SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2025
ORGANIZATION AND MANAGEMENT SERIES NO. 226

COOPERATION OF SMALL AND MEDIUM-SIZED ENTERPRISES WITH RESEARCH AND DEVELOPMENT UNITS-AN ATTEMPT TO OPERATIONALIZE THE RESEARCH MODEL

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Purpose: The purpose of this study is to analyze the author's research model in the context of finding areas in which it can be operationalized.
Design/methodology/approach: The article employs a mixed-method approach, combining a literature review on cooperation between SMEs and R&D units with empirical research. The survey included a questionnaire administered to employees representing various levels of business management in Poland (N = 38). The questionnaire assessed the perception of the model of cooperation between small and medium sized enterprises and R&D units in the context of its operationalization.
Findings: The study found that the model contains elements that can be transformed into measurable indicators.
Research limitations/implications: Given that the study was conducted among a small number of respondents, its results cannot be directly generalized to the entire population. It is recommended to extend the analysis to other user groups of participants and a broader scope of research.
Practical implications: The research findings indicate the need to expand the author's research model.
Social implications: The analysis underscores that the indicated author's research model contains elements that can be transformed into measurable indicators, thereby influencing the improvement of the model and its practical application.
Originality/value: The article introduces a new perspective to the research on cooperation between SMEs and R&D units, making cooperation even better.
Keywords: cooperation of SME's, R&D units model, operationalization of the model.
Category of the paper: Research paper.

1. Introduction

An extremely important element of the activities of modern enterprises is cooperation, by which is meant the interaction between enterprises and their environment (Bańkowski, Rzepka 2024). Establishing cooperation between an enterprise and its environment is an important factor in economic development. In the environment of the enterprise, especially small and medium-sized enterprises, research and development units have a special place. The development of enterprises depends on the effectiveness of activities in creating knowledge within it and obtaining it from external sources. Therefore, such factors as knowledge and technology acquire fundamental importance for the development of enterprises (Haberla, Kuźmińska-Haberla, 2013). Cooperation of small and medium-sized enterprises with research and development units plays a special role in the development of the competitiveness of the economy.

The purpose of the article is to try to characterize the areas in which the research model can be operationalized to indicate the advantages and disadvantages of the research model and its impact on the areas indicated. The basis for measurement was the research conducted on a group of 38 people. The research was conducted in 2025.

2. Theoretical bases

Small and medium-sized enterprises play a special role in the economy, being a kind of stimulator of economic development, and the level of their saturation in the economy is one of the measures of this development (Poznańska, 2016). Despite many publications and studies, small and medium-sized enterprises still arouse great interest among researchers. Small and medium-sized enterprises play an important role in the economy of many countries, including Poland. Supporting the development of the small and medium-sized enterprise sector is important for the development of the Polish economy.

The functioning of small and medium-sized enterprises is important for the proper operation of the market mechanism. Increasing the number of enterprises belonging to the small and medium-sized enterprise sector accelerates the processes of ownership transformation and restructuring of the economy (Skowronek-Mielczarek, 2007). The concept of small and medium-sized enterprises (SMEs) is not clearly defined (Zeng, Xie, Tam, 2010). To date, no universal definition has been created to characterize this type of enterprise in all countries around the world. Therefore, a unified definition is fundamental for any audience that wants to understand the meaning of SMEs (Zastempowski, 2010). The criteria under which a company can be classified as an SME are set out in the EU Commission Regulation No. 651/2014 of June

17, 2014 declaring certain types of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty (Regulation 651/2014), which Poland has also adopted. In a single market without internal borders, it is important that measures in favor of SMEs are based on a common definition in terms of increasing their consistency and effectiveness, as well as to limit distortions of competition.

Table 1.
Criteria for quantitative classification of small and medium-sized enterprises

Criterion Company	**Enterprise**		
	micro	**small**	**medium**
Number of employees	less than 10 people	10-49 people	50-249 people
and			
Annual turnover or balance sheet total up	to 2 million euros	2-10 million euros	10-50 million euros
	to 2 million euros	2-10 million euros	10-43 million euros
and			
Capital independence from other entities	Capital independence from other entities. In the case of specific capital ties, these must be taken into account		

Source: own study.

This definition of small and medium-sized enterprises is a valuable aid to public authorities in distinguishing between such enterprises in their policies and programs (Kowalski, 2020). As rightly stated by J.A. Welsh and J.F. White (1981), small and medium-sized enterprises are not miniatures of large enterprises, hence the way they are managed and organized should be different. The presence of small and medium-sized enterprises is a manifestation of healthy competition, as well as a reflection of entrepreneurial activities, thus allowing the individual aspirations of society to be realized (Wojdyła-Bednarczyk, 2014).

An important feature of small and medium-sized enterprises is the direct involvement of business owners in their activities, which makes it possible to make a quick decision and implement it in a short time. The situation is different for large enterprises, where it is much more difficult to make an immediate decision. Responsibility is divided among several employees, and decision-making involves the development of a common position by the management of managers (Drab-Kurowska, 2007). Another feature of small and medium-sized enterprises is a dynamic approach to the environment. These enterprises respond quickly to emerging customer needs and preferences. Therefore, they are more mobile in committing financial resources to various industries, including profitable investment ventures. Small and medium-sized enterprises are able to create new value for buyers, taking into account the level of operational and financial risk. They often rely on production that is not based on economies of scale, but on seeking market opportunities (Skowronek-Mielczarek, 2007). Having a small number of employees, focusing on a strictly defined group of customers and a narrow assortment speeds up the flow of information and reduces anonymity. They rapidly take advantage of emerging opportunities to increase sales of their products and services, adjusting their production potential to the current demand (Bednarz, Gostomski, 2009). Not without

significance is their number in Poland, as they account for as much as 99.8% of all economic entities, so they can affect the processes taking place in Poland (Chaber, 2020).

Small and medium-sized enterprises are the pillar of the economy (OECD, 2020). Such enterprises play an important role in Poland's economy, generating 48.5% of GDP and creating jobs for 68% of the total number of employees in the enterprise sector. It should also be emphasized that small and medium-sized enterprises fill market gaps that large enterprises are unable to enter, with the result that they are more flexible compared to large entities. Therefore, small and medium-sized enterprises can achieve an advantage over large enterprises by responding quickly to the changing environment, entrepreneurial use of opportunities and market opportunities, activities aimed at meeting the needs reported by the local market, products and services oriented to high quality, and by best meeting the needs of customers (Orechwa-Maliszewska, 2003). The second important area is research and development units in Poland. The R&D sector consists of all entities engaged in research or development activities, which include both private companies and public institutions. It should be noted that for most of them R& D is one of many areas of activity, which usually results in a small number of employees along with a small number of resources being engaged in R&D activities. R&D activities in an R&D entity do not have to be carried out in the same unit, but can be outsourced, which increases the number of entities included in this group (Jasiński, Głodek, Jurczyk-Bunkowska, 2019).

Still a perceived limitation is the low degree of cooperation to share risks or stabilize the market (Bohatkiewicz-Czaicka, Gancarczyk, 2024). Research and development units are units that specialize in implementing new technologies and improving them. These units were established by the Law on Research and Development Units of July 25, 1985.

According to this law, research and development units are “state organizational units separated in legal, organizational and economic-financial terms, created for the purpose of conducting scientific research and development work, and the results of which should find application in specific areas of the national economy and economic life”. According to the CSO's definition, research and development activity includes creative work conducted in a methodical manner and undertaken to increase the stock of knowledge, i.e. knowledge of human kind, culture and society, as well as to create new ways of applying existing knowledge. Therefore, such activity must be:

- novel - aimed at new discoveries,
- creative - based on original, non-obvious concepts and hypotheses,
- unpredictable - not obvious and uncertain as to the final outcome and cost, including the time spent,
- methodical - carried out in a planned manner with the identification of the purpose of the R&D project and the method and source of funding,
- transferable or reproducible, leading to results that can be reproduced.

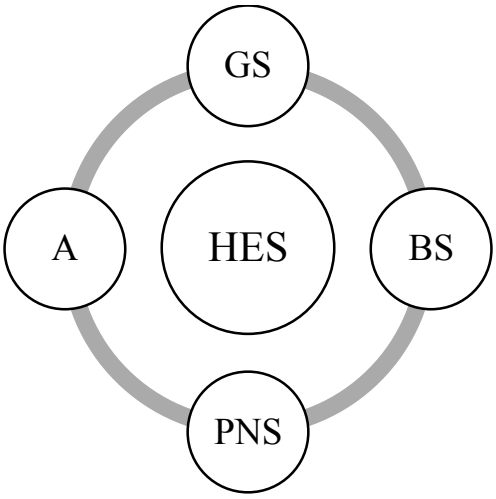

Figure 1. Component structure of the R&D sector.

Source: own compilation based on OECD 2023 data.

- HES-higher education sector.
- GS-government sector.
- BS-business sector.
- PNS-private nonprofit sector.
- A-abroad.

Figure 1 shows the structure of the R&D sector's components, indicating the central role of the higher education sector, as well as the tangential areas for each area. The area of centrality is occupied by the higher education sector, encompassing all universities, technical colleges, as well as other institutions providing formal higher education programs (regardless of funding source or legal status), as well as all research institutes, centers, experiment stations and clinics conducting R&D activities under the direct control or management of higher education institutions. The special distinction of this sector in the OECD handbook allows analysis of groups of entities that are key to the science policy of many countries.

The inclination to cooperate, and the search for suitable partners to achieve common goals is a fundamental characteristic of human beings, which translates not only into individual relationships, but, above all, into the functioning of economic activity (Pietruszka-Ortyl, 2020).

The need to undertake cooperation is the result of the specific characteristics of knowledge, especially in strictly defined content (Scherngell, 2021). Cooperation between small and medium-sized enterprises and R&D units occurs in formal and informal forms. Entering into formal cooperation obliges both parties to enter into a bilateral agreement. In the case of informal interactions between the university and the enterprise, such cooperation is not of a direct commercial nature, most often consisting in the exchange and acquisition of basic knowledge (Garcia-Perez-de-Lema, 2017). Small and medium-sized enterprises cooperate with R&D units in a variety of ways, ranging from the exchange of knowledge and information to joint investment to support the creation of continuous innovation (Grasjo, Karlsson, Bernhard 2018).

Among the forms of knowledge flow from science to business, one should also point out joint scientific and research projects (including those financed from public sources within the framework of national and EU programs), sale of patents, consulting services, student internships, postgraduate studies, conferences, symposia, industrial fairs and exhibitions, cooperation of employees within the framework of professional associations, personnel flow between science and business, training of enterprise personnel, use of university laboratories by the enterprise, acquisition of new knowledge and technology, participation of enterprise employees in the teaching process at the university. Nowadays, in scientific research it is extremely important to be able to transform theoretical concepts into concrete variables that the researcher is able to analyze and observe. The primary task of operationalization is to assist in accurately and unambiguously understanding the concepts of the phenomena under study, transforming them into variables and measuring them. The use of operationalization increases the reliability of research by creating precise conditions for repetition (BIC, 2025).

The operationalization of a research model is the process of transforming abstract theoretical concepts into concrete indicators and measurable variables that can be used in research (Zakrzewska-Bielawska, 2018). Research proceedings in management and quality sciences are accompanied by models, such as theoretical and conceptual, research or statistical (Nowosielski, 2016). A model is a construct, or scheme, that describes a certain activity and is shown as a simplified reflection of reality (Sławińska, 2010). An increasingly common phenomenon in scientific research is the exploration of the area of operationalization of the research model. The primary determinant of the objectives of the process of determining the purpose, is the need to carry out scientific research (external to the researcher or his own - internal), and as a consequence of its operationalization - the content and nature of the object and research problem.

The research model shows the path of activities performed step by step for proper cooperation between small and medium-sized enterprises and R&D units. This model is shown in Figure 2.

The model consists of seven points, and the elements of the model have been connected by arrows to indicate the path to the next area. The starting point for the model in question is the identification of cooperation as the main element connecting small and medium-sized enterprises and R&D units. The first point is the establishment of the first contact between the entrepreneur and the university. This is a key element in the establishment of cooperation, as it has a direct impact on further stages and decisions on the part of both SMEs and R&D units. The establishment of the first contact should result from its exploration and openness expressed in the need to actively seek opportunities for meetings, net-working and presentation of its offer. The establishment of the first contact is followed by a joint search for an area of cooperation. The search for areas of cooperation should be the result of joint work, both by the entrepreneur and the R&D unit. The joint search for areas for cooperation should be the result of joint work, exchange of knowledge of current trends and experiences.

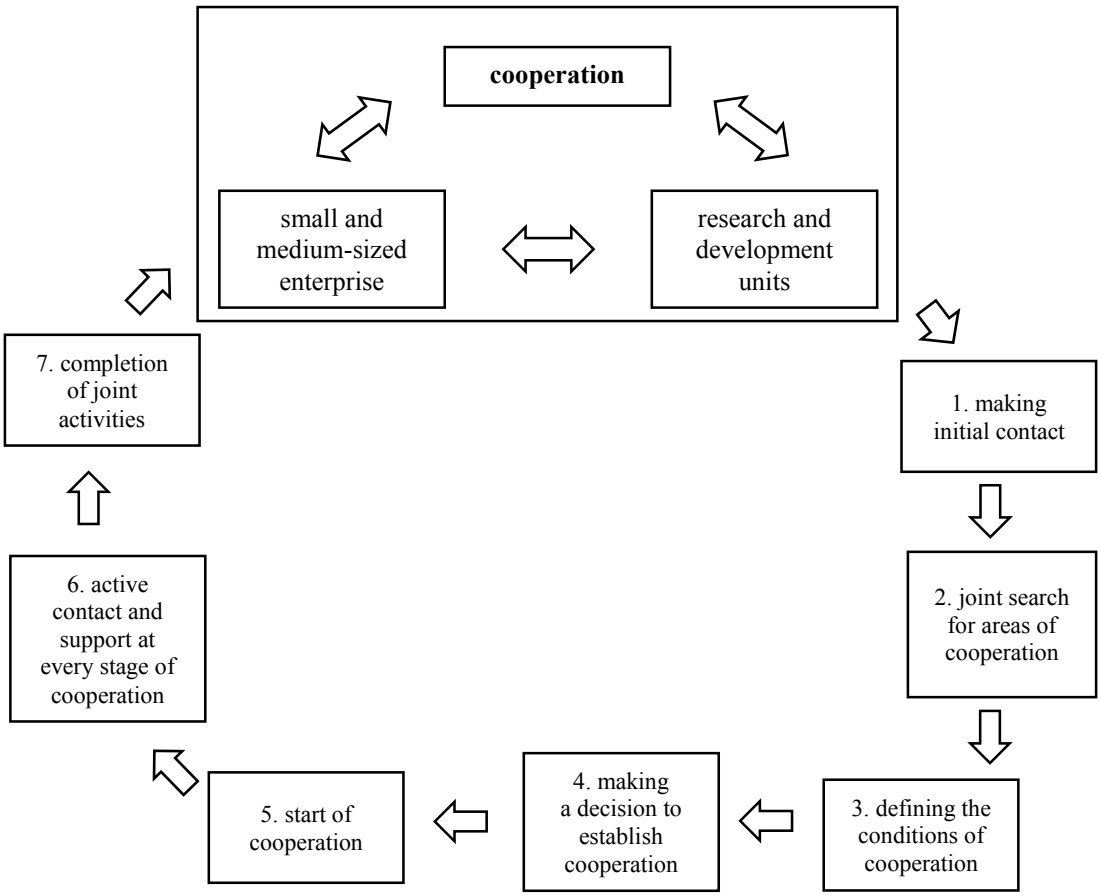

Figure 2. Research model of cooperation between small and medium-sized enterprises and R&D units. Source: own elaboration.

Next comes a clear definition of the terms of cooperation, followed by the decision to establish cooperation. Clear definition of the terms of cooperation refers to the most important elements affecting the start of cooperation, among which are the determination of the time of cooperation, personnel and financial facilities. It is important that the decision-making time does not take long, so that both parties can take joint action as early as possible The decision to cooperate is followed by the start of cooperation. For the proper implementation of the joint venture, it is important to have ongoing contact between the parties to discuss the progress of joint activities, as well as to resolve emerging issues. During the course of the cooperation, active contact and support at each stage of the cooperation is evident. The final, seventh stage involves the completion of joint activities. It includes accounting for joint activities. It is crucial to create an area for good relations, which in the future may result in another successful cooperation. The author's research model presented became the basis for further analysis.

3. Research methodology

The research results presented in this paper are part of the author's research project. The study was carried out on a sample of 38 employees working at various levels in enterprises in Poland. The selection of the research sample was purposive. In developing the criteria for the selection of the sample, several factors were taken into account among which are age, gender, experience in cooperation with R&D units (occurrence of cooperation or not) and also whether it is an employee of an SME. During the survey, respondents answered the research questions posed related to the research model presented and its application in business practice. The survey was conducted using a standardized questionnaire. Before the survey proper was conducted, a pilot survey was performed on a sample of three respondents to verify the validity of the research questions posed. The implementation time of the survey was 5 days. The survey was conducted using a survey questionnaire filled out in the presence of the researcher. Then, the resulting research material was coded in Maxqda24 software and then further analyzed.

The study posed the following three research questions:

PB1: What are the advantages and disadvantages of the presented research model?

PB2: Can the research model be operationalized and how?

PB3: To what extent could the areas identified affect cooperation if the model were used in practice?

Attempts to find answers to the indicated research questions are elaborated later in the article. Respondents to the survey were characterized by diverse characteristics. Such parameters as gender, age, experience in cooperation with R&D units, and employment in SMEs were taken into account. The characteristics of the respondents are shown in Table 2.

Table 2.
Characteristics of respondents from the survey sample

Criterion		**Percentage of indications**
gender	female	60,52
	male	39,48
age	18-34	60,40
	34 and over	39,60
experience in cooperation with R&D units	yes	84,21
	no	15,79
SME employee	yes	76,31
	no	23,69

Source: Own elaboration based on the results of the survey.

In addition to the open-ended questions, respondents additionally rated on a 5-point Likert scale whether, if the model were used in practice in its current form, whether and how it would improve project performance, reduce implementation time, increase participant satisfaction, or whether it would decrease the number of delayed or failed projects (PB.3.).

4. Findings

The author's research model presented has its advantages and disadvantages. Of all the contributions, the author has collected the five most common advantages and disadvantages of the research model in tabular form each in the respondents' answers. The presentation of the advantages and disadvantages of the model is included in Table 3.

Table 3.
Advantages and Disadvantages of the research model

Advantages	**Disadvantages**
Transparent	Inability to respond to unpredictable immediate changes
Representing an organized and thoughtful way of doing things	Lack of consideration of external factors
Structured	It does not provide for continuous cooperation or repetitive processes
Meticulously prepared	Lack of assumption of failure
Clearly guides companies and R&D units interested in cooperation	Requires high commitment from both sides

Source: own elaboration based on research results.

Among the most common advantages in the answers given by respondents was the transparency of the model. The model shown is clearly prepared and well thought out. The model shown is a model of desirable cooperation, which means that if small and medium-sized enterprises and R&D units (in this case, technical universities) worked together in the manner indicated, the cooperation would be successful. In contrast, one of the most common disadvantages of this model is that there is no room for consideration of external factors, such as the outbreak of a pandemic or war. This model leads along a path that requires the involvement of both sides. If there were a lack of commitment from at least one side, then the cooperation could fail. Therefore, the success of cooperation relies on mutual commitment.

After receiving answers related to the advantages and disadvantages of the model, the author attempted to look for areas where it would be possible to operationalize the model. Based on the literature on the subject and in the opinion of the respondents, the model can be operationalized. As a result, five areas were characterized, which are presented in Figure 3.

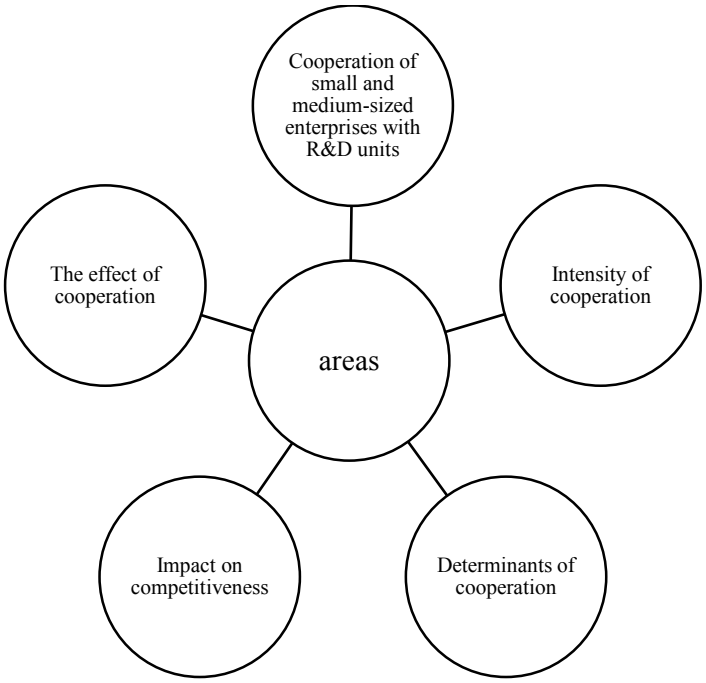

Figure 3. Areas that can be operationalized.

Source: own elaboration based on research results.

The characterized areas can be transformed into indicators and then the method of measuring them can be determined. The results of the analysis are presented in Table 4.

Table 4.
Areas in which the research model can be operationalized

Theoretical concept	Operational definition	Indicators	Measurement method
Cooperation of small and medium-sized enterprises with R&D units	Formal interactions of small and medium-sized enterprises with R&D units preceded by a relevant agreement between the parties	- number of jointly implemented projects per year/over the indicated number of years; - number of contracts signed; - number of meetings before/ during and after cooperation	- a survey of cooperating SMEs and R&D units; - analysis of documents, e.g., the contract and its provisions; - (IDI) individual in-depth interviews after the cooperation
Intensity of cooperation	Frequency and scale of contacts	- number of projects implemented annually; - type of cooperation established and its rules; - duration of individual stages	- questionnaire; - interview
Determinants of cooperation	Factors affecting cooperation	- financial availability; - experience of staff; - research infrastructure	- a survey; - expert interviews
Impact on competitiveness	Change in the market position of the company	- increase in revenue; - number of new customers	- financial data available; - interview
The effect of cooperation	Satisfaction with cooperation	- satisfaction rate with cooperation	- a survey distributed during and after the cooperation; - individual in-depth interviews (IDI)

Source: own elaboration.

In order to more accurately verify the effects of cooperation or satisfaction with cooperation, it would be good practice to set indicators and targets to be achieved at each of the steps in the model. That is, with each of the indicated points, it is assumed to develop two indicators that would be realized after each step in order to move on to the next step.

The next stage of the survey was to obtain answers to the question of indicating to what extent the implementation of cooperation based on the model in its current form would affect the following aspects, i.e. improvement of project results, reduction of cooperation implementation time, increase of participants' satisfaction and number of delayed or failed projects. The obtained answers were aggregated and shown in Fig. 4.

Figure 4. Impact of the model on the following areas.

Source: own elaboration.

If the indicated research model in its current form was used in business practice, according to the answers received by the respondents, the implementation of cooperation between small and medium-sized enterprises and R&D units will improve the project results to a medium extent. The implementation of cooperation in the presented research model, in the opinion of respondents, will to a small extent affect the shortening of cooperation implementation time. On the other hand, such a structured model of cooperation will to a large extent influence the increase of satisfaction of cooperation participants. To a medium extent, the implementation of cooperation based on the presented model will affect the number of delayed or failed projects.

5. Summary

The area of cooperation between small and medium-sized enterprises and R&D units is of great importance for economic development. Among the advantages of using the model in its current form is its transparency and orderliness, which clearly guides both parties along the path of cooperation. On the other hand, among the disadvantages of the indicated model are min: the inability to respond to unforeseen situations or the lack of assumption of failures. Thus, the research model can be operationalized. As a result of our own research, five areas were found in which the model can be operationalized. The implementation of the joint cooperation activity in the current structure, to a good extent, will increase the satisfaction of those participating in the cooperation. On the other hand, however, the implementation of the model will have a medium impact on improving project performance or reducing implementation time. The considerations arising from this publication will provide the author with an impetus for further exploration of the issue. The main limitation of the implementation of the indicated survey was the number of respondents. Future surveys will be expanded to include a larger number of respondents - a planned 150 respondents, and expanded to include a group of university employees. In addition, in order to further exploit the research, the questions posed in the questionnaire will be expanded and individual in-depth interviews (IDI) will be conducted with purposefully selected respondents.

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