(01-040) - Enhancing Project Management in Academic Research: Exploring Agile Approaches for Improved Control and Adaptability

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In university research projects, there is a lack of comprehensive project management, making project control challenging, which is essential for adhering to project goals, budget, and scheduling. Especially in a research project with a high degree of innovation and often numerous unknown factors, comprehensive project management becomes even more important.

This paper first outlines the constraints applicable to university research projects in Germany. Subsequently, it delves into the specific requirements for project management in research projects. A literature review is conducted to identify suitable methods, revealing that most methods are unsuitable for research as they cannot adapt quickly enough to the objectives of the research. The results demonstrate how the agile project management approach can enhance the processes in university research projects.

Keywords: university research projects; project management; methods

Mejorar la gestión de proyectos en la investigación académica: Exploración de enfoques ágiles para mejorar el control y la adaptabilidad

En proyectos de investigación universitaria suele haber una falta de gestión integral de proyectos, lo que dificulta el control del proyecto, aspecto esencial para cumplir con los objetivos, presupuestos y cronogramas del proyecto. Especialmente en un proyecto de investigación con un alto grado de innovación y a menudo numerosos factores desconocidos, la gestión integral de proyectos se vuelve aún más importante.

Este documento primero describe las restricciones aplicables a los proyectos de investigación universitaria en Alemania. Posteriormente, se profundiza en los requisitos específicos para la gestión de proyectos en proyectos de investigación. Se lleva a cabo una revisión de la literatura para identificar métodos adecuados, revelando que la mayoría de los métodos son inadecuados para la investigación, ya que no pueden adaptarse lo suficientemente rápido a los objetivos de la investigación. Los resultados demuestran cómo el enfoque ágil de gestión de proyectos puede mejorar los procesos en proyectos de investigación universitaria.

Palabras clave: proyectos universitarios de investigación; gestión de proyectos; métodos

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Agradecimientos: This research is part of the project MORE - Munich Mobility Research Campus. The project is funded by dtec.bw – Digitalization and Technology Research Centre of the Bundeswehr. Dtec.bw is funded by the European Union – NextGenerationEU.

1. Introduction

The number of large and complex research projects managed by universities is steadily increasing in size and scope (Moore & Shangrew, 2011). This can be seen, for example, in the third-party funding per professor at German universities. An increase in third-party funding of 3.8 % from 2020 to 2021 was observed (Statistisches Bundesamt, 2023). The majority of this funding is raised for research projects or single departments. Germany's largest public funding organization, the Deutsche Forschungsgemeinschaft (DFG), can be an example here. In 2022, 6999 new projects were approved with a total amount of €2.47 billion (DFG, 2023). The DFG developed a codex with 19 guidelines, which promotes scientific integrity and academic self-commitment (DFG, 2022). It is evident to comply with the funding guidelines, it must also be ensured at the management level that the budget and schedule for the desired objectives and quality assurance are monitored and adhered to.

By using project management to execute successful projects, up to 20 % of costs and time can be saved (Braehmer, 2005, p. 9). In addition, Barnes demonstrated in a study that project management is one of the success factors in university research projects to ensure good project monitoring, planning, and effective communication (Barnes et al., 2002). University research projects are characterized by numerous unknown factors, which can lead to paradoxical results. Due to the innovation potential, the complexity can increase and thus make the project management more challenging (San Cristóbal et al., 2018). Therefore, integrating effective and efficient project management into university research projects is essential.

This paper aims firstly to investigate the specific characteristics of an exemplary university in Germany regarding the laws and standards that influence the project and its management. Secondly, the characteristics of typical public universities are examined. Thirdly, a literature review is conducted to examine, based on the defined criteria, which methods are best suited for research projects. Finally, it will explain how agile project management approaches can enhance university research projects.

2. Definition of Projektmanagement and their methodology

Project management is defined according to DIN69901-5 as an entity of management tasks, organizations, techniques, and resources for the initiation, definition, planning, control, and completion of the project. Project management is not a new discipline and has been applied for hundreds of years. One of the most significant examples is the construction of the pyramids of Giza. They used various techniques, processes, and tools to satisfy their customers and other affected parties (PMI, 2017, p. 1).

Traditional project management (TPM) tools and techniques with well-defined information about time, cost, and resources, with extensive preplanning and controlling are often found inadequate (San Cristóbal et al., 2018). This is reasoned because a static approach provides unrealistic estimations by not including non-linear relationships and feedback processes. The environment is getting more complex, which suggests improving the TPM to properly face the challenges of today's times (San Cristóbal et al., 2018). In 2001 the agile manifesto was introduced, which laid the foundation for project management with agile methodology. The aim was to improve the project results through rapid requirement changes and feedback rounds (Kantola et al., 2019, p. 405–414). However, agile project management (APM) was primarily developed for software development. Examples of methods are Scrum, eXtreme Programming, Lean Development, Lean Startup, Kanban, and Dynamic Systems Development (Cubric, 2013; Raharjo & Purwandari, 2020). Until

2009, it was predominantly used in IT projects. The founders of the Agile Manifesto also emphasized that it can be used in any project encountering uncertainties (Stare, 2013).

Therefore, the specific characteristics of university research projects will now be examined. This shall be the basis for the criteria, which are important for the project management process and their improvement.

3. Characteristics of university research projects

3.1 Laws, Standards, and Guidelines in Germany

A German University, for example, is defined according to the Bavarian Higher Education and Innovation (BayHIG) Law Art. 2 § 1 as “an institution with the right to award doctoral degrees and primarily serves the development and maintenance of science through research, teaching, and study”. Traditionally, public universities are institutes of the state. This means that the ministries significantly influence and control these institutes (Kloss, 1968, p. 326). The researchers themselves are free in their research. This is stated in the German legal constitution under Art. 5 as a fundamental right to freedom for art and science, research, and teaching, with consideration for loyalty to the constitution. The fundament of a university is traditionally divided into two sectors: teaching and research.

After successfully securing the funds, these must adhere to various laws, guidelines, and standards of the country and the funding department for project implementation. Taking the example of the University of the Bundeswehr in Munich, among others, it must adhere to the BayHIG, the Federal Budget Code (BHO), and additionally by third-party funding to the third-party funding guidelines from the Federal Ministry of Defense (BMVg). With the BHO, it is also evident that funds are normally allocated annually, and there is an obligation to adhere to the allocated funds. Usually, funding departments also prioritize ensuring *freedom of research* and the results can be presented publicly.

The third-party funding guidelines regulate, for research projects at the Bundeswehr universities, that the following points must be adhered to upon successful confirmation (BMVg, 2018):

- Short project description
- Complete contact information of the funding agency
- Project leader
- Expected project duration
- Amount of granted third-party funding, broken down into personnel, material, and investment funds
- Possible consequential burden and follow-up costs

As evident here, the university does not provide specific guidelines for project execution. Additionally, there is no requirement for the hiring of a project manager. Still, it can be seen that the project leader must be made clear and the associated project management constraints for costs, goals, and schedule. Resources are usually allocated for personnel, materials, and investment funds.

Additionally, funding agencies typically impose their own guidelines. However, certain requirements remain consistent, such as demonstrating *moral and ethical standards* and submitting a *time and budget plan*. Therefore, selecting the right project structure, methods, and processes from the beginning is crucial for smooth execution. Adhering to time and within budget is important to ensure the project quality and maximize the research outcome.

3.2 Third-party fundings in Germany

Most funded projects in Germany are financed through third-party funding. For instance, major public funding such as the Humboldt Foundation, the DFG, and the Volkswagen Foundation usually require either a doctoral degree or a professorship as a prerequisite for applying. The reason for this is that the applicants must demonstrate their academic qualifications. However, while emphasis is placed on academic qualifications, which are equated with expertise in the field, other factors identified by Kraus and Westermann as necessary to manage a project successfully are not necessarily considered. Some of the relevant points are listed (Kraus & Westermann, 1995):

- Expertise (knowledge of information technology, knowledge of work and material management, operational procedures...)
- Methodological knowledge (project planning methods, problem-solving techniques, analytical skills...)
- Social skills (ability to handle criticism, credibility, interpersonal warmth...)

By just looking at the academic qualification the knowledge in their research field is given, but methodical skills are not automatically considered. Without training or a professional project manager, important skills can be missing. Therefore, it is even more crucial to establish *clear roles* and *responsibilities* so that resources are optimally utilized and the specific characteristics of a university research structure are accommodated. For this reason, a closer look will be made at the important constraints of project management in university research projects.

3.3 Management in Research

Research has a long-term vision for *goal setting* in mind. Management must develop a vision and ensure that short-term activities contribute to achieving long-term goals. Kjølhede states that methods for scheduling and planning are helpful, but on the other side misleading as well (Ernø-Kjølhede, 2000). The tools and techniques should be *flexible* to the objectives of the research.

In general, a project organization, as defined by DIN 69901-5, refers to the structure and processes established to execute a specific project. Since a project is a temporary endeavor, a project organization is typically preferred. Depending on the size of the project, there are usually multiple participants involved in a research project. It can be distinguished between Staff-Line-organization, Line-Organization, and Matrix-Organization. (Wirsing, 2006). When considering the structure of projects, large-scale projects are often structured like a matrix project organization. This means that individuals share their work and consequently face a dual burden, as they are usually involved in teaching and assigned to different projects. The aim of this is to acquire new knowledge, with the primary goal for academic personnel usually completing a doctorate. Even if a professor is a project leader, there will always be a duality between their interests and the project. The same goes for academics, which are focused on their individual-orientated research topic (vom Brocke & Lippe, 2015).

The special features of organizational structure predominate in university research projects, as noted by Mormann and Willjes. Here, personnel is at the center, given due to the contractual conditions of academic personnel (Wissenschaftszeitvertragsgesetz), as well as academic norms and customs, which contribute to limited control and influence over university management. Additionally, it is distinguished by a unique collegial structure among professors and other academic staff (Mormann & Willjes, 2013). This suggests that *flat hierarchies* among the scientific personnel are desirable in projects.

Due to the focus on academic personnel, it is important to advance the transfer of research results and to prioritize the supervision of doctoral candidates and academic personnel. Quality assurance in university research projects is crucial for upholding scientific standards. University research projects are also characterized by interdisciplinarity, as they often combine various fields of knowledge. However, the academic staff is also competing with each other for example in the form of publications or grants (Ernø-Kjølhede, 2000). This in fact cannot just lead to a conflict between the researchers but also can endanger the joint or overall goals, which were agreed upon. Therefore, promoting *teamwork and communication* is important to enable this interdisciplinary collaboration and commitment.

A distinctive feature of university research projects is their aim to create innovations. Due to this novelty of research projects, most of the processes are very insecure, which requires better control over the project by including *risk management.* This helps to deal with uncertainties and improve the project outcome (Moore & Shangrew, 2011). However, taking risks into account breakthrough innovations can be generated (Ernø-Kjølhede, 2000). Therefore, adapted risk management is necessary.

The outcomes of research projects are rather *complex* because the results are partly unpredictable and technically difficult. This makes the control of the projects quite hard (Huljenic et al., 2005). Therefore, methods for rapid requirement changes, which result from paradox results, are important to consider. Concluding, that the key factors (KF) of the organizational, scientific, and pedagogical aspects must be considered.

3.4 Criteria for University Research Projects

The identified characteristics for the management of research projects were investigated in sections 3.1 and 3.2 through a literature review, laws, standards, and guidelines, which are applicable as an example to the University of the Bundeswehr in Munich. The overall common standards were investigated through a general literature review in section 3.3.

The criteria of university research projects include hard and soft factors. Hard factors are scheduling, and planning and soft factors can be named exemplary as communication or creativity. These methodological KF have been defined as important for the management of a research project (BMVg, 2018; DFG, 2022; Ernø-Kjølhede, 2000; Huljenic et al., 2005; Moore & Shangrew, 2011; Mormann & Willjes, 2013; vom Brocke & Lippe, 2015):

- Rapid requirement changes (flexibility)
- Achieving innovations (complexity)
- Uncertain processes (risk management)
- Long- and short-term objectives (goal setting)
- Collegial interaction (flat hierarchies)
- Continuous and interdisciplinary collaboration (teamwork and communication)
- Adhering to time and within budget (project management constraints)
- Freedom in research (creativity)
- Compliance with moral and ethical standards (laws, guidelines)

Based on the mentioned criteria, just TPM methods will not make research projects more efficient, because this process is limited by sequential flow and low flexibility. TPM includes detailed planning and control (Ciric et al., 2019). Through paradox results the requirements cannot be defined completely from the start of the project (Salameh, 2014). Therefore methods for rapid requirement changes must be integrated into the process.

4. Methodology

Based on these results, APM can be useful for research projects. Therefore a literature review is conducted, which methods and approaches are currently used in research projects and how agile approaches can enhance university research projects.

The literature review was conducted using a systematic approach. Additionally, databases such as Scopus, ResearchGate, SpringerLink, and Google Scholar were consulted. The number of search results was reduced by refining the parameters currently used for research projects and/or innovation projects. The relevant literature was further narrowed down by reviewing the abstracts. During the evaluation of the collected publications, additional sources were included as needed.

5. Findings

5.1 General application of APM

The literature review revealed that most APM methods are still used by IT projects because of the incremental and adaptive character needed for software development. However some examples of agile methods can be seen in product development (Stare, 2013), educational projects (Edin Grimheden, 2013), venture projects (Dubinsky, 2009), and innovation projects (Hannola et al., 2013). Most of them mention the Scrum method. EXtreme Programming (XP) was mentioned as well, but in the context of software development (Shrivastava et al., 2021). The following section investigated insights into research and innovation projects.

5.2 APM in Research and/or Innovation Projects

Zivlak mentioned which challenges and benefits APM brings to innovation projects, that do not rely on software development. Benefits are “greater flexibility, reduced cost and schedule, reduced planning time, improvement of communication, flexibility to deal with uncertainty in innovation efforts, higher effectiveness and speech in the predevelopment stages of innovation, delivering what the customer expected, revealing deficiencies early through iteration and incremental testing, creating the project plan collaboratively with shared responsibility” (Zivlak, 2018). Furthermore, it was defined which benefits it can gain in education: “scientific research and writing with higher productivity and output quality, delivering results faster, working effectively in self-organizing small teams, greater responsibility of team members, team collaboration and responsiveness, transparency and openness, emergence and evidence-based decision making, continuous rapid feedback” (Zivlak, 2018). Hannola found that agile methods provide improvements regarding organizational practices, transfer of know-how, and understanding of the needs of the customer (Hannola et al., 2013). Still, there are some challenges, which must be considered, by implementing APM to the project. Raharjo and Purwandari define two big challenges in implementing APM: (1) company culture and (2) team capability as a lack of experience with the Agile method (Raharjo & Purwandari, 2020).

Nevertheless, there is no one-size-fits-all solution because every process and model has their advantages and disadvantages. It always depends on the complexity, organization, and size of the project, the involved stakeholders, and the experience of the team leader and members (Albrecht & Albrecht, 2021). The results will be discussed due to their applicability to university research and the identified characteristics of university research projects.

6. Framework for APM in Research Projects

6.1 Analysis of advantages and disadvantages of APM in research

Based on the KF, most methods are not suitable without adaption in a university research project. The APM can help to establish clear structures, but it also has the disadvantage that its rigid structures and fixed roles can lead to overstructuring, limiting freedom and creativity in the development process. Furthermore, this may hinder rapid adaption to changed requirements.

Many of the APM methods are just made for achieving short-term goals, which can influence the achievement of long-term goals negatively in their effectiveness. This in turn may lead the research results in a not-wanted way and lose control over the overarching goals. This leads to a lack of foresight when assessing goals that can be achieved primarily in the short-term and the associated risk management. Therefore, evaluations must also be integrated, which can demonstrate impacts on the overall goals.

Many APM methods promote flat hierarchies, which is important for effective and transparent communication among researchers. The flat hierarchies can promote communication with the project manager/leader and collaboration with the stakeholders and clients. As stated in section 3.3 academic personnel are often not trained in methods, which can hinder compliance with APM and extend the methodological introduction.

Through regular retrospectives, continuous improvement can be implemented. Regular team meetings can enhance collaboration and communication in the development process. Since research often suffers from resource constraints, the specific roles require significant resources. Moreover, e.g. Scrum is mostly designed for small teams, limiting project size. However, iterative and incremental processes improve intermediate goals and increase flexibility. This impacts positively risk management through the flexible goal definition and reduces short feedback loop costs and time delays.

Because of the innovation potential, that university research projects want to achieve, most of the research questions rely on the hypothesis of the academic personnel. E.g. the lean start-up method could gain some advantages by formulating hypotheses, which can be evaluated in a short time. This can integrate the scientific personnel better into the project processes. Still, the value to society must be generated for applied research. Therefore, a target group must be investigated at the beginning of the project. Due to the documentation of collaborative work, knowledge exchange can be improved.

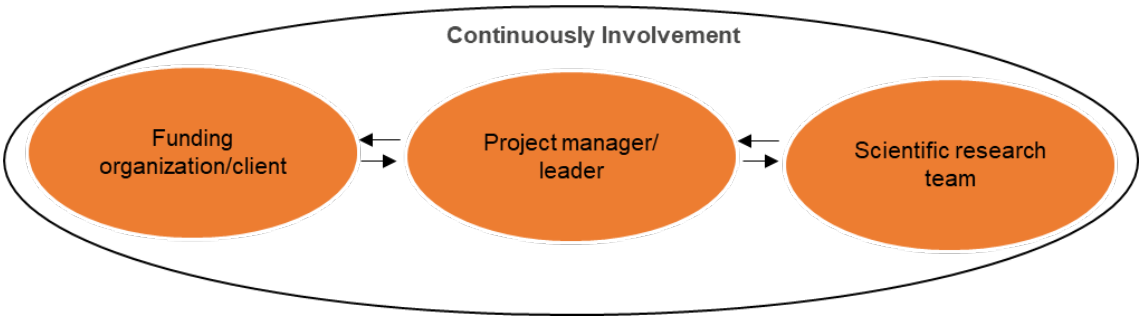
Kanban Boards may help to gain a short-term overview of the actual doing and make the processes more transparent. Considering the advantages and disadvantages, a model for scientific-orientated project management in research is shown. This shall promote comprehensive project management in research projects.

6.2 Structure

The target deviation and risks are the highest in the technical development process, which can lead to paradoxical results. This, in turn, significantly impacts the budget and schedule to be achieved. Therefore, the focus is on the research team. The established framework should promote flat hierarchies between researchers. This means that a collegial approach is taken into account. The project manager serves to promote communication between the project teams and to live the methodology. To continuously keep reporting to the funding organization, short paths should be guaranteed. This in turn involves the client or funding organization better, can avoid information asymmetry, and reduces risks. External and internal stakeholders shall be considered. This is to ensure that conflicts of interest are avoided.

Depending on the size of the project a steering committee can be helpful to promote decision-making and several project teams can be built. In Figure 1 the basic structure which shall be considered is shown.

Figure 1: basic structure of roles



6.3 Procedure scientific-orientated project management

In this section, the different APM approaches are combined to enhance the processes in the projects of university research projects. The advantages of Kanban, Scrum, Design Thinking and lean startup are incorporated. In the initial phase of the project, overarching goals and the corresponding objectives are roughly formulated. Literature reviews or formulation of research questions can promote the identification and definition of goals. Limitations of the research work shall be considered as well. For applied research, the target audience should be integrated into the goal setting. Additionally, Design Thinking workshops can be conducted to identify potential users and create creative ideas, which is relevant to create innovations. This ensures the maximum output and reduces complexity. The criteria for the overall goal achievement and requirements are roughly defined to promote an adaptive approach and flexibility in the processes.

In the planning phase, the cost planning and schedule are established. Workshops shall support the budget, time, milestone planning, risk management, and methodical approach. This ensures collaborative establishment and enhances commitment. Furthermore, training should be made to provide a better understanding of the methodologies to all stakeholders. The Plan-Do-Check-Act-cycle (PDCA) gets integrated to improve the process through this quality management method (Isniah et al., 2020). In the executing process, different methods can be used to illustrate an APM for university research projects.

The product backlog is established, based on the requirements. These requirements will be divided into user stories or concrete tasks, which are provided with acceptance criteria. The tasks get prioritized. Then the moral and ethical standards are considered.

Then the scientific research questions are considered. These should be verifiable through hypotheses and interim goals. Risk awareness and control strategies to minimize risk shall be integrated. The hypotheses can be built according to the lean startup principle. For the problem identification, the 5W method can be used. To break down the hypotheses and the associated work into small incremental steps, they are tested monthly, for example. The goals of the hypotheses are also integrated into the respective sprints. Progress is represented as a control element on a Kanban board. Through visualization, the process flow and the overview can be improved. In addition to agile methods, forecasts can also help make uncertain processes more predictable. Forecasts can be made through stochastic approaches (1. Plan).

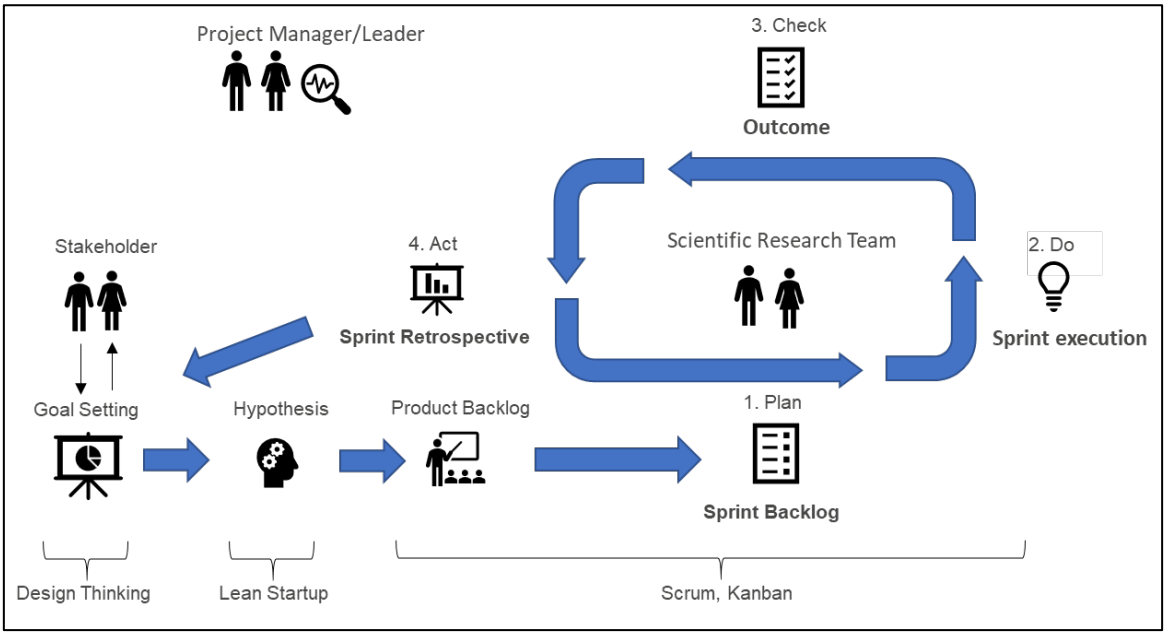
In the next step, the sprint is executed. Weekly meetings are held to strengthen communication. This, in turn, has a positive impact on collaboration, and short-term goal

achievement can be checked for advanced control. Daily stand-ups are omitted because freedom in approach should be granted (2. Do).

In the third step, the sprint is completed, and the output is evaluated and reviewed. This mainly addresses the implications of paradoxical results, which require adaptation of goal achievement. In addition, the time and budget plan can be checked by defining milestones and interim outcomes (3. Check).

In the final step, feedback is collected, favoring the continuous improvement process and evaluating progress through the sprint retrospective (4. Act). The basic structure is Illustrated in Figure 2.

Figure 2: Agile Approach to University Research Projects



7. Conclusion

Resulting in, that most of the project management methods are not suitable for research projects, because the adaption to paradox results is not adaptive enough. Some agile approaches add value to enhance the project management process in research. Adapting and combining APM methods to research projects, which concentrate on scientific personnel and research questions, improves the efficiency and control to be on time and within budget. This is important to face the challenges, which research projects are dealing with and maximize the research outcome. Adaptive methods can enhance teamwork, collaboration, flat hierarchies, and short-term goals, flexibility, and collegial interaction. However, methods can be as good as they are if they do not receive a commitment from those involved.
The scientific-orientated framework enhances APM in university research projects and puts the focus on the scientific personnel to improve control and adaptability. Still, the scientific-orientated framework must be further developed by developing a new method that can integrate adapted risk management to university research projects, and enhance the compliance of short-term into the long-term goal visions. Predictive methods due to the high uncertainty of the future shall be integrated. Therefore, the framework will be further tested and continuously improved in the future.

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Communication aligned with the Sustainable Development Goals