Domestic Law and Regulation

- National Aeronautics and Space Act (1958)—Established NASA
- Commercial Space Launch Act (1984)—Authority over commercial space launch given to the Department of Transportation
- Land Remote Sensing Policy Act (1992)—Established guidelines for the regulation of land remote sensing satellites with authority given to the Department of Commerce
- Commercial Space Act (1998)—Authority over spacecraft reentry given to the Department of Transportation
- National Space Policy (2010)—Significant shift towards the use of commercial space services
- National Space Transportation Policy (2013)—Government directed to use commercial space transportation services
- Commercial Space Launch Competitiveness Act (2015)—Property rights given to private citizens who extract resources from celestial bodies
- National Defense Authorization Act (2020)—Space Force created
- Executive Branch Policy Directives (not formally written into law)
    - Space Policy Directive 1—Directs NASA to return to the Moon with assistance from commercial partners
    - Space Policy Directive 2—Reform of commercial space activity regulation
    - Space Policy Directive 3—Established management of space situational awareness and space traffic

Source: Space Foundation, 2019e; Space Policy Online, 2019a; Space Policy Online, 2019b; FAA, 2020c; Office of Space Commerce, 2020

Appendix H

Space Industry Acronyms

AIA:	Aerospace Industries Association
CCDEV:	Crew Transportation Concepts and Technology Demonstration
CCiCAP:	Commercial Crew Integrated Capability
CCtCAP:	Commercial Crew Transportation Capability
CLPS:	Commercial Lunar Payload Services
COTS:	Commercial Orbital Transportation Services
CRS:	Commercial Resupply Services
DOC:	Department of Commerce
FAA:	Federal Aviation Administration
FAA/AST:	Federal Aviation Administration Office of Commercial Space Transportation
FCC:	Federal Communications Commission
HALO:	Habitation and Logistics Outpost
HLS:	Human Landing System
IRS:	Internal Revenue Service
ISS:	International Space Station
ITAR:	International Traffic in Arms Regulations
NASA:	National Aeronautics and Space Administration
NOAA:	National Oceanic and Atmospheric Administration
OSC:	Office of Space Commerce
PPE:	Power and Propulsion Element
PPP:	Public/Private Partnership
SIA:	Satellite Industry Association