Political, Economic and Legal Considerations for Developing Space Nations

Republic of Croatia

International Space University
Masters of Space Studies Program 2021

Prof. Gongling Sun

May Li Uy
Evan Cook
Cato Meaker
Evan Slattery
Graham Kulig
Thomas Chrétien
Harshitha S Chavan

Abstract

Despite only having a state sponsored space agency by name, the future of Croatia's space endeavors has an enormous amount of interdisciplinary potential. Since the country's establishment as an independent country in 1991, Croatia has fast tracked its way into European prominence. With a legal focus on internationalisation, education, and STEM related research, Croatia has generated momentum when the Adriatic Aerospace Association (A3) was established, negotiating its way into the European Union (EU), and drawing up plans for its first observational satellite, PERUN-1. Croatia faces many hurdles on its way to establishing a strong space program however. As a country that relies on tourism for capital, the effects of COVID-19 and a recent earthquake have hindered Croatia's efforts. Generally speaking, Croatia's unemployment rate continues to drop each year, as their PPP grows more stable. It is worth noting that despite lagging behind other world powers in space activities, Croatia stands to gain the most by learning from the mistakes of established organisations such as NASA and Roscosmos, and with an early investment in space technology.

This report details recommendations such as an emphasis on privatisation, state funded research partnerships, and international cooperation as methods Croatia may use to achieve their goals. Croatia may be a lesser known Adriatic country, but with the advent of many international's partnerships, a focus on interdisciplinary education, privatisation, and a willingness to adapt as they go, Croatia may cement itself as a formidable space power.

Abbreviations

A3	Adriatic Aerospace Association
CSA	Croatian Space Agency
DHMZ	Meteorological and Hydrological Service
EBRD	European Bank for Reconstruction and Development
ESA	European Space Agency
EU	European Union
GDP	Gross Domestic Profit
GNSS	Global Navigation Satellite Systems
HAZU	Croatian Academy of Sciences and Arts
ICT	Information and Communication Technologies
MSES	Ministry of Science, Education and Sports
NASA	National Aeronautics and Space Administration
OS	Operating System
OSCE	Organisation for Security and Co-operation in Europe
PPP	Purchasing Power Parity
RBI	Rudjer Boskovic Institute
S3	Smart Specialization Strategy
STEM	Science, Technology, Engineering and Mathematics
UHF	Ultra-high Frequency
UN	United Nations
UN COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNOOSA	United Nations Office for Outer Space Affairs
UX	User Experience
VHF	Very High Frequency

Table of Contents

List of Figures

Introduction

To understand the economic, political and legal situation of Croatia, we first need to understand its history. Politically speaking, Croatian history is complicated. Despite only recently becoming Croatia by name in 1991, centuries of religious schisms, disagreements on 'nationality,' and socialism versus fascism has defined this area of the world. Croatia was included in the Yugoslavia state. When the Berlin wall fell, Yugoslavia started to fall apart, and in 1990, Croatia held its first election. The democratic union won against the sitting communist party, but tension between Croatian and Serbia began to arise. The newly formed Croatia was split, and a number of Serbians remained in the country supported by the Yugoslavia army.

It is therefore appropriate that after years of turmoil Croatia would seek to invest in space because it may lead to increased national and international prominence. A possible catalyst for space-based motivations may be the conclusion of the Croatian War from 1991-95, also known as the Serbian Aggression. Hundreds of thousands of Croatians fled from other Yugoslavian regions to return to their home country. The conflict continued for five years before a cease-fire was adopted and a peace treaty was finally ratified. Following the conflict, Croatia gained independence from Yugoslavia, but at a high cost. Some areas of the country never recovered, as 19.5% currently fall below the poverty line (The Borgen Project, 2017). Soon after, the country became a member of the council of Europe in 1996 but entered into a severe depression. At the beginning of the 2000's, Great Britain and the Netherlands denied Croatia from entering formerly in the European Union (EU), but negotiation eventually turned in favor of Croatia. By 2008, the country had experienced six consecutive years of economic recession because of the global crisis. Five years later, Croatia formally entered the EU. This puts Croatia in a precarious, yet opportunistic position in which they must choose the best way to recover from their economic woes. Engaging in space activities provides a plethora of opportunities for Croatia to become part of the international space community.

Generally speaking, having access to space is the sign of a wealthy nation, or at least a country with enough wealth to fund satellite, science, and exploration related activities. A published report on 'The role of emerging space nations in supporting sustainable development and economic growth' asserts that besides providing the opportunity to increase the GDP of a country, access to space can provide increased food and security, military capability, communications and a decreased reliance on other countries (PwC, 2020). Increased autonomy will allow Croatia to be more involved with the United Nations (UN) Space 2030 directives which place a heavy emphasis on their motto of "Space for all." There are four areas in which the UN believes that developing will make "Space for all" tangible for developing countries: space economy, space society, space accessibility, and space diplomacy. In fact, the main directive of this plan is to "link emerging space countries to established ones" (UNOOSA, 2018). Put frankly, it is extremely difficult in the current day to build an internationally recognised space program from the ground up.

This analysis would be remiss without noting that a relatively early investment in the space industry returns the highest net profit as the years go on. This is without a doubt a prime motivation for a country like Croatia that has gotten off to a slow economic start, and for a nation of people seeking a place amongst the greater European powers that have already engaged in space activities. An in-depth analysis of Croatian space related activities follows in the report below.

Analysis

Space Policy

As it currently stands, Croatia does not have a national space policy. But changes in the global space sector and the emergence of New Space – the growing privatisation and commercialisation of the space sector (Airbus, 2020) – could provide Croatia with a number of options for future policy development. In the past, the space sector was dominated by state governments during and following the Space Race between the United States of America and the USSR. Space policy became largely motivated by politics and nationalism under the appearance of military protection. This allowed governments to pour in vast amounts of public funds into space systems and development. That, however, is no longer the case. Yet, as public funding of space activities has dwindled in recent decades, private, equity, and commercial funding has risen in its place.

Private industries now more than ever have an increasingly important role to play in the growth of the space sector (Airbus, 2020). With the industry shift towards New Space, Croatia has a unique opportunity to involve itself in the global space community at the ground level. Though it is a small country, Croatia already has a reasonably well-educated population thanks to legislative reform in education (Ziabari and Primorac, 2019), has already pursued a focus on STEM (science, technology, engineering and mathematics) sciences, and has already built strong international relationships with prominent bodies such as the European Space Agency (ESA), the EU, and the UN. Further, Croatia has already seen a number of private organisations undertake varying degrees of space systems research, including notable Croatian institutions such as the Rudjer Boskovic Institute (RBI), the Meteorological and Hydrological Service (DHMZ), the Croatian Academy of Science and Art (HAZU), and most prominently the Adriatic Aerospace Association (A3).

The A3 – a non-governmental, non-profit and independent consortium pursuing aerospace and technology research – is one of the most active organisations in establishing official Croatian space. It's four objectives can be viewed as the closest policy Croatia has to a written framework for space and technology. Those objectives are:

1) Stimulating research and development in the aerospace sector
2) Mediating projects as a point of contact
3) Education and Counselling
4) International Cooperation

Through these objectives, A3 aims to act as the first step in defining "developmental strategy" in space and aviation whilst building Croatia to be at a comparable level to countries like Germany, Israel and Turkey whose "future strategic commitment in the space sector [is] closely associated [with the] aviation sector" (A3, 2020).

However, conflicting arguments in establishing this vision have stalled A3's progress in achieving such a goal. One argument aims to encourage companies to subcontract the necessary components for large space projects, whilst the other seeks to utilise a collaborative sector in which scientific and technological projects stem from a common program (A3, 2020). Each has its own benefits and drawbacks, but to date not much headway has been made toward either argument.

Though these disagreements have served to stunt promising growth, the A3 is not the only route Croatia has towards establishing a space policy. As a partner member of the UN, Croatia falls under the Program on Space Applications which mandates international cooperation to "assist member states with capacity-

building in the use of space science and technology and their applications" (Haubold, Mathai, and Pyenson, 2020). Likewise, the partnership Croatia has with ESA will be able to open doors to future international cooperation with the EU. But regardless of the path Croatia decides to take, one thing remains abundantly clear: if Croatia wants to involve itself in the global space sector, now is the time to do it. The rise of New Space provides unprecedented opportunities to establish an expansive and varied space framework that could see Croatia "secure its place among the world's major spenders on science, education and technology" (Ziabari and Primorac, 2019).

Legal Framework

As previously stated, Croatia does not possess any national legislation on space policy. However, legislative reform within the Croatian government over the past two decades has placed the country in a prime location to further the development of space practices and eventually implement an official legal framework to oversee the aspects of a national space industry.

The legal framework of Croatia, both leading up to and continuing after its induction as a member state of the EU, has largely stemmed from two main focal points. These points – namely the pursuit of education reform and the pursuit of industrialisation – together could be viewed as Croatia's unofficial political rationale toward eventual space development. These pursuits have seen Croatia make great strides in scientific and academic research and they have furthermore laid out proposed "guidelines for the government and state institutions [to be] the crucial pillars in [the] development and implementation of strategy and program dealing with space issues" (Grgic, 2020).

Though initial policy reforms in education were largely disrupted by political disagreements in the years immediately following the Croatian War (1991-95), the Ministry of Science, Education and Sport (MSES) enacted the first policies of a continuing national education reform in the early 2000s. This legislative framework was developed to not only improve the level and accessibility of scientific, business and social education, but to facilitate and stimulate industrialisation in all aspects of education (European Commission, 2018).

The primary mission of MSES, as laid out by the European Commission (2018), is to create and implement national policy as a framework for overall development of science in Croatia through scientific research and research-based technology development. To this end, MSES has restructured the Croatian school system – from primary education to research-focused institutions – by pairing STEM with business and social studies (i.e. cultural heritage, communication technologies, and human rights). This has helped to equip Croatia's small, but well-educated population with the necessary tools and knowledge to emerge as a leading society in information and technology. The former Minister of MSES, Dr Dragan Primorac – who we were fortunate enough to contact – claimed these advances in education enacted during his tenure in office have shaped Croatia into a "society of knowledge [wherein] lies a high quality and continuous improvement of the science and education system" (Ziabari and Primorac, 2019).

In 2014, the Croatian government and MSES drafted and adopted the Strategy of Science, Education and Technology (also referred to as 'New Colours of Knowledge') – a strategic framework for the ongoing reforms and policy development with the purpose of "establishing a comprehensive framework for [further] development of education and training" (European Commission, 2018). The strategy argues for "a democratic, tolerant and innovative society where the potential of every individual can be fulfilled" (UNESCO, 2018). The core of the strategy can be broken down into three general objectives (European Commission, 2018).

1) Quality education for all as a driving force for economic growth and social welfare
2) Research and innovation supporting excellence, industrial leadership, social challenges and contribution to creating jobs, growth, and improved quality of life
3) Lifelong learning and social inclusion of all citizens with particular emphasis on the marginalised and disadvantaged groups.

Even though the adoption of this policy has set the educational system on a strong path, it is not without its issues. The new education systems must be upheld and further cooperation with universities, research centres and independent facilities in other EU member states is paramount in building toward internationalisation. In an interview conducted with *Fair Observer* (Ziabari and Primorac, 2019), Dr Primorac comments on the success of the policies enacted thus far, but cautions about the care and diligence that must be taken to ensure they continue:

> "I am glad we never compromised on the interests of education and science, [however] the future of the educational system is to be determined by the care and diligence of the responsible parties. Like many countries, Croatia faces the dual challenge of creating a sustainable economy in a gobalised world and providing its citizens with a secure future. The most efficient strategy to create and ensure a sustainable, long-term future for Croatia is to invest in education and to strengthen the research and innovation base of the country."

Croatia's commendable dedication to reform in the education sector, despite the expansion of educational resources remaining an inherent need in fostering the legal framework, goes hand in hand with its pursuit of international relations with the EU. According to the European Bank for Reconstruction and Development (EBRD) (2018), Croatia took immense strides to align its legislation with the legal standards of the EU. In addition to permitting international collaboration between educational systems within other EU member states, Croatia has not only fully aligned its legal framework on electronic communications and telecommunications but has also aligned its concessions legislation. The EBRD (2018) mentions there is "still room for improvement in public-private partnership (PPP) and concessions framework [but] the implementation of proper contract management procedures…would provide for a higher efficiency and accountability in the sector" thus strengthening legal, political and commercial ties within the EU.

In more specific terms to the eventual emergence of a national space policy, Croatia has taken some strides in international space cooperation. As early as 1994, Croatia signed an agreement with the United Nations Office for Outer Space Affairs (UNOOSA) on the rescue and return of astronauts and the return of objects launched into outer space. In 2013, Croatia again partnered with the United Nations to host a workshop on the Applications of Global Navigation Satellite Systems (GNSS) which "focused on the importance and need of cooperation to promote the greater use of GNSS capabilities to support sustainable development" (UN General Assembly, 2013).

Most recently, Croatia has taken its biggest step toward developing a space policy by signing a cooperation agreement with ESA in 2018. This agreement will permit them to take part in future ESA space programs and develop more concrete relations with EU member states including exchanging "knowledge with its European partners, [creating] a national space strategy, and [establishing] the necessary infrastructure [benefitting] ESA membership" (Adamowski, 2018).

Economy

As part of a country group with emerging economies, Croatia is aligned with the policy of developing and opening its economy more to the global market. Becoming the 28th Member State of the EU on 1 July 2013 (European Commission, 2020), the Croatian economy was finally able to resume domestic growth after six years of recession. During the worst recession period, Croatia's GDP decreased upwards of 12% according to EU data. In 2018, GDP reached $61B (Trading Economics, 2020). The economy accelerated to 2.9% in 2019 – against 2.7% a year earlier – mainly due to domestic demand and public investments supported by European funds. Rising wages and low inflation, along with increases in investment, should continue to support economic growth, but the economy is fragile and unequal. Public debt of Croatia has reportedly decreased by about 3% every year for the last three years thanks to Croatia's budget surplus. Unemployment has also decreased to its lowest score since 2000 and keeps dropping every year. It is also important to note that as salaries are pretty low, GDP expressed as Purchase Power Parity keeps rising.

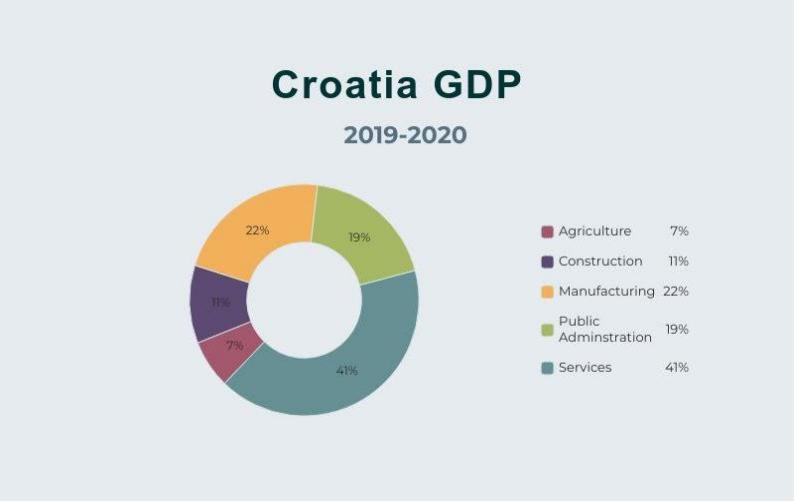

Figure 1: Croatia GDP by sector 2019-2020 (The World Bank Trading Economics, 2020)

Breaking down Croatia's recent GDP output (Figure 1), agriculture contributes 4% to GDP but employs 7% of the national population (L'agence de développement économique AD'OCC, Région occitanie, 2020). The country is auto sufficient for the most basic agricultural products like corn, wheat, fruits and even wine. Furthermore, it still possesses twice as much forest surface than agricultural lands. The secondary sector in the country encompasses goods from different industries chemicals, plastics, steel, wood products, aluminium and textiles. This sector represents 21% of the GDP but employs almost 26% of the population. The construction sector also provides around 6% of the GDP. Services accounted for 60% of GDP and tourism alone accounts for 20% of GDP in 2019 (CIA WORLD FACTBOOK, 2020). Other services include the real estate sector that represents around 9% of the GDP and commerce related service because of its predominant place in the Adriatic Sea. Thus, the economy is dependent on services, especially tourism, and any natural disasters can have a significant impact on this sector of activity (The World Bank, 2020).

Since early 2020, the COVID-19 crisis (Mikulić and Buturac, 2020) in Europe and the measures put in place by public health authorities to limit the spread of the contagion have led to a rapid recession of economic activity. As the main activity of the country is tourism, it is reasonable to say that it has taken the worst hit for the crisis. Especially about tourism because 20% of the total GDP represents $12.2 B that Croatia can't hope to achieve otherwise. Thus, it could be even harder to get back in the race. Some loans are needed which can make the public debt grow. Furthermore, they underwent another crisis – an

earthquake – and damages are still being assessed. However, this could be the start of a turn toward greater internationalisation since it is already one of the most important sectors and it could indirectly contribute to the others.

Croatia has a negative balance between exports and imports (French Senate, 2012), with the latter significantly exceeding the former. The importation of agricultural products particularly keeps increasing, but with a large quantity of arable land, agricultural exports should exceed imports and not the other way around. Moreover, Croatia also imports 50% of its total energy consumption which includes the three-quarters of its needed petroleum and 50% of natural gas. Even with the EU's aid and local investment, vital economic sectors will take some time to develop. However, the amount of EU aid given to Croatia to develop its infrastructure and agriculture is an indicator of growth (Ministère de l'économie, des finances et de la relance, 2018). This aid has greatly helped to fund modernisation projects that are necessary for the public and private markets. Croatia also is the largest IT spender in terms of investment among other countries in the region. This represents a key sector to drive the economy because it includes transport, telecommunication and oil and gas. The sector has a great potential toward exports and has been growing at a rate of 9%.

Since the cost of workers in Croatia is among the lowest even in East Europe, it is possible for the country to help increase the production of low tech products – infrastructure that could eventually compete with other countries like China or India that have to pay a toll to sell goods in Europe. Besides, the EU represents one of Croatia's main markets: 43.7% of the total export (Čutura S. and Selak G., 2017). These exports have continued to grow since Croatia joined the EU in 2013 because of the lack of customs fees in the Schengen Area. Therefore, manufacturing exports have an incredible potential to grow. It could represent the best asset for Croatia to reinforce its industry into the global value chains because of the increased demand linked to its clear access to the EU market. It has been determined that Croatia is the worst participant in the EU in terms of participation in the global market.

In addition to GDP and infrastructure, another important economic indicator has been innovation. Industry innovation could help create prosperity for companies and develop new businesses through goods and services. In other words, state policy and investment made today builds tomorrow's economy. Besides, the space industry is also in need of investments to grow.

Space Technology & Industry

Focused on services, Croatia can take advantage of its tertiary economy to venture into new markets like the space sector. The aerospace industry encompasses many different activities and can be managed without coordination (Space Generation Advisory Council, 2019). The objective is to stimulate the development of uncoordinated companies which subcontract parts supplied for major projects in the aeronautical sector, where development is central in other countries or by space agencies (A3, 2020). The advantage of this approach is that the state is not responsible for the organisation of this complex sector, while the disadvantage is that these are highly specialised companies sensitive to market competition. Another vision is to organise the sector of scientific and biological activities around a common program. The realisation of this vision would provide increased stability for the economy.

The agreement with ESA is driving economic growth in the space sector, by enabling private companies – such as Amphinicy Technologies, who already have specialised satellite products – to bid for ESA tenders and programs (Amphinicy Technologies, 2018). The Croatian population contains many enthusiastic professionals already participating in the space industry (e.g. Synergy Moon for the Google Lunar XPRIZE competition) with some especially trained in advanced information and communication technologies (ICT).

In terms of digital economy, Croatia has experienced a downward trend over the years, but as a member of the EU they have begun to take necessary measures to configure their own benchmarks globally. Nevertheless, Croatia has high quality ICT and focus on maintaining the same standards of quality by providing quality education and keeping up to date with current and developing technologies.

The Smart City infrastructure in Croatia (Privacy Shield Framework, n.d.) seems to be in demand recently among the various cities. For instance, Dubrovnik is said to be one of the leading smart cities currently with the first smart street project in action. Zagreb, the capital of Croatia is said to be working on the same lines in order to achieve an overall great profile technology wise.

Figure 2: Croatian CubeSat (Adriatic Aerospace Association, 2020)

That being said, Croatia is now an associate member state of ESA and has been working on a number of strategies to mark their presence alongside the many countries who have been successful in their space endeavours. The formation of A3 marks the beginning of the space genesis in Croatia. The A3 Space program comprises of the first Croatian Satellite PERUN 1 (Figure 2) soon to be launched into Space (Perun I – Prvi Hrvatski Satelit – Lansiranje CubeSata s kamerom, 2020). PERUN 1 is a CubeSat 2U with a camera as the main payload. The main objectives of this mission are to capture useful data from the satellite for educational purposes, to make the public aware of the increasing space technology in Croatia and. The most integral reason, to mark the inception of Croatia's first space program.

For a space program to be successful and grow in the future, several entities need to be involved either directly or indirectly. Also, there are a number of fundamental components to consider like space budget, policy, and legal and technology frameworks. It is natural for any space program to be equipped with the latest technology and resources. This could be made possible through the technology providing institutions and the young engineers and scientists who have hands-on experience with the new on-board technology. One such technology providers in Croatia is Amphinicy Technologies – a software and telecommunications company providing and developing software for satellite industries all over the world. Amphinicy Technologies is a key supporter of the A3 program and has experience working with leading space agencies across the world.

Amphinicy Technologies is concerned with developing satellite friendly platforms that help execute automated procedures. For instance, SPELL (Amphinicy Technologies, 2018) is one such open source software package with an integrated environment that helps perform the necessary functions. Furthermore, they have an in-orbit testing system that facilitates the evaluation of the payload while the satellite is in its final orbit.

Profound experience in the ground segment simulation followed by a smart solution is incorporated with UX design principles for beam roaming (Figure 3) and passive satellite ranging. The monitor and control systems are supported by their product "Monica" which is easily integrated with existing solutions to provide smooth functioning of external systems. Amphinicy Technologies is also known to provide fast, robust information when the satellites are in line of sight and communication is possible thus making

Earth observation telemetry analysis coherent. Their other well-known products – Blink and SatScout – have helped in making the satellite launch and study easier and more efficient.

Figure 3: Interface demonstrating beam roaming for satellites (Amphinicy Technologies, 2020)

Oikon – another scientific institute in Croatia dealing with remote sensing and ICT – is also a sponsor of the PERUN 1 satellite (A3, n.d.), which is reportedly said to contain a NanoCam C1U camera system payload manufactured by GOMSpace. The technical readouts of the payload consist of a lens, lens table, image acquisition, processing board alongside the flight software, and the ground station communication is equipped with UHF/VHF and S-band antennas. The operating system, however, is FreeRTOS (Real time operating system). This particular OS is known to utilise many system resources which are heavy and expensive and have low multi-tasking capacity. As an alternative, Croatia is at the primitive stages of developing blockchain technology (IBM, 2019) that can be implemented in the launch of the new age satellites. This era of entrepreneurs will ideally produce a new age of ideas leading to advanced technologies that can be used across numerous research fields on a global level.

Over the past decades, there has been a gradual modernisation of technology in Croatia. The Smart Specialization Strategy (S3) (S3 Platform, 2016) was introduced to help balance the country's technological advancements with civil development and growth. Recently, the University of Zagreb in partnership with ESA led a workshop on Earth observation which focused on the contribution of space and technology across Europe. The result saw the cooperation of multiple institutions, companies and individuals develop towards a better understanding and implementation of recent technologies for space applications. With the evolution of big data and artificial intelligence, new opportunities are emerging for the digital economy – opportunities that will help Croatia grow as a nation and integrate new technology for advancement in the global space sector.

Institutional Landscape

Adriatic Aerospace Association (A3)

The Adriatic Aerospace Association (A3) is among the key entities promoting Croatian interest in the space sector. The association was founded on 18 December 2017 by thirty founding members from research and academic institutions, schools of technology, and high technology firms (Founding Assembly – Adriatic Aerospace Association, 2020). A3 aims to assemble science and technology involving space and aviation projects across Croatia while also acting as an intermediary between Croatian space entities and international space agencies like ESA and NASA (Space program for A3 and Croatia – Adriatic Aerospace Association, 2020).

At the institutional level, A3 acts as:

"a mediator between scientific research institutions and economic entities oriented to research new technologies for the aero-space sector with the aim of raising the profile of domestic aviation space activities both on the domestic and international level" (Space program for A3 and Croatia – Adriatic Aerospace Association, 2020).

In order to promote institutional cooperation, A3 offers their own expertise. They supply business and technology consulting for operators and government bodies while also supporting education and training with the aim of inspiring the next generation of young Croatian space enthusiasts. A3 works closely the Ruđer Bošković Institute (RBI), Amphinicy Technologies, the University of Zagreb, the Croatian Academy of Science and Arts (HAZU) and many other Universities and space entities in Croatia (Space program for A3 and Croatia – Adriatic Aerospace Association, 2020).

Ruđer Bošković Institute (RBI)

The Ruđer Bošković Institute (RBI) was founded in 1950 and has been attempting to promote the space sector in Croatia long before the formation of A3. It should also be stated that A3's membership is made up in large part by individuals from RBI. Now, RBI is working in unison with A3 as "Croatia's leading scientific institute". The multidisciplinary institute is split into 11 divisions. These divisions include experimental and theoretical physics, chemistry and materials physics, organic and physical chemistry, biochemistry, molecular biology and medicine, environmental and marine research and computer science and electronics. On 29 January 2020, a conference was held at the RBI where members of A3 and RBI proposed a National Space Strategy and National Space Program. At this conference it was made clear that long term programs and individual space projects are expensive therefore requiring political support for the foreseeable future and that the state should support them financially (Što se kuha na 'Ruđeru'? – Adriatic Aerospace Association, 2020). Some of this public money could promote education and vocational training, enabling:

"the creation of a number of specialized institutions for the preparation and implementation of space projects in Croatia. And that in turn includes a strong space industry to operate successfully in the global marketplace" (Što se kuha na 'Ruđeru'? – Adriatic Aerospace Association, 2020).

As previously mentioned, there is initiative coming from within Croatia to develop the institutional landscape further. But without the consistent aid of the government and the momentous change in circumstances due to the Covid-19 pandemic, it is hard to see a national space program put in place anytime soon. Perhaps a delay in their plans, but ultimately if they keep building a cooperative framework with more interested Croatian entities then their network may become more influential with time making a national space program and strategy a possibility on the horizon.

Amphinicy Technologies

Amphinicy Technologies is a software company operating for almost 20 years in the global satellite industry having delivered over 100 projects to the satellite market worldwide. Discussions between ESA and Croatia about a potential cooperation started in 2014. Amphinicy supported this initiative from the beginning with a myriad of public outreach talks and technology and business panels. The company aims to continue to promote satellite and space science and technology in Croatia whilst raising awareness about the benefits that space can bring as an important factor in technological, economic, scientific and cultural development (Amphinicy Technologies, 2020).

Before co-founding A3, Amphinicy Technologies worked heavily to raise awareness of the Space topic in Croatia. When the prospect of A3 came about, they naturally co-sponsored the proposal (Amphinicy

Technologies, 2020). Mirta Medanić, a key individual in the development of these programs with the Space Generation Advisory Council mentioned the following:

"I am a program manager at Amphinicy Technologies, a provider of complex software solutions and innovative software products for the satellite and space industry from Zagreb Croatia, and Luxembourg. I work in the space industry from Jan 2014 (on industry projects and product development – technical and business perspective, including BLINK). Curious and eager to learn as much as I can about space, I have engaged in several space organizations: SGAC (a national point of contact 2017-2020, an organizing team member of two European conferences, and an SGAC delegate member at the 57th Scientific and Technical Subcommittee at UN COPUOS), Adriatic Aerospace Association, A3 (a company representative and a member, supporting the organization in many projects including Perun I) and ISU (SSP19 PEL participant, ISP20 mentor)"

In addition, Amphinicy is a member of the Space Reference Group at the Ministry of Science and Education which is in charge of relations with ESA and co-operation in EU programs such as Horizon 2020 in the Space sector (Amphinicy Technologies, 2020). Horizon 2020 is an EU Research and Innovation program with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market (European Commission, 2020).

Achievements

The Croatian government, being very reticent on investing in the space sector, has yet to come up with a national space program (Malgran, 2020). Although there have been projects made in 2003 to launch the first Croatian satellite, high altitude balloons, and suborbital rockets. (Negri, 2010) none of these have been accomplished yet. Since 17 August 2020, Croatia is one of the only EU member states that does not have a satellite in orbit (Kocis, 2020).

The CSA – the Croatian Space Agency (Hrvatska Svemirska Agencija) – was founded by the decision of the City of Zagreb, City Office for General Administration on 18 October 2002 (Iwata et al., 2016). It aimed to promote astronomy and astronomical research in Croatia. However, it is not an active agency as their website was archived (I Portal Hrvatske Svemirske Agencije, 2020) and the first satellite launch was cancelled when the funding came short of 80,000 euros (Kocis, 2020).

The Croatian space sector is mostly made of research institutes and technical universities operating independently. The most notable of these is A3 which was founded in June 2017 in Zagreb. The 30 founding members took upon a status of legal entity during the Founding Assembly of the Adriatic Aerospace Association held at the Ruđer Bošković Institute on 18 December 2017 (Bosanac, 2017).

The first project for A3, in accordance with its main goal to stimulate research in the aerospace sector, is to construct, mount and launch Croatia's first satellite – the PERUN 1. This would be a great beginning and achievement for the Croatian space sector.

A key event in Croatia's ascension as a nation partaking in the space sector was the official launch of the country's accession process with ESA. The process for The Republic of Croatia to become an official member of ESA debuted in April 2014 with a letter of intent sent to the Director General of the ESA, expressing the desire of the Republic of Croatia to become a member state. Since May 2015, Croatia participated as an observer state at the sessions of the ESA Council, the International Relations Committee and other working bodies.

At the 64th session, on 2 November 2017, the Government of the Republic of Croatia adopted a decision on the initiation of the procedure for concluding an agreement with ESA on peaceful exploration and use of outer space. This Cooperation Agreement was signed by Ms Blaženka Divjak of the Croatian Ministry of Science and Education, and Frédéric Nordlund, Head of External Relations Department, on behalf of the ESA Director General on 19 February 2018. This agreement will allow for a more formalised, intensive and concrete cooperation between the Republic of Croatia and ESA programs/activities. Minister Divjak said that this agreement would speed up the networking of Croatian scientists and the economy in Europe as well as the development of areas from meteorology and environmental protection to satellite navigation and robotics.

Croatian's ambition to be part of the ESA is important for many different reasons. The Cooperation Agreement will allow for full cooperation with ESA thus facilitating the information sharing through meetings, workshops, training programs and application of specific data as well as the use of the ESA's assistance in compiling the national space strategy.

For example, during its presidency of the Council of the European Union, the Republic of Croatia organised a workshop on ESA/Croatia "Space Technologies for the Green Plan and Digital Economy" on 5-6 March 2020 at the Faculty of Electrical Engineering and Computer Science, University of Zagreb. The joint organisation was conducted by the Croatian Ministry of Science and Education, the Faculty of Electrical Engineer and Computing of the University of Zagreb and ESA. It was designed to discuss needs and solutions, as well as the contribution of the space industry and technology to all key goals of the EU Council Presidency (Eu 2020.hr, 2020) (Nikal.eventsair.com, 2020). The participants were policymakers, scientists, service operators, and EU application specialists.

The cooperation of the Republic of Croatia with ESA also has economic advantages. With approximately 90% of the budget of ESA allocated for contracts with European industry, it is expected that the Agreement will ultimately open new Croatian business opportunities.

The Republic of Croatia is also involved with the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) with the observer status although they are poised to be admitted for permanent membership before the end of 2020. At the regular meetings of the Scientific and Technical Subcommittee of UN COPUOS, Croatia has been represented by OSCE Ambassador Mario Horvatić, Jasminka Dinić and Iva Baković as members of the delegation (A3, 2020).

The Republic of Croatia has also run workshops in cooperation with the UN – such as the aforementioned workshop on the Applications of Global Navigation Satellite Systems in 2013 – which was organised jointly by UNOOSA, the Faculty of Maritime Studies of the University of Rijeka and Co-organised by The International Committee on Global Navigation Satellite Systems (UNOOSA, 2013).

Although Croatia still does not have an international prestige when it comes to a space presence, the country on the whole can benefit from growing it's national and private programs within the rising era of New Space (Figure 4). Incentivising international cooperation with Croatia and stimulating partnerships with other space agencies will allow Croatia to not only increase its recognisable presence within the world space sector, but to also provide funding for future projects. Further, an increased emphasis on education in Croatia can be a long term solution to many of the infrastructural problems the country is

facing, but it would specifically help to create generations of students interested by and motivated to work in all space related endeavours.

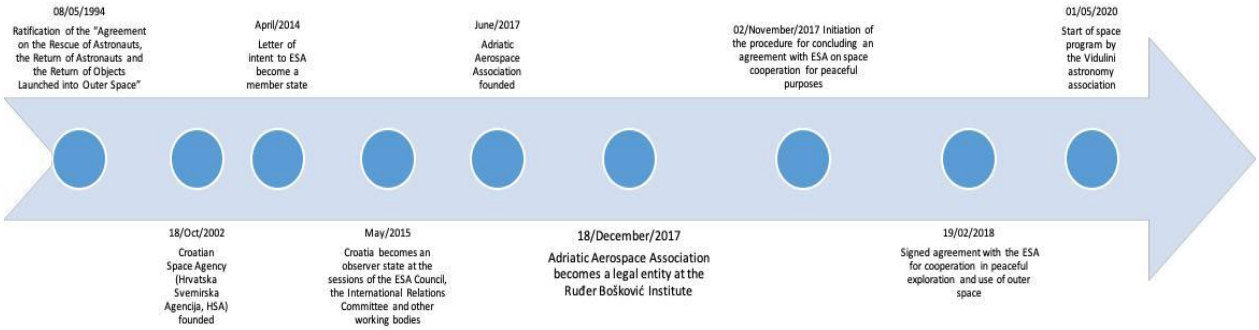

Figure 4: Summary of the key events in the Croatian space sector

Recommendations

As previously mentioned, the space sector is seeing a change with the emergence of New Space. Beginning in the United States, the shift from the Apollo missions to the Space Shuttle program was viewed as more of a lateral step in the space exploration program. Nevertheless, the United States has benefitted from having an established space agency, unlike other countries. It can be argued though, that in recent years NASA has been as much of a hindrance to space based activities. Through NASA has begun construction on the world's most powerful rocket, the Space Launch System (SLS), in 2014, the project to date is about 8 billion USD over budget, five years behind schedule, and quickly becoming less relevant (The Verge, 2020). This is due largely to the fact that the program can only develop and utilise a small number of contractors at a slow rate. Government programs in general are hindered by this lagging speed, and it is something that Croatia, as a country starting from a relatively clean slate, can learn from.

As a general recommendation, Croatia can benefit greatly from engaging in the private sector of New Space, and not be slowed down by constructing a massive state led space agency. For reference, NASA has been paying Russians to fly American astronauts on Soyuz rockets for a hefty price tag for the past decade. Each American passenger costs NASA approximately 90 million USD (Forbes, 2020). Conversely, SpaceX was awarded 2.6 billion USD from NASA to build a crew capsule and had a functioning crewed rocket within 6 years of being awarded the contract. The current estimate for the price-per-seat on a crewed SpaceX flight is 55 million USD (Space.com, 2020). A privately operating company like SpaceX can manufacture all of its parts and technology in-house, which brings down cost dramatically, and speeds up production significantly more than using contractors. To tie this back to Croatia's potential in space activities, Croatia would benefit greatly not only from developing their own private companies, but by incentivising international companies to be based in Croatia. They can do this by offering lower taxes to aforementioned companies just to be located in Croatia, or by building launch sites in different areas of the earth and offering lower prices to launch from their sites. This is a long term investment, but one that would offer a significant return on investment should it work. In summary, if Croatia can begin building a space operations framework on the private and commercial sides, they can avoid the pitfalls of a slow moving, and costly government program.

It is worth noting that the RBI, Croatia's leading scientific research institute, lists establishing a national space agency as one of its recommendations moving forward (RBI 2019). To be clear, this is still a goal that should be pursued to benefit the defense, transportation, and science industries. The important caveat is how the money will be spent, in which this report recommends the following: using government acquired funds to invest in the private sector so that the literal and figurative heavy lifting can be done cheaply and effectively. This path not only provides the least resistance, but it is a proven model, and path that is continuously defining New Space. It is important to note, this would require educated individuals from Croatia itself to stimulate this kind of development.

Education is a relatively easy crutch to use when attempting to solve a countries' issues in a targeted area. Space education, however, requires an interdisciplinary approach drawing from policy and communications to technical expertise such as aerospace engineering. Placing an emphasis on developing a successful space related education system in Croatia therefore would not only benefit the space sector, but all kinds of business in a country that struggles economically. The current estimated value based on published reports of the world's space based activities is valued at approximately 350 billion USD, and the sooner Croatia can have educated members of the country participate in space, the more money they stand to gain (Morgan Stanley, 2020). Drawing from the suggestion to privatise space activities in Croatia, the country itself could mirror what companies like Google has done in its Google Lunar XPRIZE competition defined as:

"a 2007–2018 inducement prize space competition organized by the X Prize Foundation, and sponsored by Google. The challenge called for privately funded teams to be the first to land a robotic spacecraft on the Moon, travel 500 meters, and transmit back to Earth high-definition video and images" (XPRIZE, 2020).

Five companies made it to the final stage of acquiring a launch contract, and although none of them technically landed on the moon, SpaceIL built, launched, and technically touched the moon with the help of this competition. Hosting, funding, or partnering with private companies to create a similar competition will help Croatia not only gain international prestige but will also motivate younger students to explore futures in space studies. This is a long term idea that may cement Croatia's place within the A3 and ESA as a legitimate source of intellect, and capability.

Conclusion

For Croatia to continue to develop and prosper socially and economically, it needs to largely invest in advanced technologies and knowledge. To start this process the government needs to allocate a larger share of their resources to research and development. Universities and higher education institutions need financial resources to hire the intellectual expertise necessary to produce more human capital. Thus, the desired increase in highly skilled human capital can assist in the building of the high-tech and space industry through developing STEM sectors and cooperating with business and social studies together with a young generation of professionals. Subsequently, Croatia will be able to produce more technology-oriented products and services to successfully enter the space sector.

Minister Divjak said: "We need to build synergies through this ag*reement between space science, research, education and industry."* According to her, the agreement will speed up the networking of Croatian scientists and the economy in Europe as well as the development of areas from meteorology and environmental protection to satellite navigation and robotics. This will create valued opportunities for Croatia and ESA.

To conclude, Croatia is still a developing country with a relatively clean slate when it comes to space based activities. This means Croatia can learn from the mistakes and setbacks of older space programs and adapt accordingly. Privatisation is imperative in a country like Croatia that suffers from poverty, as nationally recognised space programs are costly and slow. Promoting education for Croatian youth can establish a solid foundation for many more generations to build upon. Further, these two suggestions of privatisation and education serve as a positive feedback loop. The more educated space-centered minds there are in Croatia, the more likely it is that private companies will not only begin in the country but will stay there as well. Despite the relatively recent establishment as a sovereign nation, Croatia has potential to become a larger voice within the European and the world space economy.

REFERENCES

Adriatic Aerospace Association, 2020. *Croatia*. [online] Available at: <https://a3space.org/?tag=croatia> [Accessed 21 September 2020].

Adriatic Aerospace Association. 2020. *Founding Assembly*. [online] Available at: <https://a3space.org/?p=2836> [Accessed 20 September 2020].

Adriatic Aerospace Association, n.d. *Perun Croatian CubeSat* [pdf]. Adriatic Aerospace Association. Available at: <http://acsst.irb.hr/perun.pdf> [Accessed 17 September 2020].

Adriatic Aerospace Association, 2020. *Space Program for A3 And Croatia*. [online] Available at: <https://a3space.org/?page_id=2502> [Accessed 20 September 2020].

Adriatic Aerospace Association, 2020. *Što Se Kuha Na 'Ruđeru'?.* [online] Available at: <https://a3space.org/?p=4227&lang=hr> [Accessed 20 September 2020].

Adamowski J., 2018. *Croatian Space Industry Players Eye European, U.S. Export Prospects*. [online] Space News. Available at: <https://spacenews.com/croatian-space-industry-players-eye-european-u-s-export-prospects/> [Accessed 17 September 2020].

Amphinicy Technologies, 2018. *Amphinicy Technologies Company Profile* [pdf]. Amphinicy Technologies. Available at: https://www.amphinicy.com/sites/default/files/2018-12/at-companyprofile-general-2018.pdf [Accessed 19 September 2020].

Amphinicy Technologies, 2018.*Croatia Signs Cooperation Agreement with European Space Agency (ESA)* [online]. Available at: <https://www.amphinicy.com/news-and-press/events/croatia-signs-cooperation-agreement-european-space-agency-esa> [Accessed 19 September 2020].

Amphinicy Technologies, 2020. *National Space Strategy and National Space Program Proposed*. [online] Available at: <https://amphinicy.com/news-and-press/news/predstavljen-prijedlog-nacionalne-svemirske-strategije-i-nacionalnog-svemirskog> [Accessed 21 September 2020].

Altaf N., 2019. *Space Tech: Transforming Satellite launches with Blockchain*. [online] Blockchain Pulse: IBM Blockchain Blog. Available at: <https://www.ibm.com/blogs/blockchain/2019/06/space-tech-transforming-satellite-launches-with-blockchain/> [Accessed 17 September 2020].

BBC News, 2018. *Croatia profile: Timeline.* [online] Available at: <https://www.bbc.com/news/world-europe-17217954> [Accessed 19 September 2020].

Bosanac S., 2017. *Founding Assembly – Adriatic Aerospace Association*. [online] Available at: <https://a3space.org/?p=2836> [Accessed 21 September 2020].

CIA WORLD FACTBOOK, 2020. *Croatia Economy 2020* [online] Available at: <https://theodora.com/wfbcurrent/croatia/croatia_economy.html> [Accessed 19 September 2020].

Čutura S. and Selak G., 2017. *The ICT Sector in Croatia – Belgium Embassy – Economic Office*. [online] Available at: <https://www.awex-export.be/files/library/Infos-sectorielles/PECO/2017/CROATIE/ICT-sector-in-Croatia-2017.pdf> [Accessed 22 September 2020].

Davor Mikulić, Goran Buturac. (2020) *Sources of export growth and development of manufacturing industry: empirical evidence from Croatia*. [online] Available at: <https://www.tandfonline.com/doi/full/10.1080/1331677X.2018.1550003> [Accessed 22 September 2020].

Dreir C., 2019. *The Space Review: A new accounting for Apollo: how much did it really cost?* [online] Available at: <https://www.thespacereview.com/article/3737/1> [Accessed 22 September 2020].

Duckworth S., 2017. *Why Is Croatia Poor?* [online] Available at: <https://borgenproject.org/why-is-croatia-poor/> [Accessed 22 September 2020].

Dukic, G., Dukic, D. and Kozina, G., 2019. *Croatian High-Tech Industry: Current State and Prospects*. [online] Tehnicki vjesnik – Technical Gazette, 26(2). Available at: <https://hrcak.srce.hr/219549> [Accessed 22 September 2020].

Eu 2020.hr, 2020. *ESA – Croatian EO Workshop "Space Technologies for The Green Deal and The Digital Economy" – EU 2020 HR*. [online] Available at: <https://eu2020.hr/Events/Event?id=334> [Accessed 21 September 2020].

The European Bank for Reconstruction and Development, 2017. *Strategy for Croatia*. [pdf] Available at: <file:///C:/Users/ewcwr/AppData/Local/Temp/EBRD.pdf> [Accessed 17 September 2020].

The European Commission: EACEA Eurydice, 2018. *Croatia: Bilateral Agreements and Worldwide Cooperation*. [online] Available at: <https://eacea.ec.europa.eu/national-policies/eurydice/content/bilateral-agreements-and-worldwide-cooperation-11_en> [Accessed 17 September 2020].

The European Commission: EACEA Eurydice, 2018. *Croatia: Mobility and Internationalisation*. [online] Available at: <https://eacea.ec.europa.eu/national-policies/eurydice/content/mobility-and-internationalisation-11_en> [Accessed 17 September 2020].

The European Commission: EACEA Eurydice, 2018. *Croatia: Ongoing Reforms and Policy Developments*. [online] Available at: <https://eacea.ec.europa.eu/national-policies/eurydice/content/ongoing-reforms-and-policy-developments-11_en> [Accessed 17 September 2020].

The European Commission, 2020. *ECO-INNOVATION at the heart of European policies*. [online] Available at: <https://ec.europa.eu/environment/ecoap/croatia_en> [Accessed 19 September 2020].

The European Commission, 2020. *Ministry of Science, Education and Sports of the Republic of Croatia (MSES)* [online] Available at: <https://rio.jrc.ec.europa.eu/country-analysis/organisations/ministry-science-education-and-sports-republic-croatia-mses> [Accessed 21 September 2020].

The European Space Agency, 2018. *Croatia signs Cooperation Agreement*. [online] Available at: <https://www.esa.int/About_Us/Corporate_news/Croatia_signs_Cooperation_Agreement> [Accessed 17 September 2020].

The European Space Agency, 2020. *Space Agencies and Governmental Institutions*. [online] Available at: <https://www.esa.int/About_Us/ECSL_European_Centre_for_Space_Law/Space_Agencies_and_Governmental_Institutions> [Accessed 21 September 2020].

French Senate, 2012. *La Croatie : une « nouvelle Côte d'Azur » pour l' Union européenne ?* [online] Available at: <https://www.senat.fr/rap/r08-049/r08-0493.html> [Accessed 19 September 2020].

Google 2020. *Google Lunar XPRIZE*. [online] Available at: <https://lunar.xprize.org/prizes/google-lunar> [Accessed 22 September 2020].

Grgic M., 2020. *National Space Strategy and National Space Program Proposed*. [online] Amphinicy Technologies. Available at: <https://amphinicy.com/news-and-press/news/predstavljen-prijedlog-nacionalne-svemirske-strategije-i-nacionalnog-svemirskog> [Accessed 21 September 2020].

Grush, L., 2020. *NASA's future monster rocket is once again over budget and behind schedule*. [online] The Verge. Available at: <https://www.theverge.com/2020/3/10/21173176/nasa-space-launch-system-inspector-general-audit-over-budget-schedule> [Accessed 22 September 2020].

Horizon 2020 – European Commission. 2020. *What Is Horizon 2020? – European Commission*. [online] Available at: <https://ec.europa.eu/programmes/horizon2020/what-horizon-2020> [Accessed 21 September 2020].

I Portal Hrvatske Svemirske Agencije, 2020. *Slovenija Postala ESA-ina Evropska Partnerska Droava (ECS)*. [online] Web.archive.org. Available at: <https://web.archive.org/web/20100821142314/http://www.csa.hr/index.php> [Accessed 21 September 2020].

Iwata T., Bergamini E.W., Avenant E. and Nakamura S., 2016. Emerging Space Operations in Asia and Developing Countries: Overview. In *14th International Conference on Space Operations* (p. 2342).

Kocis D., 2020. *JEDINA SMO ZEMLJA U EU KOJA NEMA SATELIT: Bugari Su Postali Vodeća Svemirska Nacija, A Naš PERUN I Je Još Na Zemlji – Adriatic Aerospace Association*. [online] Available at: <https://a3space.org/?p=4665&lang=hr> [Accessed 21 September 2020].

Malgran, D., 2020. *Croatia | Space Generation Advisory Council*. [online] Space Generation Advisory Council. Available at: <https://spacegeneration.org/regions/europe/croatia> [Accessed 21 September 2020].

Medanić, M., 2018. *Croatian Space Report 2017 – The Foundations*. [Blog] Amphinicy Technologies. Available at: <https://www.amphinicy.com/blog> [Accessed 21 September 2020].

Ministère de l'économie, des finances et de la relance, 2018. *Le mix énergétique de la Croatie* [online] Available at: <https://www.tresor.economie.gouv.fr/Articles/2018/12/12/le-mix-energetique-de-la-croatie#:~:text=La%20Croatie%20dispose%20de%20ressources,ses%20derni%C3%A8res%20mines%20en%20Istrie.> [Accessed 19 September 2020].

Morgan Stanley, n.d. *Space: Investing in the Final Frontier*. [online] Available at: <https://www.morganstanley.com/ideas/investing-in-space> [Accessed 22 September 2020].

Negri P., 2010. *I Portal Hrvatske Svemirske Agencije*. [online] Web.archive.org. Available at: <https://web.archive.org/web/20100821142329/http://www.csa.hr/index.php?zaglavak=magazin> [Accessed 21 September 2020].

Nikal.eventsair.com, 2020. *Space Powering the Green Deal and the Digital Economy*. [online] Available at: <https://nikal.eventsair.com/QuickEventWebsitePortal/space-powering-the-green-deal-and-the-digital-economy/esa> [Accessed 21 September 2020].

Oikon, 2020. *Oikon sponsors Perun 1-First Croatian Satellite* [online]. Available at: <https://oikon.hr/oikon-sponsors-perun-i-first-croatian-satellite/> [Accessed 18 September 2020].

Perun I, 2020. *Perun I – Prvi Hrvatski Satelit – Lansiranje Cubesata S Kamerom*. [online] Available at: <https://perun-i.hr/> [Accessed 21 September 2020].

Privacy Shield Framework, n.d. *Croatia- Smart Technologies* [online] Available at: <https://www.privacyshield.gov/article?id=Croatia-Smart-Technologies> [Accessed 19 September 2020].

PwC, 2020. *The role of emerging space nations in supporting s.pdf*. [pdf] PwC. Available at: <https://www.pwc.fr/fr/assets/files/pdf/2020/03/en-france-pwc-space-practice-emerging-space-nations-paper.pdf> [Accessed 22 September 2020].

Ruđer Bošković Institute, 2020. *About RBI - Ruđer Bošković Institute*. [online] Available at: <https://www.irb.hr/eng/About-RBI> [Accessed 22 September 2020].

Ruđer Bošković Institute, 2020. *Divisions - Ruđer Bošković Institute*. [online] Available at: <https://www.irb.hr/eng/Divisions> [Accessed 20 September 2020].

S3 Platform. 2016. *Croatia Smart Specialization Strategy 2016-2020* [pdf]. Available at: <https://s3platform.jrc.ec.europa.eu/documents/20182/222782/strategy_EN.pdf/e0e7a3d7-a3b9-4240-a651-a3f6bfaaf10e> [Accessed 20 September 2020].

Spacedaily.com. 2020. *Croatia To Launch Satellite into Space*. [online] Available at: <https://www.spacedaily.com/reports/Croatia_To_Launch_Satellite_Into_Space_999.html> [Accessed 21 September 2020].

Space Generation Advisory Council, 2019. *Young Space Activities Overview in Croatia*. [online] Available at: < https://spacegeneration.org/regions/europe/croatia> [Accessed 19 September 2020].

SpaceNews.com, 2018. *Croatian Space Industry players eye European, U.S. export prospects.* [online] Available: <https://spacenews.com/croatian-space-industry-players-eye-european-u-s-export-prospects/> [Accessed 17 September 2020].

Tegler, E., 2020. *SpaceX Crew Flight to ISS a Boon to U.S. But a Costly Blow to Russian Space Program*. [online] Forbes. Available at: <https://www.forbes.com/sites/erictegler/2020/05/14/does-a-successful-spacex-demo-flight-change-the-spirit-of-detente-on-the-international-space-station/> [Accessed 22 September 2020].

Trading Economics, 2020. *Croatia GDP* [online] Available at: <https://tradingeconomics.com/croatia/gdp> [Accessed 19 September 2020].

UNESCO, 2018. *Strategy of Education, Science and Technology – New Colours of Knowledge*. [online] Available at: <https://en.unesco.org/creativity/policy-monitoring-platform/strategy-education-science> [Accessed 21 September 2020].

United Nations General Assembly, 2013. *Report on the United Nations/Croatia Workshop on the Applications of Global Navigation Satellite Systems*. [pdf] United Nations. Available at: <http://www.unoosa.org/pdf/reports/ac105/AC105_1055E.pdf> [Accessed 21 September 2020].

UNOOSA, 2020. *Space 2030 agenda: Space as a driver for peace*. [online] Available at: <https://www.unoosa.org/oosa/en/outreach/events/2018/spacetrust.html> [Accessed 22 September 2020].

UNOOSA, 2013. *United Nations /Croatia Workshop on the Applications of Global Navigation Satellite Systems.* [pdf] Available at: <https://www.unoosa.org/documents/pdf/psa/activities/2013/croatia/Abstracts_Croatia2013.pdf> [Accessed 21 September 2020].

UNOOSA, 2020. *Croatia*. [online] Available at: <https://www.unoosa.org/oosa/treaties/status/croatia/rescue_agreement.html> [Accessed 21 September 2020].

Wall M., 2020. *Here's How Much NASA Is Paying Per Seat on SpaceX's Crew Dragon & Boeing's Starliner*. [online] Space.com. Available at: <https://www.space.com/spacex-boeing-commercial-crew-seat-prices.html> [Accessed 22 September 2020].

The World Bank, 2020. *Impact of the COVID-19 Crisis* [online] Available at: <https://www.worldbank.org/en/country/croatia/overview> [Accessed 19 September 2020].

Ziabari K., Primorac D., 2019. *Croatia Values Science and Education*. [pdf] Fair Observer. Available at: <https://www.draganprimorac.com/wp-content/uploads/2020/07/Croatia-Invests-Heavily-in-Science-and-Education.pdf> [Accessed 20 September 2020].