MANAGEMENT CHALLENGES IN IMPLEMENTING SCIENTIFIC PROJECTS DURING COVID-19 PANDEMIC

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Abstract: The aim of this work is to outline the management and risk management activities related to the successful implementation of scientific projects, which have been severely affected by the pandemic situation. The methodology includes a comparative analysis between planned and implemented activities on running scientific projects. Time, budget and scope are the main three constraints of the project used in the assessment. Five main groups of activities are analysed: Management, Scientific, Educational, Dissemination and Production. While published studies present qualitative and quantitative risk analysis due to the pandemic, this work goes a step forward by suggesting risk response planning, management procedures and activities to reduce threats to the project's objectives. To the best of authors' knowledge, there is no research systemized by other research groups.

Key words Project risk management, COVID 19 challenges, Project's activities, Deliverables, Scientific projects

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Introduction

Even top experts in project risk management have hardly considered scenarios, in which successfully running a project may be "quarantined" overnight. Thus, the global pandemic declared by the WHO on 11 March 2020 suddenly made all project managers face unexpected challenges. Project managers have been urgently forced to imply changes in order to carry out the planned projects' activities (Conde et al., 2020). The restrictive pandemic measures in 2020 have necessitated re-planning and rescheduling many ongoing projects′ activities. Under these conditions, project managers have been forced to make rapid decisions, having uncertain information and an unpredictable future. One year later, there is still no clear horizon for the end of the pandemic; moreover, voices are increasingly being heard to adapt to the "new reality". Further, some studies suggest that working from home on projects' tasks will be the new norm (Egeland, 2020).
As a project-oriented research team, the new reality provokes us to analyse the impact of COVID-19 on the activities related to scientific projects and the possibilities for their modification. This is a mandatory step for the successful project's implementation in the new environment. This work aims to outline the

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activities related to the management of scientific projects, which have been severely affected by the pandemic situation, and to suggest key decisions for alternative management actions. To the best of authors' knowledge, they are not aware of any publications on this specific topic.

Literature Review

Project Risk Management (PRM) is a key tool for project managers to manage uncertainty (Ahmadi-Javid et al., 2020; Hillson, 2009) and assess possibilities, both positive and negative, that may affect the success of the project completion (Datta and Mukherjee, 2001). A wide literature review of more than 2200 articles published over the last six decades shows that risk management is one of the most popular research topics linked to project management (Padalkar and Gopinath, 2016). For more than a half-century from the establishment of project management as a discipline, PRM has evolved theoretically and practically. Initially defined classic processes of PRM (Chapman, 1997; Project Management Institute, 2003) expanded to more innovative risk management approaches (do Vale et al., 2018; Wang et al., 2018) based on the complexity of the projects, companies and stakeholders. Goodman has described the PRM evolution from 1987 to 2004 by thoroughly reviewing the Project Management Institute's (PMI®) Guide to the Project Management Body of Knowledge (PMBOK®) Guide (Goodman, 2005). The review showed that while risk management occupied a minor division from the Project management at the beginning of its development (in 1987), in 2005, the PRM became a well-established discipline, one of the ten project management knowledge areas. Moreover, the development of the PRM over the years resulted in a process with clearly defined 6 steps to control the risk effectively. Further extension of the scope of the PRM and, respectively, the update of the existing PRM processes would not have the expected effect on predicting all possible project variations. Pandemic outcomes are "lockdown" project processes and dynamic project risk management more than ever.

The pandemic and national lockdowns turned out to have a significant detrimental impact on research output (Harper et al., 2020; Rosales-Mendoza et al., 2020). Amid the pandemic, scientific journals have given priority to publications related to the coronavirus medical data and fusion on human health, the way and how fast coronavirus spread out, the development of vaccines, drugs, etc. Since many research areas are involved in overcoming COVID-19 (Gao et al., 2020), studies outside of biological and medical field were encouraged as well. The literature review for the period from March 2020 to March 2021 showed that for COVID-19 related research, the impact has been like a booster that attracts the world's financial and intellectual power to this scientific area. Billions of funds have been allocated to scientific teams and organizations to fight against the pandemic. For example, the European Commission mobilized over 1 billion euros for research and development work on vaccines and medications to address the coronavirus (Germany's Presidency of the Council of the European Union 2020, 2020). On the

other side of the ocean, in the USA, Congress provided $3,6 billion to the National Institutes of Health (NIH) for COVID-19 research and testing (Radecki and Schonfeld, 2020). The pandemic has an opposite impact on the rest of the researchers. Unfortunately, during the last year, many research teams whose studies are not related to COVID-19 have been treated as "non-essential" (Yanow and Good, 2020; Vagal et al., 2020). These teams carried the brunt of the pandemic restrictions. The restrictions on the research laboratories and infrastructure turned out to be the regulation with the greatest impact on scientific activity with both short-term and long-term consequences; some are to be assessed and analysed in the future. However, we can certainly state that delaying oncology trials or those potential investigating treatments for rapidly fatal conditions may increase the risk for the participants (Bagiella et al., 2020). For instance, a study on malaria disease demonstrated a lack of progress on scientific outcomes due to the inability to perform remote research for lockdown time (Yanow and Good, 2020).

Another serious concern is the researchers' fear of restarting long-term experiments, given the uncertainty of the period until the next lockdown (Loh et al., 2020a). Researchers involved with cell culture most commonly fall into this scenario. Thawing of frozen cell lines can be a time-consuming process; therefore, laboratories may miss months adjusting their research back (Sohrab et al., 2021). Several studies and funding organizations reported the financial impact on "non-essential" research. Cancer Research UK reduced funding to its national network of centres by 20% while announcing cutting budget to existing trials by 10% (Cancer Research UK, 2020). The result of reduced funding could be both uncompleted projects and staff redundancy in research institutions (Magan et al., 2020). Further, insufficient funding, together with the closure of laboratories, can limit the potential of the scientific career of early-stage researchers or even delay/prevent the defence of a doctoral degree by PhD students (Termini and Traver, 2020). An online survey targeted to graduate students and postdoctoral fellows who are engaged in laboratory-based research in Canada confirmed the same concerns (Suart et al., 2020). Most of the 315 respondents highlighted their worries of scarce funding for basic research, decreased research productivity, missed opportunities for global collaboration, etc. Moreover, some of the respondents declared they had already decided to revise the path of their career.

Numerous studies reveal the psychological effect of the pandemic on researchers. The International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) distributed an electronic survey to indicate the operational difficulties laboratories faced (Loh et al., 2020b). According to 1210 survey submissions, the highest challenge is ensuring personal protective equipment (PPE), followed by managing issues with staff's morale, anxiety and deployment caused by the pandemic. Such a change in staff behaviour can be explained with so-called "infodemic". A recent study classified the information disseminated during the pandemic as filled with rumours and speculations, which create an environment of fear and panic (Bushuyev et al., 2020).

The performed literature review showed that most studies are limited to quantifying the impact of COVID-19 on research and its activities. These offering solutions to deal with the effects of the pandemic are minority. Amongst them are opportunities for encouraging safe and jointly beneficial productivity for all team members (A. Nocco et al., 2021). Zandi *et al.* (2020) suggest project leaders provide mentorship that prioritizes equity and well-being on the research team during and beyond the pandemic, which is defined as the determinants of organizational commitment. Despite these publications, the lack of knowledge on this up-to-date topic is felt by project managers. The authors of the present study have sought to address this gap in the literature by sharing managerial experience and suggesting measures as correction or mitigation of possible risks caused by "quarantined" project activities. Authors who studied the influence of COVID-19 on different fields report on difficulties in gathering information on the topic and recommend more studies to be addressed (Sierra et al., 2020). Found on the above analysis, it can be hypothesized the following:

-Hypothesis 1 (H1): Risks cannot be fully eliminated or completely transferred; therefore, project managers must prioritize risks (due to the pandemic restrictions) to deal with.

-Hypothesis 2 (H2): Project managers should consider more frequent and systematic monitoring and evaluation of project progress, as long as employees work distantly from home.

-Hypothesis 3 (H3): Prolonged pandemic constraints will lead to residual risks, which will require mitigation measures based on the evaluation of the primary risk responding actions and the monitoring of project outcomes.

Methodology

Each project is unique by itself; however, in the literature, there are classifications of different types of projects, grouped by: complexity, project content, objectives, etc. (Youker, 2017). The implementation of different types of projects requires a different set of activities - a mix that determines the way the project is managed. In the case of scientific type of projects, 5 main groups of activities were defined and analysed: Management, Scientific, Educational, Dissemination, and Production activities.

Management activities

Management activities are divided into the following:

-planning;

-work meetings;

-reports;

-monitoring & control.

Before undertaking any changes to the initial project implementation plan, it is extremely critical for funded projects to clarify important issues with the funding organization (e.g., project officer) in respect to the force majeure circumstances. A manager’s responsibility is to prepare a project-specific set of questions based on

an assessment of the impact of the pandemic on the implementation of individual tasks and activities as well as the project as a whole. Such a group of questions may include queries on possibility to extend the project for the time of the pandemic (**time**), possible transfer of funds from one activity to another (**budget**), costs eligibility for new activities (**scope**), etc.
The scientific activity is related to the handling of confidential information and intellectual property. Therefore, organizing closed-door meetings for discussion of the progress and the results of the research is very important. Anti-epidemic measures for distance maintaining and limited face-to-face meetings required the use of secure methods for information transfer. A proper technique is based on encryption of the data over the network and the requirement for strong authentication to protect both the sender and recipient.
Switching entirely to virtual management (work meetings, reports, monitoring and control) results in changes in the scope of the work packages' tasks. As a result, activities related to the organization of events are reduced to the minimum, which events (depending on the size of the project and the number of participants) usually include renting a hall with presentation equipment, catering, transportation and accommodation costs, etc. On the other hand, some teams may need unforeseen funds to build a secure channel for project data transfer.

Case: In our practice, the team uses (long before the pandemic) a protected Partners' Area on the project website. The partners' area is protected by a username and a password for authorized access only. The Project Manager allows access and provides Login username and password to each of the project beneficiaries. This space provides the beneficiaries with documents for internal use, such as Grant related documents, project meetings' agendas and minutes, Work packages' deliverables, project implementation working files, etc., which are available to the project beneficiaries.

Scientific activities
The scientific activities include:
-computer simulations;
-hardware development;
-measurements & experiments;
-transfer & analysis of results;
-verification of results.
In many countries, anti-epidemic measures have required the scheduling of controlled visits and work at the office by 50% or even 30% of laboratory staff at the same time. This safety procedure has caused both, operation of the equipment at reduced capacity and longer time for implementation of some project research tasks. However, for the research teams, access to their laboratories remained the only possibility for simulations and experimentations since access to specific

scientific infrastructure, such as the Synchrotron facilities (which are limited), was inaccessible. The facilities in these high-tech scientific infrastructures are unique, and most of the planned research experiments could be carried out only there. Cancellation of experimental sessions turned out to be one of the scientific activities that is almost impossible to replace or overcome. From a PRM point of view, the simultaneously imposed very restricted access to the synchrotron facilities is the least likely event to occur; however, it negatively impacts the project implementation and research outcomes.

An option for partially overcoming the lack of experimental sessions is the accomplishment of a larger number of measurements with other equipment, which possesses suitable outcomes compared to those of synchrotron facilities. In addition, a thorough subjective evaluation of the results could be conducted instead of the planned objective assessments.

Case: The success of one of the team's projects largely depends on the verification of the results from the experimental session conducted on a synchrotron beamline facility. Usually the proposal submission is allowed twice a year and only limited number of projects are approved. During the pandemic, the team applied for beam time to two different synchrotron infrastructures – in France and in Australia. The evaluations were postponed for several months and finally the proposals were not approved. Some of the synchrotron deadlines were also either postponed or completely cancelled. This imposed the development and use of an in-house optical system, where research experiments are carried out and the results are extended to the x-ray range. In addition, more simulation work is performed instead of experimental. one.

Educational activities

The educational activities may be classified into the following categories:

-courses;
-training schools;
-mobility.

Each research project is associated with innovation goals and related developments. Running a trail in an unfamiliar environment requires additional preparation, training and upgrading of expertise. The nature of the particular project requires different types of training, such as courses, training schools and mobility. During the pandemic, all travel-related pieces of training dropped out of the teams' programs. Planned activities have been replaced by applicable forms of education, such as online courses or practical pieces of training at the place of residence. Thus, the team members will be able to develop new knowledge and skills, even if they are not at the expected level of competence.

Case: To date, the team is experiencing three waves of coronavirus, as it is also the case across Europe. The waves, however do not strike at the same time and with the same force in the different countries. This makes planning and attending face-to-face training on a European level almost impossible, especially since governments are taking different anti-epidemic measures for different periods /

duration of time. The sensible decision was to organize in-person training at the team's place of residence. When both parties in a training - trainer and trainee, are subject to the same anti-epidemic measures, flexible decisions adequate to the changes in the environment can be made. In this way, the team was able to participate in two trainings, planned, organized and conducted between two lockdowns: training in 3D printing of anthropomorphic phantoms and training in radiation safety.

Dissemination activities

Most of the dissemination activities of the research projects are traditionally carried out online. These are summarised as follows:

-publications;
-conferences;
-media;
-newsletters.

Channels for promoting scientific outcomes, such as journals publications, media/press releases, social network posts, e-brochures distribution and use of the WWW, etc., are not affected by the global pandemic. However, the main tool for presenting the scientific activity of a team is participation in conferences and seminars. As a result of the pandemic, the scientific forums planned for 2020 were either postponed or cancelled, causing the participation of projects' teams to fail or be delayed within the project duration. The conferences became web-based, which greatly changed the scope of the event. The organizers needed to provide a secure platform for the simultaneous hosting of a large audience and a direct presentation with synchronized video and audio, discussion channels, etc. Participation in online conferences has significantly reduced the cost of attending, which has opened up valuable opportunities for small teams with limited resources. Our experience has shown that researchers participate in a larger number of online events and reach a wider audience than planned face-to-face events. On the other hand, face-to-face forums bring additional benefits by creating conditions for building contact networks, collaborations and partnerships. In-person events are preferred by researchers because professional communities are created and maintained in a direct contact. Business cards were a must-have accessory for a researcher's trip. In this regard, our recommendation to the organizers of web-based events is to add to their official websites a section "Networking" for e-business cards of the participants, which may partially compensate for the lack of direct contact.

Case: Externally funded projects require strict implementation of budget items. From implementation of the financial plan point of view, dissemination activities turned out to be the most affected part of the restrictions caused by the pandemic. Funding organizations accept the imposed restrictions as force majeure, which has allowed the team to justifiably redirect the unspent funds to provide open access to publications produced under the project.

Production activities

The *production activities* may be divided into the following:

-purchase of equipment;
-installation of equipment;
-product development.
The full lockdown in most countries has directed consumers to e-commerce. The overload of online stores has led to slower processing and shipment of ordered goods. In the last year (2020), deliveries, including those for project needs, have taken much more time than usual, thus leaving less time for their exploitation within the project duration.
Case: During the pandemic, the team ordered specialized equipment for the implementation of research activities from another country, which took more than 6 months to be delivered. To overcome this, we asked our partners for help by providing temporally their equipment, necessary for carrying out the research activities.

Results

The results of the implementation of the proposed activities as an alternative to the planned ones during the pandemic are summarised.
The first double column represents the activities as planned in the project proposal and activities undertaken during the pandemic. Time, budget and scope, which are the main three constraints of project, are placed in the second large column, while the third column describes the goal of each activity and the obtained result of implementing the proposed actions (as shown in column *Implementation during COVID-19*). Usually, the initially planned activities have more than one goal. As a result, the implemented activities may completely cover all goals, partially fulfil some goals, or do not achieve any goal at all.
The results from this table show that the Global Emergency has the greatest impact on the project activities related to scientific experiments, followed by networking and project members' mobility. The only group of activities that have fulfilled their goals without any deviation in time, budget and scope are the management activities, which include planning, work meetings, reports, monitoring and control.

Table 1. Analysis of planned activities and implementation of the proposed.

Activity		Project triple constraint			Activity Goal	
Planned	**Implementation during COVID-19**	**Time**	**Budget**	**Scope**	**Description**	**Result**

Face-to-face work meetings	Virtual meetings, platform for safety data transferring	as planned	N/A	within planned	Monitoring and control of the activities implementation	Achieved
Participation at seminars, conferences, etc.	Participation at virtual (online) conferences, seminars, etc.	as planned	less funds than planned	within planned	Dissemination of the results	Achieved
					Networking New partnerships	Not achieved
Organizing conferences, seminars, etc.	Organizing e-events	as planned	less funds than planned	new product and process requirements	Dissemination of the results	Achieved
					Networking & New partnerships	Not achieved
					Promotion of the host institution	Not achieved
Courses, Training schools, Mobility	Online education, training at the host institution	delay	less funds than planned	necessary changes	New knowledge and advanced skills	Limited
Experimental sessions	Additional measurements, subjective evaluation	out of schedule	unexpended	necessary changes	Verification of results	Limited
Equipment order and delivery	Earlier delivery request than planned	delay	as planned	within planned	Exploitation of equipment	Limited
					New scientific infrastructure	Achieved

To assess and demonstrate the impact of COVID-19 on project implementation, the authors compared the number of implemented project activities in research group for two different periods before and after the pandemic, 2019-2020 and 2020-2021. The results are summarised in Table 2. The communication between the project partners has been strengthened in order to carry out quality monitoring and control in the new working project conditions (H2). The increase in numbers for the period 2020-2021 in comparison to the period 2019-2020 is due only to the activities that have been implemented online (e.g., meetings, internal communication and participation in seminars and conferences), while all other activities (e.g., organization of events, onsite experimental sessions, mobilities, etc.) have reduced numbers or have not been carried out at all (H1, H2).

Table 2. Number of project activities of the authors' research group for two different periods before and after the pandemic.

Activity	Feb 2019 -Feb 2020	March 2020-March 2021
Meetings	monthly	weekly
Participation in seminars, conferences	4	7
Organizing seminars, conferences, etc.	2	-
Courses, Training schools, Mobility	4	2
Experimental sessions	1	-
Equipment ordered and received	3	1

Discussion

The results in Table 1 show that some of the project activities can be done remotely, online/offline, and the corresponding costs can be reduced. Amongst them are part of management, educational and dissemination activities. This is also well supported by the results shown in Table 2, where indicators for the carried activities are presented. The success in the implementation of these activities by using this new approach may lead to changes in the criteria for evaluating project proposals in the near future in order to optimize costs.

The results have also shown that deviation from the planned activities and the project triple constraints, time, budget and scope, result in lower quality of implementation and/or incomplete achievement of the objectives. Similar results in the experimental sessions but another research field are reported by few studies. The Department for Business, Energy and Industrial Strategy (BEIS) (2020) conducted a nationwide survey among 8,416 researchers working in universities and research institutes in the UK. A conclusion from the survey defines blocked activities mainly as 'research activities that cannot usually be done from your home' with an almost 100% reduction. Attention to the "experimental impact" is also found in a survey conducted among 7670 postdoctoral fellows, which included questions on the impact of COVID-19 (Woolston, 2020). According to the results, the pandemic prevented the ability of 80% of respondents to run scientific experiments. The same study highlights another problem related to researchers' activity: disseminating results. 57% of the participants in the survey encounter difficulties with sharing their research findings. Similar results are reported by Myers et al. (2020), whose study shows that time devoted to research has changed the most during the pandemic. COVID-19 had a great impact on the oncology clinical trials carried within projects in many countries, and therefore, a strategy to optimize the management of the trial is urgently required (Fu et al., 2021). The authors selected the important indicators to both trials and participants, such as rate of participant withdrawal and loss to follow-up, rates of disease progression and mortality, etc. Results showed that more than 58% of all clinical trials in the Beijing Cancer Hospital were affected by the COVID-19 pandemic. Of these, 65

are international, and 238 are domestic trials. The study also showed that sending drugs by mail to patients involved in the trials is an effective approach, which also was followed by our team in the case of experimental work. As mentioned above, the physical infrastructure plays an important role in progressing the research activities. Infrastructure is the organisational backbone of the economy (Jallow et al., 2020). The impose of lockdown resulted in difficulties in implementing projects as staff members are working from home. The author found that technological tools, such as video chat and meetings via online platforms, are amongst the most effective in communication with project team.

The limited opportunities for mobility, participation in conferences and courses are not analysed by our research group alone. Mobility is the focus of international study of the EURAXESS Worldwide. The results of the survey are definite, 85%, which the pandemic impacts the mobility and scientists' ability and willingness to pursue research and studies abroad (EURAXESS Worldwide, 2020). The results of this study showed that additional events play an important role in networking in face-to-face forums, where participants enter into informal conversations, make contacts and exchange ideas. Our last year's (2020) experience with participation and organization of virtual conferences has shown that it is often not possible for participants to enter into a direct dialogue or discussion with the presenter. Moreover, some presentations are pre-recorded and played offline. Therefore, our recommendation to the organizers of online events is to add to their official websites a Networking section with e-business cards of the participants, creating e-environment for partnerships and collaborations.

Another consideration coming with the transition to an online work environment is the safety of information transfer. Similarly to the project members' protected area we used, some authors pay special attention to the need for scaling of VPN (Virtual Private Network) platforms and gateways for the needs of secure information management (Dwivedi et al., 2020).

From this and other authors' studies, summarized results have supported the proposed three hypotheses. There are no research teams that have completely eliminated the risks, and the chosen approaches for responding to the risks are in line with the project's priorities (H1). Communication over the network related to the management monitoring and control has intensified, revealing the need for channels with secure data transfer (H2). Calls for adaptation to the new reality indicate the long-term impact of the pandemic (H3), and proactive managers have already taken actions towards identifying and analyzing the secondary risks.

The findings in this work are limited to Bulgarian research activities. Therefore, the results are only tentative. However, the results may be useful to other research teams looking for successful project implementation.

Conclusions

The pandemic affected different types of projects with different scales, depending on the set of activities essential for project implementation. Inability to complete

planned activities due to unforeseen circumstances should be considered as a risk factor from the project management. Suggested measures in this study as correction of planned activities mitigated the emerging risks of project incompletion due to the pandemic restrictions. Any deviation from the planned activities and the project triple constraints, such as time, budget and scope, leads to lower quality of implementation and/or incomplete achievement of project objectives. Each planned activity can be related to more than one goal. The choice of an alternative activity should be in line with the main goal and achieve the final project results. If necessary and appropriate, more than a single action may be performed to replace the planned activity, as long as it is within the *time*, *scope* and *budget* of the project. Funding organizations should provide more flexibility in operation costs and funds transferring from one category to another in order to allow project teams to conduct alternative activities. Given the latest expectations that the pandemic will last longer, the team intends to update the study in the future with the accumulation of more information and experience over time. The future work will focus on comparing the impact of the pandemic on projects at different stages of their life cycle, from early to final stage of project implementation.

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WYZWANIA KIEROWNICZE W REALIZACJI PROJEKTÓW NAUKOWYCH PODCZAS PANDEMII COVID-19

Streszczenie: Celem pracy jest przedstawienie działań związanych z zarządzaniem i zarządzaniem ryzykiem związanym z pomyślną realizacją projektów naukowych, które zostały poważnie dotknięte sytuacją pandemiczną. Metodologia zawiera analizę porównawczą planowanych i realizowanych działań związanych z prowadzeniem projektów naukowych. Czas, budżet i zakres to trzy główne ograniczenia projektu wykorzystywane w ocenie. Analizie poddano pięć głównych grup działań: Zarządzanie, Nauka, Edukacja, Upowszechnianie i Produkcja. Chociaż opublikowane badania przedstawiają jakościową i ilościową analizę ryzyka związanego z pandemią, praca ta idzie o krok naprzód, sugerując planowanie reakcji na ryzyko, procedury zarządzania i działania

mające na celu zmniejszenie zagrożeń dla celów projektu. Według najlepszej wiedzy autorów nie ma badań usystematyzowanych przez inne grupy badawcze.

Słowa kluczowe Zarządzanie ryzykiem projektu, Wyzwania COVID 19, Działania Projektu, Efekty, Projekty naukowe

COVID-19 大流行期间实施科学项目的管理挑战

摘要:这项工作的目的是概述与成功实施受大流行情况严重影响的科学项目相关的管理和风险管理活动。该方法包括对运行科学项目的计划和实施活动之间的比较分析。时间、预算和范围是评估中使用的项目的三个主要约束条件。分析了五类主要活动:管理、科学、教育、传播和生产。虽然已发表的研究提出了大流行导致的定性和定量风险分析，但这项工作向前迈进了一步，提出了风险应对计划、管理程序和活动，以减少对项目目标的威胁。据作者所知，其他研究小组没有系统化的研究

关键词 项目风险管理，COVID 19 挑战，项目活动，可交付成果，科学项目