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Reflection Analysis of Resilient and Sustainable Research and Publication Activities at the National University of Science & Technology, Oman during COVID-19

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Abstract. COVID-19 restrictions badly impacted research activities in universities across the globe. This paper aims to reflect on resilient and sustainable research and publication activities related to undergraduate and postgraduate students and funded projects at the National University of Science & Technology, Oman. This study employed structured interviews with 32 staff members of the 3 constituent colleges of the university under study who supervised undergraduate and postgraduate student projects, and 7 staff members who supervised funded projects during COVID-19. Responses were recorded using pre-coded interview forms for better and faster analysis. Borton's reflection model was used for reflective analysis. It was found that, in response to the restrictions implemented, most of the students' projects were quick in response and

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changed from experimental studies to online case studies and that objectives were modified. No student project was delayed due to these modifications. Supervisors found online supervision useful and appreciated the university's support in terms of library access and remote access to lab software. Furthermore, regarding the funded projects, they were completed with success without needing to change the objectives. The findings of this study may be useful in designing suitable staff training, communication strategies, and internal processes for research grant approvals, and for use in preparation of sustainable practices in university research activities.

Keywords: COVID-19; performance indicators; remote access; resilient and sustainable; research publication

1. Introduction

The COVID-19 pandemic emerged as a significant external stressor, presenting unprecedented challenges to the global education arena (Almazova et al., 2020; Tadesse et al., 2020; Toquero, 2020). This crisis forced educational institutions, including the National University of Science & Technology, Oman (hereafter, the National University), to navigate uncharted territory characterized by a lack of regulation, structure, and familiarity. The sudden shift from traditional in-person teaching to online modalities disrupted established norms and posed considerable difficulties for administrators, educators, and students (Elumalai et al., 2020; Tarkar, 2020).

The COVID-19 pandemic had a significant impact on student research projects in universities across the globe (Hart et al., 2023; Lone & Ahmad, 2020). The disruption caused by the pandemic impacted various aspects of funded research and student research projects, including access to resources, collection of data, and communication with supervisors (Arnold, 2020; Bradt, 2020; Haleem et al., 2020).

Deryugina et al. (2021) studied the impact of COVID-19 on female students. In their study, female academics with children reported a disproportionate reduction in research time relative to both childless men and women academics and to male academics with children (Deryugina et al., 2021).

In an extensive literature review study, Alkatout et al. (2021) found that services in oncology were curtailed due to COVID-19. This is because medical services were focused on preventing the spread of the virus and maximizing the number of available hospital beds (Alkatout et al., 2021).

COVID-19 also impacted the allocation of funds and resources across the globe. Harper et al. (2020) have shown that before the COVID-19 pandemic, virology research, including influenza, accounted for less than 2% of all biomedical research. However, an astonishing number of laboratories and investigators have shifted their focus to address COVID-related research questions. This shift likely represents 10% to 20% of current biomedical investigations, showcasing the remarkable adaptability of the research community (Harper et al., 2020).

2. Major Challenges Faced by Researchers during COVID-19 Restrictions

COVID-19 presented the research community with various major challenges, which are discussed in this section.

Limited access to resources: Campus closures and restrictions on movements limited access to research resources such as libraries, laboratories, and fieldwork sites. This made it difficult for students to carry out their research projects as planned. After having done extensive research, Varma et al. (2021) argued that quantitative health researchers successfully transitioned to synchronous online platforms, but qualitative researchers faced unique challenges in collecting data from participants in real-world settings. Online data collection strategies may not capture the rich contextual information that qualitative research requires (Varma et al., 2021).

Research methodology: Social distancing measures required students to modify their research methodology, such as conducting experiments in the labs and conducting interviews and focus groups remotely rather than face to face. This may have affected the quality of data collected and led to less reliable results. Experiment-based student projects changed their methodology to either secondary data analysis or case studies (Suart et al., 2021).

Modification of project objectives: Owing to the disruption to research activities, limited access to resources, and changes in research methodology, project objectives had to be modified to be completed on time.

Limited communication with supervisors: Campus closures hindered face-to-face discussion between students and their supervisors, making it difficult for them to receive timely feedback on their work, ask questions, and receive guidance. This lack of support led to students feeling isolated and overwhelmed, which impacted their motivation and productivity (Rasool et al., 2022).

Impact on mental health and well-being: The pandemic and associated restrictions placed additional stress and pressure on students, thereby affecting their mental health and well-being. According to Villani et al. (2021), female students at the Università Cattolica del Sacro Cuor, Rome campus experienced higher levels of anxiety due to factors such as inability to attend university, distance from colleagues, and not being able to physically see their partner. However, engaging in physical activity was found to decrease the likelihood of anxiety (Ashton & Pintor-Escobar, 2020; Villani et al., 2021).

In short, the COVID-19 pandemic posed challenges for research projects due to limited access to resources, modified research methodologies, modified project objectives, limited communication with supervisors, and impact on students' mental health and well-being. Campus closures and restrictions hindered access to libraries, labs, and fieldwork sites. Qualitative researchers faced difficulties in collecting data online, affecting the richness of contextual information. Research methodologies were modified and communication with supervisors limited.

These disruptions negatively affected students' motivation and productivity. Additionally, the pandemic increased stress and anxiety among students, particularly affecting female students and those unable to physically attend university.

To mitigate these impacts, the faculty and management of universities intervened by changing research/project methodology, modifying objectives slightly, and providing remote access to software and online libraries. Teaching staff started using WhatsApp and Google Chat for easy and quick communication with students. Wang et al. (2020) have shown the efforts made by Chinese universities to mitigate the adverse impact of COVID-19 on university learning and research (Wang et al., 2020). As the situation gradually stabilizes and life returns to normalcy, it becomes crucial to assess the impact of COVID-19 on universities (Noori, 2021).

Not much literature is available on the sustainable practices used by the universities in the Gulf Cooperation Council (GCC) states that helped them to achieve research and publication goals during the COVID-19 pandemic. The current study aims to reflect on the efficiency of resilient and sustainable research and publication activities at the National University, Oman during the COVID-19 pandemic, evaluating its response strategies and proposing sustainable measures to thrive in a post-pandemic environment. This study employed Borton's reflection model as a framework for analysis.

3. Research Questions

This study intended to explore the following three research questions:

i. What initiatives were taken by the National University of Science & Technology, Oman to mitigate COVID-19 impacts on research and publication activities?
ii. How efficient were the initiatives?
iii. How has this experience led to the construction of future perspectives to thrive in a post-pandemic environment?

4. Borton's Reflection Model as Study Framework

Analyzing the impact of COVID-19 restrictions using multiple aspects is a challenging task. In this regard, researchers need to use an established, easy-to-use scientific model for this purpose. Borton's reflection model suggests a simple and practical way to reflect on experiences. It does not require a specific structure and is thus popular among healthcare professionals. It is a flexible and accessible framework for personal and professional development. Borton's model is based on three simple questions: *What?*, *So what?*, and *What next?* Skinner and Mitchell (2016) have used this model in healthcare contexts. They argued that it is both structured and flexible enough to fit the experiences, learning needs, and time available to healthcare practitioners (Skinner & Mitchell, 2016). Middleton (2017) used the reflection model for reflection, critical analysis, and creativity to explore the differences between leadership and management and to discover how transformational leadership can positively impact the delivery of healthcare.

Borton's model of reflection is a structured approach to reflective practice that was developed by Borton in the 1970s. It consists of three stages (Figure 1). The *What?* stage signifies a returning to the situation. In the *So what?* stage, the individual attends to feelings and re-evaluates their experience. Lastly, the *What next?* stage signifies a re-framing of the experience to construct new perspectives.

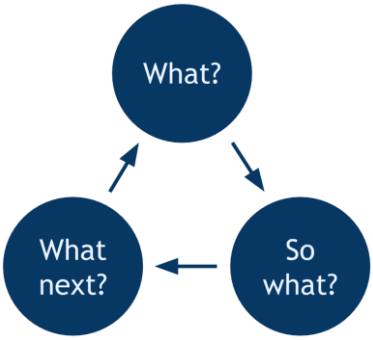

Figure 1: Borton's reflection model

Borton's model can help researchers to reflect on the impact of the COVID-19 pandemic on their research activities and to develop new perspectives and strategies to adapt to the changing circumstances. By engaging in reflective practice, researchers can enhance their resilience, creativity, and adaptability in the face of uncertainty and disruption. Nicol and Dosser (2016) have proven that this reflection model can be used as a learning tool.

5. Methodology

This research paper considers the impact of COVID-19 restrictions on research and publication activities and resilient and sustainable practices adopted at three campuses of the National University of Science & Technology, Oman. The campuses are the College of Engineering, the College of Pharmacy, and the College of Medicine and Health Sciences.

For this study, a mixed-methods design was chosen to integrate and synergize multiple data sources. The mixed-methods approach integrates qualitative and quantitative methods in research to gain a comprehensive understanding of complex issues. Qualitative methods focus on exploring subjective experiences and contexts, while quantitative methods employ statistical analyses to measure variables and test hypotheses. By combining these approaches, researchers can benefit from their respective strengths. The integration allows for complementarity, as qualitative data provide rich insights, while quantitative data offer generalizability and hypothesis testing. Triangulation is another advantage, as multiple data sources and methods validate findings, enhancing credibility. Qualitative data contextualize quantitative results, capturing nuances and complexities. Mixed-methods research facilitates exploration and explanation, allowing researchers to generate hypotheses and test relationships iteratively. This approach enhances the rigor and validity of research, providing a more comprehensive understanding of the research phenomenon (Wasti et al. 2022).

In this study, qualitative data were collected through one-on-one structured interviews with staff members. To speed up the interview process, a pre-coded interview form was used (Appendix 1). The form consists of eight questions. In this form, the most probable responses were pre-coded to save time and other resources. Along with the codes, open spaces were also provided with each question to elicit and record further perspectives. Both the participants and research team appreciated this approach. It saved a lot of time and resources and allowed for quick generation of keywords with accurate frequency for further quantitative analysis of the qualitative interview data.

In the next step, interview questions and coded responses were captured using Google Forms for chart preparation for better visual analysis (Refer Figure 2 on Research design). Although these charts could also be generated using Microsoft Excel, Google Forms is easy to use, collaborative, and intuitive.

Finally, we used Borton's reflection model to analyze the impact of COVID-19 on the resilient and sustainable research and publication practices followed at the university under study.

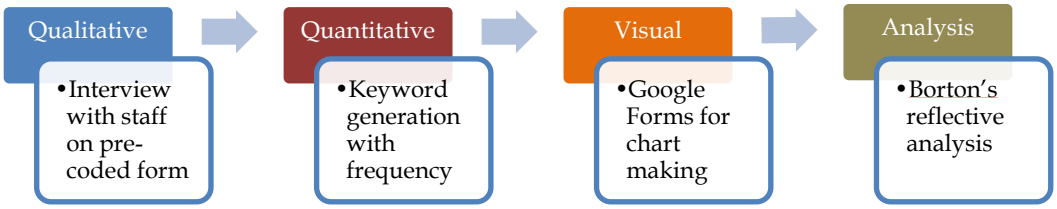

Figure 2: Research design

5.1 Research Samples and Data Collection and Analysis

This study was conducted using two sample categories. The first category was *undergraduate and postgraduate student projects.* Under this category, 32 teaching staff members who also acted as supervisors were interviewed using a structured interview questionnaire consisting of 8 questions, as presented in Table 1. Structured interviews were conducted during October and November 2022 on the respective campuses using the pre-coded interview form. Interview data were captured on Google Forms for intuitive chart preparation for better visual analysis. Considering its flexibility and usefulness, the Borton reflection model was employed in the study. Using this model also helped us to analyze the resilient and sustainable practices that helped the university to continue research and publication activities with minimum impact.

The second sample category was *funded research projects.* Under this category, we interviewed principal investigators of seven funded research projects to understand the impact of COVID-19 on their projects and the efficiency of the action taken to mitigate those impacts. A total of eight questions were asked using a structured interview protocol (as presented in Table 2). For the funded projects category, descriptive analysis was done based on keyword frequencies.

5.2 Application of Borton's Model for Analysis

This sub-section entails mapping the eight interview questions according to the three stages of Borton's model, as seen in Table 1, and providing a suitable explanation for this mapping.

What? (i.e., returning to the situation): The first stage involves returning to the situation or experience and attempting to describe it accurately. In this stage, participants reflected on how the COVID-19 pandemic affected their research activities, for example the closure of research facilities, cancellation of experiments, or the inability to conduct fieldwork due to social distancing.

So what? (i.e., attending to feelings and re-evaluating the experience): The second stage involves participants' recollection of how they reacted to the situation, and what actions were taken to complete the projects.

What next? (i.e., re-framing the experience to construct new perspectives): The final stage involves re-framing the experience by considering alternative perspectives and possible courses of action. Participants reflected on how the pandemic had created new research opportunities, and how the university can use this situation to develop itself as a resilient university against future disruptions.

In Table 1, the eight questions of the interview are categorized according to the three parameters *What?*, *So what?*, and *What next?* Based on this categorization, detailed analysis was done using charts prepared by Google Forms based on keywords.

Table 1: Mapping of interview questions with Borton's model

Stage of Borton's model	**Interview question mapping**
What happened?	What were the challenges in online supervision and feedback?
	Share your experience about the usefulness of online supervision and feedback
So what actions were taken?	What changes were adopted to complete technical projects on time?
	How much of this measure/transition was successful in completing the project?
	Mention the support provided by the university to complete the project
What next?	What kind of comments were received on project quality from the external examiner (if any)?
	How satisfied are you with the achievement of project objectives?
	Based on your experience, what should the National University management do to make the National University more resilient against future disruptions?

6. Results and Discussion

Based on the research design depicted in Figure 2, a comprehensive study was conducted, involving a total of 39 interviews across two different sample categories. The outcome of these interviews generated a substantial volume of data. To enhance clarity and facilitate comprehension, it was deemed necessary to present a detailed analysis alongside the results. As a result, each individual finding is accompanied by a thorough discussion, analysis, and appropriate citation, ensuring transparency and academic rigor within the research study.

6.1 Undergraduate/Postgraduate Student Research Projects

In this section, each stage of Borton's model is discussed with the interview questions related to it. In this section, the responses from participants in the first sample category are analyzed using Borton's model. The model's three stages (What?, So what?, What next?) are discussed, along with the interview questions relevant to each stage, to gain a deeper understanding of the participants' perspectives.

6.1.1 *What happened at National University?*

Owing to COVID-19 restrictions, research and publications were shifted to online mode using Google Meet, Zoom, Gmail, and What's App. In this dimension, two questions were loaded, which are presented below with data from the interviews.

- **Question 1: What were the challenges in online supervision and feedback?**

The effectiveness and success of online supervision hinge upon communication, time availability, student capabilities, trust, and other inherent challenges associated with remote supervision. Among these factors, one of the highest rated challenges was students' ability to comprehend instructions and effectively express themselves, accounting for 46% of the reported difficulties (Figure 3). This highlights the importance of clear communication channels and the need for supervisors to provide comprehensive guidance tailored to each student's individual needs.

Furthermore, a study conducted by Rasool et al. (2022) shed light on the impact of misunderstandings between supervisors and students on the feedback received. This underscores the importance of effective communication and clarity in instructions to avoid any potential misinterpretations that may lead to negative feedback and hinder the progress of the research (Rasool et al., 2022).

Additionally, time availability and communication emerged as significant factors impacting the quality of supervision, accounting for approximately 43.1% of the challenges faced. Adequate time allocation for supervision sessions and timely feedback are crucial for maintaining a productive and supportive supervisory relationship. However, these aspects can be hindered by various constraints, such as conflicting schedules or communication barriers, which need to be addressed to ensure optimal online supervision experiences.

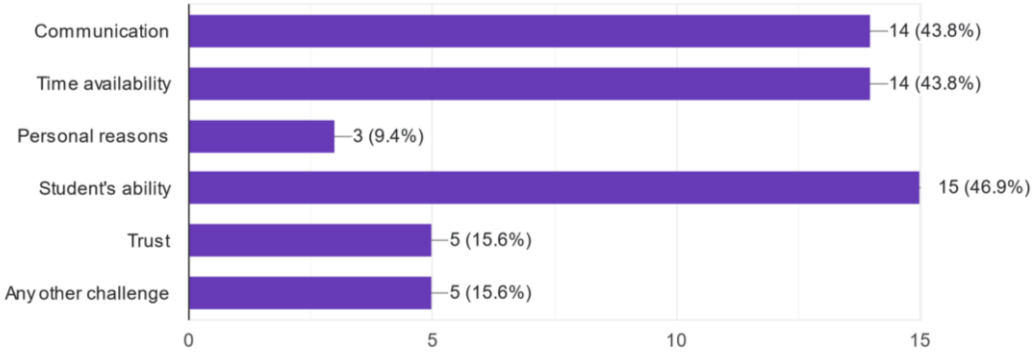

Figure 3: Challenges in online supervision and feedback

- **Question 2: Share your experience about the usefulness of online supervision and feedback**

The utilization of online communication between students and supervisors emerged as a highly valuable tool, with participants rating it to surpass 53% in its effectiveness (Figure 4). Approximately 37.5% of the participating supervisors expressed satisfaction with online supervision. The supervisors' commitment to ensuring uninterrupted research progress is evident in their proactive approach toward students through continuous feedback and communication.

Suart et al. (2021) underscored the significance of establishing efficient communication channels and maintaining consistent lines of contact to ensure a smooth and well-coordinated online supervision process. However, it is important to acknowledge that network problems, student availability, and the nature of the research itself can influence the effectiveness of online supervision (Rasool et al., 2022). Despite these challenges, 3 of the 32 participating staff members recognized the immense value of online supervision, highlighting its usefulness in their specific contexts.

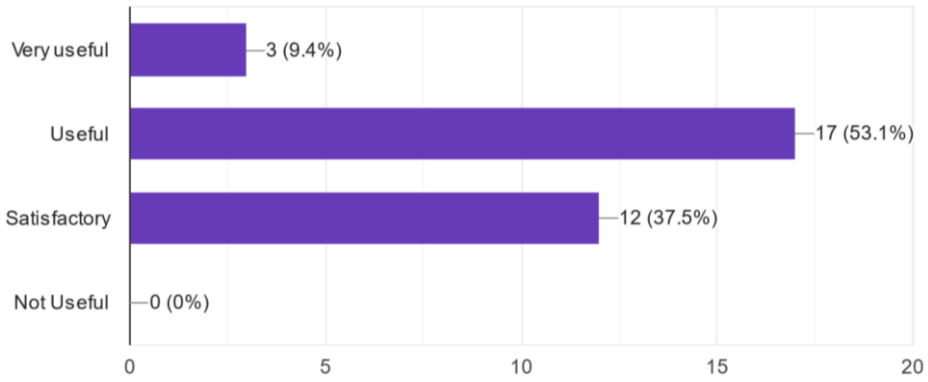

Figure 4: Usefulness of online supervision and feedback

6.1.2 ***So, what actions were taken by the university and supervisors?***

Supervisors of student research projects in national universities adopted various practices to support their students during the COVID-19 restrictions, including changes related to research methodology, objectives modification, and logistic

facilities. In this dimension, three questions were loaded, which are presented in this section with data from the interviews.

- **Question 3: What changes were adopted to complete technical projects on time?**

Figure 5 shows that a significant number of research projects changed their research methodologies. It was observed that 53.1% of the projects shifted from experimental approaches to case studies or secondary data analysis. This adaptation reflects the flexibility and adaptability of researchers in modifying their methods to suit the constraints imposed by external factors.

Additionally, for 43.8% of the projects, modifications to objectives were reported. These modifications were made to ensure the timely completion of the projects, considering the various challenges and limitations encountered during the research process. For instance, in the pharmacy college setting, face-to-face surveys were replaced with online surveys due to social distancing norms and restricted movement. These adjustments were necessary to adhere to safety guidelines while still accomplishing the research objectives and fulfilling the degree requirements (Arnold, 2020).

These changes in research design and methodology were driven by the need to navigate the restrictions and challenges imposed by external circumstances. By adopting alternative approaches and adjusting project objectives, students and researchers were able to overcome obstacles and complete their projects. A study conducted by Donohue et al. in 2021 also supports these findings, highlighting the prevalent shift in research designs in doctoral research projectsClick or tap here to enter text..

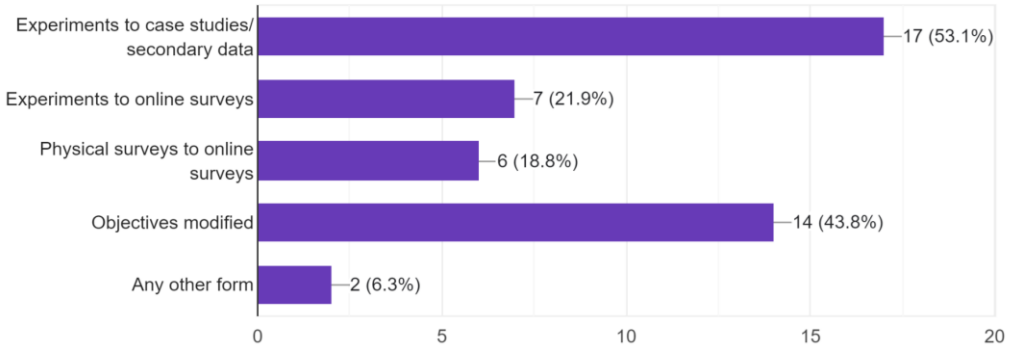

Figure 5: Changes in research methodology

- **Question 4: How much of this measure/transition was successful in completing the project?**

After the modifications made to research projects, such as shifting from laboratory-based studies to survey-based studies and adjusting objectives, a notable 59.4% of the projects reported success and 34.4% reported satisfactory completion (Figure 6). This achievement is commendable considering the challenges faced and the need to adapt research designs and objectives. Additionally, a small percentage of projects (approximately 6.3%) were exceptionally successful in their completion. This highlights the resilience and

adaptability of students and supervisors at the National University, who embraced the situation and successfully achieved their research goals. These outcomes indicate that the research community at the National University effectively responded to the circumstances by adopting new approaches and demonstrating a high level of satisfaction with their project outcomes.

In support, recent research conducted by Hart et al. (2023) boasts similar findings, emphasizing the importance of providing appropriate rescoping plans and academic support to aid medical students in completing their research projects. This highlights the significance of implementing measures that facilitate the successful completion of projects amidst challenging circumstances (Hart et al., 2023).

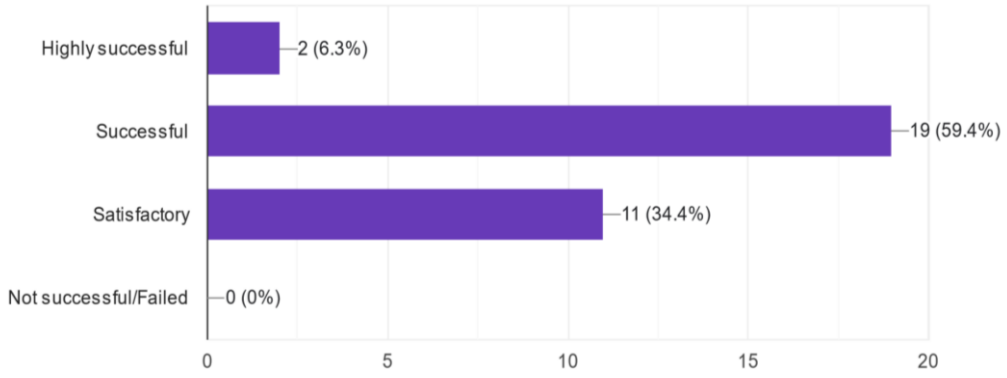

Figure 6: Success rate of changes

- **Question 5: Mention the support provided by the university to complete the project**

The participating faculty members acknowledged the significant contributions and support provided by the university during the research projects (Figure 7). The majority, accounting for 62.5%, highlighted the university's role in providing essential software, tools, and material support. This support was crucial for facilitating data collection and analysis and other research activities. The availability of necessary software and tools enabled students and researchers to carry out their work effectively and efficiently.

Furthermore, 59.4% of faculty members recognized the support received from the university library. By providing online access to library resources, students were able to conduct comprehensive literature reviews, access relevant research materials, and gather valuable information for their projects. This online library support played a vital role in ensuring the quality and depth of the research conducted.

Additionally, 31.3% of the participants acknowledged the administration and permission support provided by the university. This support was instrumental in obtaining the necessary approvals and permissions required for research projects, ensuring compliance with regulations and ethical considerations.

However, the training support provided by the National University received the lowest rating, at 25%. This suggests that there may be room for improvement in terms of providing training opportunities and resources to enhance the research skills of students and researchers.

It is worth noting that all campuses of the National University made efforts to provide remote access to educational software. For instance, the use of software such as Splash Top enabled students in the College of Engineering and College of Pharmacy programs to access laboratory software remotely, ensuring continuity in their research work despite the limitations posed by remote learning.

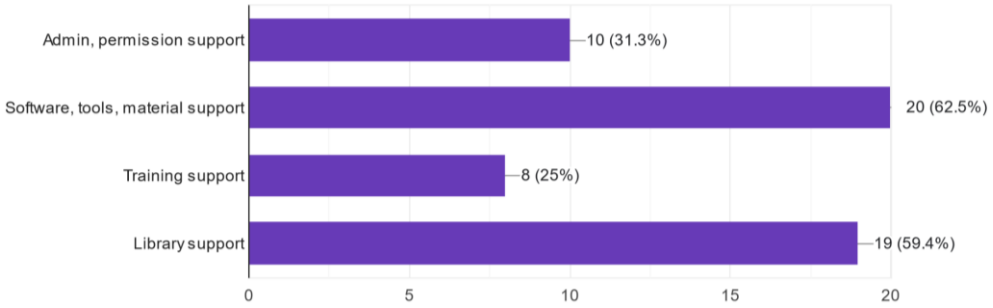

Figure 7: Support from the university

6.1.3 ***What next? (i.e. recommendations for the future)***
In this dimension, three questions were loaded, which are discussed in this section with accompanying data from the interviews.

- **Question 6: What kind of comments were received on project quality from the external examiner?**

In the evaluation of research projects, it was observed that a significant number of projects (65.6%) lacked comments from external examiners (Figure 8). This absence of comments may be attributed to the evaluation process itself, wherein external examiners did not participate in the assessment. This suggests that the projects underwent a different form of evaluation that did not involve external examiner feedback. Furthermore, it was noted that most of the projects in the College of Pharmacy and College of Engineering were evaluated based solely on pass or fail marks. This indicates that the evaluation criteria for these projects focused primarily on meeting minimum requirements rather than providing detailed qualitative feedback.

Among the evaluated projects, a noteworthy 18.8% were regarded to be of very good quality, indicating a high standard of work and achievement. Conversely, 15.6% of the projects received comments indicating an average level of quality. It is worth highlighting that none of the projects received a poor rating from the external examiners, implying that all projects met at least the minimum expectations.

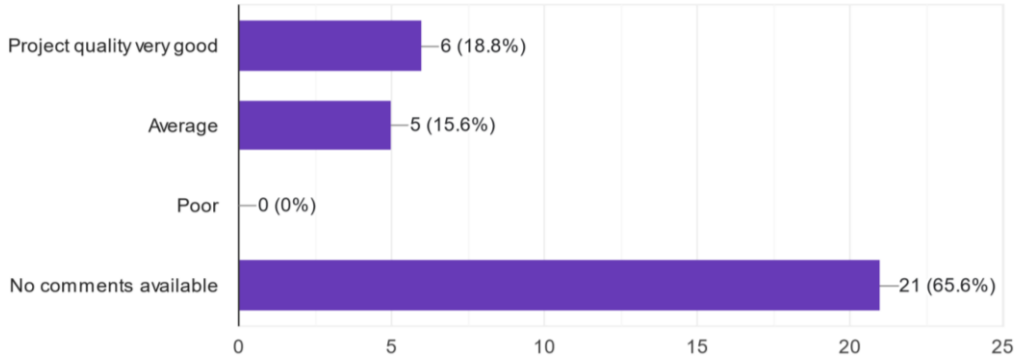

Figure 8: Comments on project quality by external examiner

- **Question 7: How satisfied are you with the achievement of project objectives?**

An impressive 56.3% of the participating supervisors reported achievement of the project objectives (Figure 9). Additionally, 31.3% of the projects covered all their objectives, marking a significant accomplishment. This high success rate of around 87% is particularly noteworthy, considering the challenges posed by the COVID-19 restrictions. It demonstrates the commitment and dedication of both students and supervisors in completing their undergraduate projects.

However, it is important to note that approximately 6.3% of the supervisors were unable to achieve some of their objectives. Despite the adjustments made in research methodologies and modifications to objectives, certain research goals could not be fully met. This highlights the inherent complexities and uncertainties involved in research undertakings, where unforeseen factors or limitations may hinder the complete achievement of all objectives.

Nonetheless, the overall success rate of the projects, where the majority achieved most or all of their objectives, reflects the resilience and adaptability of students and supervisors. It also underscores the crucial role played by the support provided by the university in enabling students to effectively navigate the challenges and restrictions imposed by the pandemic.

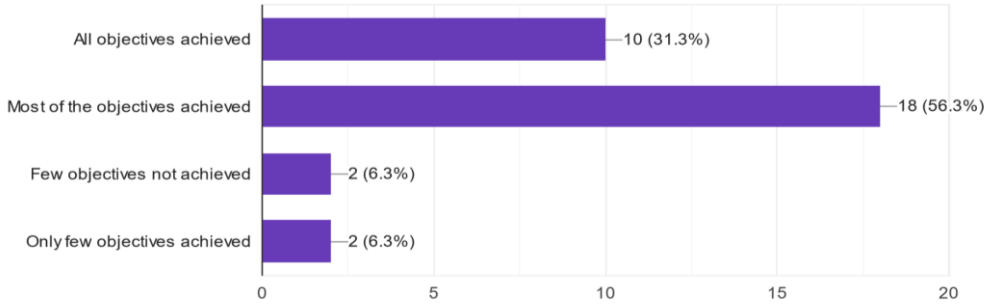

Figure 9: Achievement of project objectives

- **Question 8: Based on your experience, what should the National University management do to make the National University more resilient against future disruptions?**

The interview questionnaire administered after the pandemic sought faculty members' suggestions for future disruptions. Among the options provided, a very high percentage of participating faculty members (96.9%) emphasized the need to enhance infrastructure levels, including software, hardware, tools, and other technological resources (Figure 10). This suggests the recognition of the vital role that advanced technology plays in facilitating effective remote learning and research activities during challenging times.

Staff training was another significant suggestion, indicated by 50% of participants. This highlights the importance of equipping staff with the necessary skills and knowledge to adapt to changing circumstances. Training programs can empower faculty members to navigate new educational landscapes with confidence and ensure the delivery of high-quality instruction.

Furthermore, 31.3% of the faculty members emphasized the value of international networking collaboration. This suggests recognition of the benefits of forging partnerships and collaborations with institutions and researchers from around the world. Such collaborations can foster knowledge exchange, enhance research opportunities, and promote a global perspective in academic endeavors.

On the other hand, the suggestion related to policy-level changes received the lowest rating (21.9%). This indicates that faculty members may perceive the need for institutional policy adjustments to be less urgent compared to other aspects such as infrastructure and training.

In line with these findings, Rashid and Yadav (2020) argued that higher education institutions and universities should proactively plan post-pandemic education and research strategies to ensure the attainment of student learning outcomes and the maintenance of educational quality standards. This underscores the importance of strategic planning to address potential disruptions effectively and ensure the continued delivery of high-quality education (Rashid & Yadav, 2020).

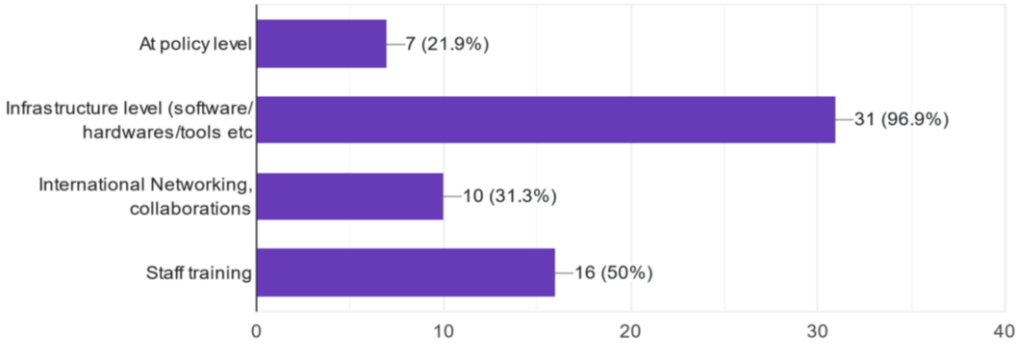

Figure 10: Suggestions for a sustainable future

6.2 Funded Projects

The COVID-19 pandemic had a significant impact on funded research activities in universities around the world (Webster, 2020). The restrictions put in place to limit the spread of the virus affected various aspects of research, including delays, communication, recruitment, data collection, and dissemination of research results (Alkatout et al., 2021; Deryugina et al., 2021; Haleem et al., 2020; Harper et al., 2020; Rashid & Yadav, 2020; Tsai et al., 2020). We interviewed principal investigators of seven funded research projects at the National University to understand the impact of COVID-19 on their projects and sustainable practices adopted to mitigate those impacts. Eight questions were asked (refer to Table 2) and responses were pre-coded to quantify the content and perspectives using Google Forms. For each question, an open space was provided for participants to add further suggestions (Appendix 2).

Table 2: Interview questions for the principal investigators of funded projects

No.	Interview question
1	In general, all research projects were delayed due to COVID-19 restrictions. How long was your project delayed?
2	In your opinion, what are the reasons behind these delays?
3	What measures were adopted to complete these projects?
4	What were the challenges in online supervision and feedback?
5	What kind of comments were received on project quality from the funding agency (if any)?
6	How satisfied are you with the achievement of key performance indicators? (In terms of publication, appointment of research assistants (RA), procurement etc as projected.)
7	Mention the support provided by the university to complete these projects.
8	Based on your experience, what should the National University management do to make the National University more resilient against future disruptions?

In the following section, a descriptive analysis of these responses is presented per question. The charts were prepared using Google Forms.

- **Question 1: In general, all research projects were delayed due to COVID-19 restrictions. How long was your project delayed?**

Among the seven projects, four experienced delays of over six months (Figure 11), with permission granted by the funding agency. However, three projects were completed within the designated timeframe. The projects that encountered significant delays were those involving substantial purchases and capital expenditures. These delays resulted primarily from procurement complications, which could be attributed to various factors leading to a postponement in the purchasing process.

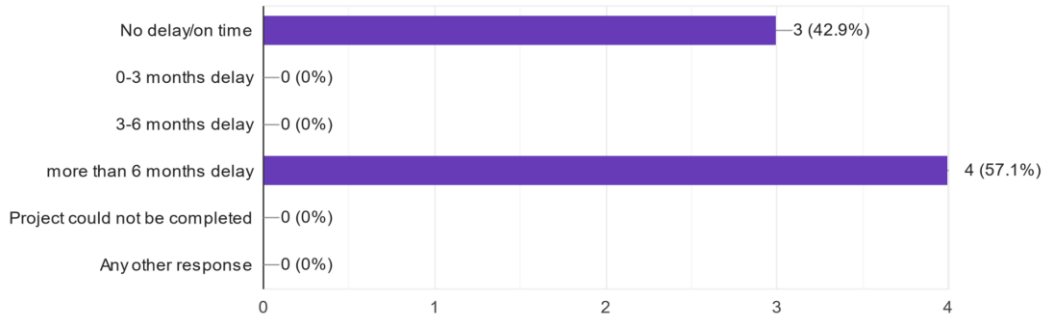

Figure 11: Project delays

- **Question 2: In your opinion, what are the reasons behind these delays?**

The data presented in Figure 12 indicate that logistics delays and administrative approval were the primary reasons behind the delays in the four projects that experienced delays. Surprisingly, restrictions in lab access did not emerge as a prominent factor contributing to the delays. In Oman, where most laboratory items are imported from the United Arab Emirates, movement restrictions and the need to implement social distancing measures were the main culprits responsible for logistics delays. The inability to physically access the lab and transport necessary items hindered the progress of these projects.

Additionally, the sudden shift from face-to-face interactions to online approvals for purchases exacerbated administrative delays. The lack of direct communication and the adjustment to a new approval process that relied on digital platforms resulted in administrative bottlenecks and hindered timely decision-making. These unforeseen challenges in logistics and administrative processes underscore the need for contingency planning and adapting to new workflows to mitigate future delays in similar circumstances.

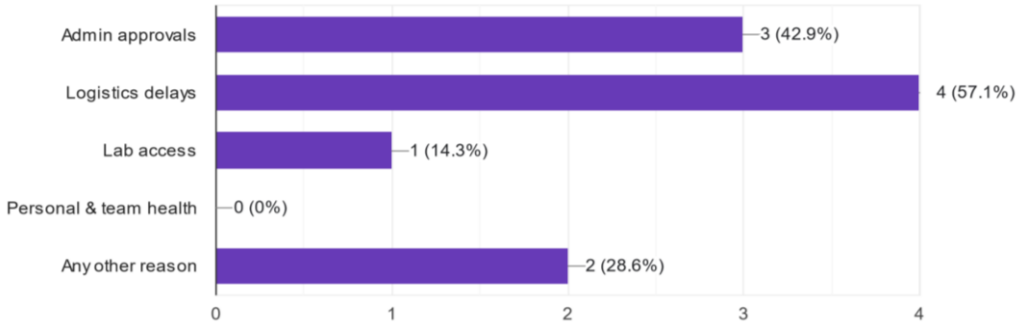

Figure 12: Reasons for project delays

- **Question 3: What measures were adopted to complete these projects?**

Despite the delays of certain projects exceeding six months, the project teams made a conscious decision to maintain the original methodology and objectives (Figure 13). This approach differed from undergraduate student research projects, where 76% of projects changed methodology or objectives. The need to complete projects within the given semester to fulfil degree requirements often necessitated adjustments. However, in the case of funded projects, both the funding agency

and the university agreed upon extensions rather than altering the methodology and project objectives.

This demonstrates the importance placed on adhering to the original research plan and objectives in funded projects, allowing for a more comprehensive and focused outcome. The flexibility and understanding of the funding agency and university in granting extensions rather than requiring changes in methodology and objectives reflect their commitment to supporting the integrity and desired outcomes of the projects.

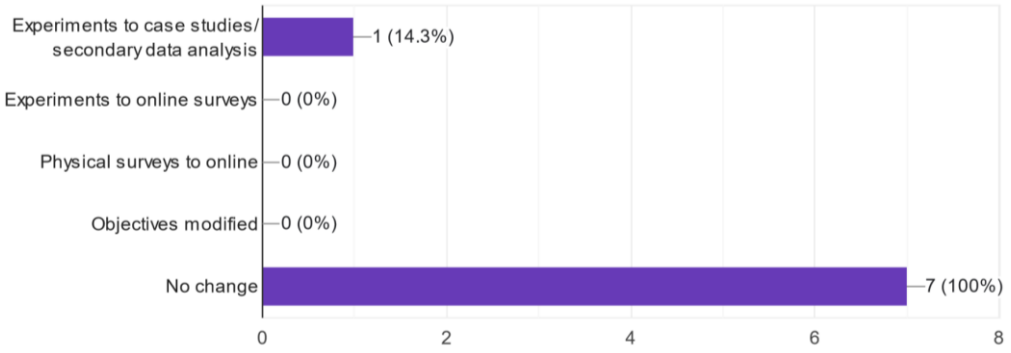

Figure 13: Measures to complete projects

- **Question 4: What were the challenges in online supervision and feedback?**

The transition to online supervision and feedback became imperative, but it posed challenges. Adapting to this new situation was not without difficulties, and one prominent challenge was ensuring proper and timely communication between supervisors and students (Figure 14). The sudden shift from in-person interactions to virtual platforms required adjustments in communication methods and practices to maintain effective and efficient supervision and feedback processes.

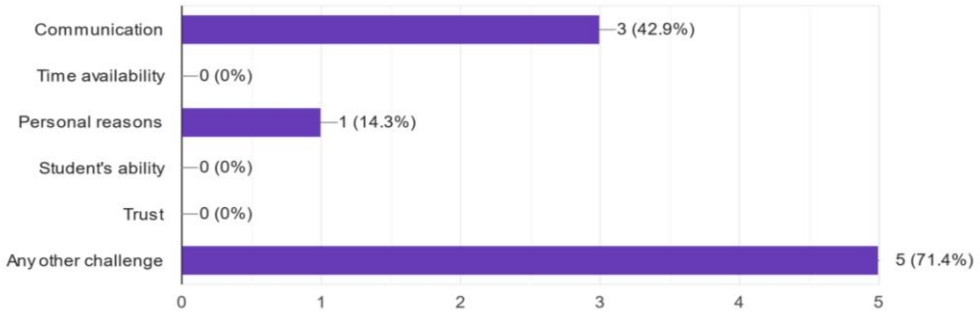

Figure 14: Challenges of online supervision

- **Question 5: What kind of comments were received on project quality from the funding agency (if any)?**

Among the projects, half received positive feedback and comments from the funding agencies regarding their quality (Figure 15). However, in some instances, no comments had been provided at the time of the interview. Additionally, two researchers participants mentioned that the success of these projects was

acknowledged and appreciated by the college and university executives, highlighting the recognition and support received from higher authorities for the achievements and outcomes of these research endeavors.

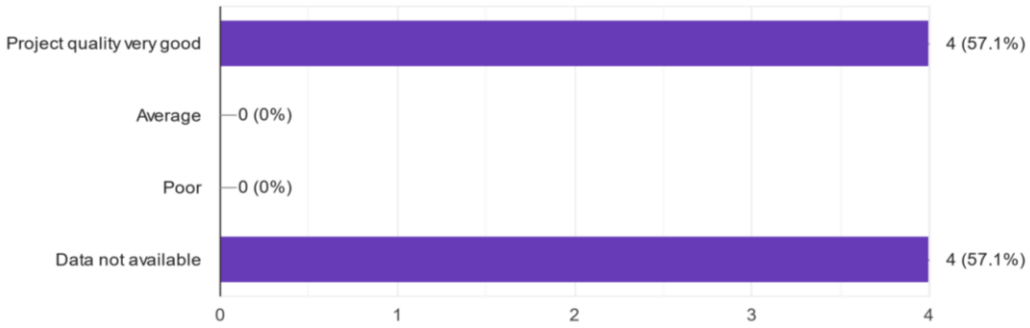

Figure 15: Comments on project quality

- **Question 6: How satisfied are you with the achievement of key performance indicators? (In terms of publication, appointment of research assistants, procurement etc as projected.)**

All the projects demonstrated success in achieving their key performance indicators (Figure 16). The research findings were effectively published in prestigious journals and presented at renowned conferences. Additionally, these projects provided opportunities for the appointment of graduate students as research assistants, contributing to their academic and professional growth. Furthermore, the projects facilitated the acquisition of various machinery, accessories, and online resources that enhanced the research infrastructure and capabilities of the university, further supporting its academic mission and fostering a conducive research environment.

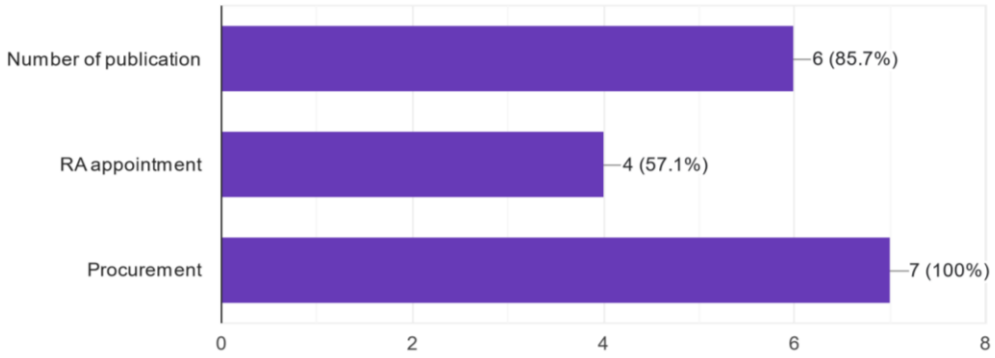

Figure 16: Achievement of key performance indicators

- **Question 7: Mention the support provided by the university to complete these projects.**

The participating principal investigators unanimously acknowledged the substantial support provided by the university whenever and wherever possible (Figure 17). However, they expressed dissatisfaction with the delays and challenges encountered in financial approvals and payments to vendors. The absence of a clear system to track the progress of their applications further compounded the issue. Additionally, the excessive use of various formats and

templates consumed valuable time and energy for all stakeholders involved, leading to inefficiencies and frustrations (Nicoletti, 2013). The participants emphasized the need for streamlining and simplifying the financial approval process to optimize efficiency and ensure a smoother experience for all parties involved.

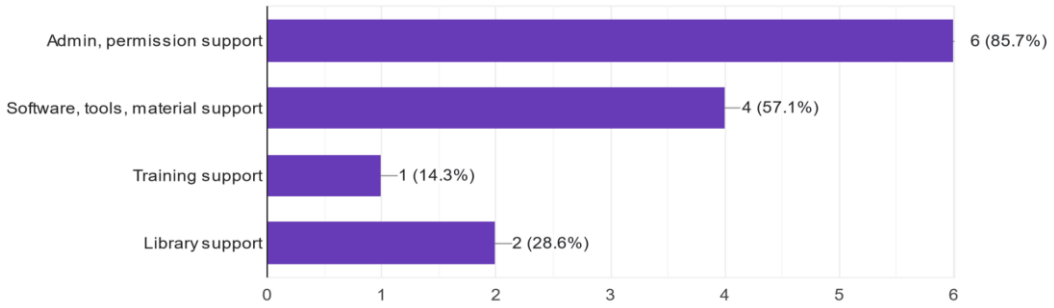

Figure 17: Support from the university

- **Question 8: Based on your experience, what should the National University management do to make the National University more resilient against future disruptions?**

During the interviews, participants highlighted the need for policy revisions related to administrative and financial approvals (Figure 18), with the aim to streamline processes and reduce paperwork. Suggestions were made for the implementation of an online system to track the progress of various applications and approvals, enhancing efficiency and transparency within the university.

Investing in industry-level software and updates, particularly in areas such as 3D printing, artificial intelligence, and remote access, was identified as another crucial aspect. Participants emphasized the significance of equipping the university with cutting-edge technologies to meet the evolving demands of industry. By staying up to date with the latest software and tools, the university can provide students with valuable practical skills and prepare them for the workforce (Alfakih, 2017).

To foster academic collaboration, participants highlighted the need for increased partnerships with renowned universities worldwide. Collaborations with prestigious institutions can facilitate knowledge exchange, sample testing, library access, and joint research projects (North, 2023; Symonds, 2019; Wu et al., 2017). These collaborations have the potential to enrich the learning experience for students and open doors for ground-breaking research opportunities.

Lastly, participants emphasized the importance of staff training on the latest industry software. To achieve this, universities should allocate appropriate budgets to provide comprehensive training programs for faculty and staff. By equipping the staff with relevant skills and knowledge, the university can ensure the effective utilization of technological resources and maintain educational quality standards.

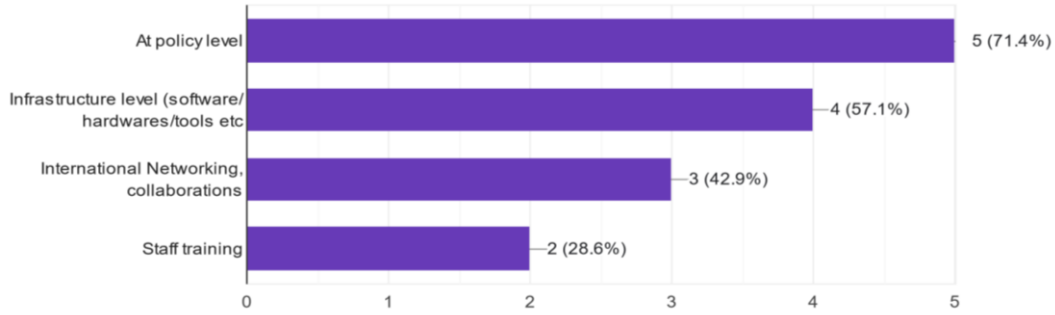

Figure 18: Recommendations for a sustainable future

In summary, participants stressed the need for policy-level changes, investments in industry-level software and updates, academic collaborations, and staff training. Implementing these suggestions can foster a supportive environment for research and learning, enhance administrative efficiency, and equip students and staff with the necessary tools and skills to thrive in a rapidly evolving educational landscape.

6.3 Resilient and Sustainable Practices at the National University, Oman

Data from the interviews clearly show that the National University was quick in responding to the COVID-19 restrictions. Following resilient and sustainable practices minimized the impact of COVID-19 on research and publication activities.

The university provided remote access to lab software for students, allowing them to continue their research and practical work from any location. This enabled them to carry out experiments, analyze data, and contribute to their research projects effectively.

Round-the-clock access to online library resources by the National University ensured that students could access research articles, journals, books, and other relevant materials at any time. This empowered them to conduct comprehensive literature reviews and stay up to date with the latest research developments.

Use of What's App, Gmail, and Google chats facilitated quick and effective communication among research team members. This enabled seamless collaboration, sharing of ideas, and prompt addressing of queries or concerns.

Supervisors adopted flexibility in research design and objectives. This flexibility helped the researchers to modify their methodologies or objectives to overcome challenges and continue making progress toward their research goals.

The National University encouraged researchers to explore digital technoogies and leverage free resources to expand their toolkit and widen their access to valuable research tools. This includes utilizing open-source software, online databases, and other digital platforms that facilitate data analysis, visualization, and research management.

The National University continued organizing capacity development programs for supervisors and students to equip them with the necessary skills and knowledge to navigate the COVID-19 restrictions effectively. These programs included training sessions on data analysis software, research ethics, project management, and other relevant topics.

Supervisors and researchers were engaged in virtual conferences, webinars, and training to stay connected with the broader academic community and continue their professional development. Virtual platforms such as Google Meet and Zoom provided opportunities for knowledge sharing, networking, and presenting research findings, despite physical limitations.

Staff and student development workshops at the campuses of the National University on research methods, tools, and strategies also played a major role in switching to fully online mode. These resilient and sustainable practices helped the researchers at the National University to successfully continue research and publication activities with minimum impact.

7. Conclusion

Undoubtedly, COVID-19 restrictions impacted the teaching, learning, and research activities in all universities across the globe. Switching to a fully online mode of teaching was not easy due to a lack of training of stakeholders, technological infrastructure, internet access, and good speed. Nonetheless, at the National University, Oman, this switch took place without much trouble. Faculty and students were trained in the use of communication tools and online learning tools due to the vast practice of e-learning tools and methodologies.

After COVID-19 restrictions had been suspended, supervisors of undergraduate and postgraduate students' projects and funded projects swiftly adopted online supervision, feedback, and communication. In support, university administration and libraries made online resources available and accessible to all faculties and students. Project methodologies and objectives were modified in students' projects due to timely degree requirements. For funded projects, funding agencies granted extra time rather than modifying the objectives.

However, delays in procurement, admin, and financial approvals caused stress among investigators. There is a need to digitize and automate these approvals to help researchers save time and energy.

8. Recommendations

In today's rapidly evolving industry landscape, universities must take strategic steps to align themselves with industry needs, enhance research capabilities, and promote global knowledge exchange. To achieve this, universities should invest in industry-level software and updates, provide training on these tools, digitize financial approval processes, and foster academic collaborations. These ideas were echoed by the participants of the funded projects sample category in response to question number 8 (refer Table 2).

Investing in industry-level software and updates enables universities to cope with technological advancements and industry standards. By providing students and researchers with access to these tools, universities equip them with the necessary skills and knowledge to succeed in their future careers (Hoteit et al., 2023; Peng & Deng, 2022). Training programs further enhance their productivity and efficiency in utilizing these software tools (Alfakih, 2017).

Digitizing financial approval processes streamlines administrative operations, reduces paperwork, and enhances transparency (Nicoletti, 2013). By implementing digital systems, universities can expedite financial approvals, allocate resources effectively, and invest in infrastructure, research projects, and collaborations.

Fostering academic collaborations facilitates the exchange of ideas, expertise, and resources (Symonds, 2019; Wu et al., 2017). Partnerships with industry leaders, other academic institutions, and research organizations enable universities to remain connected with industry trends and global knowledge exchange. These collaborations lead to joint research projects, internships, and guest lectures that bridge academia and industry, enhancing the research capabilities of universities.

By implementing these efforts, universities position themselves as hubs of innovation and excellence. Graduates are prepared to thrive in a rapidly evolving industry landscape, equipped with industry-standard tools and knowledge. These strategies attract top talent, industry partnerships, and funding opportunities, contributing to the growth and excellence of universities.

Limitations

This study encompassed researchers from the three campuses of the National University of Science & Technology, Oman. In addition, the projects selected for the study were conducted during the COVID-19 restrictions.

Ethics Statement

Informed consent was obtained from all students, supervisors, and administration involved in the study.

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Conflict of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Appendix 1: UG/PG Projects

1. What measures were adopted to complete UG/PG projects?

Items	Code	Short description
Experiments to case studies/ secondary data	1	
Experiments to online surveys	2	
Physical surveys to online surveys	3	
Objectives modified	4	
Any other form	5	

2. How much this measure/transition was successful in your project?

Item	Code	Short description
Highly successful	1	
Successful	2	
Satisfactory	3	
Not successful/Failed	4	
Any other		

3. Share your experience about usefulness of online supervision and feedback.

Items	Code	Short Description
Very Useful	1	
Useful	2	
Satisfactory	3	

Not useful	4	
Any other		

4. What were the challenges in online supervision and feedback?

Items	Code	Short Description
Communication	1	
Time availability	2	
Personal reasons	3	
Students' ability	4	
Trust	5	
Any other	6	

5. How much you are satisfied with the achievement of project objectives?

Items	Code	Short Description
All objectives achieved	1	
Most of the objectives achieved	2	
Few objectives not achieved	3	
Only few objectives achieved	4	
Any other		

6. What kind of comments were received on project quality from external examiner? (If any)

Items	Code	Short Description
Project quality very good	1	
Average	2	
Poor	3	
Data not available	4	

7. Mention the support provided by the University to complete these projects.

Items	Code	Short Description
Admin, permission, assessment support	1	
Software, tools, material support	2	

Training support	3	
Library support	4	
Any other		

8. Based on your experience, what NU management should do to make NU more resilient against future disruptions.

Items	Code	Short description
At policy level (admission/)	1	
Infrastructure level (software/hardwares/tools etc	2	
International Networking, collaborations	3	
Staff training	4	
Any other		

Appendix 2: Funded Research Projects

1. In general, all research projects delayed due to Covid-19 restrictions. How long your project was delayed?

Items	Code	Short Description
No delay/ On time	1	
0-3 months delay	2	
3-6 months delay	3	
more than 6 months delay	4	
Project could not be completed	5	
Any other		

2. In your opinion what were reasons behind these delays.

Items	Code	Short Description
Admin approval	1	
Logistics delay	2	
Lab Access	3	
Personal & team health	4	

Any other		

3. What measures were adopted to complete these projects?

Items	Code	Short description
Experiments to case studies/ secondary data	1	
Experiments to online surveys	2	
Physical surveys to online surveys	3	
Objectives modified	4	
Any other form	5	

4. What were the challenges in online supervision and feedback?

Items	Code	Short Description
Communication	1	
Time availability	2	
Personal reasons	3	
Students' ability	4	
Trust	5	
Any Other	6	

5. What kind of comments were received on project quality from funding agency? (If any)

Items	Code	Short Description
Project quality very good	1	
Average	2	
Poor	3	
Data not available	4	

6. How much you are satisfied with the achievement of KPIs? (In terms of publication, RA appointments, procurement etc as projected)

Items	Quantity	Code	Short Description
Number of publications		1	
Research assistant appointments		2	
Procurements		3	
Any other			

7. Mention the support provided by the University to complete these projects.

Items	Code	Short Description
Admin, permission, procurement	1	
Software, tools, material support	2	
Training support	3	
Library support	4	

8. Based on your experience, what NU management should do to make NU more resilient against future disruptions.

Items	Code	Short description
At policy level (admission/)	1	
Infrastructure level (software/hardwares/tools etc	2	
International Networking, collaborations	3	
Staff training	4	
Any other		