International Astronautical Federation
International Project / Programme Management Committee

IAF-IPMC Young Professionals Workshop 2020

Workshop Results Report

Workshop Organizing Committee
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The 2020 International Project Management Committee Young Professionals Workshop Delegates on 11 October 2020 during the Final Virtual (online) Event

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1. Executive Summary

The International Project / Programme Management Committee Young Professionals Workshop sought to gather ideas and recommendations from early career employees in the international space community and provide the IPMC and IAF member organizations with greater knowledge, insights, and perspectives that can help better develop and empower the next generation of space program employees. The IPMC was supported in this effort by a group of young professionals who participated in previous workshops and served as the Workshop Organizing Committee (WOC) to manage the overall process and finalize preparation of a workshop report.

The workshop began in the second quarter of 2020 with the nomination and selection of participants who were assigned to working groups, each focusing on one of five discussion topics. During the ensuing period these groups discussed and investigated the topics and reached conclusions. The groups compiled their results, findings and recommendations into reports and video-presentations. Major outcomes were then presented and discussed live with the IPMC members, workshop Delegates and guests during the Final Event held virtually in conjunction with the 71st International Astronautical Congress, The Cyberspace Edition.
Following the workshop, the WOC prepared this final report with a summary of the results and recommendations.

Topic 1:

The team investigated the issues related to remote and delocalized project teams, taking into account both the employees' and the employers' perspectives. They did so by relying on published studies and by interviewing managers and personnel in the space sector.
Among their major findings is the acknowledgement that it is important to be critical before generalizing that working from distance will always be beneficial for employees after the end of the pandemic. First, there might be negative social impact on individuals and second, space firms might report a reduction of productivity.
The team also highlights that **it is the companies' job to ensure that each employee has all the necessary provisions to maintain their productivity** by using a flexible approach as follows:

- Polling employees to ensure they can adequately perform their role remotely.
- Deploying all necessary software tools to ensure as little technological interference as possible and mimic the in-person work environment as much as possible.
- Updating company processes to accommodate a remote workforce and minimize delays in remote communication, ensuring simplification and transparency.
- Continuously monitoring the possible negative effects of work-from-home arrangements, showing empathy and caring towards the employees.
- Providing ample socialization and career progression opportunities for younger workers, while helping older employees adapt to the digital world in which they will need to continue their career.
- Selecting and monitoring appropriate metrics to see if a return to the traditional office

setting is even appropriate and the most effective way to operate in today's advancing technological world.

In the end, the team postulates that space firms will likely adopt a **hybrid work form** that allows specific tasks or roles to be performed remotely while other jobs that have suffered during the pandemic are transitioned back to the traditional in-person work environment.

Topic 2:

Through discussion, research and qualitative interviews, the team came to the following results:

- There is no difference in what young professionals expect of their managers during times of crisis then they expect in normal times. Young professionals seek managers who can lead by example, show empathy, and ensure transparency. The lack of these traits in managers has a negative impact on employee productivity and motivation.
- New leadership skills emerge during times of crisis in both young and senior professionals, such as being more self-sufficient without direct guidance, and communicating through a plethora of modalities (remote screens and phones) that require different skills (e.g. interpreting inflection rather than body language).
- Managers and leaders develop new skills and change their management methods during times of crisis and these new methods will be adopted into post-crisis times.

The team recommends that managers pay closer attention to communication skills and time management skills (in particular, meeting management and flexible scheduling). The team also recommends that companies/agencies further enable teleworking, provide training in soft skills and encourage leadership in young and senior professionals alike.

A central topic for the team is the ability of managers to **create a trusting and inclusive environment** to **demonstrate** to young professionals that a company cares about and plans for their future and safety. Managers must also **establish and model clear work-life boundaries** for themselves and their employees.

While management and leadership are recognized as distinctly different, they become less distinguishable during a time of crisis. Often management is defined by control and power, while leadership is defined by the ability to influence, inspire, motivate, and enable others to contribute toward a larger goal. During a time of crisis the best managers are also leaders.

Topic 3:

In investigating space and society in times of crisis, such as the current COVID-19 pandemic, the group concluded that **space serves a strongly beneficial role** for society, but that yet more can be done to further contribute to societal good and raise the **awareness and acceptance of the general public**. Aerospace technologies, products and expertise have been aiding people's day-to-day lives prior to COVID-19 as well. However, the crisis has led to some newly emerged societal needs, which in turn have highlighted further potential space technology applications.

Based on a literature review and interviews, the group formulated three general recommendations

aimed to enhance both space technology contributions to societies in times of crisis and the awareness of the general public.

First, **exploit to the fullest existing space products, technologies and mechanisms**, which can help provide solutions to the current issues in a timely manner.

Second, **have an interdisciplinary working group of policymakers, practitioners and researchers get together around the same table and collaborate on speedy and efficient policies**, to help governments and institutions identify the most urgent societal needs and consider potential solutions. The creation of a framework of international cooperation, supported by proper legislation, and involving not only the aerospace sector, but also specialists from other industries, would allow public bodies to identify, develop, and apply the necessary space technologies to better aid people's lives in times of crisis.

Lastly, **enhance public awareness** by demonstrating scenarios that compare society with and without space-derived technologies, to develop public acceptance and support of aerospace programs in the long run.

While these recommendations are largely based on observations of the current COVID-19 pandemic, they can provide long-term benefits to a more resilient, sustainable and innovative society.

Topic 4a:

The COVID-19 pandemic has triggered unexpected changes in several working and social domains. In space projects, the impact of the crisis brought the need for innovation, inspiration, collaboration and at the same time sacrifice and changes imposed to maintain schedules and deliveries and settle into a "new normality." Operations and practices were impacted in both negative and positive ways. The transition to new work habits also brought adjustments. Pandemic restrictions came at a cost. In particular, the small-to-medium enterprises, which constitute the bulk of industrial companies producing for the space industry, had difficulties accessing finances. In their work, the team identified several different **impacts** of the COVID-19 pandemic and mapped them to both **positive and negative consequences** on the space sector. Based on this, they suggest **ways to not only survive and resist during a crisis, but also to thrive from it**, identifying strategic changes to organizations that bring positive effects in the long run. The aspects highlighted in Figure 1 are all presented and analyzed in the team's work, from the COVID-19 impacts and their consequences on space programs, to all the identified possible recommendations for Program Managers to *Survive*, *Resist* and *Thrive.*

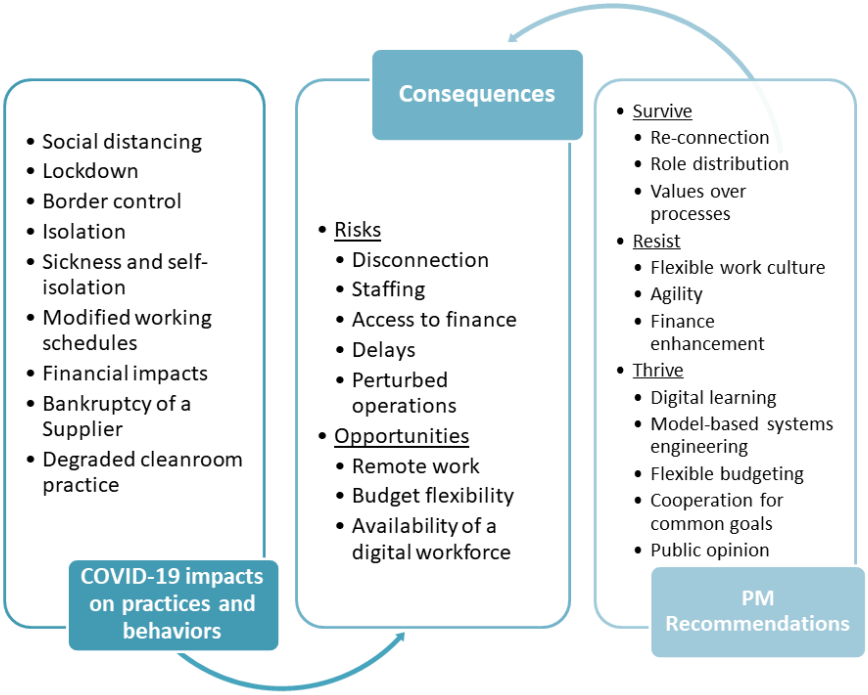

Figure 1: COVID-19 impacts, respective consequences on projects and recommendations

From their own first-hand experience, the team remarks that **young professionals care a lot about the notion of team spirit**. They like to get a sense of community from their work and the feeling that what they do is meaningful. Teams do not need a crisis to feel disconnected; a lack of engagement from management is sufficient. Values like **openness, high trust and encouragement** are beacons and a dedicated and involved project manager makes all the difference.

Topic 4b:

Two methods were utilized to understand impacts of the current crisis on space program management: a questionnaire to obtain real-world insights, and then the application of Cost-Benefit Analysis (CBA) to a case study informed by those same questionnaire results. It is considered that this work may represent the first broad data collection from space project management experiences of COVID-19. To provide quantitative insights into the application of CBA during the crisis, a simple CBA exercise was performed that quantifies in monetary units the impacts highlighted by the questionnaire, with a particular focus on evaluating the effect of teleworking.

The simplified CBA suggested a need for an efficient and effective productivity assessment tool to manage the progress in projects/programs and hence maximize the outcomes out of remote work. To this purpose, the team proposes a new productivity assessment tool, the Distinguished Analysis using Binaries (DAB).

In conclusion, the team identified higher-level actions, to be performed by governments and Institutions, as well as lower-level actions, referring to some policies to be adopted by companies or good practices to employ at the project level. The following figure briefly summarizes the recommended actions.

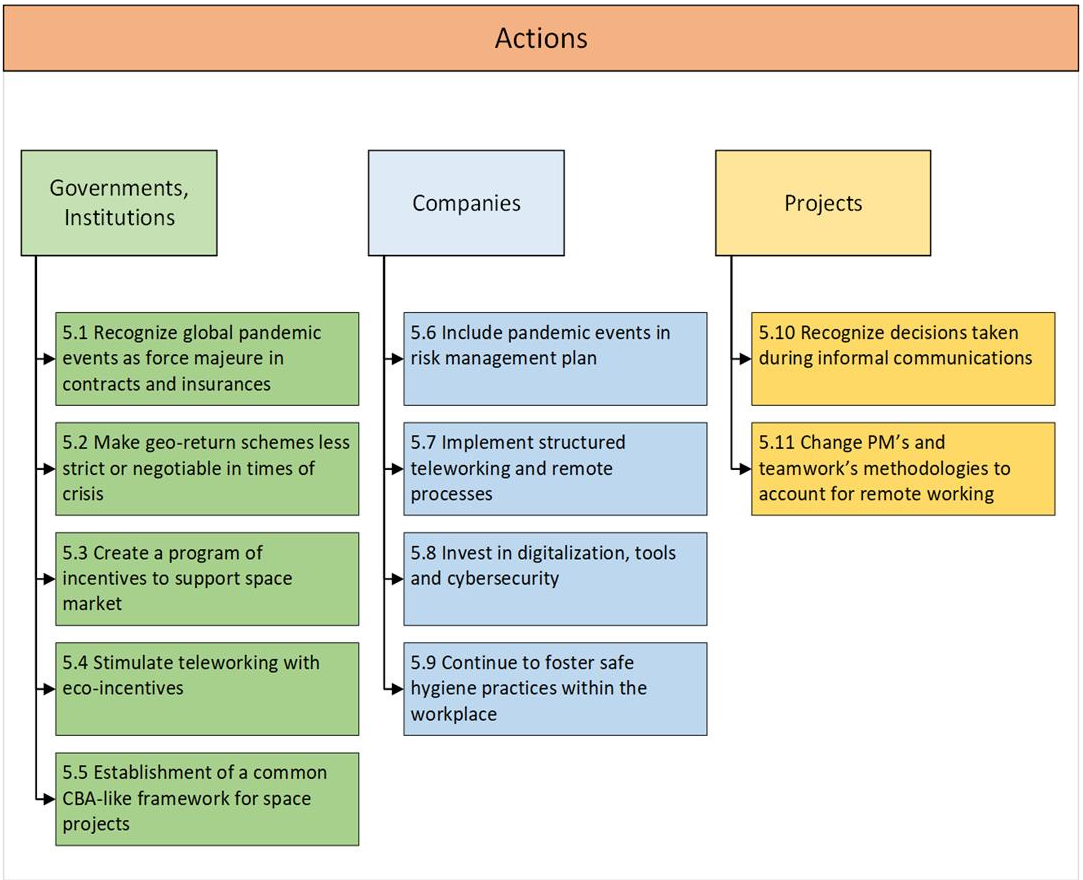

Figure 2: Categories of actions to undertake for facing a crisis as the COVID-19 pandemic

Lastly, the team recommends the formulation of a **standard set of CBA tools** that can be adopted by all projects in the space sector to allow for easy comparison of the impacts of unforeseen events and of the effectiveness of associated responsive actions set in place.

2. Introduction

On 11 October 2020, a group of 31 international young professionals – working in space agencies, companies and professional organizations – met to participate in an annual event sponsored by the International Project / Programme Management Committee (IPMC) of the International Astronautical Federation (IAF) as culmination of a 3.5-months-long workshop. The workshop was planned and organized by a team of alumni working in collaboration with the IPMC. It was held completely online in affiliation to the 71st International Astronautical Congress (IAC), The CyberSpace Edition.

The IPMC – which brings together representatives from more than twenty IAF member space agencies, companies, and professional organizations – meets semi-annually to exchange experiences, best practices and to collaborate on projects that nurture the global space workforce. The IPMC Young Professionals (YP) Workshop is an annual initiative and its Final Event is held just prior to the IAC. The IPMC selects a small group of young professionals who previously participated in a YP Workshop to serve as the Workshop Organizing Committee and help the IPMC organize and manage the event. The 2020 Workshop Organizing Committee (WOC) members were:

Linn Boldt-Christmas	Communications Manager
Mark Fittock	Operations Manager
Birgit Hartman	Strategy and Implementation Manager
Andreas Lyder Pedersen	Delegates Manager
Eleonora Zeminiani	Project Manager

The Workshop Organizing Committee members were also asked to closely follow the development of the discussion topics, guide the discussion group deliberations, and prepare this final report. The 2020 IPMC Young Professionals Workshop attracted thirty-one early career employees from government, industry, research, and professional organizations throughout the world. Each of the participants was nominated by an IAF member organization to attend the workshop in response to a call for nominations.

The workshop participants selected one out of five discussion topics to be researched in smaller discussion groups that met virtually during the period from July to October, in preparation of the final event. For further information, please see Chapter 3: Workshop Activities and Virtual Sessions Collaboration.

The results of these investigations and deliberations, with associated observations and recommendations, are presented in this report. The ideas and views expressed herein are those of the participants as individuals and do not necessarily reflect the views or positions of the IPMC, the IAF or its member organizations.

3. Workshop Activities and Virtual Sessions Collaboration

In late Spring 2020, the Workshop Organizing Committee (WOC) published the Statement of Work (SOW) and Call for Delegates and then collected candidatures and applications.
After the selection of the Delegates, the Organizing Committee administered a questionnaire to obtain information including profiles of each individual Delegate, along with their preferred social networking tools, professional capabilities, and personal hobbies. This information helped establish a basis for assigning the Delegates into the various topic groups. Each participating Young Professional expressed particular interest in one of the proposed topics. In addition to their topic interest the participants could express their desire to function as either a team leader or a rapporteur.

The Young Professionals Workshop is a several-months long initiative gathering a globally distributed and diverse group of Delegates. In order to establish relationships among the Delegates and promote teamwork on the assigned topics, the WOC encouraged use of online virtual, social and collaborative tools, such as Slack, WhatsApp, Google Docs and the scheduling tool Doodle. Delegates were also free to propose and use other tools of choice, among which were Google Meet, Trello and Miro.
The goal was twofold: on one hand to facilitate "breaking the ice," and on the other hand to initiate and maintain group conversations around the chosen discussion topics.

The WOC then organized a first meeting via Webex to introduce the Statement of Work and explain in detail the expectations, goals, timelines, and deliverables. This was also a good time for the Delegates to ask any questions, and to share their initial thoughts and ideas.
Each group was assigned a topic leader and a rapporteur. The topic leaders were responsible for producing requested deliverables and for managing other related discussion group tasks. The topic leaders were also the main point of contact for the WOC. The rapporteurs were asked to document the discussions and the progress made and ensure consistency of the deliverables with respect to the SOW requirements.

The virtual sessions process began in early July 2020. Until the October Final Event, the Delegates were asked to work on their single-team topics. Discussion group meetings, scheduled mostly through Doodle, were facilitated via videoconference and digital collaboration tools, which allowed Delegates to self-organize teamwork in line with their availability. Documents, such as mid-term reports and project execution plans, were submitted as deliverables and shared under folders in Google Docs. This proved to be a very helpful and reliable tool and was easily accessible by Delegates around the world. The teams conducted in depth investigations, held various interviews, and shared their own day-to-day experiences working in the space industry as young professionals. As a platform for collaboration among the participants from diverse locations globally, the virtual sessions worked well and were a mean to bring the Delegates together and facilitate the research prior to the live Final Event.

Mentors have been key contributors to the success of the initiative. Mentors are senior professionals with specialized insight into the topics being investigated.
Mentors were selected by the WOC in late Spring 2020, by collecting volunteer applications and by scouting suitable profiles and connections. A dedicated orientation session (once more, an online virtual meeting) was held between the WOC and Mentors, to introduce the purpose and inner workings of the workshop and to better explain to the Mentors what was expected from them. One or two mentors were assigned to each topic group, with the objective to offer advice and steering, evaluation of ongoing research, critical assessment of results and recommendations. Mentors were the "critical voice" that helped the Delegates measure their work against the typical key drivers of project management (cost, schedule, quality) and build the case for their proposals by discovering weaknesses and clearly identifying the possible "return on investment."
Mentors were in contact with their assigned topic group (through the topic leader) and each team agreed on a preferred pattern of attendance. Some teams worked more closely and more often with their Mentors, involving them in every teleconference and every discussion, while others established recurring checkpoints spaced out by periods of autonomous research.
In any case, Young Professionals and Mentors were able to form fruitful alliances to improve the value of workshop outcomes and to collectively grow the space community. They also greatly contributed to the quality of the Final Event where they had a chance to discuss live the results of their own and other teams' research.

Mentors for the 2020 IPMC YP Workshop were:

Daniel Daly	Project Management Curriculum Lead for NASA APPEL
Anthony Murfett	Deputy Head of the Australian Space Agency
Sabine Riek	Administrative Project Manager in DLR PMO
Susan Snyder	Lead for the NASA Chief Knowledge Office
Chris Stevens	Consultant for the Australian Government in Special Projects
Melanie Winzer	Executive Director, Integrated Programs and Planning and Head of Performance Measurement at CSA

4. IPMC YP Workshop reaching YPs worldwide and Special Considerations for 2020

In the nine editions of the workshop since 2012 the workshop has had 284 participants from 12 different countries on average.

Based on the location of the IAC, the WOC can observe the following:

- The nationality of the participants shows a direct link to the location, i.e. more Asian Nationalities at IAC Beijing, a majority of Europeans at IAC Bremen, etc.
- The cost of accommodation and travel is an important decision factor for young professionals to attend.
- Visa requirements can prevent young professionals from attending.
- Virtual collaboration sessions and virtual final events allow attendance of a larger pool of delegates, by cutting out travel expenses and associated limitations in Company's sponsorship budget.

As the Statement of Work for this year's IPMC Young Professionals Workshop was being finalized, the world was engulfed in the COVID-19 pandemic. The ensuing lockdowns did not spare IAF activities, which have been heavily affected with cancellation of all major events for 2020, including IAC in Dubai, which was replaced by a CyberSpace meetup.
Despite these challenges, the IPMC YP Workshop Organizing Committee decided to still pursue the 2020 edition. The motivation came from the awareness that a core strength of the workshop is the fact that it is almost entirely held online, through virtual collaboration sessions that bring together delegates from all over the world. Only the final event had to be reinvented in this new global framework.
It is the WOC's opinion that the workshop has been even more meaningful during this worldwide crisis, by proving how younger generations and their smart work approach are intrinsically resilient to disruptive events such as a widespread lockdowns and forced isolation.
The Young Professionals Delegates to the 2020 IPMC YP WS have tackled the topic proposed in the SOW with effort and dedication, reflecting on the peculiarities of current times and their effects on Project/Programme management.
2020 marked the 10th anniversary for the IPMC and the ninth occurrence of the YP WS: Young Professionals really transformed the challenge into an opportunity and demonstrated how successful teamwork and brilliant results can be achieved in such challenging, volatile and uncertain circumstances.

5. Group Topic Results

The 2020 IPMC Young Professionals Workshop dealt with Space Project Management in the world of global lockdown, remote work and mobile technology. All research themes were encompassed by this overarching topic. During the Final Event, the five discussion groups met in a plenary live session for the first time and presented their findings to the other groups along with several IPMC representatives and a general audience. The topic reports prepared by the five groups, together with each group's concluding observations and recommendations, are presented below. Due to the amount of information gathered, this report is a concise compilation of the results. Links to full research material can be found in the concluding chapters.

5.1 How do fragmented, remote, delocalized and virtual teams affect the way space projects are managed?

5.1.1 Introduction and methodology

With the onset of the COVID-19 pandemic in early 2020, industries around the world came to a screeching halt, facing unprecedented challenges. With reduced, stratified workforces, supply chain roadblocks, and heavily restricted capital resources, companies across all sectors were forced to rethink their business strategies. The global aerospace and defense community was equally affected by pandemic restrictions, particularly related to remote personnel and possible delays with productivity and production. Companies were pushed to quickly establish contingency plans for massive workforces while maintaining, to the best of their abilities, rates of manufacturing and cost baselines. The primary concern of every company remains the safety of its employees but tangential is the remedial actions necessary to survive in the era of COVID-19.

The team collected literature research and case studies surrounding topics related to the effects that both employees and space firms have endured throughout the pandemic. The pandemic is a disruptive crisis that has led to a sudden shift in the daily routine of nearly all space companies. Although extensive data is not yet published regarding aerospace productivity in general, the report argues that the current environment, created by the pandemic, provides valuable insights into the future of work, particularly related to decentralized teams.

The results are broken into two main sections: employees' perspective and employers' perspective. For the employee's perspective, based on statistics from both aerospace and generalized workforces, the team discussed the effects of social interaction, networking, and professional interconnectivity towards the ultimate success of the individual. For the employer's perspective, the team found that companies and government agencies have reported unique difficulties while dealing with COVID-19 and are still fine tuning their approaches to keep employees satisfied while maintaining productivity and efficiency.

Using the associated research on individual and corporate responses to remote work during

COVID-19, several recommendations are put forth as a conclusion. While these recommendations are currently salient, it is worth noting that continuous evaluation should be performed to ensure that both employees and employers are consistently adapting to the evolving situation. COVID-19 is a dynamic, impactful event and the response to it must be equally flexible and progressive.

To begin research on the topic of remote work, the team decided to home in on the human factors and firm responses to COVID-19. The human factors research focused on the individual and how employees in the space industry have responded to the pandemic, as well as generalized information on workplace interactions. Research into the firms' perspectives looked at industry trends within aerospace and across the globe to see effective techniques to work with stratified teams. Given the limited data currently published on COVID-19 workplace effects, the team relied heavily on literature research and expert testimonies that have been recorded through online forums, newspapers and educational journals.

The team also conducted online interviews to get first-hand testimony on the effects that aerospace entities have dealt with during COVID-19. Two space organizations provided interviews – the Space Generation Advisory Council (SGAC) and Thales Alenia Space. In a dedicated Section, the answers to these questions are discussed in depth.

5.1.2 Research and Investigation

Employee's Perspective

In the team's own experience, individuals were driven by their employers to begin working at home in March, when COVID-19 was first declared a pandemic . Although initially a stressing change, many employees are now reporting that the ability to work from home has been a welcome change, allowing for a better work-life balance and a more relaxed approach to their careers. While employees may not have initially been well prepared for the challenges of "smart working," they are now thriving and hope to carry some of the changes forward after COVID-19 has subsided.

It has become quite apparent that work from home (WFH) is a great opportunity for individuals to adapt to a new work situation, one they hope will be preserved once work restrictions are lifted. Employees have repeatedly cited the improvements related to flexibility in their work hours and additional time spent with their families as major positive indicators for their work life. Some of this feedback was collected in the Statista portal, which collected the results of over 3,500 industry interviews related to work benefits. Some of this data is reported in **Errore. L'origine riferimento non è stata trovata.** below. In particular, 58 percent of employees consider flexibility, both in terms of work-life balance and physical location, to be the most important work benefits. Beyond flexibility, the interviewees cited commutes and time off as critical decision indicators when selecting a job. (Holst, What's the biggest benefit you see to working remotely?, 2020)

Employees with children at home strongly identified the flexibility to spend more time with their families while working from home as a benefit. The ability to work remotely allowed these employees to continue their careers without having to sacrifice other key aspects of their life.

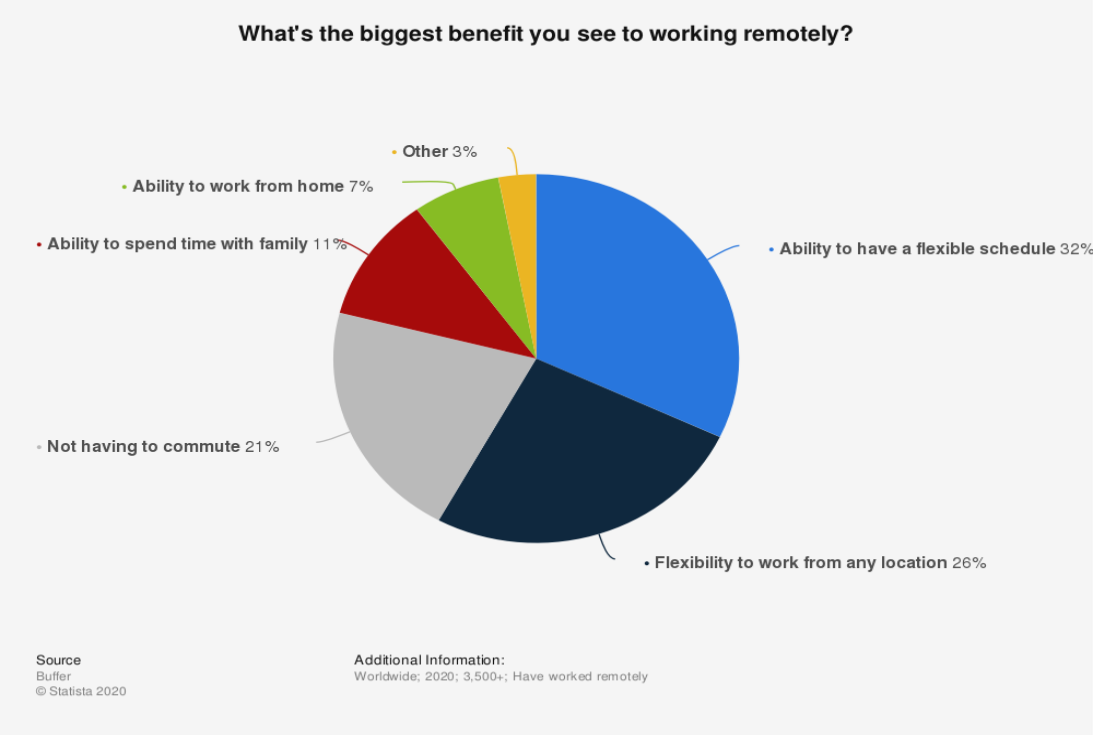

Figure 3: Statista Employee Survey

A similar study was performed with more than 3,000 professionals from Australia, the United Kingdom, the United States and Canada. The study subjects were at least 21 years of age and worked remotely with digital tools. The survey questioned their attitudes towards remote work and how they viewed various aspects of remote work when compared to a traditional office space (Holst, Attitudes on remote work for employees in companies with digital output in 2020, 2020). As seen in the **Errore. L'origine riferimento non è stata trovata.** below, almost all of the interviewees appreciated the ability to work remotely and would recommend it to a friend. Additionally, they felt very well prepared to perform their job and felt that remote work is the way that work should be performed in the future. It is also worth noting that 84 percent of the responses claimed that they could accomplish all of their tasks remotely, citing improving technology related to remote work.

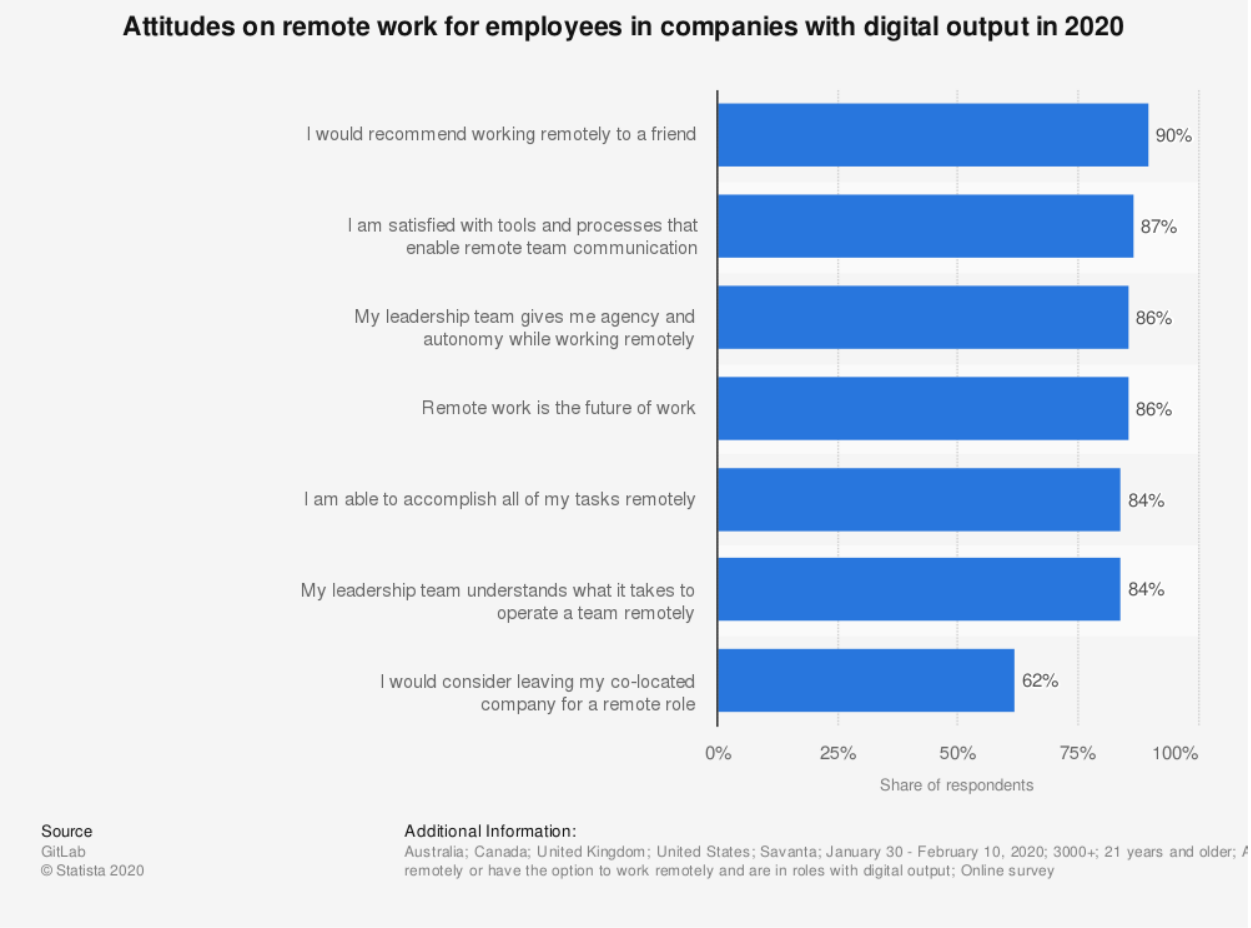

Figure 4: Statista Digital Workplace Report

Social Importance of Work

As explained by *Forbes* (Brower, 2020) and reported below, work is fundamentally a social activity. There are very few jobs that do require continuous collaboration and deep relationships with co-workers, managers, and customers. Having positive and satisfying human interactions at work is a key metric when an employee decides to stay with an organization. Often, these relationships are not immediately valued but the transition to remote work has made the importance of these direct interactions quite evident. Communication is not only verbal but also requires physical interaction to properly interact, mediate, negotiate and make decisions. Without the opportunity to interact with other humans, we potentially lose the ability to compete, adapt, and react, all pillars of a successful professional life. From the two reports mentioned above, there are two main takeaways. The first is the necessity to adapt the way employees work, shifting to relevant digital communication technologies to perform their job without changing their role.

Second is the need to use technological surrogates to substitute human relationships that typically occur while in a physical workplace

"You've known that having good work friends can help you be more satisfied and stay at your job longer, but in the midst of the coronavirus pandemic, they are more important than ever. While you're working from home, and while you're practicing social distancing, friends are critical to mental health and overall well-being." […]

"This is the power of partnerships and being in a context where cooperation is valued. In addition, it points to the positive influence of social obligation—or reciprocity—in which people expect they owe something to others when they are in a relationship together. It's social obligation that keeps us home during the coronavirus pandemic and causes us to make decisions that are not just in our own best interest, but in the best interest of the whole of the community." […] (Brower, 2020).

Age Differences and Remote Work

With fragmented, remote teams now the new norm across all workplaces, it is necessary to acknowledge that different age groups are adapting at different paces and with varying success. According to a 2017 Gallup poll, Millennials rank remote work flexibility as their highest valued job benefit. Employees 40-55 rated the same benefit nearly 20 percent lower when considering their benefits (Lister, 2020). This story rings especially true in the aerospace sector, which has one of the oldest workforces of any industry. The Aerospace Industry Association reports that nearly 35 percent of aerospace employees are aged 51-69, nearly 15 percent higher than other areas of engineering and manufacturing (Association, 2016). Given global guidelines for COVID-19, these older employees will likely be the last to return to the workplaces. However, despite the common misconception that older workers are at disadvantage with remote, more digitized work environments, Alicia Munnell of the Boston College Center for Retirement Research says that "this is just incorrect." In fact, 47 percent of workers over the age of 55+ have a job that can be performed at home with nearly no change to productivity. That number decreases to 41 percent when the employee is aged 24-35 (Munnell, 2020).

While younger employees prefer the option to work at home and seemingly adapt better to the changing environment, their jobs are actually less conducive to this change. Without the interactions of a traditional workplace, early career professionals miss opportunities to socialize, network, and develop skills necessary to be an effective worker and teammate. A 2014 LinkedIn survey found that 57 percent of employees under 35 said that having a social experience at work made them happier and, in turn, better at their jobs. With the transition to remote tools such as video conferencing and interactive workplace chat rooms, Hannes Schwandt of Northwestern's School for Education and Policy worries that younger employees will struggle to develop their careers. "Usually, socializing at conferences is a way the next generation gains ground," says Schwendt, "while the more established older cohorts are staying home" (Kaplan, 2020).

Negative Effects of Remote Work

Previous paragraphs have presented in depth some of the benefits of remote work. If properly implemented, working from home may be the future of the workforce. However, there are various drawbacks that require proper attention, as well. Newspapers, social media, and employment experts warn about the necessity to regulate work from home habits in order to preserve both physical and mental health. Beyond personal care considerations, it is important to note the hinderances that "workplace loneliness" can contribute to employees while working remotely.

Employees were forced to completely disrupt their work habits as the pandemic spread over the globe. Prior to COVID-19, most people would have daily face-to-face meetings, frequent personal discussions, and constant social interactions. Instead, employees now are forced to abandon common spaces, typically work alone, and experience little to no human interaction on a daily basis. Any in-person work is done at a social distance which, in its own right, is a lonely encounter. These environments can create "workplace loneliness" where both home and the office may feel isolated and difficult to adapt to. Some employees have reported increased depression, anxiety, and sense of despair (Ettman, 2020).

Workplace loneliness can be a problem even when everyone is working at a physical office. But the sudden shift to remote work has severely increased that risk. Research shows that workplace loneliness hurts job performance as employees become less productive and co-workers find them less approachable (Vasel, 2020). It is incredibly important that employers work to keep teams integrated, despite remote physical locations, in order to keep the mental wellbeing of their employees in check.

Employer's Perspective

In the first few months of the COVID-19 outbreak, companies and government agencies were forced to limit immediate damage and ensure the safety of their employees. New guidelines were released focusing on social distancing, proper hygiene, and selection of critical employees (Center for Disease Control, 2020). Several R&D programs across the United States were halted to preserve capital, with expectations that cash flow would fall off in the coming months (Boyden, 2020). Agencies were forced to make difficult decisions on program schedules and timelines. With a transition to a majority remote workforce, the European Space Agency was forced to push the ExoMars program launch back to 2022, with COVID-19 adding challenges with limited inter-agency travel for meetings and negotiations (Halpern, 2020). Additionally, Bigelow Aerospace, a private enterprise focused on space tourism and space habitats laid off its entire staff, citing the "perfect storm of problems" related to business closures and COVID-19 (Foust, 2020).

However, given the intertwined nature between defense and aerospace, it is critical that measures are taken to ensure that productivity and production do not suffer across the aerospace sector. In March, United States Undersecretary of Defense for Acquisition and Sustainment, Ellen Lord, declared that all aerospace and defense companies and contractors were "critical infrastructure" to

maintain the safety and security of the country (Mehta, 2020). Similar actions were taken across the globe, yet a major shift in the culture and confidence within the aerospace industry became clear shortly after the pandemic started (Boyden, 2020). Companies and government agencies must determine how to continue their production and development, despite the new challenge of remote workforces.

Supply bases and hardware development are near the top of global aerospace concerns. When consulting firm PwC polled over 300 financial leaders in North America, concerns of supply chains, government funding, workforce development and global economic downturn topped the list (PwC, 2020). Hardware-focused industries such as aerospace are inherently bottlenecked by reduced workforces as manufacturing and production cannot be performed remotely. Manufacturers immediately reduced their workforces to meet national guidelines on safe workplace practices. Social distancing, limited duration shifts, enhanced cleaning procedures and restricted contact were all put in place (Center for Disease Control, 2020).

These restrictions slowed the rate of production and are predicted to lead to massive losses across the aerospace sector. Aerospace consulting firm Teal Group estimated that aerospace manufacturing, traditionally an $80b industry, could see a reduction in orders as great as 75 percent over the course of the next 9-12 months. Both suppliers and primes suffer from this reduced demand. Global consultancy Roland Berger warns that short-staffed but overstocked suppliers will have to "...consolidate, integrate, and find the 'right-size' " when it comes to maintaining their workforce and profitability (Hader, Thomson, & Lipowsky, 2020). Without the usual production rates across the aerospace industry, suppliers will struggle to keep their heads above water, and, in turn, buyers will see delays on orders and a vicious cycle of further production delays.

Interview Discussions

As previously mentioned, in order to supplement the literature research, two case studies were performed by interviewing managers at prominent space entities: Thales Alenia Space and the Space Generation Advisory Council (SGAC). Managers from each group were asked the following set of questions:

1. *How has your team shifted its work routine to respond to COVID-19 and how have your team members reacted?*
2. *What has your project management work methodology been during COVID-19? Why did you feel this was the best path forward?*
3. *Do you think young professional were better able to adapt? Do you think they are more productive while working remotely?*
4. *What are strengths and weaknesses of remote work?*
5. *What instruments or tools have you tried to use to cope with COVID-19 and remote work?*

6. *Do you plan to use and of these tools after COVID-19 is no longer an issue?*
7. *Have the projects you are working on experienced a negative impact? A positive impact?*
8. *Have you gained new skills while coping with the COVID-19 crisis? Do you think those skills will be important for future work when the crisis is over?*
9. *Any other comments?*

In general, both Thales Alenia and SGAC expressed positive feedback after the initial shift to remote work. As documented at both the managerial and employee level, the shift to working primarily from home has allowed for more flexibility, fewer unnecessary meetings, and improved productivity overall. SGAC is a unique case given that the team was already stratified before the pandemic and was well prepared to continue working remotely. However, SGAC was able to comment on the various events they host each year that are typically in-person, including the Space Generation Congress and Space Generation Fusion Forum. The transition to online forums has been unique for SGAC and provided its own set of unique challenges.

Thales Alenia did mention that some employees reported some negative reactions to remote work, including more consistent distractions and less motivation to complete work without oversight. However, the majority of the interviewees felt that they were well equipped to work from home and the answers aligned well with the reports discussed in the literature review.

While these two organizations provide a good snapshot of how space companies are responding to the pandemic, a larger more diversified study should be performed to gather data specific to the space industry and how remote work has affected similar companies. Specifically, it would be interesting to see how hardware production has been affected, as the space industry is very uniquely tasked with outputting complicated, expensive hardware on a regular basis.

5.1.3 Conclusions and recommendations

Given the reported information on both the perspective of individuals and firms in the aerospace industry, the team offers several recommendations to best navigate the current aerospace environment.

When it comes to how firms can respond to the pandemic, the primary objective is **flexibility**. While the aerospace industry is best associated with heritage and strict processes, in these unsure times, new work methodologies are required. Any employee, regardless of age or position, should be polled to ensure they can adequately perform their role remotely. All necessary software tools should be securely deployed to ensure as little technological interference as possible for the employees' day-to-day tasks. As seen in the surveys, most employees are still able to perform their roles remotely and feel just as productive and effective, despite their new environment. It is the companies' job to ensure that the employee has all the necessary provisions to maintain their productivity.

Additionally, **processes will need to be updated to accommodate a remote workforce** and ensure that productivity, profitability, and job satisfaction remain at the forefront of the firms' priorities. Companies should look to minimize delays in remote communication. Ensure teams are responding to email communications, setting up face-to-face digital meetings, and working to establish dynamic, responsive communications methods that allow for quick, actionable responses from employees. If employees are not able to work in person together, the processes that allow for communication should mimic that work environment as much as possible. Suppliers should be integrated and manufacturing floors streamlined. The key to success in a remote world is **simplicity**. When workers are not able to communicate in person, processes must be made as **transparent** as possible and communication roadblocks must be minimized.

When implementing WFH for the long term in a post COVID-19 world, negative effects of WFH should be further studied and must be taken into account by the aerospace sector. Managers and project leads should ensure they **provide ample socialization and career progression opportunities for younger workers** while ensuring that tools are in place to help older employees adapt to the digital world in which they will need to continue their career. Regardless of how many tools are rolled out, they are no good unless employees are properly equipped with the **soft skills** required to navigate these difficult times.

Most importantly it is necessary to remember that there are real people working on the other end of your video call. The pandemic is an unplanned, unexpected, and unprecedented crisis. There will be new struggles that arise both as the pandemic continues and, eventually, as work returns to normal. Firms should remain flexible and understanding of employees' possible hesitation to return to a traditional work environment. As always, employers must show **empathy and caring** when it comes to the needs of their employees. Furthermore, metrics such as those cited in the above Sections should be continuously monitored to see if a return to the traditional office setting is even appropriate and the most effective way to operate in today's advancing technological world.

As seen in the various reports and first-hand accounts collected by the team, employees have a very positive reaction to remote work. There are several positive attributes of remote work, including flexibility in work location and schedule, less time spent commuting, and the ability to be closer to family throughout the day. However, there is still not sufficient data to show from the firm's perspective whether remote work has caused significant delays in productivity or if employees are correct when stating that they are just as effective when working from home. It is also important to keep the potential negative effects of **long-term isolation and workplace loneliness** in mind when considering the continuation of remote work after COVID-19 is resolved.

It is important to be critical before generalizing that working from distance will always be beneficial for employees after the end of the pandemic. First, there might be negative social impact on individuals and second, space firms might report a reduction in productivity.

The pandemic has created a unique experience that might provide some lessons for the future of work. An important lesson is to create a more flexible working environment for employees in a

way that doesn't affect post-pandemic work productivity and workplace social interaction. This means that more research will be required to understand how COVID-19 affected the productivity of work and which tasks have suffered the most. It's possible that space firms adapt a **hybrid work form** of sorts that allows specific tasks or roles to be performed remotely while jobs that have suffered during the pandemic are transitioned back to the traditional in-person work environment.

Overall, while COVID-19 has been incredibly straining on the world, there may be some valuable lessons learned. If productivity can be maintained, a flexible work environment is seen to make employees happier and more likely to stay with a company long term. As long as companies are able to adapt and provide adequate social interaction for their employees, whether in person or digitally, there is a strong likelihood that working from home is here to stay.

5.2 Which are the key leadership and planning aspects of PM in a time of crisis?

5.2.1 Introduction and methodology

Research on crisis management has concentrated mainly on risk management, risk assessment (Herbig, 2003), and the effect of crisis on business profitability (Slintak, 2003) but less on the key leadership skills and type of management to adopt during those time. The few studies that have looked at health crises focus more on risk and contingency planning (Brennan, McKay, & Michael, 2004; Powell, Mustafee, & Brown, 2018; Wagner, 1994). In a case study of Cisco Systems, (Groeger et al 2019) find that organizations need to adapt fast to survive those crises. To do so, organizations and their managers need to decentralize decision making to an operational level to be responsive. In fact, this study suggests that managers perceive themselves as facilitators and orchestrators rather than owners or even controllers of employees.

Recognizing that management is about control and authority, while leadership is about inspiration and motivation (Nayer, 2013), the team used COVID-19 as an opportunity to investigate "Key Leadership and Planning aspects of Project Management in a time of Crisis." It did so by providing an analysis of interviews conducted with young professionals and managers from leading space organizations from three European countries, Japan, USA, and Canada with the objective to answer the question: *How do Young Professionals look to Managers and leaders in times of crisis?*

The team examined the mandates and responsibilities of managers and leaders, how those align with what managers and leaders think young professionals expect from them, and the actual expectations of managers and leaders from young professionals during times of crisis.

The analysis is based on the assumption that management success in delivering on project objectives and deliverables depends on the productivity of employees (Henderson, 2008), which depends on their well-being and expectations of their work environment (Osa and Amos, 2014).

The team started off with three major hypotheses, i.e.:

(H1) that during times of crisis, young professionals have different expectations of their managers and leaders than managers recognize, and that this has a negative impact on employee productivity and motivation;

(H2) that new leadership skills emerge during times of crisis, such as being more self-sufficient without direct guidance and communicating through a plethora of modalities (remote screens and phones) that require different skills (e.g. interpreting inflection rather than body language);

(H3) that managers and leaders develop new skills and change their management methods during times of crisis and that these new methods will be adopted into post-crisis times.

Subsequently, the group carried out qualitative interviews to challenge and measure their assumptions and to obtain a set of recommendations for managers to lead young professionals in the space industry during times of crisis.

5.2.2 Interviews setting and findings/results

The team conducted a total of 30 qualitative interviews with managers and young professionals from 7 organizations in the aerospace sector. The interviews were conducted at 3 European organizations, 2 US, 1 Japanese and 1 Canadian aerospace organization. The organizations span from medium-sized private to large governmental-funded entities within the space sector. All organizations differ in cultural and historical background, as well as hierarchical and management structure.

The topics covered in the interviews aimed to assess people's response to the crisis and how the leadership and planning skills of their managers impacted them. Notably, the COVID-19 crisis was specifically referenced, but interviewees were free to present other relevant experiences: some of them had experienced natural disasters or social unrest as crises. Questions were structured using the de Bono six thinking hats facilitation technique (de Bono, 1985).

Of the 30 people interviewed, 46.7 percent identified as a young professional, and 53.3 percent identified as a manager of some sort. There were three participants from the Canadian Space Agency, 4 from DLR, 6 from Dynetics, 4 from JAXA, 8 from Jet Propulsion Laboratory, and 4 from Thales Alenia Space. Those interviewed represent unique viewpoints from both private industry and government organizations from around the world. The interviewees also represent a wide range of seniority in industry, ranging from less than 5 years through 20+ years of experience (Figure 5). Notably, managers and young professionals had varied experience with young professionals tending to <10 years' experience and managers tending to 20+ years' experience.

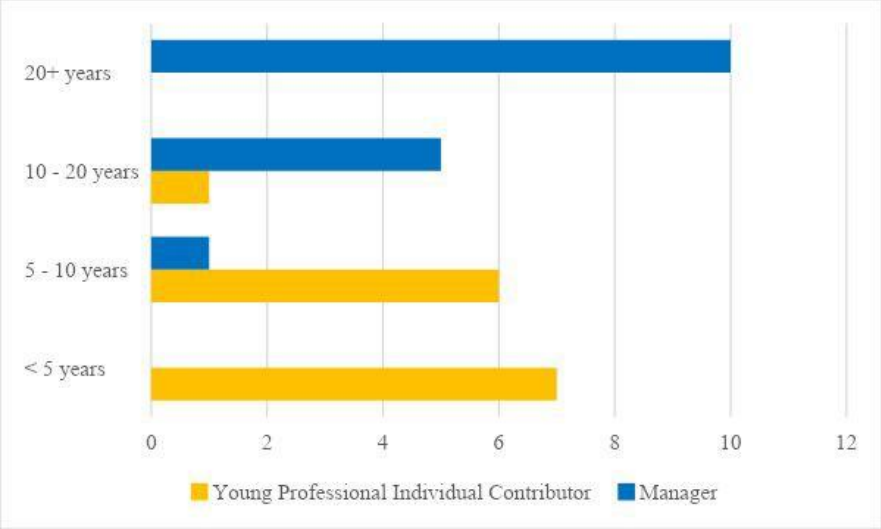

Figure 5: Distribution of Years of Experience of Interviewees by classification as Manager or Young Professional Individual Contributor

While all of those interviewed come from different backgrounds and are experiencing different situations at work due to COVID-19, there are many similarities in the expectations, surfacing

skills, and ideas for improvement during the crisis. The overarching common finding is that, during a time of crisis, managers and leaders are not distinctly different.

Management Interviews

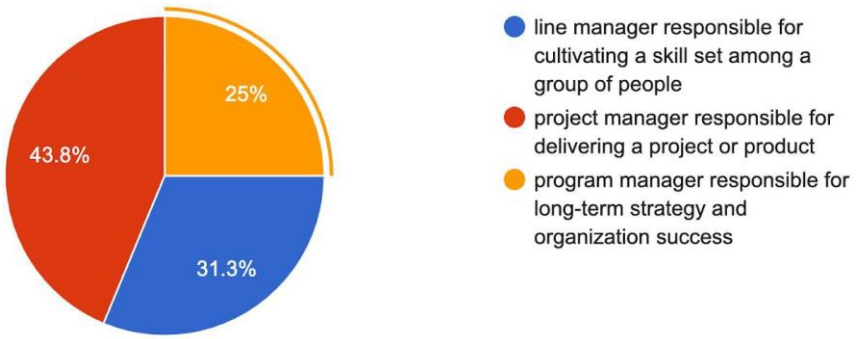

Figure 6: Distribution of Years of Experience of Interviewees by classification as Manager or Young Professional

Of the 16 Managers interviewed (Figure 6), 7 were project Managers (red), 5 were line Managers (blue), and 4 were Program Managers (gold).

<u>Managers' perception of young professionals' expectations</u>

Managers have differing opinions of what young professionals expect from them during the coronavirus crisis. The majority of managers interviewed agreed that young professionals expect to be kept informed to company and job expectations during times of crisis – they emphasized that young professionals want to be kept informed of what the company expects of them, and what the company's stance is on safety and returning to work during the crisis. In addition, managers also recognized that young professionals are looking for guidance during this time; there are young professionals who have families or are just starting their careers who may struggle in coping with the global crisis, and managers felt that young professionals expect them to provide guidance during these times.

Managers also noted that they are looking to young professionals to step into leadership and influence their own careers by inventing new and innovative ways to collaborate and promote teamwork during the crisis. Young professionals, in the eyes of management, are displaying great flexibility in working during the crisis and are contributing to management's understanding of flexibility, the use of technology in the workplace, and the success of a virtual, collaborative environment.

Limiting factors for managers to consider

Although managers understood their role to communicate, they acknowledged some limitations. Specifically, many managers pointed out a major roadblock that occurs when trying to collaborate in a virtual environment – body language. Managers noted that the absence of body language creates a work environment where it is particularly difficult to realize how everyone is doing, whether or not they are struggling, and if they need to step in to discuss further. In addition, managers pointed out the lack of "quick chats" that in the past were a result of sharing coffee in break rooms or momentarily stopping by someone's office to check in on how they're doing. Without body language and brief check-ins, management is finding it increasingly difficult to feel connected to their teams.

Another disadvantage noted by management is the need to press on to meet firm deadlines. Programs and projects may not recognize the implications of the virus on a workforce, resulting in static due dates that do not accommodate current events. This creates a challenge for managers as they must learn to be more accommodating of the more flexible schedules of their employees, who may be dealing with childcare and other limiting home aspects during this time. The pressure to meet firm deadlines is only exacerbated by the fact that managers now must plan for virtual meetings, knowing they cannot press every employee to always be available during what used to be "standard work hours."

Change in management style

The change in home priorities and work normality has forced some managers to change their management style, while others saw no difference. Only a few managers noted that there were no changes in their management style, but that they did recognize an increase in communication within their teams. Most other managers noted that they found themselves more communicative and understanding. Many of these managers are likely in the same boat as their employees, struggling to balance work and family obligations. To increase communication, managers are focusing on maintaining a flow of communication to their employees and many are setting time aside for checking in with their workforce to make sure they are receiving the support and resources they need to effectively do their jobs.

Lastly, managers have found new ways to accommodate a mostly virtual workforce. For example, many managers noted that back-to-back meetings are taxing, so they have tried to make meetings more effective. Some techniques include cutting meetings short to give everyone a break from one conference call to the next and being more focused in creating meeting agendas.

Planning has also become a significant priority for managers – several managers noted they are more intentional than ever before when planning meetings and organizing workflow. They noted how necessary the extra planning is during times of crisis to keep everyone working as a team, even though they may feel that they are working in vacuums.

Benefits to management in COVID-19

One of the obvious benefits of managing teams during COVID-19 is the move to more teleworking. Several managers noted that they are much more satisfied working from home and gaining time back in their personal schedules. More teleworking lends to the provided benefits of teleconferences, which give voice to more people on the team. More people speak up during "virtual calls" than would have normally spoken up in a conference room. Teleconferences and technology in general are forcing their workforce to write more notes, which in turn has helped the meeting outcomes to be more effective.

Managers noted the benefits of hiring during this time as well – several had successfully interviewed, hired, and on-boarded new employees, an encouraging result to what was previously thought to be an impossible task.

Along the same lines, several managers mentioned the benefit of getting to know their team better. Simple check-ins with their employees and hearing about their children or home situation has caused an increase in compassion from managers, and in all cases of those interviewed, it is seen as a great benefit.

Management styles to implement after COVID-19

During COVID-19, there were several aspects of management that interviewees identified as areas they would like to continue to support in the future such as flexibility, communication, and empathy. Management has recognized the benefits of having more flexibility because employees are satisfied that they have autonomy and can control their own schedules, which helps people be more productive. Also, managers identified that their increased communication and more focused meetings have yielded positive results in their teams' work. Lastly, many managers noted they found great satisfaction in getting to know their teams better personally and that they intend to continue to do that after the crisis.

Young Professionals Interviews

Young professionals' expectations of managers

Young professionals' expectations of managers during times of crisis (specifically, COVID-19, but not limited to) included the role of managers to be a guide and at the same time a facilitator. Many interviewed young professionals expected their managers to have well-developed soft skills. They needed quick and honest communication/information from them, flexibility, and empathy. While this was generally true, young professionals noted a greater appreciation for managers who seemed to understand their emotional struggles and provided a more flexible working environment in comparison to those who tended to be over-controlling and more dominating. Even though young professionals recognized that communication can be difficult and very limited during a crisis, they emphasized the importance of it to them.

The characteristics of good communication identified by young professionals include timeliness, transparency, accuracy, and honesty. When discussing personal situations, young professionals expected one-to-one verbal communication with management, because digital communications (e.g., emails) can sometimes omit key messaging. Young professionals also expected daily contact with the managers and with other team members, possibly using teleconferencing services to be able to see each other and communicate more effectively. Managers should also be diligent about providing feedback, now more than ever, considering that employees are isolated.
Although communication is essential, over-communication or too much communication should be avoided. Over-communication includes too much contact from managers via phone, email, etc., as well as too much feedback, follow-up, or fixed meetings, which evoked feelings of constant supervision and distrust.
Young professionals identified that managers need good leadership skills and the ability to keep their team motivated and engaged, which is more difficult during the COVID-19 global pandemic because of teleworking. Core to these leadership skills are the ability of managers to help young professionals feel that the company cares about and plans for their safety. Another key trait of a leader was flexibility in scheduling, as each individual has different life situations to be juggled with work, especially during time of crisis. Lastly, leaders lead by example, accepting that employees are not always available, and establishing and demonstrating clear work-life boundaries.

Young professionals' dissatisfaction with managers

A great majority of young professionals were dissatisfied with communication from their managers when there was a lack of clear and relevant information, acknowledgement of employees' lives and hardships, or feedback on their work. Part of this can also be due to a lack of empathy in some managers; sometimes, people felt that their managers did not care about their personal situations and struggles during this period.

Dissatisfaction also resulted when managers did not communicate a plan for navigating the crisis. Young professionals asked for more tangible solutions, plans, or guidance during times of crisis. While young professionals understand that managers do not have all the answers or know how to proceed in a new and challenging situation such as COVID-19, they expect managers to be honest and try to communicate facts. During the first few weeks of the emergency, when many people were working from home, most of them were not able to meet their managers. Many people felt isolated and left without guidance in their work. Also, there was not a clear and continuous line of communication inside projects, which lead to frustrated employees and less productivity.
These dissatisfactions had negative impacts on employee productivity. Some young professionals felt confused and distracted from work, and ultimately less productive. Many people have felt overloaded and reported being overworked, staying in front of their personal computers also during their personal free time at home, maybe also while trying to deal with kids at the same time.

Young professionals' satisfaction with managers

Young professionals positively identified skills in their managers such as good communication, honesty, support, and the ability to create a flexible and adaptable plan to help employees work outside of the office. Young professionals reported satisfaction when managers were prompt in answering questions transparently and tried to regularly keep employees informed about the evolution of the emergency. Many managers scheduled regular quiet hours, check-ins, and set up additional communication channels, making sure that everyone had what they needed to keep working together despite physical distance between them. This choice made employees feel motivated, grateful, and more inclined to work at a similar pace despite the emergency.
Good relationships with managers translated to increased motivation as employees felt useful and engaged. Interviewees reported higher satisfaction when managers reached out and offered to help, however they could – e.g., offering support, being flexible and understanding. Ultimately, it made employees feel like the Company really cared about them.

New skills surfacing: managing as a leader

Figure 7: "Wordle" of the common words used by Young Professional Individual Contributors and Managers when asked what new skills have surfaced because of COVID

Many skills identified as surfacing because of crises such as COVID-19, align with leadership traits. These include soft skills such as communicating information, maintaining connection with stakeholders, and motivating teams. Most soft skills sought from young professionals include verbal and non-verbal communication, organization, and empathy. On the other hand, managers noted the importance of new or improved soft skills such as non-verbal communication, empathy, and flexibility.

Other skills include the use of technology and ability to organize oneself and others. Managers have also improved technology-driven skills including the use of virtual conference systems and other digital communication platforms. Lastly, each employee must learn how to organize their work hours with respect to taking breaks to reach a work-life balance.

Common findings across interviews and discussion

An advantage of using de Bono six thinking hats is the ability to converge on common findings despite divergent or different perspectives, such as those of young professionals or different types of managers. Across all interview responses was a strong emphasis on good communication. This was identified as including timeliness, transparency, accuracy of relevant information, honesty, and the ability to create a flexible and adaptable plan. In general, poor communication resulted in decreased employee motivation and productivity. Such poor communication included lack of information or confusion in the information provided, a lack of acknowledgement of employees' lives and hardships, or a lack of feedback on their work. Perhaps most important to good communication is an effective use of meetings as these can impact employee health. This is especially true during a time of crisis, such as COVID-19, when many employees are working remotely, which introduces many new skills around team building and inclusivity (e.g. giving voice to everyone, including introverts) via teleconference. Lastly, crises offer an opportunity for new skills and new leaders to emerge.

Based on these qualitative findings, the team partially rejected hypothesis H1, i.e. that during times of crisis, young professionals have different expectations of their managers than managers recognize, and that this has a negative impact on employee productivity and motivation. Managers and young professionals agreed that communication was key, but young professionals also emphasized the importance of flexible schedules. While there are some aspects of schedule that are beyond a manager's control, there are intermediate deadlines that can be made more flexible.

The qualitative findings support H2, i.e. that new leadership skills emerge during times of crisis, such as communicating using different technologies and using a myriad of different skills, such as interpreting inflection rather than body language or planning and organizing effective meetings.
The qualitative findings also support H3, i.e. that managers and leaders have had to adapt and develop new skills that change their management methods.

The team found that, during times of crisis with a largely remote workforce, communication is the key aspect in maintaining employee motivation and productivity. Good communication identified by young professionals includes timeliness, transparency and accuracy of information, and honesty. Similarly, Phillips (2020) found that implementing a comprehensive communication plan is vital to ensure that the remote workforce stays informed, with a shared understanding of the situation. Brennan, Mckay, and Michael (2004) recommended after SARs that such a communication plan include a partnership between human resources and public relations "to make certain that accurate and timely information are disseminated to both local employees and senior management." An effective communication plan should also contain frequent and regular formal meetings with the whole team, subgroup / workgroup meeting as well as frequent and

regular one-to-one sessions (Phillips, 2020). The team found that having varied avenues for communicating across the team and providing information frequently results in better leadership. Similarly, Neufeld, Wang, and Fang (2010) found that communication effectiveness is a strong predictor of leader performance. According to Perkins (2009) effective leaders ask more questions, summarize points, and find consensus to improve co-worker connections and trust, which improves employee performance (Philips 2020). These aspects of effective communication can be implemented in remote work; as such, Neufeld, Wand, and Fang (2010) found that remote work, and specifically distance, has no influence on either communication effectiveness or perceived leader performance. To enable such connections, informal meetings (e.g., coffee breaks) without a formal agenda are necessary. When leaders promote attendee involvement, they foster teamwork (Leach, Rofelberg, War, et. al, 2009).

In addition to leadership, the group found that an important element of effective communication is the implementation of meeting best practices. Leach, Rogelberg, War et. al. (2009) observed that perceived meeting effectiveness depends on meeting design factors such as having a written agenda distributed in advance of the meeting. Distributing the agenda in advance of the meeting enables individuals to prepare and potentially contribute more effectively. Another key meeting design factor is meeting size. According to Leach, Rofelberg, War et. al. (2009), attendee involvement is linked to meeting size, whereby larger meetings result in lower levels of involvement and lowered perception of meeting effectiveness; however, a meeting can promote involvement even if it is large.
Specifically, the team's research found that while working remotely and using teleconferences, less dominant and more introverted team members are given a voice and communicate more than in face-to-face meetings. Others have documented the benefits of teleconferencing as helping introverts open-up and participate in discussions (Heidenreiter, 1995; Maples, 1996). Houghton (2020) found that while loud individuals tend to dominate in-person meetings and less vocal members tend to not contribute, teleconferences have levelled the so-called playing field. Important to facilitating involvement from less vocal team members and improving team dynamics is the widespread adoption of collaborative technologies. In addition to use of collaborative technologies, Phillips (2020) proposed that meetings should be documented (recorded or transcribed) to enable free flow of information among employees independent of attendance.

The team found that effective communication improved employee self-reported motivation and productivity. Specifically, young professionals reported that motivation and productivity decreased when there was a lack of information or confusion in the information provided, lack of acknowledgement of employees' lives and hardships, or a lack of feedback on their work. Similarly, Solaja, Idowu and James (2016) found that the way a leader disseminates information and responds to feedback can impact employees' performance, attitude, and commitment to organizational productivity. This confirms findings from Kuroda and Yamamoto (2018) who found that supervisors' good communication with staff and competency in managerial tasks significantly improve employees' mental health, which can enhance employee productivity,

lower presenteeism, and reduce the probability of an employee quitting. Important to increasing productivity is not merely enabling open communications, but also investing in workplace wellness as defined by supportive supervision, employee participation, job control, opportunities to learn, and a culture that prioritizes work-life balance (Lowe, 2003). In these ways, managers can influence employee satisfaction and commitment (Osa, Amos, 2014), becoming facilitators rather than controllers or approvers of business processes (Groeger, Bruce, Rolfe, 2019), thereby inspiring and mobilizing their teams using their own personality (Kottika et. al., 2020).

While communication is widely recognized as essential during times of crisis and remote work, the team found that technology adoption skills are also essential. While managers use these technologies, they rely on young professionals to lead the way. Similarly, Grewal and Tansuhaj (2001) found that times of crisis emphasize a need for "increased commercial and general enterprise skills, and also greater reliance on strong interpersonal skills to work with staff and employees." Brennan, Mckay, and Michael (2004) found that millennials are very team oriented and work well with others displaying leadership in collective action and teamwork (Groeger, Bruce, and Rolfe, 2019). These findings support acceptance of H2 and H3.

5.2.3 Conclusions and recommendations

The team recommends that both managers and young professionals recognize the limits of their perceived reality, which is why shared information through open communication is essential. Teleworking sometimes obscures things that are visible in person (e.g., body language). For example, it is difficult for managers to see the availability or progress of an individual member's work. At the same time, young professionals are concerned about the relationship between the Project / Program goals or plans and their own work, or uncertainties around their work. Open communication can help both parties understand the needs of the other.

The team recommends that managers:

1. Communicate relevant information to employees through direct communication (one-on-one calls). Relevant information directly addresses employee concerns such as manager goals, objectives, and uncertainties related to young professionals' tasks.
2. Implement effective meeting best practices such as having a meeting plan with an agenda and clear direction on expectations for mandatory or optional attendance. People need breaks between meetings.
3. Help plan, schedule, and facilitate teamwork for implementing projects. Managers need to be able to refocus the project around shifting schedules and enabling telework. Flexibility in schedules is important as individuals have different life situations that they are juggling, especially during time of crisis.

The team recommends that companies / agencies:

1. Enable teleworking for more employees as this reduces commutes and encourages more engaged discussions during teleconferencing, giving voice to introverts who otherwise struggle to speak up.

2. Provide training to all employees (especially mangers) in soft skills such as empathy as well as verbal and non-verbal communication. Empathetic skills include expressing emotions, caring, or being compassionate. Employers cannot assume that everyone has learned these skills. Suggested communication techniques include active listening (asking questions, "yes and…", etc.), team engagement, and frequency of interactions.
3. Encourage leadership from young professionals and train senior staff on the best use of information technologies to allow intra-team communication and planning. These tools and apps should be used not only for technical meetings, but also to organize periodic video calls to favour the contacts between colleagues.
4. Encourage managers to ***demonstrate*** to young professionals that the Company cares about and plans for their future and safety. During a time of crisis, managers need to become leaders. They can do this by ***establishing and modelling*** clear work-life boundaries for themselves and expecting that employees are not always available. Also, leaders establish trust in their employees by continuing mentorship, aligning team members, and creating an inclusive environment.

While management and leadership are recognized as distinctly different, they become less distinguishable during a time of crisis. Often management is defined by control and power, while leadership is defined by influence and inspiration to motivate and enable others to contribute toward a larger goal (Nayer, 2013). During a time of crisis, the best managers are also leaders.

5.3 What is the role of space programs and the space community at large in shaping the societal impacts of forced social isolation and economic lockdown?

5.3.1 Introduction and methodology

The current COVID-19 crisis has forced world governments to take unprecedented measures in order to contain the pandemic. People's mobility has been severely limited, forced social isolation has been imposed, and many production activities have been scaled down or shut down altogether – either temporarily or permanently. What started as a public health crisis has since expanded into a global economic crisis. The space community has played a key role in serving society during this period of social distancing and isolation. Satellite telecommunications, navigation systems, and Earth monitoring have helped us communicate and connect while tracking the effect of lockdown on our communities. Lessons learned from space have been applied to ease the negative impacts of lockdown as well, ranging from astronauts sharing tips on staying active in confined spaces to numerous space companies adapting their manufacturing technology to provide hospitals with much-needed medical equipment. To investigate the role of space programs and the space community at large in shaping the societal impacts of forced social isolation and economic lockdown, the team looked at areas such as technology, focusing on infrastructure, environmental monitoring, international cooperation and legal affairs, and technology transfer. Related findings showed that the space industry plays a beneficial role in the wellbeing of societies but the general public does not necessarily have a thorough understanding of the connections with space – a fact that was further highlighted by the COVID-19 crisis. The research and analysis hereinafter presented are generally based on the following two global assumptions:

- Assumption 1: Space programs and the broader space community play – and will continue to play – a positive role in societies in times of crisis, and have at their disposal many resources that could have major societal impacts across a diverse range of areas.
- Assumption 2: The awareness of civil society as a broad community could be improved with regards to the many contributions made by space, especially given that many of these contributions are used by most people in their day-to-day lives.

To test the above assumptions, several literature reviews were conducted focusing on infrastructure, environmental monitoring, international cooperation, and legal affairs, as well as the subject of technology transfer. Due to human resource and time frame constraints, where possible, the group decided to conduct direct interviews with experts from the aerospace community so as to interrogate their view of the above assumptions and to ask them to share specific examples of the application of space technology and related knowledge to the current COVID-19 crisis. Based on these literature reviews and interviews, the group formulated three global recommendations aimed at increasing the relative number and value of contributions from the aerospace sector to societies that are subject to social isolation and economic lockdown, as well as improving overall levels of public engagement and acceptance.

5.3.2 Investigation

The group considered the general topic of space and society by investigating four relevant areas: infrastructure, environmental monitoring, international cooperation, and legal affairs, as well as technology transfer. The team acknowledges that the societal impact of space technologies is by no means limited to these four subtopics, but opted to limit the scope of investigation to the aforementioned areas in the interest of brevity.

Infrastructure

Aerospace technologies have been consistent contributors to the communication and connectivity sectors prior to the COVID-19 crisis, but their importance has increased even further since lockdowns were imposed worldwide. In the analysis, the team focused on the role of space technologies and space-derived products in supporting remote communication and transportation in general, and then considered these in the context of the current crisis. In particular, the team investigated how the shift in styles of working has been supported by the satellite industry. The team also looked at air transport and then discussed its necessity in times of isolation.

Space technologies, in particular communication satellites, provide real-time connectivity to volumes of people worldwide (Whalen, 2010). Communication satellites have become crucial to support the new crisis-imposed workstyle. The satellite industry has been classified as “essential,” allowing operations to continue despite lockdown and limited direct face-to-face interaction (Labrador, 2020) (ITU News, 2020). Satellites support all-weather navigation and global positioning as well. Satellite navigation-enabled technology has formed a basis for the development of multiple applications to monitor the COVID-19 pandemic (European Global Navigation Satellite Systems Agency, 2020). Air transportation supports business and leisure on a daily basis. In lockdown the traffic has decreased substantially compared to pre-COVID-19 levels, but nevertheless ground and air transport remain necessary in times of isolation to support a functioning society. Air travel as we know it has changed dramatically, leading to the definition of “pre-COVID-19” and “post-COVID-19” levels of air travel. An overall reduction of air passengers (both international and domestic) ranging from 50 percent to 60 percent in 2020 compared to 2019 levels has been predicted (International Civil Aviation Organization (ICAO), 2020). However, the team argues that air transport will not become obsolete in the foreseeable future for several reasons. First, air cargo has continued to play an important role in not only providing the logistics for many of the daily goods needed by society, but also for the transportation of medicine and medical supplies to areas in need. In any disaster, response times are of the utmost essence, and aircraft typically remain the best method of delivering both personnel and supplies where they are most needed in the most expedient time. Airlines have adapted quickly to requirements of increased cargo volumes by transporting goods in passenger aircraft. The International Air Transport Association (IATA) has even issued safety guidelines to support this practice (International Air Transport Association (IATA), 2020). Business air travel has decreased dramatically, especially with regards to international flights, though some essential workers have continued to fly. In the R&D community, most conferences have been either cancelled or changed to a virtual format. Even though remote meetings do foster the promotion of

ideas, the role of in-person communication when networking cannot be neglected. In an expert talk given to the delegates of this workshop by Kate Underhill, a Propulsion Engineer in ESA's Space Transportation Directorate, she stressed that her experience with remote working has been positive because she had a level of previously-established trust and an already-existing good rapport with her business contacts and work partners, for example.

Although aerospace technology is already benefitting society during the crisis, there is still more to be done. In an interview with JAXA's Aeronautical Technology Directorate, Management and Integration Department Director Shigeya Watanabe, he said he believed aeronautical technology, researchers, and engineers might potentially be able to contribute more to the solution of the COVID-19 crisis, if they were challenged more. For example, in the past, a lot of noise-abatement technology was developed in answer to new and strict regulations / standards, i.e. if aircraft did not become quieter, they would not have been able to continue flying. Watanabe also highlighted the large potential of drones to reduce the need for human contact when making deliveries. Currently, drones are not allowed to fly over metropolitan areas in Japan, so such potential applications should be considered in future regulation.

More flexible approaches to the adaptation of technology in times of crisis might be beneficial, too. Naoki Matayoshi JAXA's Manager for Strategic Planning Office, Management and Integration Department, highlighted how the expertise and facilities of research institutes could potentially be used to help society in the current crisis. For example, Fugaku, the world's fastest supercomputer (not a JAXA facility), has been "*churning out simulations demonstrating the frightening ease with which coronavirus spreads between human hosts on trains and in other indoor settings*" (CRAFT, 2020). Accurately assessing the demands of society is essential for such technology adaptation. According to Watanabe, connecting aeronautical specialists and people from other areas is essential. To be resilient in terms of crisis, such joint groups must convene and act on a regular basis – much like several of JAXA's consortiums, which bring people with no prior interest in aeronautics to share technology and knowledge. Both JAXA experts also said that such technology used in people's daily life has been highly valued – for example, the use of JAXA's disaster relief technology and the Airport Low-level Wind Information (ALWIN) advisory system (Japanese Aerospace Exploration Agency (JAXA), 2018), cooperatively developed by JAXA and the Japan Meteorological Agency. These technologies increase the safety of operations and the benefits are intuitive to understand. Such tangible technologies are also readily received and appreciated by the general public. Watanabe also highlighted the importance of long-term research, however, as it can provide essential benefits to society in the long run.

Environmental Monitoring

The COVID-19 crisis has had an unprecedented socioeconomic impact. Despite the heavy loss of life and socioeconomic repercussions, the impact that forced social isolation has had on the environment in terms of reductions in the levels of air, sea, and land-based pollution has been positive (Muhammad, 2020).

In this respect, Space Agencies such as NASA, ESA, and JAXA created the COVID-19 Earth

Observation Dashboard – a global observation platform able to show how the overall lockdown has had beneficial effects on the environment. Sharing this data with the general public has indirectly played a very important role in promoting environmental protection through Earth observation. Images of empty cities and natural ecosystems have been shown, contributing to raising awareness on how slowing down economic productivity and industrial activities can have a beneficial effect on the environment. In this sense, the dissemination of environmental data has been crucial to demonstrating how the lockdown has positively affected environmental conditions in terms of decreasing levels of air and water pollution (National Aeronautics and Space Administration (NASA), 2020).

According to Quirino Morante, Head of Innovative Solutions Labs & Digital Transformation Department at Thales Alenia Space, the crisis has given the industry the chance to implement a global adaptation plan and to use space technology as a tool to stem and monitor the state of the crisis. In this respect, data from satellites Sentinel 1A and 1B, built for the European Space Agency as part of Copernicus (the European Union's environmental monitoring program) facilitated understanding of the COVID-19 crisis in Italy by tracking its development and supporting the planning of future economic activities.

In the same way, Morante added, Earth observation satellites such as COSMO-SkyMed second-generation satellites, built at the Satellite Integration Center in Rome, have played a crucial role in territorial monitoring. This has helped us understand the outcomes of the pandemic even if they were originally built to monitor climate change, manage road traffic, and provide geolocation services. This crisis has demonstrated that the space industry has a great variety of technologies at its disposal, giving the general public the awareness of how data can be crucial in tracking movements and preventing contagion.

The vision from space, Morante concluded, is fundamental for rapid intervention and an improvement in early warning technologies would help in building resilience in case of future crises.

In this respect, the European Environment Agency will bring together coronavirus and environment-related knowledge and contribute to an informed debate. The role of the space industry in providing environmental data from Earth observation satellite systems will be extremely important to coordinate the policy actions needed to achieve the common goal (Bruyninckx, 2020).

Recovery efforts will give countries a chance to make much-needed environmental improvements an integral part of the economic recovery, rather than such measures being perceived as an additional burden at a time of crisis.

International Cooperation and Legal Affairs

Disasters are phenomena that do not respect borders – thus, in times of acute crisis, the international community often pulls together to tackle the problem as a coordinated whole, so as to best mitigate the effects upon human society in its entirety. As our collective use of space has increased in step with the advancement of technology, many governments, industry, and other institutions have recognized the uniquely powerful tools that space data, services, and derived products may bring in the event of a crisis. This spirit of cooperation has since penetrated deep into the international space community.

In international contexts, cooperation is typically enacted by means of 'activating' agreements, treaties, or other articles of international legislation that were established for that purpose. The first foundational pieces of international space law, such as the 'Outer Space Treaty' (1967 Treaties and Principles Governing the Activities of States in the Exploration and Use of Outer Space) were written during a period of intense geopolitical tension. It mandates space to be reserved as a domain for the benefit of all humanity – a domain within which international cooperation and activities benefiting everyone should essentially be the norm. While these treaties set out the requirement to cooperate, they generally do not establish the formal mechanisms of how to actually, practically enact this cooperation – such work was left for later. Thus, mechanisms such as the 'International Disaster Charter' (Charter On Cooperation To Achieve The Coordinated Use Of Space Facilities In The Event Of Natural Or Technological Disasters) have since been established to fill the gap of exactly how to cooperate.

While states enjoy significant assistance each year in mitigating the effects of disasters upon their societies through the provision of space data and space-derived products by means of their activation of such charters and agreements, these charters and agreements are largely optimised to respond to disasters that cause mechanical damage to society (e.g. earthquakes, flooding, and tsunamis). As a result, while states and space agencies have acted unilaterally to use their own domestic space capabilities to better respond to pandemics suffered, widespread international cooperation by means of established mechanisms has in this way been less prolific. Over the past decade, the International Disaster Charter has been activated in response to a disease-related disaster only in the case of the 2014 Ebola epidemic; however, activities relating to space as a tool for international disaster risk reduction and mitigation also exist outside of such charters. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response, for example, has been active throughout the COVID-19 pandemic, providing a hub for expertise and knowledge-sharing, as well as performing other activities beneficial to all states. In addition, the largely open provision of services such as Global Navigation Satellite Systems (GNSS), could arguably represent instances of international cooperation. This is especially pertinent, as GNSS is now heavily internationally depended upon in a remarkably widespread fashion, including for services essential to healthcare and pandemic mitigation, yet the overall number of states operating GNSS constellations remains fairly limited.

Specific mechanisms of international collaboration aside, the team also noted that national space law is something that should be independently established in each country for states to ensure they

meet their obligations under international law when performing space activities. In many cases, this can exist as a factor acting to restrict the sharing of space data and derived products, as well as the transfer of space technologies – typically due to national security concerns. These restrictions may exist in terms of to whom data may be shared, upon what type or quality of data may be shared (e.g. enforcing sensor type or image resolution limits), on data that arises from what source (e.g. states are unlikely to openly share spy satellite data), or indeed depending on the geographic area that is covered by the data (e.g. not being able to share images of a particular facility or country). Given that even commercial operators are subject to the monitoring and control of the state under the requirements of international space law, these restrictions will thus constrain all sources of space data, not only those operated by the state.

As will be subsequently discussed, the modification of existing international legislation to more explicitly cater to disasters manifesting in the form of epidemics or pandemics could lead to an increase in the use of space services, data, and derived products to support societies subject to such crises. Alternatively, similar benefits could be reaped by the establishment of new, standalone mechanisms suitably tailored to address pandemics and epidemics.

Technology Transfer

Over the last few years, the importance of technology transfer from space missions to Earth applications has increased more and more. Space agencies created dedicated offices and programs to ensure that innovations developed in space programs are broadly available to the public, maximizing the benefits to the nations, e.g. ESA's Technology Transfer and Patent Office (European Space Agency (ESA), 2020), NASA's Technology Transfer Program (National Aeronautics and Space Administration (NASA), 2020).

This demonstrates the importance of technology transfer and the benefits Earth can have from space missions. This thinking is shared by Dylan Taylor, founder of Space for Humanity and CEO of Voyager Space Holdings in an interview with Space.com. Taylor summarized the importance of applying space technologies on the Earth's surface with these sentences: *"Space technologies are an integral part of our evolution as a society. As we further explore the cosmos, the level of innovation and exploration needed to do so will help inform how we may purposefully integrate and adapt these tools to benefit our lives down on the surface."*

The recent period of lockdown highlighted the changing needs of society confined to their homes. Some examples are the capability of practicing sport with limited space; maintaining motivation for exercise during lockdown (Lim, 2020); the possibility of performing medical checks remotely to monitor non-urgent medical issues without the need to go to the hospital or the doctor in person; the capability to keep food stocks for a longer duration, and hence reducing the need to go to the supermarket so frequently (Smithers, 2020) (Fowle, 2020); the possibility to remotely access and control machinery outside a company premises (McKinsey & Company, 2020); and the possibility to purify air without polluting it with hazardous particles (e.g., virus and bacteria) from outside the house.

In a recent interview, Giovanni Malucchi, Thales Alenia Space's Head of the Operations, Logistics & Mission Support Department in the Domain Exploration and Science, said that several of these needs are shared with the life of astronauts when they are forced to live for several months on the International Space Station (ISS). For this reason, many solutions commonly used for years on the ISS can also ease life on Earth – especially during periods of lockdown. Malucchi highlighted that these technologies and products have not yet been widely adopted for Earth applications for two main reasons. First, there is a limited knowledge of them outside the field of space. Second, there exists a general belief that space products have an associated high cost of production and thus are not suitable for wide-scale distribution. This, in synthesis, reduces the interest of industry to invest in such technologies. Malucchi is convinced that the space community should increase its efforts in demonstrating that the adaptation and application of space technologies on Earth is feasible and involves only limited efforts – especially for telemedicine (Menon, 2017) and remote control applications (European Space Agency (ESA), 2020) (Weselby, 2020).

Another fundamental aspect that has limited the dissemination of space-developed technologies and products on Earth is that the space community often behaves as a closed environment, with limited interaction with other industry sectors. In a recent interview, Mario Montagna, the Thales Alenia Space's Head of Avionics, Data Systems & Communication Design Department in the Domain Exploration and Science, said that space-developed technologies and products are a sort of "craftsmanship" that is only developed to fulfil the needs of the space mission without the consideration of potential future applications. This, in the majority of cases, allows brilliant performances to be attained at the expense of huge recurrent development costs, which make other industries reluctant in adoption. Montagna confirmed that to overcome this reluctance, future space missions (in particular exploratory ones) should not only consider the needs of the scientific community, but also those of industry on Earth – for example, competitive non-recurrent cost, limited modifications requirement for technology deployment on Earth, etc. This approach could completely change the views of industry on Earth with regards to space activities. Space missions would then be considered a sort of test-bench for products and technologies that could then be deployed on Earth at a later point in time. Space could then be considered as a fundamental step for product and technology development and validation processes. To ease this transformation process, the needs of different industrial sectors should be considered when defining the goals of future space missions.

5.3.3 Conclusions and recommendations

Based on a conducted literature review and interviews, discussion among team members led to the formulation of the following three major recommendations:

1. **Exploit to the fullest extent existing** products, technologies, and mechanisms.
    a. **Create an "aid goal"**: One way to take better advantage of existing technologies would be to create an "aid goal" for each project team, re-allocate their time and resources, and challenge them to consider how space can assist in pandemics and other crises. Historically, in aeronautics, for example, a lot of noise-abatement technology was

developed in answer to new and strict regulations and standards, i.e. engineers were required to leave their comfort zone and come up with working solutions if aircraft were to keep operating at major airports. Challenging teams can potentially lead to innovative applications and solutions to the COVID-19 crisis as well as other crises to come.

b. **Adapt to the current needs** of society: In light of the COVID-19 crisis, new needs of society are emerging, such as making an office environment safer or purifying air at home. A good example is the use of Fugaku, the world's fastest supercomputer, to process aerodynamic models in order to demonstrate the spread of coronavirus. These simulations can be used to argue for the importance of physically partitioning otherwise open workspaces. Yet another application of technology to the newly emerging needs of society could be air purification based on knowledge and expertise gained from creating the Environmental Control and Life Support System for the International Space Station. Similar technologies can be used on Earth to develop domestic air purifiers that remove air pollution from inside the house without introducing potentially hazardous particles from the environment outside the home.
c. **Consider non-space applications when designing** technologies: Technologies developed for space, are, for example, often fully customized to meet the requirements of the mission and do not consider further potential applications. This may result in huge recurrent development costs, which can be mitigated if wider applications on Earth are considered at design and development stages. Space missions can then be considered as a sort of test-bench, providing resilient technology necessary in times of crisis. Also, investigating other applications once the product is designed can add value and benefit society.
d. **Modify existing disaster-relief mechanisms** to respond to the pandemic: Future mechanisms of international collaboration for disaster relief and disaster prevention should more explicitly be tailored to also include the mitigation of pandemics and their resulting effects on society in addition to those disasters that largely manifest in the form of mechanical damage to society and infrastructure. Alternatively, existing mechanisms aiming to mitigate the effects of more "conventional" disasters using space data and space services should be suitably modified to increase their suitability for pandemic response, or otherwise be supplemented by standalone legislation or mechanisms for international disaster relief efforts that are specific to pandemics. As noted by Watanabe, JAXA's disaster relief technology D-NET, for example, supports information exchange between areas affected by disaster and command centers. When adapted for the current pandemic, it will also include COVID-19-related information to aid safe execution of rescue missions and avoid large gatherings at command centers.

2. Have an **interdisciplinary working group of policymakers, practitioners and researchers get together** around the same table and collaborate on speedy and efficient policies:
   a. **Support policymakers to accelerate technologies** that can benefit society: Engineers should work with makers of legislation and policy to accelerate the realization of products and technologies needed to answer the rapidly changing needs of society. The current

pandemic has highlighted the potential use of drones for delivery involving no human contact, for instance. Aeronautical experts can help inform policymakers and lawmakers on changes ideally needed to best realize such drone operations.

b. **Establish partnerships before a crisis strikes** so that once it is here, we are more prepared to act: Space law has historically had to make regulations regarding issues that, while dangerous, do not present an imminent existential threat. This is essential when writing policies for disaster risk reduction and the mitigation of the effects of disasters upon society. We can potentially do more if we can better identify the overlap between "needs" and "available technologies/knowledge." To do so, connecting people from fields outside the space industry and having them talk together with professionals from inside the space industry is important. This will inform the space community of the needs and constraints arising from other industry sectors, and could eventually lead to the development of products and technologies applicable to not only space missions, but also industrial needs on Earth. To be resilient in times of crisis, such joint groups and/or consortiums should convene and act together on a regular basis.
c. For fast crisis response, **establish an agile international think-tank**, policy institute, or other form of working group focusing on pandemic mitigation using space data and space services (as well as factors such as dissemination, coordination, and integration with national-level entities). This should ideally comprise forward-leaning representatives and stakeholders from governments, NGOs, the international community, and the private space sector, in order to best inform and drive future national and international policymaking and legal activities in a timely fashion.
d. **Develop guiding principles that can support policies designed to maintain the positive effects of lockdown**: Principles aiming to establish specific sustainable mechanisms using lessons learned in lockdown should be proposed. The space community can provide data supporting the positive effects of lockdown on emissions and the associated environmental impact, for example. Such data can be used to support the making of long-term emission reduction policies. Defining the role of space as it relates to the pandemic and social isolation can help formulate guiding principles for future aerospace development efforts, as well.

3. **Enhance public awareness by demonstrating scenarios comparing society existing** with and without space-derived technologies.
   a. **Deliver directly** to the general public: To raise public awareness, show specific detailed scenarios showing the contribution of each technology or product together with quantitative analyses (similar to a world with / without the technology / product). For instance, satellite-enabled communication and navigation are being used by many people around the world on a daily basis and are also crucial to numerous industries like aviation and shipping. Such communication or navigation satellites cannot be developed overnight, which highlights the value of long-term funding for aerospace technology research. Project managers should encourage knowledgeable employees working on such projects to do more outreach in their community.

b. **Show the big picture so that the public can see the forest for the trees**: Worldwide travel restrictions have brought down the volume of air transportation, but it is safe to say that air cargo will remain important as it is currently the only feasible solution for rapid long-range transport. Therefore, even though one may argue that aviation is unnecessary, its value is clear when presented with the bigger picture.
c. **Use social media to outline how aerospace technology improves other areas** of society and the economy: Synthetic-aperture radar (SAR) satellites can provide imagery even in cloudy weather, thus allowing all-weather missions to support disaster response efforts, for instance. Such applications are tangible and should be communicated through social media so as to reach wider audiences who may not necessarily be interested in the space sector. Yet another example is X-ray technologies, which were originally developed for space applications, but are now essential to general healthcare. Such interesting facts should be illustrated in a clear and easy-to-comprehend manner.

Concluding remarks

In investigating space and society in times of crisis, such as the current COVID-19 pandemic, the group concluded that space has a strongly beneficial role, but that yet more can be done to further contribute to societal good and the awareness and acceptance of the general public. Aerospace technologies, products and expertise have been aiding people's day-to-day lives prior to COVID-19 as well. However, the crisis has led to some newly emerged society needs, which in turn have highlighted further potential space technology applications. Based on conducted literature review and interviews, the group formulated three general recommendations aimed to enhance both space technology contributions to societies in crisis and the awareness of the broad community. First, exploiting to the fullest existing products, technologies and mechanisms can help provide solutions to the current issues in a timely manner. Second, having an interdisciplinary working group of policymakers, practitioners, and researchers get together around the same table and collaborate on speedy and efficient policies can help relevant parties identify the most urgent society needs and offer them hints on potential solutions. The creation of a framework of international cooperation, supported by proper legislation, and involving not only the aerospace sector, but also specialists from other industries would allow them to identify, develop, and apply the necessary space technologies to better aid people's lives in times of crisis. Lastly, enhancing public awareness by demonstrating scenarios comparing society existing with and without space-derived technologies can eventually result in public acceptance and support of aerospace programs in the long run. While these recommendations are largely based on observations of the current COVID-19 pandemic, they can provide long-term benefits to a more resilient, sustainable, and innovative society.

5.4 What is the impact of the current international crisis for the future of space projects, and how can PMs shape this impact into successful progress, ensuring acceptable risk and pioneering a new way forward? (Focus on: Impacts and lessons learned)

5.4.1 Introduction and methodology

During 2020, the novel coronavirus COVID-19 outbreak has quickly spread globally, and the World Health Organization (WHO) declared a state of pandemic on March 11, 2020. Besides the repercussions on health systems, the crisis has also had severe consequences in the global economy, including the space sector. The World Bank Group Report classified this recession as the "deepest global recession in decades." Modern society heavily relies on satellite data provided by space agencies and companies, which during the pandemic have provided earth observation imagery for monitoring and studying the impact of the novel coronavirus. Moreover, space actors have helped society through donation of equipment or by proposing ways to limit the impact of the pandemic in the world. The overall resilience of the space sector is generally higher than other sectors because of the characteristics of products, but it has nonetheless suffered heavily from this global crisis. Project and program managers across the industry have had to make decisions that would ensure the successful continuation and delivery of projects during these turbulent times.

Thus, the objective of the present work is to answer the question: "*What is the impact of the current international crisis for the future of space projects, and how can PMs shape this impact into successful progress, ensuring acceptable risk and pioneering a new way forward?*" The team analysed the impacts of the COVID-19 turmoil on the space industry and furnished recommendations for program managers that would help them **survive**, **resist,** and **thrive** from this and other crises.

This research provides Program Managers the key to understand, analyse, and overcome the impacts of a worldwide crisis on their projects. The proposed methodology follows the logical sequence described hereafter:

- First, an analysis of the **direct and indirect impacts** of the COVID-19 outbreak on the space industry is provided to help Program Managers recognize the diverse impacts on operations.
- The second part presents the **consequences** of such impacts and highlights the possible double-sided effects as both *risks* and *opportunities* for space projects, from which the Program Managers can perform a "lessons learned" analysis.
- Finally, the **recommendations** section provides an action plan for Program Managers to limit negative consequences and boost opportunities in a fast-changing environment. The impacts of the recommendations are split in three different levels:
    - *Survive*: Recommendations to carry out the project with limited damages and continued deliverability.

- *Resist*: Recommendations for maintaining the main project indicators at an acceptable state and being able to deliver, preserving costs and planning.
- *Thrive*: Recommendations to come out stronger from the crisis. A certain level of commitment is required, but the practical recommendations provided will guide Program Managers to transform a threat into an opportunity.

5.4.2 Research and Investigation

COVID Direct and Indirect Impacts on Practices and Behaviors

Social distancing

In the era of social media and social networking, the COVID-19 pandemic brought about the new condition of social distancing. In order to comply with government regulations for new social distancing measures, most companies in the space sector have resorted to "minimal operations," with the closure of facilities and teleworking as primary effects. The consequences were compounding: a broken supply chain led to delays in manufacturing and deliveries; limitation of staff in cleanrooms led to delays in assembling, integration, and testing. Missions have been put on hold, some launches were postponed, while other missions had the challenge of making sure not to miss the launch window. With the gradual relaxation of governmental guidelines, every entity has readjusted their operations, allowing a very limited number of staff to resume their activities under certain hygiene measures that affected the social aspect of space projects, which is the very nature of such collaborative and international undertakings. Reduced contact for a project team leads to a reduced team atmosphere.

Generalized lockdown and border control

Many countries declared a national health emergency, followed by strict lockdowns. The travel restrictions have had two major impacts on space companies: limited movement of personnel to different suppliers and customers and limited movement of products throughout the supply chain. Supply chains have also been greatly affected by the crisis because of difficulties faced by suppliers, disruptions in logistics due to border closures, and issues faced in the transportation sector. The travel restrictions resulted in delays and cost overruns in the space supply chain and the general functioning of a program.

Sickness and isolation

Another impact of the COVID-19 pandemic is sudden illness. When ill or showing symptoms of COVID-19, an individual needs to self-isolate to potentially slow the spread of the virus. Individuals who are not ill themselves but may have been exposed to COVID-19 have to go into quarantine for 14 days, as the WHO recommends. A company would have to expect that some employees will eventually become sick during the pandemic, causing a complete shutdown and forcing most individuals into self-isolation. Closures and absence of key personnel can cause significant disruption for the operations of companies.

Most people impacted by social isolation are ill-prepared to cope with loss of human interaction over an extended period of time. Healthcare professionals and researchers of think that isolation can have detrimental side effects on individuals. Such changes are particularly dangerous for the most vulnerable members of society, especially the world's elderly population.

Modified working schedules

After the lockdown, many companies allowed employees to come back to work on-site but with modified schedules. The most common ways are "horizontal shift" (some days of teleworking and some days on-site), "vertical shift" (only half-day on-site) or also dependent on the function in the company. Many companies imposed these schedules, sometimes in a rush, to get back to work in an efficient way.

Financial impacts

The space sector is historically more resilient than other sectors, thanks to long-term contracts that can mitigate the effects of temporary disruptions. But the effects of the global turmoil must not be underestimated. The space sector involves several domains that can be affected in different ways and that have different resilience levels to the COVID-19 crisis. The crisis had been preceded by years in which the space sector enjoyed a period of strong growth, both financially and technologically.. For these reasons, the effects of the crisis can be strong, especially for start-up companies. In the team's full report, the analysis of three significant space domains with different estimated overall resilience is reported as an example of the financial impact of the crisis.

Bankruptcy in a supply chain and adjacent industries slow down

In this turbulent time, the probability of the bankruptcy of any component of the supply chain increases and the effect is highly dependent on how critical the component is to design and when the bankruptcy occurs in the project life cycle. For suppliers that are critical, there will be negative

impacts in both schedule and cost. Moreover, many aerospace companies operate in both fields of aeronautics and space and that can lead to a dangerous "spill-over" effect.

Consequences on Space Projects and Programs

This section describes the **risks** but also the **opportunities** that arose from the recent period of crisis. In this way, the Program Managers interested in the subject discussed in this work can have a clear vision of the *double-sided effects* this crisis had on projects.

Risks arising during a crisis

Feeling of disconnection

Staying connected in a time of recommended social distancing is a challenge. Self-isolation can cause several health problems in people and those who have been in quarantine may be stigmatized, with other social implications. The human factor impacts a project's success and therefore the evaluation of the needs of team members is of paramount importance.

Staffing during the lockdown

Hiring during the lockdown has been another hurdle for organizations in all industries due to hiring limitations, including freezes. This is a downside for both employers and potential employees, as project needs are not being met due to lack of resources. The CEO of Space Individuals has been interviewed on this topic. The company has, in fact, reported an increased interest in job openings. Companies that have not introduced a hiring ban have sustained an entirely virtual hiring process. However, starting a new job fully remotely may be off-putting, making the integration difficult for a new employee.

Delays and time management

Most missions have suffered delays on three major aspects of space programs: hardware manipulation, deliverables, and operations. All of these lead to negative impacts on space product development, with the delays of the entire program as a consequence and thus limited ability to deliver. Moreover, the majority of programs have a significant focus on *key individuals* and if they are removed or unable to attend work, the programs can suffer large disruptions and delivery delays. Generally, staff and managers were forced to find solutions to support operations remotely.

Limited access to finance and budget modification

One of the immediate consequences of the COVID-19 outbreak is the economic crisis. A high

number of small and medium-sized companies are struggling. The government investments are the primary source of finances for this sector and, in particular, small- and medium-sized enterprises often have the government itself as a single source of revenue. The governments sheltered the industries with their contracts from the short-term effects, but the concerns about the medium- and long-term effects of the crisis are increasing both on budgets and demand. For large space companies, the effects on revenues are limited thanks to the mitigations due to the financial support provided by the institutions, but on the contrary, the smaller suppliers suffered stronger short-term effects. The lack of long-term R&D projects and commercial orders is the main concern. For start-ups, the crisis hit even more strongly, with lack of future contracts as a major concern. The direct consequence of the difficulties in accessing the finances and in raising money from the agencies in the space sector is the program budget modification with some programs that are more attractive due to their strategic relevance.

Opportunities arising from crisis

Remote work

Call it home office, teleworking, "smart"working or remote work – arrangements for home office generally vary across organizations: some do not allow it because of contractual obligations, and others allow it under limited and justified conditions. The COVID-19 pandemic has however forced this unparalleled experience on organizations and has shown that, with sufficient supporting IT infrastructure, home office and remote work are possible. Research has shown that productivity can increase with remote working and that, generally, workplace flexibility has a favorable effect on several aspects. Furthermore, remote working can open possibilities for people with disabilities or for those with family caregiving responsibilities.

Availability of a digital workforce

The megatrends of digitalization have been developing since before the era with COVID-19. Some of the space agencies and companies have also established their own digitalization strategies to incorporate new technologies and digital processes into their programs and operations. By spinning-in, investing in and embracing digital engineering throughout all the design, development and exploitation phases, there is the possibility to draw full benefit from this technology. Having a well-established digital workforce is, in many ways, an asset, as it can be employed to reduce development costs, to enable more agile product life cycles, and to adopt innovative technologies in space systems much faster.

Budget flexibility and financial support

Several agencies are facing the crisis by defining special measures to counter or mitigate payment interruptions and consequent budget reallocations, ensuring some continuity of the activities and

safeguarding business plans. Another alternative is the possibility to compete in money prizes offered by ESA by participating in contests related to the satellites data analysis to fight the COVID-19. The budget modifications are not always negative, an example of which comes from the collaboration between ESA, ASI, and the Italian Minister of Technological Innovation and Digitalization. The business expenses for on-site operations saved during a lockdown period could be in part reallocated. This agility of the budget can be obtained only if the policies and the decision process for the reallocation of the resources are strongly regulated. Moreover, a more flexible budget can make the program more resilient to unforeseen events, which is the key – together with the capacity of accessing special finances – to the survivability of a space program.

5.4.3 Conclusions and recommendations

Previous sections have presented the impacts of the COVID-19 outbreaks on the space sector and their corresponding consequences on space programs; these consequences have been categorized as both risks and opportunities. The current chapter tries to provide insight into what is believed to either mitigate the risks, or enrich the opportunities that resulted from the crisis, by providing a set of recommendations for space program managers, on three layers: "*SURVIVE – RESIST – THRIVE*" (see Methodology).

I. Survive

Reconnection

Fostering a *connecting* work culture and actively engaging team members during a time of crisis can help alleviate the downsides of the perceived grief caused by, for example, social distancing. This can be achieved by a number of things such as:

- Offering a set of tools that allows teams to communicate efficiently
- Holding regular progress meetings, e.g. daily stand-up or weekly progress meetings
- Maintaining a team task board to keep an overview of project progress
- Suggesting regular social (virtual) meetings, for example "Friday coffee," "Thursday beer o'clock," trivia and game meetings (such as Pictionary)
- Asking is caring: as a project manager, regularly ask every team member "How is it going?" and genuinely care about your team's wellbeing

Role distribution

Facing resource planning issues during a crisis is a risk to the schedule of the project. In order to mitigate this risk, program managers can employ the following:

- Ensure frequent and periodic knowledge distribution sessions in your team
- Ensure that your team is cross-skilled (i.e. no one employee is a bottleneck and that each topic can be addressed by a minimum of two team members)
- Maintain a logbook of the role and task distribution in the team, and a clear breakdown structure and resourcing plan. This can help early identification of resource gaps and, hereby, a timely planning

Re-centralize values over processes

With the crisis, teams are relying more than ever on the structures and processes of their companies. Large companies in the space sector tend to prefer process over results, particularly in the Procurement, Information Systems and Human Resources departments. This is also known as one of the consequences of Parkinson's law: when an organization is growing, internal work becomes bigger than work for external clients. While these processes have been initially put in place to improve the quality of products or for cost reduction initiatives, they in fact generate hidden costs (time spent to search or understand, delays on prototyping, delays on procuring, etc.). It is therefore proposed to perform a user experience study aimed at finding ways to reduce low-value tasks that affect operational personnel; support functions should support the projects and engineering team in increasing project efficiency and not the opposite.

II. Resist

Flexible work culture

Making remote work more accessible leads to an improved work-life balance for employees, which has been shown to increase productivity, performance, and retention. Remote work can be supported with an improved infrastructure, including sufficient IT resources to enable remote connections for all PCs needed by employees, putting measures in place for switching laboratory units on and off remotely with the acquisition of special plugs, and setting up a hardware and software configuration that could allow remote tele-commanding of units, either from home to the workplace or from one institute to another (useful in AIT). Additionally, program managers can support a flexible work culture by:

- Being a team member and still maintaining clear reporting lines and clear role distribution (with cross-functional distributions, no team member being a bottleneck) and fostering a connecting work culture (see above in “Reconnection”)
- Demonstrating values such as openness and trust, to enable the exchange of ideas even if team members are not co-located
- Promoting the use of tools that allow for transparency and clarity in the task distribution and general work status (i.e. virtual boards, tools for issue tracking, etc.)

Agility and iterative life cycles

Inter-team communication and the capability to overview the current state of duties have suffered because of the sudden transition to teleworking during the lockdown. An agile mindset is supposed to have a beneficial impact in these times, as it provides a clarity with "rhythm and cadence for work" and it provides scope for needed shifts due to the break-down of work in smaller tasks. Despite the skepticism towards the applicability of these methodologies in large enterprises, a subset of the practices encouraged by lean methodologies could be effective and welcome in the face of adversities, such as the consequences on projects due to the COVID-19 crisis. One practice found to be useful and which could be implemented in projects with minimal effort is the use of virtual tools for task allocation visualization and also the division of work in short iterations. Moreover, the practice of inspecting and adapting a team's work can positively affect the overall quality of work delivered.

Finance enhancement opportunities

The capability of a space program to *Survive* and *Resist* in a period of global crisis like the on-going one is strictly connected in the capability of maintaining an incoming flux of finances for the specific program. Program Managers can consider the following to secure the access to extra finances during a period of crisis:

- Allocate resources from the team to monitor the opportunities to participate in competitions or in contests with money-prizes sponsored by major agencies
- Make the program short-term objectives compliant with the requests of the main "competitions" as much as possible (e.g. data analyses useful for both the sides)

III. Thrive

Digital learning enhancement

Personal development has been the last priority for HR services during the crisis, and many in-person learning courses were cancelled. Together with the improvements of the IT infrastructures, also new methods of personal development are required. The needs of each member of the team can be different and the development program of each can be tuned on this. A working learning program could also help to make everybody comfortable with the technology recently introduced. To take the strongest benefit from this, a Program Manager should:

- Promote and enhance digital learning and use targeted communication
- Decentralize in-person events and perform multiple training courses with people sharing

the same workplace
- Provide individual motivations and focus on the needs of a single element of the team providing ad-hoc learning processes
- Remember to cultivate also informal interaction and, most importantly, do not rely only on virtual interactions

Implement a model-based approach

The COVID-19 crisis highlighted how people's resources shall not be wasted by performing low-value tasks. This can be achieved through MBSE (Model-Based System Engineering) with a proper change management plan for both mindset and tools. MBSE aims to model the analysis and document aspects of the System Engineering lifecycle. Project Managers are the key persons able to develop the use of such tools. MBSE introduction requires careful implementation to be adopted by the team because it is at the frontier between the technical and the cultural aspects of a team. Recommendations on how to adopt an MBSE-culture are:

- Define clear objectives of the modelling
- Interview future users and adjust modelling objectives in function
- Involve all the stakeholders and ensure that everyone is participating
- Have an MBSE expert on board to increase chances of success

Flexible budgeting

The capability of defining a “flexible budget” could determine the survivability of the program itself in a short-term horizon during a crisis. Learning and being capable of approaching a flexible budget can be also a good practice for the future, making the space program more resilient to unforeseen events. The Bid and Program Managers can use the next suggestions as guidance to start being familiar with a “flexible budget.”

- Preserve a medium-term perspective to budgeting
- Identify the strategic or the priority sectors to face a limitation of the resources and the needs to ensure sustainable spending for a certain timeframe
- Be ready to conduct bigger reallocations (more than usual) from a sector to another in order to face criticisms and the priorities stated at the previous point
- Set up contingency/reserve envelopes to address the emergency spending needs or the revenues shortfall
- Remember that insufficient flexibility can be a limiting factor in case of uncertain spending needs, but too much flexibility will undermine the budget credibility

Supply chain mapping

Many space and defense projects already require a double source supply chain for a single component or materials as common practice and this can be handled by a strategic "*Make or Buy*" policy. A supply chain network mapping inspired by McKinsey recommendations is proposed as a possible part of a risk-mitigation strategy. The map can be used also to identify risk and interruption of the chain and eventually also back-up solutions, thus making the network map a tool to identify a roadmap to solution to the crisis. From this, a Program Manager should:

- Allocate resources (time, people, and funds) to the definition of a supply chain network map
- Identify the optimal solution to save economic resources
- Stipulate contracts that spell out expected recovery times and method during a crisis
- Identify and put in the map possible back-up solutions in case of supply chain disruption

Having a centralized point of view, thanks to the supply chain map, allows the Project Management team to have an overview of the system they are developing, which will be helpful to manage the project schedule and the deliverables.

Cooperation for common goals

Cooperation between agencies can simplify the programs and can give birth to interesting bonds between agencies. During the pandemic, a lot of initiative and collaborations between agencies arose to face together the COVID-19 crisis by defining common objectives and working together as a "single global team," In the same way Program Managers can try to share knowledge. The following suggestions can be seen as tips to collaborate and to cooperate:

- Create a database fully accessible to people of the space sector
- Promote events of divulgation
- Promote the mobility of people from a program to another to gain expertise and to bring fresh ideas into a program. This could be adopted gradually.

Public opinion

Trying to involve a majority of the population in the space project can have strong benefits because together with the general public, investors and founding institutions could be attracted, leading to possible financial benefits. Campaigns to "interact" with the public on social networks have already been carried out during the past months. To attract and positively impact public opinion, the Program Managers can develop their own strategy on the following suggestion:

- Allocate resources (financial and human) to Social Media Managing
- Inform the public on what is going on in the program with a fixed schedule

- Share curiosities from topics related to the program
- Try to understand what "people need" at the moment and create related contents
- Interact with the public as much as possible

Another good practice that could be considered by Program Managers is investing time to share knowledge and take simple lessons about space to students at school to incentivize their interest in space related topics.

Concluding Remarks

The COVID-19 pandemic has triggered unexpected changes in several working and social domains. The impact of the crisis brought the need for innovation, inspiration, and collaboration, while at the same time sacrifice and imposed changes, in order to maintain schedules and deliveries and settle into a "new normality." Several new difficulties perturbed operations and practices both in a negative and also in a positive way. The transition to new work habits also implied adjustments and the derived restrictions came at a cost. In particular, the small-to-medium enterprises, which constitute the bulk of industrial companies producing for the space industry, had difficulties accessing finances.

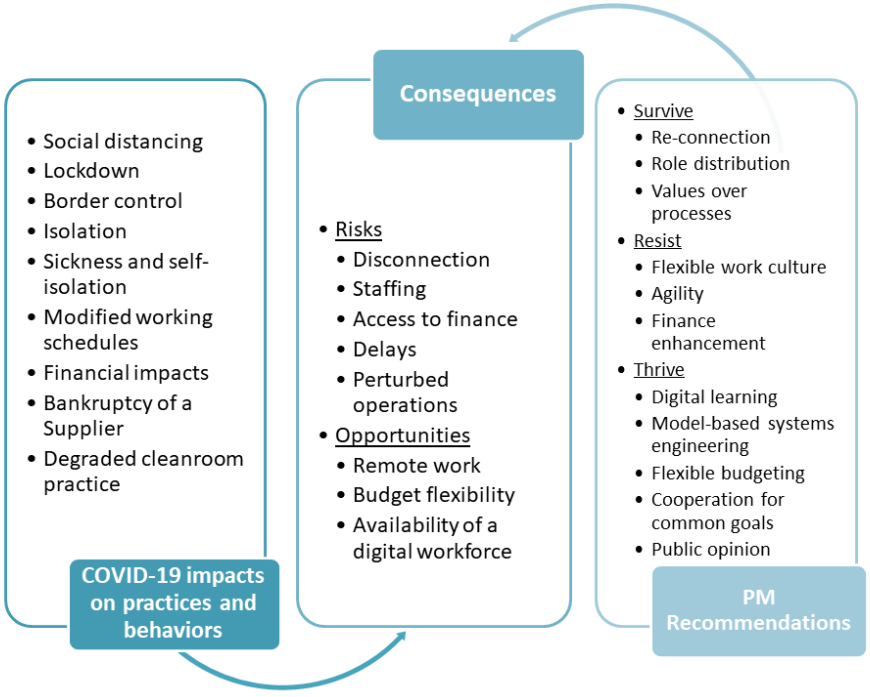

Figure 8: COVID-19 impacts, respective consequences on projects and recommendations

This work suggests ways to survive and resist during a crisis, but also to thrive from it, identifying strategic changes to organizations with positive effects in the long run. The aspects highlighted in Figure 8 are all presented and analyzed in the Full Report, from the COVID-19 impacts and their consequences on space programs, to all the identified possible recommendations for Program Managers to *Survive*, *Resist*, and *Thrive.*

From their own first-hand experience, the team remarks that young professionals care a lot about the notion of team spirit. They like to get a sense of community from their work and the feeling that what they do is meaningful. Teams do not need a crisis to feel disconnected; a lack of engagement from management is sufficient. Values like openness, high trust and encouragement are beacons and a dedicated and involved project manager makes all the difference.

The team, as young professionals, wishes that the work provided in the Full Report will support project and program managers in their decision-making process. They have described practical ways to implement their recommendations into projects and encourage senior professionals and managers to reuse them and to share them in their companies.

5.5 What is the impact of the current international crisis for the future of space projects and how can PMs shape this impact into successful progress, ensuring acceptable risk and pioneering a new way forward? (Focus on: Cost Benefit Analysis and new way forward)

5.5.1 Introduction and methodology

The primary challenge for all space project managers in 2020 has been and continues to be how to adapt for COVID-19 and the consequent new world of global lockdown, remote work, and mobile technology. Therefore, this was the focus of the 2020 IPMC YP Workshop. This study represents the work of one of the five teams. The question it seeks to address is:

"What is the impact of the current international crisis for the future of space projects and how can PMs shape this impact into successful progress, ensuring acceptable risk and pioneering a new way forward using Cost-Benefit Analysis (CBA)?"

In order to address the question, the study:

1. Investigates the impacts of the current international crisis on project management implementation of CBA; and
2. Recommends approaches for PMs to shape this impact into successful progress, ensuring acceptable risk, and pioneering a new way forward.

It is considered that this work may represent the first broad data collection from space project management experiences of COVID-19. Capturing these experiences, both statistically and qualitatively, has the potential to inform managers with unique insights to guide their performance both within this current crisis, and for those of the future.

To solve the issues shown above, two methods were utilized in the present study: a questionnaire to obtain real-world insights, and then the application of CBA to a case study informed by them. The questionnaire was conducted to identify the impact of the pandemic on space projects, with a focus on the factors accounted for in a CBA. Targeted approaches were made to persons responsible for project / program management functions in active global space projects. A breadth was achieved in the interviewee population of 51 persons, which spanned: three continents, various project/program management functions, project phases, domains, project types, and both institutional and commercial projects. The questionnaire was performed via direct in-person interviews, email, and web questionnaire tools. Categories of the questions in the questionnaire included general information (to map the population and project variables as listed above), impact of COVID-19 on KPIs (existing and new), awareness of COVID-19 measures put in place in their region, and lessons learned.

For the attempt to provide quantitative insights into the application of CBA during the crisis, a simple CBA exercise was performed that quantifies the impacts informed by the questionnaire in monetary units, with a particular focus on evaluating the effect of teleworking. Thus, only the costs and benefits associated with teleworking were considered under some assumptions (e.g., monetary

values of costs and benefits do not vary from year to year during the project term, the remote work environment is created from scratch at the onset of the crisis, etc.).

The simplified CBA suggested a need for an efficient and effective productivity assessment tool to manage the progress in projects / programs and hence maximize the outcomes out of remote work. The present study provides a new productivity assessment tool, the Distinguished Analysis using Binaries (DAB).

5.5.2 Major findings

Questionnaire results

The questionnaire was administered to 51 respondents from three different continents: Europe, Asia, and North America. Approximately 60 percent of respondents work in Asia, 30 percent in Europe, and 10 percent in North America, giving a nearly global coverage of the research. The most common profile in the research, representing 71 percent of the sample, is Project Manager, which includes Project Sub-Managers. Other profiles represented in the research are coordination figures such as Department Heads, Directors, and Researchers. The questionnaire targeted people from all project phases, from initiating to closing, and included several project domains.

Most of the respondents' companies are currently open (90.2 percent) with a predominance of teleworking practices. It is interesting how the majority of companies that are "open and completely operational" are located in European countries, which was one of the first regions to get infected with COVID-19 and also one of the first locations to implement collective virus response strategies. This helped to "flatten the contagion curve" and allow for, in terms of work habits, a near return to the previous lifestyle. This is evidence of the importance of government-level policies in handling the pandemic. Albeit the emergency phase in a large number of countries has passed, many companies are still teleworking. Telework is appreciated by employees because it allows greater flexibility, reduces commuting time, and improves work-life balance in some cases.

When the team asked project managers about CBAs performed during the pandemics, most of them replied that it's not in use. This has been a major impediment to the research.

Both industries and Space Agencies commented:

"Commercial projects have been much less impacted than institutional ones, but in the future, we are afraid of the effect of COVID-related economic crises on both private and public investors."

"We are worried about the public funding of the projects, 2022 will be a far less good year for space initiatives if the member states' economy will not start soon to recover from the current losses."

Open questions have been posed to investigate which Key Performance Indicators (KPIs) are used more commonly in the space sector, if any, and how they have been affected by COVID-19. The

final goal was to understand if there is a space sector CBA standard or if each entity has its own way to measure costs / benefits and perform a risk assessment and relevant process changes. Indeed, the group found out that a standard CBA does not exist, and sometimes KPI seems to not be even used. Please note that 98 percent of the respondents work for institutional projects or at least commercial projects whose final users are still government or public entities. Therefore, the following considerations on CBA and used KPI do not reflect what happens in commercials projects for the private sector. The team still considers this figure interesting as in general the space sector, except for telecommunication providers and other smaller businesses, relies on public investments.

As remarked, 49 percent of the respondents seem to not perform a CBA based on KPI identification. For those who do, the most used KPIs are milestones and schedules. The associated overruns costs are therefore because of delays in the activities. That is why the main negative changes impacting KPIs are schedule delays caused by COVID-19 restrictions such as national lockdowns, travel restrictions, quarantine, and difficult remote communications.

As a matter of fact, 45 percent of the respondents think that COVID-19 has had negative impacts on their KPI (costs higher than benefits). That 45 percent can be further broken down: 41 percent of the respondents see only negative effects and 4 percent registered both positive and negative ones.

Only 8 percent of the respondents shared with the team economic figures of the current crisis impact upon their projects. This has been a very critical issue for the investigation. The registered figures came up to be in-line with the Aerospace and Space Economy Observatory's estimates for which the potential revenue losses have been between 14 percent up to 25-30 percent.

Respondents from institutional projects said that they have lost from 10 percent to 30 percent of their original contract values. These losses are mainly due to stop of travels and lockdowns and quarantines in different countries and epochs. The latter caused from 1 to 3 months of delays in integration and test activities. Indeed, these activities cannot be fully performed remotely, and they require HW component procurement from one country to another. That is why the most impacted projects are those in their late development stages with HW activities involved. Moreover, these projects are also those in which the initial risk margins have been already totally or partially used, leading to poor options to contrast the crisis.

The main negative impacts and relevant causes registered through the questionnaire, are reported in the following Table, divided by project type / phase.

Project Phase/Type	Negatively Impacted KPI	COVID-19 causes
Institutional Project/Programs in phases that require manipulating HW	AIT/AIV activities delays Manpower HW procurement	Travel restrictions for people and HW Quarantine period National lockdowns or pandemic peaks in different countries at different times
Institutional Projects/Programs in Early phases based on SW or design tasks	Delays due to difficult communication inside the team (Teamwork / Team-building)	Remote working had negative effects on new teams or teams in which the relationship between the team members was already difficult
R&D projects with HW and facilities	Internal facilities HW procurement	COVID-19 impacted procurement of HW components needed for R&D and on the possible access to the facilities. The sanitizing products to be used following COVID-19 requirements, could not be used in facilities that perform cleanliness certification tests as they are based on organic products and they risk falsifying the data of the cleanliness tests.

Concerning changes in KPIs due to the pandemic, 67 percent of the respondents did not introduce any new KPI, while the 14 percent indicate new KPIs such as COVID-19 PPE costs, supply chain delays, direct manpower, and cybersecurity.

Generally speaking, the respondents did not take into account catastrophic events such as the pandemic in their risk assessment at the project level. Usually, these kinds of factors are considered at the industry or government level. Twenty percent think that pandemic / catastrophic events shall be introduced in the risk assessment of the project level and even in legal contracts.

Besides the negative impact on KPIs / costs registered during the crisis, the team expressly asked if any positive or negative effects have impacted the projects. About 82 percent of the overall respondents found that the COVID-19 impacted positively their work (of which 55 percent only positive effect, 27 percent positive and negative effects). The positive effects are mainly due to:

- A better work-life balance thanks to teleworking
- Travels cost reduction thanks to meetings performed remotely

This outcome is interesting because the same factors are used as the primary cause of the negative effects. Similar to what has been found on COVID-19's negative effects on KPIs, 6 percent of the overall respondents said that poor communication with team members and / or subcontractors was

present already before the crisis. It is therefore possible to infer that if a team had built good relationships, the digitalization of the process was welcomed as an improvement, while in the other cases it worsened an already difficult situation.

To investigate how much possible benefits / opportunities related to COVID-19 have or have not been taken into account by the questionnaire's respondents, the team asked them if they knew measures created by governments or space agencies to counteract the COVID-19 economic crisis. From the responses, it seems that Europe has been more active in sustaining the space sector during the global crisis, or at least that industries in the European space sector have been informed efficiently by their national governments / space agencies. Indeed, 61 percent of the COVID-19 measures mentioned are by ESA.

The questionnaire results also reveal that CBA is not often utilized in the respondents' projects / programs. This fact leads to a question: Are theoretical ways of applying CBA pre-pandemic still applicable during a pandemic or post-pandemic if space projects / programs need to account for pandemic-related risk management?

CBA results

Information gathered through the survey indicates that project managers do not systematically perform CBA.

Theoretically, CBA is not only useful for deciding whether to undertake a project or not, which seems to be the assumption of the respondents, but can also be utilized to support complex decision making about whether to commence, continue, pause, delay, re-scope, or close a project. The usefulness of CBA in the course of a project would rely on the establishment of appropriate underlying assumptions, and the understanding of these by the stakeholders both conducting the analysis (project managers) and taking decisive action based on the results (typically senior management). CBA can only be a useful decision-making tool if its limits and applicability are also understood by both parties.

CBA involves two important steps: (1) setting the terms of the analysis and items to consider, and (2) conducting the analysis. Appropriate decision making as an outcome of this analysis is dependent on the quality of performing both steps. During times of high uncertainty, existing items may no longer be appropriate, or a reprioritization may be needed. Conducting the analysis can be challenging due to the inability to track the costs and benefits in real time. Project managers in institutional space projects have mainly cost-driven KPIs. However, costs cannot be considered alone. For example, large cost increases may be acceptable if they are associated with large increases in benefit. Small costs may be undesirable if they bring only small benefits. It is therefore hypothesized here that if project managers were to track the benefit side of their CBA equation more thoroughly in the course of their project, their ability to properly track and implement and make decisions from the status of their cost-focused KPIs will be enhanced in times of crisis.

To investigate this point, the team applied a simplified CBA to a case study with the goal of identifying the validity or appropriateness of teleworking in terms of net result on work

productivity. Parameters used in the analysis are: Software Costs, Training Costs, Equipment Costs, IT Member Costs, Travel Saving Benefits, Space-Saving Benefits.

The primary outcomes of CBA involve the finding that if an approximately 10 percent enhancement in work productivity is realized, benefits stemming from implementation of teleworking become larger than costs, suggesting that remote work has a positive effect on projects / programs. Further, if the remote work environment is already cultivated via advanced investment before the crisis occurs, a necessary increase rate in productivity for generating the net benefit becomes lower.

Another outcome of the CBA is the need for an efficient and effective productivity assessment tool to track and manage the progress in projects / programs and hence maximize the positive outcomes of remote work. Globally accepted methodologies such as Earned Value Management are already available to help measure productivity, however, a simplified tool could be beneficial in allowing a more widespread monitoring of project productivity and efficiency. Therefore, the team also provides a new productivity assessment tool, the Distinguished Analysis using Binaries (DAB). The objective of the DAB is to track the project resources and assess the impact and risk. The DAB focuses on using just binary scores to assess the engagement / productivity of team members, and cumulative scores are then used to highlight the project progress using the following eight (8) indicators.

1. “Impact” is an indicator used to determine the productivity of the team members in terms of costs.

2. “Risk” is an indicator used to determine overall inefficiencies. An important point to consider is that Risk allows the Project Sponsor or the Project Manager to take into account both the overrunning costs and the delays for an active project.

3. “Spare Liquidity” is an indicator used to account for saved budget that is helpful to cope with possible project failure in terms of costs incurred and delays suffered.

4. “Secured Liquidity” is an indicator used to account for remaining budget after inefficiencies measured as Risk have been deducted from the Spare Liquidity.

5. “Actual Project Value” is an indicator used to determine the overall project value by adding up Spent Liquidity and Risk. It helps in quickly identifying the existing margin of costs with respect to an ideal project value – that is to say, an allocated project budget.

6. “Ideal Efficiency” is an indicator used to evaluate the potential project efficiency in case Risks were not to be covered by Spare Liquidity.

7. “Actual Efficiency” is an indicator used to determine the real project efficiency after Risk has been spent and only Secured Liquidity remains. It helps understanding how far the project is from an ideal condition (margin of efficiency with respect to an Ideal Efficiency).

8. “Engaging Energy” is exactly the difference between the maximum attainable (ideal) efficiency and the actual one. A large value for Engaging Energy is an indication for the Project Sponsor or the Project Manager to initiate responsive measures like training,

education, etc.

The team believes that the DAB should be developed further as an Artificial Intelligent System able to compute a complete set of combinations and permutations of all the binary scores so to predict and identify combinations that lead to project failure in terms of costs incurred and delays suffered.

5.5.3 Conclusion and recommendations

By taking into account both the data collected with the questionnaire and the results of the simplified CBA, the team SurVirals recommends the following list of approaches for PMs to shape the impact of the COVID-19 crisis into successful progress, ensuring acceptable risk, and pioneering a new way forward.

Recognize global pandemic events as force majeure in contracts and insurances

Investigating the higher-level actions that governments and institutions can take, the team suggests including some general policies to **recognize global pandemic events as force majeure in contracts and insurances**. This will avoid contractors incurring monetary fees for the delays as well as having to cover the cost of salaries in case of unexpected interruption of activities.

Make geo-return schemes less strict or negotiable in times of crisis

For institutional projects in several regions involving Europe and Asia, contracts establish at the very beginning the project cost, schedule, and the possible supply chain, which can in part be due to geo-return constraints. On one hand, this kind of policy makes sure that the agencies equally distribute commissions between subcontractors from several nations, but in times of crisis it restricts project flexibility and limits actions taken to reinforce both small local companies and large integrator networks. Due to geo-return constraints, PMs cannot change their project supply chain and must pay for the elongation or other impacts incurred by their subcontractors. The group suggests allowing the **allocation of different percentages of geo-return in case of catastrophic events** at contract level. These can help to sustain both small and large contractors, and it can also help project managers to be more flexible in counteracting the crisis.

Create a program of incentives to support the space market

The need to harvest resources in a time of crisis can cause an organization to cut its investment budget. This issue, together with the difficulties encountered in attracting new clients during the

pandemic, would lead to a wrongful shutting down of Research and Development (R&D) as the first measure to mitigate the crisis. One possible solution at the governmental level could be **creating a program of incentives** to invest in missions that experienced increasing demands because of the catastrophic events. As an example, in the case of COVID-19, some sectors such as telecommunications (TC) and earth observations (EO) have been very useful to analyse and counteract the pandemic. That is why program incentives in these fields could fill the market's demand and provide clients to these sectors of the space industry at the same time. Indeed, the future of the space sector depends on the ability of governments, institutions, and companies to legitimize the role of space in our daily life. Lobbying is necessary to maintain and enhance space investments in the next global policies. This topic has been addressed by workshop delegates investigating Topic 3 as well, and the reader is encouraged to refer to their Full Report for further information.

Stimulate teleworking with eco-incentives

In this world mainly based on market economy, we somehow have believed that people, industries, governments, etc. would be better if concentrated into one city since it would lead to effective communication and other associated benefits. However, as we now noticed, this system created infection-vulnerable hubs. As this system maintains, there will always be a risk of natural disasters (such as earthquakes, tsunamis, pandemics, etc.) threatening these aggregation centers that we call cities. Thanks to various telecommunication tools, we now do not need as much physical proximity. We may be required to decide whether or not to bravely renovate what we have built in this pandemic situation, similar to Paris' huge renovation in the 19th century due to Cholera. That is why the team suggests governments and institutions introduce **policies stimulating teleworking with eco-incentives**. Hence, this may be a great opportunity to renovate present common employment systems into a new one in which employees can live far from their workplaces.

This system will not only enhance the city's resilience, but it will also help to gather better human resources, irrelevant of where they live. This could accelerate international space projects if we are able to reboot our working system and take advantage of these opportunities because it allows for more chances to collaborate with organizations located remotely, such as international collaborations between suppliers and partners.

Establishment of common CBA-like framework for space projects

A major and unexpected outcome from the questionnaire was that space project managers do not typically consider conducting any CBA during their projects. All questionnaire respondents answered that they do account for risks and opportunities, but that they do not use CBA as a PM's decision tool. Indeed, CBA literature is extensive, but no examples applied to the space sector have

been found by the team. From the CBA exercise done to try to quantitatively measure the costs and benefits of teleworking, the group believes that CBA is a powerful instrument to make weighted decisions, especially while facing new unexpected crises such as COVID-19.

It is recommended that a **common CBA-like framework be established for space projects**, tailored to space project management needs on both the customer and supplier sides. This would include a mapping of the potential parameter categories that project managers could consider for inclusion or prioritization. For each of these items, recommendations on how to track them, and factors to consider, especially in times of change, should be made. This would, in effect, provide strong guidance to the PM's decision-making process. Space project managers and organizations could then draw upon this framework in times of crisis as a checklist to identify which items they may like to consider and track more closely. This is both to support the project managers, as well as to aid comparison between projects. **If each project continues to only have its own individual definition of cost and benefit items, the comparison is limited.** A common framework for CBA could be beneficial, for example in case within organizations, at program or portfolio management level, decisions have to be made to choose which projects to prioritize and which to penalize in terms of schedule slip and resource allocation.

Include pandemic events in risk management plans

At the organization level, all the questionnaire respondents said that COVID-19 was not included in their organization's risk management plan. The team suggests **having a risk management plan which considers the costs of all the measures needed in case of a catastrophic event such as COVID-19**. In case of a pandemic, these costs are for personal protective equipment (PPE), sanitizing, training, and stopping or lengthening the duration of activities that cannot be performed completely in a remote setting. Although several options can be analyzed when a project is in an early stage, very little action can be taken when a project is in the process of closing because its margins have usually already been used. That is why including these costs in the project's margin at risk assessment level is important.

Implement structured teleworking and remote processes

COVID-19 pushed the world toward digitalization and remote working. In particular, teleworking has been a valuable instrument, experimented with massively for the first time in several countries. This new way of working and its potential are far from being fully exploited. Teleworking increased the flexibility and the resilience of the teams to the current pandemic crisis, reducing the economic losses of the space sector. In normal time, it can cut the important cost of a large office, and it may allow more flexibility and work-life balance on a personal level, boosting employee's morale and thus productivity.

However, there is also a downside to teleworking. Many workers, during this first experience with it, have put in more hours as their "right to disconnect" is difficult to enforce, especially when home and work environments are not clearly separated. On the other side, some projects registered a loss in productivity due to teleworking. These are projects where the team dynamics were already difficult to manage before COVID-19, and / or projects where important negotiation were on-going. Finally, there are not only economic benefits but also costs associated with teleworking as well as for training, hardware (e.g. laptops), software tools, and cybersecurity's costs.

The team believes that teleworking should and will become an important part of our society, but it needs to be structured, organized, and recognized at the organizational level. Indeed, not everything can be done working from home: one of the most significant lessons learned from COVID-19 is that, after all, we all are human beings and we need physical interaction to be productive and to maintain high spirits. This is why the group is prone to believe that some of work activities will remain preferably on-premises, such as some teamwork sessions and negotiation. At the same time, performing teamwork remotely twice per week can help workers and teams to get used to working far from each other, augmenting the project resilience when a catastrophic event such as COVID-19 occurs. That is why the team suggests **introducing a standard telework 20-40 percent (1-2 days/week).** This could be the ideal solution for balancing teleworking costs and benefits.

Sometimes, unfortunately, it is impossible to keep company activities running based on telework during a pandemic, such as in the case of Hardware Assembly, Integration Test, and Verification activities (AIT, AIV). Anyway, also this kind of process can benefit from digitalization. Some questionnaire respondents said that they now can **perform tests and integration remotely** by using webcams. This can help during a global crisis, with travel restrictions, in performing integration or tests at customer facilities, but it can also cut travel costs in normal periods.

<u>Continue to foster safe hygiene practices within the workplace</u>

For those activities that need to be conducted in specific work areas and cannot completely be performed remotely, attention should be given to creating safe workspaces swiftly, such that employees can resume activities. One solution can be **altering the PPE and social distancing rules within clean rooms**. Another one can be **changing processes and creating virtual plugins for AIT / AIV activities** that can then be performed with fewer people in the same location (e.g. conducting functional tests from remote operations rooms / centers with only a few having to be in the cleanroom / test center dealing with hardware). Addressing these challenges creates upfront costs (NRCs), which can add up to form a high percentage of total costs and will likely ensure long-term benefits. That is why the costs should be borne by the organizational level, rather than by individual projects.

Invest in digitalization, tools, and cybersecurity

A great way to deal with the possibility of working through a pandemic is, based on the results obtained in the questionnaire, **investing in digitalization, remote tools, and cybersecurity**. In fact, companies that already developed a good digital infrastructure were less damaged by the crisis. Allowing employees to perform their jobs remotely as much as possible in case of need will make the company more resistant to unforeseen events of any kind and it would cut down losses related to the impossibility to physically be present in the workplace. In certain cases, organizations (both private and institutional) changed the rules so that employees could even take some hardware home and work on it there, where possible. Moreover, digitization of engineering towards Model-Based System Engineering (MBSE) has, potentially, a very important role to play to support the monitoring of space project progress, and the streamlined collaboration between teams not collocated in the same place. In order to sustain and make this digitalization work, it is necessary to have a well-structured IT department inside the company that takes care of all the issues that could arise and cybersecurity. In this sense, huge investments are required since most of the small and medium engineering companies still do not have IT personnel. Cybersecurity would be an associated increased cost, given all these virtual interactions, and should be accounted for in future project plans, as well as the training cost associated with the IT innovation inside the company. One of the respondents said: "Training has huge costs in terms of both material and time. Especially in the case of test campaigns and IT activities, where special training must be done."

Recognize decisions taken during informal communications

New, flexible, and less formal means of communication between clients and suppliers spread in the working environment during COVID-19. Messengers, video conferences, and telephone calls are a few examples of these agile ways to exchange information. These new means of communication turned out to be also a useful instrument for customer loyalty management. However, they still need a formal acknowledgment of their contractual validity from the program management. Before the pandemic, projects' decisions were usually taken and acknowledged during formal meetings through proper Minute of Meetings (MoMs). Now, **recognizing decisions taken during informal communication** is being identified as a valuable alternative in the decision-making process. One way this could be structured would be the introduction of a project journal where all the performed activities can be recorded to keep track of processes and responsibilities.

Change PM's and teamwork's methodologies to account for remote working

COVID-19 changed our way of working by forcing the transition to remote work in our daily lives. This is a process that is highly likely to continue after this pandemic crisis. Numerous private

companies and public organizations have introduced, or are going to introduce, teleworking in their employment contracts. However, during the pandemic, not all the PMs and teams were prepared for such an innovation. From the questionnaire's answers, it came up that small SW companies, managed using Agile methods, have been almost not impacted by the COVID-19 crisis. Big organizations with very complex organization structures have been less flexible in embracing the changes, registering economic losses from 10 percent to 30 percent of their contract's values. From the questionnaire, it is evident that most questionnaire respondents think that to enhance team productivity, physical interactions are necessary. While this can be true in activities such as negotiation, for teamwork activity this is not always the case.

The team believes that a change of mindset is therefore needed. **PMs need to change the way they evaluate the team-member's performance from an hour-based to a goal-oriented scale** and they shall **also change the way they manage employees, teams, and the project itself.** For example, the group suggests good practices such as lean meetings for team management. In this way, the number of in-person gatherings can be drastically reduced to a few significant meetings with a selected number of necessary participants. This would reduce the cost of the projects, and it would increase the overall efficiency of those events also in regular circumstances. For what concerns the project itself, taking some practices from Agile methodology (e.g. creating the project scope with minimal textual description, creating the project plan collaboratively with shared responsibility, using a plan updating approach on a weekly basis, etc.) can help to manage projects in an easier way and increase the project efficiency. Even if these changes require significant effort, the prize in return will be significant: increase of productivity, reinforced team spirit, and augmented project resilience to unforeseen events as COVID-19.

Last, but not least, Think positive! Even during the huge global crisis, there could be new opportunities. Some respondents said, "Some difficulties during the crisis have been transformed into opportunities for new business."

Concluding remarks

The team identified higher-level actions, to be performed by Governments and Institutions as well as lower-level actions, referring to some policies to be adopted by Companies or good practices to employ at Project level. The following figure briefly summarizes the recommended actions.

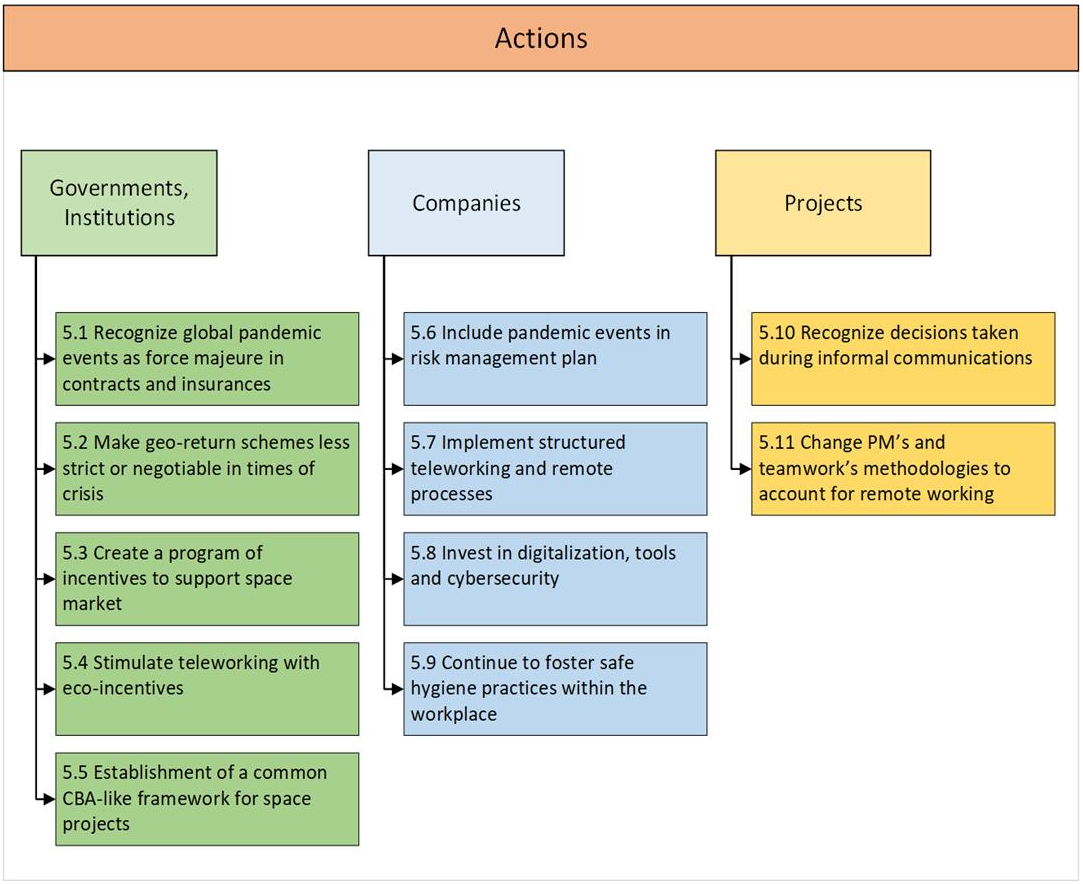

Figure 9: Categories of actions to undertake for facing a crisis such as the COVID-19 pandemic

Lastly, the team recommends the formulation of a standard set of CBA tools that can be adopted by all projects in the space sector. A standard handbook of CBA that provides metrics and consistent methods to measure productivity can be the first step in the global assessment and comparison of impacts due to unforeseen events and the associated mitigation actions.

6. General Concluding Observations

Every year the IPMC YP workshop topics are carefully chosen in close collaboration with the committee members. The topics represent the interest and challenges that the aerospace industry and organisations face on a daily basis.

The 9th edition of the IPMC YP WS has been tailored to the exceptional circumstances of year 2020. To recognize and respect the worldwide crisis, the WOC proposed a customized Statement of Work to reflect on the peculiarities of current times and their effects on Project / Program management. Instead of the usual collection of five topics to be investigated, the SOW focused on the singular experience of working in the space industry during a global lockdown. Young Professionals were encouraged to use their first-hand experiences, their informed opinions, and their fresh ideas to provide an insightful analysis of the research themes, all linked with Space Project Management in the world of global lockdown, remote work, and mobile technology.

The young professionals have a clear view of how the space sector is changing and how to navigate in this change. They are digital natives, resourceful and flexible in envisioning, accepting, and trying out new ways of working that can contribute to fostering the strength and ability of the space workforce and of space organizations to cope with such exceptional times.
The delegates explain to us the importance of interconnectedness and globalization despite a forced lockdown. They point out that our sector can benefit from: well-balanced, smart, remote working practices deployed in consultation with the employees; a leadership well versed in communication skills, empathy, transparency, and willing to lead by example; and a conscious and conspicuous investment into public outreach to forge a stronger link between Space and Society. They identify and explore the merits and the shortcoming of managers and management methods throughout the COVID-19 pandemic. They work around the reluctancy of organizations to divulge information on how they acknowledged, measured, and tackled the impacts brought by the global crisis to provide us lessons learned and recommendations on how to face a crisis for which we have no previous experience and proven remedies.
Amidst all of this, Young Professionals bring fresh ideas and new energies, they are technology-savvy and open to change. They will quickly grow into tomorrow's workforce.

We invite the IAF's IPMC committee members and the Young Professionals to further discuss the findings of these topics and find a way to implement the recommendations in their respective organisations. The recommendations are evident, well thought out, and based on the examples, experiences and input from today's way of preserving, conducting, and developing business across turbulent times.

7. List of Workshop Delegates

First Name	Last Name	Organisation
Kathryn	Dunlop	Airbus
Katherine	Bennell	Australian Space Agency
Campbell	Pegg	Australian Space Agency
Cynthia	Fonseca	CSA
Dona	Sandu	DLR
Antje	Stamm	DLR
Miranda	Caserta	Dynetics
Louis	Le Breuilly	ESA
Abhisek Akash	Diggewadi	ISU
Adriana	Andreeva-Mori	JAXA
Hiroko	Asakura	JAXA
Kentaro	Nishi	JAXA
Takeshi	Shoji	JAXA
Michele	Bechini	NASA
Maurizio	Clemente	NASA
Carlyn	Lee	NASA
Natasha	Stavros	NASA
Ghanim	Alotaibi	SGAC
Charlotte	Flory	SGAC
Marco	Romero	SGAC
Mehdi	Scoubeau	SGAC
Simon	Shuham	SGAC
Jacopo	Capolicchio	Thales Alenia Space
Sara	Consorti	Thales Alenia Space
Sabrina	Dionisio	Thales Alenia Space
Martina	Giraudo	Thales Alenia Space
Clément	Goujon	Thales Alenia Space
Davide	Grana	Thales Alenia Space
Daniele	Rolfo	Thales Alenia Space
Eleonora	Trentin	Thales Alenia Space
Claudio	Tribbia	Thales Alenia Space

8. Previous Workshop Reports

All previous IAF's IPMC Young Professional Workshop reports are available on the IAF website, please follow this link.

9. Acknowledgements

The Workshop Organizing Committee greatly appreciates the support of the IAF, the IPMC, and all their affiliated organizations who nominated Delegates for the 2020 edition. The WOC would like to warmly thank the Mentors for their inspiring and selfless support to the Young Professionals. The WOC also thanks the IAF Secretariat for their continued interest and assistance in including the Workshop among the IAC satellite events.

The Workshop Organizing Committee also extends a special thank you to the 2020 cohort of Delegates, who decided to enrol and attend the Workshop in spite of the difficult times, on a volunteer basis and on top of their already demanding work and personal commitments.

The WOC is looking forward to the future with preparation for the next workshops and the continuation of the implementation of previously presented recommendations. The WOC, in close collaboration with the IPMC, strives to advance on the development and empowerment of the next generation space workforce.

10. Full topic reports

The full reports per topic are presented in the attached link.