The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

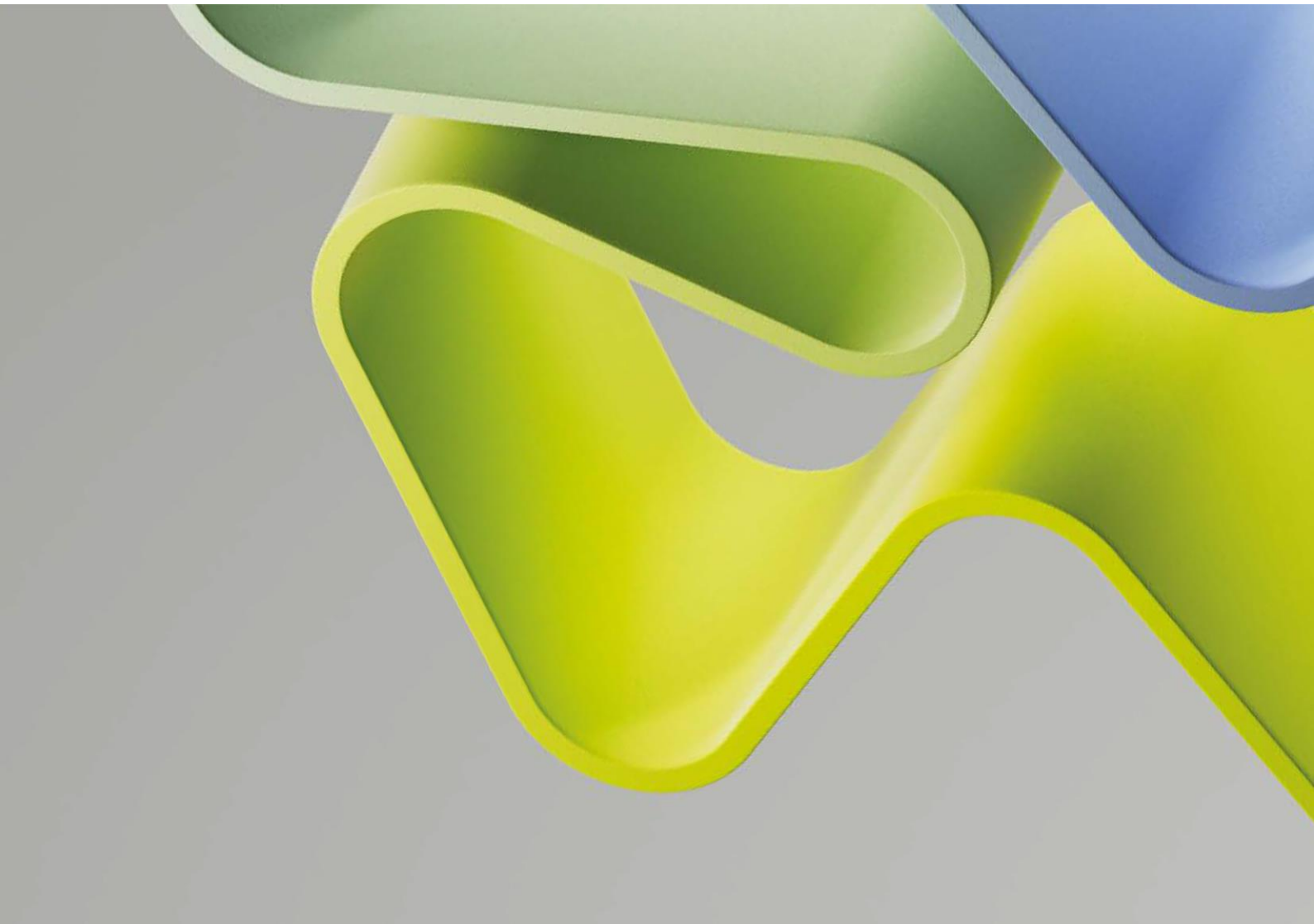
Evaluation Report for Administrative Unit

Administrative Unit: **Department of ICT and Natural Sciences**

Institution: **Norwegian University of Science and Technology (NTNU)**

Evaluation Committee Higher Education Institutions 2

December 2024



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The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions within Mathematics, ICT and Technology 2023-2024 and has submitted a report for each administrative unit:

- Department of Computer Technology and Computational Engineering (IDBI), UiT The Arctic University of Norway
- Department of Automation and Process Engineering (IAP), UiT the Arctic University of Norway
- Department of Electronic Systems (IES), Norwegian University of Science and Technology (NTNU)
- Department of ICT and Natural Sciences, Norwegian University of Science and Technology (NTNU)
- Department of Information Security and Communication Technology (IIK), Norwegian University of Science and Technology (NTNU)
- Department of Engineering Cybernetics (DeptCybernetic), Norwegian University of Science and Technology (NTNU)
- Department of Information Systems (IIS), University of Agder (UiA)
- Department of Computer Science, Oslo Metropolitan University (OsloMet)
- Faculty of Science and Technology (REALTEK), Norwegian University of Life Sciences (NMBU)
- Department of Science and Industry Systems (IRI), University of South-Eastern Norway (USN)
- School of Economics, Innovation and Technology (SEIT), Kristiania University College

The conclusions and recommendations in this report are based on information from the administrative units (self-assessment), digital meetings with representatives from the administrative units, bibliometric analysis and personnel statistics from the Nordic Institute for Studies of Innovation, Research, and Education (NIFU) and Statistics Norway (SSB), and selected data from the National survey for academic staff in Norwegian higher education and the National student survey (NOKUT). The digital interviews took place in the autumn 2024.

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee consisted of the following members:

Professor Jan Canbäck Ljungberg
University of Gothenburg

Professor Bo Wahlberg (Chair)
KTH

Professor Nancy Pouloudi
Athens Univ. of Economics and Business

Professor Alessandra Costanzo
University of Bologna

Professor Torsten Braun
Universität Bern

Professor Stefan Wermter
University of Hamburg

Description of the Administrative Unit

The Department of ICT and Natural Sciences (IIR) is part of the Norwegian University of Science and Technology (NTNU). The fields of research and innovation at IIR centre around maritime technology, energy informatics, urban planning, and healthcare technology. The unit currently comprises three full-time professors, all of whom are male. There are 11 associate professors, with 36% of them being female. Additionally, there is one male assistant professor, three postdocs (one of whom is female), and 13 PhDs, of which four are female. IIR actively seeks to enhance gender diversity among its researchers, and in the last two years recruited two female associate professors and three female Ph.D. candidates.

IIR's research and innovation activities are organised according to two research groups: the Cyber-Physical Systems (CPS) lab, and the Sustainable Digital Transformation (SDT) R&D group. CPS focuses on maritime technology and biomechatronic, while SDT works on urban planning and energy informatics. The collaborative efforts within and between the groups underscore the interdisciplinary nature of research at IIR, fostering a holistic approach to addressing challenges and opportunities in the focus areas, and maximising synergies across the unit.

NTNU Strategy (2018-2025) and the IE Faculty Strategy (2018-2025) share a common vision of achieving overarching objectives in the areas of research, researcher training, innovation activities, education, and the learning environment, as well as dissemination and communication. IIR research strategic goals are aligned with NTNU's strategic research areas. These encompass the pursuit of innovative solutions to intricate health challenges under the banner of NTNU Health, the transition towards smart sustainable cities and built environment under NTNU Sustainability, the advancement and integration of renewable and sustainable energy sources within NTNU Energy, and the commitment to fortifying Norway's position as a maritime leader through initiatives falling under NTNU Ocean.

Education and research are the cornerstones of IIR, shaping its distinctive identity in the area of computer science, automation, and intelligent systems. The institute offers a comprehensive educational landscape that includes a 2-year MSc program and two BSc programs. The institute prioritises research by strategically managing teaching responsibilities for professors and associate professors, ensuring that their commitments do not exceed the nominal 40%. A significant proportion of the faculty actively engages in externally funded projects. The institute prioritises sharing its findings with the wider academic and industrial communities, contributing to the global body of knowledge in the area of intelligent robotics. This commitment to dissemination also reinforces its role as a knowledge hub. Crucially, IIR distinguishes itself by the applied nature of a substantial portion of its research initiatives. The institute actively collaborates with industry partners across diverse sectors, bridging the gap between theoretical knowledge and practical applications. This collaborative ethos positions IIR as an influential player in facilitating the seamless integration of cutting-edge research into real-world contexts.

IIR has actively engaged in many national and international research projects. Over the past five years, IIR has been involved in one Centre for Research-Driven Innovation (SFI) project and three projects funded by the Research Council of Norway (NFR). On the international front, IIR has contributed to a regional project sponsored by the European Commission. At a national level, IIR has secured funding from a diverse array of sources, including contributions from industry partners, the public sector, and support from the Research Council of Norway. Internationally, IIR has been the recipient of funding from the European Union, highlighting the institute's involvement in transnational research collaborations.

IIR NTNU in Ålesund has assumed a pivotal role in catering to the research and educational needs in information and communication technology (ICT) within the Møre og Romsdal region. The department plans to introduce a new MSc program in mechatronics and automation starting in 2024 based on interest from technological companies in Ålesund. One notable example is the Norwegian Maritime Competence Centre (NMK), which hosts some of Norway's most advanced technological firms, including Kongsberg Maritime, AugmentCity, and Offshore Simulator Centre (OSC). Graduates from IIR's existing programs frequently find employment in these cutting-edge companies. The skills and knowledge imparted by the department align seamlessly with the needs of these industries, contributing to the growth and innovation in the maritime and shipbuilding sectors in the region.

Overall Assessment

In this section we present the overall summary of the Evaluation Committee findings and the overall evaluation including strengths, weaknesses and the terms of reference points.

The IIR department of NTNU is a relatively small department in the Information Technology and Electrical Engineering (IE) faculty and as such has the ability to make flexible research contributions and answer to research demands according to new directions and opportunities. The research is diverse which may also lead to some challenges for collaborations between the two major research groups, as it is not clear what kind of synergies can be achieved. A particular challenge is to bridge and intensify the collaborations between the research groups to avoid isolated small-scale research. At the same time, it is important that very good research groups maintain their standing and are also allowed to pursue independent research interests even if they do not seem to fit completely into a faculty scheme so that departmental autonomy and research group autonomy are respected during collaborations.

Related to the Terms of Reference of the administrative unit, the IIR department is focused on automation, computing and natural sciences providing education primarily at the level of MSc and BSc. The focus on nurturing interdisciplinary partnerships is well established for the maritime technology and healthcare. While there has been some research related to EU and international collaboration, the involvement in international research and EU research funding is limited and should be considered for future improvement.

Regarding the strengths of the administrative unit, while it has a small size there is some basis for diversity and youthful demographics, for instance with an average age of 36 among associate professors. The relatively small size should also allow for a quick adaptation to new research directions. Regarding weaknesses of the administrative unit, the IIR consists of two separate research groups, each focusing on different areas, which allows for specialised exploration but also creates challenges in collaboration between them. To improve collaboration, it is vital to encourage interdisciplinary interactions and joint projects, fostering a culture that values diverse perspectives and promotes a more integrated research environment for the two current research groups.

Finally, we come to the future prospects in relation to plans and visions described in the strategy and self-evaluation for the administrative unit. The Evaluation committee welcomes that IIR has started to expand its research network, gaining some recognition both nationally and internationally, for instance evidenced by invitations to SFI and EU consortia, highlighting its commitment to participating in advanced global research initiatives. The combination of demographics and diversity positions IIR as a small but focused dynamic administrative unit capable of addressing new research directions as they currently occur, for instance in the areas of machine learning and artificial intelligence.

The Terms of Reference for the administrative unit is attached to the report.

Recommendations

In the following we present the summary of the recommendations to the administrative unit for considering how to improve and develop future research strategies to ensure high quality of research relevant both to national and international development. More details of the summary recommendations in this section will then be explained in the respective following sections. The Evaluation Committee recommends:

- Increasing funding through industry and international EU sources due to decreasing government support.
- Considering how the involvement in international and European projects can be addressed and get stronger in the future.
- Considering measures in order to make research more visible internationally with more international-level publications and projects.
- Exploiting and intensifying the synergies of the CPS group and SDT group.
- Sharing expertise and resources between CPS and SDT groups for project- and application collaboration.
- Collaborating with other larger institutions, such as participating in joint research projects and initiatives.
- Improving the quality of publications by conducting regular peer review schemes of research papers before submission.
- Involving younger faculty in the grant proposal writing process and in leveraging local industry connections to enhance collaboration.
- Taking advantage of international collaborations, local industry and student projects in order to improve the research quality.
- Increasing the number of research students with local MSc programs and international recruitment and projects.
- Considering personal development and mentoring schemes to create a developmental environment that could contribute to better gender balance in the future.
- Developing a stronger strategy towards open access publications.

1. Strategy, Resources, and Organisation of Research

The IIR overall organisation and strategy is based on the NTNU Strategy and the Information Technology and Electrical Engineering (IE) Faculty Strategy which are planning documents reaching until 2025. The overall NTNU strategy is to focus on knowledge for a better world. The Department of ICT and Natural Sciences (IIR) is slightly more focused on making the future smart, safe and sustainable, addressing four research areas of NTNU including Health, Sustainability, Energy and Ocean. Both NTNU and IIR aim at general objectives which are to foster innovative research, training of students and researchers based on a learning environment as well as dissemination to the public.

The IIR focuses its research in the areas of energy informatics, healthcare, maritime technology and urban planning. Energy informatics aims at integrating information technology and energy technology. Using analytical and optimising methodologies for energy production, the aim is to address measures to tackle climate change. For healthcare, the goals are new technologies for diagnostics, rehabilitation and personal healthcare. For maritime technology, the aim is to focus on safety and efficiency of vessel building and operation based on digital twins and information technology. Besides information technology serving as a general basis in all research areas, urban digital twins are examined for their role in urban planning and urban science.

Overall, the integration of these diverse research areas poses a challenge for IIR, and they have therefore structured research into two research groups of cyber-physical systems and sustainable transformation. This may also allow to improve the publication strategy further.

According to the NIFU report the IIR 2022 publications (80), modified author shares (37.9) and percentage of all author shares (0.7) were in the middle of the scores of institutions while it has to be noted that IIR is not a large administrative unit but relatively small.

1.1 Research Strategy

The research strategy of the institution NTNU is Knowledge for a better world and therefore very general. Main objectives focus on gaining best possible students and having departments that have academic groups at international level in at least one of their core areas. While this constitutes a realistic-to-reach goal, this is also somewhat easy to reach depending on the definition of core areas. Overall, the Evaluation Committee notes that the vision and goals are fairly generic at the institutional level.

There is an NTNU institutional Strategy and IE Faculty Strategy, both running from 2018-2025. This is worth noting since this also means that the strategy cycle has been started in 2018 and is coming to its end and an updated strategy is to be expected soon. Given that the research topics of Cyber-Physical Systems and Sustainable Digital Transformation have seen progress and changes over the last few years in terms of progress in robotics, climate research, as well as IT and AI Technology, updates are also to be expected and needed in the research strategies and the integration of the research groups.

In terms of the research strategy of the faculty of information technology and electrical engineering, their vision is to “make the future smart, safe and sustainable”. To reach this vision, various challenges have been identified in the past, in particular intensified competition for recruiting best staff and students, strengthening the interaction with the society, willingness to change in a research organisation and meeting the expectation of the society. Against this background of challenges, a number of goals have been identified between 2018 and 2025 including that IE faculty aims to be recognised as one of the leading university communities in their discipline in the Nordic countries. In particular, the aim is to have world-leading research in some core areas and to be internationally competitive in their disciplines.

Against this background, the research strategy needs to contribute to developing the research environment of the university and faculty. However, the goals of the strategy are also formulated partly in a very general manner, for instance to attract and retain the best students and staff to Norway, to have laboratories at an international level for experimental activities and an advanced physical infrastructure for all activities. Furthermore, it is stated that the faculty aims to be the preferred Norwegian academic partner in their disciplines for international and Norwegian industry, the public and private sectors, EU consortia and international academia. This goal is relevant to point out in terms of the strategy of the administrative unit since currently the state of interaction in EU coordinations, proposals or grants is still limited.

Recommendations to the administrative unit:

Consider measures in order to make research more visible internationally with international-level publications and projects

1.2 Organisation of Research

The research in the administrative unit IIR is organised as two research groups: the Cyber-Physical Systems (CPS) Lab and the Sustainable Digital Transformation Group (SDT). Both research groups are general in scope and try to connect different diverse foci of its staff. Regarding the SDT group, there are some goals to research urban planning and energy

informatics. The other research group, CPS, is based on the research areas of maritime technology and biomechatronics. These are two very different areas where the first focuses on maritime industry, vessel efficiency, safety and environmental implications while the biomechatronics lab focuses on biomechanics of the human body with the lab at Ålesund Hospital. Therefore, and regarding the research strategy the question remains open for the Evaluation Committee why these two diverse areas were linked into one Cyber-Physical Systems Lab.

Regarding the goals to attract and recruit new staff, the faculty is aware of and refers to an NTNU policy for gender equality and diversity. Both CPS and SDT are areas with challenges for gender equality and diversity so that specific measures are to be considered beyond the reference to the NTNU policy. Mobility opportunities and a goal of internationalisation is mentioned at a higher institution level.

The organisation of the research groups emphasises the potential for interdisciplinary research but only at a generic general level of so-called interdisciplinary research initiatives. There is some training and mentoring of PhD candidates and post-docs/young researchers, for instance with training initiatives and regular assessment and feedback mechanisms. Overall, the organisation of research contributes to the institutional strategies and objectives, in particular with the topic of sustainability and knowledge but it is not very well motivated why and how maritime technology and biomechatronics are related.

Research career opportunities are supported by the allocation of a number of PhD positions by the IE Faculty. The aim is to support associate professors with potential for supervising PhD candidates. This is seen as a stepping stone for associate professors to build a critical capacity in order to apply for RCN or ERC grants within the next 5 years. Overall, it is not transparent how many of these early research career opportunities exist per annum, but staff is encouraged in general to dedicate up to 40% of time to research and it is possible to apply for a sabbatical after four years of service for a one-year sabbatical.

Recommendations to the administrative unit:

Exploit and intensify the synergies of the CPS lab and SDT groups.

Collaborate with other larger institutions, such as participating in joint research projects and initiatives rather than getting into direct competition with larger institutions.

Improve the quality of publications for instance by conducting regular internal peer review schemes of research papers before submission.

1.3 Research Funding

The research funding comes from a range of diverse sources including industry partners, the public sector, and support from the Research Council of Norway. Most of the funding comes from national sources with one research-driven innovation project and three RCN projects. There is some success on national funding resources on current topics like autonomous ships and planning support systems.

Besides this national funding there is some limited international funding from the European Commission. In the self-assessment report, one European project has been flagged up and the topic is on mediating the needs of people and nature in Nordic after-dark environments. In general, the level of European funding does not correspond to the international goals and objectives and is not sufficient for the administrative unit’s aspiration to be internationally excellent.

There is some support to researchers and associate professors within IIR by providing mechanisms for applying for internal PhD candidates which indirectly may also assist with building up critical mass for research groups to eventually also develop research grant proposals. Furthermore, there is a sabbatical scheme which is helpful for writing grant proposals in new research areas.

Given the focus of the research groups on Cyber-Physical Systems and the Sustainable Digital Transformation, the Evaluation Committee states that these research groups should have some more potential to get involved in European funding in their core areas of research.

Recommendations to the administrative unit:

Involve younger faculty in the grant proposal writing process, and in leveraging local industry connections to enhance collaboration.

Take advantage of collaborations with local industry and student projects in order to maintain high research relevance.

Increase funding through industrial and international EU sources due to decreasing government support.

1.4 Research Infrastructures

The IIR has some listed infrastructure in their department which includes a Biomechanical Lab as well as an Instron 34SC-5 for testing human tissues and organs. Furthermore, there is the Manulab as a national infrastructure for manufacturing which is however also managed by the department of manufacturing and civil engineering. Also listed is a KUKA LBR Med 14 robot arm which is a compact robot arm particularly designed for medical applications. Overall, this hosted infrastructure reflects the level of research in cyber-physical systems.

In terms of national and international infrastructure, staff are able to access a variety of existing external infrastructure. However, this stated freedom and autonomy on the staff side also indicates that there is not a clear strategy on how this flexibility can be channelled to a specific strategic goal. Furthermore, staff must take into consideration the costs for each of the possible national or international research infrastructure use, which then has to be built into the costing of research projects. Regarding data on infrastructure, the IIR is aware of and supports the FAIR goals and principles in a general manner. The access to data is promoted where possible and data management plans are part of research plans and research proposals. While there is some statement on the FAIR principles in the self-assessment, the description is somewhat high-level and generic, and the self-assessment report does not get into specific details.

Recommendations to the administrative unit:

Extend participation in international infrastructure. There is some involvement in very good infrastructures (CERN, EMBL, etc) and this should be continued but extending infrastructure involvement should be considered for cyber-physical systems as well.

Build costs for infrastructure into national and international research grant applications.

1.5 National and international collaboration

In general, there has been a commitment to fostering collaborations at both national and international levels. IIR aims at engaging in joint research projects with other universities and industry partners to some extent. Furthermore, there are some joint research publications

with national and international collaborators and students get exposed to different academic and industrial environments. Overall, the existing collaborations are related to the vision of IIR and represent some added value to the research quality in the unit.

The IIR administrative unit supports and facilitates cross-sectoral collaboration as evidenced by links to industry and RCN projects. Furthermore, there is also some interdisciplinary collaboration for instance in the cyber-physical systems area. At the national level there are a number of industry collaborations and funded projects, for instance in the autonomous ship research and development area.

While this general commitment to national and international levels is recognised and it is described that the significance of international collaborations for IIR cannot be overstated, this is not reflected to-date in the international and EU research funding and projects. Currently, the number of research projects at a European scale is rather modest; the self-assessment report only refers to the NORDARK project, where IIR collaborate with KTH and Aalto University. The involvement in international and European projects could be stronger.

Recommendations to the administrative unit:

Consider how the involvement in international and European projects can be addressed and get stronger in the future.

Strengthen the collaboration internationally via joint publications with other international researchers.

1.6 Research staff

The self-evaluation summarises the staff basis as 7 full-time professors (0% female), 10 associate professors (40% of them female). Additionally, there is 1 male assistant professor, 3 postdocs (1 of whom is female),13 PhDs (30% female). Overall, the Evaluation Committee notes that the administrative unit IIR has a relatively high number of full and associate professors compared to a relatively low number of postdocs and PhD students. The department has some young and ambitious researchers applying for funding from different resources.

In terms of the requirements for gender balance, IIR is aware and intends to address gender diversity and for recruiting female talents. For instance, recently two new female associate professors and some female PhD candidates have been hired. However, beyond this, there is limited action planning for diversity visible in the self-assessment report.

Regarding the distribution of research time among the staff, there are possibilities and criteria for research leave and sabbaticals (including mobility options) and staff can spend some 40% of their time on research. Overall, the IIR department is trying to bootstrap research with some PhD positions for associate professors which is one important step. However, there is a lack of collaborations with strategic partners and top-level researchers at other international institutions.

Recommendations to the administrative unit:

Share expertise and resources between CPS and SDT groups for project- and application collaboration.

Increase the number of research students with the local MSc program, and international recruitment and projects.

Consider personal development and mentoring schemes to create a developmental environment that could contribute to better gender balance in the future.

1.7 Open Science

The IIR unit states that dissemination is done to the public whenever it is both practical and legally permissible but there may be restrictions arising from commercial agreements. In the self-assessment report in the section on open science policies there is little information regarding open access publications, open access to research data, implementation of FAIR data principles, open access to educational resources, open peer review or skills training for open science. Nonetheless, the NIFU report indicates that more than 80% of publications of the unit in the last two years reviewed (2020 and 2021) were open or golden open access.

One specific section of the self-assessment mentions the Open Simulator Platform (OSP) software which is designed to be utilised by researchers within the maritime industry. However, this OSP software is primarily used in the context of the maritime industry. Overall, the admin unit's policies, approaches and activities to open sciences are not yet described in detail, and IIR instead follows the NTNU open science policy.

Recommendations to the administrative unit:

Develop a clearer strategy towards open access publications specific to the administrative unit.

2. Research production, quality and integrity

In the administrative unit IIR there are different research topics, and two major research groups are put forward and their evaluations are presented in the following. The descriptions of the research topics are based on the self-assessment report.

Research in Cyber-Physical Systems

Focuses in general on maritime technology and biomechatronics

Aims at the development and enhancement of control systems, ensuring the efficiency and safety of maritime operations control systems

Aims at fault diagnosis enhancing the reliability of cyber-physical systems in maritime applications

Aims at data-driven discovery leveraging data analytics for uncovering novel patterns and insights, contributing to the evolution of smarter and more efficient systems

Research in Digital Transformation

Focuses in general on urban planning and energy informatics

Aims at urban planning with the creation of sophisticated simulation models and visualisation tools

Aims at data analytics with the extraction of meaningful information from vast datasets, facilitating evidence-based decision-making in urban contexts

Aims at building digital twins for creating virtual replicas of physical systems, optimising their performance, and aiding in predictive analysis

The IIR policy on research integrity emphasises ethical standards to maintain the credibility of its research activities. The IIR policy emphasises maintaining high ethical standards to ensure the credibility of research activities. Key elements include ethical conduct, compliance with regulations, accurate authorship and publication practices, disclosure of conflicts of interest, and rigorous data management. Researchers are expected to uphold honesty and transparency while respecting participants' rights and privacy. The policy outlines preventive measures against integrity risks and specifies actions for addressing

violations, reinforcing a culture of integrity within the research community. Overall, it aims to foster trust in research by promoting ethical practices and accountability among researchers. Key components include:

- the ethical expectation of honesty and transparency in research conduct
- compliance with relevant regulations
- accurate authorship and publication practices
- disclosure of conflicts of interest
- rigorous data management practices

Regarding the NIFU reports we can also see that the share of publications with international coauthors counts have raised mostly over the years 2013 to 2020. However, for the period 2020 to 2022 the share of publications with international coauthors dropped from 83.9% to 62.2% and 60% for the years 2021 and 2022 respectively. Therefore, the Evaluation committee recommends increasing the international collaborations and international co-authorships.

2.1 Research quality and integrity

Research group Cyber-Physical Systems Lab overall assessment

The Cyber-Physical Systems Lab at the Norwegian University of Science and Technology consists of a Maritime Technology division and a Biomechatronics Lab. The synergies between these divisions seem limited and it is not clear why these research topics should be in the same research group. The group is fairly small (4 Professors, 5 Associate Professors, 1 Assistant Professor, 1 Post Doc, PhD students). The number of PhD per faculty is low making it hard to do internationally leading and visible research. The resources available are low, and the research output is sufficient in national context supporting local industry, but not leading international development in the research area. Considering all these factors, the group faces a number of challenges related to the research output quality and quantity as well to attracting and retaining talent and faculties. The group has collaboration with local industry but does not have any significant international collaborations. Their ability to attract funding from research councils including the Norwegian Research Council is very low.

Research group Sustainable Digital Transformation Research and Development Group (SDT) overall assessment

The SDT R Group at NTNU has demonstrated a strong commitment to research in software and information systems engineering, focusing on sustainable digital transformation. The group’s strengths lie in its clear strategic direction, diverse team composition, and ability to secure funding from various sources. However, there are areas for improvement, such as enhancing gender balance at all levels and increasing industry engagement. They have a well-defined research strategy, a diverse team of researchers, and a growing funding portfolio. Their research quality is evident in their publications, although the choice of publication outlets could be improved. The group’s societal contributions are significant, particularly in the area of sustainability, though the extent to which they involve users in their research is unclear from the self-assessment (and therefore scored accordingly). The group has established collaborations with institutions in the Netherlands, Sweden, and the Philippines. However, there is potential to expand these collaborations to other regions and diversify their international partnerships. In conclusion, the SDT R Group is well-positioned to achieve its goals. With some improvements, particularly in terms of gender balance and

external engagement, the group can further enhance its contributions to the field and society at large.

3. Diversity and equality

The administrative unit's policies against discrimination are given with the respective links: 1) NTNU Development plan for gender equality and diversity, 2) Whistleblowing – web page 3) Speak up! – web page.

The IIR Faculty aims at enhancing gender diversity, given that there is an inequality at professorial positions. Against this context, in the last two years there has been recruitment of two female associate professors. According to the NIFU report, this marks a notable increase in the female share of associate professors, from 8% in 2017 to 29% in 2021. However, the unit has had no female full professors, and the share of female students has been decreasing from 67% to 33%, even though it has increased in absolute numbers.

IIR is committed to maintaining an inclusive and diverse work environment based on non-discrimination, equal opportunity, inclusive culture, and zero-tolerance harassment. According to the self-assessment report, one of the female associate professors has been tasked with overseeing the aspects of gender equality and diversity within the department. The Evaluation Committee is concerned that this may not be the most effective strategy unless there are clear structures at Faculty or University level that can provide support.

Furthermore, in view of the gender imbalance, the unit could invest in targeted professional growth mentoring and development plans to motivate employees and avoid a 'glass ceiling' phenomenon in the future.

4. Relevance to institutional and sectorial purposes

The IIR activities contribute to the sector-specific objectives of Master and PhD-level education provision and innovation. PhD education occurs primarily through the PhD programs in Engineering Cybernetics and the majority of PhD students are internally funded. There is training and mentoring within the PhD project and career opportunities for young researchers are enabled by the administrative unit by generating internal PhD and associating them with younger supervising associate professors.

Regarding Master students, most of the Master thesis projects are connected to ongoing research projects. In addition to the normal Master provision there is a transitional route towards PhD which is called Integrated PhD. This route allows a transition between Master and PhD studies and supports the internal intake of PhD students to undertake specialisation, and to align the Master studies with a future PhD project.

In addition to a Master's program in simulation and visualisation, the administrative unit also offers two bachelor programs in computer science and automation, as well as intelligent systems. There is some student transfer into the Norwegian Maritime Competence Centre for Romsdal region which is a hub for shipbuilding industries.

As a research institute the IIR also contributes to policy development, sustainable development, and societal and industrial transformations. Furthermore, some of the key strategies employed are stakeholder engagement, collaborative research projects, dissemination and outreach. Overall, the Evaluation Committee finds the description of the relevance to institutional and sectorial purposes outlined at a high level.

5. Relevance to society

Overall, the section on relevance to society in the self-assessment report is not described in detail. The text is brief, and only 1 impact case is presented. As a result, the Evaluation Committee cannot provide an in-depth evaluation of the unit's societal impact.

IIR associates its societal impact with its educational portfolio; it offers two bachelor programs in the automation and artificial intelligence domain as well as a master's program in simulation and visualisation starting, that produce "industry-ready professionals". The administrative unit caters mostly for the local industry and society. This strong link was made evident also in the interview of the Evaluation Committee with the administrative unit. Many of its students work in local industry or the Norwegian Maritime Competence Centre and local shipbuilding industries. This stresses the relevance of the University's faculty into job market for computer science and automation.

The self-evaluation report claims that the research and innovation activities/projects at IIR play a pivotal role in contributing to the knowledge base for policy development, sustainable development, and broader societal and industrial transformations. However, the statements are made at very high level and are very general. For example, concerning Sustainable Development, the unit notes that "the IIR's innovation activities focus on developing and implementing innovative solutions that contribute to the UN sustainable development goals. These solutions may involve technological advancements, process improvements, or novel strategies for resource management." The report does not provide further detail or concrete examples to provide further evidence for this statement.

5.1 Impact cases

Comments to impact case 1: Co-simulation technology for digital twins

Modern vessels operate increasingly autonomously and consist of many subsystems which also may have simulations contributing to the overall simulation and digital twin. Such digital twins are desirable for simulating the unpredictable conditions of an overall complex system and its subcomponents. Co-simulation allows an integration of different simulation tools and co-simulation can improve the overall accuracy of the digital twin. In this research domain an Open Simulation Platform (OSP) has been developed as a relevant ship building- and simulation platform.

This research is for the purpose of simulating ship building and simulation. The Evaluation committee welcomes this research as important and relevant for the industry-driven exploration of digital ship twins which has its strength in the focused application. This research is directly related to the expertise of the administrative unit IIR in the context of maritime technologies and combines the applied research of IIR with the interest of the industry partners. What is lacking in the descriptions is the link to other international and EU research along those lines in order to reach out or collaborate with other activities in this research sector across Europe and beyond.

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys (only for HEIs)

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit two weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research groups' evaluation reports, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary with minor adjustments.

Limitations

The Committee judged the information received through documentary inputs and the interview with the Administrative Unit sufficient to complete the evaluation.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norwegian University of Science and Technology (NTNU)	Department of ICT and Natural Sciences	Cyber-Physical Systems Lab
		Sustainable Digital Transformation Research and Development Group (SDT)

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Information Technology and Electrical Engineering, NTNU mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess the Department of ICT and Natural Sciences (IIR) based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by the Department of ICT and Natural Sciences as well as its relevance to institutional and sectoral purposes, and to society at large. You should do so by judging the unit's performance based on the following five assessment criteria (a. to e.). Be sure to take current international trends and developments in science and society into account in your analysis.

a) Strategy, resources and organisation

b) Research production, quality and integrity

c) Diversity and equality

d) Relevance to institutional and sectoral purposes

e) Relevance to society

For a description of these criteria, see Chapter 2 of the mathematics, ICT and technology evaluation protocol. Please provide a written assessment for each of the five criteria. Please also provide recommendations for improvement. We ask you to pay special attention to the following 3 aspects in your assessment:

1. IIR is entrusted with the mandate to provide education in the areas of automation and computer science, as well as natural sciences at the bachelor and master level.

2. IIR strives to cultivate a culture that encourages young researchers to actively engage in both foundational and innovation-driven research endeavours.

3. IIR's key focus is nurturing interdisciplinary research partnerships with a regional emphasis, particularly within the domains of maritime/marine, manufacturing/business, and healthcare, often leading to the development of relevant case studies for our students.

In addition, we would like your report to provide a qualitative assessment of the Department of ICT and Natural Sciences as a whole in relation to its strategic targets. The committee assesses the strategy that the administrative unit intends to pursue in the years ahead and the extent to which it will be capable of meeting its targets for research and society during this period based on available resources and competence. The committee is also invited to make recommendations concerning these two subjects.

Documentation

The necessary documentation will be made available by the mathematics, ICT and technology secretariat at Technopolis Group.

The documents will include the following:

- a report on research personnel and publications within mathematics, ICT and technology commissioned by RCN
- a self-assessment based on a template provided by the mathematics, ICT and technology secretariat

Interviews with representatives from the evaluated units

Interviews with the Department of ICT and Natural Sciences will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway or as a video conference.

Statement on impartiality and confidence

The assessment should be carried out in accordance with the *Regulations on Impartiality and Confidence in the Research Council of Norway*. A statement on the impartiality of the committee members has been recorded by the RCN as a part of the appointment process. The impartiality and confidence of committee and panel members should be confirmed when evaluation data from the Department of ICT and Natural Sciences are made available to the committee and the panels, and before any assessments are made based on these data. The RCN should be notified if questions concerning impartiality and confidence are raised by committee members during the evaluation process.

Assessment report

We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the Department of ICT and Natural Sciences and RCN. The Department of ICT and Natural Sciences should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the board of the Faculty of Information Technology and Electrical Engineering and the RCN no later than two weeks after all feedback on inaccuracies has been received from the Department of ICT and Natural Sciences

Appendices

1. Description of the evaluation of EVALMIT
2. Invitation letter to the administrative unit including address list
3. Evaluation protocol
4. Template of self-assessment for administrative unit (short-version)

The Research Council of Norway

Norges forskningsråd
Besøksadresse: Drammensveien 288
Postboks 564
1327 Lysaker

Telefon: 22 03 70 00

post@forskningsradet.no
www.forskningsradet.no

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