Title: Barriers and facilitators to the adoption and promotion of Open Science practices in psychology. The case of Slovakia.
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Conflict of interest
MA, GB, DF, PK, MM, and LV are members of the Slovak Reproducibility Network.

Abstract

Various ~~The replication crisis has underscored that the self-correcting mechanism of science is not functioning as effectively as anticipated. A variety of~~ responsible research practices emphasizing transparency, such as open data, open code, open peer review, and preregistration, have been introduced to enhance the reproducibility and replicability of findings. The ongoing initiatives of open science movements are crucial for bolstering the credibility and integrity of social science research. However, awareness of these practices and progress in their adoption has been slow, and ~~encountering~~ numerous barriers have been encountered at ~~at both~~ individual and systemic levels. The objective of this study is to conduct a qualitative examination of the barriers and facilitators of transparent and responsible research practices in the field of psychology in Slovakia. The study aims to map the perceptions and experiences of the barriers and facilitators ~~identify sets of barriers~~ unique to different stakeholder groups and specific research practices. Data will be collected through interviews and focus groups with a diverse sample of master's and PhD students, researchers, policymakers ~~policy makers~~, and media representatives, all of whom are from the field of psychology. Thematic analysis will be employed to identify the most common barriers, facilitators, and overarching themes. [results added later]. The findings could provide valuable insights to various stakeholders about which practices need support, the nature of that support, and how different barriers are interconnected and mutually reinforce each other.

Keywords: ~~transparency,~~ open science, questionable research practices, reproducibility ~~reproducibility, sharing~~, responsible research practices, sharing, transparency ~~questionable research practices~~

Introduction

Over the past two decades, we have learned that the self-correcting mechanism of science is not functioning as optimally as many had hoped. However, the corrections can be made through concerted, targeted actions and collaboration among all stakeholders in the research ecosystem, including researchers, institutions, funders, publishers, and learned societies (Munafò et al., 2022; Stewart et al., 2022). In response to this complex issue, promoting open science practices (hereafter referred to as OSPs) - that put emphasis on transparency, accessibility, reusability, research integrity, and collaboration - should be prioritized (Banks et al., 2019; Nosek et al., 2015).

One of the core purposes of open science is to enhance the transparency, integrity, and reproducibility of research (Banks et al., 2019). The incorporation of OSPs (e.g., sharing of data, sharing of analytical code, and pre-registration) have the potential to bolster a crucial aspect of scientific endeavor - the credibility of research findings. Nevertheless, the benefits associated with OSP hinge upon researchers actively implementing them, which appears to remain somewhat challenging (Armeni et al., 2021; Nosek et al., 2015; Obels et al., 2020). To enhance reproducibility and foster public trust in science, we need to adopt both bottom-up and top-down approaches. The bottom-up approach involves scientists adopting and internalizing OSP, while the top-down approach involves the implementation of policies by institutions, funders, and publishers (Armeni et al., 2021). OSPs are not yet the norm, nor are they commonly applied or required, although policies vary across disciplines, countries, and methodologies (Branney et al., 2023; Pownall, 2024). There is also an ongoing debate about how and if all OSPs should be applied in qualitative research (Humphreys et al., 2021; Steltenpohl et al., 2023; TalkadSukumar & Metoyer, 2019). In this context, we aim to map perceptions and experiences of the barriers and facilitators related to the adoption and implementation of OSP in Slovakia by examining them qualitatively.

Barriers to the adoption of Open Science Practices

The adoption of open science practices still has room for improvement, as lower-than-optimal adoption has been observed (see, e.g., Gopalakrishna et al., 2022; Hardwicke et al., 2022; Rajčáni et al., 2023). For example, Rajčáni et al. (2023) found that while 63% of Slovak psychology researchers are aware of preregistration and consider it relatively important, but only about 14% have pre-registered a study.

This shortage cannot be attributed solely to researchers. In a survey conducted by the European Commission in 2022 (European Commission, 2022), more than half of the over 1200 researchers surveyed identified the lack of requirement for OSP by funders, home research institutions, or journals as the most significant factor negatively affecting reproducibility. This report highlights that nearly one-third of journal editors do not deem implementing registered reports important. Similarly, almost one-sixth do not prioritize publishing null or negative results.

Furthermore, approximately half of the research funders do not mandate sharing raw data and pre-registration of studies. This is despite the fact that according to the 'open data directive' (Directive (EU) 2019/1024 of the European Parliament and of the Council), „Member States must adopt policies and take action to make publicly funded research data openly available, following the principle of 'open by default', and support the dissemination of research data that are findable, accessible, interoperable and reusable" (EUR-Lex, 2023).

In pursuing the broader implementation of open science, policymakers, journals, institutions, and funding agencies play a crucial role (Armeni et al., 2021; Obels et al., 2020). However, despite the credibility crisis, systematic efforts from stakeholders to support OSP are still lacking, and institutional changes are decidedly slow (Kekecs et al., 2023; Steinhardt et al., 2023). Therefore, barriers can also arise within the journals, institutions, and general research climate, as editors, reviewers, and senior researchers may resist certain procedural changes when it is perceived as less advantageous from their viewpoint (Haven et al., 2020; Karhulahti & Backe, 2021).

Obviously, the implementation of OSP faces different barriers at both the structural and individual levels. Therefore, it is necessary to look for facilitating factors that could be present in various parts of the research ecosystem. The barriers to adopting OSP vary not only between disciplines (Bouter, 2018) but very likely also between institutions, countries and cultures, and different parts of the research ecosystem. A systematic review of facilitators or barriers is currently lacking or is still in preparation (see Dudda et al., 2023).

According to available findings, the top four barriers, as indicated by researchers, journal editors, and funders, are pressure to publish for career advancement, the time-consuming nature of OSPs, lack of recognition, and lack of guidelines and commonly acceptable standards for reproducible research practices (European Commission, 2022). The commonly reported prevailing barriers are a lack of knowledge and skills, time demands, time scarcity for training, insufficient or absent support, journal policies, and financial reasons, but also barriers related to fear of judgment and criticism, confidence issues, fear of making mistakes and being exposed, fear of misusing data or being scooped, or incompatibility with research paradigm (El Amin et al., 2023; Gownaris et al., 2022; Pownall et al., 2023; Zečević et al., 2021). For example, Gownaris et al. (2022) identified insufficient awareness and training, excessively demanding time requirements, and constraints or insufficient incentives from supervisors as the most frequent barriers among early career researchers. However, little is known about these barriers in Slovakia.

Facilitators of the adoption of Open Science Practices

Although some research attention was dedicated to potential barriers, much less attention has been devoted to facilitators that have the potential to alleviate reported barriers systematically. Shmagun et al. (2023) identified four thematic clusters (i.e., institutional and regulatory factors; resource-related factors; individual and motivational factors; and external factors such as national culture), containing 24 unique factors that can serve as promoters or inhibitors of implementation of OSP. Alessandroni and Byers-Heinlein (2022) suggest ten strategies (e.g., introduce OSP in your courses and create opportunities for people to specialize in open science) that could be applied by researchers to foster OSP. From our practice, several

possible facilitators can help the adoption of OSPs in early career researchers. These include activities focused on increasing awareness about open-science practices during their education (in undergraduate and graduate students) and routinizing OSPs; organizational support for new applicants of OSPs, encouraging and facilitating authors' willingness to share their data through "good examples", promotion of good quality research indicators, increasing the available resources, and so on.

Sustained initiatives aimed at promoting OSP and research transparency are essential to enhance the credibility and integrity of social science research and can be another important facilitator of OSP. Examples of such initiatives are Reproducibility networks, which originated from the UK Reproducibility network and, over three years, grew into 18 different national Reproducibility networks (Munafò et al., 2020). Despite their activities, institutional endorsement of OSP is mediocre at best (Ong et al., 2023), and strong incentives for OSP in academic hiring and promotion, research publishing, and grant funding are also severely lacking (Diong et al., 2021; Moher et al., 2018). Moreover, a majority of researchers are not being formally trained in OSP (Portillo et al., 2022).

A summary of identified barriers and facilitators based on the above-mentioned studies can be found in Table S1 in supplementary materials (https://osf.io/qf834).

Transformation examples from psychology research

The field of psychology was among the first to recognize and respond to the existence of the credibility crisis. The renowned Reproducibility Project: Psychology (Open Science Collaboration, 2015) is just one of many high-powered, multi-lab collaborative reproducibility/replicability projects in the field. Registered Replication Reports (such as those by Alogna et al., 2014; Bouwmeester et al., 2017; Alogna et al., 2014; Simons et al., 2014; Wagenmakers et al., 2016), Many Labs projects (such as those by Klein et al., 2014; Klein et al., 2018), and ManyBabies projects (Frank et al., 2020) are just a few examples. The increased awareness of reproducibility and replicability issues has led to the growth of informal groups like the Reproducibility Networks (Munafò et al., 2020) and the Psychological Science Accelerator (Moshontz et al., 2018) committed to promoting OSP, fostering transparency, integrity, collaboration, and replicability in research.

The continuous advancements in technology and support from the Center for Open Science (COS) have simplified the process for scientists to disseminate their data, materials, and analytical code and to prepare pre-registration or registered report. This ease of sharing not only facilitates other researchers in reusing the data but also allows them to verify the authenticity and/or replicate published research. However, for the benefits of open science to emerge on a wider scale, collective action is needed from all parts of the system in the form of a combination of bottom-up and top-down approaches.

Goals of the study

All the information mentioned above led us to formulate the following research questions in our qualitative study on the perceptions and experiences of the barriers

and facilitators to adopting and implementing OSP in psychology research among stakeholders in Slovakia[1]:

1 Barriers
1.1 What barriers - both on the individual and systemic level - arise in the adoption and implementation of open science practices?

 This question seeks to identify the specific obstacles psychologists face when adopting and implementing open science practices. Individual-level barriers might include a lack of knowledge or skills, resistance to change, the absence of meaning in practices, or concerns about the time and effort required. Systemic barriers could involve institutional policies, a lack of resources or incentives, and cultural norms within the field.

1.2 How do these impact the adoption and implementation of specific open science practices into research workflows?

 This question examines the consequences of the identified barriers to the practical implementation of open science practices by psychology researchers in Slovakia. It aims to explore how they affect researchers' ability to integrate practices like data sharing, preregistration, and open-access publishing into their daily research activities. The focus is on the practical implications and the extent to which these barriers hinder progress.

Introduction

 Over the past two decades, we have learned that science does not inherently possess a self-correcting mechanism, or at least it is not functioning as optimally as many had hoped. Corrections can only be made through concerted, targeted action and collaboration among all stakeholders in the research ecosystem, including researchers, institutions, funders, publishers, and learned societies (Munafò et al., 2022). In response to this complex issue, promoting open science practices (OSP) should be prioritized (Nosek et al., 2015; Banks et al., 2019). One of the core purposes of open science is to enhance the transparency, integrity, and reproducibility of research (Banks et al., 2019). The incorporation of OSP (e.g. sharing of data, sharing of analytical code, pre-registration) undoubtedly has the potential to bolster a crucial aspect of scientific endeavor - the credibility of research findings. This credibility has been called into question due to the prevalent issues of low reproducibility and high prevalence of questionable research practices (Nosek et al., 2015; Kekecs et al., 2023). Nevertheless, the benefits associated with open science practices hinge upon researchers actively implementing them, which appears to remain somewhat challenging (Obels et al., 2020; Nosek et al., 2015; Armeni et al., 2021). To enhance reproducibility in science and foster public trust in science, which is fundamentally based on reproducibility, we need to adopt both bottom-up and top-down approaches. The bottom-up approach involves scientists adopting and internalizing OSP, while the top-down approach involves the implementation of policies by institutions, funders, and publishers (Armeni et al., 2021). OSP are not yet the norm, nor are they commonly applied, although progress varies across disciplines and countries. In this context, we aim to study issues

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[1]The underlying philosophical approaches (i.e., constructivism and relativism) and their implications should be taken into account and will be considered when contemplating the generalization of findings.

related to the adoption of OSP by examining qualitatively the barriers and facilitators of OSP in Slovakia

The slow adoption of OSP cannot be solely attributed to researchers. In a survey conducted by the European Commission in 2022 (European Commission, 2022), more than half of the over 1200 researchers surveyed identified the lack of requirement for OSP by funders, home research institutions, or journals as the most significant factor negatively affecting reproducibility. For instance, nearly one-third of journal editors do not deem the implementation of registered reports as important. Similarly, almost one-sixth do not prioritize the publication of null or negative results. Furthermore, approximately half of the research funders do not mandate the sharing of raw data and pre-registration of studies. This is despite the fact that according to the 'open data directive' (Directive EU 2019/1024 of the European Parliament), „Member States must adopt policies and take action to make publicly funded research data openly available, following the principle of 'open by default', and support the dissemination of research data that are findable, accessible, interoperable and reusable" (EUR-Lex, 2023). In pursuit of broader implementation of open science, policymakers, journals, institutions, and funding agencies play a crucial role (Armeni et al., 2021; Obels et al., 2020). However, despite the credibility crisis, systematic efforts from stakeholders to support OSP are still lacking and institutional changes are decidedly slow (Steinhardt et al., 2023; Kekecs et al., 2023). Therefore, challenges can also arise within the journals, institutions, and general research climate, as editors, reviewers, and senior researchers may resist certain procedural changes when it is perceived as less advantageous from their viewpoint (Karhulahti & Backe, 2021; Haven et al., 2020).

Obviously, implementing OSP faces different barriers and it is necessary to look for facilitators that could be present in different parts of the research ecosystem. The barriers to adopting OSP vary not only between disciplines (Bouter, 2018) but very likely also between institutions, countries and cultures, and different parts of the research ecosystem. A systematic review of facilitators or barriers is currently lacking or is still in preparation (as proposed by Dudda et al., 2023). According to available findings, top four barriers as indicated by researchers, journal editors, and funders are pressure to publish for career advancement, the time-consuming nature of OSP, lack of recognition, and lack of guidelines and commonly acceptable standards for reproducible research practices (European Commission, 2022). The commonly reported prevailing barriers are a lack of knowledge and skills, time demands, time scarcity for training, insufficient or absent support, journal policies, and financial reasons, but also barriers related to fear of judgment and criticism, confidence issues, fear of making mistakes and being exposed, fear of misusing data or being scooped, or incompatibility with research paradigm (Gownaris et al., 2022; El Amin et al., 2023; Pownall et al., 2023; Zečević et al., 2021). For example, Gownaris et al. (2022) identified insufficient awareness and training, excessively demanding time requirements, and constraints or insufficient incentives from supervisors as the most frequent barriers among early career researchers. Much less attention has been devoted to facilitators that have the potential to systematically alleviate reported barriers. Shmagun et al. (2023) identified four thematic clusters (institutional and regulatory factors; resource-related factors; individual and motivational factors; external factors such as national culture) containing 24 unique factors that can serve as promoters or inhibitors of implementation of OSP. Alessandroni and Byers-

Heinlein (2022) suggest ten strategies (e.g., introduce open science practices in your courses; create opportunities for people to specialize in open science) that could be applied by researchers to foster OSP. From our practice, there are several possible facilitators that can increase the adoption of OSP in early career researchers. These include activities focused on increasing awareness about open-science practices during their education (in undergraduate and graduate students) and making OSP routine; organizational support for new applicants of OSP, encouraging and facilitating authors' willingness to share their data through "good examples", promotion of good quality research indicators, increasing the available resources, and so on. Sustained initiatives aimed at promoting OSP and research transparency are essential to enhance the credibility and integrity of social science research and can be another important facilitator of OSP. Examples of such initiatives are Reproducibility networks, which originated from the UK Reproducibility network and over three years grew into 18 different national Reproducibility networks (Munafò et al., 2020). Despite their activities, institutional endorsement of OSP is mediocre at best (Ong et al., 2023) and strong incentives for OSP in academic hiring and promotion, research publishing and grant funding are also severely lacking (Diong et al., 2021; Moher et al., 2018). Moreover, a majority of researchers are not being formally trained in OSP (Portillo et al., 2022).

The continuous advancements in technology and support from the Center for Open Science (COS) have simplified the process for scientists to disseminate their data, materials, and analytical code, prepare pre-registration or registered report. This ease of sharing not only facilitates other researchers in reusing the data but also allows them to verify the authenticity and/or make replications of published research. However, these benefits will emerge only if researchers will be aware of and will apply OSP. Hence, all aforementioned information led us to formulate the following research questions in our qualitative study:

1 Challenges and barriers

1.1 What challenges and barriers, both on the individual and systemic level, arise in the adoption and implementation of open science practices in psychology?

1.2 How do these impact the adoption and implementation of specific open science practices into research workflows?

1.3 What strategies do individuals employ to overcome these challenges?

2 Facilitating factors

2.1 What factors, both on the individual and systemic level, facilitate the adoption and implementation ofare most helpful in facilitating open science practices?
This question aims to identify the key enablers of open science practices. On an individual level, this might include training or mentorship, personal initiatives, collaborations, use of available tools and resources. Systemically, it could involve supportive institutional policies, funding opportunities, and a culture that values transparency and openness.

2.2 What factors should be promoted or developed to support the adoption and implementation ofin order to support open science practices?

Building on the previous question, this one focuses on the actionable steps that can be taken to promote and support open science. It seeks to identify gaps and areas for improvement, suggesting specific actions, policies, or resources that could be developed to enhance the adoption and implementation of open science practices in Slovakia.

Authors' positionality and context of OSP in Slovakia

Many authors of this study are members of the Slovak Reproducibility Network, which aims to promote transparent and trustworthy research practices in the academic environment. The use of OSP among Slovak researchers is relatively rare, with the exception of publishing in the open-access mode (Adamkovič et al., 2024). Explicit support from universities is infrequent and uncertain. None of the domestic grant agencies explicitly require transparency. Of the indexed social science journals, only one explicitly supports using OSPs. The detailed context of open science in Slovakia - how transparency and reproducibility have developed over the years at different levels is described in the following living document (https://tinyurl.com/ax637vas). Our qualitative study, therefore, focuses on barriers and facilitators in psychology. To further describe the context of our study and mitigate issues regarding methodological integrity by managing authors' perspectives (APA, 2020), we also add our individual positionality statements in the form of a separate supplementary available at https://osf.io/3vqma.

The field of psychology was among the first to recognize and respond to the existence of a credibility crisis. The renowned Reproducibility Project: Psychology (Open Science Collaboration, 2015) is just one of the many high-powered, multi-lab collaborative reproducibility or replicability projects in the field. Registered Replication Reports (such as those by Bouwmeester et al., 2017; Alogna et al., 2014; Simons et al., 2014; Wagenmakers et al., 2016), Many Labs projects (such as those by Klein et al., 2014; Klein et al., 2018), and ManyBabies projects (Frank et al., 2020) are just a few examples. The increased awareness of reproducibility and replicability issues has led to the growth of informal groups like the Reproducibility Networks (Munafò et al., 2020) and the Psychological Science Accelerator (Moshontz et al., 2018) committed to promoting open science practices, fostering transparency, collaboration, and replication in research. Many authors of this study are members of both groups. Our qualitative study therefore focuses on barriers and facilitators in the field of psychology. In order to further describe the context of our study, we also add our positionality in the form of a separate supplementary available here (https://osf.io/3vqma).

Methods

The permission to conduct the study was approved by the Ethics Committeecommittee of the Centre of Social and Psychological Sciences at Slovak Academy of Sciences, nr. 25042024, following the ethical principles stated in the Declaration of Helsinki.

Participants

We will sample our participants from a target population of Slovak researchers and students from the field of psychology, as well as policymakers and journalists as representatives of the general public and direct consumers of scientific outputs. The

following Supplementary document (https://osf.io/hwdpm or living document: https://tinyurl.com/ax637vas) introduces the context of open science in Slovakia - how transparency and reproducibility have developed over the years at different levels such as researchers, funders, journals, government, or NGOs. For the purposes of the present research, we have divided the target population into the following five groups:

Table 1
Sample description

Group	Sample description	Sample size (N)	Data collection method
Researchers	Researchers consisting of different career stages (professors, associate professors, assistant professors, researchers) working at universities, the Research Institute of Child Psychology and Pathopsychology, and the Slovak Academy of Sciences	12-20	individual interviews
PhD students	PhD students and candidates*	12-20	individual interviews
Students	bachelor and master psychology students - only final-year students for which doing research and writing a thesis is relevant	3*(6-9)	focus group
Policymakers	(1) representatives of three major national grant agencies (2) executives of the Ministry of Education, Slovak Academy of Science, organizational administrator of scientific libraries and databases (the Slovak Centre of Scientific and Technical Information, open science section) or accreditation agency (The Slovak Accreditation Agency for Higher Education), university officials (vice-dean or vice-rector for scientific research, members of the scientific councils) (3) Chief and associate editors of Czech and Slovak scientific psychology journals**	1*(6-12)	focus group
Media	representatives of media publishing/processing results of scientific research (mainstream and popular educational news and magazines, Slovak radio and television channels)	1*(6-12)	focus group
Group	Sample description	Sample size (N)	Data collection method
Researchers	Researchers consisting of different career stages (professors, associate professors, assistant professors, researchers) working at universities and the Slovak Academy of Sciences	6-9	individual interviews
PhD students	PhD students and candidates*	6-9	individual

			interviews
~~Students~~	~~BA and MA psychology students - only final-year students for which doing a research and writing a thesis is relevant~~	~~6-9~~	~~focus group~~
~~Policy makers~~	~~(1) representatives of national grant agencies (APVV, VEGA, VAIA)~~ ~~(2) executives of the Ministry of Education, academy of sciences (SAV), organizational administrator of scientific libraries and databases (CVTI, open-science section) or accreditation agency (SAAVŠ), university officials (vice-dean or vice-rector for scientific research, members of the scientific councils)~~ ~~(3) Chief and associate editors of Czech and Slovak scientific psychology journals**~~	~~6-9~~	~~focus group~~
~~Media~~	~~representatives of media publishing/processing results of scientific research (mainstream and popular-educational news and magazines, Slovak radio and television channels)~~	~~6-9~~	~~focus group~~

*Notes: * - PhD candidates are those who have thesis proposal approved, and have passed necessary coursework and exams; in Slovakia, this is usually done in the 2nd year of PhD study; ** - only Slovak editors will be invited*

To ensure diversity in perspectives and opinions, we will apply no selection criteria based on gender, age, and preliminary knowledge about OSP. While it would be interesting to explore various subfields of psychology, departments are less specialized in Slovakia, and such distinctions will not be feasible for the purpose of the present study. For example, specialized labs are relatively rare and this is also true for the Slovak Academy of Sciences. The exception is The Research Institute of Child Psychology and Pathopsychology (Slovak abbr. VÚDPaP), a specific research organization focused on child psychology. However, in the present context, we assume that the culture of the workplace could play a more important role than a specific sub-discipline of psychology in the use of OSPs. Thus, to capture a diverse range of psychology researchers in Slovakia, a maximum of one participant from each department or faculty will be sampled. Furthermore, at least one person from VÚDPaP and one person from the Slovak Academy of Sciences will be sampled to ensure a broad representation of the field. To ensure the diversity of methodological approaches, at least 2 researchers will be included who have conducted most of their research (but not necessarily current research) using qualitative approaches. We aim to employ a mixed sampling method by combining stratified sampling (researchers, students, and PhD students) or snowball technique (policymakers, media representatives) (Johnson, 2014). Given that our research questions encompass perceptions and experiences of barriers and facilitators at both individual and systemic levels, we plan to utilize stratified sampling to ensure representation from various strata. These strata will include researchers from different career stages and academic institutions. We will carefully consider these factors and transparently report them in our research findings, contributing to the validity and reliability of our study.

We set our sample sizes based on the guidelines for thematic analysis proposed by Braun and Clarke (2013) and also based on a systematic review of sample sizes for saturation (Hennink & Kaiser, 2022). Due to pragmatic reasons—the challenge of obtaining a specific sample of policymakers and media representatives within Slovakia's relatively small population—we aim to maintain smaller sample sizes for these two groups (6-12 participants per group).

To ensure diversity in perspectives and opinions, we will apply no selection criteria based on gender, age, and the preliminary knowledge about open science practices. We aim to employ a mixed sampling method by combining stratified and respondent-driven sampling (researchers, students, and PhD students) or snowball technique (policymakers, media) (Johnson, 2014). Given that our research questions encompass understanding challenges and solutions at both individual and systemic levels, we plan to utilize stratified sampling to ensure representation from various strata. These strata will include researchers from different career stages, academic institutions, policymakers, and media professionals. After identifying initial participants through stratified sampling, we will subsequently inquire if they are aware of other researchers who have encountered challenges or achieved success in implementing open science practices. Using a respondent-driven sampling limits the overrepresentation of those with a higher number of ties to others in the population network. This combination of methods allows us to enhance the likelihood of obtaining a diverse set of perspectives while maintaining some degree of structure in our sampling process. We will carefully consider these factors and transparently report them in our research findings, contributing to the validity and reliability of our study.

The determination of sample size in qualitative research is a complex and context-dependent process, influenced by factors such as the research method, purposeful sampling strategy, and the intended research product (Sandelowski, 1995). While some argue that larger samples are needed for positivist-oriented research, others suggest that even a single case can be informative (Boddy, 2016). However, a review of qualitative studies found little rigor in justifying sample size, indicating a need for more consistent practices (Marshall et al., 2013). It is crucial to emphasize the influence of research context and design (the role of the research design influences sample size decisions), the concept of data saturation, the significance of purposive sampling, and the qualitative principle of prioritizing data quality over quantity. After taking all these factors including pragmatic considerations into account and the absence of generally accepted rules, we set our sample size to be between 6 and 9 people per group.

Measures

A semi-structured interview for researchers and PhD students was developed to answer the research questions. The interview contains questions for the participants and short and neutral descriptions of particular practices (i.e., to provide the same starting position = information about what eachthe practice represents). The questions are grouped into three main themes: 1) meaning of science (for the researcher, for society, and the extent to which this perceived meaning is fulfilled in current practice), 2) meaning of OSP (for the researcher, for the society, and experiences with OSP), open science practices, and 3) barriers and facilitators of their use (use of the practice, motivation for it, institutional support, perceived barriers, and perceived facilitators) and the final two questions focused on support and promotion of OSP in Slovakia. Five questions related to barriers and facilitators will be asked separately for each of the following OSP: open data and open

materials; open code; preregistration and registered reports; replication; open access and/or preprint; open peer review. ~~.~~ Interview questions were adapted for ~~the~~ use in focus groups with other ~~three~~ subgroups of participants (i.e., media, policymakers~~media, policy makers~~, and students). Focus groups were selected for specific groups because the insights and opinions that emerge from the dynamics in discussions with peers in the same profession or similar organizations tend to be more intriguing than their initial, unfiltered viewpoints. Given the limited progress in the field of OSPs by grant agencies and university leadership in Slovakia, policymakers must engage in a mutual exchange of perspectives. Identifying obstacles and discussing necessary changes will be more valuable than relying solely on unexamined original opinions without feedback. The interview and focus group~~The interview~~ questions (in Slovak and English) can be accessed at: https://osf.io/9f6bs/.

Both content and feasibility of the interviews were~~was~~ developed and piloted with 1) a focus group consisting of 8 ECR and PhD students from social psychology, 2) a focus group with 6 master students, and 3) an individual interview with an assistant professor.

Debriefing and reflection (immediate individual and group debriefing). Right after data collection,~~A thorough discussion with~~ the research team will conduct a thorough discussion ~~follow right after data collection~~ about emerging themes and encountered challenges~~, and~~ to identify areas for improvement.

Individual Reflection. In the following days, each ~~Each~~ participant will be contacted by email ~~the following days~~ with an invitation to complete or clarify their answers during the focus group or to express their feelings or comments on the ~~focus group~~ discussion.

Additionally, each subgroup of participants will be offered additional discussion or consultation about the OSP~~open science practices~~ with ambassadors and members of the Slovak Reproducibility Network.

Procedure

Individual interviews will be conducted either face-to-face or, if not possible, online via Zoom by one of the authors~~researcher~~. Focus groups will be conducted online only ~~and~~ by two researchers from the author's team. The role of the second researcher - moderator - will be mainly to monitor and check that all topics and OSPs have been thoroughly discussed. In designing the structure of both interviews and focus groups, we draw upon a wealth of research that underscores the efficacy of the combination of both approaches in qualitative inquiry (e.g., Goonewardene & Persad, 2018; Wilson et al., 2022). While data from the individual interviews provides a comprehensive insight into individual's experiences and perceptions~~perception~~ of open science among various groups, such as early career researchers (Zečević, et al., 2021) or researchers and developers of research infrastructure (Scheliga & Friesike, 2014), focus groups can also be very beneficial as they trigger ~~, utilizing~~ group dynamics (Tijdink et al., 2016). A combination of interviews and focus groups allows for a more comprehensive understanding of barriers and facilitators of the adoption of open science (González-Terue et al., 2022). From a philosophical position, our study adopts a constructivist approach, recognizing that knowledge is constructed through interactions between individuals and their environment (Anderson, 2003). This perspective allows us to explore how different stakeholders

perceive and experience the barriers and facilitators of open science practices. We also adopt a relativist ontology, positing that reality is subjective and can vary based on individual experiences and contexts (Kelly, 1997~~Interviews and focus group discussions will be recorded on secure devices and transcripts will be made using a GDPR-compliant web service Konch. Transcripts will be anonymized and then shared via the OSF. Due to budgetary constraints, only student and PhD student groups will be given the opportunity to enter a lottery and win a cash prize (1 winner of 100 euros per group~~).

Both immediate individual and group debriefings will be documented. The transcripts from these sessions will be analyzed in conjunction with the reflections we receive individually via email. Although the texts from these three sources will be analyzed collectively, their results will be reported separately corresponding to the preregistered analysis (with interviews and focus groups transcripts). Interviews and focus group discussions carried out in the Slovak language will be recorded on secure devices and transcripts[2] will be made using a GDPR-compliant web service (e.g., Konch). Transcripts will be anonymized and then shared via the OSF project subpage "Transcripts" with assigned DOI. During anonymization, we will proceed according to the guidelines for qualitative data, e.g., blurring potentially identifiable information or redacting text entirely if it cannot be blurred (Campbell et al., 2023). Due to budgetary constraints, only student and PhD student groups will be given the opportunity to enter a lottery and win a cash prize (1 winner of 100 euros per group).

Triangulation

We will employ a triangulation of methods, incorporating data from a survey for the researchers' target group. The survey questions mirror the interview structure and were also developed based on previous work (Abele-Brehm et al., 2019; Beaudry et al., 2023; Spitzer & Mueller, 2021. The complete survey is available on OSF in a text file format (https://osf.io/abe6y), and administration will be conducted using the Psytoolkit tool (version 3.4.4). The survey results will be presented following the thematic analysis results, and their degree of agreement will be discussed.

Analysis

First and foremost, we ~~We~~ will utilize mainly a bottom-up, analyst-driven thematic approach to uncover patterns, themes, and insights ~~directly from the data without imposing predefined categories or theoretical frameworks~~ (Braun & Clarke, 2022). Reflexive thematic analysis will enable us to derive meaning from the richness of qualitative data, facilitating a deep and nuanced understanding of participants' experiences with OSPs. ~~open science practices. It's essential to note that while we approached the data without a prepared list of codes (i.e., inductively), researchers are never entirely detached from existing empirical studies and theoretical concepts, as Braun and Clarke (2022) point out. Thus, our approach to data analysis involves a combination of inductive and deductive perspectives. The software Atlas.ti will aid in managing and organizing the data, facilitating the coding process, and visualizing the emerging themes.~~

However, It's essential to reflect that researchers are never entirely detached from existing empirical studies and theoretical concepts, as Braun and Clarke (2022)

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[2]Transcripts will be available in Slovak language

point out. Thus, our approach to data analysis involves a combination of inductive and deductive perspectives. Based on the previous findings and our own experiences, we formulated our expectations for each research question. These served as the basis for creating deductive codes, which we present in the codebook (available on OSF: https://osf.io/abe6y). The categorization of codes into three main areas—structure, process, and outcome—closely follows the TRUST model (Mayo-Wilson et al., 2021), to capture: policies (e.g., rules that may either promote or hinder the adoption or implementation of OSP); procedures (e.g., methods or mechanisms that could serve as levers for implementing behavioral change, or conversely, that can inhibit such change concerning the adoption and implementation of OSP); and practices (e.g., behaviors of organizations or institutions, as well as individual researchers in terms of OSP adherence). Originally, these three areas focused solely on institutions, but we have extended them to differentiate between individuals as well. Deductive codes will be analyzed similarly to inductive ones, with the additional step of coding alongside the inductive and deductive codes together. Description of deductive codes will be reported separately in relation to the research questions. The discussion of their frequency will involve evaluating their relative occurrence—high frequency (at least among 50% of participants) will indicate support for our assumptions. The software Atlas.ti will aid in managing and organizing the data, facilitating the coding process, and visualizing the emerging themes.

The analysis will proceed through several steps. After familiarizing themselves with the data, each transcript (in Slovak language) will be coded independently (with coders blinded to each other) by two randomly assigned authors from Team 1 (GB, DF, SI, PK, VM, MM, JP, LV) to ensure no important information is omitted. Each pair of authors from Team 1 will analyze the codes for the assigned transcript together, refining the descriptions of codes and removing duplicates while retaining all unique codes. Together, 15-21 transcripts (depending on the final sample sizes) will need to be coded, each by a different pair of authors from Team 1. Another pair of authors (Team 2: MA, MK) will analyze all the codes and generate themes. In the last step, Team 2 will lead a joint discussion with Team 1 to review and refine the identified themes into final themes. Consensus coding will be used in both phases of the analysis: during initial coding and later during theme creation, to avoid overlooking any important information. Different coders may have varying perspectives and notice different aspects. For this reason, after the initial coding of the entire transcript, the coders will compare their work and agree on which codes to retain for the second step - theme creation - through open discussion. If both coders mark the same parts of the text but assign codes that differ in content and meaning, the goal of the open discussion will be to reach a consensus - creating or retaining one code that best captures that part of the text. In cases where the coders have differing views on a certain part of the text and cannot reach a consensus, both semantically different codes will be retained rather than choosing just one. For the survey results, we will report only descriptive statistics.

The results of the analysis will be organized as follows: For each sample group, which includes researchers, students, PhD students, media, and policymakerspolicy makers, we will report A) a list of all barriers and facilitators identified during the interviews or focus groups, and B) more abstract themes that characterize groups of barriers and facilitators. These For all sample groups, these

themes will be integrated into a single research ecosystem for all sample groups to illustrate ~~to illustrate their interconnectedness and~~ their potential interconnectedness~~causal relationships~~. For instance, a barrier that prevents funders from supporting a certain practice may be perceived as a reason for not implementing the same practice at the individual level. We will also present a list of barriers, facilitators, and themes associated with responsible practices (such as open data, open code, preregistration, replication, open access, and open peer review) in one of two ways: We will either first present the practice and then the corresponding barriers, facilitators, and overarching themes, or we will first present the themes and then the practices that fall under the same theme.

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