Co-funded by the Horizon 2020
Framework Programme of the European Union

H2020-WIDESPREAD-2018-01

Project:

Sano

Centre for New Methods in Computational Diagnostics and Personalised Therapy

Deliverable number and title:

D2.6 Research and Development evaluation review report

Lead Beneficiary	Sano
WP number and title	WP2
Dissemination level	Public
Delivery date	30.11.2025
Type	Report

Short description:

The final evaluation of R&D activities and results of the Centre, with recommendations towards sustainability.

Authors list:

Leading Author		
Name and Surname	Beneficiary	Contact e-mail
Anna Dziduszko	Sano	a.dziduszko@sanoscience.org
Tomasz Gubała	Sano	t.gubala@sanoscience.org
Dominik Czaplicki	Sano	d.czaplicki@sanoscience.org
Katarzyna Baliga-Nicholson	Sano	k.nicholson@sanoscience.org
Maciej Malawski	Sano	m.malawski@sanoscience.org
Maria Sendecka	Sano	m.sendecka@sanoscience.org
Piotr Nowakowski	Sano	p.nowakowski@sanoscience.org
Katarzyna Kolasa	Sano	k.kolasa@sanoscience.org
Dominik Stosik	Sano	d.stosik@sanoscience.org
Magdalena Chrzanowska	Sano	m.chrzanowska@sanoscience.org

Version log			
Issue date	Version	Author	Change description
18.11.2025	First Full Draft	Sano	
26.11.2025	Internal review report	FZJ	
29.11.2025	Final Version	Sano	

Table of Contents

Table of Contents 3
1 Introduction 4
2 Research and development achievements of Sano 4
2.1 Research Excellence 4
2.1.1 Key Performance Indicators (KPIs) 4
2.1.2 Summary of publications 5
2.1.3 Grants 6
2.2 Business development excellence 12
3 Evaluation 14
3.1 Periodic evaluation of Sano's researchers' performance 14
3.2 Periodic review and update of Sano Research Agenda 16
3.3 Evaluation of the IRAP Project by the Foundation for Polish Science 18
3.4 EC recommendations after #4 Review and proposed solutions 18
4 Recommendations towards sustainability 26
4.1 General recommendations 26
4.2 Digital Health Solutions 26
4.2.1 Neuro-Oncology and Digital Pathology 27
4.2.2 Acute Stroke and Rehabilitation 28
4.2.3 Medical Imaging Methodology and Quality 30
4.3 Scientific recommendations 31
4.4 Technical recommendations 32
5 Conclusion 34

1 Introduction

The following document constitutes a holistic summarisation of broad evaluation of Sano's Research and Development efforts, through coalesced reviews and evaluations coming from different sources, personal and institutional, which Sano received in recent months, including:

- Institutional reviews coming from Sano's own governance system (Management Board, Foundation Council, International Scientific Committee) and its closest advisory sources (translational, entrepreneurial and clinical experts);
- Self-evaluation that is continuously the subject of several experts working inside the structure of Sano: Management Board, senior scientists who also work in advisory roles (incl. visiting researchers), and experts of the Sano Development Department;
- External formal evaluations that are attached to Sano chief founding streams: the reviewers of the European Commission, the Foundation for Polish Science, and the Polish Ministry of Science and Higher Education;
- External evaluations of particular elements (outputs) of Sano R&D efforts, according to adequate processes: peer review of publications, grant submissions, award recognitions, and similar.

In this document we undertake the threefold exercise. First, we present the current level of achievements and outputs of Sano research and development efforts. Against this background we present the most relevant and prevalent evaluation remarks extracted from those various formal and informal sources of feedback, followed by the list of recommendations for the sustainable future of Sano, combined and curated from the same sources. The recommendations related to research were consulted with Sano's International Scientific Committee, which, according to Sano Statute, holds a high authority regarding Sano's R&D directions and strategy. As a key element of the narrative we present the new Sano Research Agenda, for years 2025-2028, as co-created by all Sano employees, according to the recommendations of the ISC, and approved by the Management Board for implementation.

2 Research and development achievements of Sano

2.1 Research Excellence

2.1.1 Key Performance Indicators (KPIs)

The project indicators are measured over different time intervals, as the significant impact of medical innovations becomes measurable only after the completion of relevant projects—following a long and complex development process. One of the key direct outcomes of Sano's activities is the generation of new knowledge, which is evaluated through both output indicators (such as publications and patents) and impact indicators (including citations and revenue).

Within the Scientific Excellence dimension—highly important and essential for researchers' activities—Sano has made significant progress.

The table below presents the extent of project KPI achievement within the Scientific Excellence dimension:

Dimension	KPI description	Target for M72 2025-07	Current value M76	Target for M120 2029-07
Scientific Excellence	Total no. of publications	120	**181**	240
	Publications describing application of the methodology	70	**99**	140
	Publications describing new methods and techniques	15	**78**	40
	Articles in peer reviewed journals	90	**169**	180
	Number of citations of articles	800	**1296**	2000
	Co-publications with national and foreign partners	60	**100**	120
	EU and other international research grants acquired	10	**6**	16
	Regional/national grants for scientific activities, development and application of Sano's products with other Polish partners	3	**9**	6

Table 1 Project KPI achievements.

2.1.2 Summary of publications

By the end of November 2025, the total number of articles published in journals reached 95. In addition, Sano's output includes 70 publications in peer-reviewed conference proceedings — particularly important in the field of computer science — presented at major international conferences such as MICCAI, SC (Supercomputing), IROS, ISMAR, and ICCS (see sec. 2.1.1.1).

The table and chart below present the number of journal and conference publications, broken down by research teams and by the years of Sano's operation.

Research Team	2019 – 2024	2025	Total
Medical Imaging and Robotics	38	5	43
Computational Neuroscience	30	7	37
Computational Intelligence	15	4	19
Structural and Functional Genomics	5	6	11
Extreme-Scale Data and Computing	23	8	31
Scientific programmers	6	6	12
Senior Researchers	11	1	12
Other	15	1	16
Total	143	38	181

Table 2 Publications.

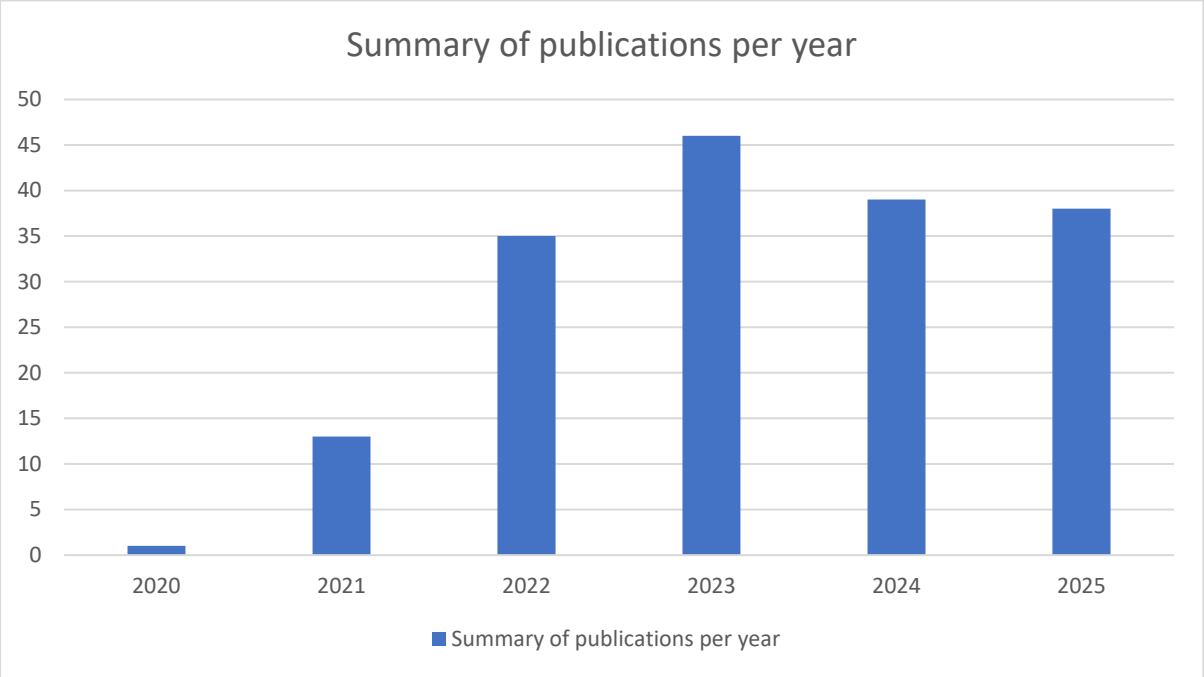

Figure 1 Publications.

2.1.3 Grants

Sano regularly searches for the most promising grant calls in its field and supports its scientists in submitting grant applications to both national and international funding agencies. This effort is coordinated by a full-time specialist within the Centre.

In September 2025, the Grant Office was established as a separate unit within Sano, led by Ewelina Szymańska-Skolimowska PhD. Its creation is expected to improve Sano's success rate in competitive grant calls. Previously, fundraising activities were part of the Business and Development team. The primary goal of the Grant Office is to secure and obtain new funding from competitive funding opportunities.

Period	Number of proposals				
	Submitted			Funded	Under Evaluation
	International	Polish	Total		
2019-2021	7	2	9	1 (11%)	-
2022	10	4	14	1 (7%)	-
2023	9	15	24	4 (16%)	-
2024	15	15	30	4 (13%)	-
2025	18	20	38	5/24 (20%)*	14

Table 3. The rate of submission and the percentage of acceptance for Sano proposals throughout the periods of time since the establishment. (*) The 2025 success rate computed as a percentage of the proposals that were already evaluated (failed or approved).

When evaluating the performance of Sano's activities targeted at acquisition of new R&D grants (Table 3), the steady increase of the number of proposals submitted can be seen. The acceptance rate is fluctuating but, in general, improved in comparison to earlier periods (up to and including 2022).

During its existence, Sano has acquired seven new projects from the National Science Centre, two projects funded by the Foundation for Polish Science (FNP), not including the IRAP POIR project (2019-

2023), which served as a part of Sano's national complementary funding. We have also obtained six projects financed from European funds, not including the Teaming for Excellence project.

Research and development projects carried out, or guaranteed to be funded in the future, at Sano					
Project name	***Project number***	***Project Leader***	***Duration***	***Obtained funding***	***Comments***
Funded nationally (National Science Centre, Foundation for Polish Science)					
IRAP	MAB PLUS/2019/13	Maciej Malawski *(Director)*	2019 - 2023	35 000 000 PLN	
PRELUDIUM	2023/49/N/ST6/01841	Michał Grzeszczyk *(Medical Imaging and Robotics)*	2024 – 2027	170 160 PLN	
PRELUDIUM	2023/49/N/ST6/04252	Magdalena Otta *(Extreme-scale Data and Computing)*	2024 – 2025	69 950 PLN	
SONATA	2023/51/D/NZ7/02596	Barbara Pucelik *(Structural and Functional Genomics)*	2024 – 2027	330 620 PLN	
WEAVE	2023/05/Y/NZ2/00080	Tomasz Kościółek *(Structural and Functional Genomics)*	2024 - 2027	2 395 726 PLN	International bilateral cooperation with a team from Switzerland
PRELUDIUM	2024/53/N/NZ4/03513	Joan Roget Falco (Computational Neuroscience)	2025 – 2027	139 650 PLN	
SONATA	2024/55/D/NZ5/02998	Cemal Koba (Computational Neuroscience)	2025 2027	568 520 PLN	
SONATA	2024/55/D/ST6/02081	Marek Wodziński	2025 2028	1 246 840 PLN	
Prime	PRIME 02.06-0153/25	Magdalena Otta Katarzyna Baliga-Nicholson Dominik Czaplicki	2025 2026	69 849 PLN	
First Team	FENG.02.02-IP.05-0158/25	Tomasz Kościółek	2026-2029	3 980 000 PLN	
PRELUDIUM		Monika Pytlarz	2026	69 997 PLN	
Funded internationally (European framework programmes)					
Teaming for Excellence	Horizon2020 ID: 857533	Maciej Malawski *(Director)*	2019 2026	8 961 955 EUR	Consortium: PL, UK, DE
InSilicoWorld ISW	Horizon2020 ID: 101016503	Marian Bubak *(Scientific Affairs Director)*	2021 2024	356 250 EUR	Consortium: IT, PL, NL, BE, HU, DE

Research and development projects carried out, or guaranteed to be funded in the future, at Sano					
Project name	*Project number*	*Project Leader*	*Duration*	*Obtained funding*	*Comments*
NearData	HorizonEurope ID: 101092644	Maciej Malawski *(Extreme-scale Data and Computing)*	2023 2025	320 625 EUR	Consortium: ES, PL, DE, IE, UK
GEMINI	HorizonEurope ID: 101136438	Marian Bubak *(Scientific Affairs Director)*	2023 2029	532 500 EUR	Consortium: NL, PL, IT, IE, HU, FR, DE, CH, TW
ThromboRisk	HORIZON-MSCA 101227706	Maciej Malawski *(Extreme-scale Data and Computing)*	2026 2030	502 301 EUR	Consortium: NL, PL, BE, DE, UK, RO, CH
Gaia AI	EuroHPC JU/Poland (AI Factories)	Maciej Malawski *(Extreme-scale Data and Computing)*	2026 2029	750 000 EUR	Polish consortium coordinated by Cyfronet
CEREBRIS	EIC Pathfinder 101257536	Maciej Malawski *(Extreme-scale Data and Computing)* Katarzyna Baliga Nicholson (Head of Innovation and Communication)	2026 2029	351 662 EUR	Consortium: IE, PL, UK, NO, PT, BE, DE, CH, GR, ES, AT.

Table 4. Sano R&D Grants: finished, under implementation, and to be started.

2.1.3.1 Conferences

Sano has established a strong and growing international presence through active participation in the world's leading conferences in computational medicine, artificial intelligence, medical imaging, bioinformatics, robotics, and high-performance computing. Over the evaluation period, Sano researchers presented their work across Europe, North America, and Asia at 168 conferences, reinforcing the Centre's role as a prominent contributor to global scientific discourse.

Sano research teams have demonstrated scientific competitiveness through repeated acceptance to the top-tier conferences in their respective domains, including:

- MICCAI – the world's premier conference for medical image computing and computer-assisted interventions
- ICCS – a flagship venue for high-impact computational science
- VPH – the central forum for Virtual Physiological Human and in silico medicine research
- Supercomputing (SC) – the global benchmark event for high-performance computing
- IROS – a leading international conference in intelligent robotics and systems

Acceptance to these highly selective venues is a clear indicator of scientific excellence, methodological rigor, and international relevance. Sano's repeated presence at such events confirms the quality,

originality, and credibility of its research outputs and strengthens the Centre's position in the global scientific landscape.

Impact of contributions:

Across these events, Sano teams delivered impactful oral presentations, posters, demonstrations, and invited contributions, covering a broad spectrum of research areas including:

- Personalised computational medicine and digital twin technologies
- Haemodynamic and vascular modelling, including DVT and venous flow simulations
- State-of-the-art AI architectures for biomedical imaging and prediction
- Genomics, network biology, and explainable bioactivity prediction
- Neuroscience research from the synaptome to the whole-brain connectome
- Protein stability prediction and transfer learning methods
- VR-based surgical simulation technologies
- Large-scale cloud–HPC performance optimisation
- Real-world clinical decision support systems implemented in hospital settings

This multidisciplinary portfolio reflects Sano's ability to deliver advanced, clinically relevant, and technologically advanced solutions aligned with current and future needs in digital health and computational medicine.

Strategic value for sustainability:

Sano's strong international visibility is a critical enabler of sustainability. Engagement with top-tier global conferences:

- Enhances the Centre's scientific reputation,
- Increases competitiveness in securing international grants and consortia participation,
- Expands opportunities for industry partnerships and technology translation,
- Supports talent acquisition and retention,
- Ensures continuous integration with global developments in computational medicine.

Maintaining and further strengthening this global presence remains a strategic priority for the long-term sustainability and impact of the Centre.

Below is a table with examples of the most significant conferences at which Sano researchers gave presentations:

No.	The name of the conference	Sano representative	Country	Year	Title of the presentation
1.	VPH	Marian Bubak	online	2020	Sano Centre – towards an innovative research program in computational medicine'
2.	ICCS	Marian Bubak	Poland	2021	Towards Personalised Computational Medicine – Sano Centre Perspective
3.	MICCAI	Szymon Płotka	Singapore	2022	BabyNet: Residual Transformer Module for Birth Weight Prediction on Fetal Ultrasound Video
4.	ICCS	Magdalena Otta	UK	2022	Sensitivity analysis of a model of lower limb haemodynamics.
5.	SC (Super-computing)	Maciej Malawski	USA	2022	Using Unused: Non-Invasive Dynamic FaaS Infrastructure with HPC-Whisk
6.	VPH	Jose Sousa, Magdalena Otta, Michał Grzeszczyk, Maciej Malawski	Portugal	2022	• Machine self-semantic learning of cancer disease: a case study on brain tumor early progression. • Local flow analysis in the iliac vein bifurcation informed by a 0D model of the lower limb haemodynamics • Poster: Social Behaviour as a Profiler of Dementia: Exploratory Self-Learning Computational Intelligence on ELSAData • Predicting miRNA-mRNA targets with graph neural networks
7.	IROS	Przemysław Korzeniowski	Japan	2022	Virtual Reality Simulator for Fetoscopic Spina Bifida Repair Surgery
8.	MICCAI	M. Grzeszczyk, S. Malec, J. Kaleta, S. Płotka	Canada	2023	TabAttention: Learning Attention Conditionally on Tabular Data
9.	MICCAI	Michał Grzeszczyk	Marocco	2024	Presentations and posters: • TabMixer: Noninvasive Estimation of the Mean Pulmonary Artery Pressure via Imaging and Tabular Data Mixing • Let Me DeCode You - Decoder Conditioning with Tabular Data
10.	ICCS	Alessando Crimi, Karolina Tlałka, Adam Sułek, Jakub Klimczak,	Spain	2024	Presentations and posters: • Fact-Checking Generative AI: Ontology-Driven Biological Graphs for Disease-Gene Link Verification • Local sensitivity analysis of a closed-loop in silico model of the human baroregulation. • EsmTemp - Transfer Learning Approach for Predicting Protein Thermostability

No.	The name of the conference	Sano representative	Country	Year	Title of the presentation
					• Stylometric Analysis of Large Language Model-Generated Commentaries in the context of Medical Neuroscience
11.	ICCS	Wiesław Nowiński, Piotr Kica, Magdalena Otta, Jakub Klimczak	Singapore	2025	Presentations and posters: • From the synaptome to the connectome: data bigness estimation for the human connectome at the nanoscale • Accelerating Cloud-Based Transcriptomics: Performance Analysis and Optimization of the STAR Aligner Workflow • Towards sensitivity analysis: 3D venous modelling in the lower limb • Explainable Artificial Intelligence for Bioactivity Prediction: Unveiling the Challenges with Curated CDK2/4/6 Breast Cancer Dataset
12.	MICCAI	Joanna Kaleta, Tomasz Szczepański, Michał Grzeszczyk, Jan Fiszer, Magdalena Otta	South Korea	2025	Presentations and posters: • Machine Learning-Based Decision Support for Allergy Diagnosis: Real-World Implementation in a Hospital Setting • GEPAR3D: Geometry Prior-Assisted Learning for 3D Tooth Segmentation • RegScore: Scoring Systems for Regression Tasks • Shape vs flow: a 2D statistical shape analysis of the projection of common iliac veins in patients with deep vein thrombosis
13.	IROS	Przemysław Korzeniowski, Michał Naskręt, Sabina Martyniak	China	2025	Presentations and posters: • Virtual Reality Simulator for Fetoscopic Spina Bifida Repair Surgery • FF-SRL Meets Isaac Lab: Equipping Standardized Robotic RL with Surgical-Grade Simulation Tools • SimuScope: Realistic Endoscopic Synthetic Dataset Generation through Surgical Simulation and Diffusion Models/VitreoRet-SD: Realistic Synthetic Dataset Generation for Vitreoretinal Surgery via Diffusion Models
14.	IEEE CCGrid 2025	Piotr Kica	Norway	2025	Serverless Approach to Running Resource-Intensive STAR Aligner (bioinformatics software)

No.	The name of the conference	Sano representative	Country	Year	Title of the presentation
15.	ISMB/ ECCB	Paweł Szczerbiak Tomasz Kościółek Filip Schymik	UK	2025	Mapping protein structure space to function: towards better structure-based function prediction

Table 5. Notable conferences.

2.2 Business development excellence

Business development activities has played an increasingly integrated role in supporting the Centre's research and innovation agenda. The focus remains on strengthening translation pathways, fostering clinical collaboration, and building internal capacity for early-stage innovation support, all of which contribute directly to the long-term relevance and sustainability of Sano's R&D efforts.

A key milestone was the completion and dissemination of an updated Business Development Strategy, developed through a collaborative process with researchers, clinicians, and operational teams. The strategy now serves as a cross-cutting framework that aligns commercialisation planning with the Centre's research priorities and enhances support structures around clinical engagement, product development, and entrepreneurial training.

As part of its early implementation, we revised the internal Standard Operating Procedure (SoP) RD-01 on Intellectual Property and Commercialisation, providing clearer internal guidance on managing innovation, assessing commercial potential, and preparing for future technology transfer. While a procedural step, it reflects the Centre's growing operational maturity in supporting innovation pipelines.

Business development also contributed to the identification and early development of a product portfolio, with the following three projects currently in incubation:

1. CFD-Based Digital Twin Platform for Blood Flow

A general simulation platform that uses Computational Fluid Dynamics (CFD) and Digital Twin concepts to model patient-specific blood flow in different parts of the vascular system. From standard medical imaging and clinical data, it creates virtual replicas of individual patients to support risk assessment, treatment planning, and outcome prediction. Currently we are working on two use cases for the platform:

1a. *GIRAFlow – Venous DVT Decision-Support Tool*

A specialised DT-based CFD application focused on deep vein thrombosis (DVT). It builds a personalised model of a patient's venous system to compute haemodynamic metrics and thrombosis risk indicators. These insights help vascular specialists compare treatment options (e.g. stenting strategies) and choose the optimal approach for each patient.

1b. *CFD Module for Cardiac and Arterial Diseases*

A dedicated CFD component for simulating blood flow in the heart and arterial system (e.g. coronary arteries). Using patient-specific anatomy, it estimates haemodynamic factors associated with disease progression—such as regions prone to plaque formation, stenosis progression, or aneurysm growth. The goal is to stratify patients by their future risk of developing cardiovascular conditions, prioritise follow-up and preventive therapies, and support earlier, more targeted intervention before critical events occur.

2. NEED – Neuromonitoring EEG for Early Detection of Dementia

A portable EEG and machine-learning system that delivers an objective, automated assessment of early cognitive impairment. A short stimulation protocol generates EEG biomarkers that are analysed by a proprietary algorithm, producing an interpretable report with prediction and confidence scores to support GPs and specialists in faster, more accurate referrals.

3. Angiography Simulator

A combined hardware–software simulator for training interventional specialists in catheter manipulation. A physical tracker box connected to a tablet runs realistic simulations of different patient anatomies, catheter shapes, and access routes. Initially focused on coronary angiography, it is designed to expand to angioplasty, stenting, electrophysiology, neurovascular, and peripheral vascular procedures.

Each has received structured support in validation, user feedback, and preliminary business planning. These early efforts reflect a broader shift across the Centre to support projects with potential real-world application and foster research impact beyond publication.

Entrepreneurship development was further supported through the Sanbox – Entrepreneurial Activation Program, which continues to provide a structured pathway for researchers interested in translating ideas into ventures. Two projects (GIRAFlow and NEED) completed the program and progressed to external acceleration opportunities, while other two (Angiography Simulator and tracking recovery tool in stroke) are engaged in prototyping and user validation. This initiative has helped build a stronger foundation for entrepreneurial thinking within the scientific community at Sano.

Stronger clinical collaboration also marked a positive development: Two collaborative grants with the Uniwersytecki Dziecięcy Szpital Kliniczny im. L. Zamenhofa in Białystok were submitted to the Medical Research Agency (ABM), and are currently under evaluation, in the area of rare peadiatric diseases, reinforcing our capacity to co-develop solutions in clinical environments and building trust with healthcare partners. Participation in such national-level programmes positions Sano more firmly within translational and applied research communities.

To support these evolving activities, the Business Development team expanded to include two new advisory roles:

- A Senior Advisor for Global Deployment of Safe and Effective Medtech, contributing expertise in regulatory strategy and international market adoption.
- A Clinical Advisor for AI & Digital Health Solutions, ensuring that innovation projects remain aligned with real-world clinical needs.

In parallel, communication and outreach activities were initiated to support visibility. The launch of the Sano Innovations Web provided a dedicated space to showcase translational projects and service offerings. Work also began on refining brand communication, content strategy, and stakeholder materials to better represent Sano's mission externally. These actions remain in development but reflect a long-term commitment to increasing the Centre's visibility and engagement with external partners.

Overall, business development efforts in contributed to the Centre's ability to link research with real-world application, increase institutional readiness for translation, and enhance connections with clinical and industry stakeholders. These are essential elements in building a sustainable research ecosystem that balances scientific excellence with practical relevance.

3 Evaluation

3.1 Periodic evaluation of Sano's researchers' performance

As designed in Sano Statute, the foundation's main governance document, a periodic evaluation of Sano's researchers' performance, and the impact of their scientific output, is conducted by the International Scientific Committee. This was first conducted in 2024, after first four full years of the implementation of the Sano Research Agenda, and the detailed report of the result of that evaluation was presented in *D2.5 Research Teams Evaluation Review Report* (01.2025). Summarising, the evaluation proposed **29** recommendations, which were grouped into **25** action strands, to which **71** action items were described, assigned to four status groups:

Activity executed between the evaluation outcome and the D2.5 due date.	29
Activity ongoing at the time of writing the D2.5.	26
Activity planned in the future.	13
Further justifications where Sano selected to not fully implement a recommendation.	3
Total	71

Table 6. The quantitative summary of the status of completion of the 71 action items proposed in the wake of the Teams and Leaders evaluation, as reported in D2.5 (01.2025).

Following the receipt of the recommendations from the ISC (International Scientific Committee), Sano and its partners undertook a set of measures aimed at enhancing both the operational and scientific capacities of the organisation.

The section below provides a concise overview of the key areas of progress achieved within one year of receiving the recommendations.

1. Collaboration and Synergy Between Teams

In response to the recommendation regarding insufficient collaboration and synergy across teams, Sano has increased the number of joint projects and publications:

- HORIZON-HLTH-2025-01-TOOL-03 (Extreme-Scale Data and Computing + Computational Intelligence)
- HORIZON-HLTH-2025-01-TOOL-03 (Extreme-Scale Data and Computing + Computational Intelligence + Scientific Programmers Team)

- HORIZON-HLTH-2025-01-CARE-01 (Extreme-Scale Data and Computing + Medical Imaging and Robotics)
- HORIZON-INFRA-2025-01-TECH-04 (Extreme-Scale Data and Computing + Computational Neuroscience)
- HORIZON-CL4-2025-04-DATA-02 (Extreme-Scale Data and Computing + Structural and Functional Genomics)
- HORIZON-CL4-2025-04-DATA-02 (Extreme-Scale Data and Computing + Computational Neuroscience)
- ABM/2025/2 (Extreme-Scale Data and Computing + Innovations and Communication + Scientific Programmers Team)
- I3-2025-INV1 (Extreme-Scale Data and Computing + Scientific Programmers Team)

One example of newly initiated cross-team collaboration in the area of entrepreneurship includes:

- Two PhD students (Rosmary Blanco and Luca Gherardini) have commenced work on establishing a spin-off company, based on research conducted at Sano (see the NEED tool in Section 2.2).

The new Research Agenda for 2025-2028 also emphasises the synergy between teams, by proposing a comprehensive plan for development of a Digital Twin Platform, where all teams contribute to development of models and tools that can be used to address various aspects of computational medicine. The research agenda was also a basis for a large 30M PLN IRAP FENG proposal submitted to the Foundation for Polish Science in 2025 (under evaluation).

2. Financial Sustainability and Grants

Securing external funding and ensuring financial stability were identified by reviewers as critical needs. Several actions and developments have taken place in 2025.

Sano has introduced the new Head of Grant Office position, and thus allocated more effort within the Support and Development Department to direct assistance in proposal writing to Sano researchers. Among others, this has resulted in an increase of the submission rate of Sano proposals, and proposals in which Sano participates as a consortium member (Table 3).

During 2025 eight grant proposals were awarded with a total funding of approx. €2.5 million as detailed in Table 4. Fourteen proposals, worth approximately €15.6 million, are still under evaluation which will further affect the final success rate (which currently stands at 20% for all 2025 proposals that were already evaluated). These contributes to strengthening Sano's financial position and support progress towards its financial sustainability targets.

3. Institute Positioning and Long-term Funding

Sano continues actions to strengthen its institutional positioning and secure long-term financial stability, including efforts to access statutory governmental funding.

- Sano is a member of the Polish Teaming Club and is scheduled to host a joint meeting of all Polish Teaming Centres in 2026.

- Sano leads the effort implement the legal changes in Poland to provide statutory funding for the Teaming Centres of Excellence in Poland, in dialogue with the Ministry of Science and Higher education and other centres.

- Sano has now progressed to the official partner of the Avicenna Alliance (https://www.avicenna-alliance.com/partners.html) which advocates deployment of computer modelling and simulation solutions to medtech testing and clinical trials.

- Dr Maciej Malawski, Sano's Director, was invited to join the Board of Directors of the VPH Institute (Sano is already a regular institutional member of this organisation, the only one from Poland).

4. Progress of the Computer Vision / Computational Neuroscience Team (Jan Argasiński)

The team was encouraged to increase productivity and expand external funding. The following progress has been made:

- The NCN Weave-Unisono proposal has been submitted (October/November 2025).
- Two patent applications—one related to EEG-based stroke detection (Rosmary Blanco), and another concerning tools and techniques for post-stroke rehabilitation (Cemal Koba)—are expected to be submitted by the end of 2025.

5. Progress of the Health Informatics Team (Przemysław Korzeniowski)

The team is exploring innovative organisational models, such as surgical planning services and the establishment of a joint laboratory within a hospital setting. It is also pursuing the development of VR-based preoperative planning software.

- For this software—whose deployment requires medical certification—the work is underway on preparing a patent application.

In numbers, the progress is the following:

	01.2025	11.2025
Completed	29	29
Ongoing	26	30
Planned	13	9
Not planned	3	3
Total	71	71

Table 7 Comparison of the status of completion of the 71 action items listed in D2.5, proposed as the response to the internal, statutory Teams and Leaders evaluation, between the D2.5 report submission (01.2025) and now (11.2025).

Overall, the analysis indicates that well over 50% of the ISC recommendations have been either fully completed or are currently in progress. This demonstrates that Sano is actively implementing the recommendations and continuously upgrading its operational and scientific processes in line with the Committee's guidance.

3.2 Periodic review and update of Sano Research Agenda

Apart from the periodic evaluation of research teams and research leaders, Sano also conducts another fundamental review process: a periodic review and update to its Research Agenda. This process was conducted in later part of 2024 and early 2025 for the first time in Sano's existence. The actors directly taking a role in the process were:

- International Scientific Committee (ISC) as the chief creative force behind the reflection on the current state of affairs and input to the update [Sano Statute, 12.2.4];
- Research Team Leaders, Senior Researchers, the Director for Scientific Affairs and the Director of Sano, who represent the personnel responsible for implementation of the Agenda, and as such crucial in forming any adjustment to this foundational document;
- Support and Development department, represented in this process by General Manager, Heads of Innovations and Partnerships, and Legal Counsel, as individuals who are instrumental

to the success of any element of the Agenda which pertains to the development and translation of knowledge, know-how and technologies;
- Advanced Partners, who play key role as active support of the implementation of the current, and then future, Agenda, and as such have valuable insight as to the elements of the update which are related to their area of expertise and support;
- Management Board, who overlooks and facilitates this entire process.

Apart from direct influence of these stakeholders, the new Agenda was also inspired by recommendations and critique, over the years, coming from external opinion sources: domestic (FNP FENG) and European (Teaming) reviewers, and experts of Sano's Healthcare and Clinical Expert Pool (HCEP), Sano Box incubator mentors, and Sano Translational Advisory Board.

The process itself took several steps, and involved co-authoring live documents, and on-site and hybrid meetings:

- Step 1. Initial Reflection by the International Scientific Committee
- Step 2. Structured Discussions of the Key Changes
- Step 3. Creation of the Updated Research Agenda
- Step 4. Iterative Process of Refining the Updated Research Agenda
- Step 5. Introduction of the Updated Research Agenda as the new Research Agenda of Sano

The result of this thorough, multi-faceted process (which included analysis of both internal and external factors) was the creation of the refreshed, updated Sano Research Agenda 2025-2028, which is now put in place and being implemented (the full text is available at the following link: https://sano.science/sano-e-books/).

The most notable changes that characterise the new Agenda 2025-2028 in comparison with the former version, are the following:

1. Reformulation of the strategic theme in alignment with the Virtual Human Twin initiative, a consequence of both high-level recommendations, and the direct involvement of ACC Cyfronet AGH in EC's roadmap-defining EDITH initiative.
2. Inclusion of explicit reconciliation of two streams of technologies, coming from the artificial intelligence stem, and that from the mechanistic modelling stem, formulated in a coherent strategy to align them together on a single health tech pathway, for combination of respective strengths of these approaches, and neutralisation of shortcomings.
3. Establishment of a more explicit anchor for all Sano projects and technologies, in the form of the Sano Digital Twin Platform.
4. Proposed focus on the selected clinical domains, including cardiovascular, neurological and gastrointestinal health and disorders, as well as the interactions between these domains, in line with the gut-brain-heart axis.
5. In response to recommendations voiced by both national (FNP) and European (EC) reviewers, calling for a stronger inclusion of the computational genomics research strand, a new, fully formed research team led by Dr Tomasz Kościółek.
6. Adjustment of research focus of three other Sano research teams, from more broad, exploratory areas of interest, into more focused directions best reflecting respective team's strengths:
    a. Health Informatics -> Medical Imaging and Robotics
    b. Personal Health -> Computational Intelligence

c. Computer Vision -> Computational Neuroscience

7. Due to competences accumulated in years 2019-2024, the new Agenda is much stronger established in the environment, both local and international, with more pronounced links to academia, clinics and industry.
8. The translation path is now clearer, with deeper structure in terms of personnel and processes.

Again, this new Sano Research Agenda will undergo another review and update process in a four-years' time.

3.3 Evaluation of the IRAP Project by the Foundation for Polish Science

In October 2023, following the second mid-term evaluation and taking into account the feedback from external experts, the FNP Board formulated several decisions and recommendations addressing the strategic orientation, collaboration, staffing, and operational performance of the R&D implementing unit (Project Sano). The second mid-term evaluation focused primarily on the following areas regarding the R&D implementing unit:

1. Evaluation of research excellence of team leaders and the entire R&D implementing unit.
2. Establishment of cooperation with entrepreneurs.
3. The level of internationalisation and development of R&D personnel for the needs of an innovative economy.

The final report of the IRAP project was submitted to the FNP in January 2024, and it was subsequently positively evaluated and accepted in August 2024.

3.4 EC recommendations after #4 Review and proposed solutions

Following the Review Meeting summarising the 4th Reporting Period, the Teaming Project Sano received the official Review Report, which included a set of valuable and substantial recommendations concerning the project's R&D activities and overall implementation.

In response to these recommendations, Sano has developed a comprehensive Action Plan defining the strategic approach, corrective measures, and planned activities to effectively address the reviewers' comments and ensure full alignment with the project's objectives and expected impacts.

The following section presents the recommendations pertaining specifically to R&D activities, and corresponding planned actions suggested and enacted by Sano.

1. Scientific Strategy and Research Focus (Recommendation number 2 from the Review Report)

Sano urgently needs to strengthen and clearly communicate a long-term scientific strategy aligned with European priorities and developed in collaboration with key stakeholders. The International Scientific Committee (ISC) should play a decisive strategic role in shaping this direction. A focused and inclusive research agenda will improve Sano's visibility, collaboration potential, and funding opportunities for the remainder of the project and any requested extension.

Sano's Response and Action Plan:

We fully agree that the research strategy of Sano needs reinforcement, articulation and promotion. As the process of update of Sano Research Agenda document has already been initiated prior to the review meeting (including the evaluation of research teams by the former ISC, a workshop organised with the new ISC in Feb 2025, and ongoing discussions with ISC members), we would like to thank our

Evaluators for the additional impulse to give the research agenda of Sano better focus in both technological and clinical directions. As a result, we have decided to embrace the following strategic decisions:

- Technological focus on development of the Sano Digital Twin Platform, which combines AI and physics-based modelling, including hybrid approaches – the convergence of these two paradigms is where the most exciting innovations are happening today: these include physics-informed neural networks and AI-based surrogate modelling, which combine the interpretability of mechanistic models with the adaptability and scalability of AI. Sano is a unique centre which combines and innovates in these two paradigms for medicine.
- Clinical **focus** on the domains of **cardio**vascular, **neuro**logical, and **gastro**enterological health, and their interactions along the increasingly important ***heart-brain-gut axis*** – which is a new focus. These three domains were strategically selected based on their clinical importance, existing experience of Sano in modelling and AI techniques that can be applied to them, availability of excellent clinical collaborators with access to data, as well as translation potential and impact. The presented strategic shift is performed in coordination with the ISC.

To reinforce, articulate and promote the new Research Agenda, the following steps have already been implemented since the close of the previous reporting period:

1. Definition of key domains and technical focus based on strategic directions recommended by ISC in February 2025.
2. Preparation of Research Agenda for IRAP proposal with the focus on digital twin platform and three domains (cardio, neuro, gastro) (€7.5M submission on 12 May 2025), with input from all the team leaders, consultations with ISC members who reviewed the proposal, with the Translation Advisory Board (TAB) – notably with the Ansys Corporation agreeing to be a strategic industrial partner for the proposal, with the Teaming project consortium and with clinical partners from around Europe (representing each respective domain). The aforementioned proposal includes a budget for establishing a new research team on hybrid modelling techniques and interaction between the various models in the digital twin platform.
3. Becoming a member of the Avicenna Alliance – an association of industry and academia/healthcare organisations who have a commercial or research interest in the development of *in silico* medicine in May 2025.
4. Formal discussions held with the ISC Chair during his recent visit to Krakow, focusing on strategic directions, on 13-16 May.
5. Discussions with Thierry Marchal (Ansys) from the Translational Advisory Board (TAB) on 15-16 May during his visit to Krakow at the Lifescience4EU Conference.
6. Meeting with ISC Chair on June 2 on the roles and involvement of ISC in shaping the research strategy.
7. Strategy meeting with all team leaders and business development team at Sano on June 6.
8. Updating the Research Agenda document with aligned team agendas – by the end of June 2025

9. Further elaboration upon specific plans, in cooperation with the ISC and remarks for the final document – end of July 2025
10. Public announcement at Krakow Conference on Computational Medicine (KCCM) on 15-18 October 2025
11. Meeting with ISC members during KCCM Conference, 15-18 October 2025
12. Final version of the Research Agenda approved

Publishing the Research Agenda as an open access electronic book at Sano websiteIn light of the Evaluators' suggestions, we also plan additional ways to better engage with the ISC and the TAB:

- Introducing regular meetings with ISC Chair and Sano Management (already started after April 2025)
- Appointment of ISC subcommittees – dedicated to technical and biomedical topics
- Appointment of ISC vice-chairs
- Regular meetings between the TAB and the Sano Management Board (at least twice a year).

These strategic research decisions will become drivers for the clinical and industrial collaborations, grant acquisition strategy (as shown in the recent IRAP proposal submitted in May 2025, and in other grant proposals we continue to prepare), as well as commercialisation strategy, as described in the following sections of this Action Plan. This strategy also positions Sano as an important player in the various EU-led initiatives, most notably those related to the Virtual Human Twins and the corresponding calls for proposals in Horizon Europe programme, and is furthermore aligned with the upcoming EHDS regulations, in which digital health and explainable AI play a key role.

The requested extension of the project from July 2026 to July 2027 can help Sano to become more actively involved in the following strategic activities:

1. Active participation in VPH 2026 Conference in September 2026, which is a key event for the virtual human twin community and can be used to showcase Sano as an important player in this European initiative.
2. Participation in the proposals for the call HORIZON-HLTH-2027-01-TOOL-04: Virtual Human Twins (VHTs) for integrated clinical decision support in prevention and diagnosis, with deadline in April 2027.
3. Krakow Conference on Computational Medicine organised by Sano in July 2027, as an important event summarising the results of the Teaming project and showing the successes of Sano in the research and translational domains, and presenting the strategy of the sustainable centre of excellence.

While most of these commitments can be delivered upon within the remaining period of the project, we also believe that the requested extension will give us the time needed to better capitalise on the existing investments and see the fruits of our recent – as well as planned –actions aiming to reinforce our research strategy.

2. **Establish a Dedicated Grant Support Unit (Recommendation number 5 from the Review Report)**

Sano should build or strengthen a dedicated grant office to support competitive funding. The team would help with proposal writing, partner matchmaking, and submission processes, especially for Horizon Europe and ERC calls. Embedding this support in the centre's growth model is crucial for visibility, financial independence, and the ability not only to participate but also to initiate and lead projects.

Sano's Response and Action Plan:

In full agreement with Recommendation 5, Sano has already acknowledged the necessity of an improved grant acquisition process some time ago and has initiated a strategy for addressing this matter. We are currently in the middle of this process and are already witnessing positive changes. Below we describe our recent actions, the current state of the process, future steps, and the target level of performance we want to attain in the long term.

Recent actions

- Sano's Grant Acquisition Expert, Ms Alina Bogacz, recently received support from Dr Eng. Ewelina Szymańska-Skolimowska (PhD in experimental physics), who was appointed on a half-time basis to assist Sano researchers with authoring grant proposals. Dr Eng. Szymańska-Skolimowska herself has acquired several international and national grants in the past, but even more importantly, has served for seven years as a programme manager at the Polish Funding Agency - National Science Centre (NCN), running evaluation panels for many top calls, prior to joining Sano. She now applies this experience in helping Sano scientists with NCN, FNP and NCBR proposals, and is also assigned to support Sano's first ERC proposal, with Dr Tomasz Kościółek as the PI, to be submitted January 2026.
- Other Sano's S&D specialists, notably Dr Dominik Czaplicki (Head of Relationships), Dr Katarzyna Baliga-Nicholson (Head of Innovation and Communication), Ms Wioletta Niwińska and Anna Kajda-Twardowska (legal counsels) and Mr Tomasz Gubała (Co-founder) have been assigned on a part-time basis to support establishment of grant consortia, acquisition of LoIs, commercialisation strategy, exploitation and promotion, IP Management, resolving potential conflicts of interests, risk management, etc. In scientific proposals these aspects are usually taken into account by evaluators and may improve the overall score – not to mention ensuring more robust project implementation process if a positive decision is obtained.

Current stage

- While the aforementioned grant capture support unit is an interim stage of the process towards a fully developed Grant Office, as proposed in the Recommendation, we have already noticed some improvements in our national grant application success rate. While in late 2023 Sano had no national research grant in place, we have since steadily improved: we currently have 4 national grants in the implementation phase, and 3 further grants already approved and at the Grant Agreement signing stage. We also are witnessing more active participation from Sano researchers: in comparison to single applications submitted to the NCN Preludium researcher grant program in 2023 and 2024 respectively, this year we already have 8 such proposals in preparation.

Future steps

- Sano currently implements five H2020/HE projects, but all of them are being carried out in the context of two teams (the Extreme Scale and Computing Team, and the Scientific Programming support team – both of which are led by professionals who both have 20+ years of experience in Framework Programme participation), along with a single bilateral project (PL-CH Weave scheme). This is below both our ambitions, and the targets we have set for ourselves, and therefore we now aim to strengthen other teams' international grant success rates.

1. Internally, we have a two-step plan for establishing the final form of the Sano Grant Office. First, we further strengthen the team with another specialist joining Sano: Dr Paweł Sobkowicz, highly experienced in Polish and European grant acquisition and implementation, with specialisation for AI and physics for health (in line with Sano Research Agenda). Dr Sobkowicz has already begun to support the process at Sano with a detailed review of our IRAP FENG 2025 proposal draft (currently under evaluation).

2. Sano has launched an international recruitment campaign for the Head of Grant Office professional (the published offer, after checking in the gender decoder, is already out, available at Head of Grant Office | EURAXESS). A Ewelina Szymańska-Skolimowska (PhD) has been appointed as the Head of the Grant Office. We are currently in the process of recruiting an additional person to support grant preparation and fundraising.

We also observe increased competence in grant proposal authoring on the part of our research personnel, and we expect this to further improve the quality of future proposals, thus, by itself, increasing chances of acceptance and funding.

Expected outcome

Effort. Starting in 2026 we plan to have two senior specialists assigned on a full-time basis to the Grant Office. Further commitment from the Support & Development team will add up to at least an additional 1.5 FTE, supporting specialised elements of proposals (relations, IP, data, regulatory, letters, PR, translation & commercialisation, risk management, scheduling, budgeting, costing, and similar non-scientific elements).

Output. We plan to have the following number of proposals submitted in 2026: 8 HE (7 participation, 1 coordination), 1 ERC, 3 bilateral international, 5 junior/mid researcher stage national, 4 senior researcher stage national, 3 national consortia.

Results. In 2025, Sano has achieved a significant amount of grant income keeping it on track towards its respective financial sustainability target and is awaiting the outcomes of several additional proposals submitted in the second half of the year. Consequently, further increase in grant funding are planned for 2026 and 2027, assuming that the extension of the Teaming grant is approved by the Commission, allowing us to sustain the planned funding intensity for this activity.

Clinical partnerships (Recommendation number 6 from the Review Report)

Clinical research must be developed as a core element of Sano's mission, supported by a clear strategy for recruiting clinical collaborators and establishing formal partnerships with hospitals and healthcare providers. Strengthening stable, strategic clinical collaborations and activating the Clinical Advisory Committee and Translation Advisory Board are essential to ensure Sano's translational relevance.

Sano's Response and Action Plan:

Sano has a multi-level strategy towards its clinical engagement, which includes:

- inviting selected clinical audiences and individuals to Sano;
- meeting clinicians *in situ*, in the environment of hospital, medical centres and clinical sites;
- attending "clinical" venues, e.g. hospital events, medical conferences and partnering shows.

In this way Sano has managed to significantly expand into the medical realm with actions such as formalising new clinical relations/partnerships, hosting cross-sector conferences (e.g. Sano Science Day, Life Science Open Space), showcasing Sano R&D among clinically-relevant audiences, co-developing use cases with medical professionals, networking with relevant environments, e.g. Avicenna Alliance, VPH, Health Tech Forward.

As part of this strategy, in RP#4 Sano moved beyond the concept of a Clinical Advisory Committee with a more agile and project-focused Healthcare and **Clinicians Expert Pool** (as reported in the Periodic Report #4, Section 7). This model enables direct, targeted involvement of clinicians in research, development, and evaluation activities where their expertise is most relevant. With over 50 medical professionals currently on board, the expert pool is involved on a case-by-case basis into co-creation of Sano solutions to keep them tailored to real clinical needs, with faster iteration cycles and avoiding bureaucratic overhead of the committee-centered approach. Clinicians engage in pilot studies, joint grant proposals, and early-stage technology testing. We believe this dynamic approach better reflects the diversity of clinical domains and strengthens Sano's translational mission through meaningful, operational partnerships - locally and internationallyclini. Recent examples of those clinical relations are four internships of Sano Ph.D. students completed in the first half of 2025 and held in the clinical setting in European and US hospitals (Amsterdam UMC; *Gaetano Martino* University Hospital in Messina; Massachusetts General Hospital, Boston; Children's Hospital of Philadelphia, Yale University). The general direction of clinical collaborations is linked to key areas of Sano's research agenda (see our reply to Recommendation no. 2 above). Clinical focus builds on pre-existing collaborations in the domains of cardiovascular research and neuroscience, with gastroenterological health as the new focus related to the heart-brain-gut axis.

On top of this network approach, Sano has also strengthened internal capacity and recently introduced a formal **Clinical Advisor** role to ensure that medical knowledge and real-world healthcare experience directly inform our research and development agenda. The Clinical Advisor, employed part-time in 2Q2025 as part of Sano's Business Development team, has a background as radiologist, AI innovation specialist, and startup entrepreneur with deep expertise in the clinical validation of AI healthcare solutions. With training from Stanford, MIT, Yale, and Imperial College London, and affiliations with leading radiological societies, the Clinical Advisor serves in a strategic, scientific, and evaluative capacity, bridging the gap between technological innovation and clinical applicability.

Sano is dedicated to strengthening its clinical outreach beyond the above and will take specific actions towards Recommendation no. 6.

Expected outcome

- community engagement (events, panels, workshops): 400 participants (by July 2026) and a further 400 by July 2027, assuming extension of the Teaming project)

- dedicated events/workshops for medical professionals: 3 (by July 2026) and a further 5 (by July 2027, assuming extension of the Teaming project)
- formalised key clinical/hospital partnerships: 3 (by July 2026) and a further 5 (by July 2027, assuming extension of the Teaming project)

These outcomes should strengthen the clinical outreach of Sano and provide further directions for clinically translatable outcomes.

3. Commercialisation strategy (Recommendation number 6 from the Review Report)

Sano must adopt a strong innovation strategy, identify technologies with commercialisation potential, and build professional tech-transfer capacity, supported by clear KPIs and timelines to ensure measurable innovation outcomes.

Sano's Response and Action Plan:

Following the review process, the Business Development team critically evaluated the Sano Innovation Strategy formulated in January 2025. As a result, Sano's innovation strategy has been refined to more effectively address the challenges raised by experts. Developed collaboratively and shared broadly, this updated strategy underscores our commitment to respond to the challenges raised.

The primary goals of the strategy remain consistent and are outlined below:

1. Accelerate the translation of innovation into practice
2. Develop a competitive and diversified product portfolio
3. Support financial and operational sustainability
4. Grow a collaborative ecosystem with industry, academia, and healthcare
5. Embed innovation governance and IP strategy at all levels

This strategy is designed to span the period from 2025 to 2027, focusing on the development, translation, and commercialisation of innovation. While here we outline key actions and KPIs for that timeframe, the strategy is rooted in achieving a longer-term vision. Based on results, market dynamics, and stakeholder feedback gathered during this period, the strategy will be revisited and may be adapted to reflect emerging priorities and insights. The implementation of the strategy begins with a series of structured feasibility studies designed to evaluate high-potential clinical opportunities. In parallel, we are building cross-functional teams that bring together technical, clinical, and business expertise to ensure that projects are shaped by diverse perspectives from the outset.

A key is the requirement for all research teams to involve clinical professionals or biomedical professionals from the outset, ensuring clinical relevance. Teams are also expected to contribute to Sano's product portfolio (see https://sanoinnovations.com) – which is growing and regularly being updated to reflect our evolving pipeline of innovations. To enhance usability and adoption of Sano's technological tools, the strategy includes the development of graphical user interfaces (GUIs), starting with the CACTUS platform and the DVT/CFD models. The DVT/CFD project is already underway, supported by a signed contract and a cross-functional team. Parallel to this, a Digital Health Validation Framework will be developed to incorporate best practices in verification, validation, uncertainty quantification (VVUQ), and implementation science. This will provide a foundation for evaluating digital health tools before deployment.

Real-world testing becomes a core element of our strategy and tightly aligned with our research agenda focused on Digital Twin technologies in neurology, gastroenterology, and cardiology. The Business Development team is currently launching projects in three hospitals to assess and refine Sano technologies in real clinical environments:

- FL for MRI quality improvement – initiated at the University Children's Clinical Hospital in Białystok, supporting our neuro-focused research
- XR-based training tool – piloted at the Institute of Mother and Child (IMiD), also in the neurology domain, enhancing practical training through immersive technologies
- CFD tool for radiology procedures – under evaluation at John Paul II Hospital, directly contributing to our cardiology-oriented work.

Gastroenterology-related solutions are currently in development and will follow soon. This area will be more closely linked to the pharmaceutical industry, particularly in applications related to drug response modelling, treatment optimisation, and personalised medicine.

We are also committed to increasing the involvement and participation of patients and members of the public from all backgrounds in research and innovation. As part of this effort, Sano and the pediatric hospital in Białystok are designing a study to evaluate the impact of a simulation playroom on the experience and outcomes of pediatric MRI procedures. We are also working on user research to better understand their needs and identify critical problems.

The SanBox incubation program will continue and will support 2–4 early-stage projects per year, now enhanced with structured training, performance-based bonuses, and access to external opportunities to boost engagement and impact.

While organic growth through programs such as SanBox remains a priority, we are also focused on scaling our outputs into market-ready ventures. To this end, and in line with the presented recommendations, we are expanding our Business Development team with two strategic expert roles: a Clinical Advisor for AI & Digital Health Solutions and a Senior Digital Health Advisor who will provide expertise regarding deployment of medical technologies for a global environment, in a safe and effective manner. These roles will enhance our ability to shape value propositions, evaluate cost-effectiveness, navigate payer systems, and ensure real-world alignment of our solutions. This year we launched the Sano Innovations Web (see https://sanoinnovations.com/) to enhance visibility and create opportunities for revenue through diverse R&D services. The platform showcases our evolving innovation pipeline and supports engagement across our ecosystem. Combined with our active presence at events and growing digital reach, this is generating external interest. We are now advancing strategic partnerships with GE HealthCare, Siemens Healthineers, and NVIDIA to access valuable insights, validation pathways, and market opportunities.

Our innovation strategy is outcome-driven. We track progress using clear metrics: service revenue, conversion of leads into signed contracts, the number of collaborative projects, and increased technology readiness levels (TRLs). A key performance milestone is the creation of spin-offs by 2027: a target we are actively pursuing.

Recent and ongoing achievements and developments:

- Secured funding for commercialisation support of scientific innovations;
- Established a dedicated team around our Digital Twin for Deep Vein Thrombosis (DVT) project;

- In development: a spin-off based on our highest-TRL innovation – an XR-based surgical simulator that enhances access to advanced training in minimally invasive and robotic surgery
- a term sheet has already been signed;
- a proposal for EIC-supported funding is currently in preparation;
- this innovation will be showcased at the upcoming BIO Convention in Boston, marking a key milestone in our translational journey.

4 Recommendations towards sustainability

4.1 General recommendations

It is recommended that Sano – Centre for Computational Personalised Medicine – embed sustainability into its R&D strategy by aligning innovation pathways with evidence requirements, health-system needs, and long-term industrial partnerships. Building on its mission to translate advanced computational methods into clinical impact, Sano should implement a structured approach based on the PICO framework (Population, Intervention, Comparator, Outcome) and commercialisation readiness principles.

It is recommended that each project define its PICO parameters early to ensure that the technology's target population, intended use, and measurable outcomes are clearly linked to clinical and reimbursement value. This alignment will support systematic evidence generation through consecutive technology readiness levels (TRLs), from proof of concept to large-scale deployment.

It is further recommended that Sano establish a roadmap for evidence development that integrates technical validation, usability studies, and clinical pilots with health-economic and outcomes research (HEOR). This will enable early identification of reimbursement potential and facilitate dialogue with payers and regulators. The roadmap should reflect the progression from concept validation (TRL 3–4) through real-world evidence generation (TRL 7–8), ensuring readiness for market and policy adoption (TRL 9).

To sustain impact, it is recommended that Sano formalise long-term collaborations with pharmaceutical and med-tech partners, focusing on therapeutic areas where computational and predictive tools can demonstrate measurable improvements in patient outcomes, efficiency, and system performance. Such partnerships should include joint design of study protocols, access to clinical data, and co-development of health-economic models to meet payer expectations.

Finally, it is recommended that Sano apply commercialisation readiness assessment tools, such as the one already developed, to evaluate clinical, technical, and market maturity across projects. Embedding these assessments into governance processes will ensure that R&D efforts remain aligned with healthcare system priorities, regulatory requirements, and financial sustainability goals. This integrated approach will position Sano as a strategic, evidence-driven partner for the pharmaceutical sector and healthcare innovation ecosystem.

4.2 Digital Health Solutions

The role of a Clinical Advisor for AI and Digital Health Solutions is essential at the Sano Centre for Computational Medicine because it ensures that advanced computational technologies are grounded

in real clinical needs. Embedded within the Business Development team, the Clinical Advisor works across all projects at Sano, systematically assessing their clinical relevance, feasibility, and readiness for implementation. By translating between scientific innovation and everyday medical practice, this role guarantees that AI-driven models, digital biomarkers, and decision-support tools are designed for genuine clinical impact, safety, and usability. It provides the clinical perspective necessary to validate algorithms, guide data requirements, and shape solutions that can seamlessly integrate into diagnostic and therapeutic workflows. The Clinical Advisor also safeguards ethical, regulatory, and patient-centred considerations, enabling Sano's research to progress from technical excellence to meaningful healthcare improvements. In doing so, the role strengthens Sano's mission to build clinically relevant, scalable, and translational digital-health innovations for the future of personalised medicine.

Clinically Assessed Sano Projects to Date:

The following section outlines the clinical evaluation of the clinically assessed projects to date of the Sano project portfolio. The projects have been assessed based on their medical viability, technical maturity, and potential for market adoption. The individual evaluations are grouped by clinical domain to facilitate a thematic analysis of sustainability pathways.

4.2.1 Neuro-Oncology and Digital Pathology

Project: Explainable Glioma-Grading from Whole-Slide Images

This project develops a WHO glioma-grading tool utilizing HLA-stained whole-slide images, combining texture and cell-morphology features with deep-learning techniques. It incorporates interpretability modules (e.g., SHAP/Grad-CAM) to visualize the basis of grade prediction.

- **Clinical Value & Strengths:** The project addresses a significant gap in neuropathology: the need for reproducible grading and transparent decision support. Its primary strengths are the focus on explainability and the utilization of routine stains, which lowers integration barriers.
- **Challenges:** The current dataset relies on single-centre data with limited sample size and minimal region-level labels. Without multi-centre validation and prospective testing, clinical applicability remains limited.
- **Path to Sustainability:** To ensure commercial viability, this project should pivot from a standalone diagnostic tool to a B2B licensing model. The sustainability strategy includes:
    - **Regulatory Positioning:** Define the product as a Class II Clinical Decision Support (CDS) tool—a "second reader" that flags regions of interest—rather than an autonomous diagnostic, reducing the burden of proof for regulatory clearance (CE/FDA).
    - **Integration:** Focus development on API compatibility with major Digital Pathology cockpit vendors (e.g., Philips), as hospitals are unlikely to purchase a separate software suite for a single pathology task.
    - **Validation:** Prioritize a multi-centric retrospective study to demonstrate robustness across different scanners, which is a prerequisite for any commercial partnership.

Project: Non-local Diffusion MRI Biomarker for Glioblastoma

This initiative develops a Lesion-Tract Density Index (L-TDI) to measure how GBM lesions intersect with a normative white-matter scaffold. The goal is to stratify patient survival and add prognostic value to standard clinical variables (age, MGMT status, extent of resection).

- **Clinical Value & Strengths:** This work successfully translates the "GBM as a network disease" paradigm into a quantitative, reproducible metric. Strengths include the use of large, multi-site cohorts for validation and a conceptually elegant biomarker that utilizes standard structural MRI without requiring specialized acquisition sequences.

- **Challenges:** As with many imaging biomarkers, the analysis is currently retrospective and dependent on accurate segmentation. The use of normative rather than patient-specific tractography may introduce inaccuracies in heavily distorted brains.

- **Path to Sustainability:** The commercial potential lies in "Advanced Visualization" and clinical trial stratification.

    - **Product Definition:** Position L-TDI as a post-processing plug-in for neuro-oncology PACS viewers or Radiotherapy planning systems (TPS), specifically for defining "high-risk" white matter avoidance zones.

    - **Clinical Trials Market:** Market the biomarker to pharmaceutical companies and research consortia as a stratification tool for GBM clinical trials, helping to homogenize patient cohorts based on survival risk.

    - **Evidence Generation:** Shift research focus to demonstrating that L-TDI-guided treatment planning alters clinical management (e.g., changes the radiation field), which is essential for future reimbursement codes.

4.2.2 Acute Stroke and Rehabilitation

Project: Portable EEG + AI for Pre-hospital Stroke Triage

This project focuses on a portable system for use by paramedics. It utilizes a machine learning model to first distinguish stroke from mimics, and subsequently flag Large Vessel Occlusion (LVO) to guide transport to thrombectomy-capable centres.

- **Clinical Value & Strengths:** The clinical need is acute, as early routing to comprehensive stroke centres is a critical bottleneck. The project demonstrates strong methodological rigor in signal denoising within the noisy ambulance environment and offers a classifier tuned for high sensitivity.

- **Challenges:** The dataset for positive LVO cases is currently small and imbalanced, posing risks of overfitting. There is a need for external, multi-site validation against CTA/MRA ground truth to confirm performance. Operational challenges, such as cap placement time and motion artefacts, require rigorous quantification.

- **Path to Sustainability:** The sustainability of this project relies on proving economic efficiency for healthcare systems.
    - **Health Economics:** Beyond diagnostic accuracy, the team must generate data on "Time-to-Needle" reduction. This health-economic data is critical for convincing ambulance services and insurers to adopt the technology.
    - **Hardware Partnership:** Rather than developing proprietary hardware, the software should be validated on commercially available, low-cost EEG headsets to facilitate a Software-as-a-Medical-Device (SaMD) business model.
    - **Clinical Workflow:** Validation must move to a prospective "shadow mode" study in real ambulances to prove that the device does not delay transport times.

Project: Oculomotor Biomarkers for Stroke Assessment and Rehabilitation

This project operates on two layers: a core method decoding eye movements from fMRI, and a clinical application using eye-movement metrics as biomarkers for stroke severity and the basis for a rehabilitation paradigm.

- **Clinical Value & Strengths:** The rehabilitation angle has clear medical value, as oculomotor deficits are common post-stroke and objective bedside eye-tracking is feasible. A standardised training protocol could significantly improve functional outcomes.
- **Challenges:** The fMRI-based gaze decoding component is complex and costly compared to standard eye-tracking, making it unlikely to become a routine clinical tool, though it remains valuable as a methodological research contribution.
- **Path to Sustainability:** The strategy should bifurcate the research output from the clinical product.
    - **Product Focus:** Prioritize the development of the "Digital Therapeutic" aspect—the bedside eye-tracking rehabilitation protocol. This has a clearer path to market as a stroke unit assessment tool compared to the fMRI decoding method.
    - **IP Licensing:** The fMRI gaze-decoding algorithms should be treated as methodological IP, potentially licensable to neuroimaging research software suites (e.g., BrainVoyager, SPM toolboxes) rather than clinical end-users.
    - **Usability Testing:** Immediate focus should be placed on usability studies in high-throughput stroke units to ensure the rehabilitation protocol fits into the tight schedules of occupational therapists.

4.2.3 Medical Imaging Methodology and Quality

Project: Hybrid Image-Quality Framework for CT/MRI

This project develops a framework combining classical numerical metrics with pairwise radiologist preference judgments to evaluate denoised images. It aims to derive a clinically grounded "quality score" that fuses physics metrics with human perception.

- **Clinical Value & Strengths:** The project addresses the need for shorter MRI exams and standardized evaluation of aggressive denoising algorithms. The study design, bridging physics metrics and human perception, is a key strength.
- **Challenges:** The evaluation currently relies on a limited number of test cases and synthetic noise. High aesthetic scores ("prettier images") must be correlated with diagnostic accuracy (e.g., lesion detection) to be clinically valid.
- **Path to Sustainability:** The primary customer for this technology is the Imaging Industry (OEMs), not the hospital.
    - **B2B Service Model:** Position the framework as a "Quality Assurance & Validation Service" for MRI/CT manufacturers developing AI-based reconstruction algorithms (e.g., Deep Learning Reconstruction).
    - **Standardisation:** Work towards establishing this composite score as an industry-standard metric for "diagnostic confidence," moving beyond simple Signal-to-Noise Ratio (SNR).
    - **Clinical Safety:** To increase value, the model must be trained to detect "hallucinations" (artifacts created by AI denoising), serving as a safety check for regulatory submissions of new imaging AI.

Project: MRI-Histology Synthesis and Tractography Benchmarking

This project involves paired post-mortem MRI and histology of the corpus callosum to create ground-truth datasets for benchmarking diffusion MRI algorithms ("Traktogan").

- **Clinical Value & Strengths:** The histology-based ground truth concept is scientifically robust and addresses the lack of validation standards in tractography.
- **Challenges:** The highly specialized nature of the data and the challenges in 3D registration limit direct clinical application. Scaling beyond specific brain regions remains a hurdle.
- **Path to Sustainability:** This project represents a high-value academic asset rather than a clinical product.
    - **Open Science Leadership:** Leverage the dataset to establish Sano as a global reference center for tractography validation. This builds institutional reputation which attracts further grant funding.

- **Data Licensing:** Refined, co-registered datasets can be licensed to commercial developers of surgical navigation software who need "ground truth" to validate their fiber-tracking algorithms.

- **Methodological Consulting:** The expertise gained in MRI-histology registration is a sellable consultancy service for pharmaceutical companies conducting preclinical neuroimaging studies.

Business Development is shifting from tech-driven, prototype-only AI projects to a portfolio of clinically anchored, explainable digital-health tools that plug into real workflows in pathology, neuroradiology, stroke care and imaging QA (e.g. explainable glioma grading, tract-based GBM survival markers such as L-TDI, portable EEG stroke triage, eye-tracking stroke rehab, and CT/MRI quality-scoring frameworks). Commercially, B&D is moving towards realistic SaMD and B2B integration paths (PACS/pathology viewer plug-ins, scanner and RT-planning add-ons, EMS and rehab platforms).

4.3 Scientific recommendations

Recommendations regarding the research directions were suggested by the members of the International Scientific Community during the interactions with Sano over the recent period, including visits to Sano in February 2025, during Conference on the Future of Life Sciences in May 2025, at ICCS Conference in July 2025 and during Krakow Conference on Computational Medicine (KCCM) in October 2025. They were also expressed during the work and feedback on the Sano Research Agenda (see Section 3.2), and during other exchanges.

The recommendations about the vision and strategic focus of Sano are centred around balancing focus and diversity: how much variety in research goals is beneficial versus overwhelming. In other words, it is a decision whether the teams be unified around a specific research challenge, or should we maintain a broader, more diverse approach. The research domains should be selected based on their clinical importance, existing experience of Sano in modelling and AI techniques that can be applied to them, availability of excellent clinical collaborators with access to data, as well as translation potential and impact. Another dimension of strategic directions results from the experience that Sano has opportunities to apply its expertise to both medical and engineering domains, so the question remains how the priorities should be set. Clearly, Sano has grown from the technological expertise, but the medical applications are key, so the clinical focus should be also strengthened and maintained, to avoid development of technologies in isolation from the real clinical needs.

The recommendations about the scope and domains of the particular research projects can be summarised as follows. The research projects that are worth pursuing are those, which have a current clinical or medical challenges. This should also be based on two conditions: (1) access to sufficient levels of clinical or medical data, and (2) when we can guarantee real involvement of medical specialists as collaborators. Projects related to Digital Twin in Healthcare should always produce a clinical or medical endpoint, which in many cases will require hybrid modelling, bringing together knowledge-driven (or physics-based) and data-driven (AI-based) models. It is also important to keep focus on the domains where the teams already have expertise and experience, for example cardiovascular modelling. Such a domain can be extended by moving into other domains which are characterised by many scientific and medical challenges, for example the neurovasculature.

The recommendations about the research culture and management at Sano include the following. Strategic decision-making processes could be more efficient with a strong unifying vision that aligns people and goals, so the focus in the research agenda can help in this regard. Scientific guidance could be more structured, ensuring regular collaboration among PhD students to facilitate discussions and knowledge sharing, since closer contact between PhD students is essential - regular meetings should focus on presenting research progress and fostering peer collaboration. Moreover, Sano researchers should practice pitching and entrepreneurial tasks or challenges, to facilitate better articulation of which research questions they try to answer and why they are working on a specific topic. This should be also supported by mentoring which can be expanded beyond students to include leadership development for postdoctoral researchers and team leaders. From the practical perspective, Sano also should have a good strategy for selecting journals and conferences that we would like to publish, to satisfy both the reporting requirements of funding agencies, and the impact of these publications.

4.4 Technical recommendations

On the technical front, by the submission time of this deliverable Sano has established a sound framework for procurement and use of infrastructural resources for the purposes of research work carried out by our teams. This is a result of Sano's own efforts, as well as the benefits of collaboration with Advanced Partners in the Teaming project, particularly Cyfronet, which serves as the main provider of large-scale computational power for our research work.

The following set of technical recommendations have been formulated by the Sano Scientific Programming Team with regard to ensuring infrastructural sustainability in 2026 and beyond.

1. In-house computational resources

Sano maintains an in-house computational infrastructure which is collocated at a secure facility operated by a major telecom (Netia Data Center SOUL) in Kraków. This infrastructure facilitates limited-scale computational studies and supports storage and processing of data which cannot contractually be shared outside of Sano. Given our increasing reliance on such data in the early-stage research and development work related to our ongoing projects, maintaining this infrastructure is of critical importance for Sano; accordingly, the recommendation is to secure financial and administrative resources which would enable us to retain it (as part of Sano's financial planning).

In terms of the extent of computational resources provisioned in the above context, the following resources are available:

- **Computing Servers:** 2 servers with A100 GPUs and 2 disk arrays with 700 TB storage space + dedicated Kubernetes servers;
- **Accounting and HR Servers:** 3 servers handling accounting, HR, and network configuration.

The key recommendation is to carry on with the planned purchase of an additional server to support growing computational needs, as well as to replace the current low-performing TP-Link switches with two 48-port Juniper switches, enabling further infrastructure growth (this process is already in progress as of the preparation date of this deliverable).

An additional recommendation is to implement firewalls to support secure P2P VPN connections between employees and Sano systems, as well as the computational infrastructure.

Assuming the above, the computational infrastructure in place is regarded as adequate given the current and anticipated research needs of Sano teams.

2. High-performance computing

Given that Sano is not, in itself, a high-performance computing centre, access to high-performance computing is facilitated in collaboration with our Advanced Partners as well as with commercial providers of computational resources, such as Microsoft Azure and Amazon EC2.

In this scope it is crucially important to maintain our links to the above-mentioned partners; particularly Cyfronet where a large portion of the computational resources provisioned to the Polish scientific community (as well as to its foreign collaborators) is concentrated.

More specifically, in the context of ongoing research work, we will continue to rely on the following:

- **Ares HPC cluster:** for "traditional" (i.e. non-GPU-reliant) computational tasks, provisioned in the framework of the PL-Grid infrastructure,
- **Athena GPU cluster:** for GPU-oriented computational tasks, provisioned in the framework of the PL-Grid infrastructure,
- **Helios CPU cluster:** currently the most modern computing cluster operating at Cyfronet – for scale-up studies involving computational models devised at Sano.

The status of Sano as a research centre enables us to take advantage of the 95% discount on the use of computational resources (in accordance with current policies in force at CYF); hence, maintaining this collaboration is crucially important for optimised allocation of financial resources. Sano staff furthermore maintains close contacts with Cyfronet personnel, which helps troubleshoot emerging issues and ensures smooth operation of resources assigned to Sano under PL-Grid research grants.

In addition to the above, the status of Cyfronet as a member of the LUMI consortium provides the possibility to access even larger pools of resources offered under the EuroHPC initiative - which remains a valuable opportunity for Sano research teams.

3. Procedural and organisational matters related to use of technical resources

Sano is in the process of updating its Standard Operating Procedures to match ongoing legal changes, particularly those related to introduction of new EU legislation regarding secondary use of medical data, which is of particular concern to the research underway at the Centre.

In terms of operational support, it is crucially important to maintain staff whose role will be to assist researchers in making efficient use of the available infrastructural resources, carry out internal dissemination/training activities, and help troubleshoot emerging issues. This is the role of the Scientific Programming Team in place at Sano.

An emerging requirement which needs to be addressed is to establish a formalised pathway for performing verification, validation and uncertainty quantification (VVUQ) of computational models as a prerequisite for their eventual certification and deployment in a clinical setting. Preliminary work towards this goal has already been carried out in the context of the GEMINI project (where Sano is involved in the relevant tasks) and is ongoing as of the submission time of this deliverable.

4. Other dedicated technical infrastructure, software and resources

Additional technical infrastructure (other than computational power, data storage and network connectivity) is occasionally required in projects carried out by the Sano research teams. While the existing availability of such resources is regarded as adequate, we are faced with requirements which

arise as a result of anticipated research work (under newly established grants) as well as the need to improve and streamline our own administrative and technical operations.

In light of the above, the following recommendations can be formulated:

Custom research software. Sano already operates a set of software tools devoted to deploying, managing and executing computational models on the available high-performance computing resources. This consists, in particular, of the Model Execution Environment (a workflow platform developed in collaboration with CYFRONET) as well as a set of extensions for downloading and publishing primary research data in a managed manner – this is facilitated by Sano's instance of the Dataverse platform, deployed as part of the RODBUK data sharing initiative, of which Sano is a member.

It is recommended that the above tools are maintained and extended in line with emerging requirements, and that user surveys are periodically carried out to ascertain how these requirements evolve. The development of a common platform for training and managing computational models is also being contemplated, given its potential to enable creation of prototypes whose commercialisation could then be pursued by the Business Development team in partnership with Sano's industrial partners and collaborating medical care providers.

Technical managerial and administrative support. Sano also provides a platform for collaboration between employees via the Microsoft 365 system. It enables both traditional e-mail communication via the Exchange Online service, interactive teleconference with Teams as well as secure data storage both personal (OneDrive) as well as group (SharePoint). The solution is extended with the Entra ID P1 (formerly Azure Active Directory Premium P1) license increasing the security level of employees' accounts managed by the Entra ID (former Azure Active Directory) platform. Moreover, Sano procured some Exchange Online Plan 1 licenses to support technical mailboxes (such as accounting, printing) with lowest possible cost, while keeping the coherent ecosystem.

Administrative and legal support related to GDPR compliance, secure data storage and traceability is provided by the Sano Scientific Programming team, as well as the Data Protection Officer, supported by the Legal Team where required.

5 Conclusion

Due to the complex nature of the investment scheme that was put in place to establish and develop Sano (the Teaming programme, the International Research Agendas programme, and the Ministry Funding Programme), Sano periodically undergoes various evaluations related to these funding streams. Furthermore, Sano enjoys feedback from its own governance structure. Thus far Sano's R&D progress and plans were reviewed and evaluated by:

- Externally: European Commission (REA), Foundation for Polish Science, Polish Ministry of Science and Higher Education, Polish National Centre for Research and Development.
- Internally: Foundation Council (annual evaluation of Sano Annual Activity Report; continuous oversight and advisory), International Scientific Committee (periodic evaluation of Research Teams and Research Team Leaders; periodic evaluation of Sano Research Agenda; less formal consultation and advisory visits).

Further source of feedback and an important factor in keeping Sano research relevant and up to date is meticulous analysis of all evaluations of the grant applications the centre submits. As demonstrated,

Sano is increasingly active in grant acquisition efforts and therefore receives an inflow of Polish and international grant evaluations. By analysing them, regardless, if the submission was successful in attracting funding or not and applying the distilled knowledge in future R&D activities, Sano keeps its research direction focused and current. As a notable example of how this process works at Sano, we can quote the recent Tomasz Kościółek's First Team FNP grant (941 kEUR), which was a much improved re-submittion of a 2023 one. Furthermore, Sano's external position is already good enough to attract notable scientists to host their new grants (Marek Wodziński, awarded a very prestigious *Polityka* Scientific Prize 2025[1], implements his NCN Sonata 293 kEUR grant at Sano).

This document summarises most important elements of these evaluations processes taking place in Sano, and presents Sano completed, ongoing and planned activities aimed to keep relevance and thematic sustainability.

[1] https://www.polityka.pl/tygodnikpolityka/nauka/nagrodynaukowe/2318643,1,dr-inz-marek-wodzinski-laureatem-nagrod-naukowych-2025.read