Organizational ambidexterity: How space companies can balance exploitation and exploration to compete successfully in the launch business

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Summary

In the face of increasing competition in the space industry driven by companies such as SpaceX, organizational ambidexterity: the ability for space companies to manage both exploitation and exploration activities, is increasing vital for these companies to compete successfully. This research applies the concept of organizational ambidexterity to the space sector to explore the validity of organizational ambidexterity in space companies. First, the academic concepts and frameworks behind organizational ambidexterity are explored. Next, the space sector is analyzed empirically to identify key success factors vital to the success of space companies. Subsequently, the connections between the academic framework and empirical factors are drawn to propose an organizational ambidexterity model specific to the space industry. The proposed model is discussed and validated in the context of several case studies, especially that of SpaceX. Finally, we make recommendations for the use and future research of organizational ambidexterity models for the space sector.

Keywords: Organizational ambidexterity, Exploration, Exploitation, Space industry, Innovation management, Launch business

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1. Introduction

The ability for organizations to find the optimal balance between the leveraging of existing mature products or services to generate steady profits and the management of innovation to develop the next novel product or service to stay competitive in the market has always been a point of interest for all business organizations. To put it in other popular business management concepts and terms, how should an organization manage its product life cycles? How should companies distribute their efforts between milking cash cows and developing the next question marks into stars?

To answer this question, the concept of organizational ambidexterity was introduced. Organizational ambidexterity covers many research areas, but its goal is fundamentally to explore the strategies that successful organizations utilize to strike the balance between exploration and exploitation activities. A better understanding of the antecedents, outcomes, moderators and mediators of organizational ambidexterity will allow organizations to optimize their management strategies to deliver a competitive edge over companies that fail to organize themselves properly.

The study of organizational ambidexterity in the context of the space industry is particularly relevant and exciting. Recent business activities in the past decade spearheaded by new players such as SpaceX in the launch business have posed an unprecedented threat to their more mature counterparts. It is evident that mature players have been slow to react to their newfound competitors due to an excessive bias towards exploitation activities over exploration ones.

The central research question that drives this particular research is therefore: how should space companies apply organizational ambidexterity to deliver a competitive advantage in the launch business? This research attempts to explore the academic literature on organizational ambidexterity and the empirical research on space industry characteristics to propose a theoretical model which links the relevant dimensions of the academic framework to those of the empirical framework. The considerations put into and the validity of the proposed model are discussed in the context of select examples and case studies, most notably SpaceX. This research further puts forth recommendations for future research on the application of organizational ambidexterity in the context of the space industry.

Although this project focuses its analysis on the launch business, the implications of the research findings can be extended to companies in the general space business or to companies which share similar business characteristics to the space industry.

2. Academic framework

This section of the paper aims to explore, analyze and summarize existing academic frameworks applicable to the concept of organizational ambidexterity.

2.1 The concept of organizational ambidexterity

The origin of the term “organizational ambidexterity” can be traced back to Duncan (1976). Duncan employed the concept of ambidexterity in an organizational sense to describe how organizational structures were implemented to manage the conflicting trade-offs of alignment and adaptation. However, the basis of organizational ambidexterity can also be traced indirectly to other authors including March and Simon (1958), Burns and Stalker (1961), Woodward (1965) as well as Lawrence and Lorsch (1967). Burns and Stalker (1961) explored the effects of the opposing nature of stable and turbulent business environments on the structure of firm management systems, which they noted led to “mechanistic” and “organic” systems being developed respectively. Woodward (1965) and Lawrence and Lorsch (1967) discovered that organizational structure was closely related to strategic and environmental conditions. Tushman and O’Reilly (1996) further formalized this concept of organizational ambidexterity by defining ambidexterity as “the ability to simultaneously pursue both incremental and discontinuous innovation and change” (p. 24).

March (1991) generalized the concept of organizational ambidexterity by identifying the main underlying tension: the tension between exploitation and exploration activities. According to March, exploitation activities refer to activities such as “refinement, efficiency, selection and implementation”, whereas exploration activities refer to those such as “search, variation, experimentation and discovery” (p. 102). The ability of a firm to simultaneously exploit current profit-making positions and resources and explore new opportunities in upcoming technologies and markets is vital to her long-term sustainability. In his original words, “the basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, devote enough energy to exploration to ensure its future viability” (p. 105). This fundamental exploitation-exploration tension underpins the issues, trade-offs and paradoxes in the implementation of organizational ambidexterity in firms.

The first industrial revolution started in 1784 with mechanical production and steam power, with subsequent revolutions focusing on mass production (1870), automated production (1969) and big data and robotics (today). Mass production greatly changed the world by supplying people with great amount of goods, however, requirements from customers and markets have been becoming more and more complicated and unexpected, so business need to change to adapt to new environment.

It can be seen that when a company grows, it tends to become more complicated. According to Tushman and O’Reilly (1996), the paradox of success is that the growing of the company in terms of size, complexity and age (or experience) can lead to success in the current market but also makes it difficult for companies to change

themselves. Culture is one of the most difficult parts to change (Tushman and O'Reilly, 1996). The strong link between ambidexterity and business performance is confirmed by Gibson and Birkinshaw (2004).

Adaptability is the way to help a company react to changes in the environment and customer requirements (Campanella, et al., 2016; Zakrzewska-Bielawska, 2016). In markets with rapidly changing requirements, a company with a high level of adaptability and flexibility has more advantages and vice versa (Gibson and Birkinshaw, 2004). However, Gibson and Birkinshaw (2004) believe that a successful company requires not only adaptability (including ability of innovation) but also alignment e.g. ability to deliver the value of current assets such as technologies and knowledge of the company to customers.

Charitou and Markides (2003) suggest five ways for a company to react to "disruptive strategic innovation" of competitors: focusing on traditional business, ignoring the rise of new strategic innovation, creating newer alternatives to compete with new strategy, developing ambidexterity and adopting innovation. Noticeably, most companies in this research applied ambidexterity as the strategy to deal with their issues. Alpkan and Gemici (2016) also propose that ambidexterity enhances performances of companies and help deal with innovation from competitors.

In the most general way, ambidexterity is defined as the ability to exploit current resources and competencies as well as explore innovation and new challenges. When mentioning about ambidexterity, Gibson and Birkinshaw (2004) talk about the balance between alignment and adaptability. Alignment helps to exploit current resources to optimize operation and save activity costs, while adaptability enhances firm innovation.

According to Zakrzewska-Bielawska (2016), in order to adapt to changes in business environment, the structure of an organization must be flexible, less centralized and formalized, and horizontal. Similarly, Campanella, et al. (2016) mentioned about the requirement of flexibility as a company transforms into an ambidextrous organization.

Tushman and O'Reilly (1996) use terms such as "radical and incremental innovation" to describe ambidexterity. The term "reflexivity" is also used as the core competency to help individuals in ambidextrous organization deal with the unexpected (Campanella, et al., 2016). In markets with highly changing requirements, a company with a high level of adaptability and flexibility has more advantages and vice versa (Gibson and Birkinshaw, 2004). The change between the state of exploitation and the state of exploration in an organization can be "static or dynamic" (Zakrzewska-Bielawska, 2016). Static ambidexterity is "adopting certain configurations", but most research show that ambidexterity is based on dynamic characteristics – trigger events. In fact, many companies change their approaches or strategies based on changes in the environment.

The authors refer to an ambidextrous company as one able to operate in many different sectors or markets owing to her ability to adapt (Tushman and O'Reilly, 1996). In fact,

ambidexterity can be applied to many industries such as the banking sector (Campanella, et al., 2016; Gibson and Birkinshaw, 2004), marketing sector (Sarkees, et al., 2010) and the mobile devices industry (Gibson and Birkinshaw, 2004).

2.2 Types of ambidextrous organizations

As mentioned, an ambidextrous organization requires the characteristics of flexibility, decentralization and adaptability. However, an organization with a large size faces difficulty in changing from fixed operations to flexible processes, in adapting to customer requirements, and in implementing the process of decentralization. Therefore, most authors suggest two types of ambidexterity in an organization: structural and contextual ambidexterity (Gibson and Birkinshaw, 2004). While some authors analyze organizations which apply only one kind of ambidexterity, the idea of using both strategies in an organization is well supported (Gibson and Birkinshaw, 2004). Moreover, flexibility should not only be employed as a tactic to deal with changes from customers but should be built into the architecture of an organization to develop ambidexterity. This is illustrated by the parallel architecture and the switching between states of exploitation and exploration.

In the following sections, the definitions and characteristics of contextual and structural ambidexterity will be detailed.

2.2.1 Structural ambidexterity

Ambidexterity in an organization is the approach to enhance the business with both exploitation and exploration. Exploitation helps to optimize the whole operation and save costs, taking advantage of current assets and resources, while exploration helps to deal with changes in the markets and industries. However, when a company grows, its architecture becomes complex with many functions and departments. This issue can be compounded by tough market conditions in which various competitors, competing products and substitute products exist. It then becomes difficult to combine both exploration and exploitation into one unit. Further, the features of two the strategies are also different. Whereas exploiting current resources requires centralization in management, hierarchy, efficiency and responsibility (Raisch, 2008), exploration requires decentralization, flatter structures and flexibility. Hence, many authors suggest the use of structural ambidexterity in which an organization separates the business into two different parts. Gibson and Birkinshaw (2004) proposed an approach to build exploitation business units focusing on current products, technologies and markets, and exploration units focusing on research and development (R&D) or new strategy development. Raisch, et al. (2009) use the term “differentiation” to describe an organization in which departments responsible for exploration are separated from other departments, usually less focused and more decentralized, to ensure competitiveness to other opponents.

Chen and Kannan-Narasimhan (2015) emphasize the role of the manager and the strategy of the company in integrating innovation into business units. In other words,

authors view top managers as separate entities from these business units. Zakrzewska-Bielawska (2016) researched the relationship between organizational structure and strategy. Both factors impact the ambidexterity capability of an organization, but the research focus based on the CEO point of view places bias on the impact of organizational structure.

The distinguishing feature of structural ambidexterity is the separation of exploitation and exploration departments in an organization. Raisch (2008) analyzes European companies based on combination of strategies (Fig. 2). There are three models: temporal separation, parallel structure and structural separation.

In the first model, some departments or functions in a company change their internal processes from centralization to decentralization and vice versa, to adapt to the new environment. It helps the company explore its resources while exploiting current markets. In the second one, a company exploits current resources to explore new markets. All functions can be involved in innovation processes, in contrast to the first model. The structural separation enables companies to create new products or services to boost sales while current products or services are at the peak or mature stage in life cycle. The exploration units are given more power to control and make decisions by themselves (less hierarchy), creating a new value chain. Differing from other models, it explores new markets with different resources to core business functions (Raisch, 2008).

Enriching the “structural separation” model, Chen and Kannan-Narasimhan (2015) built a framework of integrating core business and a new venture as an ambidextrous organization, based on two questions: “who initiates new venture and when collaboration is solicited”. In the first type of integration, despite starting and growing projects by itself, the business unit invests in the innovation unit and both possess ownership over the final product. Compared to that in type one, the innovation unit in this second type is more active in selecting, starting and leading projects, but depends much more on resources of business units.

In the third type, the business unit only invests and involves itself in projects at the mature stage due to significant and visible benefits. However, the business unit and the innovation unit might not be in harmony in terms of culture, benefits or resources (Chen and Kannan-Narasimhan, 2015).

The drawback of structural ambidexterity is the isolation experienced when R&D does not align with the core value delivered to customers, as well as with core competencies (Gibson and Birkinshaw, 2004). Separating the business into two different functions of exploration and exploitation is the attempt to solve the issue of combining two different strategies into one unit. However, it is difficult for an organization, especially a large one, to operate both exploitation and exploration with separate functions (Tushman and O’Reilly, 1996).

2.2.2 Contextual ambidexterity

Contextual ambidexterity is an approach to build flexibility and adaptability in the face of specific contexts or events. This approach focuses on building an organization from the bottom-up, allowing individuals, teams or business units to react to customer requirements. Gibson and Birkinshaw (2004) support the idea of a single business unit which engages in both exploitation and exploration activities, instead of having two separate units taking on either of the two functions. This unit should be built on a set of systems, regulations and business contexts to allow each individual employee the flexibility to react to several contexts and variations from markets. Individuals can arrange their own tasks, manage their own time and make their own decisions in performing both exploitation and exploration activities (Gibson and Birkinshaw, 2004; Raisch, et al., 2009). Fiset and Dostaler (2013), Alpkan and Gemici (2016) believe that low-level employees in an ambidextrous company are able to boost the performance of the company in difficult contexts or to conduct innovation. In other words, ambidexterity in an organization can be built from the bottom-up. This outcome matches the suggestion of Tushman and O'Reilly (1996) about coherence in a company. Notably, Gibson and Birkinshaw (2004) define the "individual" as two different business units in an organization, two departments in a business unit, two teams in a department, or even two individuals in a team.

As seen, the contextual ambidexterity strategy is based on the flexibility and adaptability of the individual employee. Therefore, it is necessary to build decentralization which can in turn boost innovation and induce quick reaction to changes. However, this can be costly due to complicated structures and increases risks for investors (Raisch, 2008). In large organizations with many products in the market, organizations intend to adjust structure from centralization and complicated hierarchies to decentralization and self – autonomy (Tushman and O'Reilly, 1996). Charitou and Markides (2003) also mention about autonomy in new units: budgets, strategy, routine tasks and operations.

As the key of this strategy, an individual in such an organization should be supported to overcome safe zones (Gibson and Birkinshaw, 2004). Moreover, ambidexterity should be applied in a company simultaneously: same time, same place, same person, from the top to ground level employees, with appropriate structures (Alpkan and Gemici, 2016), and organizational structures and regulations to enable each employee to be flexible to the context (Raisch, et al., 2009).

The characteristics of individuals in an ambidextrous organization include independence, activity outside routine jobs, cooperation with other colleagues within and without business environments, multitasking to manage and handle different tasks, adaptability (Gibson and Birkinshaw, 2004), and flexibility (Campanella, et al., 2016).

However, increasing exploration in lower levels of an organizational structure can burden the overall exploration efficiency of the organization. In other words, decentralization can limit exploration, due to complex information flows in multi-level

organizations. In this case, information systems and data processing play an important role in enhancing the performance of exploration (Siggelkow and Rivkin, 2006).

The authors concentrate on finding decisive factors which help to build the team and improve team performance in reacting to changes in external environment, a typical case of contextual ambidexterity, based on the findings of Gibson and Birkinshaw (2004). Companies selected in this research had complicated supplier and partnership networks (Fiset and Dostaler, 2013).

There is a strong correlation among the three factors: ambidexterity, organization context (including management and social support) and performance, but only ambidexterity can used as an independent variable to predict performance. In other words, ambidexterity plays the role of mediator in the relationship between organization context and performance (Gibson and Birkinshaw, 2004).

2.3 Pathways to ambidexterity

Gibson and Birkinshaw (2004) believe that there is no definite key performance indicators used to enhance ambidexterity in an organization. However, there are several key points that organizations must consider. These include understanding organizational contexts, building consistency, focusing on key indicators, developing coherence, and combining both structural and contextual ambidexterity strategies. In contrast, Campanella, et al. (2016) propose the key exploitation indicators of procedural, controlling and structuring indicators, as well as the key exploration indicators of connecting, cultural, top management principles and R&D expense.

Chen and Kannan-Narasimhan (2015) promote the role of manager and strategy to build an ambidextrous company, while Alpkan and Gemici (2016) focus on organizational coherence in building a structure of ambidexterity from top manager to each executive. Building on the findings of Gibson and Birkinshaw (2004), Fiset and Dostaler (2013) concentrate on finding decisive factors which help to build a team and improve team performance in reacting to changes in external environment: a classic case of contextual ambidexterity.

Research from Gibson and Birkinshaw (2004) supports the idea of both functions exploration and exploitation in a company due to their relationship. In this case, it requires flexibility, alignment between organizational structure, environment (market requirements) and strategies when a company transforms to an ambidextrous organization (Campanella, et al., 2016).

Contextual ambidexterity matches the dynamic approach. However, structural ambidexterity in an organization with separate departments can also be dynamic if the departments responsible for exploration are able to adjust themselves to become more ambidextrous.

However, the way to ambidexterity is also difficult. First, culture is one of the most difficult parts to change. Tushman and O'Reilly (1996) believe that core cultures are used to make the whole organization coherent, but the variation of cultures (or local cultures) in each brand or small unit should be accepted. Second, the complicated structure of an organization together with the dependence among departments can make autonomy in low level management infeasible (Siggelkow and Rivkin, 2006). Last but not least, increasing autonomy at low level management can allow managers to adapt to changes in the environment and expose them to more information, but at the cost of limiting information to higher level managers (Siggelkow and Rivkin, 2006).

2.4 Theoretical frameworks

There are two frameworks discovered in this research, one proposed by Gibson and Birkinshaw in 2004 and the other by Raisch and Birkinshaw in 2008.

2.4.1 Gibson and Birkinshaw (2004) framework

Gibson and Birkinshaw (2004) propose the framework including four factors including stretch, discipline, support and trust (Fig. 3). This framework is based on work of Ghoshal and Bartlett (1994). The explanation of the four factors support, trust, discipline and stretch is described in the table below the framework (Fig. 4).

Gibson and Birkinshaw (2004) separate the organization context into four types: Country Club Context, burnout context, low and high-performance context which differ on two scales: social support (evaluated by factors of support and trust) and performance management (evaluated by factors of stretch and discipline). Due to interaction among these factors, a well-organized company cannot miss any factors.

2.4.2 Raisch and Birkinshaw (2008) framework

Based on the fundamental concepts of organizational ambidexterity, exploitation and exploration, numerous branches of research were conducted on the subject, which were concisely represented by Raisch and Birkinshaw (2008). The authors compiled previous research on organizational ambidexterity to form a complete and usable framework which considers the antecedents, outcomes, moderators and mediators of organizational ambidexterity (Fig. 5). The following sections will explore some of these theoretical concepts in reference to the framework.

a. Organizational ambidexterity

Organization learning is the ability to exploit current assets and knowledge to learn how to be innovative. The organizational structures are top-down knowledge flow which supports exploitation and bottom-up knowledge flow which supports exploration.

There are two types of technological innovation: "incremental and radical innovation". The first strategy is just the adjustment or small changes of the company dealing with

the changes of market or customer requirements, while the last one involves changing the business completely. The combination of exploration and exploitation can boost innovation efficiency to a higher level than separate innovation.

Organizational adaptation refers to the balance between exploration and exploitation. Problems can arise from excessive changes made to a business. The top management plays an important role in radical innovation while the middle management is more responsible for incremental innovation.

Strategic management concerns the choice between exploitation and exploration strategies. While the former decreases the number of variations, the latter increases variation. This choice is reflected by the strategy and scope of the company in the trade-off between creating new competences and focusing on current strength.

Organizational design is the term to describe the organizational structure of a business in supporting exploitation and/or exploration e.g. parallel structures, structural separation and contextual ambidexterity structure.

b. Organizational antecedents

The antecedents of organizational ambidexterity refer to the theoretical factors that serve as the precursors of organizational ambidexterity. The three main antecedents identified include structural, contextual and leadership-based antecedents.

Structural solutions to organizational ambidexterity involve the use of different structural configurations within an organization to cater to exploitation and exploration activities separately. Building on the idea of “dual structures” from Duncan (1976), Gibson and Birkinshaw (2004) proposed the development of “structural mechanisms to cope with the competing demands faced by the organization for alignment and adaptability, and Gupta et al. (2006) suggested that differentiated efforts be put in place to focus on either exploitative or exploratory activities.

Proponents of spatial separation argue that the tensions between exploitation and exploration activities cannot be reconciled, thus there is a need to separate the organization into multiple business units, or to partition tasks within a single business unit. Drucker (1985) and Galbraith (1982) proposed the “hiving off” of new businesses in a separate unit, while Tushman and O’Reilly (1996) suggested the creation of autonomous business units. Burns and Stalker (1961), as well as Lawrence and Lorsch (1967) noted that the disadvantage lies in the burden of coordinating multiple business units or groups within the same organization.

In contrast to spatial separation, temporal separation involves the use of parallel structures to allow the same unit to work sequentially on exploitation and exploration activities (McDonough and Leifer, 1983; Adler et al., 1999). The separation of the business unit over time rather than space allows for a single unit to fulfil both

exploitation and exploratory requirements but requires managers to exercise judgment to divide the work over competing needs.

Leadership-based antecedents focus on the role of senior executives and top managers in delivering ambidexterity to the organization. Leadership can be understood as either complementary to or independent from structural and contextual antecedents. The composition of leadership teams able to deliver an optimal mix of exploitation and exploration is another interesting focus for leadership-based ambidexterity research.

c. Outcomes

Following the research of Raisch and Birkinshaw (2008) on other papers, ambidexterity is the key to boost the performance of a company, and due to the lack of empirical tests, ambidexterity enhances the outcomes in whole company level and also business unit level. Moreover, the success of a company should be secured to be sustainable. The authors suggest analyzing the outcome based on key performance indicators as accounting, market, growth.

d. Environmental factors

Environment is the moderator on the interaction between ambidexterity and performance (outcome), and on the interaction between ambidexterity and antecedents, and its impact on ambidexterity. Levels of competitiveness and dynamism are important boundaries for companies in seeking ambidexterity.

e. Moderators

The first considerable moderator that authors propose is market orientation, which concerns the role of customers in a company's decision on product design and the outcome of its business. Without this factor, the performance of new product sales can be impacted. The second factor is resource endowment. A company with sufficient resources such as finance and knowledge should be more advantaged in building and managing a complicated structure of ambidexterity. Last but not least, firm scope or size of firm is the decisive factor in the strategy to build ambidexterity: small companies with a flatter hierarchy and greater flexibility can build leadership-based ambidexterity, while large companies are favored to build structural ambidexterity.

3. Empirical framework

This section aims to introduce the state of the space industry and analyze the external and internal key success factors required for space companies to succeed in the market environment. Some emphasis will be placed on the launch industry to lay the foundation for the discussion of case studies in the launch sector.

3.1 Overview of the space industry

The space industry is largely dominated by the satellite industry. As of year 2016, the satellite industry makes up 77% of the space economy, with the remainder 23% consists of the non-satellite industry (Bryce, 2017). The global space economy is valued at 344.5 billion USD for the year 2016, showing a 1% growth in revenues over 2015. Comparing the satellite portion of the space industry to the overall space economy, there has been faster growth in the former at 2% growth rate.

The satellite industry is made up of four main categories: satellite services, ground equipment, satellite manufacturing and the launch industry. In 2016, the satellite industry posted revenues of 260.5 billion USD, with satellite services and ground equipment leading at 127.7 billion USD and 113.4 billion USD respectively. Satellite manufacturing came in third at 13.9 billion USD and the launch industry was last at 5.5 billion USD (Fig. 6). Satellite services can be further split into consumer services, fixed satellite services, mobile satellite services and Earth observation services. The ground equipment sector consists of network equipment and consumer equipment.

The launch industry has remained relatively stable in terms of overall revenue from the period of 2012 to 2016, averaging 5.6 billion USD. From 2016 to 2017, however, a fall in revenues of up to 16% were observed in the launch industry despite a similar number of launches. This signals a trend in which customers prefer less expensive launch vehicle types and providers. Spearheading this change is the maturing of companies such as SpaceX, which bring ever greater levels of competition into the market.

3.2 Key success factors for space companies

In the face of what seems to be increasing competition from private companies, it is prudent to review the external and internal key success factors required for space companies to compete effectively in the market environment. We examined the external market environment with a Porter's five forces framework and identified competitive rivalry and the threat of new entrants as the main areas of relevance. The increasing competition is driven by new technological innovation and the introduction of new practices into the space industry. However, the presence of high barriers to entry such as the funding of exorbitant space R&D costs, access to military and national markets, as well as the strict legal and regulatory framework continue to favor mature space companies. Looking inwards, we identify company culture and structure as having a significant impact on the outlook and performance of space companies. The contrast in the company culture between traditional space companies originating from national

space programs and new players which are mainly privately funded appears to have significant impact on organizational innovation.

3.2.1 Competitive rivalry

Traditionally, space companies were founded based on national interests to develop the capability to conduct space launches and other space activities. For instance, Arianespace was founded in 1980 by the National Centre for Space Studies (CNES) and the European Space Agency (ESA) to support the Ariane launch vehicle program aimed at developing the capability to send commercial satellites into geostationary orbit (Harvey, 2003). Up until 2014, few countries possess the technology and facilities to carry out orbital space launches or to maintain a fleet of operational launchers (OECD, 2014). These included the United States, Russian Federation, China, Japan, India, Israel, Iran and Korea, as well as the ESA.

Since most institutional satellites are launched by national launchers, the market for commercial launchers remains small. In 2014, there were six companies capable of commercial launches of satellites to geostationary orbit (GEO). These included the European Arianespace company with the Ariane 5 launcher, the Russian Federation's International Launch Services with the Proton launcher, the United States' Lockheed Martin with the Atlas V and Boeing with the Delta launchers, China Great Wall with the Long March launchers and the Sea Launch international consortium formed by Norway, Russian Federation, Ukraine and United States (OECD, 2014).

In recent years, however, the launch market has seen notable competition from private spaceflight companies such as Blue Origin and SpaceX. The latter has significantly shaken up the market by promising to cut launch prices by up to a factor of 10. SpaceX plans to achieve this drastic level of cost reduction mainly through technological innovation and the introduction of best practices from other industries. In terms of technological innovation, SpaceX was the first commercial launcher to implement reusable launchers, in direct contrast to the competition which uses expendable rockets (Simberg, 2012). SpaceX attracts customers to its reusable launching solutions by providing up to a 10% discount for launch missions that utilize their reusable launchers (Selding, 2016). This particular reusable launching technology appears to be more radical than incremental, with major competitors such as Arianespace unable to answer the offer with similar technologies.

Adding to the reusable launcher technology is the innovation in industrial qualification procedures, vertical industrial processes and mass production (OECD, 2014). In an industry where safety, quality and reliability are emphasized strongly, the trade-off between laborious verification procedures and timely cost-effective production systems appears to be insurmountable. However, SpaceX tries to overcome some of these regulatory barriers to increase production efficiency. These efforts will be covered in later sections. The use of vertical industrial processes is also different from the overall industry, which favors a horizontal supply chain in which parts are outsourced and produced in many different countries. The fact that more than 70% of each SpaceX

launch vehicle is produced in a single factory may lead to very different dynamics in terms of production lead times and costs. Finally, best practices from the automobile industry are imported into the manufacturing of launch vehicles to achieve a high volume and low-cost production system. SpaceX is configuring its factories to produce up to 40 rocket cores annually in a single factory and targeting to provide space launch services for around 60 million USD: a price much lower than existing competitors (OECD, 2014). These low costs coupled with the recent advances in GEO launch capabilities showcased by the Falcon 9 and planned for Falcon Heavy have placed strong pressure on the competition to provide equally cost-effective launch solutions.

3.2.2 Threat of new entrants

The development of space technologies requires significant funding, which serves as a huge deterrent for new players looking to enter the market. In the space sector, one huge obstacle for product commercialization is the Technological Readiness Level (TRL) requirements (OECD, 2016). In order to advance a particular technology from a functional prototype to actual space demonstration, space companies must advance from TRL 5 to TRL 6, a phase known as the “valley of death” (Fig. 7). According to Mankins (2009), the cost of crossing this valley of death is generally about four times costlier than the accumulated R&D costs required to bring the technology to TRL 5.

Recent years has seen increased private funding in space companies, contributing to advancements in space technologies. Whereas the focus of public funding has generally been to enable national capabilities to conduct space programs, private investors from non-space sectors such as information technology are interested in lowering costs (OECD, 2016). Some private funding efforts for space innovation include SpaceX with its innovation in the Falcon 9 and Falcon Heavy launchers with reusable technologies for first stage engines, and Blue Origin with its development of the reusable BE-4 engine and reusable New Shepard suborbital manned rocket (OECD, 2016). The overarching trend of private funding for the development of space technologies such as CubeSats, additive manufacturing and reusability of space systems signal the cost-consciousness inherent in commercial markets.

The access to military and national markets serves as yet another barrier to new entrants. Even though the commercial market is sizeable, there are two main concerns to the demand presented by commercial markets. The first lies in the capricious choice of space service providers by commercial customers. Military and national customers tend to choose their providers based on security concerns. This would mean that space companies which are based in the customer’s country will be favored over the long run. For instance, the United States would prefer to purchase from Lockheed Martin and Europe from Arianespace. Commercial customers, on the other hand, have fewer considerations in this regard and tend to choose their providers according to price. The gradual erosion of market share from traditional launchers to SpaceX in recent years is a reminder to the unreliable nature of commercial demand.

The second is that for certain commercial space operations, the size of military and national markets trump the size of their commercial counterparts. This is especially true in the commercial launch industry. According to a 2018 report by the Federal Aviation Administration (FAA), the United States government budget for space activities amounts to 47.5 billion USD, dwarfing the 5.5 billion USD launch services market. Securing contracts with military and national customers go a long way in securing funding and cash flow for commercial operations of these space companies.

3.2.3 Internal factors

Internal factors such as company structure and culture are also vital to the performance of space companies. These factors contribute to the balance of exploitation and exploration activities, which in turn impact the final performance of the company. Innovation management, for instance, is closely connected to company structure and culture. Larger and more mature companies generally employ greater levels of hierarchy and bureaucracy in their corporate structures. Typically, these companies would derive their innovation organically from R&D projects through a process in which managers have to justify the required resources for the projects. For example, a cost-benefit analysis could be presented to convince upper management to provide funding and manpower for the proposed innovation projects. However, these approaches tend to encourage incremental innovation, since the short-term benefits can be justified more easily. However, space innovation in recent years on reusable and low-cost launchers are more radical. This calls for a different approach to innovation management.

One common strategy that mature space companies employ is merger and acquisitions (M&A) of start-up companies which have made the requisite technological advancements in the field of interest. For instance, Boeing acquired Digital Alloys in 2018 to obtain the technological capability for high-speed, multi-metal additive manufacturing systems for the production of 3D-printed aerospace parts (Boeing, 2018). Airbus has also set up their Airbus Bizlab accelerator program to attract promising startups to contribute ideas and technologies for aerospace applications (Airbus, 2018). This M&A strategy makes sense for large mature space companies due to their reputation, financial wealth, and emphasis on short-term benefits and minimal changes to existing structure and culture of the main organization.

However, it remains obvious that radical innovations in the space sector are not originating from traditional space companies. Newer entrants such as SpaceX have the opportunity to operate with a completely different structure and culture, which could have contributed to this phenomenon. These private companies do not originate from national organizations serving military and national markets. Thus, they are able to configure their corporate structure to be much flatter and less bureaucratic compared to their mature competitors. Moreover, the effect of leadership is much more pronounced in these new entrants, with founders such as Elon Musk of SpaceX and Jeff Bezos of Blue Origin being much more recognized and influential compared to their counterparts in mature companies. This leadership impact can drive a different company culture to produce corporate performance unique to these new companies.

4. Proposed model and discussion

The framework proposed by Gibson and Birkinshaw (2004) is more appropriate to analyze the internal factors in an organization, while the second one proposed by Raisch and Birkinshaw (2008) is wider with external environmental factors. Therefore, the second one is used in this research. Drawing connections between the chosen academic framework and the empirical factors contributing to the success of space companies, we propose that a modified Raisch and Birkinshaw framework (Fig. 1) would be most suited to the specific characteristics of companies competing in the space sector.

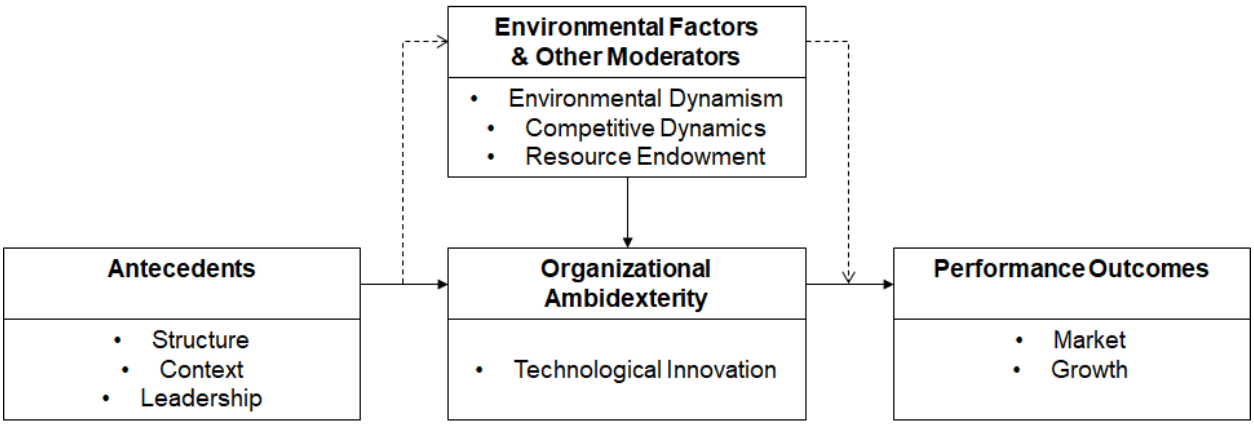


Figure 1: Modified Raisch and Birkinshaw (2008) framework for the space industry

We will discuss some of the considerations and main characteristics of the proposed model based on examples from the launch industry, with a special focus on SpaceX as an example of what we consider to be an ambidextrous organization.

4.1 Organizational antecedents

The structure of an organization is an important factor in the framework of ambidexterity when this is listed in both sections: organizational antecedents and organizational ambidexterity. If the factor in the antecedents section is related to the current structure and passive to changes in environment, the other is the active change from the inside of the organization.

An ambidextrous organization has many ways to implement both exploitation and exploration. Some choose to merge with or acquire research companies or startups at different stages of project development to boost exploration activities and innovation for its business. This is the case of companies such as Boeing or Airbus, as discussed previously. However, in the case of SpaceX, the fast-growing space company, the M&A activities are not so transparent. In 2017, the most significant acquisition was the satellite facility in Redmond, which SpaceX used as an R&D lab and from which she

recruited employees to utilize innovation (McIntosh, 2017). Recently, some predictions of merger between SpaceX and Tesla, an automobile company managed by the founder of SpaceX, were discussed in media, but they have not been proven true to date. However, the transmission of techniques and technologies from Tesla to SpaceX, and the link between both companies are proven. For example, Tesla provided a dummy payload for SpaceX's test flight in 2018 (Mosher, 2018).

Regarding organizational structure, SpaceX has not openly revealed information, but many people believe that it has a flat structure (Maddamsetty, 2016), recruits self-driven employees and encourages teamwork and trust (Quora, 2017). Employees arrange their own performance and pace (Cofield, 2016), and have the right to make their own decisions (Maddamsetty, 2016). However, the organizational structure of Tesla – characterized by function-based hierarchy and centralization (Meyer, 2018) - should be considered because of the close link between Tesla and SpaceX. Therefore, further research of the SpaceX organizational structure is expected.

As can be seen from the last section, there is the shift in space industry from high cost to low cost, and from military and national focus to commercial purposes. In this context, SpaceX is a market leader. The requirement in this case is the combination of exploration (which is always highly demanded in this field) and exploitation (which makes private space companies competitive). From the perspective of supply chain structure, SpaceX completes 70% of projects in-house (Jorge, 2015). This helps to exploit resources to reduce cost.

Another factor which boosted the success of SpaceX is the role of Elon Musk, whose exceptional leadership skills were proved. As the founder of SpaceX, he always sets high standards and eagerly deals with change (Lahey, n.d.). The latter is very important in building ambidexterity: Elon Musk dares to change to meet expectations. Moreover, the introduction of Elon Musk in the official SpaceX website shows his vision: "…SpaceX is the first commercial provider to launch and recover a spacecraft from orbit, attach a commercial spacecraft to the ISS ... By pioneering the development of fully and rapidly reusable rockets and spacecraft, SpaceX is dramatically reducing the cost of access to space, the first step in making life on Mars a reality in our lifetime…". Doing something that no one has done before, Elon Musk is the leader at exploration.

4.2 Organizational ambidexterity

Technology is usually the key resource to boost the performance and development of an organization. In an ambidextrous organization, exploring and exploiting technology determine strategy, especially in the space industry. As mentioned in the literature review, there are two types of technological innovation: incremental and radical innovation. SpaceX can be considered as the leader in space industry with radical innovation. It has been the first to achieve many accomplishments: first privately developed liquid fuel rocket to enter Earth orbit (2008), to deliver a commercial satellite to Earth orbit (2009), to reenter and recover a spacecraft and cargo from orbit (2010) (SpaceX, 2011), to offer a personal tour in space in 2023 (SpaceX, 2018), and to deliver

a human to Mars (Mosher, 2018). These achievements should be accounted to Elon Musk when he made exceptional targets for his business. Besides that, we believe that SpaceX is good at exploitation. One of the remarkable benefits of exploitation is cost reduction, and SpaceX is working well on cost: it offers lowest cost to orbit (SpaceX, 2011). Hence, technological innovation is the strategy helping SpaceX to develop fast in the industry.

4.3 Performance outcomes

With regards to performance outcomes, we have decided to keep market and growth as the two most relevant factors out of the original three factors of accounting, market and growth. Performance outcomes represent most objectively in the framework the benefits of achieving a good balance between exploitation and exploration. Although a good corporate strategy may not always lead to a good outcome, we argue that in the long run, organizational ambidexterity will lead to an accumulation of benefits which will be reflected in performance outcomes of the company.

Out of the three factors of accounting, market and growth, accounting is by far the most subjective performance indicator: skillful accounting techniques can paint an over-optimistic picture of the financial health of a company. Furthermore, the space industry is dominated by companies which are less than transparent in their accounts. In contrast to companies in industries such as the Fast-Moving Consumer Goods sector, space companies generally do not provide timely periodic updates of their financial reports. For example, a quick search on the internet for the 2017 annual reports of SpaceX and Arianespace, two of the launch market leaders, yielded negative results. The private or national nature of these companies hinders the objective evaluation of company performances by means of accounting data.

The market and growth performances are much easier to analyze in comparison to accounting. Global and regional market data such as revenues of various classes of space activities are well reported in publications such as those by Bryce (Fig. 6) and the FAA (Fig. 8). These sources are reputable and can be cross-checked for verification. Zooming in on the market share and general growth trends of specific companies, the data is also readily available. Taking the launch industry as an example, the official figures can be gathered from a variety of sources. For instance, there were a total of 90 orbital launches conducted in 2017 by the United States, Russia, Europe, China, Japan, India and New Zealand (FAA, 2018). Of these 90 launches, 33 of them were commercial, while the remaining 57 were non-commercial. 22 launches were conducted by the United States, amounting to revenue of about 1.731 billion USD. Out of these 22 launches, 17 of them were conducted using the Falcon 9 FT vehicle by SpaceX (FAA, 2018).

With this granularity of official data available, market and growth performance data can be readily and objectively evaluated. We can see that SpaceX has done an admirable job of securing up to 51.5% market share in terms of the number of commercial launches conducted in 2017 since it was founded in 2002. Projections for the total

market and market shares of each company can also be made based on the number of contracted launches. There are 7 contracted launches in 2019, one Iridium NEXT satellite to be launched by Falcon 9 and 3 OneWeb Satellites to be launched by Soyuz rockets (FAA, 2018). The evaluation gleaned from these figures provides objective evidence as to whether organizational ambidexterity is present in the company, and to what extent, assuming that the correlation or cause-effect relation between organizational ambidexterity and performance outcomes hold. Our preliminary evaluation of SpaceX, for example, is that her performance outcomes based on market and growth indicators are very positive, signaling a high degree of organizational ambidexterity present in the company.

Certain limitations to using performance outcomes as a measure of organizational ambidexterity do exist. Take for example the suspicion by Alain Charmeau, chief executive of ArianeGroup, that the true cost structure of Space is deliberately held as a secret to allow SpaceX to artificially drive down launch prices (Berger, 2018). Organizational ambidexterity, in our opinion, affects performance outcomes in a more operational way (such as cost-effectiveness of operations and breakthroughs in innovation) rather than in the strategic sense e.g pricing strategies. This would mean that performance indicators need to be filtered through critical lenses to identify if these outcomes were the result of organizational ambidexterity and not other factors.

4.4 Environmental factors and other moderators

Raisch and Birkinshaw (2008) focused on a total of five moderators for organizational ambidexterity: environmental dynamism and competitive dynamics (under environmental factors), market orientation, resource endowment and firm scope (under other moderators). Out of these five moderators, we deem three of them: environmental dynamism, competitive dynamics and resource endowment as being the most significant.

As analyzed in the empirical framework section of the paper, the external market factors of competitive rivalry and threat of new entrants are most pronounced in the space market environment. More specifically, technological innovation, the introduction of new practices, funding of space R&D, access to military and national markets, and the strict legal and regulatory framework have the greatest potential to moderate the effects of organizational ambidexterity. To illustrate, a space company might be able to achieve organizational ambidexterity and achieve a perfect balance in terms of exploitation and exploration activities. However, should the company fail to acquire necessary sources of funding for R&D activities, the company could eventually lose out to competitors which fail to achieve organizational ambidexterity, but which are adequately funded by national organizations.

The market factors identified in the empirical framework are closely related to environmental dynamism (barriers to entry in the form of access to military and national markets, as well as strict legal and regulatory framework), competitive dynamics (competitive rivalry in the form of technological innovation and the introduction of new

practices) and resource endowment (funding of space R&D). The connections to market orientation and firm scope are judged to be weak at best. Out of the two, firm scope appears to be a promising moderator since it could be generalized that larger firms are more suited to structural ambidexterity and smaller firms to contextual ambidexterity. However, recent entrants in the space market such as SpaceX in the launch sector have contradicted the generalization in that contextual and leadership-based ambidexterity continue to be observed in the company despite the growing size of the organization.

An interesting observation can be made about the nature of the moderators. Although all the three moderators identified appear to be dependent factors which the company is unable to control (external market characteristics or size of the company), an organization can change the way it interacts with these moderators. Zapata (2017) performed a comparison between the predicted development costs for the Falcon 9 under the NASA Commercial Orbital Transportation Services (COTS) program if it were done by NASA herself at between 1.7 billion USD and 4.0 billion USD, and the actual development costs reported by SpaceX at 390 million USD. The difference in the development costs up to a factor of 10 was attributed partly to the innovative development process utilized by SpaceX under a non-typical public-private partnership. This illustrates the possibility for space companies to explore novel methods of interacting with the moderators in the framework to deliver the positive outcomes promised by organizational ambidexterity.

5. Conclusion and recommendations

In this research, organizational ambidexterity was explored to understand the types of organizational ambidexterity and how an organization can build ambidexterity. Based on the theoretical framework proposed by Raisch and Birkinshaw (2008), and our empirical framework which focuses on key success factors in the space industry, a framework specific to the space industry was suggested. A significant amount of data and information about SpaceX and other companies from academic and media sources were used to analyze the proposed framework, and we can see links between the framework and ambidexterity in the launch industry.

This research utilizes a framework based on the trends in academic research of ambidexterity in various industries. During the application of the framework to the space industry in general and to the launch industry in particular, we found difficulties in collecting data and information, even when we focused on SpaceX (a well-known organization), so some media information was used. Therefore, it is highly recommended to conduct deep research on a specific case to understand how ambidexterity is implemented in this industry. First-hand information such as visits to space companies, surveys of company structure and culture, as well as interviews of management and employees would be valuable in validating the framework.

Although this framework includes various factors ranging from antecedents, internal characteristics and structures, to environment and outcomes, there is a lack of clear and strong interrelation among factors. It can be said that every factor can influence the performance outcome factors of market and growth. However, the relationship, for instance, between the firm scope factor (other moderators) and the organizational learning factor (organizational ambidexterity) is not verified in the industry. This is also the limit of this research. For further research, we hope that these relationships can be validated through both qualitative and quantitative tests.

Last but not least, the large number of factors in this framework makes it difficult to use. It is not wise to analyze all factors, and therefore we decided to use empirical research to sort the factors to produce a more practical framework.

List of Tables and figures

Appendices

Table 1. Three Types of Balanced Design Solutions

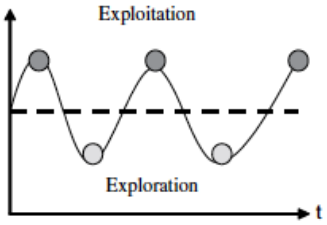
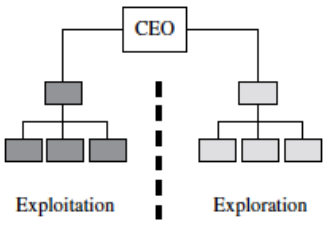
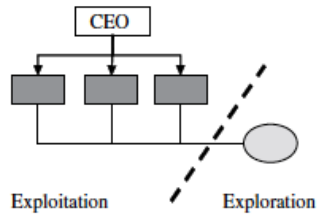
Category	Description	Related Theoretical Concepts
Temporal Separation 	■ Organizations change back and forth between different corporate structures. ■ Decentralization is used to ignite innovation and change; centralization to increase coordination and efficiency. ■ Exploitation and exploration are emphasized *sequentially* rather than simultaneously.	■ Cycling (e.g., Cummings, 1995; Eccles & Nohria, 1992) ■ Sequencing (Siggelkow & Levinthal, 2003) ■ Vacillation (Nickerson & Zenger, 2002)
Structural Separation 	■ Organizations are divided into two (or more) separate units with different structures. ■ Flexible 'innovative units' explore new areas for growth; more formal 'operational units' ensure efficient operations in the existing business. ■ Exploitation and exploration are addressed by *different* employees and organizational units.	■ Ambidextrous organization (e.g., Duncan, 1976; O'Reilly & Tushman, 2004; Tushman & O'Reilly, 1997) ■ Plural form (Bradach, 1997) ■ Loosely coupled organization (Christensen, 1998; Levinthal, 1997)
Parallel Structures 	■ Organizations create supplemental network structures to complement the formal primary structure. ■ Employees switch between the two types of structures depending on their respective tasks. ■ Exploitation and exploration are addressed by the *same* employees, but in *different* structural environments.	■ Collateral organization (Zand, 1974) ■ Dualistic structures (Goldstein, 1985) ■ Hypertext organization (Nonaka & Takeuchi, 1995) ■ Parallel learning structures (Bushe & Shani, 1991; McDonough & Leifer, 1983; Stein & Kanter, 1980)

Figure 2: Three types of structural ambidexterity (Raisch, 2008)

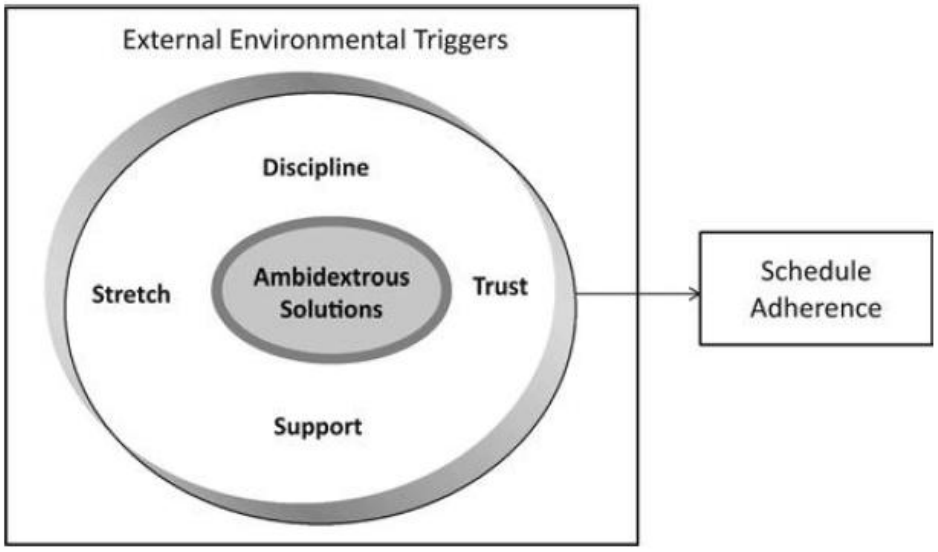


Figure 3: Theoretical framework (Fiset and Dostaler, 2013)

Discipline: meeting goals of organizations	● Clear performance standards: standards and benchmarks – basement for evaluation and avoid difference in personal points of view or personal standards. ● Fast cycle feedback: tom keep track and ensure the performance of business unit. ● Consistent sanction: “no excuse” for low level performance
Stretch: overcome the boundary, expectation to achieve higher standards.	● Shared information: ● Collective identity: “find own way to do things together” in a separated structure organization. ● Personal Meaning: each individual in an organization understand his tasks and overall context so they can contribute more for the final outcomes. This is establishment for breakthrough but ensure the alignment in company.
Trust: Trust in commitment of other colleagues	● Fairness ● Equity
Support: allow to borrow and exploit resource from other departments or division, including exchange information and technology.	● Guidance and help

Figure 4: Description of factors for theoretical framework

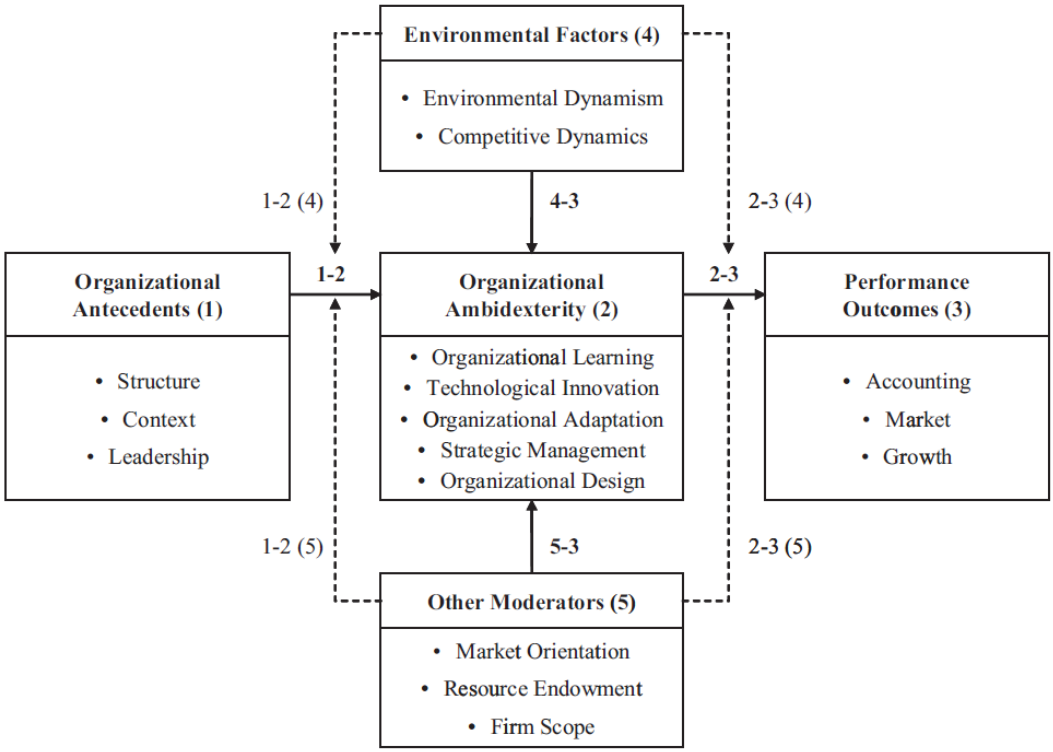


Figure 5: A framework for understanding organizational ambidexterity research (Raisch and Birkinshaw, 2008)

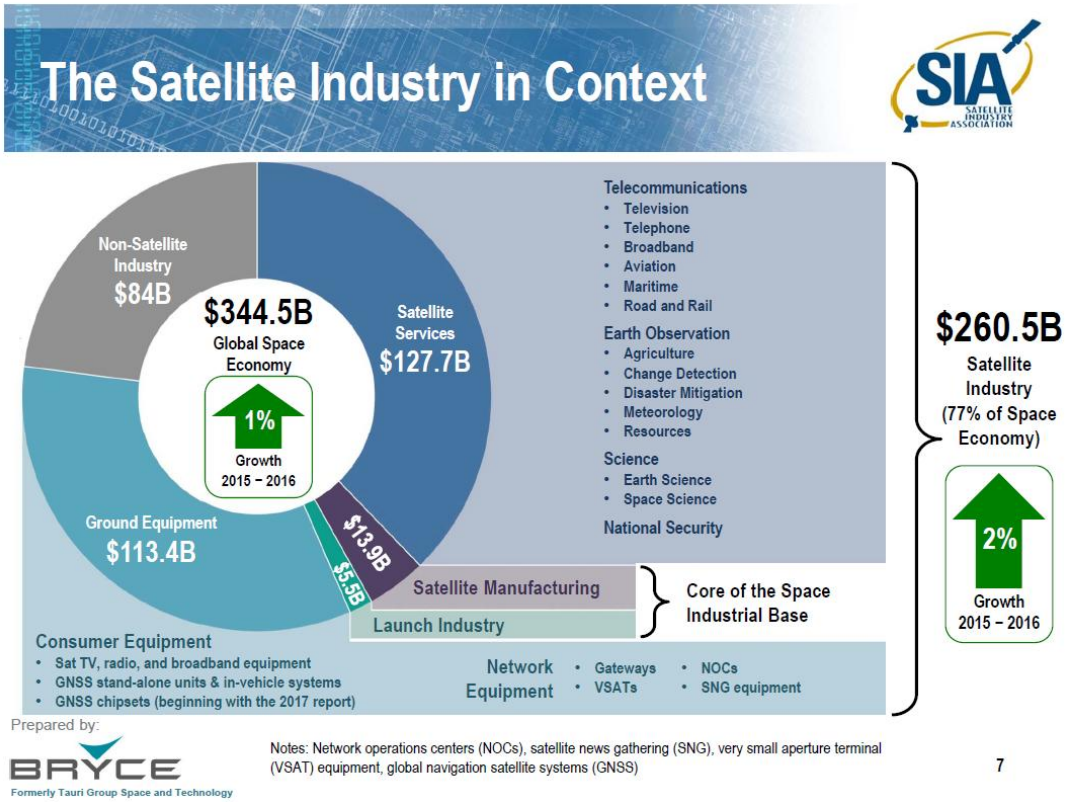


Figure 6: Snapshot of the space industry for the year of 2016 (Bryce, 2017)

Figure 1.1. **Simplified overview of technology readiness levels with funding and R&D actors**

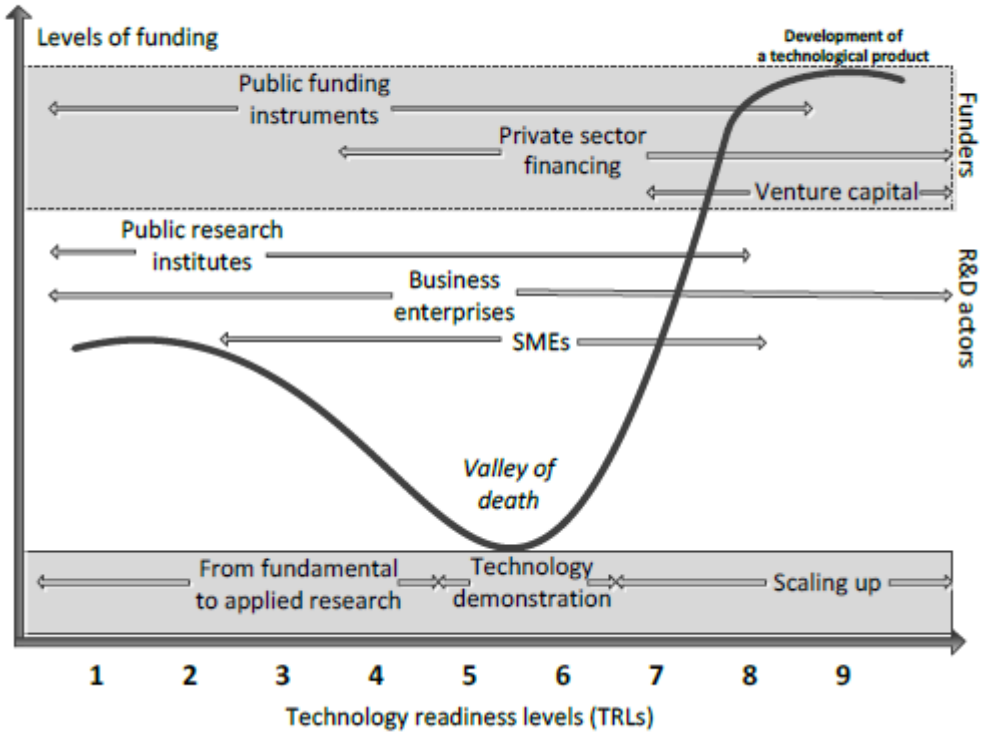


Figure 7: Valley of death in TRL advancement for space technologies (Mankins, 2009)

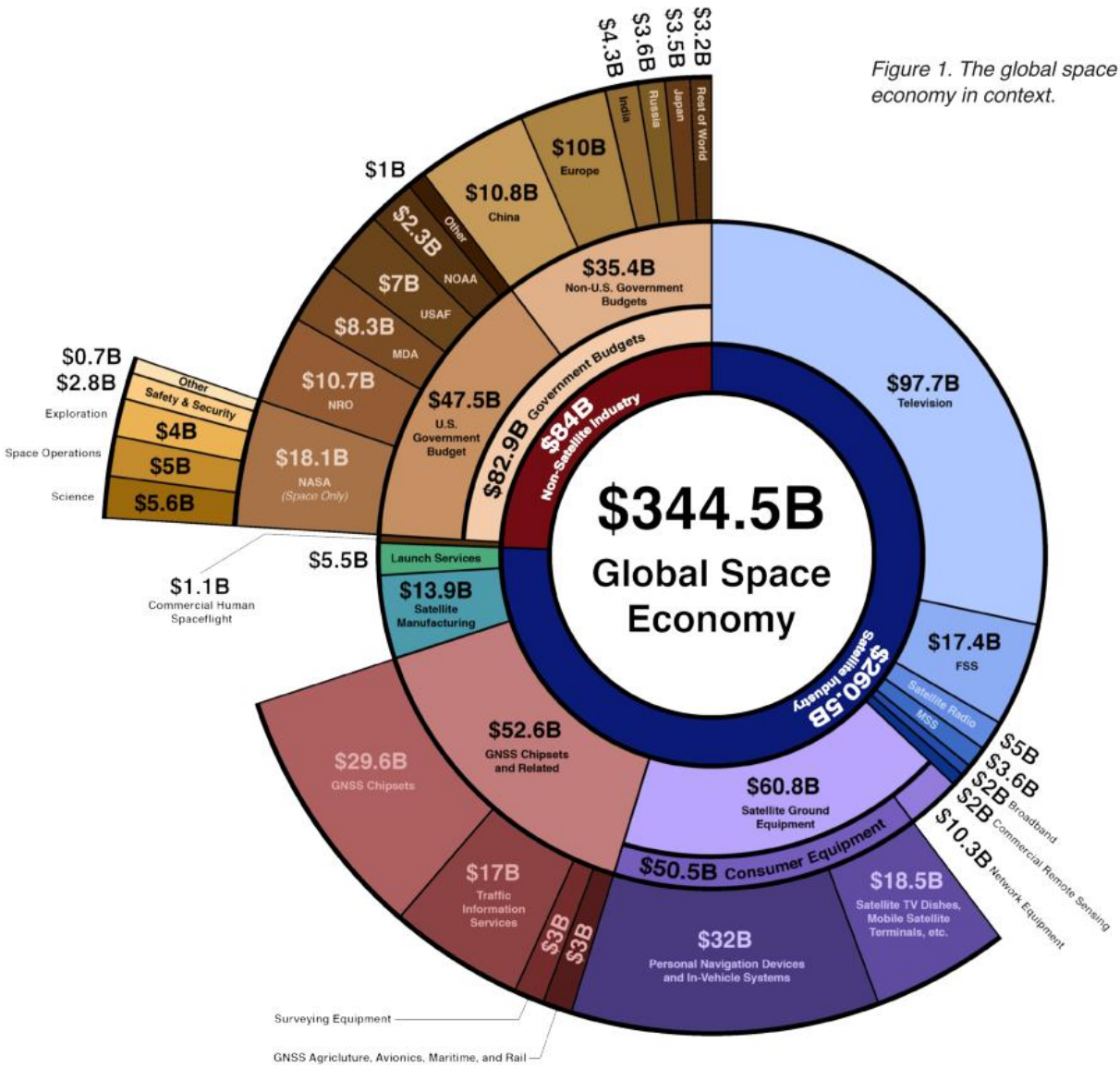


Fig. 8: The global space economy in context (FAA, 2018)

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